MINISTRY OF ENVIRONMENT AND PARKS
PROVINCE OF BRITISH COLUMBIA

SKEENA-NASS AREA
LOWER KITIMAT RIVER AND KITIMAT ARM

WATER QUALITY ASSESSMENT AND OBJECTIVES

TECHNICAL APPENDIX

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Victoria, B.C.
January, 1987

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INTRODUCTION

The Kitimat River basin has a drainge of about 2 000 km^2. Only a small portion of this, the lower 10 km of the Kitimat River, is dealt with in this report. The section of river studied begins at the bridge on Highway 25, just west of the community of Kitimat, and includes all of the river downstream to the mouth. Kitimat Arm and Minette Bay are also included in the study.

This short stretch of river is a major salmon migration route and one of the most heavily sport-fished rivers in British Columbia. All the water licences and the four major waste discharges in the Kitimat River drainage are concentrated in this small area. The waste discharges to the river are from the District of Kitimat Municipal Sewage Treatment Plant and the Eurocan Pulp and Paper Mill. The Aluminum Company of Canada Smelter and the Ocelot Industries Methanol Plant discharge to Kitimat Arm.

The community of Kitimat, the only one in the basin, has about 13 500 people and is primarily dependent upon Alcan and Eurocan for its economy. Alcan employs about 2 500 people directly. Both resident and non-resident hunting and fishing are major recreational activities in the area. The whole Kitimat River drainage is within Tree Farm Licence 41 and is steep, mountainous terrain covered in coniferous forest. There is no significant agricultural activity in the drainage basin and the only level ground is the estuary of the Kitimat River and the Kitimat townsite.

2. HYDROLOGY

The Kitimat River arises on the west side of the Coast Mountain Range just south of Terrace and the Skeena River. Major tributaries are the Wedeene and Little Wedeene Rivers and Hirsch and Chist Creeks. The Kitimat River flows into Kitimat Arm located at the head of Douglas Channel off Hecate Strait.

Water Survey of Canada stream gauging station 08FF001 is situated at the bridge on Highway 25 just west of Kitimat. This station, which is shown on Figure 4 and has a drainage area of 1 990 km^2, is the upstream limit of the area under study. Table 1 gives the winter and summer mean low flows in the Kitimat River measured at the Water Survey of Canada station. The means are for 7-day average low flows in the Kitimat River for return periods of 10, 20, 30 and 50 years. Winter low flows are based on November through April data from 1967 to 1981; summer low flows are based on August and September data from 1965 to 1981. The means in Table 1 are accompanied by 95% confidence limits. The 10-year winter and summer mean low flows are 9.8 m^3/s and 39.3 m^3/s, respectively.

Figure 3 shows the streamflow envelope of maximum, minimum and mean daily flows, for the period 1967-1981, at the Water Survey of Canada station. These plots are generated from the same data set used to estimate the 7-day average low flows given in Table 1. Table 2 gives the velocities and calculated residence times of the water in the Kitimat River at various sites between the Water Survey of Canada station and Kitimat Arm for the period 1976-1982. There was no apparent change in the velocity of the river within the reach in which measurements were made. The mean residence time of the water in the Kitimat River below the Eurocan pulpmill discharge was estimated to be 1 to 2.5 hours.

The licenced water withdrawals from the Kitimat River below the Water Survey of Canada station total 5.06 m^3/s, of which only 44% or 2.23 m^3/s is actually withdrawn at present. Most of this present withdrawal, 1.54 m^3/s, is returned to the river, but 0.69 m^3/s is discharged directly to Kitimat Arm, and constitutes a reduction in river flow. This reduction must be subtracted from the values in Table 1 to obtain true flows in the lower reaches of the Kitimat River below the Eurocan pulpmill discharge. Thus, the 10-year return period winter low flow of 9.79 m^3/s measured at the gauging station (see Table 1) would, under present use, be reduced to 7.56 m^3/s below the water intakes (see Figure 4), but increase to 9.1 m^3/s below the Eurocan pulpmill discharge. If, in the future, the full licenced withdrawal of 5.06 m^3/s is made then the 10-year return period winter low flow would be reduced to 4.73 m^3/s below the intakes and rise to 8.22 m^3/s below the Eurocan pulpmill discharge. Flows immediately upstream from the Eurocan discharge are increased from those just below the intakes by the amount of discharge from the Kitimat sewage treatment plant. The mean value of this discharge is 0.24 m^3/s at present and will be 0.32 m^3/s in the future.

3. WATER USES

The location (and licence number) of licenced water withdrawal sites on the lower Kitimat River are shown in Figure 4. These sites are clustered in the upper portion of the river upstream from the first waste discharge (effluent from the District of Kitimat sewage treatment plant), and are described in Table 3. The water is used for drinking, a fish hatchery and industrial purposes.

Much of the water use is non-consumptive and no major change in licenced water use is expected in the near future. As indicated in Section 2, on Hydrology, even if the licences were fully utilized there would be little effect on the Kitimat River flow below the Eurocan pulpmill as long as present non-consumptive uses prevail. Water quality may, however, be affected.

Industrial and fish hatchery water requirements are met by pumping from the river upstream from the waste discharges. Kitimat drinking water is drawn from infiltration wells along the river, the water being filtered through river sediments. Drinking water is then fluoridated and chlorinated before use. The other uses of the river below the waste discharges are recreation, fisheries and aquatic life habitat.

There are several parks upstream from the waste discharges, in the water withdrawal section of the river and above. Most of the primary contact recreation, such as swimming, occurs in this reach of the river due to lack of access to lower reaches. Secondary contact recreation, including boating, rafting, and fishing occurs along the whole length of the river as does hiking, photography and birdwatching. The Kitimat Indian Reserve 1 fronts on a 2 km stretch of the river beginning about 1 500 m below the Eurocan pulpmill discharge, and the Indians make use of the river for recreation and a food fishery.

The Kitimat River is one of the most heavily sport-fished rivers in Canada and is fished year-round. Fishing is the primary tourist attraction for the area, although most fishing is done by resident sport fishermen. Coho, chinook, steelhead, dolly varden, rainbow and cutthroat are the major species of fish in the river. Douglas Channel is used as a nursery for salmon from the Kitimat River, and supports a major saltwater sport fishery. The Kitimat River is a major salmon migration route. Spawning and juvenile rearing occurs primarily in the tributaries of the Kitimat River, but gravels downstream from the waste discharges may support a limited amount of chum spawning.

Alcan owns all the shoreline and foreshore in the western portion of the harbour. There is a swimming and picnic site at 'Alcan beach' provided by Alcan, but all recreation along this shore is at Alcan's pleasure and convenience and is subject to cancellation at any time should the company require the land for other activities. The present Alcan waste discharges do not preclude most forms of public recreation at 'Alcan beach'.

4. WASTE DISCHARGES

4.1 POINT SOURCES

Many of the tables of water quality data mentioned in this section contain water quality criteria for various water uses. Refer to Section 5 for an explanation of these criteria.

