WATER QUALITY SERIES

Water Quality Assessment and Monitoring for the Lower Kitimat River

Technical Report

MAY 2020

BRITISH COLUMBIA
Ministry of Environment and Climate Change Strategy

This Technical Report form part of a series of water quality parameter reports whose purpose is to inform updates to the 1987 Provincial Water Quality Objectives for the lower Kitimat River. This report and others in the series assess the current state and potential impacts of contaminants in the lower Kitmat River; incorporate new scientific research and monitoring of water quality; and reflect a broader understanding of goals and values to improve the health of the waters of the Kitimat River. Updating the 1987 Provincial Water Quality Objectives is a priority action due to the significant industrial changes that have and are occurring within the Kitimat Valley. For additional information visit:

https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-objectives/skeena-region-water-quality-objectives

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Kitimat River taken from the Hwy37 Haisla Bridge looking upstream. Photo Credit: Stock photo from ourBC.com

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TABLE OF CONTENTS

List of Figures

LIST OF TABLES

LIST OF ACRONYMS

AAC	Annual Allowable Cut
ENV	British Columbia Ministry of Environment and Climate Change Strategy
BCCDC	British Columbia Conservation Data Centre
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
DFO	Department of Fisheries and Oceans
DOK	District of Kitimat
EMS	Environmental Monitoring System
FISS	Fisheries Information Summary System
FL	Forest Licence
LC50	Lethal Concentration 50%
LNG	Liquid (or Liquified) Natural Gas
PAH	Polycyclic Aromatic Hydrocarbons
RISC	Resource Inventory Standards Committee
SAD	Strong Acid-Dissociated
STP	Sewage Treatment Plant
TFL	Tree Farm Licence
TOC	Total Organic Carbon
TSS	Total Suspended Solids
WAD	Weak Acid-Dissociated
WQG	Water Quality Guideline
WQO	Water Quality Objective

EXECUTIVE SUMMARY

Provisional Water Quality Objectives (WQOs) were established for the lower Kitimat River in 1987 (Warrington, 1987). Attainment monitoring has been sporadic and limited to 1987-1995. Insufficent monitoring since 1995 and changes that have occurred in the watershed suggest that the provisional WQOs may need to be updated.

This report examines water quality for the lower Kitimat River based on 1987 to 2005 water quality data from 12 sites as well as data collected from 5 sites in 2015. Based on the data collected over the past 40 years, the primary water quality concerns in the Kitimat River pertain to elevated turbidity and total suspended solids concentrations, as well as elevated fecal coliforms. However, over this time, modifications in sampling locations, changes in land-use as well as changes in discharge (volumes and quality) make it difficult to assess trends within the watershed or make informed predictions regarding potential parameters of concern. For this reason, the implementation of a robust sampling program is recommended at sites upstream and downstream of the primary discharge sources or historic sources of contamination. Once collected, this information can be used to characterize current water quality conditions and re-assess the Kitimat River provisional WQOs. Subsequent attainment monitoring would be required to determine if water quality objectives were being met.

1.0 INTRODUCTION

The British Columbia (B.C.) Ministry of Environment and Climate Change Strategy (ENV) provides leadership in the development of water strategies, policy, legislation and regulations to protect and manage the quality and quantity of surface water and groundwater. As part of this effort, ENV conducts assessments on both the current state of water quality and long-term trends and in some instances establish ambient Water Quality Objectives (WQOs) on a watershed specific basis. WQOs are not legally binding, but rather provide benchmarks that should be met to ensure protection of designated water uses. They are based on Water Quality Guidelines (WQGs), which are developed for individual water parameters. WQGs set safe thresholds for parameters based on toxicity and impact studies for water uses (including aquatic life and wildlife, drinking water, primary and secondary contact recreation, irrigation, etc.). WQOs differ from WQGs in that they are site-specific, taking into consideration the natural conditions in a watershed. For example, if a specific parameter (for example, turbidity) naturally and regularly exceeds the WQG in a watershed, the WQO takes this into consideration and sets the threshold higher. WQOs provide direction for resource managers, serve as a guide for issuing permits, licenses, and orders by ENV, and establish benchmarks for assessing the Ministry's performance in protecting water quality. WQOs and attainment monitoring results are reported out both to local stakeholders and on a province-wide basis through forums such as State of the Environment reporting.

In 1987, provisional WQOs were established for the lower 10 km of the Kitimat River and immediate marine areas of the Kitimat Arm (Warrington, 1987) (Table 1). However, attainment monitoring to assess whether the objectives were being met is sporadic and limited to 1987-1995. Insufficent monitoring since 1995 and considerable changes to sources of effluent and air discharges in the Kitimat area raise concerns that the provisional WQOs require updating. More specifically:

- There have been updates to the science used to support many of the provincial and federal water quality guidelines upon which the WQOs are based (e.g., cadmium). As such, specific WQO values may need to be reviewed and updated.
- The major industrial activities in the watershed have changed since the WQOs were developed; sources and locations of air and effluent discharges are considerably different (see Section 4.6) and some of the recommended parameters may no longer be relevant while others may need to be added.
- New information is available pertaining to air discharges with respect to SO_2 and future potential for nitrogen oxides.

The purpose of this report is to examine the existing water quality of the lower Kitimat River using data from the British Columbia Environmental Monitoring System (EMS) database. As well, it recommends sampling necessary to update WQOs based on potential effects and water quality parameters of concern.

Table 1. Summary of Provisional WQOs for the lower Kitimat River (Warrington, 1987)

Parameter	WQO
turbidity	5 NTU maximum increase when the upstream value is less than or equal to 50 NTU 10% maximum increase when the upstream value exceeds 50 NTU
suspended solids	10 mg/L maximum increase when the upstream value is less than or equal to 100 mg/L 10% maximum increase when the upstream value exceeds 100 mg/L
periphyton growth	up to 50 mg/m^2 as a mean
undissociated H_2S	0.002 mg/L maximum
un-ionized ammonia-nitrogen	Ammonia guidelines
nitrite-nitrogen	less than or equal to 0.020 mg/L mean 0.060 mg/L maximum
dissolved oxygen	7.8 mg/L minimum
pH	6.5 to 9.0
toxicity	the percent concentration of pulp mill effluent in the river should not exceed 0.05 of the 96-h LC50 of the pulp mill effluent at any time

The Kitimat River is one of the most heavily sport-fished rivers in British Columbia, with steelhead, rainbow trout, cutthroat trout, all five species of pacific salmon, and Dolly Varden all present at some point during the year (FISS, 2016). Eulachon, a fish central to the traditional harvest of the Haisla First Nation, also spawn in the lower river, though the population has been too low to sustain a catch since the 1990s. This is in part due to habitat losses from developments in the estuary (Rolston, 2010). Tainting (changes in taste) from industrial effluent discharges in the river discouraged eulachon harvesting in the 1980s. Traditional groundfish and shellfish harvesting in the northern Kitimat Arm also declined at this time owing to concerns about industrial contamination.

Licenced water uses for the Kitimat River include drinking water for the District of Kitimat (population estimate 8,211 in 2015), water supply for a Department of Fisheries and Oceans (DFO) hatchery, industrial uses (including for the Rio Tinto Alcan aluminum smelter) and firefighting. At this time, the District of Kitimat Municipal Sewage Treatment Plant, Chevrons Kitimat LNG and LNG Canada have permitted discharges to the Kitimat River. There is also the potential for liquefied natural gas development in the area with a number of export facilities proposed. Associated with such facilities are air emissions of substances such as sulphur dioxide and nitrogen oxides which could affect water quality. Other anthropogenic land uses within the watershed include timber harvesting, historical mining, rural and urban residential development, industrial and residential landfills, and recreation. These activities, as well as natural erosion and the presence of wildlife, all potentially affect water quality in Kitimat River.

The Lower Kitimat River Water Qualtiy Assessment project consisted of five phases: collecting water quality data, gathering information on water use, determining land use activities that may influence water quality, assessing water quality based on land use influences and re-evaluation of the WQOs. This report focusses on the first four phases and makes recommendations for future monitoring necessary to revise existing WQOs for the lower Kitimat River.

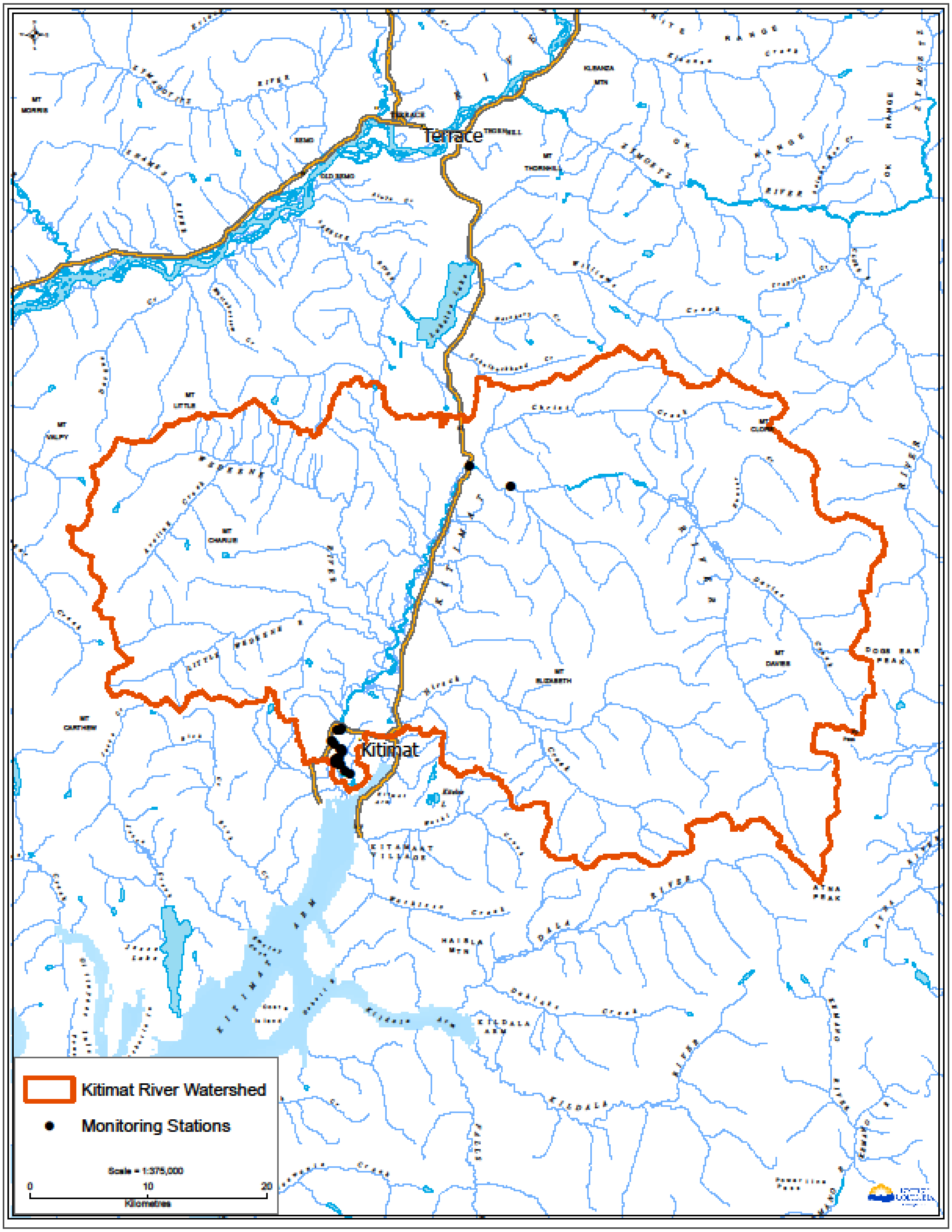

Figure 1. Overview Map of lower Kitimat River watershed and Kitimat River monitoring stations. (B.C. FLNRO, 2019)

2.0 WATERSHED PROFILE AND HYDROLOGY

2.1 BASIN PROFILE

The Kitimat River, near the mouth, is a sixth-order stream located in the west-central portion of British Columbia that enters the Pacific Ocean in the Kitimat Arm, at the north end of the 90 km long Douglas Channel. The watershed is 1,990 km in area (WSC, 2016), and the river is 97.7 km in length (B.C. Watershed Dictionary, 2016). It originates on the slopes of Atna Peak in the Kitimat Ranges, part of the Coast Mountains, and collects water from a number of glacial mountains. The Kitimat River flows in an arc, beginning in a northerly direction from its headwaters, then curving to the west before flowing south through the District of Kitimat. The Kitimat River is susceptible to periodic glacial-lake outburst flood events, possibly originating in upper Chist Creek (Schwab, 2011). Glacier meltwater is trapped behind an ice dam at the top of the watershed, and under specific conditions the ponded water escapes, causing a high volume of water to flush down Chist Creek and into the Kitimat River approximately two km upstream of the Highway 37 Bridge. These rare, stochastic events generate large amounts of suspended solids, temporarily skewing water quality in the river. This report considers primarily the lower 10 km of the river. With the exception of forestry and possible long-range atmospheric deposition, there are few anthropogenic influences on the upper watershed. All authorized effluent discharges and water licences are within the lower 10 km of the river.

There are 81 mapped tributaries to the Kitimat River, most of which are fast-moving streams cut through steep mountain canyons (MacDonald and Shepherd, 1983). The largest of these are summarized in alphabetical order in Table 2.

Table 2. Summary of significant tributaries to the Kitimat River.

Name of Tributary	Length
Bolton Creek	12 km
Chist Creek	31 km
Cecil Creek	15 km
Davies Creek	18 km
Deception Creek	8 km
Hirsch Creek	34 km
Hoult Creek	14 km
Humphreys Creek	11 km
Little Wedeene River	25 km
McKay Creek	15 km
Nalbeelah Creek	16 km
Wedeene River	37 km

The District of Kitimat falls within the Coastal Western Hemlock (very wet maritime submontane, CWHvm1) biogeoclimatic zone. As elevations within the watershed increase, the zones transition through to CWHvm2 (very wet maritime montane), then moist maritime windward and leeward (CWHws1 and CWHws2), the Mountain Hemlock zone (MHmm1, moist maritime variant), and finally, at the highest elevations (approximately 1200 m and above), the Coastal Mountain-heather Alpine (CMAun) zone.

2.2 Hydrology and Precipitation

Environment Canada operates a weather station in Kitimat for which climate normal data (a consecutive 30-year record of air temperatures and precipiation) is available (Environment Canada, 2016). The highest levels of rainfall occur in October and November, while peak precipitation (including snowfall) is between October and January (Figure 2). In December and January, about one third of the precipitation falls as snow in the town, and the ratio of snow to rainfall increases with elevation.

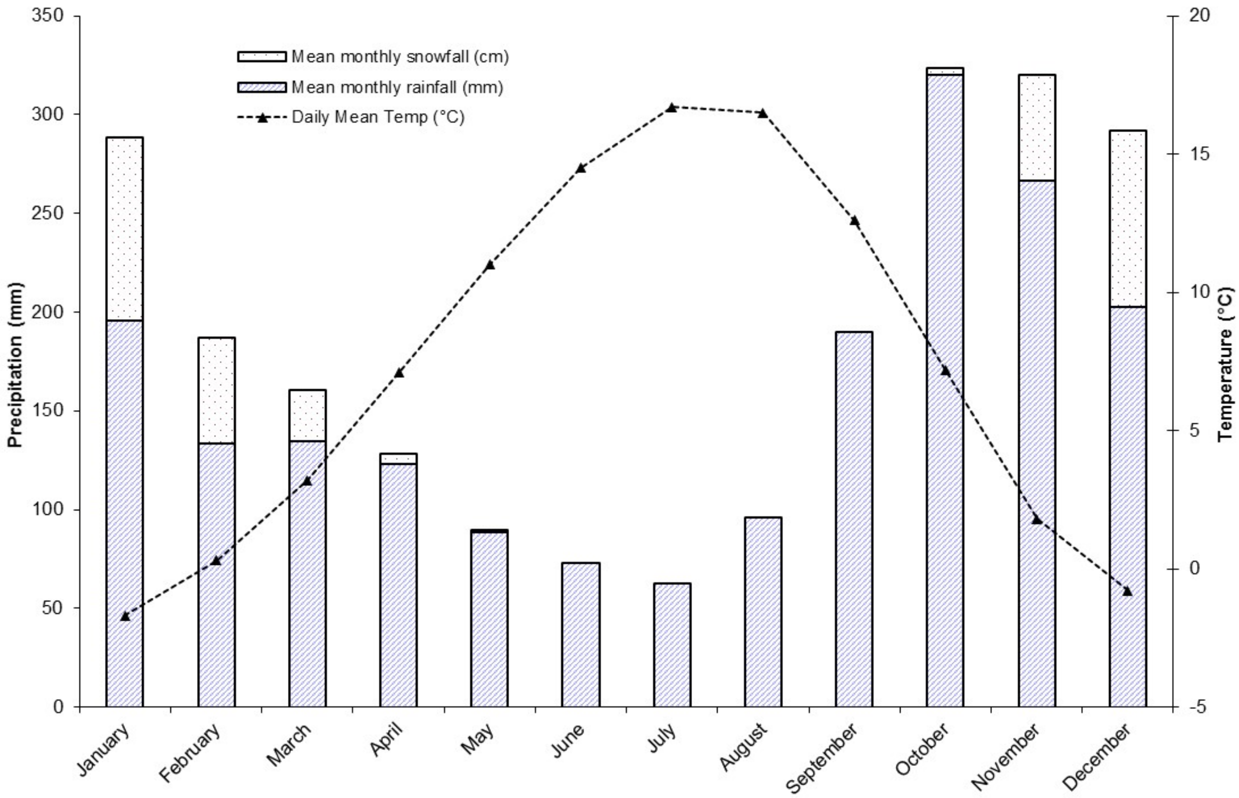

Figure 2. Climate data (1981 – 2010) for Kitimat Townsite (Environment Canada Climate Station 1064320).

Water Survey Canada has measured discharge in the Kitimat River below Hirsch Creek (located upstream from the Haisla Blvd bridge) since 1964 (Figure 3). In addition, discharge in two smaller tributaries was also measured - Hirsch Creek near the mouth from 1966 to 2013 (Figure 4) and the Little Wedeene River below Bowbyes Creek from 1966 to 2013 (Figure 5). These hydrographs differ only in volume – in each case, maximum average peak flows occur during the summer months in response to higher elevation snowmelt, while their highest instantaneous flows occur during the fall and early winter (late September to mid-January) in response to rain events. Mean annual discharges for the rivers and creeks are, 17.6 m^3/s for the Little Wedeene River, 21.8 m^3/s for Hirsch Creek and 131 m^3/s for the Kitimat River.

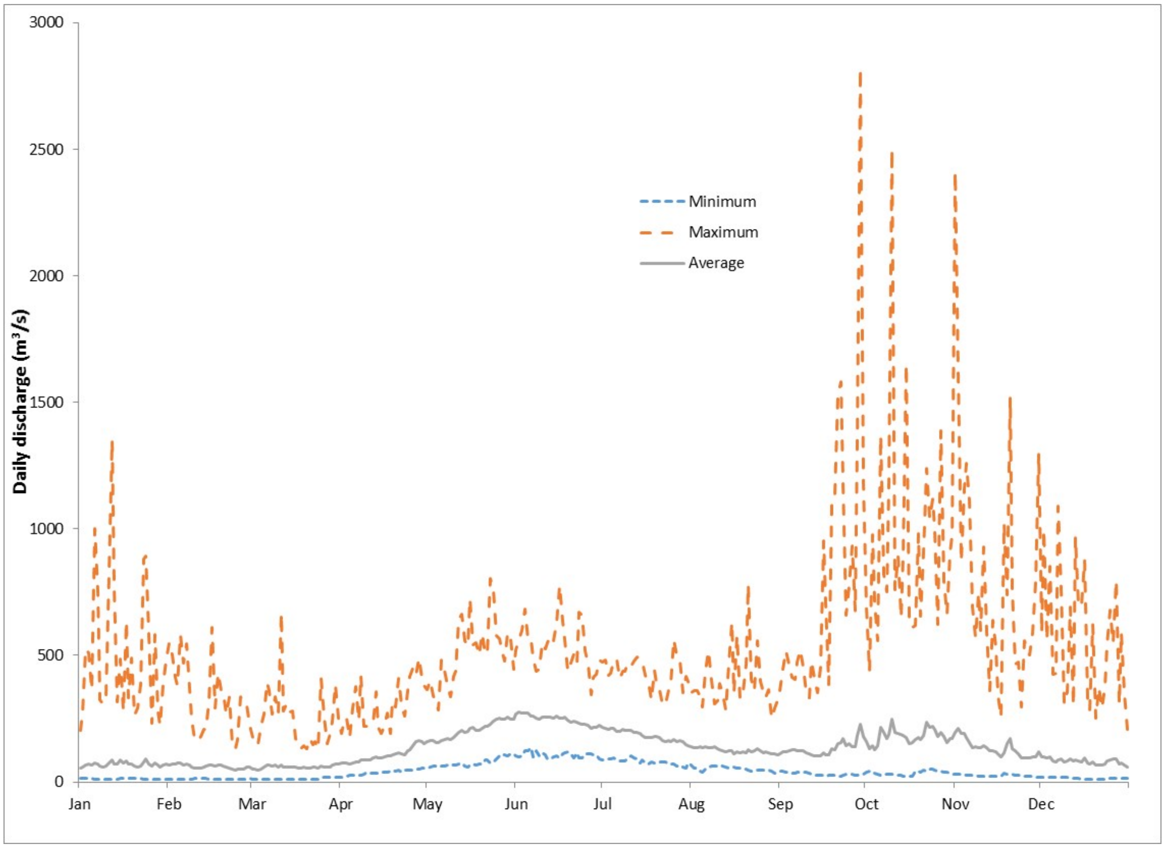

Figure 3. Minimum, maximum and average daily discharge data for Kitimat River below Hirsch Creek (Water Survey Canada Station 08FF001) between 1964 and 2014 (Water Survey of Canada, 2016).

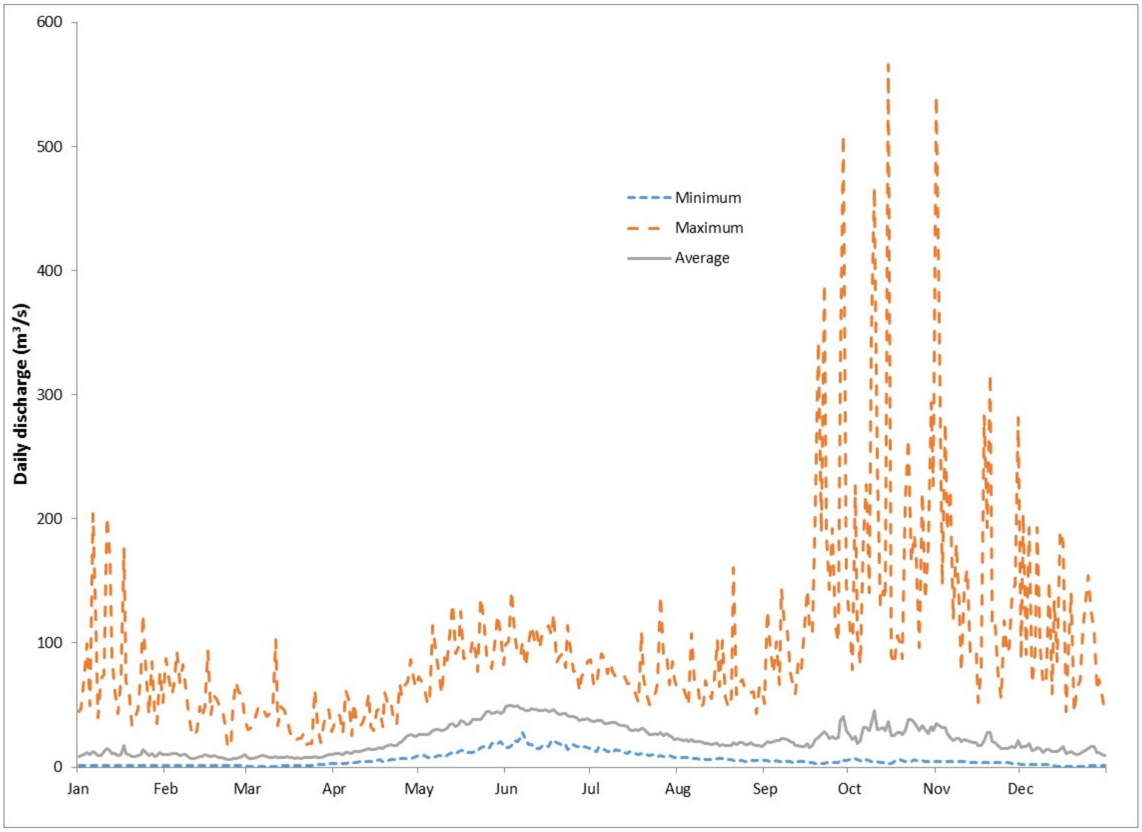

Figure 4. Minimum, maximum and average daily discharge data for Hirsch Creek near the mouth (Water Survey Canada Station 08FF002) between 1966 and 2013 (Water Survey of Canada, 2016).

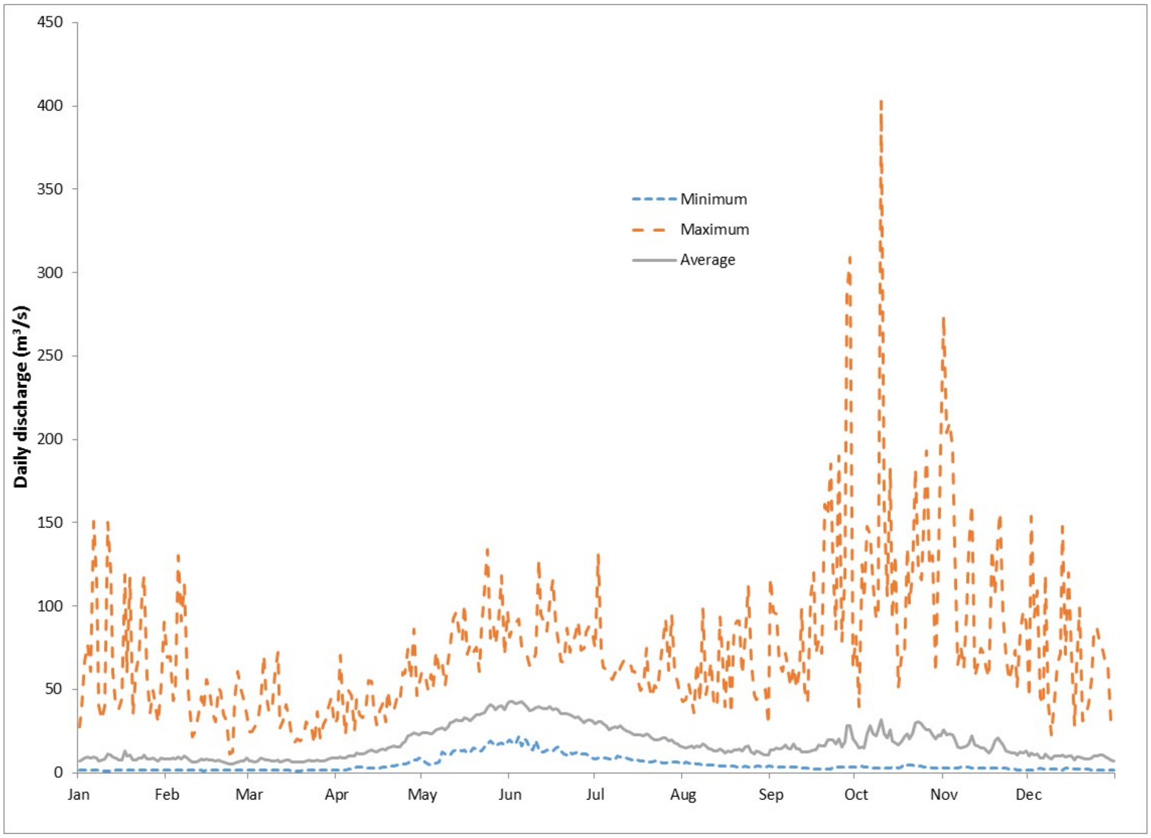

Figure 5. Minimum, maximum and average daily discharge data for Little Wedeene River (Water Survey Canada Station 08FF003) between 1966 and 2013 (Water Survey of Canada, 2016).

3.0 WATER USES

Identifying water uses helps to define specific water quality and quantity parameters of concern for a given waterbody and allows us to make management recommendations to protect these uses. The known water uses of the Kitimat River include fish and wildlife, drinking water and domestic water supply, recreational water use, and water for industrial processes (such as smelting aluminium). Agricultural crops and livestock are not recognized water uses for the Kitimat River at present, nor have they been in the past.

3.1 WATER LICENSES

Eleven water licences have been issued for withdrawals from the Kitimat River (Table 3). More than two-thirds of the overall volume of the licences is represented by withdrawals by Rio Tinto Inc., as part of their aluminum manufacturing process. The DFO also withdraws a considerable volume of water (about 25% of all licenced withdrawals) for the operation of their fish hatchery. Waterworks licences issued to the District of Kitimat for the residential water system in the town represent about 4% of the licenced water withdrawals. Two short-term approvals have also been issued for withdrawals from the Kitimat River (Table 4). Licences have also been issued for power generation on a number of tributaries to the Kitimat River, including Hirsch Creek, McKay Creek, Bolton Creek, Dahl Creek, and Bowbyes Creek.