The four major point source waste discharges are shown on Figure 4 and identified by their waste management permit numbers. The Kitimat Municipal sewage treatment plant (PE-256) and the Eurocan Pulp and Paper Mill (PE-292) discharge to the Kitimat River. Ocelot Industries (PE-6006) discharges directly to Kitimat Harbour. The Aluminum Co. of Canada Ltd., PE-1494(01) to (04), discharges to Kitimat Harbour (01 and 02), and to Moore Creek (03 and 04), which is a tributary of the Kitimat River. These waste discharges are summarized in Table 4 and shown on Figure 4 by their permit numbers. The Department of Fisheries and Oceans Fish Hatchery does not have a waste discharge permit. This hatchery is newly constructed and not yet in routine operation. There are no effluent data available. Due to the high flow rates through hatcheries and the high quality of water required, it is not expected that nutrient loads or concentrations will significantly affect water quality in the Kitimat River when this facility becomes fully operational. Waste hot water from the Eurocan Pulp and Paper Mill is being used by the fish hatchery as a source of warm water.

4.1.1 DISTRICT OF KITIMAT (PE-256)

The District of Kitimat holds permit PE-256 for the effluent discharge from its municipal sewage treatment plant, via an outfall on the east bank of the Kitimat River just south of Kitimat. The discharge point is about 4 km upstream from the mouth of the Kitimat River. The permit limits the daily average discharge to 18 200 m^3/d (0.21 m^3/s), containing up to 45 mg/L BOD_5 and 60 mg/L suspended solids. No toxic chemicals are permitted. The sewage is ground in a barminuter and aerated in a lagoon, but not chlorinated. Population projections for Kitimat are for an increase of 32% from 13 546 in 1983 to 17 942 in 1993, an increase of 4 396 people. Effluent flows and loadings from the sewage treatment plant may be expected to rise in proportion to the population increase.

Permit monitoring requirements consist of daily flow records, monthly grab samples of effluent analyzed for BOD_5 and total suspended solids, and annual submission of the results to the Waste Management Branch. Effluent monitoring results for 1972 to August 1982 are summarized in Table 5. The effluent generally met the permit conditions. Only 1 of 515 BOD_5 values was appreciably above the permit limit of 45 mg/L. This one value was recorded as greater than 195 mg/L in July 1973. All of the 878 suspended solids values were below the permit limit of 60 mg/L. Effluent flows, with a mean of 20 388 m^3/d, exceeded the permitted daily mean of 18 200 m^3/d. Surface runoff into the storm sewers in the winter months, due to the heavy rainfall, is responsible for some of this increased effluent flow.

There is a groin in the Kitimat River on the east bank below the outfall from PE-256 which directs the effluent plume from the outfall into the centre of the river. About 800 m further downstream this plume passes over the diffuser from the Eurocan PE-292 outfall, and thus below PE-292 the two effluent plumes are mixed and not separable.

Water quality monitoring site 0430018 (Table 29) is located about 900 m downstream from the discharge from PE-256. The data from this site are indistinguishable from those of sites 0430017 and 0430025 (Tables 26 and 27) which are upstream control sites. Although site 0430018 is actually downstream from the PE-292 discharge from Eurocan, this site was not affected by the Eurocan discharge (note the Na levels in Tables 29 and 30) since it is a surface sampling site and the plume from PE-292 has not yet surfaced at this point. The effluent from PE-256 had no measurable effect on the water quality of the Kitimat River 900 m downstream from its discharge point, but only a few measurements were made and some important contaminants in treated sewage such as ammonia, nitrate, nitrite, suspended solids and fecal coliforms were not measured. Beyond the 900 m point, the plume from PE 292 has surfaced and the two plumes are mixed. The predicted effects of the present and future waste discharge from the District of Kitimat sewage treatment plant are discussed further in Sections 5.1.2 and 5.1.3.

4.1.2 EUROCAN PULP AND PAPER CO. LTD. (PE-292)

PE-292 covers the effluent discharge from an unbleached kraft pulp and paper mill to the Kitimat River through a submerged diffuser located about 800 m downstream from the Kitimat Municipal Sewage discharge. The mill, which has been operating since 1972, has a nominal production of 943 air dried tonnes per day of linerboard and kraft pulp and paper. The maximum permitted discharge rate is 68 190 m^3/d (0.79 m^3/s) and this effluent passes through a settling pond and aeration lagoon before being discharged to the Kitimat River. Permit limits for the effluent are: pH of 6.5-8.0, temperature up to 35°C, floatable solids should be negligible, total suspended solids up to 6 770 kg/d, BOD_5 up to 16 770 kg/d, settleable solids up to 0.5 mg/L, mercaptans up to 0.5 mg/L, sulphides up to 0.5 mg/L, resin acids up to 5.0 mg/L, dissolved oxygen over 2.0 mg/L and a 96 h LC50 of 100%.

The permit conditions outlined above were in effect at the time the effluent data in Table 6 were collected. A permit amendment on August 2, 1983 changed these conditions as follows: discharge to a maximum of 68 000 m^3/d, total suspended solids up to 10 400 kg/d, BOD_5 up to 7 800 kg/d and no restrictions on floatable solids, settleable solids, mercaptans, sulphides and resin acids. The other permit conditions remained unchanged.

The effluent monitoring program involves continuous, daily, and weekly grab and composite samples that are taken and analyzed by the permittee with the results submitted monthly to the Waste Management Branch. Monitoring of the Kitimat River has taken place in the mixing zone and further downstream; results from 1976 to August 1982 are summarized in Tables 29 and 31 to 36, and Figures 7 to 16. The 1981 effluent monitoring data indicate substantial compliance with the permit conditions. In previous years however there have been problems with foam, colour, suspended solids, BOD_5 and toxicity; this was most pronounced during low flows in the winter of 1979-1980.

The most probable dilution of pulp mill effluent at low Kitimat River flows after complete mixing is 10:1 at present and 6:1 under future full use of water licences. The worst case would be 4:1 if the peak recorded pulp mill discharge coincided with a 10-year return period, 7-day average low flow in the Kitimat River (see Table 37). At Kitimat River low flows, when the dilution ratio is less than 20:1, there may be problems with colour, tannin and lignin, and suspended solids. See Chapter 5.1.3 for a discussion of the measured and predicted effects of the Eurocan Pulp Mill effluent on water quality in the Kitimat River. Due to the short residence time (1 to 2.5 hours) of the effluent in the Kitimat River (see Table 2), the BOD_5 levels do not cause a dissolved oxygen problem in the river. As discussed in Chapter 3, there is a very important fisheries resource in the Kitimat River which must be protected.

Loading calculations for PE-292 for the period 1974-1982 give the following mean values: BOD_5 4 700 kg/d based on 24 samples, suspended solids 7 300 kg/d based on 25 samples, mercaptan 9.3 kg/d based on 127 samples, resin acids 245 kg/d based on 349 samples, sulphide 24 kg/d based on 221 samples and settleable solids 24 m^3/d based on 325 samples. An analysis of the existing benthic invertebrate data on the Kitimat River by E.V.S. Consultants in 1982 indicated that there was no "distinct adverse biological effect" of the Eurocan discharge and that a "stable benthic community structure has been maintained throughout this section of the river". It would appear that loadings of this magnitude can be tolerated by the benthic community in this stretch of the Kitimat River.