Table 3. Summary of licenced water withdrawals from the Kitimat River.

Water Use	Volume (cubic decameters/year)	Number of licences	Primary Licencee
Waterworks: Local Provide	6,902.78	4	District of Kitimat
Processing & Mfg: Process	107,224.96	4	Rio Tinto Alcan Inc.
Conservation: Use of Water	40,176.86	1	Fisheries & Oceans Canada
Comm. Enterprise: Enterpr	11.95	1	0892818 BC LTD.
Misc Ind'L: Fire Protecti	12.00	1	0892818 BC LTD.
Total	**154,328.56**	**11**	

Table 4. Summary of short-term approvals for water withdrawals from Kitimat River.

Water Use	Volume (cubic decameters/year)	Number of licences	Primary Licencee	Start Date	End Date
Road Maintenance	8.29	1	Nechako Northcoast Construction Services	07-Apr-16	11-Nov-17
Other water purpose	365.00	1	LNG Canada Development Inc.	27-Nov-15	26-Nov-17

3.2 Fisheries

The Kitimat River is known as one of the preeminent sportfishing destinations in the province. The B.C. Fisheries Information Summary System (FISS) lists 18 species of fish occurring in the Kitimat River, including all five species of salmon (chinook, chum, coho, pink and sockeye), rainbow trout, steelhead, cutthroat trout, Dolly Varden, kokanee, eulachon, three species of stickleback and one species of sculpin. Due to sharp decreases (by an order of magnitude) in escapement numbers in the 1970s (likely due to severe floods in 1974, 1976 and 1978 (Karanka, 1993), DFO built the Salmonid Enhancement Program Hatchery on the Kitimat River. Since that time, escapement numbers of all salmonids have recovered considerably, and DFO continues to release chinook, chum and coho salmon, as well as steelhead and cutthroat trout on an annual basis (Table 5). On the strength of these releases, the Kitimat River is the only river in the province where angler retention of steelhead is permitted (hatchery fish only) (B.C. Fishing Regulations, 2015-2017).

Table 5. Summary of fisheries releases by DFO hatchery into Kitimat River.

Fish	Years released	Avg # released/yr	Min # released/yr	Max # released/yr
Chinook	1978-2016	1,566,032	39,199	2,768,456
Coho	1982 - 2016	524,878	54,000	796,882
Chum	1982 - 2016	3,981,225	30,345	6,750,396
Steelhead	1982-2016	51,870	25,600	85,144
Cutthroat trout	1986-2010	6,419	716	13,126

3.3 FLORA AND FAUNA

The Kitimat River watershed provides habitat to a diverse assemblage of both animal and plant species. The B.C. Conservation Data Centre (BCCDC) indicates the presence of a few species of concern within the watershed boundaries, including coastal tailed frogs (*Ascaphus truei*) in the upper Kitimat River and tributaries, and the white adder’s mouth orchid (*Malaxis brachypoda*), the bog adder’s mouth orchid (*Malaxis paludosa*), and oldgrowth specklebelly lichen (*Pseudocyphellaria rainierensis*) in the lower watershed (BCCDC, 2016). All of the above species are considered blue-listed species of concern. There are also two ecological communities considered blue-listed by the BCCDC found in locations along the Kitimt River and its tributaries in the upper watershed: the black cottonwood – red alder/salmonberry (*Populus trichocarpa - Alnus rubra / Rubus spectabilis*) and the Sitka spruce – salmonberry Wet Submaritime 1 (*Picea sitchensis / Rubus spectabilis* ws1) communities.

3.4 RECREATION

Fishing is very common on the Kitimat River throughout the year. As mentioned in Section 3.2 above, the river is a destination hotspot for anglers from across the province and internationally. There is a 57-unit campground (Radley Park) located on the banks of the Kitimat River, and a number of other primary and secondary contact recreational activities (e.g. canoeing, kayaking, paddle boarding, Class 2 whitewater rafting, etc.) are practiced regularly.

3.5 Designated Water Uses

As discussed in Section 3.1 above, water licences have been issued for drinking water and industrial use on the lower Kitimat River. In addition, the river is used extensively for primary and secondary contact recreation (see Section 3.4). Finally, the presence of salmonid species throughout the watershed, as well as the normal fauna of the area, suggests that the water uses to be protected include drinking water, industrial use, primary-contact recreation and the protection of wildlife and aquatic life. Ultimately, WQOs are developed to protect the most sensitive water uses in a water body.

4.0 Influences on Water Quality

The following sections give a brief overview of potential concerns associated with categories of potential impacts. Prior to the construction of the Alcan aluminum refinery in the 1950s, the Kitimat River watershed was largely pristine, maintained by traditional Haisla land use practices. The town of Kitimat was constructed to support the operation of the smelter.

4.1 Land Ownership

The upper portion of the Kitimat River watershed falls within Tree Farm Licence (TFL) 41. The District of Kitimat is located in the lower portion of the watershed, as are the industries (including Rio Tinto Aluminum, the former Methanex gas plant (now LNG Canada), and the former Eurocan Pulp and Paper Co. (now Kitimat LNG). A summary of land use in the Kitimat River watershed is given in Table 6.

Table 6. Summary of land use within Kitimat River watershed (from Downie, 2005).

Land Use Category	Area (km^2)
Alpine, sub-alpine, glaciers, etc.	749
Water (including wetlands)	14
Recently logged or burned	264
Forest (young and old)	1,017
Agriculture	0
Recreation	1
Urban	12
Total	**2,057**

Elevated turbidity from land disturbances (including forestry activities and residential/commercial construction), contaminants from industrial discharges to air and water, increased nutrients and/or fecal coliforms from a variety of sources (including lawn fertilizers, faulty septic systems, pets and wildlife), and contamination from metals and polycyclic aromatic hydrocarbons (PAHs) deposited on roads all potentially contribute to water quality problems. When portions of a watershed are cleared and buildings or roads are constructed, these areas become impermeable to water, thus speeding overland flow. Any contaminants on those surfaces, including oil and gasoline from automobiles, will be washed into waterways with little or no absorption by the land. Storm sewers discharge to creeks and ditches, which eventually enter streams and lakes that support different uses (including recreation and wildlife). The population of Kitimat is approximately 8,000 people, residing in about 2,600 households. The layout of the town is such that neighborhoods are laid out as “super-blocks”: homes are accessed by short local streets and many face inwards to green spaces containing pedestrian walkways (DOK, 2009). These green spaces likely mitigate, to some extent, runoff from impervious surfaces such as roads and rooftops in the residential areas. Light industrial businesses are concentrated on the west side of the river, in an area called the “Service Centre”.

4.2 Licenced Water Withdrawals

Water withdrawls can influence water quantity and quality downstream from the withdrawal, especially during periods of low-flow. When withdrawals are large relative to flow levels, downstream areas can be affected by lower water levels and elevated summer temperatures. Average daily flows in the Kitimat River range from 47.3 m^3/s in late February to 275.9 m^3/s in early June. Assuming maximum withdrawals are taken, and that the volume of withdrawal is constant throughout the year, this volume would represent approximately 10% of the low-flow volume. During the remainder of the year, when water levels are much higher, the relative proportion of the withdrawal would be considerably lower. Therefore, it is not likely that water withdrawals are significantly impacting water quality or quantity in the Kitimat River watershed.

4.3 Forest Harvesting and Forest Roads

The removal of trees can decrease water retention times within the watershed and result in a more rapid response to precipitation events and earlier and higher spring freshets. The improper construction of roads can change drainage patterns, destabilize slopes, and introduce high concentrations of sediment to streams. The loss of riparian vegetation can increase the mobilization of sediments and other contaminants due to the reduced barrier between land and water.

Logging within the Kitimat River watershed began in the 1960s by the Crown Zellerbach and MacMillan Bloedel logging companies. In 1978, TFL 41 was created by the Ministry of Forests, and in 1986 the, then Ministry of Forests and Range designated approximately 24,000 hactares of unalienated Crown Land within the municipality of Kitimat a Forest Licence (FL) area (FL A16885) (DOK, 2009). All forestry activities within the Kitimat River watershed now occur in either TFL 41 (located upstream from Chist Creek and Highway 37 crossing, see Figure 6) and FLA16885 (which is confined to land within the District of Kitimat boundary (DOK, 2009). Skeena Saw Mills Ltd. conducts forestry activities within both the TFL and the FL.

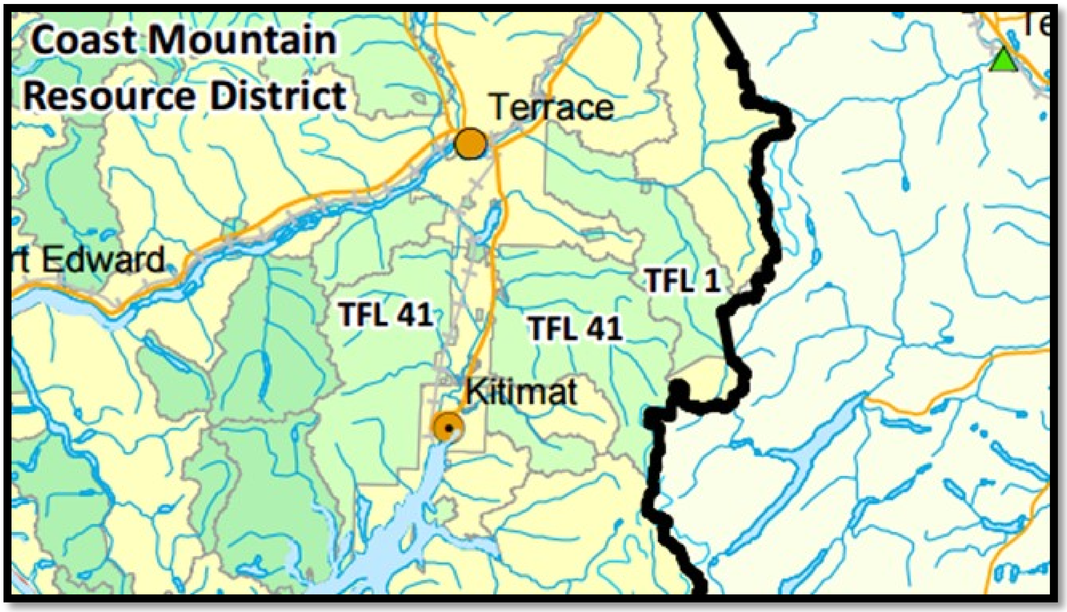

Figure 6. Map showing TFL 41 boundaries, relative to the Kitimat River watershed (from B.C. Ministry of Forests, 2016a).

In 2011, approximately 478,000 hectares was removed from the TFL, including much of the Hirsch Creek watershed. The current annual allowable cut (AAC) for TFL 41 is 128,000 m^3 (B.C. Ministry of Forests, 2012). The AAC for FL 16885 in 2016 was 26,112 m^3 (B.C. Ministry of Forests, 2016b).

Karanka (1993) published a report documenting the cumulative effects of forest harvesting on the Kitimat River. Approximately 85% of the riparian old growth along the Kitimat River was removed between 1962 and 1969, including 80 ha of forests on 17 islands in the river. There was also a very high density of roads and tracks, often leading up to the streambank, during that period, which can lead to increased turbidity and suspended solids in the river. As the lower Kitimat River flows through a floodplain, it is susceptible to changes in the channels through which it flows. Karanka found that the active riparian area (i.e. that portion of vegetation directly adjacent to the river) of the middle reaches of the Kitimat River increased by 25% between the 1960s and mid-1980s. This was primarily due to breakouts along the old stable sidechannel network (where the river jumped its banks and carved new channels through the floodplain), resulting in extensive erosion. Gottesfeld (1985, in Karanka, 1993) estimates that the delta of the Kitimat River had advanced about 300 m between 1953 and 1985, due to the movement of approximately 330,000 m^3/year of gravel and sediments. This is over an order of magnitude greater than the typical gravel load of an average lightly glacierized basin on the west coast of the Coast Mountains of between 17,000 and 26,000 m^3/year (Sutek and Kellerhals, 1989, in Karanka, 1993). However, Karanka did not link the overall changes in the Kitimat River directly to the overall rate of forest harvesting. Changes in forestry practices beginning in the 1970s have severely restricted harvesting in riparian areas, and impacts are expected to decrease as riparian growth stabilizes the riverbank.

4.4 RECREATION

Erosion associated with 4-wheel drive and ATV vehicles, direct contamination of water from vehicle fuel, and fecal contamination from human and domestic animal wastes (*e.g.*, dogs or horses) are typical examples of potential recreational effects in most watersheds. Watercraft in the Kitimat River are restricted to non-motorized vessels only (including for fishing), and so the likelihood of a fuel spill in the river is reduced. However, the fact that people camp and drive along the river banks means that fuel spills are still a possiblity. Anglers typically use drift boats, rafts, or cast from shore. While logging roads offer access to the upper watershed, no specific studies have been conducted with regards to recreational activities in this area. It is unlikely that recreational activities are having a significant impact on water quality in the Kitimat River.

4.5 WILDLIFE

Wildlife can influence water quality because warm-blooded animals can carry pathogens such as Giardia lamblia, which causes giardiasis or “beaver fever”, and Cryptosporidium oocysts which cause the gastrointestinal disease, cryptosporidiosis. In addition, warm-blooded animals excrete fecal coliforms in their feces, and can cause elevated levels of this indicator in water. Fecal contamination of water by animals is generally considered to be less of a concern to human health than contamination by humans because there is less risk of inter-species transfer of pathogens. However, without specific source tracking methods, it is impossible to determine the origins of coliforms.

The Kitimat River watershed contains valuable wildlife habitat and provides a home to species including grizzly and black bear, black-tailed deer, wolf, mountain goat, moose, wolverine, fisher, and porcupine. The watershed is also inhabited by waterfowl, eagles, hawks, owls, and numerous other species of small birds. These are among the sources of fecal coliforms common to most watersheds.

4.6 Permitted Discharges

The Town of Kitimat was designed as a whole by the American urban planner Clarence Stein, and was built over a relatively short time period in the early 1950s. Residential, light industrial and industrial areas were segregated in what was known as the Garden City design concept. The Rio Tinto Aluminum smelter, also built at the same time, was located on the west side of the Kitimat River. North of the smelter the Eurocan Pulp and Paper Co. was built in 1969 and operated until January 2010. After which, it was purchased by Kitimat LNG (owned by Chevron Canada Limited and Woodside Energy International (Canada) Limited) for the purpose of developing a liquefied natural gas (LNG) export facility. Another major industrial facility in Kitimat was the Ocelot/Methanex gas plant, which produced methanol (beginning in 1982) and ammonia (in 1986). It ceased production in 2005 due to high natural gas prices. The ammonia plant was dismantled and shipped to the Middle East, while the methanol plant remains intact. The Methanex terminal was used for a period to import methanol, while the plant was used to process condensate (used to dilute bitumen) that was shipped by rail to Alberta. Royal Dutch Shell purchased the Methanex site in 2011 to utilize the deep-water harbor, with plans to convert the site to an LNG export facility, and currently operates the site as LNG Canada. A third LNG company, BC LNG, also has interests in the area. LNG Canada is an active project in Kitimat with preliminary construction activities underway. Once built and operational, LNG export facilities will be significant new sources of nitrogen oxide and sulphur dioxide emissions.

The following paragraphs summarize licenced discharges to the Kitimat River and its tributaries.

Rio Tinto currently has four authorized effluent discharges that are administered under a single permit (P2-0001). All discharges are either directly to Kitimat Arm, or to Beaver Creek, which flows into Moore Creek before entering Kitimat Arm. The effluent discharges from Rio Tinto do not influence water quality in the Kitimat River.

There are also eight authorized air discharges and one approval for Rio Tinto under the P2 permit. Deposition from air discharges can affect water quality when contaminants settle in the watershed, flushing into surface waters where absorption and buffering are exceeded. In 2015, Rio Tinto completed building a new, modernized aluminum smelter in Kitimat, which nearly doubled production capacity and significantly decreased fluoride and PAH emissions. However, the authorized sulphur dioxide emissions for the new facility increased from 27 tonnes/day (SO_2) to 42 tonnes/day. The SO_2 Technical Assessment Report (STAR) from 2013 found that sulphur dioxide emissions of 42 tonnes/day are predicted to cause changes to water quality in seven lakes, lowering the pH of these lakes by more than 0.3 pH units (enough to cause a shift in the biology of these aquatic ecosystems) (ESSA, 2014). No effects were predicted for Kitimat Valley streams or the Kitimat River due to the buffering capacity of these catchments.

As discussed above, two of the major industries in Kitimat (Eurocan and Ocelot/Methanex) have changed hands in the past seven years, and therefore, while the permits issued to the original licensee have been transferred to the new owners, the quantity and signature of the effluent being discharged is likely considerably different than it was prior to operations ceasing.

Four permits have been issued to LNG Canada to authorize effluent discharges. The first allows them to discharge an average of 500 m^3/day (3,200 m^3/d max) of effluent with restrictions on pH, chemical oxygen demand (COD), ammonia, volatile non-filterable residue (VNFR), and an LC50 96-hour bioassay survival rate of >50% at 100% effluent concentration to Kitimat Arm. The other three permits pertain to stormwater discharges, of which one is to the Kitimat River, one is to Beaver Creek, and the third is to Kitimat Arm. LNG Canada also has one permit for air discharge, allowing sweet petroleum condensate vapour discharged from their storage tanks such that Workers Compensation Board of B.C. requirments are met.

Kitimat LNG (formerly Eurocan) holds three effluent discharge permits. The first discharges treated landfill seepage into the Kitimat River through a surge pond, landfill leachate collection system, two alternate settling basins, an aeration lagoon, and a submerged outfall. Effluent discharged under this permit has restrictions on pH, biological oxygen demand (BOD_5), TSS, dissolved oxygen (DO), and an LC50 96-hour bioassay survival rate of >50% at 100% effluent concentration. The second discharges site runoff into Symes Creek, and the third permits landfill leachate overflow to discharge into Beaver Creek.

Finally, the District of Kitimat (DOK) has a permit for discharge from their municipal sewage treatment plant (STP) into the Kitimat River. The permit allows a maximum discharge of 18,200 m^3/d from the STP, with restrictions on BOD_5 and TSS. The outfall for the STP is located about 4 km upstream from the mouth of the Kitimat River.

Leachate associated with the DOK landfill is a potential source of contaminants to nearby Hirsch Creek. Several inconclusive studies on the potential impact of leachate on the creek have been conducted. The situation receives ongoing monitoring by the DOK and the Ministry as required.

Water quality sampling sites have been established upstream and downstream of the permitted discharge to the Kitimat River and to determine potential impacts on water quality. These data are discussed as part of the analyses conducted in Section 6.0.

4.7 MINING

B.C. MINFILE, the online database of mineral occurrances, shows a number of prospects and showings within the Kitimat River watershed for a wide variety of minerals including copper, silver, gold, barite, tungsten, nickel, iron, lead, zinc, magnetite, cadmium, molybdenum, and silica (B.C. MINFILE, 2016). In addition, there is one past producer (the Wedeene Mine, also known as Iron Mountain), located on the Wedeene River, which produced iron, magnetite and copper (B.C. MINFILE, 2016). In the future, if interest is shown in developing these mineral deposits, an Environmental Assessment Certificate will be required to ensure that potential developments do not significantly impair the receiving environment, including the water quality of the Kitimat River.

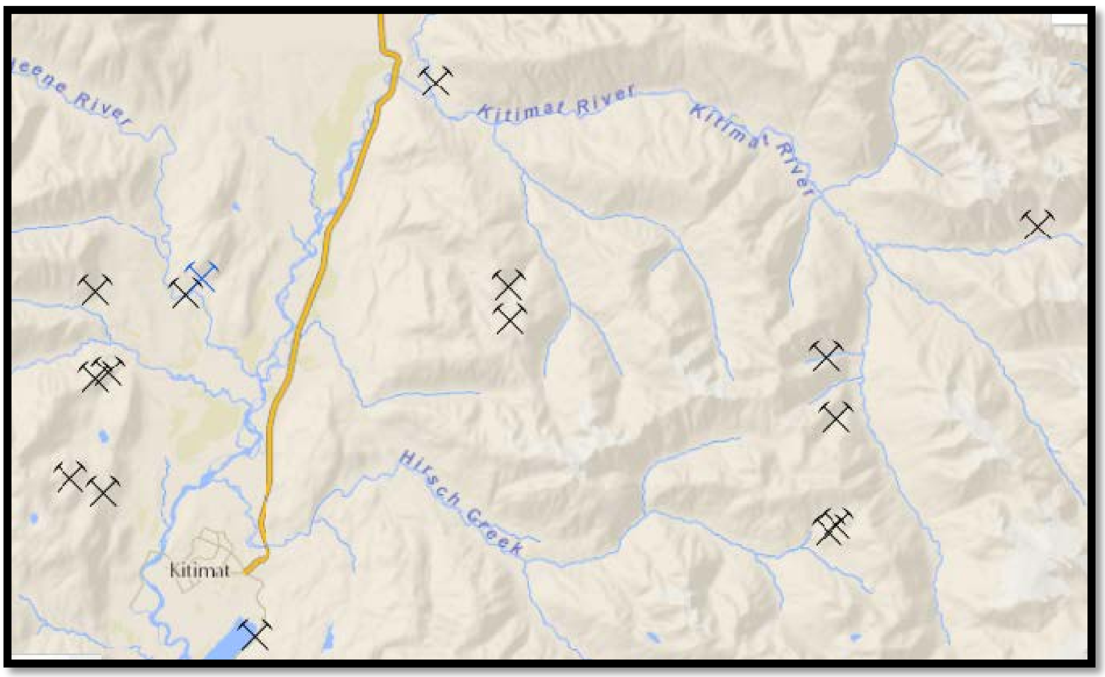

Figure 7. Map of Kitimat watershed showing mineral occurrences (in black) and past producer (in blue) (B.C. MINFILE, 2016).

5.0 STUDY DETAILS

This report provides an assessment of water quality data collected from the Kitimat River and a number of its tributaries from 1976 to 2016. Many of the water quality monitoring sites discussed in this report were first sampled by ENV in the 1970s to monitor the effects of permitted discharges, and to develop WQOs. Data collected prior to 1983 was addressed in the previous WQOs report (Warrington, 1987). Recent sampling by ENV (in 2015) occurred at five sampling locations (see Table 7). Water samples have also been collected by a number of other sources, including industry and the DOK, and those results will be discussed below in the respective sections. In addition, five sites were sampled near Hirsch Creek between 2005 and 2008 to monitor potential leachate from the landfill, as recommended in the 1987 WQOs report (Warrington, 1987). The Hirsch Creek leachate study data are summarized in Appendix I, Tables 41-45 although no further review is provided as it was not part of the scope of this report. All samples were collected according to Resource Inventory Standards Committee (RISC) standards (Cavanagh *et al.*, 1997a&b).

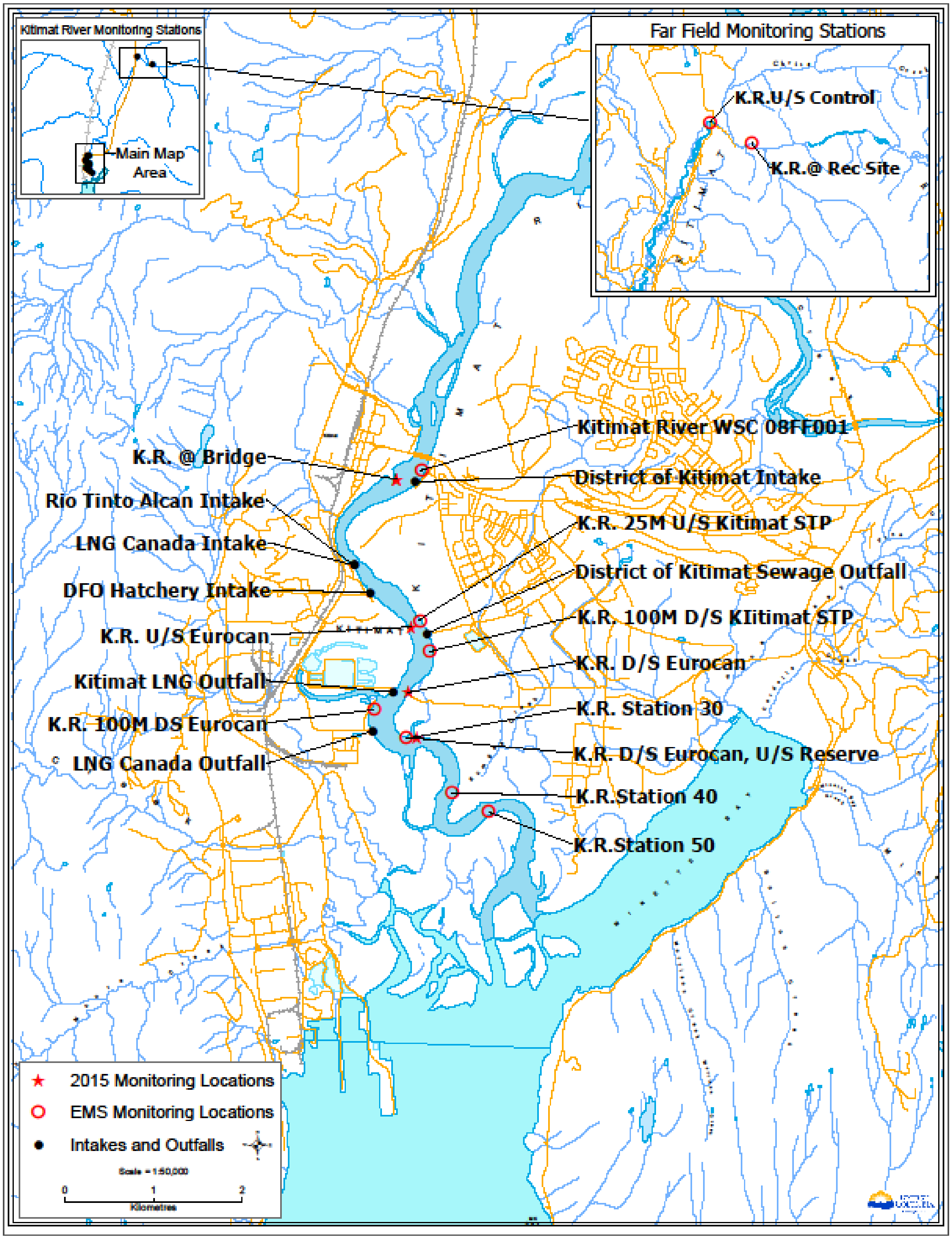

Figure 8 Map of lower Kitimat River showing monitoring locations (in red) and intakes and outfalls (in black) (B.C. FLNRO 2019)

Table 7. Summary of ENV water quality monitoring sites on the Kitimat River, upstream to downstream.

EMS ID	Site Name	Longitude (Decimal Degrees)	Latitude (Decimal Degrees)	Date of first sample collection	Date of most recent sample collection
E260483	KITIMAT RIVER @ REC SITE	128.4686	54.24621	8/22/2005	8/22/2005
E301870	KITIMAT RIVER U/S CONTROL (KR REF)	128.523	54.26039	5/3/2015	6/3/2015
0430025	KITIMAT RIVER AT BRIDGE	128.6814	54.0567	8/23/1976	6/3/2015
E253649	KITIMAT RIVER AT DISTRICT OF KITIMAT INFILTRATION GALLERY	128.6781	54.05589	9/30/2003	7/5/2004
E234009	KITIMAT RIVER 25M U/S KITIMAT STP PE-00256	128.675	54.0408	9/23/1998	9/25/1998
E207568	KITIMAT RIVER 100M D/S KITIMAT STP PE-00256	128.6753	54.0395	10/3/1989	9/23/1998
E207569	KITIMAT R U/S EUROCAN	128.6779	54.0419	8/9/1988	6/3/2015
E207570	KITIMAT R D/S EUROCAN	128.678	54.0353	8/9/1988	6/3/2015
0430020	KITIMAT RIVER STATION 30	128.6772	54.0314	8/23/1976	4/15/1982
E207686	KITIMAT R 100M D/S EUROCAN	128.6753	54.0395	3/21/1989	10/3/1989
E218981	KITIMAT RIVER D/S EUROCAN, U/S RESERVE	128.6764	54.0311	3/31/1993	6/3/2015
0430022	KITIMAT RIVER STATION 40	128.6686	54.0253	8/23/1976	4/15/1982
0430023	KITIMAT RIVER STATION 50	128.6633	54.0236	8/23/1976	4/15/1982

Based on the current knowledge of potential environmental risks to the watershed (generally associated with discharges from industries and the sewage treatment plant, timber harvesting, recreation and rural and urban residential development), and natural features (aquatic life and wildlife), the following water quality variables were included at the monitoring sites:

- Physical and chemical: pH, temperature, specific conductance, true color, turbidity, non-filterable residue (total suspended solids)
- Carbon: total organic carbon
- Nutrients: total phosphorus, nitrate, nitrite
- Total and dissolved metals concentrations, hardness
- Polycyclic aromatic hydrocarbons (PAHs)
- Microbiological indicators: fecal coliforms, *E. coli*, enterococci, *Giardia* and *Cryptosporidium*

Water samples were collected episodically through the 1970s and 1980s at many sites on the Kitimat River. As mentioned in Section 4.6, the closure of two of the major industries with authorized discharges (Eurocan and Ocelot/Methanex) in 2010 and 2011, and the start-up of the modernized aluminum smelter in 2016 represent important changes in the air and effluent discharges to the watershed, such that changes in water quality may be occurring.

More than one laboratory was used to analize water samples over the course of the study (as laboratories contracted to the province changed a number of times during this period), which is a potential source of error common to most long-term data sets. Summary statistics were calculated on all available data. Data are summarized in Appendix I.

5.1 Quality Assurance / Quality Control

Quality assurance and quality control for sampling conducted by ENV staff was verified by collecting duplicate and blank samples. Duplicate co-located samples were collected by filling two sample bottles in as close to the same time period as possible (one right after the other) at a monitoring location, and then calculating the relative percent difference between the laboratory results reported for the samples. The maximum acceptable percentage difference between duplicate samples is 25%. However, this interpretation only holds true if the results are at least 10 times the detection limits for a given parameter, as the accuracy of a result close to the detection limit shows more variability than results well above detectable limits. As well, some parameters (notably bacteriological indicators, or chlorophyll *a*) are not homogeneous throughout the water column and therefore, we expect to see a higher degree of variability between replicate samples. For blanks, the Guidelines for Interpreting Water Quality Data (Cavanagh et al, 1998) state that contamination has occurred when 5% or more of the blanks show any levels above the method detection limit. If the blanks are within the guidelines, the data are to be considered acceptable and the samples are considered to be uncontaminated.

6.0 WATER QUALITY ASSESSMENT AND OBJECTIVES

The B.C. ENV WQGs (available at http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html) are benchmarks for ambient fresh and marine water quality which are used to assess, manage and protect the health, safety and sustainability of B.C.'s aquatic resources for use by aquatic and terrestrial life, including humans. WQGs provide the basis for the development of WQOs for a specific waterbody, which can be integrated into a water protection program designed to protect all uses of the resource, including drinking water sources. Typically, WQOs are established based on the most sensitive use (often aquatic life, but occasionally drinking water or other uses), which in turn protects all water uses.

6.1 QUALITY ASSURANCE / QUALITY CONTROL

Results of the QA/QC analyses are summarized in Appendix II. Over the course of the study, three sets of duplicate samples were collected. For the first set of duplicate samples, collected on May 3, 2015 from the Kitimat River at Bridge site (EMS #0430025), samples were analyzed for general chemistry, and five of 14 parameters differed by more than 25% (Table 46). Duplicate samples were also collected on May 13, 2015, from the Kitimat River Upstream Control site (EMS #E301870), and analyzed for general chemistry, total and dissolved metals, and PAHs. For this set of duplicates, 22 of 114 parameters differed by more than 25% (Table 47). Finally, duplicate samples were collected from the Kitimat River upstream from Eurocan (EMS #E207569) on May 27, 2015 and 12 of 113 parameters differed by more than 25% (Table 48). These samples were also analyzed for general chemistry, total and dissolved metals, and PAHs. Parameters that differed by more than 25% between the duplicate samples included total and dissolved ammonia, total and dissolved sulphur, Kjeldahl nitrogen, organic nitrogen, *E. coli*, and some total and dissolved metals. As turbidity and suspended solids are typically high in the Kitimat River (see Section 6.5) these differences are likely due to a lack of homogeneity in suspended materials in the samples. However, all of the concentrations were at low levels (well below guidelines) and therefore, would not affect interpretations of water quality. Based on these samples, the duplicate data are considered to be within acceptable limits for data quality.

Data for two sets of field blanks were included in the dataset reviewed for this study. The first sample was from October 29, 2008 from the Kitimat Landfill Hirsch Pit #5 (EMS

#E264247) analyzed for general chemistry and total and dissolved metals. Only total phosphorus concentrations were reported at detectable limits (0.002 mg/L, equal to the detection limit-Table 49). The second blank sample was from May 13, 2015, from the Kitimat River downstream from Eurocan and upstream from the reserve (EMS #E218981), analyzed for general chemistry, total and dissolved metals, and PAHs. In this sample, dissolved ammonia and dissolved fluoride, total sulphide, total phosphorus, total and Kjeldah nitrogen, total and dissolved aluminum, total copper, total lead, dissolved vanadium, and total and dissolved zinc, were found at concentrations above the detection limits (Table 50). It is likely that some of this contamination is likely the result of improper bottles being supplied by the laboratory (bottles containing preservative, necessary to stabilize some samples) for the analysis of chloride, sulphate, nitrate, nitrite and fluoride (Penno, pers. comm. 2017). While none of the concentrations found were particularly high (and therefore unlikely to result in a false guideline exceedance being reported), it is interesting that these parameters were generally the same as those for which relative percent differences exceeded 25% (see paragraph above). It is possible that contamination is occurring at some point during the sample collection, or transport, and additional field blanks and duplicates should be collected in the future to try and identify whether this is a significant problem.

6.2 pH

The aesthetic objective for drinking water is a pH between 6.5 and 8.5 (McKean and Nagpal, 1991). Corrosion of metal plumbing may occur at both low and high pH outside of this range, while scaling or encrustation of metal pipes may occur at high pH. The effectiveness of chlorine as a disinfectant is also reduced outside of this range. The guideline for the protection of aquatic life is that for naturally low pH water (< 6.5 pH units) is that no statistically significant decrease from natural conditions should occur. For high pH water (> 9.0 pH units), the guideline also recommends no statistically significant increase from natural conditions (McKean and Nagpal, 1991). For waters where ambient conditions are within the range of 6.5 to 9.0 pH units, unrestricted change is allowed to occur within this range.

Table 8 summarizes laboratory pH measured at ENV water quality monitoring sites between 1976 and 2016. All samples collected by ENV had values between 6.5 and 8.0 pH units, with averages at each site ranging from 7.0 to 7.5 pH units. Hardness (calculated based on calcium and magnesium concentrations) is very low in the Kitimat River, ranging from 9.2 mg/L to 22 mg/L for 35 samples collected throughout the watershed over the course of the study. The river has very little buffering capacity and is therefore, susceptible to changes in pH. This is one of the reasons that the pH of effluent from licenced discharges is required to remain within the guideline range of 6.5 to 8.5 pH units (see Section 4.6). In water samples collected at the old Eurocan water intake in 2016 (by industry staff), pH ranged from 6.22 pH units to 7.22 pH units. The sample with the lowest pH (and the only sample outside the guideline range) was collected earliest in the year (May 26, 2016) during the spring freshet and is likely a result of low-pH snowmelt runoff.

Table 8. Summary of laboratory pH at ENV sites on the Kitimat River, 1976 - 2015.

Site Number	Site Description	Minimum	Maximum	Average	No. of samples
E260483	Kitimat River @ Rec Site	7.42	7.42	7.4	1
E301870	Kitimat River at Hwy 37 Bridge	7.2	7.67	7.4	5
0430025	Kitimat River at Bridge	6.5	7.9	7.0	83
E253649	Kitimat River at DOK Infiltration Gallery	7	7.4	7.3	8
E207569	Kitimat River U/S Eurocan	6.8	8	7.3	25
E207570	Kitimat River D/S Eurocan	7	7.9	7.4	20
0430020	Kitimat River Station 30	6.9	7.8	7.3	34
E218981	Kitimat River 100m D/S Eurocan, U/S Reserve	7.09	7.9	7.5	12
0430022	Kitimat River Station 40	6.9	7.8	7.2	34
0430023	Kitimat River Station 50	6.6	7.7	7.2	35

Field pH was also measured at five monitoring sites in 2015 (Table 9). Field pH tends to be lower than laboratory pH, because dissolved carbon dioxide is released from water samples over time, elevating the pH. However, field probes used to measure pH require frequent calibration to ensure accuracy and can drift considerably over the course of a day. Field probes should be checked against standards regularly throughout the day, to ensure accurate readings. In the Kitimat River in 2015, pH at the upper site (E301870, at the Hwy 37 Bridge) was slightly higher than at the downstream sites, primarily due to one reading (7.2 pH units).

Table 9. Summary of field pH at ENV sites on the Kitimat River, 2015

Site Number	Site Description	Minimum	Maximum	Average	No. of samples
E301870	Kitimat River at Hwy 37 Bridge	6.4	7.2	6.7	3
0430025	Kitimat River at Bridge	6.2	6.5	6.4	4
E207569	Kitimat River U/S Eurocan	6.4	6.7	6.6	3
E207570	Kitimat River D/S Eurocan	6.3	6.7	6.5	4
E218981	Kitimat River 100m D/S Eurocan, U/S Reserve	6.3	6.8	6.5	3

Due to the relatively few samples collected over the course of the study, the fact that sampling locations changed, and the seasonality of pH (with lower values resulting from rainfall or snowmelt in the fall and spring), no useful analysis can be made of trends over time in the Kitimat River.

6.3 TEMPERATURE

Temperature is considered in drinking water for aesthetic reasons and is also an important driver in the biology of aquatic ecosystems. The aesthetic guideline is 15°C; temperatures above this level are considered to be too warm to be aesthetically pleasing (Oliver and Fidler, 2001). For the protection of aquatic life, the allowable change in temperature is +/-1°C from naturally occurring levels. The optimum temperature ranges for salmonids and other cold-water species are based on species-specific life history stages such as incubation, rearing, migration, and spawning, and each species has its own optimum temperature range. For steelhead, the optimum temperature ranges are: 10 – 12°C for incubation; 16 – 18°C for rearing; and 10 – 15.5°C for spawning (Oliver and Fidler, 2001). Chum salmon are the most sensitive salmonid to warmer temperatures (12 – 14°C for rearing). However, the juveniles are not present in the river during the summer months. Steelhead and coho, which have similar temperature thresholds, are the species present in the watershed for the longest periods of time, including the summer. Maturation of the embryos is temperature-dependent, but coho typically emerge by mid-May and steelhead by late June.

Water temperatures measured at the ENV sampling sites are summarized in Table 10. As would be expected, water temperatures were seasonal, with the highest temperatures measured in August and September, and the lowest temperatures measured in January. All of the water temperature measurements were within the ranges appropriate for drinking water aesthetics and fresh water aquatic life survival. Due to the relatively few temperature measurements each year, as well as changes in sampling locations over the course of the study period, no trend analysis can be made with regards to water temperature over time. In order to accurately assess water temperature trends (both in a downstream direction and over time at individual locations), automated temperature sensors would need to be installed at the sampling locations, to ensure that temperature maxima are measured (rather than depending on monthly site visits to try and capture these extremes).

Table 10. Summary of water temperature (°C)[1] measured at ENV sampling locations on the Kitimat River, 1976-2016.

Site Number	Site Description	Minimum	Maximum	Average	No. of measurements
E301870	Kitimat River at Hwy 37 Bridge	7.9	7.9	7.9	1
0430025	Kitimat River at Bridge	0.0	12.3	7.4	17
E207569	Kitimat River U/S Eurocan	10.0	10.0	10.0	1
0430020	Kitimat River Station 30	2.0	13.0	7.7	34
E218981	Kitimat River 100m D/S Eurocan, U/S Reserve	8.5	12.8	11.2	4
0430022	Kitimat River Station 40	2.0	12.9	7.9	34
0430023	Kitimat River Station 50	2.0	13.3	8.0	35

[1] based on a review of EMS lab temperature data

6.4 SPECIFIC CONDUCTANCE

Coastal systems with high annual rainfall values and typically short water retention times generally have low specific conductance (<80 microsiemens/centimeter (µS/cm)), while interior watersheds generally have higher values. Increased flows resulting from precipitation events or snowmelt tends to dilute the ions, resulting in decreased specific conductance levels with increased flow levels. Therefore, water level and specific conductance tend to be inversely related. However, in situations such as landslides, where high levels of dissolved and suspended solids are introduced to the stream, specific conductance levels tend to increase. As such, significant changes in specific conductance can be used as an indicator of potential impacts.

Specific conductance in the Kitimat River was very low, ranging from 18 µS/cm to a maximum of 80 µS/cm for all of the samples, and averages at the sites ranged from 28 µS/cm to 48 us/cm (Table 11). Specific conductance was seasonal, with minimum values occurring between June and August (during the receding limb of the freshet) when discharge in the Kitimat River is low.

Table 11. Summary of specific conductance (μS/cm) measured at the ENV sampling locations on the Kitimat River, 1976-2016.

Site Number	Site Description	Minimum	Maximum	Average	No. of measurements
0430025	Kitimat River at Bridge	18	62	38	81
E253649	Kitimat River at DOK Infiltration Gallery	26	43	32	8
E207569	Kitimat River U/S Eurocan	25	33	28	5
E207570	Kitimat River D/S Eurocan	35	57	43	6
0430020	Kitimat River Station 30	18	80	48	33
0430022	Kitimat River Station 40	18	66	48	34
0430023	Kitimat River Station 50	16	75	48	34

6.5 Turbidity and Total Suspended Solids

Turbidity is a measure of water clarity defined by the amount of light scattered by the particles present in a given water sample. Turbidity values are reported as nephelometric turbidity units (NTU). Turbidity is most commonly an aesthetic consideration, but it is correlated with algal growth and bacterial contamination. Total suspended solids (TSS, or non-filterable residue or NFR) include all of the undissolved particulate matter in a sample. This value is typically closely correlated with the turbidity value; however, unlike turbidity, it is not measured by optics. Instead, a quantity of the sample is filtered, and the residue is dried and weighed so that a weight of residue per volume is determined.

The turbidity guideline for raw drinking water that does not receive treatment for the removal of suspended matter before consumption is a change from background of 1 NTU at any time when natural background is less than 5 NTU or a change from background of 5 NTU at anytime (Singleton, 2001). No TSS guideline has been established for drinking water sources at this time.

Distinct water quality guidelines for turbidity and suspended sediments are required for the protection of aquatic life during clear[1] flow and turbid[2] flow periods (Singleton, 2001).

Turbidity in the Kitmat River tends to be naturally high, in part because it is glacier fed. Glaciers contain glacial till (sediment contained in the glacier, produced by the glacier grinding on the underlying strata), and therefore runoff from glaciers typically contains relatively high levels of suspended sediments and turbidity. Coupled with the extensive logging that occurred in the 1960s, 1970s and 1980s (see Section 4.3) that reduced natural hydrological buffering, elevated turbidty levels in the watershed are common, especially after rain events. Due to high turbidity the District of Kitimat (DOK) has an infiltration gallery on the Kitimat River, which provides some natural filtration to the raw water prior to it entering the chlorination/fluoridation facility. Turbidity ranged from 0.7 NTU (on October 4, 1993, at the Haisla Blvd Bridge) to a maximum of 320 NTU (on September 30, 1992, at the site downstream from Eurocan) (Table 12). On the day on which the maximum value was measured, 263.6 mm of rain fell in the previous three days at the Kitimat townsite Environment Canada weather station (Site #1064320) (Environment Canada, 2016), and concentrations were also high at the Haisla Blvd site (220 NTU).

[1] Clear flow - the portion of the hydrograph when suspended sediment concentrations are low (i.e., less than 25 mg/L or less than 8 NTU)
[2] Turbid flow - the portion of the hydrograph when suspended sediment concentrations are relatively elevated (i.e., greater than or equal to 25 mg/L or greater than or equal to 8 NTU)

Table 12. Summary of turbidity (NTU) measured at ENV sampling locations on the Kitimat River, 1976-2016.

Site Number	Site Description	Minimum	Maximum	Average	No. of measurements
E260483	Kitimat River @ Rec Site	4.2	4.2	4.2	1
0430025	Kitimat River at Bridge	0.7	220	8.2	88
E253649	Kitimat River at DOK Infiltration Gallery	1.74	87.9	35.5	8
E207569	Kitimat River U/S Eurocan	1.5	29	6.4	24
E207570	Kitimat River D/S Eurocan	2.5	320	22.9	25
0430020	Kitimat River Station 30	2.6	9.8	6.2	15
E218981	Kitimat River 100m D/S Eurocan, U/S Reserve	1.8	8.3	4.5	8
0430022	Kitimat River Station 40	2.4	9.9	6.3	15
0430023	Kitimat River Station 50	2.4	10.6	6.3	15

Table 13 contains a summary of turbidity measurements collected in the Kitimat River, on those sampling dates for which turbidity was measured at more than one site on the river on the same day. The downstream change in the final column represents the difference in NTU from the uppermost sample collected to that of the sample collected furthest downstream in the watershed (a positive number denotes an increase in turbidity, and a negative number denotes a decrease between the two sites). From this table, it is evident that turbidity tends to be relatively high even in the upper watershed but continues to increase as it passes through town and eventually past the industrial discharges. Therefore, while glacial till and possible runoff associated with forestry in the upper watershed are likely contributing to turbidity in the Kitimat River, there are also significant sources of turbidity in the lower watershed. As all the data summarized in this table is at least 10 years old, additional sampling should be conducted, to determine if elevated turbidity in the lower watershed continues to be a concern.

Table 13. Summary of changes in turbidity (NTU) in a downstream direction in the Kitimat River, 1980-2005.

	E260483 @ Rec Site	0430025 at Bridge	E207569 U/S Eurocan	E207570 D/S Eurocan	0430020 Station 30	E218981 100m D/S Eurocan, U/S Reserve	0430022 Station 40	0430023 Station 50	**D/S change**
4/22/1980		4.6			6		6	6	**1.5**
9/22/1980		2.1			4		3	3	**0.6**
4/14/1981		8.6			10		10	10	**1.4**
9/17/1981		3.7			5		5	5	**1.1**
4/15/1982		5.7			8		8	8	**2.4**
8/9/1988		9.7	14	16					**6.3**
8/15/1988		1.5	1.5	2.5					**1.0**
8/21/1988		3	3.3	4.2					**1.2**
8/29/1988		8	14	16					**8.0**
9/5/1988		4.5	4.6	6.1					**1.6**
7/19/1989		3.9	3.9	5.5					**1.6**
7/26/1989		3.4	4	4.8					**1.4**
8/1/1989		3.9	4.1	5.5					**1.6**
8/10/1989		3.1	3.3	4.5					**1.4**
8/15/1989		4.7	5.8	7.5					**2.8**
8/1/1990		2	2	3.5					**1.5**
8/8/1990			2.5	4					**1.5**
8/15/1990		4	3.7	5.5					**1.5**
8/21/1990		4.6	5.3	6.3					**1.7**
8/29/1990		1.3	2	4					**2.7**
9/30/1992		220		320					**100.0**
10/7/1992		3.7		3.9					**0.2**
10/14/1992		6.9	9	14					**7.1**
10/19/1992		48		100					**52.0**
10/28/1992		11	11	14					**3.0**
3/31/1993		2.6				5.2			**2.6**
4/21/1993		3				3.5			**0.5**
5/27/1993		5.3				8.3			**3.0**
6/21/1993		3				4.8			**1.8**
7/19/1993		2.1				3.9			**1.8**
8/10/1993		2				4.9			**2.9**
9/8/1993		4.6				3.4			**-1.2**
10/14/1993		0.7				1.8			**1.1**
7/6/1994			7.2	4.6					**-2.6**
7/12/1994			7.5	4.5					**-3.0**
7/19/1994			5.2	7					**1.8**
7/27/1994			3.3	4					**0.7**
8/2/1994			4.5	5					**0.5**
8/22/2005	4.2		3.9						**-0.3**
Average downstream change:									**5.5**

Table 14 contains a summary of total suspended solids concentrations measured from the Kitimat River. Table 15 contains a comparison of changes in total suspended solids concentrations in a downstream direction, for those days on which total suspended solids were measured at more than one site on the river. In general, increases were below 25 mg/L, except on October 19, 1992, when TSS increased beween the Haisla Blvd. bridge

(0430025) and the site downstream from Eurocan (E207570). Runoff caused by approximately 118 mm of precipitation in the preceding three days is likely responsible for this increase (as measured at the Kitimat townsite Environment Canada weather station (Site #1064320) (Environment Canada, 2016).

Table 14. Summary of total suspended solids (mg/L) measured at ENV sampling locations on the Kitimat River, 1976-2016.

Site Number	Site Description	Minimum	Maximum	Average	No. of measurements
E260483	Kitimat River @ Rec Site	5	5	5.0	1
E301870	Kitimat River at Hwy 37 Bridge	3.3	21	8.2	5
0430025	Kitimat River at Bridge	1	321	14.4	95
E207568	Kitimat River 100m D/S DOK STP	4	21	10.1	8
E207569	Kitimat River U/S Eurocan	4	73	12.8	29
E207570	Kitimat River D/S Eurocan	6	479	31.5	32
E207686	Kitimat River 100m D/S Eurocan	4	18	8.6	10
E218981	Kitimat River 100m D/S Eurocan, U/S Reserve	3.8	24	12.0	13

Table 15. Summary of changes in total suspended solids concentrations (mg/L) in a downstream direction in the Kitimat River, 1988-2015.

	E260483 @ Rec Site	E301870 at Hwy 37 Bridge	0430025 at Bridge	E207568 100m D/S DOK STP	E207569 U/S Eurocan	E207570 D/S Eurocan	E207686 100m D/S Eurocan	E218981 100m D/S Eurocan, U/S Reserve	**D/S Change**
8/9/1988			16		31	35			**19**
8/15/1988			5		5	17			**12**
8/21/1988			8		6	10			**2**
8/29/1988			29		31	38			**9**
9/5/1988			7		9	9			**2**
7/19/1989			6		7	10			**4**
7/26/1989			8		9	11			**3**
8/1/1989			6		10	10			**4**
8/10/1989			9		7	9			**0**
8/15/1989			6		10	13			**7**
10/3/1989			4	4		23	8		**19**
8/1/1990			9		10	14			**5**
8/8/1990					5	6			**6**
8/15/1990			11		10	14			**3**
8/21/1990			11		13	20			**9**
8/29/1990			1		6	8			**7**
10/7/1992			16			21			**5**
10/14/1992			17		18	22			**5**
10/19/1992			212			479			**267**
10/28/1992			18		21	26			**8**
3/31/1993			5					12	**7**
4/21/1993			21					23	**2**
5/27/1993			20					24	**4**
6/21/1993			4					7	**3**
7/19/1993			6					9	**3**
8/10/1993			7					12	**5**
9/8/1993			9					18	**9**
10/14/1993			4					5	**1**
7/6/1994			4		6	10			**6**
7/12/1994			4		4	7			**3**
7/19/1994			5		11	11			**6**
7/27/1994			4		5	7			**3**
8/2/1994			5		8	17			**12**
8/22/2005	5				7				**2**
5/3/2015		4			4			4	**0**
5/13/2015		8.8			19.8			21	**12.2**
5/21/2015		4			6.5			6.3	**2.3**
5/27/2015		21			11.3			11.5	**-9.5**
6/3/2015		3.3			7			3.8	**0.5**
Average downstream change:									**12.0**

As with turbidity, there are relatively few recent data setsfor TSS in the Kitimat River, and additional sampling should be conducted to determine potential sources for the TSS increases.

6.6 Colour and Total Organic Carbon

Colour in water is caused by dissolved and particulate organic and inorganic matter. True colour is a measure of the dissolved colour in water after the particulate matter has been removed, while apparent colour is a measure of the dissolved and particulate matter in water. Colour can affect the aesthetic acceptability of drinking water. The aesthetic water quality guideline is a maximum of 15 true colour units (TCU) (Moore and Caux, 1997). Colour is also an indicator of the amount of organic matter in water. When organic matter is chlorinated it can produce disinfection by-products (DBPs) such as trihalomethanes, which may pose a risk to human health.

True colour ranged from below detectable limits (< 5 TCU) at most of the sites to as high as 60 TCU at the infiltration gallery and at the site 100 m downstream from the Eurocan outfall (Table 16). Unfortunately, no samples were collected upstream from the infiltration gallery on the dates when samples were taken, so it cannot be determined if true colour increased in a downstream direction. Table 17 compares true colour in a downstream direction for the ENV sampling locations on the Kitimat River. During the summer months (June to August), colour was low (< 5 TCU) at all sites, while during the spring and fall values were higher, and showed a slight increase from the Haisla Blvd bridge (Site #0430025) to those sites further downstream.

Table 16. Summary of true colour (TCU) measured at ENV sampling locations on the Kitimat River, 1984 - 2015

Site Number	Site Description	Minimum	Maximum	Average	No. of measurements
E260483	Kitimat River @ Rec Site	5	5	5	1
E301870	Kitimat River at Hwy 37 Bridge	< 5	18.7	12	3
0430025	Kitimat River at Bridge	< 5	40	10	29
E253649	Kitimat River at DOK Infiltration Gallery	< 5	60	28	8
E207568	Kitimat River 100m D/S DOK STP	< 5	5	5	8
E207569	Kitimat River U/S Eurocan	< 5	30.2	12	12
E207570	Kitimat River D/S Eurocan	< 5	50	12	16
E207686	Kitimat River 100m D/S Eurocan	< 5	60	18	10
E218981	Kitimat River 100m D/S Eurocan, U/S Reserve	< 5	29.4	11	11

Table 17. Summary of changes in true colour in a downstream direction in the Kitimat River, 1988-2015.

Sample date	E260483 @ Rec Site	E301870 at Hwy 37 Bridge	0430025 at Bridge	E207568 100m D/S DOK STP	E207569 U/S Eurocan	E207570 D/S Eurocan	E207686 100m D/S Eurocan	E218981 100m D/S Eurocan, U/S Reserve	**Downstream change**
10/3/1989			6	5		9	13		**7**
10/14/1992			20		10	20			**0**
10/19/1992			40			50			**10**
10/28/1992			15		20	20			**5**
7/6/1994					5	5			**0**
7/12/1994					5	5			**0**
7/19/1994					5	5			**0**
7/27/1994					5	5			**0**
8/2/1994					5	5			**0**
8/22/2005	5				5				**0**
5/3/2015		19			30			29	**11**
5/13/2015		12			14			14	**2**
6/3/2015		5			5			5	**0**
Average downstream change:									**3**

Elevated total organic carbon (TOC) levels (above 4.0 mg/L) can result in higher levels of DBPs in finished drinking water if chlorination is used to disinfect the water (Moore, 1998). As the District of Kitimat uses chlorine to disinfect their drinking water, TOC concentrations should be monitored. Concentrations of TOC ranged from < 0.5 mg/L to 8.0 mg/L for the 32 samples analyzed for TOC throughout the watershed between 1983 and 2005 (Table 18). Four of the 32 samples had TOC concentrations exceeding the guideline. Similar to turbidity and TSS, TOC tended to increase in a downstream direction, from an average of 0.5 mg/L at the upper Rec Site to 2.9 mg/L at the intake site. The reason for the increase in both true colour and TOC in a downstream direction is not known but could be due to inflow from a tributary that passes through wetlands or could be due to anthropogenic factors in the lower watershed. The concentration of TOC measured below the intake (0.7 mg/L at the site upstream from Eurocan) was lower, but it was only measured for one sample. Therefore, TOC concentrations should be monitored throughout the watershed, to determine potential sources as well as to ascertain whether potential byproducts from chlorination may be a concern in drinking water.

Table 18. Summary of total organic carbon (mg/L) at ENV sampling locations within the Kitimat River watershed, 1983 - 2005.

Site Number	Site Description	Minimum	Maximum	Average	No. of samples
E260483	Kitimat River @ Rec Site	0.5	0.5	0.5	1
0430025	Kitimat River at Bridge	< 1	8.0	2.1	22
E253649	Kitimat River at DOK Infiltration Gallery	< 0.5	5.1	2.9	8
E207569	Kitimat River U/S Eurocan	0.7	0.7	0.7	1

6.7 NUTRIENTS (NITRATE, NITRITE, AMMONIA, AND PHOSPHORUS)

The concentrations of nitrogen (including nitrate, nitrite and ammonia) and phosphorus are important parameters since they are typically the limiting nutrients in aquatic ecosystems. Therefore, productivity is closely related to the availability of these parameters. Nitrogen is usually the limiting nutrient in terrestrial systems, while phosphorus is often limiting in freshwater aquatic systems. In watersheds where drinking water is a priority, it is desirable that nutrient levels in surface water remain low to avoid potentially toxic algal blooms and foul-tasting water. Similarly, to protect aquatic life, nutrient levels should not be too high, or the resulting plant and algal growth can deplete oxygen levels during decomposition, as well as during periods of low productivity when plants consume oxygen (*i.e*., at night and during the winter under ice cover).

The guideline for the maximum concentration for nitrate in drinking water is 10 mg/L as nitrogen and the guideline for nitrite is a maximum of 1 mg/L as nitrogen. When both nitrate and nitrite are present, their combined concentration must not exceed 10 mg/L as N. For the protection of freshwater aquatic life, the nitrate guidelines are a maximum concentration of 32.8 mg/L and an average concentration of 3 mg/L. Nitrite concentrations are dependent on chloride; in low chloride waters (i.e., less than 2 mg/L) the maximum concentration of nitrite is 0.06 mg/L and the average concentration is 0.02 mg/L, and the limit increases in relation to the ambient concentration of chloride (Meays, 2009). There is no B.C. guideline for ammonia in drinking water. The guidelines for maximum ammonia concentrations for the protection of aquatic life are dependent on temperature and pH; as either or both of these factors increase in the water, so does the toxicity of ammonia. The same is true for average ammonia concentrations. At the highest recorded water temperature (13.3ºC) and pH (8 pH units), the maximum guideline for ammonia is 5.7

mg/L, and the average guideline (based on a minimum of five samples collected within a 30-day period) is 1.1 mg/L.