4.1.3 OCELOT INDUSTRIES LTD. (PE-6006)

Ocelot Industries Ltd. started production of methanol from natural gas in September 1982. The plant produces about 1 200 t/d of methanol. First, any residual H_2S and mercaptans are removed by a catalyst from the natural gas feedstock (methane). The presence of these sulphur compounds would poison the methanol conversion catalyst at later steps if not removed. The purified methane and steam are heated to 900°C in contact with a catalyst to produce CO, CO_2 and H_2. These products are then cooled, compressed and reacted at 240°C in the presence of a catalyst to produce methanol (CH_3OH) which is then distilled from the crude product.

There are four main wastewater streams. Process effluents are neutralized and along with plant sewage are sent to a septic tank, a rotating biological contactor unit and a clarifier. Treated water goes to the effluent sump. Demineralizer washwater is neutralized, combined with boiler blowdown and filter washwater and then flows to a settling basin. The overflow from the basin goes to the effluent sump. Cooling water blowdown goes directly to the effluent sump. Contaminated tankfarm drain water joins the process effluent stream at the rotating biological contactor. The effluent sump pumps wastewater to the Kitimat Arm outfall pipe. Uncontaminated tankfarm drain water and surface runoff water are discharged to the Kitimat River. The outfall to Kitimat Arm is 3.5 m below low tide and is thus always submerged. The flow rates on the permit are a maximum of 1 000 m^3/d and an average of 750 m^3/d. The major contaminants are methanol, oil and grease, and sodium and methyl formates. A Beak Consultants' report[19] estimated the dilution ratio, at the edge of the 100 m initial dilution zone, as 75:1. The reliability of this estimate is not known, but it is the only estimate available. Table 7 gives a summary of effluent monitoring results for Ocelot Industries Ltd., PE-6006, for 1982. Table 63 gives 1984 data for Ocelot. Most characteristics showed no substantial change with the following exceptions: C.O.D. and oil and grease were considerably reduced from 1982 levels but were still over permit levels and methanol and organic carbon were considerably reduced from 1982 levels. Flows still exceeded permit limits in 1984.

Using the 75:1 dilution ratio at the edge of the dilution zone - at worst case conditions of low tide, maximum effluent flow and maximum contaminant concentrations-only fecal coliforms and oil and grease would exceed marine water criteria. The oil and grease could be as much as 15.3 mg/L compared to the criterion of not objectionable (defined as a non-detectable) levels. Detection limits of the laboratory are 1.0 mg/L for oil and grease. Fecal coliforms could reach 440 MPN/100 mL which exceeds the shell fish criterion of 14/100 mL, and also the recreational criterion of 200/100 mL.

Ocelot Industries Ltd. has recently announced that it will build an ammonia production plant. This project is cause for some concerns about ammonia in effluents since ammonia is very toxic to fish. However, effluent from Ocelot does not go into the Kitimat River, but rather into Kitimat Arm. The ammonia plant would add additional quantitites of most effluent components in less than or approximately equal amounts to what is already being discharged from the existing methanol plant.

4.1.4 ALCAN SMELTERS AND CHEMICALS LTD. (PE-1494)

The Alcan Aluminum Smelter has a capacity of about 300 000 tons per year of aluminum. Effluents from the Aluminum Smelter come from wet scrubbers, cooling water, surface runoff and a carwash. The effluents contain suspended solids, coke, aluminum, oil and grease, dissolved fluoride, dissolved iron, cyanide and polyaromatic hydrocarbons, and have raised temperatures. They are discharged through four separate outfalls as indicated in Table 8. Summaries of effluent monitoring results are shown in Tables 9-12. Figure 5 shows the location of the outfalls.

Permit monitoring consists of weekly flow rate measurements and a comprehensive program of monthly and quarterly sampling of effluent and ambient water quality sites. Analyses are performed for suspended solids, pH, oil and grease, temperature, coliform bacteria, total cyanide and dissolved iron, aluminum and fluoride. Annual and semi-annual bioassays are required.

Outfall (01) from wet scrubbers, cooling water and Smelter 'A' surface runoff, has a permitted maximum flow of 50 000 m^3/d under wet weather conditions and 33 000 m^3/d under dry conditions. Major contaminants are aluminum, fluoride and a low pH level. The PE 1494(01) outfall is simply overflow from a settling pond which spills over a weir and runs via a ditch through the beach into Kitimat Arm.

Outfall (02) from cooling water and the coke calciner surface runoff has a permitted flow of 1 360 m^3/d. The main contaminants are aluminum, calcium, fluoride, iron, oil and grease, suspended solids and both high and low pH values. This outfall discharges directly to Kitimat Arm.

Outfall (03) from cooling water and Smelter 'B' surface runoff has a permitted flow of 17 700 m^3/d. The primary contaminants are aluminum and fluoride. This outfall discharges to Moore Creek which flows through the estuary and joins Beaver Creek before entering Kitimat Arm.

Outfall (04) is from the carwash and storm sewer. This effluent contains only minor contamination, and is discharged to Moore Creek with the effluent from outfall (03).

Total cyanide, and dissolved aluminum, iron and fluoride loads in PE 1494(01), PE 1494(02), PE 1494(03) and diffuse loads to Moore Creek are given in Table 40. Table 43 gives the percentages of the total loads from Alcan that came from each of these four sources. PE 1494(01) was the largest source of these contaminants followed by diffuse loads in Moore Creek, then PE 1494(03) and finally PE 1494(02). PE 1494(01) and PE 1494(02) discharge directly to Kitimat Arm while PE 1494(03) discharges to Moore Creek which eventually reaches Kitimat Arm via the Kitimat River estuary.

Table 14 summarizes the values of several characteristics in Moore Creek measured at site 0400507 upstream from PE 1494(03) and PE 1494(04), and at site 0400508, downstream from these discharges, as shown on Figures 4 and 5. There was no substantial change in the measured values of the characteristics between the upstream and downstream sites. The loadings from PE 1494(03), and for most characteristics of PE 1494(04), were small fractions of the loads already existing at the upstream site. A few characteristics of PE 1494(04) were of similar concentrations to those already present at the upstream site. The upstream site, 0400507, had abnormally high fluoride and aluminum values and appears to have been affected by diffuse sources such as fugitive dust or airborne emissions from Alcan and is thus not a true upstream control site. The very low minimum pH value of 3.6 in Moore Creek is detrimental to aquatic life. Other characteristics which exceeded aquatic life criteria in these two Moore Creek sites were iron, aluminum, fluoride and zinc. Copper exceeded the criterion at the downstream site.

Table 16 gives the fluoride levels in Kitimat Arm for two locations (3 depths at each location) which are subject to effluent from PE 1494(01). The locations are called sites 0400509 to 0400514 and are shown on Figure 5. Fluoride levels are relatively high at the surface and drop rapidly with increasing depth in the water column.