Dissolved nitrate concentrations in the Kitimat River ranged from below detectable limits (<0.002 mg/L) to a maximum of 0.112 mg/L at the infiltration gallery (Table 19). Dissolved nitrite ranged from below detectable limits (<0.001 mg/L or <0.002 mg/L) for all sites, to maximum of 0.06 mg/L at the site upstream from Eurocan (Table 20). The maximum concentration of 0.06 mg/L was equal to the maximum nitrite guideline level, suggesting nitrite monitoring is necessary at the DOK drinking water intake.

Table 19. Summary of dissolved nitrate concentrations (mg/L) measured at ENV sampling locations on the Kitimat River, 2003 - 2015.

Site Number	Site Description	Minimum	Maximum	Average	No. of samples
E260483	Kitimat River @ Rec Site	< 0.002	< 0.002	< 0.002	1
E301870	Kitimat River at Hwy 37 Bridge	0.021	0.091	0.048	5
0430025	Kitimat River at Bridge	0.020	0.098	0.048	5
E253649	Kitimat River at DOK Infiltration Gallery	0.013	0.112	0.072	7
E207569	Kitimat River U/S Eurocan	0.018	0.111	0.045	6
E207570	Kitimat River D/S Eurocan	0.028	0.098	0.055	4
E218981	Kitimat River 100m D/S Eurocan, U/S Reserve	0.022	0.109	0.050	5

Table 20. Summary of dissolved nitrite concentrations (mg/L) measured at ENV sampling locations on the Kitimat River, 1990 - 2015.

Site Number	Site Description	Minimum	Maximum	Average	No. of samples
E260483	Kitimat River @ Rec Site	< 0.002	< 0.002	< 0.002	1
E301870	Kitimat River at Hwy 37 Bridge	< 0.001	0.002	0.002	5
0430025	Kitimat River at Bridge	< 0.002	0.040	0.006	16
E253649	Kitimat River at DOK Infiltration Gallery	< 0.002	0.005	0.004	8
E207569	Kitimat River U/S Eurocan	< 0.001	0.060	0.007	19
E207570	Kitimat River D/S Eurocan	< 0.002	0.040	0.006	19
E218981	Kitimat River 100m D/S Eurocan, U/S Reserve	< 0.001	0.002	0.002	5

Concentrations of dissolved ammonia ranged from below detection limits (< 0.005 mg/L) at most of the sites, to a maximum of 0.340 mg/L for one sample at the Haisla Blvd site (Table 21). All concentrations were well below the maximum guideline level. The sampling frequency was insufficient to calculate average values for comparison with the guideline (a minimum of five samples in a 30-day period), but it does not appear likely that the average guideline was exceeded.

Table 21. Summary of dissolved ammonia concentrations (mg/L) measured at ENV sampling locations on the Kitimat River, 1983 - 2015.

Site Number	Site Description	Minimum	Maximum	Average	No. of samples
E260483	Kitimat River @ Rec Site	0.011	0.011	0.011	1
E301870	Kitimat River at Hwy 37 Bridge	< 0.005	0.014	0.010	5
0430025	Kitimat River at Bridge	< 0.005	0.340	0.016	90
E253649	Kitimat River at DOK Infiltration Gallery	< 0.005	0.012	0.008	8
E207568	Kitimat River 100m D/S DOK STP	< 0.005	0.082	0.037	8
E207569	Kitimat River U/S Eurocan	< 0.005	0.069	0.026	24
E207570	Kitimat River D/S Eurocan	< 0.005	0.061	0.021	32
E207686	Kitimat River 100m D/S Eurocan	< 0.005	0.044	0.024	8
E218981	Kitimat River 100m D/S Eurocan, U/S Reserve	0.009	0.025	0.019	5

Warrington (1987) identified total phosphorous as a potential issue affecting algal growth during the growing season. Total phosphorous was higher than draft water quality criteria in the 1980's but there were no algal growth concerns - likely due to phosphorous being bound to sediment and not available for biological activity. Water quality guidelines for phosphorus in streams have not been developed to date.

Prior to 1983, detection limits for total phosphorus varied considerably. Several recent samples used an analytical method with a higher detection limit (<0.1 mg/L), rather than a more sensitive method with lower detection limits (< 0.002 mg/L). Only samples collected after 1983 using the lower detection limit are reported here (Table 22). Total phosphorus concentrations ranged from below detection limits (< 0.002 mg/L) at the Haisla Bridge site (0430025) to a maximum of 0.174 mg/L at the same site. For the 24 samples collected in 2015, total phosphorus concentrations ranged from below detectable limits (< 0.002 mg/L) to 0.0069 mg/L. Dispite there being no guideline for streams, for comparison purposes, all concentrations were below the guideline of 0.01 mg/L (10 µg/L) for lake drinking water as well as within 0.005 – 0.015 mg/L (5-10 ug/L) for aquatic life in lakes.

Table 22. Summary of total phosphorus concentrations (mg/L) measured at ENV sampling locations on the Kitimat River, 1984 - 2015.

Site Number	Site Description	Minimum	Maximum	Average	No. of samples
E260483	Kitimat River @ Rec Site	0.009	0.009	0.009	1
E301870	Kitimat River at Hwy 37 Bridge	0.002	0.005	0.003	5
0430025	Kitimat River at Bridge	< 0.002	0.174	0.017	64
E207568	Kitimat River 100m D/S DOK STP	0.005	0.019	0.011	8
E207569	Kitimat River U/S Eurocan	0.003	0.014	0.006	6
E207570	Kitimat River D/S Eurocan	0.003	0.027	0.016	12
E207686	Kitimat River 100m D/S Eurocan	0.005	0.089	0.021	8
E218981	Kitimat River 100m D/S Eurocan, U/S Reserve	0.004	0.007	0.005	5

6.8 METALS

Total and dissolved metals concentrations have been measured in the Kitimat River since 1976. The methodology, and detectable limits, for many of the metals changed quite drastically during this time, becoming increasingly more sensitive. It is important to remember when analyzing and interpreting long-term water quality data, that results within ten times the detection limits are not as accurate, or reliable, as those found at higher concentrations. For this reason, analytical methods with detection limits no greater than 10% of the guideline concentration are recommended for sample analyses. Table 23 contains a summary of the maximum reported values for a number of metals, as well as weak acid dissociated cyanide (CN-WAD), fluoride, and sulphate, compared with the guideline levels (B.C. ENV, 2016). For this comparison, values below detection limits were omitted, as were samples analyzed with detection limits greater than or equal to the guideline level.

Table 23. Summary of approved water quality guidelines and maximum concentrations of metals found in the Kitimat River watershed, 1976-2015.

	Guideline (mg/L)	Maximum concentration measured	Location of max concentration	Date of sample	No of exceedences	No of samples
Al-D max	0.1	0.24	0430025	1984	8	75
As-T max	0.005	0.029	0430025	1984	1	82
B-T max	1.2	0.039	0430025	1992	0	58
Cd-D max (µg/L)	0.0719 µg/L*	0.0058 µg/L	E207569	2015	0	79
Cd-D avg (µg/L)	0.047 µg/L*	< 0.005 µg/L	E207569	2015	0	3
Co-T - max	0.11	0.00011	E253649	2004	0	25
Co - avg	0.004	0.00017	E207569	2015	0	3
Cu-T max	0.003*	0.009	0430025	1983	10	116
Cu-T avg	0.002	0.001	E218981	2015	0	3
CN-WAD max	0.01	0.001	E301870	2015	0	12
CN-WAD avg	0.005	< 0.001	E301870	2015	0	3
Fluoride-D**	0.4	0.065	0430025	2015	0	32
Fe-T	1	5.36	E253649	2004	11	116
Fe-D	0.35	0.56	0430025	1987	1	68
Pb-T max (µg/L)	3.5 µg/L*	0.6 µg/L	E253649	2004	0	23
Pb-T avg (µg/L)	6.1 µg/L*	0.09 µg/L	E207569	2015	0	3
Mn-T max	0.8	0.14	0430025	1984	0	115
Mn-T avg	0.7	0.01	E207569	2015	0	3
Mo-T max	0.05	0.00095	E260483	2005	0	24
Se-T avg	0.002	0.0004	E253649	2004	0	25
Sulphate - D avg	128	5000***	E207570	2015	1	76
Zn-T max	0.033*	0.14	0430025	1993	1	136
Zn-T avg	0.0075*	0.001	E207569	2015	0	3

*at average hardness 13 mg/L
**Fluoride guideline expressed at total fluoride
***next highest concentration 9.8 mg/L

Aluminum, copper and iron exceeded guidelines in approximately 10% of samples. The most recent sampling, analyzed with low detection limits, did not show guideline exceedances with the exception of one dissolved sulphate sample measured downstream from Eurocan (E207570) on May 3, 2015 (5000 mg/L). However, dissolved sulphate concentrations at this site in the subsequent three weeks ranged from 0.93 mg/L to 1.72 mg/L, so it is not known if the single high concentration was due to contamination or represents an actual result. Metals concentrations measured in samples collected at the old Eurocan intake in 2016 (see Table 32) showed a similar pattern. Guidelines for dissolved aluminum, total copper and total iron were exceeded in one of nineteen samples collected. The sample was collected on September 26, 2016, when 87 mm of precipitation fell in the preceding 24 hours, and turbidity in the sample was very high (237 NTU). The majority of the metals present in this sample were likely bound in suspended sediments and not biologically available. It is recommended that total and dissolved metals concentrations be analyzed at the established monitoring sites, upstream and downstream from potential contamination.

Metal speciation determines the biologically available portion of the total metal concentration, and ultimately influences toxicity. Only a portion of the total metals' concentrations are in a form which can be toxic to aquatic life. Naturally occurring organic materials in the watershed can bind proportions of the metals which are present, forming metal complexes that are not biologically available. Levels of organics as measured by dissolved organic carbon (DOC) vary among water bodies. To aid in future development of metals objectives, DOC should be included in the Kitimat River monitoring program. As increasing water hardness can decrease the toxicity of metals, hardness should also continue to be included in the Kitimat River monitoring program.

6.9 Polycyclic Aromatic Hydrocarbons (PAH)

Polycyclic aromatic hydrocarbons (PAHs) are hydrocarbons (organic compounds containing only carbon and hydrogen) composed of multiple aromatic rings. They are found in fossil fuels and result from the incomplete combustion of organic material. Natural sources include forest fires and volcanic activity, while anthropogenic sources include the burning of fossil fuels in vehicles, wood-burning stoves, and different industrial processes. The Rio Tinto aluminum smelter has emitted PAHs for more than 60 years, and as a result, PAHs are elevated in local soils, sediments, marine waters and streams. They are considered to be carcinogenic, and are therefore of concern to human health, as well as to aquatic life and wildlife.

PAHs were measured at four sites on the Kitimat River (Sites 0430025, E207569, E218981 and E301870). Concentrations of all PAHs were at, or below, detectable limits and are presently not considered a concern in the Kitimat River.

6.10 MICROBIOLOGICAL INDICATORS

Fecal contamination of surface waters used for drinking and recreating can result in high risks to human health from pathogenic microbiological organisms as well as significant economic losses due to beach closures (Scott *et al*., 2002). The direct measurement and monitoring of pathogens in water, however, is difficult due to their low numbers, intermittent and generally unpredictable occurrence, and specific growth requirements (Scott *et al*., 2002). To assess risk of microbiological contamination from fecal matter, resource managers commonly measure fecal indicator bacteria levels (Field and Samadpour, 2007; Ishii and Sadowsky, 2008). The most commonly used indicator organisms for assessing the microbiological quality of water are the total coliforms, fecal coliforms (a subgroup of the total coliforms more appropriately termed thermotolerant coliforms as they can grow at elevated temperatures), and *E. coli* (a thermotolerant coliform considered to be specifically of fecal origin) (Yates, 2007). Enterococci counts are also an important microbiological indicator and are considered more stabile in brackish waters than *E. coli* (Rieberger, 2010).

Total and fecal coliforms have traditionally been used in the assessment of water for domestic and recreational uses. However, research in recent years has shown that there are many differences between the coliforms and the pathogenic microorganisms they are a surrogate for, which limits the use of coliforms as an indicator of fecal contamination (Scott *et al*., 2002). For example, many pathogens, such as enteric viruses and parasites, are not as easily inactivated by water and wastewater treatment processes as coliforms are. As a result, disease outbreaks do occur when indicator bacteria counts are at acceptable levels (Yates, 2007). Additionally, some members of the coliform group, such as *Klebsiella*, can originate from non-fecal sources (Ishii and Sadowsky, 2008) adding a level of uncertainty when analyzing data. Waters contaminated with human feces are generally regarded as a greater risk to human health, as they are more likely to contain human-specific enteric pathogens (Scott *et al*., 2002). Measurement of total and fecal coliforms does not indicate the source of contamination, which can make the actual risk to human health uncertain; thus, it is not always clear where to direct management efforts.

The B.C. approved water quality guidelines for microbiological indicators were developed in 1988 (Warrington, 1988) and include *E. coli*, enterococci, *Pseudomonas aeruginosa*, and fecal coliforms. The monitoring programs of the B.C. ENV have traditionally measured total coliforms, fecal coliforms, *E. coli* and enterococci, either alone or in combination, depending on the specific program. As small pieces of fecal matter in a sample can skew the overall results for a particular site, the 90th percentiles (for drinking water) and geometric means (for recreation) are generally used to determine if the water quality guideline is exceeded, as extreme values would have less effect on the data. The B.C. ENV drinking water guideline, for raw waters receiving disinfection only, is that the 90th percentile of at least five weekly samples collected in a 30-day period should not exceed 10 CFU/100 mL for either fecal coliforms or *E. coli* (B.C. ENV, 2001).

Fecal coliform concentrations were measured 104 times at different sites on the Kitimat River between 1989 and 2015, with values ranging from below detection limits (<1 CFU/100 mL) to a maximum of 165 CFU/100 mL. Samples were collected with sufficient frequency (a minimum of five weekly samples within 30 days) on 15 occasions, and the 90th percentile for these groups of samples ranged from 8.6 CFU/100 mL to 60.7 CFU/100 mL (Table 24). All but one of the 90th percentile values exceeded the drinking water guideline. Water samples collected at the infiltration gallery in April 2003 as part of the Downie report (Downie, 2005) had fecal coliform concentrations ranging from 2 CFU/100 mL to 165 CFU/100 mL but were not collected at a sufficient frequency to enable a 90th percentile calculation.

Table 24. Summary of 90th percentile values calculated for fecal coliform concentrations measured in the Kitimat River, 1989-2015.

	10/3/1989	Jul 6 - Aug 2, 1994	Jun 21 - Sept 8, 1993
0430025	13	8.6	
E207568	20.6		
E207569		40.4	
E207570	20.6		
E207686	13.2		
E218981			21.2 - 60.7*

*represent nine 90th percentile values based on rolling 90th percentiles.

E. coli concentrations were measured at least 25 times at sites throughout the watershed between 1992 and 2015 (Table 25). In 2015, at least five samples were collected within a 30-day period at three sites. The 90th percentile values ranging from 2.2 CFU/100 mL at Kitimat River upstream from Eurocan (Site E207569), to 9.6 CFU/100 mL at the Highway 37 Bridge (Site E301870). The highest 90th percentile value occurred at the site furthest upstream in the watershed, above all effluent discharge outfalls, and it is likely that the source of the *E. coli* at this site was wildlife.

Table 25. E. coli data, 1992-2015 and 90th percentile values calculated for 2015 concentrations measured in the Kitimat River.

	0430025	E207568	E207569	E207570	E218981	E234009	E253649
1992-07-14	2						
1998-09-23	3	8				4	
2003-09-30							26
2003-10-15							1
2003-10-21							78
2004-01-14							54
2004-03-08							51
2004-07-05							5
2015-05-03			1	1	3		
2015-05-13			1	3	8		
2015-05-21			1	14	9		
2015-05-27			3	1	7		
2015-06-03			1	1	4		
90th percentile			2.2	9.6	8.6		

Downie (2005) measured enterococci in 2003 and 2004 at the infiltration gallery (E253649), and concentrations ranged from 4 CFU/100 mL to 250 CFU/100 mL; however, sampling frequency was insufficient to allow comparisons with guidelines. As part of his study, Downie (2005) also found *Cryptosporidium* oocysts and *Giardia* cysts in raw water samples from the Kitimat River at the infiltration gallery, but found considerably decreased levels of bacteria and no parasites in the water after it had passed through the infiltration gallery (but prior to chlorination). *Giardia* cysts were also found in the one sample collected in 2016 at the Eurocan intake.

7.0 Recommendations for future sampling necessary to develop WQO

Based on the data collected over the past 40 years, the primary concerns associated with water quality in the Kitimat River appear to pertain to elevated turbidity and total suspended solids concentrations, as well as elevated fecal coliforms. However, considerable changes have occurred in that time (modifications in sampling locations, and changes in land-use as industries closed and changed ownership and therefore an anticipated change in volume and signature of discharges). These changes make it difficult to assess trends within the watershed (either upstream to downstream or over time at the same location), as well as make predictions regarding potential parameters of concern. For this reason, we recommend the implementation of a robust sampling program, whereby samples are collected on a regular basis for at least three years at sites upstream and downstream from the primary potential sources of contamination.

Table 26. Recommended sampling locations for 2017-2019 Kitimat River water quality monitoring program.

EMS ID	Site Name	Longitude (Decimal Degrees)	Latitude (Decimal Degrees)
E301870	KITIMAT RIVER U/S CONTROL (KR REF)	128.523	54.26039
0430025	KITIMAT RIVER AT BRIDGE	128.6814	54.0567
E207569	KITIMAT R U/S EUROCAN	128.6779	54.0419
E207570	KITIMAT R D/S EUROCAN	128.678	54.0353
E218981	KITIMAT RIVER D/S EUROCAN, U/S RESERVE	128.6764	54.0311

A number of WQGs (including sulphate, *E. coli*, and some metals) are assessed using average values, based on a minimum of five samples collected at regular intervals within a 30-day period. Therefore, we recommend samples be collected at this frequency twice a year (during the low-flow period in March or April, and during the fall, correlated with elevated rainfall events, if possible). In this way, the two most sensitive periods for water quality would be represented: low flows (when dilution of contaminants is lowest), and high flow (when elevated runoff can cause elevated turbidity and TSS levels). Outside of this period, we recommend sampling on a monthly or bi-monthly schedule.

Table 27. Recommended water quality paramters for 2017-2019 Kitimat River water quality monitoring program.

Parameter	Justification / Concern
Chloride	Standard field measurement. Nitrite guideline varies with chloride concentration.
*Chlorophyll *a* (periphyton in fall)	Index of algal biomass. Concern for recreational uses, fish habitat and changes in aquatic communities.
*Color	Indicator of organic matter. Drinking water aesthetic concern.
Metals total and dissolved + hardness	Full suit with interest in aluminum, arsenic, copper, iron, sulphate and zinc. Discharge concerns
E. coli (CFU) (freshwater)	Indicator organism for assessing microbiological quality of water. Drinking water and recreational use concern.
Fluoride	Proximity to aluminum smelter. Drinking water and aquatic life concern.
*pH – field / lab	River has little buffering capacity therefore suseptable to changes in pH. Acidification concerns related to air emisssions.
Specific Conductance	Standard field/lab measurement. Potential impact indicator (landslides, discharges)
Sulphate	Industrial discharges. Drinking water and aquatic life concern.
TOC	Potential indicator of increased DBP in drinking water due to DOK WTP chlorination disinfection processes. Monitor for potential sources.
*TSS	Closely correlated with turbidity. Aquatic health and water withdrawal concens.
*Turbidity – field /lab	Naturally high in Kitimat River. Potential impact indicator (glacial melt, erosion). Water withdrawal concens.
DOC	Aid in development of metals objective. Organic material can bind with metals such that they are not biologically available.
*Ammonia Nitrogen (total)	Related to productivity. Potential drinking water and aquatic life/health impact indicators.
*Nitrite Nitrogen	
Nitrate, Nitrite + Nitrate	
Nitrogen -Total	
Total Kjeldahl Nitrogen	
Total Organic Nitrogen	
Orthophosphorus - dissolved	
Phophorus - Total	

*Provisional WQO have been identified for the lower Kitimat River for these parmeters

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APPENDIX I. SUMMARY OF WATER QUALITY DATA COLLECTED FROM KITIMAT RIVER, 1976-2016

Table 28. Summary of water quality data collected from Kitimat River at Hwy 37 Bridge (upstream control), Site E301870, 2015.

LOWER DEPTH	Minimum	Maximum	Average	Std Dev	No. of samples
Amonia Dissolved (mg/L)	< 0.005	0.014	0.010	0.004	5
Amonia:T (mg/L)	0.006	0.014	0.011	0.003	4
Chlrid:D (mg/L)	< 0.5	0.56	0.51	0.03	5
Color True (Col.unit)	< 5	18.7	11.8	6.9	3
Dissolved Oxygen-Field (mg/L)	12.11	13.21	12.71	0.56	3
E Coli (CFU/100mL)	< 1	14	4	6	5
FluordeD (mg/L)	0.02	0.04	0.03	0.01	5
Hardness (Dissolved) (mg/L)	10.1	17.9	12.7	3.1	5
Hardness Total (T) (mg/L)	10.7	19.6	13.2	3.6	5
N.Kjel:T (mg/L)	0.042	0.114	0.061	0.030	5
Nitrate (NO3) Dissolved (mg/L)	0.0209	0.0912	0.0478	0.0307	5
Nitrate + Nitrite Diss. (mg/L)	0.0209	0.0912	0.0478	0.0307	5
Nitrogen - Nitrite Diss. (mg/L)	< 0.001	< 0.002	< 0.0018		5
Nitrogen Organic-Total (mg/L)	0.028	0.103	0.052	0.030	5
Nitrogen Total (mg/L)	0.036	0.182	0.102	0.060	5
Ortho-Phosphate Dissolved (mg/L)	< 0.001	0.0019	0.0013	0.0004	5
pH (pH)	7.2	7.67	7.38	0.18	5
pH-Field (pH)	6.39	7.17	6.72	0.40	3
P--T (mg/L)	< 0.002	0.0048	0.0026	0.0012	5
Residue Non-filterable (mg/L)	3.3	21	8.2	7.5	5
Specific Conductance-Fld (uS/cm)	17.8	28.2	23.7	5.4	3
Sulfat:D (mg/L)	1.19	1.94	1.47	0.35	5
Sulfide Total (mg/L)	< 0.005	0.0115	0.007	0.003	4
Sulfur Dissolved (mg/L)	0.58	0.58	0.58		1
Sulfur Total (mg/L)	0.58	0.58	0.58		1
Temp (C)	7.9	7.9	7.9		1
Temperature-Field (C)	6.8	9	7.9	1.6	2
Ag-D (mg/L)	< 0.000005	0.000032	0.000010	0.000012	5
Al-D (mg/L)	0.0148	0.0366	0.0262	0.0092	5
As-D (mg/L)	< 0.00002	< 0.00002	< 0.00002	0	5
Ba-D (mg/L)	0.00771	0.0155	0.01027	0.00307	5
B--D (mg/L)	< 0.005	< 0.01	< 0.009		5
Be-D (mg/L)	< 0.00001	< 0.00001	< 0.00001	0	5
Bi-D (mg/L)	< 0.000005	< 0.000005	< 0.000005		5
Ca-D (mg/L)	3.53	6.01	4.36	0.98	5

LOWER DEPTH	Minimum	Maximum	Average	Std Dev	No. of samples
Cd-D (mg/L)	< 0.000005	< 0.000005	< 0.000005		5
Co-D (mg/L)	0.000009	0.000013	0.000010	0.000001	5
Cr-D (mg/L)	< 0.0001	< 0.0001	< 0.0001	0	5
Cu-D (mg/L)	0.00033	0.00055	0.00040	0.00009	5
Fe-D (mg/L)	0.008	0.022	0.013	0.006	5
Hg-D (mg/L)	< 0.000005	< 0.00001	< 0.000009		5
K--D (mg/L)	0.267	0.449	0.329	0.072	5
Li-D (mg/L)	< 0.0005	< 0.0005	< 0.0005		5
Mg-D (mg/L)	0.303	0.696	0.424	0.156	5
Mn-D (mg/L)	0.000661	0.001130	0.000852	0.000184	5
Mo-D (mg/L)	0.000632	0.001010	0.000759	0.000146	5
Na-D (mg/L)	0.519	0.974	0.647	0.190	5
Ni-D (mg/L)	0.000033	0.000043	0.000037	0.000005	4
Pb-D (mg/L)	< 0.000005	0.000015	0.000010	0.000004	5
Sb-D (mg/L)	< 0.00002	0.000054	0.000027	0.000015	5
Se-D (mg/L)	< 0.00004	< 0.00004	< 0.00004		5
Si-D (mg/L)	1.2	2.47	1.64	0.49	5
Sn-D (mg/L)	0.000027	0.000027	0.000027		1
Sr-D (mg/L)	0.0242	0.0475	0.0309	0.0095	5
Ti-D (mg/L)	< 0.0005	< 0.0005	< 0.0005		4
Tl-D (mg/L)	< 0.000002	0.000002	0.000002		5
U--D (mg/L)	0.000063	0.000140	0.000089	0.000031	5
V--D (mg/L)	0.00024	0.00136	0.00050	0.00048	5
Zn-D (mg/L)	< 0.0001	0.00035	0.0002	0.0001	5
Zr-D (mg/L)	< 0.0001	< 0.0001	< 0.0001		4
Ag-T (mg/L)	< 0.000005	0.000009	0.000006	0.000002	5
Al-T (mg/L)	0.042	0.36	0.143	0.130	5
As-T (mg/L)	< 0.00002	0.000062	0.00003	0.00002	5
Ba-T (mg/L)	0.00948	0.0159	0.01178	0.00257	5
Be-T (mg/L)	< 0.00001	0.000011	0.0000102		5
Bi-T (mg/L)	< 0.000005	< 0.00002	< 0.000008		5
B--T (mg/L)	< 0.005	< 0.05	< 0.017		5
Ca-T (mg/L)	3.63	6.79	4.52	1.28	5
Cd-T (mg/L)	< 0.000005	0.000009	0.0000058	0.0000018	5
Co-T (mg/L)	0.0000151	0.0002020	0.0000741	0.0000753	5
Cr-T (mg/L)	< 0.0001	0.0009	0.0003	0.0003	5
Cu-T (mg/L)	0.000531	0.00168	0.0008158	0.000491614	5
Fe-T (mg/L)	0.036	0.346	0.132	0.126	5
Hg-T (mg/L)	< 0.000005	< 0.00001	< 0.000009		5
K--T (mg/L)	0.286	0.428	0.339	0.054	5

LOWER DEPTH	Minimum	Maximum	Average	Std Dev	No. of samples
Li-T (mg/L)	< 0.0005	< 0.0005	< 0.0005	0	5
Mg-T (mg/L)	0.378	0.648	0.470	0.116	5
Mn-T (mg/L)	0.00117	0.0116	0.004864	0.004180255	5
Mo-T (mg/L)	0.000708	0.001	0.0007832	0.000121806	5
Na-T (mg/L)	0.531	0.936	0.647	0.167	5
Ni-T (mg/L)	0.000043	0.00061	0.0001854		5
Pb-T (mg/L)	0.0000155	0.0001490	0.0000593	0.0000557	5
Sb-T (mg/L)	< 0.00002	< 0.00005	< 0.00003		5
Se-T (mg/L)	< 0.00004	< 0.00004	< 0.00004		5
Si-T (mg/L)	1.4	2.4	1.8	0.4	5
Sn-T (mg/L)	0.000035	0.000035	0.000035		1
Sr-T (mg/L)	0.0245	0.0459	0.0306	0.0087	5
Ti-T (mg/L)	< 0.0005	0.0186	0.008175	0.007751811	4
Tl-T (mg/L)	< 0.000002	0.000005	0.000003	0.000001	5
U--T (mg/L)	0.0000737	0.000143	0.000103	0.000029	5
V--T (mg/L)	0.00035	0.00128	0.000638	0.000372518	5
Zn-T (mg/L)	0.00024	0.0014	0.000702	0.000492209	5
Zr-T (mg/L)	< 0.0001	< 0.0001	< 0.0001		4
CN-T (mg/L)	< 0.001	< 0.001	< 0.001		1
Cyanide (WAD) (mg/L)	< 0.0005	0.005	0.0015	0.002	5
Cyanide S.A.D. (mg/L)	< 0.0005	0.00092	0.0007	0.0002	4
2-Methylnaphthalene (mg/L)	< 0.0001	< 0.0001	< 0.0001		4
Acenaphthene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Acenaphthylene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Acridine (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Acridine d9 (%)	81.1	81.1	81.1		1
Anthracene (mg/L)	< 0.00001	< 0.00005	< 0.00002		5
Benzo(a)anthracene (mg/L)	< 0.00001	< 0.00005	< 0.000018		5
Benzo(b)fluoranthene (mg/L)	< 0.00005	< 0.00005	< 0.00005		1
Benzo(b+j)fluoranthene (mg/L)	< 0.00005	< 0.00005	< 0.00005		4
Benzo(g;h;i)perylene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Benzo(k)fluoranthene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Bezo(a)pyrene (mg/L)	< 0.000009	< 0.00001	< 0.0000092		5
Chry-d12 (%)	85.6	85.6	85.6		1
Chrysene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Dibenzo(a;h)anthracene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Fluoranthene (mg/L)	< 0.00002	< 0.00005	<0.00003		5
Fluorene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5

LOWER DEPTH	Minimum	Maximum	Average	Std Dev	No. of samples
Indeno(1;2;3-cd)pyrene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Naphthalene d8 (%)	95.6	95.6	95.6		1
Napthalene (mg/L)	< 0.00005	< 0.0001	< 0.00009		5
Oil&Grease (mg/L)	< 1	< 1	< 1		4
PAH (High molecular wt) (mg/L)	< 0.00005	< 0.00015	< 0.00007		5
PAH (Low molecular wt) (mg/L)	< 0.00012	< 0.00024	< 0.00022		5
PAH- (mg/L)	< 0.00021	< 0.00024	< 0.00023		5
Phenanthrene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Phen-d10 (%)	95.2	95.2	95.2		1
Pyrene (mg/L)	< 0.00002	< 0.00005	<0.00003		5
Quinoline (mg/L)	< 0.00005	< 0.00024	< 0.0002		5

Table 29. Summary of water quality data collected from Kitimat River at Bridge, Site 0430025, 1976 – 2015.