These locations are 150 m (for 0400509-0400511), and 800 m (for 0400512-0400514) from the PE 1494(01) discharge point. This discharge contains 97 percent of the fluoride discharged by Alcan, and it appears that a layer of freshwater containing most of the fluoride had still not mixed with the underlying salt water at these sample points. Seawater naturally contains 0.8-1.4 mg/L of fluoride. The marine aquatic life criterion for fluoride is 1.5 mg/L[3]. As indicated in Table 16, this criterion was regularly exceeded at these two sites.

The data upon which the discussion has been based up to this point were collected prior to 1982. New effluent data from 1982 to 1984 are summarized in Tables 52-54. While iron, fluoride, pH and suspended solids still occasionally exceeded permit limits, the 1982-1984 data show very considerable improvements in effluent quality compared to the pre-1982 data.

For example, the average concentrations of fluoride, iron and aluminum in 1982-84 from PE 1494(01), the major source of these contaminants, were about one-half of the pre-1982 levels. Cyanide concentrations were unchanged.

4.2 DIFFUSE SOURCES

The main diffuse sources, all landfills, are shown on Figure 4 by their permit numbers and are summarized in Table 17.

4.2.1 DISTRICT OF KITIMAT LANDFILL (PR-3608)

The District of Kitimat has a municipal landfill located 150 m from Hirsch Creek, a tributary of the Kitimat River, as shown in Figure 4. Up to 191 m^3/d of municipal refuse and some industrial wastes may be deposited in the landfill, and up to 80 m^3/d of septic tank pumpage may be placed in infiltration pits. Refuse may not be placed within four feet of the water table and must be covered daily. Periodic inspections are carried out by the Waste Management Branch. The landfill is well maintained and is generally in compliance with permit conditions. No monitoring of Hirsch Creek for leachate from this landfill is required by the permit or has ever been carried out. It is recommended that at least one year of monitoring should be done at low flows in Hirsch Creek, both upstream and downstream from the landfill, to check for any leachate problems. If no contamination is found then the sampling can be stopped.

4.2.2. EUROCAN PULP AND PAPER CO. LTD. LANDFILL (PR-1650)

Pollution Control Permit PR-1650 allows industrial refuse from the pulp and paper mill operation to be deposited in a modified sanitary landfill located as shown on Figures 4 and 6. There are actually two refuse locations: an old site west of the wood mill and Beaver Creek, and a current site north of Beaver Creek and south of the wood mill. Leachates from the old refuse site were still affecting Beaver Creek. The new refuse site drains towards Beaver Creek and Syme Creek, which are tributaries of

Anderson Creek. Anderson flows into the Kitimat River estuary. Both Anderson and Beaver Creeks are used by spawning coho salmon.

There are no limits on the composition of the 87 m^3/d waste which may be deposited. It generally consists of settling pond solids, green liquor dregs, slaker dregs, power boiler ash and wood mill waste. The coloured, high BOD_5 leachate from the landfill contains suspended solids, resin acids and sodium.

A monitoring program carried out by Eurocan is required by the permit with results submitted quarterly to the Waste Management Branch. The leachate from the landfill is monitored for pH, colour, dissolved oxygen, suspended solids, total solids, volatile suspended solids, BOD_5, and turbidity. Visual monitoring of algal growth is also carried out. Permit inspections by the Waste Management Branch show that the landfills are substantially in compliance with permit requirements with respect to quantities and maintenance, but receiving water analyses show a progressive deterioration of the water quality in Syme and Beaver Creeks. Tables 18 to 22 summarize the water quality data for these two creeks. The locations of the water sampling sites are shown in Figures 4 and 6. Tables 23 and 24 give the flow rates and loadings at these sites to indicate their relative importance as sources of leachate from the landfills. In the following discussion, sites are referred to without their common prefix, 04300.

Inspection of Table 24 and Figure 6 indicates that the old landfill between sites 26 and 27 was responsible for a large increase in BOD_5, sodium, and suspended and dissolved solids. Inspection of Table 18 and 19 also indicates greatly increased turbidity and colour downstream from the landfill. There was apparently insufficient residence time for the increased BOD_5 to have affected the dissolved oxygen level in Beaver Creek at site 27. The new landfill contributed substantial quantities of BOD_5, sodium, colour, and turbidity, far in excess of the amounts already present at the upstream site 26. While appreciable dissolved and suspended solids are contributed by the new landfill, the actual quantities are only 2/3 those already present in Beaver Creek at Site 26 (Table 24). Dissolved oxygen levels, however, were considerably depressed in the drainage from the new landfill (site 30), before it entered Beaver Creek.

The drainage from Syme Creek (site 28) also contributed BOD_5, sodium, suspended solids, colour and turbidity loads in excess of those at site 26, and showed a considerable depression of dissolved oxygen levels. As indicated in Table 24, the suspended solids subtotal (the sum of loads from sites 27, 28 and 30), is much greater than the load at site 29 further downstream, indicating that suspended solids were settling out in Beaver Creek in significant amounts.

Table 44 compares the water quality at site 26, upstream, with that at site 29, downstream. Most characteristics increased considerably between the upstream and downstream sites. Dissolved oxygen decreased, likely in response to the increased BOD_5. A comparison of loadings for some characteristics in Beaver Creek at site 29 with loadings from the PE 292 effluent is shown in Table 45, and indicates the relative importance of the two waste loads. It is apparent that the waste load in Beaver Creek is significant to Beaver Creek, but it is a relatively minor input to the Kitimat River compared to the Eurocan effluent.

4.2.3 ALUMINUM CO. OF CANADA LANDFILL (PR-2527)

Pollution Control Permit PR 2527 authorizes three industrial refuse landfills containing three types of waste from the Alcan Smelter Complex. The locations of these three landfills, in relation to the buildings and the surface water flows, are shown in Figure 5. Landfill PR 2527(01) receives up to 6.9 m^3/d of pot linings (carbon and brick impregnated with fluoride compounds during electrolytic reduction). Up to 19.1 m^3/d of mixed industrial refuse (wood, scrap, domestic waste) may be deposited in landfill PR 2527(02). Inert industrial refuse (brick, concrete, road sweepings) up to 1.53 m^3/d may be deposited in landfill PR 2527(03). These landfills are required to be covered and compacted regularly.

The monitoring program for these landfills consists of weekly monitoring of potlining leachate and flow rates from PE 2527(01), quarterly and yearly reports to the Waste Management Branch on fluoride and cyanide leachate, volumes of refuse and covering activities, and occasional inspections by Waste Management staff. The landfills are often poorly covered and compacted.

In 1981, for example, 9 711 tonnes of potlinings were deposited in PR 2527(01). Seepage from this dump site passes through two settling ponds before being discharged to Kitimat Arm with the PE 1494(01) effluent. Table 25 gives a summary of leachate monitoring results for site 0700058, which is in the drainage from PR 2527(01) as shown on Figure 5. The leachate contained high levels of cyanide and fluoride, equal to 41% and 11%, respectively, of the levels in the PE 1494(01) effluent.