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Alkalinity Total 4.5 (mg/L)	9.2	22.5	14.7	3.4	56
Amonia Dissolved (mg/L)	< 0.005	0.34	0.016	0.037	90
Amonia:T (mg/L)	0.008	0.033	0.015	0.012	4
Biomass (mg)	302	468	385	117	2
BiomsFix (mg)	290	456	373	117	2
Carbon Total Inorganic (mg/L)	1	7	4	1	55
Carbon Total Organic (mg/L)	< 1	8	2	2	22
Chlorophyll A (g/m2)	0.0133	0.0571	0.03	0.01	12
Chlrid:D (mg/L)	< 0.5	2	0.9	0.4	21
Coli:Fec (CFU/100mL)	1	109	11	23	20
Coli:Tot (CFU/100mL)	7	7	7		1
Color Apparent (Col.unit)	8	68	31	20	10
Color True (Col.unit)	< 5	40	10	9	29
ColorTAC (TAC)	6	14	9	4	3
Diss Oxy (mg/L)	10.9	13.9	11.8	0.9	11
Dissolved Oxygen-Field (mg/L)	11.22	12.8	12.2	0.7	4
E Coli (CFU/100mL)	2	3	3	1	3
Entercoc (CFU/100mL)	4	4	4		1
Flow Rte (m3/s W)	0.065	0.116	0.091	0.036	2
FluordeD (mg/L)	0.037	0.19	0.101	0.026	52
Hardness (Dissolved) (mg/L)	9.07	19.9	13.8	3.9	7
Hardness Total (T) (mg/L)	11.3	22	16	4	10
N.Kjel:T (mg/L)	< 0.01	0.53	0.08	0.08	63
Nitrate (NO3) Dissolved (mg/L)	0.02	0.0978	0.048	0.029	5
Nitrate + Nitrite Diss. (mg/L)	< 0.02	0.15	0.06	0.03	81

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Nitrogen - Nitrite Diss. (mg/L)	< 0.002	0.04	0.006	0.009	16
Nitrogen Organic-Total (mg/L)	< 0.02	0.052	0.039	0.013	5
Nitrogen Total (mg/L)	0.04	0.64	0.17	0.12	26
NO2+NO3 (mg/L)	< 0.02	0.098	0.049	0.029	5
Ortho-Phosphate Dissolved (mg/L)	< 0.001	0.023	0.003	0.002	84
pH (pH)	6.5	7.9	7.0	0.3	83
pH-Field (pH)	6.24	6.48	6.36	0.14	4
Phosphorus Tot. Dissolved (mg/L)	< 0.003	0.038	0.005	0.005	60
P--T (mg/L)	0.0024	2.4	0.081	0.355	76
Res:Tot (mg/L)	2.2	366	53.7	51.0	69
Residue Filterable 1.0u (mg/L)	17	50	31	10	22
Residue Non-filterable (mg/L)	1	321	14	42	95
Silica:D (mg/L)	2.8	6.2	4.3	1.2	13
Specific Conductance (uS/cm)	18	62	38	12	76
Specific Conductance-Fld (uS/cm)	20.2	35.6	27.7	6.6	4
Sulfat:D (mg/L)	1.5	6.3	3.3	1.3	46
Sulfide Total (mg/L)	< 0.5	< 0.5	< 0.5	0	10
Sulfur Total (mg/L)	0.64	0.76	0.70	0.08	2
Temp (C)	0	12.3	7.4	3.2	17
Temperature-Field (C)	3.7	9.5	7.7	2.7	4
Turbidity (mg/L)	1	16.7	6.6	6.1	6
Turbidity (NTU)	0.7	220	8.2	24.2	88
Wtr Vel (m/s)	0.274	1.271	0.922	0.369	6
Ag-T (mg/L)	< 0.01	< 0.03	< 0.03	0.005	32
Al-D (mg/L)	< 0.02	0.3	0.07	0.06	51
Al-T (mg/L)	< 0.02	4.43	0.44	0.67	89
As-D (mg/L)	< 0.001	< 0.25	< 0.056	0.104	64
As-T (mg/L)	0.001	< 0.25	< 0.061	0.095	112
Ba-D (mg/L)	< 0.01	0.06	0.01	0.01	50
Ba-T (mg/L)	0.006	0.025	0.013	0.005	32
B--D (mg/L)	< 0.01	0.01	0.01	0.00	50
Be-T (mg/L)	< 0.001	< 0.001	< 0.001		32
Bi-T (mg/L)	< 0.02	< 0.02	< 0.02		32
B--T (mg/L)	0.023	< 0.04	< 0.04	0.003	32
Ca-D (mg/L)	2.64	8.09	5.05	1.39	50
Ca-T (mg/L)	2.38	10.8	5.19	1.71	90
Cd-D (mg/L)	< 0.0005	< 0.01	< 0.003	0.004	64
Cd-T (mg/L)	0.0005	< 0.01	< 0.003	0.004	112
Co-D (mg/L)	< 0.1	0.1	< 0.1		50
Co-T (mg/L)	< 0.003	0.12	0.066	0.047	90

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Cr-D (mg/L)	< 0.01	< 0.01	< 0.01		50
Cr-T (mg/L)	< 0.002	0.01	0.052	0.421	90
C--T (mg/L)	2	9	6	2	34
Cu-D (mg/L)	0.001	< 0.01	< 0.003	0.004	63
Cu-T (mg/L)	0.001	< 0.01	< 0.004	0.003	111
Fe-D (mg/L)	0.03	0.56	0.17	0.10	53
Fe-T (mg/L)	0.11	5.28	0.62	0.77	90
K--D (mg/L)	0.3	0.6	0.4	0.1	13
K--T (mg/L)	< 0.4	0.8	0.6	0.3	2
Mg-D (mg/L)	0.27	0.95	0.57	0.17	50
Mg-T (mg/L)	0.3	2.05	0.73	0.31	90
Mn-D (mg/L)	< 0.01	0.06	0.02	0.01	50
Mn-T (mg/L)	0.008	0.14	0.024	0.020	90
Mo-D (mg/L)	< 0.01	0.02	0.01	0.00	50
Mo-T (mg/L)	0.004	0.01	< 0.008	0.003	90
Na-D (mg/L)	< 0.5	2.7	1.4	0.5	58
Na-T (mg/L)	0.88	1.18	1.03	0.21	2
Ni-D (mg/L)	< 0.05	< 0.05	< 0.05		50
Ni-T (mg/L)	< 0.008	< 0.05	< 0.036	0.019	89
Pb-D (mg/L)	0.001	< 0.1	< 0.024	0.042	64
Pb-T (mg/L)	0.001	< 0.1	< 0.029	0.037	112
Sb-T (mg/L)	< 0.015	< 0.02	< 0.020	0.001	32
Se-T (mg/L)	< 0.03	< 0.03	< 0.03		32
Si-T (mg/L)	0.19	4.6	2.30	1.15	32
Sn-T (mg/L)	< 0.02	< 0.02	< 0.02		32
Sr-T (mg/L)	0.014	0.059	0.030	0.012	32
Te-T (mg/L)	< 0.02	< 0.02	< 0.02		32
Ti-T (mg/L)	0.005	0.043	0.014	0.008	32
Tl-T (mg/L)	< 0.003	< 0.03	< 0.028	0.007	32
V--D (mg/L)	< 0.01	< 0.01	< 0.01		50
V--T (mg/L)	< 0.003	0.01	0.008	0.003	90
Zn-D (mg/L)	< 0.005	0.02	0.006	0.003	63
Zn-T (mg/L)	< 0.005	0.14	0.009	0.013	111
Zr-T (mg/L)	< 0.003	< 0.003	< 0.003		32
Acenaphthene (mg/L)	< 0.00001	< 0.00001	< 0.00001		1
Acenaphthylene (mg/L)	< 0.00001	< 0.00001	< 0.00001		1
Acen-d10 (%)	84	84	84		1
Anthracene (mg/L)	< 0.00001	< 0.00001	< 0.00001		1
Benzo(a)anthracene (mg/L)	< 0.00001	< 0.00001	< 0.00001		1
Benzo(g;h;i)perylene (mg/L)	0.00001	0.00001	0.00001		1

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Benzofluoranthene (ug/g)	< 0.00001	< 0.00001	< 0.00001		1
Bezo(a)pyrene (mg/L)	< 0.00001	< 0.00001	< 0.00001		1
Bromodichloromethane (mg/L)	< 0.001	< 0.001	< 0.001		2
Bromoform (mg/L)	< 0.001	< 0.001	< 0.001		2
Chlorodibromomethane (mg/L)	< 0.001	< 0.001	< 0.001		2
Chloroform (mg/L)	< 0.001	< 0.001	< 0.001		2
Chry-d12 (%)	104	104	104		1
Chrysene (mg/L)	< 0.00001	< 0.00001	< 0.00001		1
Dibenzo(a;h)anthracene (mg/L)	0.00001	0.00001	0.00001		1
Fluoranthene (mg/L)	< 0.00001	< 0.00001	< 0.00001		1
Fluorene (mg/L)	< 0.00001	< 0.00001	< 0.00001		1
Indeno(1;2;3-cd)pyrene (mg/L)	0.00001	0.00001	0.00001		1
Napthalene (mg/L)	0.00001	0.00001	0.00001		1
PCB's - Total (mg/L)	0.0004	0.0004	0.0004		2
Pery-d12 (%)	110	110	110		1
Phenanthrene (mg/L)	< 0.00001	< 0.00001	< 0.00001		1
Phen-d10 (%)	84	84	84		1
Pyrene (mg/L)	< 0.00001	< 0.00001	< 0.00001		1

Table 30. Summary of water quality data collected from Kitimat River upstream from Eurocan, Site E207569, 1988 – 2015.

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Alkalinity pH 8.3 (mg/L)	< 0.5	< 0.5	< 0.5		1
Alkalinity Total 4.5 (mg/L)	15	15	15		1
Amonia Dissolved (mg/L)	< 0.005	0.069	0.026	0.015	24
Amonia:T (mg/L)	0.01	0.038	0.020	0.013	4
Carbon Total Organic (mg/L)	0.7	0.7	0.7		1
Chlorophyll A (mg/L)	0.0012	0.0022	0.0016	0.0004	6
Chlrid:D (mg/L)	< 0.5	1.6	0.9	0.5	6
Coli:Fec (CFU/100mL)	5	78	30	29	7
Color True (Col.unit)	< 5	30.2	11.6	9.9	12
Dissolved Oxygen-Field (mg/L)	12.31	13.15	12.62	0.46	3
E Coli (CFU/100mL)	< 1	3	1	1	5
FluordeD (mg/L)	0.02	< 0.1	0.07	0.04	11
Hardness (Dissolved) (mg/L)	8.6	14.7	10.6	2.4	5
Hardness Total (T) (mg/L)	9.18	14.4	11.6	2.1	6
N.Kjel:T (mg/L)	0.035	0.088	0.057	0.020	5
Nitrate (NO3) Dissolved (mg/L)	0.0177	0.111	0.0451	0.0348	6
Nitrate + Nitrite Diss. (mg/L)	0.0198	0.111	0.0401	0.0215	16
Nitrogen - Nitrite Diss. (mg/L)	0.001	0.06	0.007	0.013	19

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Nitrogen (Kjel.) Tot Diss (mg/L)	0.1	0.1	0.1		1
Nitrogen Organic-Total (mg/L)	0.025	0.05	0.039	0.011	6
Nitrogen Total (mg/L)	0.047	0.147	0.106	0.042	6
Nitrogen Total Dissolved (mg/L)	0.134	0.134	0.134		1
NO2+NO3 (mg/L)	< 0.003	0.112	0.045	0.044	5
Ortho-Phosphate Dissolved (mg/L)	< 0.001	0.0036	0.0025	0.0010	9
PAH- (mg/L)	< 0.00021	< 0.00024	< 0.000234		5
pH (pH)	6.8	8	7.3	0.3	25
pH-Field (pH)	6.44	6.72	6.57	0.14	3
Phosphorus Tot. Dissolved (mg/L)	< 0.003	0.006	0.004	0.002	3
P--T (mg/L)	0.0026	0.014	0.0056	0.0043	6
Res:Tot (mg/L)	35	35	35		1
Residue Filterable 1.0u (mg/L)	28	28	28		1
Residue Non-filterable (mg/L)	< 4	73	13	14	29
Specific Conductance (uS/cm)	25	33	28	3	5
Specific Conductance-Fld (uS/cm)	20.5	25.4	22.7	2.5	3
Sulfat:D (mg/L)	1.27	2.5	1.63	0.45	6
Sulfide Total (mg/L)	< 0.005	< 0.5	< 0.34		15
Sulfur Dissolved (mg/L)	< 0.5	< 3	< 2.5		5
Sulfur Total (mg/L)	< 0.5	< 15	4.2	5.4	6
Temp (C)	10	10	10		1
Temperature-Field (C)	7.5	9.3	8.4	1.3	2
Turbidity (NTU)	1.5	29	6.4	5.9	24
Ag-D (mg/L)	< 0.000005	< 0.000005	< 0.000005		5
Al-D (mg/L)	0.0154	0.0495	0.0255	0.0104	10
As-D (mg/L)	0.00002	0.000041	0.000027	0.000008	5
Ba-D (mg/L)	0.00596	0.0113	0.00777	0.00206	5
B--D (mg/L)	< 0.005	< 0.01	< 0.009		5
Be-D (mg/L)	< 0.00001	< 0.00001	< 0.00001		5
Bi-D (mg/L)	< 0.000005	< 0.000005	< 0.000005		5
Ca-D (mg/L)	2.97	4.89	3.59	0.76	5
Cd-D (mg/L)	< 0.000005	0.000006	0.000005	0.0000004	5
Co-D (mg/L)	0.0000165	0.0000342	0.0000253	0.0000063	5
Cr-D (mg/L)	< 0.0001	0.00011	0.0001	0.0000	5
Cu-D (mg/L)	0.000334	0.000724	0.000510	0.000147	5
Fe-D (mg/L)	0.031	0.0859	0.0441	0.0235	5
Hg-D (mg/L)	< 0.000005	< 0.00001	< 0.000009		5
K--D (mg/L)	0.277	0.45	0.341	0.068	5
Li-D (mg/L)	< 0.0005	< 0.0005	< 0.0005	0	5
Mg-D (mg/L)	0.289	0.6	0.396	0.129	5

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Mn-D (mg/L)	0.00295	0.0061	0.00435	0.00118	5
Mo-D (mg/L)	0.000442	0.000517	0.000468	0.000035	5
Na-D (mg/L)	0.615	1.39	0.98	0.39	5
Ni-D (mg/L)	0.000037	0.000064	0.000052	0.000010	5
Pb-D (mg/L)	0.0000078	0.0000198	0.0000135	0.0000044	5
Sb-D (mg/L)	< 0.00002	0.000059	0.00003	0.00002	5
Se-D (mg/L)	< 0.00004	< 0.00004	< 0.00004	0	5
Si-D (mg/L)	1.24	2.67	1.63	0.59	5
Sn-D (mg/L)	< 0.0002	0.0003	0.0002	0.0000	5
Sr-D (mg/L)	0.0182	0.0317	0.02244	0.00540	5
Ti-D (mg/L)	< 0.0005	0.0008	0.0006	0.0002	4
Tl-D (mg/L)	< 0.000002	0.000003	0.000002	0.0000004	5
U--D (mg/L)	0.0000699	0.000103	0.0000854	0.0000149	5
V--D (mg/L)	0.00023	0.00053	0.00035	0.00013	5
Zn-D (mg/L)	0.00014	0.00058	0.00035	0.00019	5
Zr-D (mg/L)	< 0.0001	< 0.0001	< 0.0001	0	4
Ag-T (mg/L)	< 0.000005	0.00002	< 0.000008		6
Al-T (mg/L)	0.0937	0.865	0.2918	0.2883	6
As-T (mg/L)	0.000029	0.000156	0.000075	0.000047	6
Ba-T (mg/L)	0.00913	0.0143	0.01101	0.00200	6
Be-T (mg/L)	< 0.00001	0.00002	0.000013	0.000004	6
Bi-T (mg/L)	< 0.000005	< 0.00002	< 0.00001		6
B--T (mg/L)	< 0.005	< 0.05	< 0.0155		6
Ca-T (mg/L)	3.03	4.75	3.78	0.67	6
Cd-T (mg/L)	< 0.000005	0.00001	0.000006	0.000002	6
Co-T (mg/L)	0.0000625	0.000425	0.0001652	0.0001337	6
Cr-T (mg/L)	0.00013	0.00103	0.00038	0.000332	6
Cu-T (mg/L)	0.000643	0.00213	0.001129	0.000526	6
Fe-T (mg/L)	0.137	0.85	0.317	0.267	6
Hg-T (mg/L)	< 0.000005	< 0.00001	< 0.000009		5
K--T (mg/L)	0.319	0.445	0.373	0.060	5
Li-T (mg/L)	0.00018	< 0.0005	< 0.00045	0.00013	6
Mg-T (mg/L)	0.384	0.74	0.52	0.15	6
Mn-T (mg/L)	0.00578	0.0237	0.01148	0.00638	6
Mo-T (mg/L)	0.000404	0.00054	0.000472	0.000058	6
Na-T (mg/L)	0.67	1.7	1.11	0.44	6
Ni-T (mg/L)	0.000105	0.00078	0.000277	0.000255	6
Pb-T (mg/L)	0.0000297	0.000187	0.0000811	0.0000578	6
Sb-T (mg/L)	0.000007	< 0.00005	< 0.000023	0.000014	6
Se-T (mg/L)	< 0.00004	< 0.0002	< 0.00007	0.00006	6

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Si-T (mg/L)	1.51	2.69	1.99	0.60	5
Sn-T (mg/L)	< 0.00001	< 0.0002	< 0.00014		6
Sr-T (mg/L)	0.0197	0.0309	0.0241	0.0048	6
Ti-T (mg/L)	0.00215	0.0325	0.01278	0.01160	5
Tl-T (mg/L)	< 0.000002	0.000007	0.000004	0.000002	6
U--T (mg/L)	0.00008	0.000143	0.000105	0.000022	6
V--T (mg/L)	0.0005	0.00205	0.00093	0.00057	6
Zn-T (mg/L)	0.00042	0.0022	0.00101	0.00064	6
Zr-T (mg/L)	< 0.0001	< 0.005	< 0.00108	0.002	5
CN-T (mg/L)	< 0.001	< 0.001	< 0.001		1
Cyanide (WAD) (mg/L)	0.0005	0.00072	0.00056	0.00011	4
Cyanide S.A.D. (mg/L)	< 0.0005	0.00074	0.00056	0.00012	4
Abietic Acid (mg/L)	< 0.001	< 0.001	< 0.001		1
Dehydroabietic Acid (mg/L)	< 0.001	< 0.001	< 0.001		1
Isopimaric Acid (mg/L)	< 0.001	< 0.001	< 0.001		1
Levopimaric Acid (mg/L)	< 0.001	< 0.001	< 0.001		1
Neoabietic Acid (mg/L)	< 0.001	< 0.001	< 0.001		1
Pimaric Acid (mg/L)	< 0.001	< 0.001	< 0.001		1
Sandaracopimaric Acid (mg/L)	< 0.001	< 0.001	< 0.001		1
2-Methylnaphthalene (mg/L)	< 0.0001	< 0.0001	< 0.0001		4
Acenaphthene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Acenaphthylene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Acridine (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Acridine d9 (%)	68.3	68.3	68.3		1
Anthracene (mg/L)	< 0.00001	< 0.00005	< 0.000018		5
Benzo(a)anthracene (mg/L)	< 0.00001	< 0.00005	< 0.000018		5
Benzo(b)fluoranthene (mg/L)	< 0.00005	< 0.00005	< 0.00005		1
Benzo(b+j)fluoranthene (mg/L)	< 0.00005	< 0.00005	< 0.00005		4
Benzo(g;h;i)perylene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Benzo(k)fluoranthene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Bezo(a)pyrene (mg/L)	< 0.000009	< 0.00001	< 0.0000092		5
Chry-d12 (%)	77.1	77.1	77.1		1
Chrysene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Dibenzo(a;h)anthracene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Fluoranthene (mg/L)	< 0.00002	< 0.00005	< 0.000026		5
Fluorene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Indeno(1;2;3-cd)pyrene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Naphthalene d8 (%)	89.3	89.3	89.3		1

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Napthalene (mg/L)	< 0.00005	< 0.0001	< 0.00009		5
Oil&Grease (mg/L)	< 1	< 1	< 1		4
PAH (High molecular wt) (mg/L)	< 0.00005	< 0.00015	< 0.00007		5
PAH (Low molecular wt) (mg/L)	< 0.00012	< 0.00024	< 0.000216		5
Phenanthrene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Phen-d10 (%)	88.2	88.2	88.2		1
Pyrene (mg/L)	< 0.00002	< 0.00005	< 0.000026		5
Quinoline (mg/L)	< 0.00005	< 0.00024	< 0.000202		5

Table 31. Summary of water quality data collected from Kitimat River downstream from Eurocan, Site 0E207570, 1988 – 2015.

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Amonia Dissolved (mg/L)	< 0.005	0.061	0.021	0.014	32
Amonia:T (mg/L)	0.018	0.048	0.028	0.014	4
Chlorophyll A (mg/L)	0.0015	0.0022	0.0017	0.0003	6
Chlrid:D (mg/L)	< 0.5	0.53	0.5075	0.015	4
Coli:Fec (CFU/100mL)	0	151	22	36	16
Coli:Tot (CFU/100mL)	200	200	200		1
Color SW (SWU)	19	19	19		1
Color True (Col.unit)	< 5	50	12	11	16
Dissolved Oxygen-Field (mg/L)	11.43	13.39	12.59	0.84	4
FluordeD (mg/L)	0.02	< 0.1	0.08	0.03	18
N.Kjel:T (mg/L)	0.062	0.296	0.138	0.109	4
Nitrate (NO3) Dissolved (mg/L)	0.0276	0.0979	0.0551	0.0312	4
Nitrate + Nitrite Diss. (mg/L)	0.0276	0.102	0.0567	0.0238	22
Nitrogen - Nitrite Diss. (mg/L)	0.002	0.04	0.006	0.008	19
Nitrogen Organic-Total (mg/L)	0.044	0.248	0.110	0.095	4
Nitrogen Total (mg/L)	0.099	0.324	0.195	0.094	4
NO2+NO3 (mg/L)	0.028	0.103	0.057	0.033	4
Ortho-Phosphate Dissolved (mg/L)	0.0018	0.0054	0.0032	0.0008	17
pH (pH)	7	7.9	7.4	0.2	20
pH-Field (pH)	6.34	6.67	6.51	0.14	4
Phosphorus Tot. Dissolved (mg/L)	< 0.003	0.01	0.006	0.003	5
P--T (mg/L)	0.0032	0.027	0.0157	0.0085	12
Residue Non-filterable (mg/L)	6	479	32	83	32
Specific Conductance (uS/cm)	35	57	43	8	6
Specific Conductance-Fld (uS/cm)	16.7	39.3	25.6	9.7	4
Sulfat:D (mg/L)	0.93	5000	1003	2235	5
Sulfide Total (mg/L)	< 0.5	< 0.5	< 0.5	0	15
Temperature-Field (C)	7.8	9	8.3	0.5	4

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Turbidity (NTU)	2.5	320	22.9	64.8	25
Al-D (mg/L)	< 0.02	0.02	0.02	0	5
Na-D (mg/L)	4.2	8.7	5.8	1.2	9
Abietic Acid (mg/L)	< 0.001	< 0.001	< 0.001		1
Dehydroabietic Acid (mg/L)	< 0.001	< 0.001	< 0.001		1
Isopimaric Acid (mg/L)	< 0.001	< 0.001	< 0.001		1
Levopimaric Acid (mg/L)	< 0.001	< 0.001	< 0.001		1
Neoabietic Acid (mg/L)	< 0.001	< 0.001	< 0.001		1
Pimaric Acid (mg/L)	< 0.001	< 0.001	< 0.001		1
Sandaracopimaric Acid (mg/L)	< 0.001	< 0.001	< 0.001		1

Table 32. Summary of water quality data collected from Kitimat River downstream from Eurocan, upstream from reserve, Site 0E218981, 1993 – 2015.

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Amonia Dissolved (mg/L)	0.0087	0.025	0.0189	0.0073	5
Amonia:T (mg/L)	0.014	0.025	0.020	0.006	4
Chlrid:D (mg/L)	< 0.5	1.7	0.8	0.5	5
Coli:Fec (CFU/100mL)	3	85	22	18	34
Color True (Col.unit)	< 5	29.4	10.7	7.5	11
Dissolved Oxygen-Field (mg/L)	11.93	12.47	12.24	0.28	3
E. coli (CFU/100mL)	3	9	6.2	2.6	5
Entercoc (CFU/100mL)	4	4	4		1
FluordeD (mg/L)	< 0.02	0.043	0.029	0.010	5
Hardness (Dissolved) (mg/L)	8.7	15.3	10.6	2.7	5
Hardness Total (T) (mg/L)	9.19	15.3	11.0	2.5	5
N.Kjel:T (mg/L)	0.036	0.1	0.071	0.028	5
Nitrate (NO3) Dissolved (mg/L)	0.0219	0.109	0.0495	0.0362	5
Nitrate + Nitrite Diss. (mg/L)	0.0219	0.109	0.0500	0.0363	5
Nitrogen - Nitrite Diss. (mg/L)	< 0.001	0.0022	0.0018	0.0005	5
Nitrogen Organic-Total (mg/L)	< 0.02	0.083	0.055	0.025	5
Nitrogen Total (mg/L)	0.045	0.156	0.116	0.043	5
NO2+NO3 (mg/L)	< 0.005	0.109	0.045	0.043	5
Ortho-Phosphate Dissolved (mg/L)	< 0.001	0.0041	0.0024	0.0012	5
pH (pH)	7.09	7.9	7.46	0.25	12
pH-Field (pH)	6.26	6.75	6.54	0.25	3
P--T (mg/L)	0.0038	0.0069	0.0047	0.0013	5
Residue Non-filterable (mg/L)	3.8	24	12.0	7.2	13
Specific Conductance-Fld (uS/cm)	14.8	26.5	21.2	5.9	3
Sulfat:D (mg/L)	0.82	2.32	1.39	0.57	5

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Sulfide Total (mg/L)	0.0053	0.0112	0.0076	0.0026	4
Sulfur Dissolved (mg/L)	< 0.5	< 3	< 2.5		5
Sulfur Total (mg/L)	< 0.5	< 15	< 4.9		5
Temp (C)	8.5	12.8	11.2	2.0	4
Temperature-Field (C)	8.4	9.1	8.8	0.5	2
Turbidity (NTU)	1.8	8.3	4.5	1.9	8
Ag-D (mg/L)	< 0.000005	< 0.000005	< 0.000005		5
Al-D (mg/L)	0.0165	0.0512	0.0311	0.0129	5
As-D (mg/L)	< 0.00002	0.00003	0.00003	0.00001	5
Ba-D (mg/L)	0.00612	0.0112	0.00770	0.00202	5
B--D (mg/L)	< 0.005	< 0.01	< 0.009	0.002	5
Be-D (mg/L)	< 0.00001	< 0.00001	< 0.00001		5
Bi-D (mg/L)	< 0.000005	< 0.000005	< 0.000005		5
Ca-D (mg/L)	3.01	5.09	3.60	0.84	5
Cd-D (mg/L)	< 0.000005	< 0.000005	< 0.000005		5
Co-D (mg/L)	0.00002	0.00003	0.00002	0.00001	5
Cr-D (mg/L)	< 0.0001	< 0.0001	< 0.0001		5
Cu-D (mg/L)	0.000371	0.000625	0.000485	0.000110	5
Fe-D (mg/L)	0.0302	0.0978	0.0458	0.0292	5
Hg-D (mg/L)	< 0.000005	< 0.00001	< 0.000009		5
K--D (mg/L)	0.289	0.465	0.347	0.069	5
Li-D (mg/L)	< 0.0005	< 0.0005	< 0.0005	0	5
Mg-D (mg/L)	0.287	0.622	0.393	0.132	5
Mn-D (mg/L)	0.0034	0.0082	0.0047	0.0020	5
Mo-D (mg/L)	0.000408	0.000518	0.000461	0.000041	5
Na-D (mg/L)	0.646	1.7	0.924	0.442	5
Ni-D (mg/L)	0.000042	0.00008	0.000054	0.000016	5
Pb-D (mg/L)	< 0.000005	0.00118	0.000258	0.000517	5
Sb-D (mg/L)	< 0.00002	< 0.00002	< 0.00002	0	5
Se-D (mg/L)	< 0.00004	< 0.00004	< 0.00004	0	5
Si-D (mg/L)	1.24	2.58	1.63	0.55	5
Sn-D (mg/L)	0.00003	0.0003	0.00019	0.00010	5
Sr-D (mg/L)	0.0181	0.0321	0.0223	0.0056	5
Ti-D (mg/L)	< 0.0005	0.00063	0.00053	0.00007	4
Tl-D (mg/L)	< 0.000002	0.000003	0.000002	0.000000	5
U--D (mg/L)	0.000065	0.000108	0.000082	0.000016	5
V--D (mg/L)	< 0.0002	0.00055	0.0003	0.00014	5
Zn-D (mg/L)	0.00011	0.00909	0.002006	0.00396	5
Zr-D (mg/L)	< 0.0001	< 0.0001	< 0.0001	0	4

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Ag-T (mg/L)	< 0.000005	0.000008	0.000006	0.000001	5
Al-T (mg/L)	0.0902	0.723	0.2758	0.2563	5
As-T (mg/L)	0.000049	0.000158	0.000075	0.000046	5
Ba-T (mg/L)	0.00867	0.0128	0.01036	0.00170	5
Be-T (mg/L)	< 0.00001	0.000018	0.000012	0.000004	5
Bi-T (mg/L)	< 0.000005	< 0.00002	< 0.000008		5
B--T (mg/L)	< 0.005	< 0.05	< 0.017		5
Ca-T (mg/L)	3.08	5.09	3.62	0.83	5
Cd-T (mg/L)	< 0.000005	< 0.000005	< 0.000005	0	5
Co-T (mg/L)	0.000060	0.000384	0.000160	0.000130	5
Cr-T (mg/L)	0.00014	0.00082	0.00033	0.00028	5
Cu-T (mg/L)	0.00066	0.00212	0.001103	0.000593	5
Fe-T (mg/L)	0.165	0.728	0.301	0.241	5
Hg-T (mg/L)	< 0.000005	< 0.00001	< 0.000009		5
K--T (mg/L)	0.329	0.464	0.377	0.056	5
Li-T (mg/L)	< 0.0005	< 0.0005	< 0.0005		5
Mg-T (mg/L)	0.367	0.63	0.476	0.139	5
Mn-T (mg/L)	0.00648	0.0216	0.01126	0.00595	5
Mo-T (mg/L)	0.000354	0.000499	0.000424	0.000053	5
Na-T (mg/L)	0.628	1.67	0.928	0.428	5
Ni-T (mg/L)	0.000104	0.000690	0.000271	0.000241	5
Pb-T (mg/L)	0.000032	0.000175	0.000085	0.000056	5
Sb-T (mg/L)	< 0.00002	< 0.00005	< 0.000026	0.00001	5
Se-T (mg/L)	< 0.00004	< 0.00004	< 0.00004	0	5
Si-T (mg/L)	1.49	2.61	1.92	0.53	5
Sn-T (mg/L)	< 0.00001	< 0.0002	< 0.000162		5
Sr-T (mg/L)	0.0191	0.032	0.0227	0.0054	5
Ti-T (mg/L)	0.00262	0.0282	0.01262	0.01098	4
Tl-T (mg/L)	< 0.000002	0.000007	0.000003	0.000002	5
U--T (mg/L)	0.00008	0.00013	0.00010	0.00002	5
V--T (mg/L)	0.00057	0.00203	0.00092	0.00062	5
Zn-T (mg/L)	0.00031	0.00210	0.00101	0.00068	5
Zr-T (mg/L)	< 0.0001	< 0.0001	< 0.0001	0	4
CN-T (mg/L)	< 0.001	0.001	0.001		1
Cyanide (WAD) (mg/L)	< 0.0005	0.00058	0.00052	0.00004	4
Cyanide S.A.D. (mg/L)	< 0.0005	0.00069	0.000558	0.00009	4
2-Methylnaphthalene (mg/L)	< 0.0001	< 0.0001	< 0.0001		4
Acenaphthene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Acenaphthylene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Acridine (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Acridine d9 (%)	80	80	80		1
Anthracene (mg/L)	< 0.00001	< 0.00005	< 0.000018		5
Benzo(a)anthracene (mg/L)	< 0.00001	< 0.00005	< 0.000018		5
Benzo(b)fluoranthene (mg/L)	< 0.00005	< 0.00005	< 0.00005		1
Benzo(b+j)fluoranthene (mg/L)	< 0.00005	< 0.00005	< 0.00005		4
Benzo(g;h;i)perylene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Benzo(k)fluoranthene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Bezo(a)pyrene (mg/L)	< 0.000009	< 0.00001	< 0.0000092		5
Chry-d12 (%)	81.6	81.6	81.6		1
Chrysene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Dibenzo(a;h)anthracene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Fluoranthene (mg/L)	< 0.00002	< 0.00005	< 0.000026		5
Fluorene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Indeno(1;2;3-cd)pyrene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Naphthalene d8 (%)	101.6	101.6	101.6		1
Napthalene (mg/L)	< 0.00005	< 0.0001	< 0.00009		5
Oil&Grease (mg/L)	< 1	< 1	< 1		4
PAH- (mg/L)	< 0.00021	< 0.00024	< 0.00023		5
PAH (High molecular wt) (mg/L)	< 0.00005	< 0.00015	< 0.00007		5
PAH (Low molecular wt) (mg/L)	< 0.00012	< 0.00024	< 0.000216		5
Phenanthrene (mg/L)	< 0.00005	< 0.00005	< 0.00005		5
Phen-d10 (%)	90.8	90.8	90.8		1
Pyrene (mg/L)	< 0.00002	< 0.00005	< 0.000026		5
Quinoline (mg/L)	< 0.00005	< 0.00024	< 0.000202		5

Table 33. Summary of water quality data collected from Kitimat River south bank, near old Eurocan water intake, 2016.

Parameter	Units	Minimum	Maximum	Average	Std Dev	No. of Samples
pH	pH units	6	7	7	0	19
True Colour	Colour units	<5	46	15	17	5
Turbidity	NTU	1	237	15	54	19
Total Dissolved Solids	mg/L	8	50	21	11	19
Total Suspended Solids	mg/L	<2	374	28	96	15
Alkalinity (pH 4.5)	mg CaCO3/L	7	18	12	3	19
Escherichia Coli (E.coli)	MPN/100mL	3	488	53	111	19
Organic Nitrogen (calc)	mg/L	<0.1	0.20	<0.1		1
Chloride	mg/L	0.41	0.91	0.67	0.15	19
Nitrate-N	mg/L	0.01	0.14	0.03	0.03	19
Nitrite-N	mg/L	<0.005	<0.005	<0.005		0
Sulphate	mg/L	1.40	2.70	2.09	0.32	19

Parameter	Units	Minimum	Maximum	Average	Std Dev	No. of Samples
Fluoride	mg/L	<0.02	0.03	0.02	0.01	3
Bromide	mg/L	<0.05	<0.05	<0.05		0
Ammonia-N	mg/L	<0.01	0.08	0.03	0.02	13
Nitrogen - Total Kjeldahl (TKN)	mg/L	<0.1	0.30	0.20	0.08	4
Nitrogen - Total	mg/L	<0.05	0.35	0.13	0.09	9
Ortho-Phosphate	mg/L	<0.001	0.005	0.002	0.00	17
Phosphorus Total	mg/L	<0.005	0.430	0.04	0.11	15
Total Hardness (calc)	ug CaCO3/L	10700	46600	15179	7781	19
Aluminum Total	µg/L	83	14100	881	3201	19
Antimony Total	µg/L	<0.5	<0.5	<0.5		0
Arsenic Total	µg/L	<0.1	1.7	0.4	0.6	7
Barium Total	µg/L	9.0	112.0	16.6	23.2	19
Beryllium Total	µg/L	<0.05	0.18	<0.05		1
Boron Total	µg/L	<5	<5	<5		0
Cadmium Total	µg/L	<0.01	0.08	<0.01		1
Calcium Total	µg/L	3620	8250	4706	1008	19
Chromium Total	µg/L	<0.5	17.0	8.8	11.7	2
Cobalt Total	µg/L	0.05	8.03	0.51	1.82	19
Copper Total	µg/L	<0.5	35.1	3.0	8.0	18
Iron Total	µg/L	111	14000	920	3168	19
Lead Total	µg/L	<0.05	2.10	0.36	0.77	7
Lithium Total	µg/L	<0.5	5.0	2.8	3.2	2
Magnesium Total	µg/L	407	6310	830	1329	19
Manganese Total	µg/L	4.00	375	27.42	84.20	19
Mercury Total	µg/L	<0.01	0.02	<0.01		1
Molybdenum Total	µg/L	0.6	0.8	0.7	0.1	19
Nickel Total	µg/L	<0.5	14	14		1
Potassium Total	µg/L	350	2540	574	481	19
Selenium Total	µg/L	<0.5	0.8	0.8	<0.5	1
Silver Total	µg/L	<0.02	0.04	<0.02		2
Sodium Total	µg/L	846	2920	1195	444	19
Thallium Total	µg/L	0.04	0.07	0.06	0.02	2
Titanium Total	µg/L	3	499	33	113	19
Uranium Total	µg/L	0.05	0.92	0.11	0.20	19
Vanadium Total	µg/L	<1	33	<3	16	4
Zinc Total	µg/L	<5	31	<5	18	2
Hardness (calc)	µg CaCO3/L	9380	16200	12667	1702	19
Aluminum Dissolved	µg/L	11	132	21	27	19
Antimony Dissolved	µg/L	<0.2	<0.2	<0.2		0
Arsenic Dissolved	µg/L	<0.1	0.20	<0.1		2
Barium Dissolved	µg/L	7.80	18.20	10.31	2.25	19
Beryllium Dissolved	µg/L	<0.01	<0.01	<0.01		0
Boron Dissolved	µg/L	<2	<2	<2		0
Cadmium Dissolved	µg/L	<0.01	0.01	<0.01		1
Calcium Dissolved	µg/L	3120	5480	4315	578	19
Chromium Dissolved	µg/L	<0.5	<0.5	<0.5		0

Parameter	Units	Minimum	Maximum	Average	Std Dev	No. of Samples
Cobalt Dissolved	µg/L	<0.05	0.13	<0.05		1
Copper Dissolved	µg/L	<0.2	2.40	0.72	0.61	18
Iron Dissolved	µg/L	23	149	41	27	19
Lead Dissolved	µg/L	<0.05	0.05	<0.05		2
Lithium Dissolved	µg/L	<0.5	<0.5	<0.5		0
Magnesium Dissolved	µg/L	359	613	458	67	19
Manganese Dissolved	µg/L	3	24	6	5	19
Mercury Dissolved	µg/L	<0.01	<0.01	<0.01		0
Molybdenum Dissolved	µg/L	0.30	0.79	0.60	0.13	19
Nickel Dissolved	µg/L	<0.2	0.4	0.3	0.1	3
Potassium Dissolved	µg/L	318	817	452	110	19
Selenium Dissolved	µg/L	<0.5	<0.5	<0.5		0
Silver Dissolved	µg/L	<0.02	<0.02	<0.02		0
Sodium Dissolved	µg/L	801	1400	1068	155	19
Thallium Dissolved	µg/L	<0.01	0.01	<0.01		2
Titanium Dissolved	µg/L	<0.5	2.4	0.9	0.6	10
Uranium Dissolved	µg/L	0.03	0.16	0.06	0.03	19
Vanadium Dissolved	µg/L	<0.5	0.60	<0.5		1
Zinc Dissolved	µg/L	<2	9.0	3.9	2.4	7
COD	mg/L	<10	46	19	13	6
Chlorophyll-a	µg/L	<0.5	4.4	1.7	1.1	15
Cyanide (WAD)	mg/L	<0.002	0.010	0.006	0.006	2
Cyanide (SAD)	mg/L	<0.002	0.046	0.017	0.025	3
Benzo(b+j)fluoranthene	µg/L	<0.1	<0.1	<0.1		0
Naphthalene	µg/L	<0.05	<0.05	<0.05		0
Quinoline	µg/L	<0.1	<0.1	<0.1		0
Acenaphthylene	µg/L	<0.05	<0.05	<0.05		0
Acenaphthene	µg/L	<0.05	<0.05	<0.05		0
Fluorene	µg/L	<0.05	<0.05	<0.05		0
Phenanthrene	µg/L	<0.05	<0.05	<0.05		0
Anthracene	µg/L	<0.05	<0.05	<0.05		0
Acridine	µg/L	<0.05	<0.05	<0.05		0
Fluoranthene	µg/L	<0.05	<0.05	<0.05		0
Pyrene	µg/L	<0.02	<0.02	<0.02		0
Benzo(a)anthracene	µg/L	<0.05	<0.05	<0.05		0
Chrysene	µg/L	<0.05	<0.05	<0.05		0
Benzo(b)fluoranthene	µg/L	<0.05	<0.05	<0.05		0
Benzo(j)fluoranthene	µg/L	<0.05	<0.05	<0.05		0
Benzo(k)fluoranthene	µg/L	<0.05	<0.05	<0.05		0
Benzo(a)pyrene	µg/L	<0.01	<0.01	<0.01		0
Indeno(1,2,3-c,d)pyrene	µg/L	<0.05	<0.05	<0.05		0
Dibenzo(a,h)anthracene	µg/L	<0.05	<0.05	<0.05		0
Benzo(g,h,i)perylene	µg/L	<0.05	<0.05	<0.05		0
Naphthalene - d8	%	74	99	84	7	19
2-Fluorobiphenyl	%	71	101	85	7	19

Parameter	Units	Minimum	Maximum	Average	Std Dev	No. of Samples
P-Terphenyl - d14	%	76	112	90	9	19
Total Chlorine Demand	mg/L	0.05	0.68	0.24	0.18	19
Oil and Grease - Total	mg/L	<1	<1	<1		0
Total Organic Carbon	mg/L	0.60	7.60	1.37	1.54	19
Carbon Dissolved Organic	mg/L	0.60	9.20	1.55	1.92	19
Sulfide	mg/L	<0.01	0.02	0.01	0.00	10
D_{50}%	(µm)	0.00	29.76	2.96	6.90	19
Cryptosporidium (oocysts)	oocysts	0.00	0.00	0.00		1
Giardia (cysts)	cysts	4.00	4.00	4.00		1

Table 34. Summary of water quality data collected from Kitimat River Station 30, Site 0430020, 1976 – 1982.

	Minimum	Maximum	Average	Std Dev	No. of samples
Color Apparent (Col.unit)	10	449	64	85	31
Diss Oxy (mg/L)	10.6	13.8	11.8	1.0	34
Flow Rte (m^3/s W)	0.03681	0.10477	0.07929	0.02952	4
N.Kjel:T (mg/L)	0.04	0.1	0.07	0.03	5
Na-D (mg/L)	0.8	18	3.9	3.2	34
pH (pH)	6.9	7.8	7.3	0.2	34
P--T (mg/L)	0	2.5	0.3	0.7	21
Res:Tot (mg/L)	25.5	549.5	93.8	100.9	25
Specific Conductance (µS/cm)	18	160	52	25	34
Temp (C)	2	13	8	3	34
Turbidity (mg/L)	1	26	8	7	19
Turbidity (NTU)	2.6	9.8	6.2	2.3	15
Wtr Vel (m/s)	0.64009	1.9995	1.4204	0.5490	6

Table 35. Summary of water quality data collected from Kitimat River Station 40, Site 0430022, 1976 – 1982.

LOWER DEPTH	Minimum	Maximum	Average	Std Dev	No. of samples
Color Apparent (Col.unit)	16	86	42	19	34
Diss Oxy (mg/L)	10.5	13.9	11.8	1.0	35
Flow Rte (m^3/s W)	0.04	0.11	0.08	0.04	3
Na-D (mg/L)	1.7	7.9	3.5	1.5	35
pH (pH)	6.9	7.8	7.2	0.3	34
P--T (mg/L)	0.1	2.3	0.8	0.8	8
Res:Tot (mg/L)	1	234	62	46	29
Specific Conductance (µS/cm)	18	66	48	13	34
Temp (C)	2	12.9	7.9	3.4	34
Turbidity (mg/L)	1	19	9	7	19
Turbidity (NTU)	2.4	9.9	6.3	2.5	15
Wtr Vel (m/s)	0.73	1.37	1.07	0.21	6

Table 36. Summary of water quality data collected from Kitimat River Station 50, Site 0430023, 1976 – 1982.

Paramater	Minimum	Maximum	Average	Std Dev	No. of samples
Color Apparent (Col.unit)	8	85	37	19	31
Diss Oxy (mg/L)	10.4	13.9	11.7	1.0	35
Flow Rte (m^3/s W)	0.01	0.09	0.06	0.04	3
Na-D (mg/L)	0.8	7.7	3.6	1.6	34
pH (pH)	6.6	7.7	7.2	0.3	35
P--T (mg/L)	0.1	1.9	0.7	0.7	6
Res:Tot (mg/L)	28	218	70.9	42.4	25
Specific Conductance (µS/cm)	16	75	48	13	34
Temp (C)	2	13.3	8.0	3.3	35
Turbidity (mg/L)	1	19.3	8.3	6.1	20
Turbidity (NTU)	2.4	10.6	6.3	2.7	15
Wtr Vel (m/s)	0.21	1.92	0.97	0.56	6

Table 37. Summary of water quality data collected from Kitimat River 100 m downstream from DOK STP, Site E207568, 1989.

LOWER DEPTH	Minimum	Maximum	Average	Std Dev	No. of samples
Amonia Dissolved (mg/L)	0.005	0.082	0.037	0.033	8
Color True (Col.unit)	< 5	5	5	0	8
FluordeD (mg/L)	< 0.1	< 0.1	< 0.1		8
Na-D (mg/L)	1.6	4	2.8	1.2	8
Nitrate + Nitrite Diss. (mg/L)	0.08	0.08	0.08	0	8
Ortho-Phosphate Dissolved (mg/L)	< 0.003	0.011	0.006	0.003	8
P--T (mg/L)	0.005	0.019	0.011	0.006	8
Residue Non-filterable (mg/L)	4	21	10	7	8
Coli:Fec (CFU/100mL)	3	54	17	15	9
E Coli (CFU/100mL)	8	8	8		1

Table 38. Summary of water quality data collected from Kitimat River 100 m downstream from Eurocan, Site E207686, 1989.

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Color True (Col.unit)	< 5	60	18	21	10
Na-D (mg/L)	1.8	25.7	9.2	8.7	10
Residue Non-filterable (mg/L)	4	18	9	4	10
Amonia Dissolved (mg/L)	0.005	0.044	0.024	0.017	8
Coli:Fec (CFU/100mL)	6	16	10	3	8
FluordeD (mg/L)	< 0.1	< 0.1	< 0.1		8
Nitrate + Nitrite Diss. (mg/L)	0.03	0.08	0.07	0.02	8
Ortho-Phosphate Dissolved (mg/L)	< 0.003	0.006	0.004	0.001	8
P--T (mg/L)	0.005	0.089	0.021	0.028	8
Mtx5IC50 (%(V/V))	< 100	< 100	< 100	0	2

Table 39. Summary of water quality data collected from Kitimat River at DOK infiltration gallery, Site E253649, 2003-2004.

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Alkalinity Total 4.5 (mg/L)	7.6	15.1	10.7	2.5	8
Amonia Dissolved (mg/L)	< 0.005	0.012	0.008	0.003	8
Carbon Total Organic (mg/L)	< 0.5	5.1	2.9	1.6	8
Chlrid:D (mg/L)	0.5	1.5	0.8	0.3	8
Coli:Fec (CFU/100mL)	2	165	53	56	7
Color True (Col.unit)	< 5	60	28	23	8
E Coli (CFU/100mL)	< 1	78	38	28	7
Entercoc (CFU/100mL)	4	250	92	113	7
FluordeD (mg/L)	< 0.01	0.04	0.03	0.01	8
Hardness Total (T) (mg/L)	12.0	22.0	16.7	3.4	8
Nitrate (NO3) Dissolved (mg/L)	0.013	0.112	0.072	0.037	7
Nitrate + Nitrite Diss. (mg/L)	0.018	0.116	0.076	0.035	8
Nitrogen - Nitrite Diss. (mg/L)	< 0.002	0.005	0.004	0.001	8
pH (pH)	7	7.4	7.3	0.2	8
P--T (mg/L)	< 0.1	0.3	0.2	0.1	8
Residue Filterable 1.0u (mg/L)	18	38	27	6	8
Specific Conductance (µS/cm)	26	43	32	6	8
Sulfat:D (mg/L)	1.6	3.1	2.1	0.4	8
Sulfur Total (mg/L)	0.5	0.9	0.7	0.1	8
Turbidity (NTU)	1.74	87.9	35.50	37.69	8
Ag-T (mg/L)	< 0.00002	< 0.00002	< 0.00002		8
Al-T (mg/L)	0.0629	1.43	0.635	0.582	8
As-T (mg/L)	< 0.0001	0.0004	0.0002	0.00013	8
Ba-T (mg/L)	0.00923	0.0296	0.01854	0.00716	8
Be-T (mg/L)	< 0.00002	0.00005	0.00003	0.00001	8

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Bi-T (mg/L)	< 0.00002	0.00004	0.00002	0.00001	8
B--T (mg/L)	< 0.008	< 0.008	< 0.008	0	8
Ca-T (mg/L)	4.03	5.34	4.70	0.43	8
Cd-T (mg/L)	< 0.00001	0.00003	0.00002	0.00001	8
Co-T (mg/L)	0.000051	0.00111	0.000472	0.000449	8
Cr-T (mg/L)	< 0.0002	0.0014	0.0008	0.0005	8
Cu-T (mg/L)	0.0006	0.0057	0.0028	0.0023	8
Fe-T (mg/L)	0.145	5.36	2.15	2.13	8
K--T (mg/L)	< 1	2	1.1	0.4	8
Li-T (mg/L)	< 0.00005	0.00076	0.00032	0.0003	8
Mg-T (mg/L)	0.48	2.21	1.21	0.69	8
Mn-T (mg/L)	0.00519	0.08430	0.03834	0.03168	8
Mo-T (mg/L)	0.00017	0.00057	0.00037	0.00018	8
Na-T (mg/L)	1.08	1.67	1.32	0.25	8
Ni-T (mg/L)	< 0.00005	0.00124	0.00052	0.00049	8
Pb-T (mg/L)	0.00008	0.00123	0.00048	0.00049	8
Sb-T (mg/L)	0.00001	0.00002	0.00001	0.00001	8
Se-T (mg/L)	< 0.0002	0.0004	0.0002	0.0001	8
Sn-T (mg/L)	< 0.00001	0.00004	0.00002	0.00001	8
Sr-T (mg/L)	0.0223	0.0336	0.0265	0.0038	8
Te-T (mg/L)	< 0.05	< 0.05	< 0.05	0.00	8
Ti-T (mg/L)	< 0.003	0.18	0.073	0.073	8
Tl-T (mg/L)	< 0.000002	0.000012	0.000006	0.000004	8
U--T (mg/L)	0.000058	0.000308	0.000181	0.000110	8
V--T (mg/L)	0.00032	0.00430	0.00199	0.00163	8
Zn-T (mg/L)	0.0005	0.0082	0.0033	0.0031	8
Zr-T (mg/L)	< 0.005	< 0.005	< 0.005	0	8

Table 40. Summary of water quality data collected from Kitimat River at rec site, Site E260483, 2005.

Parameter	8/22/2005
Alkalinity pH 8.3 (mg/L)	< 0.5
Alkalinity Total 4.5 (mg/L)	13.8
Amonia Dissolved (mg/L)	0.011
Carbon Total Organic (mg/L)	< 0.5
Chlrid:D (mg/L)	< 0.5
Color True (Col.unit)	5
Hardness Total (T) (mg/L)	12.6
Nitrate (NO3) Dissolved (mg/L)	< 0.002
Nitrate + Nitrite Diss. (mg/L)	0.018
Nitrogen - Nitrite Diss. (mg/L)	< 0.002
Nitrogen (Kjel.) Tot Diss (mg/L)	0.02
Nitrogen Organic-Total (mg/L)	< 0.02
Nitrogen Total (mg/L)	0.04
Nitrogen Total Dissolved (mg/L)	0.038
Ortho-Phosphate Dissolved (mg/L)	0.001
pH (pH)	7.42
P--T (mg/L)	0.009
Res:Tot (mg/L)	29
Residue Filterable 1.0u (mg/L)	24
Residue Non-filterable (mg/L)	5
Sulfat:D (mg/L)	2.2
Sulfur Total (mg/L)	0.7
Turbidity (NTU)	4.2
Ag-T (mg/L)	< 0.00002
Al-T (mg/L)	0.275
As-T (mg/L)	< 0.0001
Ba-T (mg/L)	0.0166
Be-T (mg/L)	< 0.00002
Bi-T (mg/L)	< 0.00002
B--T (mg/L)	< 0.008
Ca-T (mg/L)	4.11
Cd-T (mg/L)	0.00003
Co-T (mg/L)	0.000168
Cr-T (mg/L)	0.0004
Cu-T (mg/L)	0.00113
Fe-T (mg/L)	0.366
K--T (mg/L)	< 1
Li-T (mg/L)	0.00025

Parameter	8/22/2005
Mg-T (mg/L)	0.56
Mn-T (mg/L)	0.011
Mo-T (mg/L)	0.00095
Na-T (mg/L)	0.71
Ni-T (mg/L)	0.00022
Pb-T (mg/L)	0.0001
Sb-T (mg/L)	< 0.000005
Se-T (mg/L)	0.0003
Sn-T (mg/L)	< 0.00001
Sr-T (mg/L)	0.0321
Ti-T (mg/L)	0.023
Tl-T (mg/L)	0.000005
U--T (mg/L)	0.000117
V--T (mg/L)	0.00099
Zn-T (mg/L)	0.0017
Zr-T (mg/L)	< 0.005

Table 41. Summary of water quality data collected from Kitimat Landfill Hirsch Pit #1, Site E264243, 2005-2008.