Table 14 gives the levels of several contaminants in Moore Creek both upstream and downstream from landfill PR 2527 (02) and of effluent discharges PE 1494(03) and PE 1494(04). The location of the water sampling sites are shown on Figures 4 and 5. There was no significant change in the measured contaminants between the upstream and downstream sites. Since the materials in PR 2527(02) are relatively inert, no change due to leachate from the landfill was expected.

5. WATER QUALITY

In many of the tables of ambient water quality data there are columns for aquatic life, recreation and drinking water criteria. This permits ready comparison of actual values with literature reports of the necessary levels commensurate with the use of the water for recreation, by aquatic life or as a raw drinking water source. Table 56 is a compilation of all these criteria with a reference number to indicate the source of the value. Values, such as turbidity, which are expressed as <+5 NTU mean that the criterion is not more than a 5 NTU increase over the existing natural background at that site and time of year. These are the working water quality criteria that the Ministry of Environment is using until approved criteria can be established. Approved criteria, which may differ from the working criteria, have been issued for particulate matter, nutrients and algae, cyanide, molybdenum, and nitrogen (nitrate, nitrite, and ammonia).

5.1 FRESH WATER QUALITY - KITIMAT RIVER

5.1.1 KITIMAT RIVER UPSTREAM FROM THE WASTE DISCHARGES

Water quality monitoring sites on the lower Kitimat River are mapped in relation to effluent discharges, landfills and water licences on Figure 4. The water quality of the Kitimat River above the first effluent discharge (District of Kitimat treated sewage, PE 256) was measured at sites 0430017 and 0430025. All but one of the licenced water withdrawals in the lower Kitimat River are located in the vicinity of these two water quality sites; the exception, CL55545, is about 10 km further upstream. Water quality data for these sites for 1976-1984 are summarized in Tables 26 and 27.

The water quality met drinking water criteria for most characteristics that were measured. Turbidity naturally and quite regularly exceeded the criterion of 5 NTU, indicating that treatment for the removal of turbidity is required before the water may be used for drinking. However, drinking water withdrawals are made from riverside infiltration wells which filter the water through river sediments prior to use (Section 3). Iron and manganese also exceeded drinking water criteria, but they appear to be associated with the suspended sediments and the removal of this fraction during infiltration should remove these contaminants. Cobalt, copper, iron, lead and manganese occasionally exceeded aquatic life criteria, but these metals were probably also associated with suspended sediments and not biologically active since dissolved levels were low. Aluminum exceeded the aquatic life criterion and may have been, at least partially, of anthropogenic origin since aluminum dustfall measurements in Kitimat were up to 0.45 $mg/dm^2/d$. Background levels in the Kitimat area are in the range of 0.02 to 0.03 $mg/dm^2/d$. Direct deposition to the rivers and surface runoff from the drainage basin would introduce some of this aluminum to the Kitimat River. The apparent colour measurements exceeded the true colour criterion substantially, and thus true colour may also have exceeded the criterion. The drinking water criterion for colour is based on aesthetic rather than health considerations. Except as noted above, the water quality in this stretch of the river met the criteria for drinking water, primary contact recreation, and aquatic life, which are the three water uses in this section of the river.

Total phosphorus levels were somewhat high, but no algal problems have been noted. Much of the total phosphorus may also be tied up in the suspended solids fraction and not be available for algal growth. Since the river discharges directly to the ocean where phosphorus is not of concern the phosphorus levels are not of concern.

Some additional water quality characteristics were measured at sites 0430003 and 0430004, found between sites 0430025 and 0430017 in the Kitimat River upstream from the waste discharges. These data are combined and presented in Table 28. They are 1974 data and the number of samples is small, but the data help to characterize the quality of the water in the river prior to 1982 when similar characteristics were first measured at site 0430025. The water was quite soft and had a low acid buffering capacity.

5.1.2 KITIMAT RIVER DOWNSTREAM FROM THE DISTRICT OF KITIMAT TREATED SEWAGE DISCHARGE (PE 256).

The first effluent discharge to enter the lower Kitimat River is PE-256. There are no ambient water quality monitoring sites below PE-256 and above the next discharge, PE-292 (Eurocan Pulp and Paper Co. Ltd.). Site 0430018 (~800 m downstream from PE-256) is about 30 m downstream from the Eurocan effluent diffuser, but off to the side of the effluent plume from PE-292. This effluent is not yet fully mixed across the river in this first 30 m since measured values of water quality characteristics were still essentially the same as at the upstream sites. This indicates that the discharge from PE-256 had no effect on the measured water quality characteristics at site 0430018, although characteristics such as fecal coliforms, that are sensitive indicators of sewage, were not monitored. The water quality data for site 0430018 (1976-1982) are summarized in Table 29. Water uses downstream from PE 256 are aquatic life, wildlife, and secondary contact recreation, and the working criteria for these uses were met for the characteristics measured.

The maximum potential concentration increases that could occur in the Kitimat River due to the District of Kitimat treated sewage discharge were calculated using the effluent loadings from Table 5 and the Kitimat River flows from Section 2; the results are presented in Table 30. Dilution ratios under worst conditions (minimum river flow and maximum effluent flow) are 6:1 at present and 3:1 in the future. For a minimum river flow and mean effluent flow the ratios are 32:1 at present and 20:1 in the future. The dilution ratios calculated using minimum river flow and mean effluent flow are more probable than those calculated using minimum river flow and maximum effluent flow.

The actual maximum loadings, calculated from paired values of flow and concentration during the low flow period of November to April, were used to calculate the theoretical concentrations contributed to site 0430018 by PE 256. These maximum theoretical concentrations are compared with actual measured concentrations, for the same time period, where such data exist. Table 30 shows that the theoretical contribution from PE-256 after complete mixing with the river is generally less than or of the same order of magnitude as the existing background values in the river as reported in Tables 26-28. Only ammonia is, theoretically, significantly higher than at the control sites during maximum load periods. Once the effluent is fully mixed with the Kitimat River, it will not impair the water quality of the river for aquatic life or secondary-contact recreation uses even at maximum projected loads and minimum projected river flows. Additional monitoring would be required to determine the effects of the effluent on the river in the mixing zone (after the initial dilution zone, but before full mixing has taken place).

Predicted fecal coliform levels for now and the future under worst conditions, 550 and 1 200 MPN/100 mL, exceed the secondary contact recreation criteria of 200/400 MPN/100 mL. Under a mean effluent flow regime these levels drop to 100 and 200 MPN/100 mL which is within criteria limits.

5.1.3 KITIMAT RIVER DOWNSTREAM FROM EUROCAN PULP AND PAPER MILL DISCHARGE, PE-292

Table 2 gives the measured velocities of the Kitimat River below the Highway Bridge at ambient monitoring sites 0430017-0430024. There is no perceptible trend in these velocities from upstream to downstream sites so a mean was calculated for the maximum, mean and minimum velocities in this reach of the Kitimat River. The distance from the Eurocan discharge to Kitimat Arm is about 5 km. The residence time of the water and pulp mill effluents in the lower part of the river ranges from a minimum of one hour to a maximum of three hours using the mean values, and from a minimum of 0.7 hour to a maximum of 6.6 hours based on the extreme measured velocities. These periods of time are far too short for the BOD_5 loads from the pulp mill to have any appreciable effect on dissolved oxygen levels in the Kitimat River.

There are a series of six water quality sites on the Kitimat River between site 0430018 (Table 29) and Kitimat Arm. These are, in order from upstream to Kitimat Arm: 0430019, 0430020, 0430021, 0430022, 0430023 and 0430024, and the data are summarized in Tables 31 to 36, respectively. These sites are shown on Figure 4 and the data are displayed graphically in Figures 7 to 16, which also include data from upstream control sites 0430025 and 0430017. The water uses downstream from Eurocan (PE 292) to Kitimat Arm are aquatic life, wildlife, and secondary-contact recreation.

At site 0430019, 60 m downstream from the Eurocan discharge, the plume surfaced and, as inspection of Figures 7 to 16 shows, had a marked effect on the levels of most characteristics measured. These elevated levels dropped back to, or near to, upstream levels by site 0430020 (400 m downstream) or 0430021 (1000 m downstream), once more thorough mixing had taken place. The total solids increase noted on Figure 14 and Table 31 appears to be due primarily to dissolved solids rather than suspended solids, as indicated by the turbidity data in Figure 16. Turbidity levels rose only 2 NTU at site 0430019 over the upstream level. Eurocan effluent solids levels are about 90% dissolved solids and 10% suspended solids (Table 6). The background ratio in the river is about 60% dissolved and 40% suspended.

Water quality in the lower reaches of the river outside of Eurocan's initial dilution zone (i.e., 100 m downstream) appeared to meet all aquatic life and recreation criteria with the exception of colour and phosphorus. The phosphorus criteria are quite crude and do not take into account many site-specific factors which govern algal growth. There are no algal problems in the river and phosphorus is not a problem in the ocean, so the phosphorus levels found are not of concern. Mean colour levels in apparent colour units increased from the 20-30 range upstream to the 40-45 range 1000 m downstream (Figure 7). Both these levels exceed the desirable level for recreation of 15 true colour units. The maximum colour criterion for recreation is 100 true colour units, and this was exceeded up to four-fold at 60 m and 400 m downstream from the PE 292 discharge from Eurocan. It is expected that apparent colour values were slightly higher than true colour values in the Kitimat River.

An analysis of existing benthic invertebrate data from the Kitimat River, by EVS Consultants[34] in 1982, showed that there was no distinct adverse biological effect from the Eurocan discharge. They also reported that up to that time a stable benthic community structure has been maintained throughout this section of the river.

The minimum dilutions for the Eurocan effluent in the Kitimat River, assuming complete mixing, were calculated for several conditions and are given in Table 37. The future dilutions of 4:1 to 6:1 are based upon full use of the existing water licences by the same licencees as at present. Present minimum dilutions are 6:1 to 10:1. The lower dilution ratios are a worst case and very rare, if they occur at all. The lower ratios require the maximum recorded Eurocan effluent flow to occur coincidentally with the 10-year return period 7-day average low flow. This situation could be avoided if Eurocan temporarily reduced effluent flows during rare low flow periods. The 6:1 and 10:1 ratios occur when mean Eurocan effluent flows occur during the 7-day average low flow with a 10-year return period, and are the most probable minimum dilution ratios. Ratios will be smaller within the mixing zone which extends about 400-1 000 m downstream from the diffuser.

Using the dilution ratios in Table 37 and the effluent data in Table 6, the maximum potential concentration increases of selected contaminants in the Kitimat River during low flow periods, due to the Eurocan discharge, were calculated and are presented in Table 38. This table results from using maximum reported concentrations of contaminants and is a worst case. Effluent loading calculations in table 39 use the same Kitimat River low flows as in Table 37 and the same data set as Table 6, but use only paired (data collected simultaneously) effluent flow and concentration data. As the Tables 38 and 39 show, the concentration increases predicted using a 10:1 dilution ratio with maximum effluent concentrations are almost the equivalent of using paired effluent and concentration data.

The suspended solids increase under these conditions would exceed the 10 mg/L increase which is the provincial criterion for aquatic life. Colour also would exceed the working recreation criteria of 100 maximum and 15 desirable. The sulphide criterion is for undissociated H_2S. Conversion of the total sulphide level to its equivalent undissociated H_2S level is dependent upon pH, temperature and conductivity. Using average values of pH, temperature and conductivity in the river at the low flow time of year, one can calculate[46] that about 50-60% of the sulphide would be in the undissociated H_2S form in the lower reaches of the river below the mixing zone. Within the mixing zone, the undissociated H_2S would be about 30-40% of the total sulphide. However, dissolved oxygen levels in the mixing zone are about 11 mg/L, and about 12 mg/L in the rest of the river. Under these oxygen levels one would not expect H_2S to be present in any appreciable amount since it would be almost immediately oxidized, ultimately to sulphate.

Walden[22] proposed a criterion for sublethal threshold response levels of aquatic life to kraft pulp mill effluent. The criterion states that no detectable sublethal response should occur below 0.05 to 0.1 of the 96 h LC50 effluent concentration (i.e., 10-20:1 dilution, at an LC50 of 100%). Since, as shown in Table 37, the minimum dilution at low flow after complete mixing is 10:1, there may be sublethal effects when the LC50 is 100%. The minimum dilution in the effluent mixing zone which extends for some 400-1 000 m downstream from the outfall would be less, and thus the risk of sublethal effects even greater. The actual 96 h LC50 value for 1985 was >100% since all of the test fish survived in 100% effluent (Wilkes[45]). This analysis suggests that it is important to ensure that the effluent is never acutely toxic to fish, as measured by the 96 h LC50, particularly during low flow periods.

5.2 MARINE WATER QUALITY

5.2.1 KITIMAT ARM WATER

Dye studies show that water movement from the Ocelot wharf area, at ebb or changing tides and calm or northerly winds, would be south along the west side of Kitimat Arm. At flood tides it would be into the dredged channel. Unless there are strong countering winds the estuary is not likely to be affected by spills or discharges in the wharf area.

Soluble materials like ammonia would stay in the surficial fresh water layer, the upper 1-2 meters, and not affect deeper biota. Intertidal and shallow subtidal zones near the Ocelot wharf would be most affected. This area is already greatly modified and disturbed[44].

Sampling in Kitimat Arm is generally inadequate to determine seasonal or long term trends, and only fluoride has been measured repetitively at one location. Table 16 gives fluoride levels at several depths for two locations 150 and 800 m offshore from the Alcan PE 1494(01) outfall. These are 1975-1981 data. The locations of the sites are shown in Figures 4 and 5. The natural background level of fluoride in the ocean is 0.8 to 1.4 mg/L[3]. The maximum level criterion for maintenance of marine life is 1.5 mg/L. There is little, if any, assimilative capacity in marine waters for additional fluoride. Surface concentrations at the closest site, 150 m offshore, reached a maximum of 50.6 mg/L and a mean of 4.5 mg/L. At the 800 m offshore site, on the surface, the maximum was 4.0 mg/L and the mean was 1.2 mg/L. Recent (1982-84) Alcan effluent data indicate that the fluoride discharged was less than one-half of the pre-1982 level (see section 4.1.4), and thus fluoride concentrations in Kitimat Arm are now expected to be lower. Limited 1983 data for Kitimat Arm suggest this, but more monitoring is needed to determine the present levels.