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Alkalinity pH 8.3 (mg/L)	< 0.5	< 0.5	< 0.5		1
Alkalinity Total 4.5 (mg/L)	5.5	13.8	10.1	3.4	5
Amonia Dissolved (mg/L)	< 0.005	0.032	0.009	0.009	13
Bromide Dissolved (mg/L)	< 0.01	< 0.1	< 0.07		10
C.O.D. (mg/L)	< 10	46	21	14	12
Carbon Dissolved Organic (mg/L)	1.2	3.8	2.4	1.1	4
Carbon Total Organic (mg/L)	< 0.5	< 0.5	< 0.5		1
Chlrid:D (mg/L)	< 0.5	4.7	2.9	1.1	13
Color True (Col.unit)	5	5	5		1
Hardness (Dissolved) (mg/L)	6.7	13.5	9.7	2.3	12
Hardness Total (T) (mg/L)	7	24.4	11.7	4.9	13
N.Kjel:T (mg/L)	0.04	0.09	0.06	0.02	4
Na-T (mg/L)	0.71	4.09	3.03	0.83	13
Nitrate (NO3) Dissolved (mg/L)	< 0.002	0.334	0.091	0.094	11
Nitrate + Nitrite Diss. (mg/L)	0.008	0.436	0.157	0.159	13
Nitrogen - Nitrite Diss. (mg/L)	< 0.002	0.068	0.016	0.024	11
Nitrogen (Kjel.) Tot Diss (mg/L)	0.02	0.02	0.02		1
Nitrogen Organic-Total (mg/L)	< 0.02	0.09	0.05	0.03	5
Nitrogen Total (mg/L)	0.04	0.21	0.12	0.06	5
Nitrogen Total Dissolved (mg/L)	0.038	0.038	0.038		1
NO2+NO3 (mg/L)	0.01	0.14	0.08	0.06	4
Ortho-Phosphate Dissolved (mg/L)	0.001	0.001	0.001		1

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
pH (pH)	6.3	7.42	6.68	0.32	13
Phosphorus Tot. Dissolved (mg/L)	< 0.1	< 0.1	< 0.1		3
P--T (mg/L)	0.004	0.4	0.109	0.125	9
Res:Tot (mg/L)	29	168	67	57	5
Residue Filterable 1.0u (mg/L)	18	48	31	12	5
Residue Non-filterable (mg/L)	< 4	120	36	49	5
Specific Conductance (uS/cm)	29	49	39	7	12
Sulfat:D (mg/L)	1.4	6.4	2.9	1.5	13
Sulfur Dissolved (mg/L)	1.2	1.6	1.4	0.2	3
Sulfur Total (mg/L)	0.7	1.5	1.2	0.3	4
Turbidity (NTU)	4.2	4.2	4.2		1
Ag-D (mg/L)	0.000005	0.000020	0.000009	0.000007	12
Al-D (mg/L)	0.0191	0.528	0.0879	0.1412	12
As-D (mg/L)	0.00002	0.00009	0.00004	0.00002	9
Ba-D (mg/L)	0.0114	0.0274	0.0173	0.0055	12
B--D (mg/L)	0.008	0.05	0.023	0.020	12
Be-D (mg/L)	< 0.00001	0.00002	0.00001	0.00000	12
Bi-D (mg/L)	0.000005	0.000020	0.000009	0.000007	12
Ca-D (mg/L)	1.98	3.87	2.85	0.64	12
Cd-D (mg/L)	0.000008	0.000070	0.000025	0.000018	12
Co-D (mg/L)	0.000027	0.00129	0.000320	0.000420	12
Cr-D (mg/L)	< 0.0001	0.0003	0.0001	0.0001	12
Cu-D (mg/L)	0.00063	0.00435	0.00120	0.00102	12
Fe-D (mg/L)	< 0.005	0.302	0.057	0.105	12
K--D (mg/L)	0.55	0.82	0.69	0.09	9
Li-D (mg/L)	0.00015	0.00015	0.00015	0.00000	2
Mg-D (mg/L)	0.42	0.94	0.63	0.17	12
Mn-D (mg/L)	0.002	0.0913	0.022	0.032	12
Mo-D (mg/L)	< 0.00005	0.00007	0.00005	0.00001	12
Na-D (mg/L)	2.44	3.78	3.18	0.34	12
Ni-D (mg/L)	0.00044	0.00205	0.00098	0.00051	12
Pb-D (mg/L)	0.000005	0.000320	0.000041	0.000090	12
Sb-D (mg/L)	< 0.00001	0.00003	0.00002	0.00000	12
Se-D (mg/L)	< 0.00004	< 0.0002	< 0.00008		12
Si-D (mg/L)	1.99	5.01	2.88	1.07	9
Sn-D (mg/L)	0.00001	0.00003	0.00002	0.00001	12
Sr-D (mg/L)	0.0123	0.0279	0.0197	0.0062	12
Ti-D (mg/L)	< 0.0005	0.0046	0.0017	0.0015	12
Tl-D (mg/L)	0.000002	0.000014	0.000004	0.000003	12
U--D (mg/L)	0.000012	0.000103	0.000031	0.000025	12
V--D (mg/L)	0.00006	0.00361	0.00070	0.00099	12

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Zn-D (mg/L)	0.0005	0.0044	0.0012	0.0011	12
Zr-D (mg/L)	< 0.005	< 0.005	< 0.005	0	3
Ag-T (mg/L)	0.000005	0.000070	0.000022	0.000024	13
Al-T (mg/L)	0.053	9.14	1.250	2.538	13
As-T (mg/L)	0.00002	0.0003	0.00010	0.00011	9
Ba-T (mg/L)	0.0132	0.135	0.0320	0.0339	13
Be-T (mg/L)	< 0.00001	0.00031	0.00004	0.00008	13
Bi-T (mg/L)	0.000005	0.000020	0.000012	0.000007	13
B--T (mg/L)	0.006	< 0.05	< 0.021	0.020	13
Ca-T (mg/L)	1.99	5.79	3.26	1.10	13
Cd-T (mg/L)	0.000011	0.000290	0.000051	0.000077	13
Co-T (mg/L)	0.00006	0.01340	0.00167	0.00371	13
Cr-T (mg/L)	< 0.0001	0.0059	0.0009	0.0016	13
Cu-T (mg/L)	0.00073	0.0537	0.00804	0.01499	13
Fe-T (mg/L)	0.054	14.2	2.223	4.207	13
K--T (mg/L)	0.54	0.88	0.73	0.11	9
Li-T (mg/L)	0.00025	0.00224	0.00113	0.00101	3
Mg-T (mg/L)	0.45	2.42	0.86	0.56	13
Mn-T (mg/L)	0.0032	0.6410	0.0814	0.1776	13
Mo-T (mg/L)	< 0.00005	0.00095	0.00013	0.00025	13
Ni-T (mg/L)	0.00022	0.00875	0.00180	0.00231	13
Pb-T (mg/L)	0.000013	0.004580	0.000622	0.001296	13
Sb-T (mg/L)	0.000005	0.000044	0.000022	0.000011	13
Se-T (mg/L)	< 0.00004	0.0003	0.00010	0.00010	13
Si-T (mg/L)	1.87	6.26	3.06	1.42	9
Sn-T (mg/L)	0.00001	0.00003	0.00002	0.00001	13
Sr-T (mg/L)	0.0123	0.0425	0.0226	0.0090	13
Ti-T (mg/L)	0.001	0.088	0.021	0.027	13
Tl-T (mg/L)	0.000002	0.000076	0.000013	0.000021	13
U--T (mg/L)	0.000022	0.00166	0.000253	0.000460	13
V--T (mg/L)	0.0005	0.0498	0.0068	0.0140	13
Zn-T (mg/L)	0.0008	0.0383	0.0056	0.0105	13
Zr-T (mg/L)	< 0.005	< 0.005	< 0.005		1

Table 42. Summary of water quality data collected from Kitimat Landfill Hirsch Pit #2, Site E264244, 2007.

Parameter	9/30/2007	10/8/2007
Amonia Dissolved (mg/L)		< 0.005
Bromide Dissolved (mg/L)	< 0.01	< 0.01
C.O.D. (mg/L)		11
Chlrid:D (mg/L)	7.8	2.5
Hardness (Dissolved) (mg/L)	9.5	10.5
Hardness Total (T) (mg/L)	58	12.1
Nitrate (NO3) Dissolved (mg/L)		0.074
Nitrate + Nitrite Diss. (mg/L)		0.082
Nitrogen - Nitrite Diss. (mg/L)		0.008
pH (pH)	6.8	6.5
Phosphorus Tot. Dissolved (mg/L)	< 0.1	< 0.1
P--T (mg/L)	2.6	0.1
Specific Conductance (uS/cm)	53	42
Sulfat:D (mg/L)	1.3	2.2
Sulfur Dissolved (mg/L)	0.7	0.7
Sulfur Total (mg/L)	0.7	0.7
Ag-D (mg/L)	< 0.00002	< 0.00002
Al-D (mg/L)	0.0601	0.0757
As-D (mg/L)	< 0.0001	< 0.0001
Ba-D (mg/L)	0.0322	0.0211
B--D (mg/L)	< 0.008	0.009
Be-D (mg/L)	< 0.00002	< 0.00002
Bi-D (mg/L)	< 0.00002	< 0.00002
Ca-D (mg/L)	2.87	3.21
Cd-D (mg/L)	0.00004	0.00001
Co-D (mg/L)	0.000134	0.000076
Cr-D (mg/L)	< 0.0002	< 0.0002
Cu-D (mg/L)	0.00359	0.00068
Fe-D (mg/L)	0.013	0.006
K--D (mg/L)	6	1
Li-D (mg/L)	< 0.00005	< 0.00005
Mg-D (mg/L)	0.57	0.61
Mn-D (mg/L)	0.0984	0.0119
Mo-D (mg/L)	0.00009	< 0.00005
Na-D (mg/L)	2.96	3.07
Ni-D (mg/L)	0.0011	0.00037
Pb-D (mg/L)	0.00002	< 0.00001
Sb-D (mg/L)	0.000041	0.000012

Parameter	9/30/2007	10/8/2007
Se-D (mg/L)	< 0.0002	< 0.0002
Sn-D (mg/L)	0.00001	0.00002
Sr-D (mg/L)	0.0188	0.0179
Ti-D (mg/L)	< 0.003	< 0.003
Tl-D (mg/L)	0.000013	0.000003
U--D (mg/L)	0.000038	0.00004
V--D (mg/L)	0.00018	0.00009
Zn-D (mg/L)	0.0011	0.0002
Zr-D (mg/L)	< 0.005	< 0.005
Ag-T (mg/L)	0.00022	< 0.00002
Al-T (mg/L)	56.1	2.03
As-T (mg/L)	0.0023	0.0003
Ba-T (mg/L)	0.97	0.0426
Be-T (mg/L)	0.00139	< 0.00002
Bi-T (mg/L)	0.00003	< 0.00002
B--T (mg/L)	0.012	0.011
Ca-T (mg/L)	15.3	3.53
Cd-T (mg/L)	0.00118	0.00004
Co-T (mg/L)	0.0592	0.00145
Cr-T (mg/L)	0.0316	0.0011
Cu-T (mg/L)	0.241	0.00764
Fe-T (mg/L)	33.6	0.9
K--T (mg/L)	9	< 1
Li-T (mg/L)	0.00881	< 0.00005
Mg-T (mg/L)	4.85	0.81
Mn-T (mg/L)	8.59	0.116
Mo-T (mg/L)	0.00034	< 0.00005
Na-T (mg/L)	3.44	3.14
Ni-T (mg/L)	0.0262	0.00138
Pb-T (mg/L)	0.0159	0.00056
Sb-T (mg/L)	0.000113	0.000008
Se-T (mg/L)	0.0004	< 0.0002
Sn-T (mg/L)	0.00008	0.00005
Sr-T (mg/L)	0.0851	0.0217
Ti-T (mg/L)	0.289	0.027
Tl-T (mg/L)	0.000236	0.000012
U--T (mg/L)	0.00757	0.000263
V--T (mg/L)	0.171	0.00679
Zn-T (mg/L)	0.135	0.0052

Table 43. Summary of water quality data collected from Kitimat Landfill Hirsch Pit #3, Site E264245, 2007.

Parameter	9/16/2007	9/24/2007	9/30/2007
Amonia Dissolved (mg/L)	< 0.005	< 0.005	< 0.005
Bromide Dissolved (mg/L)	< 0.01	< 0.01	0.01
C.O.D. (mg/L)		< 10	15
Chlrid:D (mg/L)	4.3	5.4	5.5
Hardness (Dissolved) (mg/L)	10.3	12.6	17.6
Hardness Total (T) (mg/L)	15.8	13.3	19.2
Nitrate (NO3) Dissolved (mg/L)	0.217	0.286	0.245
Nitrate + Nitrite Diss. (mg/L)	0.22	0.292	0.258
Nitrogen - Nitrite Diss. (mg/L)	0.003	0.006	0.013
pH (pH)	6.2	6.4	6.9
Phosphorus Tot. Dissolved (mg/L)	< 0.1	< 0.1	< 0.1
Specific Conductance (uS/cm)	38	52	63
Sulfat:D (mg/L)	2.6	2.7	3.8
Sulfur Dissolved (mg/L)	1	1.2	1.5
Sulfur Total (mg/L)	0.9	1.3	1.6
Ag-D (mg/L)	< 0.00002	< 0.00002	< 0.00002
Al-D (mg/L)	0.064	0.0586	0.0637
As-D (mg/L)	0.0002	< 0.0001	< 0.0001
Ba-D (mg/L)	0.0125	0.0155	0.0177
B--D (mg/L)	0.015	0.014	0.025
Be-D (mg/L)	< 0.00002	< 0.00002	< 0.00002
Bi-D (mg/L)	< 0.00002	< 0.00002	< 0.00002
Ca-D (mg/L)	3.11	3.76	5.33
Cd-D (mg/L)	< 0.00001	0.00002	0.00002
Co-D (mg/L)	0.000103	0.00018	0.000352
Cr-D (mg/L)	< 0.0002	< 0.0002	< 0.0002
Cu-D (mg/L)	0.00104	0.00043	0.00084
Fe-D (mg/L)	0.018	0.005	0.014
K--D (mg/L)	< 1	< 1	< 1
Li-D (mg/L)	< 0.00005	< 0.00005	< 0.00005
Mg-D (mg/L)	0.63	0.78	1.05
Mn-D (mg/L)	0.0136	0.0299	0.0704
Mo-D (mg/L)	< 0.00005	< 0.00005	< 0.00005
Na-D (mg/L)	3.62	4.08	4.53
Ni-D (mg/L)	0.00033	0.00032	0.00038
Pb-D (mg/L)	< 0.00001	< 0.00001	< 0.00001
Sb-D (mg/L)	0.000015	0.000013	0.000015
Se-D (mg/L)	0.0002	< 0.0002	< 0.0002

Parameter	9/16/2007	9/24/2007	9/30/2007
Sn-D (mg/L)	0.00001	0.00001	0.00002
Sr-D (mg/L)	0.022	0.0285	0.0358
Ti-D (mg/L)	< 0.003	< 0.003	< 0.003
Tl-D (mg/L)	0.000003	0.000002	0.000003
U--D (mg/L)	0.000018	0.000032	0.000024
V--D (mg/L)	0.00028	0.00015	0.00015
Zn-D (mg/L)	0.001	0.0005	0.0011
Zr-D (mg/L)	< 0.005	< 0.005	< 0.005
Ag-T (mg/L)	< 0.00002	0.00006	0.00004
Al-T (mg/L)	3.68	3.18	2.29
As-T (mg/L)	0.0004	0.0003	0.0002
Ba-T (mg/L)	0.0475	0.0404	0.0346
Be-T (mg/L)	0.00005	0.00011	0.00005
Bi-T (mg/L)	< 0.00002	< 0.00002	< 0.00002
B--T (mg/L)	0.015	0.019	0.024
Ca-T (mg/L)	4.54	3.92	5.65
Cd-T (mg/L)	0.00005	0.00004	0.00003
Co-T (mg/L)	0.00153	0.00133	0.00133
Cr-T (mg/L)	0.0011	0.0007	0.0008
Cu-T (mg/L)	0.00796	0.0069	0.00538
Fe-T (mg/L)	2.35	0.471	0.917
K--T (mg/L)	1	2	< 1
Li-T (mg/L)	0.00045	0.00037	0.00029
Mg-T (mg/L)	1.08	0.86	1.23
Mn-T (mg/L)	0.101	0.0655	0.11
Mo-T (mg/L)	0.00006	< 0.00005	< 0.00005
Na-T (mg/L)	3.56	3.94	4.82
Ni-T (mg/L)	0.00112	0.00132	0.00106
Pb-T (mg/L)	0.00101	0.00095	0.00058
P--T (mg/L)	0.3	0.1	0.1
Sb-T (mg/L)	0.000012	0.000016	0.000015
Se-T (mg/L)	< 0.0002	< 0.0002	< 0.0002
Sn-T (mg/L)	0.00001	0.00002	0.00002
Sr-T (mg/L)	0.0297	0.0284	0.0362
Ti-T (mg/L)	0.072	0.013	0.03
Tl-T (mg/L)	0.000017	0.000012	0.000011
U--T (mg/L)	0.000334	0.000353	0.000202
V--T (mg/L)	0.00856	0.00495	0.00484
Zn-T (mg/L)	0.0062	0.0039	0.0045

Table 44. Summary of water quality data collected from Kitimat Landfill Hirsch Pit #4, Site E264246, 2007-2008.

Parameter	9/16/2007	9/24/2007	9/30/2007	11/25/2007	10/14/2008	10/21/2008	11/4/2008	11/4/2008
Alkalinity Total 4.5 (mg/L)					12	7.2	9.9	9.1
Amonia Dissolved (mg/L)	< 0.005	< 0.005	< 0.005	< 0.005	0.026	< 0.005	0.014	0.032
Amonia:T (mg/L)					0.03	0	0.01	< 0.03
Bromide Dissolved (mg/L)	< 0.01	< 0.01	< 0.01	< 0.01			< 0.01	< 0.01
Carbon Dissolved Organic (mg/L)					4.1	6.8	1.6	1.7
Chlrid:D (mg/L)	5	5.5	3.2	2.2	2.7	1	2	2.8
Hardness (Dissolved) (mg/L)	10.5	11.7	11.3	6.1	8.9	8.4	10.1	10.1
Hardness Total (T) (mg/L)	17.6	23.1	16.5	9.3	12.6	9.7	9.7	10.4
N.Kjel:T (mg/L)					0.08	0.07	0.07	0.05
Nitrate (NO3) Dissolved (mg/L)	0.031	0.059	0.022	0.066	0.039	< 0.002	0.043	0.049
Nitrate + Nitrite Diss. (mg/L)	0.031	0.114	0.097	0.101	0.05	0.012	0.046	0.053
Nitrogen - Nitrite Diss. (mg/L)	< 0.002	0.055	0.075	0.035	0.011	0.011	0.003	0.004
Nitrogen Organic-Total (mg/L)					0.05	0.07	0.06	< 0.02
Nitrogen Total (mg/L)					0.13	0.08	0.12	0.1
NO2+NO3 (mg/L)					0.05	0.01	0.05	0.05
pH (pH)	6.2	6.3	6.7	6.6	6.9	7	6.9	6.8
Phosphorus Tot. Dissolved (mg/L)	< 0.1	< 0.1	< 0.1					
P--T (mg/L)	0.7	1.1	1		0.045	0.052	0.067	0.123
Res:Tot (mg/L)					83	75	56	58
Residue Filterable 1.0u (mg/L)					34	26	24	28
Residue Non-filterable (mg/L)					49	49	32	30
Specific Conductance (uS/cm)	41	47	40	22	35	27	32	31
Sulfat:D (mg/L)	3.3	3.1	2.1	0.7	2.2	2.1	1.9	2.2
Sulfur Dissolved (mg/L)	1.3	1.3	0.9	< 3	< 3	< 3	< 3	< 3
Sulfur Total (mg/L)	0.8	1.3	0.9	< 3	< 3	< 3	< 3	< 3
Ag-D (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.000005	< 0.000005	< 0.000005	< 0.000005	< 0.000005
Ag-T (mg/L)	0.00002	0.00005	0.00004	0.000099	0.000028	0.000032	0.000009	0.000008
Al-D (mg/L)	0.0443	0.0415	0.0609	0.0551	0.112	0.168	0.102	0.101
Al-T (mg/L)	14.8	25.7	9.14	3.95	1.82	1.77	0.339	0.496
As-D (mg/L)	0.0001	< 0.0001	< 0.0001	0.00003	0.00012	0.00005	0.00007	0.00007
As-T (mg/L)	0.0008	0.0007	0.001	0.00042	0.00029	0.00022	0.0001	0.00013
Ba-D (mg/L)	0.0119	0.0162	0.0109	0.0108	0.011	0.00615	0.00978	0.00952
Ba-T (mg/L)	1.09	0.469	0.199	0.0878	0.03	0.032	0.0165	0.0195
B--D (mg/L)	0.019	0.019	0.01	< 0.005	< 0.05	< 0.05	< 0.05	< 0.05
Be-D (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Be-T (mg/L)	0.00046	0.00057	0.00042	0.00009	0.00004	0.00004	0.00001	0.00002
Bi-D (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.000005	< 0.000005	< 0.000005	< 0.000005	< 0.000005
Bi-T (mg/L)	< 0.00002	0.00002	< 0.00002	0.000032	0.000018	0.000023	< 0.000005	< 0.000005

Parameter	9/16/2007	9/24/2007	9/30/2007	11/25/2007	10/14/2008	10/21/2008	11/4/2008	11/4/2008
B--T (mg/L)	0.018	0.024	0.016	< 0.005	< 0.05	< 0.05	< 0.05	< 0.05
C.O.D. (mg/L)		50	38	12	33	15	19	26
Ca-D (mg/L)	3.05	3.43	3.4	1.91	2.59	2.44	3.02	3.01
Ca-T (mg/L)	5.59	5.79	4.44	2.44	3.07	2.59	2.88	3.07
Cd-D (mg/L)	0.00001	0.00001	0.00003	< 0.000005	0.000011	0.000005	0.000009	0.000008
Cd-T (mg/L)	0.00028	0.00016	0.00008	0.000037	0.000029	0.000015	0.000008	0.000012
Co-D (mg/L)	0.000178	0.000187	0.000627	0.000468	0.000072	0.000051	0.000122	0.000107
Co-T (mg/L)	0.00276	0.0125	0.00366	0.00202	0.00122	0.000834	0.000211	0.000332
Cr-D (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0001	0.0004	0.0001	0.0001	0.0001
Cr-T (mg/L)	0.001	0.007	0.0018	0.0013	0.0014	0.0008	0.0002	0.0002
Cu-D (mg/L)	0.00072	0.00052	0.00117	0.00071	0.00097	0.001	0.00048	0.00048
Cu-T (mg/L)	0.0215	0.0914	0.0256	0.0154	0.0075	0.00725	0.00133	0.00201
Fe-D (mg/L)	0.005	< 0.005	0.026	0.012	0.133	0.079	0.077	0.078
Fe-T (mg/L)	1.15	4.65	3.54	1.77	1.95	1.02	0.199	0.287
K--D (mg/L)	< 1	< 1	< 1	1.74	0.57	0.49	0.45	0.45
K--T (mg/L)	2	2	2	2.03	0.75	0.61	0.44	0.49
Li-D (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Li-T (mg/L)	0.00044	0.00253	0.00179	0.0006	0.0006	< 0.0005	< 0.0005	< 0.0005
Mg-D (mg/L)	0.7	0.76	0.68	0.32	0.59	0.56	0.63	0.63
Mg-T (mg/L)	0.87	2.09	1.3	0.79	1.19	0.78	0.61	0.67
Mn-D (mg/L)	0.0269	0.0298	0.115	0.00861	0.0097	0.00233	0.0146	0.0136
Mn-T (mg/L)	0.149	0.471	0.225	0.0875	0.0628	0.0345	0.0193	0.0245
Mo-D (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Mo-T (mg/L)	< 0.00005	0.00006	< 0.00005	< 0.00005	0.0001	0.00005	< 0.00005	< 0.00005
Na-D (mg/L)	3.21	3.22	2.58	1.25	2.37	2.61	2.05	2.04
Na-T (mg/L)	3.19	3.48	2.85	1.21	2.48	2.64	1.86	1.98
Ni-D (mg/L)	0.00042	0.0003	0.00035	0.0001	0.00067	0.00032	0.00023	0.00015
Ni-T (mg/L)	0.00109	0.0106	0.0021	0.00196	0.00219	0.00116	0.00037	0.00044
Pb-D (mg/L)	< 0.00001	< 0.00001	< 0.00001	< 0.000005	0.000044	0.000021	0.00002	0.000016
Pb-T (mg/L)	0.00261	0.00545	0.00185	0.00115	0.000449	0.000371	0.0001	0.000145
Sb-D (mg/L)	0.000016	0.000013	0.000017	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Sb-T (mg/L)	0.000018	0.000032	0.000027	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Se-D (mg/L)	0.0003	< 0.0002	< 0.0002	< 0.00004	< 0.00004	< 0.00004	< 0.00004	< 0.00004
Se-T (mg/L)	< 0.0002	< 0.0002	0.0003	0.00005	< 0.00004	< 0.00004	0.00006	0.00005
Si-D (mg/L)				3.03	4.13	3.59	4.63	4.3
Si-T (mg/L)				5.88	5.44	4.51	4.15	3.86
Sn-D (mg/L)	< 0.00001	0.00002	0.00002	0.00003	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Sn-T (mg/L)	0.00001	0.00004	0.00002	0.00003	0.00001	0.00001	< 0.00001	< 0.00001
Sr-D (mg/L)	0.0191	0.0225	0.0195	0.0131	0.0146	0.0135	0.0167	0.0168
Sr-T (mg/L)	0.0514	0.042	0.0259	0.0173	0.0176	0.0143	0.0162	0.0168
Ti-D (mg/L)	< 0.003	< 0.003	< 0.003	< 0.0005	0.0033	0.0024	0.0024	0.0026
Ti-T (mg/L)	0.029	0.04	0.045	0.0387	0.0683	0.0306	0.0054	0.0091

Parameter	9/16/2007	9/24/2007	9/30/2007	11/25/2007	10/14/2008	10/21/2008	11/4/2008	11/4/2008
Tl-D (mg/L)	0.000003	0.000003	0.000003	< 0.000002	0.000002	0.000002	< 0.000002	< 0.000002
Tl-T (mg/L)	0.000036	0.000051	0.000018	0.000016	0.000012	0.000007	< 0.000002	< 0.000002
U--D (mg/L)	0.000017	0.00002	0.000023	0.00002	0.000025	0.000046	0.000026	0.000027
U--T (mg/L)	0.00179	0.00205	0.000866	0.000394	0.000132	0.000147	0.00005	0.000061
V--D (mg/L)	0.00017	0.00016	0.00022	0.0002	0.0009	0.0007	0.0006	0.0006
V--T (mg/L)	0.00644	0.0329	0.00877	0.0062	0.0057	0.0036	0.0011	0.0013
Zn-D (mg/L)	0.0006	0.0003	0.0005	0.0007	0.0005	0.0002	0.0004	0.0002
Zn-T (mg/L)	0.0059	0.0364	0.009	0.007	0.0058	0.003	0.0008	0.0012
Zr-D (mg/L)	< 0.005	< 0.005	< 0.005					

Table 45. Summary of water quality data collected from Kitimat Landfill Hirsch Pit #5, Site E264247, 2007-2008.

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Alkalinity Total 4.5 (mg/L)	67	74	70.5	3.5	4
Amonia Dissolved (mg/L)	< 0.005	0.04	0.009	0.011	17
Bromide Dissolved (mg/L)	< 0.01	0.02	0.01	0.004	7
C.O.D. (mg/L)	< 10	59	19	14	16
Carbon Dissolved Organic (mg/L)	0.5	3.4	1.75	1.3	4
Chlrid:D (mg/L)	< 0.5	3.2	1.7	0.6	17
Hardness (Dissolved) (mg/L)	71.8	90.5	78.8	5.0	17
Hardness Total (T) (mg/L)	72	96	81	7	17
N.Kjel:T (mg/L)	< 0.02	0.04	0.03	0.01	4
Nitrate (NO3) Dissolved (mg/L)	0.416	0.545	0.479	0.040	16
Nitrate + Nitrite Diss. (mg/L)	0.419	0.554	0.482	0.041	17
Nitrogen - Nitrite Diss. (mg/L)	< 0.002	0.011	0.005	0.003	16
Nitrogen Organic-Total (mg/L)	< 0.02	0.04	0.03	0.01	4
Nitrogen Total (mg/L)	0.43	0.48	0.46	0.02	4
NO2+NO3 (mg/L)	< 0.41	< 0.46	< 0.43	0.02	4
pH (pH)	7.6	8	7.81	0.14	17
Phosphorus Tot. Dissolved (mg/L)	< 0.1	< 0.1	< 0.1		6
Res:Tot (mg/L)	135	560	252	206	4
Residue Filterable 1.0u (mg/L)	120	160	143	21	4
Residue Non-filterable (mg/L)	6	400	109	194	4
Specific Conductance (uS/cm)	150	190	168	12	17
Sulfat:D (mg/L)	7.9	17	12	3	17
Sulfur Dissolved (mg/L)	3	6	4	1	17
Sulfur Total (mg/L)	3	6	4	1	17
Ag-D (mg/L)	< 0.000005	< 0.00002	< 0.00001		17
Al-D (mg/L)	0.0027	0.0148	0.0093	0.0037	17
As-D (mg/L)	0.00002	< 0.0001	0.00005	0.00004	17

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Ba-D (mg/L)	0.00243	0.00416	0.00325	0.00053	17
B--D (mg/L)	0.018	< 0.05	< 0.026		17
Be-D (mg/L)	< 0.00001	< 0.00002	< 0.00001	0.000005	17
Bi-D (mg/L)	< 0.000005	< 0.00002	< 0.00001		17
Ca-D (mg/L)	21.9	27.3	23.8	1.4	17
Cd-D (mg/L)	< 0.000005	< 0.00001	< 0.000006		17
Co-D (mg/L)	< 0.000005	0.000107	0.000038	0.000036	17
Cr-D (mg/L)	< 0.0001	< 0.0002	< 0.0001		17
Cu-D (mg/L)	< 0.00005	0.0006	0.00024	0.00015	17
Fe-D (mg/L)	0.007	0.04	0.018	0.011	17
K--D (mg/L)	2	3	2	0	17
Li-D (mg/L)	0.00148	0.0021	0.00168	0.00015	17
Mg-D (mg/L)	4.12	5.42	4.72	0.39	17
Mn-D (mg/L)	0.00022	0.0773	0.03026	0.02480	17
Mo-D (mg/L)	0.00009	0.00016	0.00013	0.00002	17
Na-D (mg/L)	2.54	3.27	2.93	0.19	17
Ni-D (mg/L)	0.00004	0.00082	0.00019	0.00021	17
Pb-D (mg/L)	< 0.000005	0.000021	0.000009	0.000005	17
Sb-D (mg/L)	< 0.000005	0.00007	0.000019	0.000015	17
Se-D (mg/L)	< 0.00004	< 0.0002	< 0.00001		17
Si-D (mg/L)	10.5	13.2	12.1	1.0	11
Sn-D (mg/L)	< 0.00001	0.00004	0.00002	0.00001	17
Sr-D (mg/L)	0.107	0.139	0.123	0.010	17
Ti-D (mg/L)	< 0.0005	< 0.003	< 0.001		17
Tl-D (mg/L)	< 0.000002	0.000002	0.000002		17
U--D (mg/L)	0.000008	0.000021	0.000013	0.000004	17
V--D (mg/L)	0.00011	0.0004	0.00022	0.00008	17
Zn-D (mg/L)	< 0.0001	0.0005	0.0002	0.0001	17
Zr-D (mg/L)	< 0.005	< 0.005	< 0.005	0	6
Ag-T (mg/L)	< 0.000005	< 0.00002	< 0.00001		17
Al-T (mg/L)	0.0318	2.41	0.6402	0.7369	17
As-T (mg/L)	0.00002	0.00027	0.00009	0.00008	17
Ba-T (mg/L)	0.00332	0.032	0.00896	0.00763	17
Be-T (mg/L)	< 0.00001	0.00005	0.000018	0.000013	17
Bi-T (mg/L)	< 0.000005	< 0.00002	< 0.00001		17
B--T (mg/L)	0.014	< 0.05	< 0.026		17
Ca-T (mg/L)	21.4	28.1	24.4	1.9	17
Cd-T (mg/L)	< 0.000005	0.000035	< 0.000011	0.000009	17
Co-T (mg/L)	0.000026	0.00257	0.00064	0.00077	17
Cr-T (mg/L)	< 0.0001	0.0016	0.0004	0.0004	17

Parameter	Minimum	Maximum	Average	Std Dev	No. of samples
Cu-T (mg/L)	0.0002	0.00846	0.00235	0.00267	17
Fe-T (mg/L)	0.115	8.93	1.478	2.150	17
K--T (mg/L)	2	3	3	0	17
Li-T (mg/L)	0.00149	0.0034	0.00205	0.00050	17
Mg-T (mg/L)	4.19	6.28	4.89	0.61	17
Mn-T (mg/L)	0.00951	1.2	0.210	0.285	17
Mo-T (mg/L)	0.00008	0.00019	0.00012	0.00003	17
Na-T (mg/L)	2.48	3.15	2.91	0.23	17
Ni-T (mg/L)	0.00008	0.00221	0.00060	0.00057	17
Pb-T (mg/L)	0.000009	0.00052	0.000176	0.000182	17
P--T (mg/L)	0.037	0.3	0.152	0.094	10
Sb-T (mg/L)	< 0.000005	< 0.00002	0.000015	0.000007	17
Se-T (mg/L)	< 0.00004	< 0.0002	< 0.00001		17
Si-T (mg/L)	9.59	15.2	12.0	1.5	11
Sn-T (mg/L)	< 0.00001	0.00003	0.00002	0.00001	17
Sr-T (mg/L)	0.108	0.155	0.126	0.011	17
Ti-T (mg/L)	0.0011	0.0992	0.0189	0.0240	17
Tl-T (mg/L)	< 0.000002	0.000015	0.000004	0.000004	17
U--T (mg/L)	0.000013	0.000169	0.000050	0.000048	17
V--T (mg/L)	0.0003	0.0079	0.0022	0.0024	17
Zn-T (mg/L)	0.0002	0.0075	0.0023	0.0024	17

APPENDIX II. SUMMARY OF ANALYSIS OF DUPLICATE AND FIELD BLANK SAMPLES

Table 46. Comparison of duplicate samples collected at EMS Site 0430025, Kitimat River at Bridge on May 3, 2015.