In 1983, additional water sampling was carried out at these sites, but the depths assigned to each site number differed from those used previously. Sites 0400509-0400511 were always 150 m offshore and sites 0400512-0400514 were always 800 m offshore. The table below indicates the depth of the water sample for each site for a given date. Some of these sites were used as bottom or sediment sampling sites in 1983 as indicated by 'sediment' in the table instead of a depth. The water sampling data for 1983 are found in Table 50. At any given site and depth, there was only one sample taken so no statistical analyses are possible. Tables 47 and 48 give water sampling results for site 0700128 in the centre of Minette Bay for two dates in 1983. The location of site 0700128 is shown on Figure 4.

	DATE		
Site	1975-1981	July 5, 1983	Sept. 28, 1983
0400509	0 m		
0400510	4 m	1 m	2 m
0400511	8 m	sediment	
0400512	0 m	0 m	
0400513	2 m	10 m	2 m, 9 m
0400514	3 m	sediment	

Total aluminum only exceeded the aquatic life and recreation criteria at 2 m and 9 m in Minette Bay on September 27, 1983 (Table 48), but exceeded the criteria on both dates and at all depths in the Kitimat Harbour Area (Table 50) except for 10 m samples.

Fluoride levels in Minette Bay in September, 1983 exceeded the working criteria for marine aquatic life of 1.5 mg/L at medium depths, but not at any other sites or dates. The sampling regime in 1983 was not comparable to that in 1975-1981 so it is difficult to compare the data. The one site and depth which was resampled, 0400513 at 2 m, showed a decline from 1.7 mg/L in 1975-81 to 0.5 mg/L in 1983 based upon only one sample in 1983. The fluoride results for Minette Bay seem to indicate that Alcan effluent has been carried into the Bay which is probably poorly flushed.

Copper did not exceed the working criterion in Minette Bay on July 6, 1983, but exceeded the criterion at all depths on September 17, 1983.

Copper exceeded the criterion on both dates and at all depths at the Kitimat Harbour sites (Table 50). The detection limit for cyanide was too high, 100 µg/L, to determine whether or not cyanide exceeded the marine aquatic life criterion of 1.0 µg/L.

Inspection of Tables 47 and 48 shows that the centre of Minette Bay is an unbounded fresh water 'lake' floating on marine water. This 'lake' was at least 9 m deep on July 6, 1983, and between 2 m and 9 m deep on Sept. 27, 1983. Values for temperature, salinity, fluoride, pH, conductivity and turbidity all show abrupt changes at these depths. Apparently, Minette Bay is a poorly flushed area where fresh water from the Kitimat River accumulates on top of the more dense salt water. This area is thus essentially a fresh water habitat on the surface, but a marine habitat below and in the sediments.

This type of observation points out a need for a proper marine control site, or sites, somewhere in Kitimat Arm. Field testing would be required to locate such a site to avoid the type of situation found in Minette Bay, and also to avoid contamination by the flow of Kitimat River water or any diluted effluent stream past the control site.

Table 40 gives the mean fluoride, iron, cyanide and aluminum loadings to Kitimat Arm by Alcan, 1978 to 1982. If one assumes that the ratio of fluoride to the other contaminants in the total effluent load to Kitimat Arm was the same as the ratio found at sites 0400509-0400514, then concentrations of iron, cyanide and aluminum at these sites can be calculated from the known fluoride levels. These calculated values are given in Table 55. These calculations indicate the possibility that cyanide and aluminum exceeded or equalled their criteria at all depths for the 150 m location and for the 800 m location. Since there is likely input of aluminum from the atmosphere in addition to that in the effluent, it is probable that actual values may have been somewhat higher than those calculated for surface samples. Actual cyanide may be less since hydrogen cyanide is volatile and would tend to dissipate. Recent (1982-84) Alcan effluent data indicate that aluminum and iron discharges were reduced to about one-half of pre-1982 levels, but that cyanide remained the same (see section 4.1.4). Consequently, aluminum and iron concentrations in Kitimat Arm may now be lower than predicted. Further monitoring in Kitimat Arm to determine the present levels of contaminants is needed. There are also measurable amounts of aluminum discharged by the Ocelot methanol plant into Kitimat Arm, but these are insignificant compared to the loads from Alcan (see Table 40).

The background fluoride to chloride ratio of seawater is relatively constant at $6.71 \pm 0.07 \times 10^{-5}:1$. Fluoride contamination should be readily detected by a change in the ratio[24]. Observed F:Cl ratios in the surface water of Kitimat Harbour averaged $158 \times 10^{-5}:1$ (13 to $1500 \times 10^{-5}:1$). Subsurface samples averaged 7.61×10^{-5} (6.64 to $15.0 \times 10^{-5}:1$) for depths between 10 and 100 m[25].

Comparable samples from Howe Sound surface waters showed an average of $14.5 \times 10^{-5}:1$ (7.8 to $66 \times 10^{-5}:1$) which is an order of magnitude lower than in the surface waters of Kitimat Harbour. The surface water concentrations of fluoride in Kitimat Harbour averaged 1.17 (0.1 to 11.0) mg/L in the study by Warner et al.[24]. As indicated in Table 16, fluoride levels before 1982 have been reported to reach 50.6 mg/L, which corresponds to a ratio of F:Cl of $6\,900 \times 10^{-5}:1$. The mean concentration of fluoride from Table 16, site 0400509 on the surface, is 4.5 mg/L which corresponds to a ratio of F:Cl of $613 \times 10^{-5}:1$. These values are 1 000 and 100 times higher, respectively, than the reported background levels, and 500 and 50 times higher than the Howe Sound levels.

5.2.2 KITIMAT ARM SEDIMENT

In July 1976, the Pollution Control Branch carried out sediment sampling at 30 sites in Kitimat Harbour and Kitimat Arm as shown on Figure 17. These samples were analyzed for particle size, fluoride and a selection of heavy metals. The results of these analyses are given in Tables 41 and 42 and Figure 18. In July 1983, sediment samples were taken at sites

0400511 and 0400514, 150 m and 800 m, respectively, from Alcan's PE 1494(01)discharge in Kitimat Harbour (Figure 5). These analyses are shown in Table 49. An Eckman grab and a sediment core were taken in the center of Minette Bay, site 0700128, in July 1983. Analyses of these samples are given in Table 15, from Wilkes[45].

For comparison, some background levels of heavy metals in marine sediments are reported in Table 46. Krenkel[26] reports that mercury is lower in sandy sediments than in silty and organic sediments. The same result for copper is reported by McDuffie[27].