Sample type	Regular*	Replicate*	Relative % difference
Amonia Dissolved (mg/L)	0.0079	0.023	98%
Amonia:T (mg/L)	0.008	0.023	97%
Chlrid:D (mg/L)	0.87	1.7	65%
FluordeD (mg/L)	0.037	0.041	10%
N.Kjel:T (mg/L)	0.053	0.075	34%
Nitrate (NO3) Dissolved (mg/L)	0.0978	0.0978	0%
Nitrate + Nitrite Diss. (mg/L)	0.0978	0.1	2%
Nitrogen - Nitrite Diss. (mg/L)	0.002	0.0025	22%
Nitrogen Organic-Total (mg/L)	0.045	0.052	14%
Nitrogen Total (mg/L)	0.151	0.175	15%
NO2+NO3 (mg/L)	0.098	0.1	2%
Ortho-Phosphate Dissolved (mg/L)	0.002	0.0021	5%
P--T (mg/L)	0.0039	0.0037	5%
Sulfat:D (mg/L)	1.68	2.27	30%

*samples reported below detection limit were given value of detection limit for the purpose of calculating relative percent differences

Table 47. Comparison of duplicate samples collected at EMS Site E301870, Kitimat River Upstream Control, on May 13, 2015.

Sample type	Regular*	Replicate*	Relative % difference
Amonia Dissolved (mg/L)	0.011	0.0088	22%
Amonia:T (mg/L)	0.011	0.009	20%
Chlrid:D (mg/L)	0.5	0.5	0%
Color True (Col.unit)	11.7	12.1	3%
Cyanide (WAD) (mg/L)	0.0005	0.0005	0%
Cyanide S.A.D. (mg/L)	0.00061	0.00065	6%
E Coli (CFU/100mL)	3	4	29%
Hardness (Dissolved) (mg/L)	11.4	11.3	1%
Hardness Total (T) (mg/L)	12.3	12.4	1%
N.Kjel:T (mg/L)	0.114	0.09	24%
Nitrate (NO3) Dissolved (mg/L)	0.0674	0.0699	4%
Nitrate + Nitrite Diss. (mg/L)	0.0674	0.0699	4%
Nitrogen - Nitrite Diss. (mg/L)	0.002	0.002	0%
Nitrogen Organic-Total (mg/L)	0.103	0.081	24%
Nitrogen Total (mg/L)	0.182	0.16	13%
NO2+NO3 (mg/L)	0.068	0.07	3%

Sample type	Regular*	Replicate*	Relative % difference
Ortho-Phosphate Dissolved (mg/L)	0.001	0.0012	18%
pH (pH)	7.2	7.28	1%
P--T (mg/L)	0.0021	0.0024	13%
Residue Non-filterable (mg/L)	8.8	9	2%
Sulfat:D (mg/L)	1.23	1.12	9%
Sulfide Total (mg/L)	0.0115	0.0116	1%
Sulfur Dissolved (mg/L)	3	3	0%
Sulfur Total (mg/L)	15	3	133%
Ag-D (mg/L)	0.000005	0.000005	0%
Ag-T (mg/L)	0.000009	0.000005	57%
Al-D (mg/L)	0.0343	0.0357	4%
Al-T (mg/L)	0.36	0.248	37%
As-D (mg/L)	0.00002	0.00002	0%
As-T (mg/L)	0.000062	0.000041	41%
Ba-D (mg/L)	0.00897	0.00972	8%
Ba-T (mg/L)	0.0126	0.0119	6%
Be-D (mg/L)	0.00001	0.00001	0%
Be-T (mg/L)	0.000011	0.00001	10%
Bi-D (mg/L)	0.000005	0.000005	0%
Bi-T (mg/L)	0.00002	0.000005	120%
B--D (mg/L)	0.01	0.01	0%
B--T (mg/L)	0.05	0.01	133%
Ca-D (mg/L)	3.93	3.88	1%
Ca-T (mg/L)	4.04	4.13	2%
Cd-D (mg/L)	0.000005	0.000005	0%
Cd-T (mg/L)	0.000009	0.000005	57%
Co-D (mg/L)	0.0000126	0.0000148	16%
Co-T (mg/L)	0.000202	0.000145	33%
Cr-D (mg/L)	0.0001	0.0001	0%
Cr-T (mg/L)	0.0009	0.00025	113%
Cu-D (mg/L)	0.000394	0.000595	41%
Cu-T (mg/L)	0.00168	0.0011	42%
Fe-D (mg/L)	0.0144	0.0171	17%
Fe-T (mg/L)	0.346	0.245	34%
Hg-D (mg/L)	0.00001	0.00001	0%
Hg-T (mg/L)	0.00001	0.00001	0%
K--D (mg/L)	0.305	0.328	7%
K--T (mg/L)	0.34	0.368	8%
Li-D (mg/L)	0.0005	0.0005	0%
Li-T (mg/L)	0.0005	0.0005	0%

Sample type	Regular*	Replicate*	Relative % difference
Mg-D (mg/L)	0.382	0.399	4%
Mg-T (mg/L)	0.53	0.505	5%
Mn-D (mg/L)	0.00113	0.00121	7%
Mn-T (mg/L)	0.0116	0.0101	14%
Mo-D (mg/L)	0.000736	0.000745	1%
Mo-T (mg/L)	0.000737	0.000762	3%
Na-D (mg/L)	0.582	0.606	4%
Na-T (mg/L)	0.63	0.62	2%
Ni-D (mg/L)	0.00004	0.000067	50%
Ni-T (mg/L)	0.00061	0.000192	104%
Pb-D (mg/L)	0.0000119	0.0000173	37%
Pb-T (mg/L)	0.000078	0.0000667	16%
Sb-D (mg/L)	0.00002	0.00002	0%
Sb-T (mg/L)	0.00005	0.00002	86%
Se-D (mg/L)	0.00004	0.00004	0%
Se-T (mg/L)	0.00004	0.00004	0%
Si-D (mg/L)	1.54	1.61	4%
Si-T (mg/L)	1.95	1.99	2%
Sn-D (mg/L)	0.0002	0.0002	0%
Sn-T (mg/L)	0.0002	0.0002	0%
Sr-D (mg/L)	0.029	0.0277	5%
Sr-T (mg/L)	0.0292	0.031	6%
Ti-D (mg/L)	0.0005	0.0005	0%
Ti-T (mg/L)	0.0186	0.0135	32%
Tl-D (mg/L)	0.000002	0.000002	0%
Tl-T (mg/L)	0.000005	0.0000029	53%
U--D (mg/L)	0.0000928	0.000102	9%
U--T (mg/L)	0.000122	0.000129	6%
V--D (mg/L)	0.00136	0.00048	96%
V--T (mg/L)	0.00128	0.00126	2%
Zn-D (mg/L)	0.00016	0.00093	141%
Zn-T (mg/L)	0.0014	0.001	33%
Zr-D (mg/L)	0.0001	0.0001	0%
Zr-T (mg/L)	0.0001	0.0001	0%
2-Methylnaphthalene (mg/L)	0.0001	0.0001	0%
Acenaphthene (mg/L)	0.00005	0.00005	0%
Acenaphthylene (mg/L)	0.00005	0.00005	0%
Acridine (mg/L)	0.00005	0.00005	0%
Anthracene (mg/L)	0.00001	0.00001	0%
Benzo(a)anthracene (mg/L)	0.00001	0.00001	0%

Sample type	Regular*	Replicate*	Relative % difference
Benzo(b+j)fluoranthene (mg/L)	0.00005	0.00005	0%
Benzo(g;h;i)perylene (mg/L)	0.00005	0.00005	0%
Benzo(k)fluoranthene (mg/L)	0.00005	0.00005	0%
Bezo(a)pyrene (mg/L)	0.000009	0.000009	0%
Chrysene (mg/L)	0.00005	0.00005	0%
Dibenzo(a;h)anthracene (mg/L)	0.00005	0.00005	0%
Fluoranthene (mg/L)	0.00002	0.00002	0%
FluordeD (mg/L)	0.033	0.027	20%
Fluorene (mg/L)	0.00005	0.00005	0%
Indeno(1;2;3-cd)pyrene (mg/L)	0.00005	0.00005	0%
Napthalene (mg/L)	0.0001	0.0001	0%
Oil&Grease (mg/L)	1	1	0%
PAH (High molecular wt) (mg/L)	0.00005	0.00005	0%
PAH (Low molecular wt) (mg/L)	0.00024	0.00024	0%
PAH- (mg/L)	0.00024	0.00024	0%
Phenanthrene (mg/L)	0.00005	0.00005	0%
Pyrene (mg/L)	0.00002	0.00002	0%
Quinoline (mg/L)	0.00024	0.00024	0%

*samples reported below detection limit were given value of detection limit for the purpose of calculating relative percent differences

Table 48. Comparison of duplicate samples collected at EMS Site E207569, Kitimat River Upstream from Eurocan, on May 27, 2015.

Sample type	Regular*	Replicate*	Relative % difference
Amonia Dissolved (mg/L)	0.014	0.023	49%
Amonia:T (mg/L)	0.014	0.024	53%
Chlrid:D (mg/L)	0.5	0.69	32%
E Coli (CFU/100mL)	3	7	80%
FluordeD (mg/L)	0.02	0.02	0%
Hardness (Dissolved) (mg/L)	8.6	8.55	1%
Hardness Total (T) (mg/L)	9.18	9.58	4%
N.Kjel:T (mg/L)	0.048	0.049	2%
Nitrate (NO3) Dissolved (mg/L)	0.0177	0.0189	7%
Nitrate + Nitrite Diss. (mg/L)	0.0198	0.021	6%
Nitrogen - Nitrite Diss. (mg/L)	0.0021	0.0021	0%
Nitrogen Organic-Total (mg/L)	0.034	0.025	31%
Nitrogen Total (mg/L)	0.068	0.07	3%
NO2+NO3 (mg/L)	0.02	0.021	5%
Ortho-Phosphate Dissolved (mg/L)	0.0018	0.0016	12%
pH (pH)	7.32	6.93	5%
P--T (mg/L)	0.0032	0.0029	10%

Sample type	Regular*	Replicate*	Relative % difference
Residue Non-filterable (mg/L)	11.3	15.5	31%
Sulfat:D (mg/L)	1.69	0.79	73%
Sulfide Total (mg/L)	0.005	0.005	0%
Sulfur Dissolved (mg/L)	3	3	0%
Sulfur Total (mg/L)	3	3	0%
Ag-D (mg/L)	0.000005	0.000005	0%
Ag-T (mg/L)	0.000005	0.000005	0%
Al-D (mg/L)	0.0264	0.0262	1%
Al-T (mg/L)	0.278	0.3	8%
As-D (mg/L)	0.000023	0.000029	23%
As-T (mg/L)	0.000068	0.00007	3%
Ba-D (mg/L)	0.00596	0.00602	1%
Ba-T (mg/L)	0.00983	0.00976	1%
B--D (mg/L)	0.01	0.01	0%
Be-D (mg/L)	0.00001	0.00001	0%
Be-T (mg/L)	0.00001	0.00001	0%
Bi-D (mg/L)	0.000005	0.000005	0%
Bi-T (mg/L)	0.000005	0.000005	0%
B--T (mg/L)	0.01	0.01	0%
Ca-D (mg/L)	2.97	2.95	1%
Ca-T (mg/L)	3.03	3.16	4%
Cd-D (mg/L)	0.000005	0.000005	0%
Cd-T (mg/L)	0.000005	0.000005	0%
Co-D (mg/L)	0.000025	0.00002	22%
Co-T (mg/L)	0.000176	0.000187	6%
Cr-D (mg/L)	0.0001	0.0001	0%
Cr-T (mg/L)	0.0003	0.00032	6%
Cu-D (mg/L)	0.000578	0.000366	45%
Cu-T (mg/L)	0.00122	0.00119	2%
Fe-D (mg/L)	0.0314	0.0306	3%
Fe-T (mg/L)	0.27	0.277	3%
Hg-D (mg/L)	0.00001	0.00001	0%
Hg-T (mg/L)	0.00001	0.00001	0%
K--D (mg/L)	0.277	0.267	4%
K--T (mg/L)	0.319	0.326	2%
Li-D (mg/L)	0.0005	0.0005	0%
Li-T (mg/L)	0.0005	0.0005	0%
Mg-D (mg/L)	0.289	0.288	0%
Mg-T (mg/L)	0.393	0.414	5%
Mn-D (mg/L)	0.00429	0.00441	3%

Sample type	Regular*	Replicate*	Relative % difference
Mn-T (mg/L)	0.0117	0.0116	1%
Mo-D (mg/L)	0.000442	0.000445	1%
Mo-T (mg/L)	0.000471	0.000436	8%
Na-D (mg/L)	0.615	0.613	0%
Na-T (mg/L)	0.674	0.666	1%
Ni-D (mg/L)	0.000037	0.000048	26%
Ni-T (mg/L)	0.000289	0.000278	4%
Pb-D (mg/L)	0.000015	0.000012	22%
Pb-T (mg/L)	0.0001	0.000095	5%
Sb-D (mg/L)	0.00002	0.00002	0%
Sb-T (mg/L)	0.00002	0.00002	0%
Se-D (mg/L)	0.00004	0.00004	0%
Se-T (mg/L)	0.00004	0.00004	0%
Si-D (mg/L)	1.24	1.21	2%
Si-T (mg/L)	1.51	1.58	5%
Sn-D (mg/L)	0.0003	0.0002	40%
Sn-T (mg/L)	0.0002	0.0002	0%
Sr-D (mg/L)	0.0182	0.0183	1%
Sr-T (mg/L)	0.0197	0.02	2%
Ti-D (mg/L)	0.0008	0.0005	46%
Ti-T (mg/L)	0.0121	0.0114	6%
Tl-D (mg/L)	0.000002	0.000002	0%
Tl-T (mg/L)	0.000004	0.000004	0%
U--D (mg/L)	0.000074	0.000077	4%
U--T (mg/L)	0.000107	0.000105	2%
V--D (mg/L)	0.00028	0.00027	4%
V--T (mg/L)	0.00095	0.00095	0%
Zn-D (mg/L)	0.00032	0.00042	27%
Zn-T (mg/L)	0.00121	0.00106	13%
Zr-D (mg/L)	0.0001	0.0001	0%
Zr-T (mg/L)	0.0001	0.0001	0%
Cyanide (WAD) (mg/L)	0.00053	0.0005	6%
Cyanide S.A.D. (mg/L)	0.0005	0.0005	0%
2-Methylnaphthalene (mg/L)	0.0001	0.0001	0%
Acenaphthene (mg/L)	0.00005	0.00005	0%
Acenaphthylene (mg/L)	0.00005	0.00005	0%
Acridine (mg/L)	0.00005	0.00005	0%
Anthracene (mg/L)	0.00001	0.00001	0%
Benzo(a)anthracene (mg/L)	0.00001	0.00001	0%

Sample type	Regular*	Replicate*	Relative % difference
Benzo(b+j)fluoranthene (mg/L)	0.00005	0.00005	0%
Benzo(g;h;i)perylene (mg/L)	0.00005	0.00005	0%
Benzo(k)fluoranthene (mg/L)	0.00005	0.00005	0%
Bezo(a)pyrene (mg/L)	0.000009	0.000009	0%
Chrysene (mg/L)	0.00005	0.00005	0%
Dibenzo(a;h)anthracene (mg/L)	0.00005	0.00005	0%
Fluoranthene (mg/L)	0.00002	0.00002	0%
Fluorene (mg/L)	0.00005	0.00005	0%
Indeno(1;2;3-cd)pyrene (mg/L)	0.00005	0.00005	0%
Napthalene (mg/L)	0.0001	0.0001	0%
Oil&Grease (mg/L)	1	1	0%
PAH (High molecular wt) (mg/L)	0.00005	0.00005	0%
PAH (Low molecular wt) (mg/L)	0.00024	0.00024	0%
PAH- (mg/L)	0.00024	0.00024	0%
Phenanthrene (mg/L)	0.00005	0.00005	0%
Pyrene (mg/L)	0.00002	0.00002	0%
Quinoline (mg/L)	0.00024	0.00024	0%

*samples reported below detection limit were given value of detection limit for the purpose of calculating relative percent differences

Table 49 Summary of laboratory results for analysis of field blank collected at EMS Site E264247, Kitimat Landfill Hirch Pit #5, on October 29, 2008.

Parameter	Result (mg/L)
Alkalinity Total 4.5 (mg/L)	< 0.5
Amonia Dissolved (mg/L)	< 0.005
Bromide Dissolved (mg/L)	< 0.1
C.O.D. (mg/L)	< 10
Ca-D (mg/L)	< 0.05
Carbon Dissolved Organic (mg/L)	< 0.5
Chlrid:D (mg/L)	< 0.5
Hardness (Dissolved) (mg/L)	< 0.5
Hardness Total (T) (mg/L)	< 0.5
N.Kjel:T (mg/L)	< 0.02
Nitrate (NO3) Dissolved (mg/L)	< 0.002
Nitrate + Nitrite Diss. (mg/L)	< 0.002
Nitrogen - Nitrite Diss. (mg/L)	< 0.002
Nitrogen Organic-Total (mg/L)	< 0.02
Nitrogen Total (mg/L)	< 0.02
pH (pH)	5.5
P--T (mg/L)	0.002
Res:Tot (mg/L)	< 14

Parameter	Result (mg/L)
Residue Filterable 1.0u (mg/L)	< 10
Residue Non-filterable (mg/L)	< 4
Specific Conductance (uS/cm)	1
Sulfat:D (mg/L)	< 0.5
Sulfur Dissolved (mg/L)	< 3
Sulfur Total (mg/L)	< 3
Ag-D (mg/L)	< 0.000005
Ag-T (mg/L)	< 0.000005
Al-D (mg/L)	< 0.0002
Al-T (mg/L)	< 0.0002
As-D (mg/L)	< 0.00002
As-T (mg/L)	< 0.00002
Ba-D (mg/L)	< 0.00002
Ba-T (mg/L)	< 0.00002
B--D (mg/L)	< 0.05
Be-D (mg/L)	< 0.00001
Be-T (mg/L)	< 0.00001
Bi-D (mg/L)	< 0.000005
Bi-T (mg/L)	< 0.000005
B--T (mg/L)	< 0.05
Ca-T (mg/L)	< 0.05
Cd-D (mg/L)	< 0.000005
Cd-T (mg/L)	< 0.000005
Co-D (mg/L)	< 0.000005
Co-T (mg/L)	< 0.000005
Cr-D (mg/L)	< 0.0001
Cr-T (mg/L)	< 0.0001
Cu-D (mg/L)	< 0.00005
Cu-T (mg/L)	< 0.00005
Fe-D (mg/L)	< 0.001
Fe-T (mg/L)	< 0.001
K--D (mg/L)	< 0.05
K--T (mg/L)	< 0.05
Li-D (mg/L)	< 0.0005
Li-T (mg/L)	< 0.0005
Mg-D (mg/L)	< 0.05
Mg-T (mg/L)	< 0.05
Mn-D (mg/L)	< 0.00005
Mn-T (mg/L)	< 0.00005
Mo-D (mg/L)	< 0.00005
Mo-T (mg/L)	< 0.00005

Parameter	Result (mg/L)
Na-D (mg/L)	< 0.05
Na-T (mg/L)	< 0.05
Ni-D (mg/L)	< 0.00002
Ni-T (mg/L)	< 0.00002
Pb-D (mg/L)	< 0.000005
Pb-T (mg/L)	< 0.000005
Sb-D (mg/L)	< 0.00002
Sb-T (mg/L)	< 0.00002
Se-D (mg/L)	< 0.00004
Se-T (mg/L)	< 0.00004
Si-D (mg/L)	< 0.1
Si-T (mg/L)	< 0.1
Sn-D (mg/L)	< 0.00001
Sn-T (mg/L)	< 0.00001
Sr-D (mg/L)	< 0.00005
Sr-T (mg/L)	< 0.00005
Ti-D (mg/L)	< 0.0005
Ti-T (mg/L)	< 0.0005
Tl-D (mg/L)	< 0.000002
Tl-T (mg/L)	< 0.000002
U--D (mg/L)	< 0.000002
U--T (mg/L)	< 0.000002
V--D (mg/L)	< 0.0002
V--T (mg/L)	< 0.0002
Zn-D (mg/L)	< 0.0001

Table 50. Summary of laboratory results for analysis of field blank collected at EMS Site E218981, Kitimat River downstream from Eurocan, upstream from reserve, on May 13, 2015.

Parameter	Result (mg/L)
Amonia Dissolved (mg/L)	0.019
Amonia:T (mg/L)	< 0.009
Chlrid:D (mg/L)	< 0.5
Color True (Col.unit)	< 5
E Coli (CFU/100mL)	< 1
FluordeD (mg/L)	0.018
Hardness (Dissolved) (mg/L)	< 0.5
Hardness Total (T) (mg/L)	< 0.5
Nitrate (NO3) Dissolved (mg/L)	< 0.002
Nitrate + Nitrite Diss. (mg/L)	< 0.002
Nitrogen - Nitrite Diss. (mg/L)	< 0.002
Nitrogen Organic-Total (mg/L)	< 0.02

Parameter	Result (mg/L)
Nitrogen Total (mg/L)	0.029
N.Kjel:T (mg/L)	0.029
Ortho-Phosphate Dissolved (mg/L)	< 0.001
pH (pH)	6.2
P--T (mg/L)	0.0038
Residue Non-filterable (mg/L)	< 4
Sulfat:D (mg/L)	< 0.5
Sulfide Total (mg/L)	0.0096
Sulfur Dissolved (mg/L)	< 3
Sulfur Total (mg/L)	< 3
Ag-D (mg/L)	< 0.000005
Ag-T (mg/L)	< 0.000005
Al-D (mg/L)	0.00115
Al-T (mg/L)	0.00101
As-D (mg/L)	< 0.00002
As-T (mg/L)	< 0.00002
Ba-D (mg/L)	< 0.00002
Ba-T (mg/L)	< 0.00002
B--D (mg/L)	< 0.01
Be-D (mg/L)	< 0.00001
Be-T (mg/L)	< 0.00001
Bi-D (mg/L)	< 0.000005
Bi-T (mg/L)	< 0.000005
B--T (mg/L)	< 0.01
Ca-D (mg/L)	< 0.05
Ca-T (mg/L)	< 0.05
Cd-D (mg/L)	< 0.000005
Cd-T (mg/L)	< 0.000005
Co-D (mg/L)	< 0.000005
Co-T (mg/L)	< 0.000005
Cr-D (mg/L)	< 0.0001
Cr-T (mg/L)	< 0.0001
Cu-D (mg/L)	< 0.00005
Cu-T (mg/L)	0.000061
Fe-D (mg/L)	< 0.001
Fe-T (mg/L)	< 0.0019
Hg-D (mg/L)	< 0.00001
K--D (mg/L)	< 0.05
K--T (mg/L)	< 0.05
Li-D (mg/L)	< 0.0005
Li-T (mg/L)	< 0.0005

Parameter	Result (mg/L)
Mg-D (mg/L)	< 0.05
Mg-T (mg/L)	< 0.05
Mn-D (mg/L)	< 0.00005
Mn-T (mg/L)	< 0.00005
Mo-D (mg/L)	< 0.00005
Mo-T (mg/L)	< 0.00005
Na-D (mg/L)	< 0.05
Na-T (mg/L)	< 0.05
Ni-D (mg/L)	< 0.00002
Ni-T (mg/L)	< 0.00002
Pb-D (mg/L)	< 0.000005
Pb-T (mg/L)	0.0000061
Sb-D (mg/L)	< 0.00002
Sb-T (mg/L)	< 0.00002
Se-D (mg/L)	< 0.00004
Se-T (mg/L)	< 0.00004
Si-D (mg/L)	< 0.05
Si-T (mg/L)	< 0.05
Sn-D (mg/L)	< 0.0002
Sn-T (mg/L)	< 0.0002
Sr-D (mg/L)	< 0.00005
Sr-T (mg/L)	< 0.00005
Ti-D (mg/L)	< 0.0005
Ti-T (mg/L)	< 0.0005
Tl-D (mg/L)	< 0.000002
Tl-T (mg/L)	< 0.000002
U--D (mg/L)	< 0.000002
U--T (mg/L)	< 0.000002
V--D (mg/L)	0.00069
V--T (mg/L)	< 0.0002
Zn-D (mg/L)	0.00018
Zn-T (mg/L)	0.00021
Zr-D (mg/L)	< 0.0001
Zr-T (mg/L)	< 0.0001
Cyanide (WAD) (mg/L)	< 0.0005
Cyanide S.A.D. (mg/L)	< 0.0006
2-Methylnaphthalene (mg/L)	< 0.0001
Acenaphthene (mg/L)	< 0.00005
Acenaphthylene (mg/L)	< 0.00005
Acridine (mg/L)	< 0.00005

Parameter	Result (mg/L)
Anthracene (mg/L)	< 0.00001
Benzo(a)anthracene (mg/L)	< 0.00001
Benzo(b+j)fluoranthene (mg/L)	< 0.00005
Benzo(g;h;i)perylene (mg/L)	< 0.00005
Benzo(k)fluoranthene (mg/L)	< 0.00005
Bezo(a)pyrene (mg/L)	< 0.000009
Chrysene (mg/L)	< 0.00005
Dibenzo(a;h)anthracene (mg/L)	< 0.00005
Fluoranthene (mg/L)	< 0.00002
Fluorene (mg/L)	< 0.00005
Indeno(1;2;3-cd)pyrene (mg/L)	< 0.00005
Napthalene (mg/L)	< 0.0001
Oil&Grease (mg/L)	< 1
PAH (High molecular wt) (mg/L)	< 0.00005
PAH (Low molecular wt) (mg/L)	< 0.00024
PAH- (mg/L)	< 0.00024
Phenanthrene (mg/L)	< 0.00005
Pyrene (mg/L)	< 0.00002
Quinoline (mg/L)	< 0.00024