Lead exceeded the reported background of 20 µg/g[31] at the following locations: the mouth of the yacht basin, site 5 (28.5 µg/g); site 21, directly across Kitimat Arm from the mouth of the Kitimat River (21.9 µg/g); just off the PE 1494(01) discharge point, site 30 (22.3 µg/g); at sites 0400511 and 0400514, 150 m and 800 m, respectively, from PE 1494(01) (51 µg/g and 25 µg/g, respectively); and at three depths in the core from site 0700128 in the centre of Minette Bay (32 µg/g, 32 µg/g and 27 µg/g at 0-8 cm, 16-24 cm and 32-40 cm, respectively).

Mercury slightly exceeded the background level of 0.11 µg/g[32] only at site 30, adjacent to the PE 1494(01) effluent discharge (0.13 µg/g).

All the cadmium values exceeded the usually reported background level of 0.4 µg/g[33], some by 3 or 4 times. Background cadmium levels in Kitimat Arm are apparently higher than elsewhere, probably in the range of 0.6 to 1.1 µg/g. If this is true, then the local background was exceeded at site 5, the mouth of the yacht basin (1.5 µg/g); at site 21, across the Arm from the Kitimat River mouth (1.2 µg/g); and at site 27, adjacent to the Ocelot dock (1.4 µg/g).

The copper background level of 80 µg/g, reported by Thompson and McComas[28] was never exceeded. The background level of 16.8 µg/g reported by Taylor[29] was exceeded at half the sites in 1976, and at all the sites and depths sampled in 1983, except site 0400511 which was 150 m from the PE 1494(01) discharge. Background copper levels in the Kitimat Arm appear to be in the 10-25 μg/g range. The only sites exceeding this level were site 4, near the PE 1494(02) discharge (43.1 μg/g); site 21, across the Arm from the Kitimat River mouth (51.6 μg/g); site 0400514, 800 m from the PE 1494(01) discharge; and all the sediment core sections at site 0700128 in Minette Bay.

No zinc samples exceeded the 140 μg/g background level of Thompson and Paton[30], and only the surface sediment sample at site 0700128 in the centre of Minette Bay exceeded the 65 μg/g background level of Taylor[29], reaching 121 μg/g. Zinc backgrounds in Kitimat Arm appear to be in the 15-45 μg/g range. The sediment core in Minette Bay, site 0700128, exceeded this with values of 53-55 μg/g. Site 4 near the PE 1494(02) discharge (59.1 μg/g), site 5 at the mouth of the yacht basin (46.5 μg/g), and site 21 across the Arm from the Kitimat River mouth (60.0 μg/g) also exceeded this range.

Fluoride levels were also analyzed in the sediments at all these sites. Background levels of fluoride in Kitimat Arm appear to be up to about 90 μg/g. Site 30, near the PE 1494(01) discharge point, had the highest level of sediment fluoride at 2 830 μg/g. Site 5, at the mouth of the yacht basin, had 850 μg/g. Site 0400511, 150 m from the PE 1494(01) discharge had a fluoride level of 290 μg/g. Other sites with somewhat elevated fluoride levels in the 110-140 μg/g range included site 4, near the PE 1494(02) discharge; site 6, on the opposite side of the mouth of the yacht basin from site 5; site 8, across the channel from site 4; site 21, across the Arm from the mouth of the Kitimat River; site 27, adjacent to the Ocelot dock; and site 0400514, 800 m from the PE 1494(01) discharge. Except for site 6, all these sites have also shown elevated levels of at least one heavy metal. All sediment core segments from the centre of Minette Bay, regardless of their depth, had high fluoride levels in the 230-430 μg/g range. Neither heavy metals nor fluoride showed any trend with depth. Their concentrations were relatively constant from the surface down to 40 cm.

Certain sites had elevated levels of more than one element in their sediments, and appear to be unusual in some respect. Site 21, across Kitimat Arm from the mouth of the Kitimat River had elevated levels of lead, cadmium, copper, fluoride and zinc. This site also had the greatest proportion of fine sediments (Table 41), which may be the reason for the unusually high levels. The samples in the centre of Minette Bay had high levels of lead, fluoride, copper and zinc. Particle size analysis does not indicate very fine sediments. This is a deep bay surrounded by shallow mud flats and may tend to collect particulate matter during slack tides, but is too deep to be flushed out when tidal currents resume. Site 4, with high copper, fluoride and zinc, is adjacent to the PE 1494(02) discharge point, but neither copper nor zinc were high in this effluent. Site 30, with high mercury, fluoride and lead levels, is near the PE 1494(01) discharge point. Fluoride was high in this discharge, but mercury and lead were not, although only a few lead and mercury measurements were made (Table 9). Site 5, at the mouth of the yacht basin, had high fluoride, lead, cadmium and zinc levels.

Fluoride, lead, mercury, copper, zinc and cadmium are elevated in the sediments at some sites in Kitimat Arm. Of these, only fluoride is found in quantity in Alcan waste discharges and can be directly attributed to waste discharges. However, there are too few data on lead, mercury, cadmium and zinc in Alcan discharges and more data are needed. Cyanide and aluminum have not been adequately monitored in sediments. (Technical considerations are responsible for the lack of cyanide data but aluminum poses no problems). Fluoride enrichment due to Alcan appears to be limited mainly to Kitimat Harbour and Minette Bay.

5.3 PROVISIONAL WATER QUALITY OBJECTIVES

5.3.1 KITIMAT RIVER UPSTREAM FROM THE KITIMAT SEWAGE DISCHARGE (PE 256)

This section of the river contains all the water intakes for industrial, fish hatchery and domestic use. Fish use this section of the river for migration, spawning and rearing. Primary and secondary contact recreation occur in this reach of the river. It is recommended that water quality in this section of the river be protected for drinking water, aquatic life, wildlife, primary contact recreation and industrial use. There are no specific waste discharges or activities that are expected to alter the water quality of this reach of the Kitimat River significantly for the foreseeable future, and thus no water quality objectives are proposed now. Water quality objectives for variables of concern can be developed in the future if the need arises. It is recommended that the present monthly monitoring of the Kitimat River at site 0040025 continue, to develop a long-term data base for the river for the detection of any trends, and the development of water quality objectives, if needed. The river naturally reaches turbidity levels in excess of the 5 NTU criterion for drinking water and thus needs to be filtered prior to use. Filtration should also remove particulate iron and manganese that naturally exceed drinking water criteria designed to prevent staining. This is accomplished by drawing the drinking water from infiltration wells alongside the river. Colour levels in the river at times exceed the 15 TCU criterion for drinking water. This may detract from the aesthetic appeal of the water, but it is not harmful to human health.

Several other metals, such as aluminum, cobalt, copper and lead, naturally exceed their aquatic life criteria at times, but they are believed to be bound to suspended sediments and not biologically active.

5.3.2 KITIMAT RIVER DOWNSTREAM FROM THE KITIMAT SEWAGE DISCHARGE (PE-256)

This section of the river is used extensively by migrating fish, for secondary contact recreation and by industry as an effluent discharge and dilution zone. No water withdrawals for drinking, irrigation, or stock watering are recorded. It is recommended that water quality in this section be protected for aquatic life, wildlife and secondary contact recreation. To achieve this, the following provisional objectives apply everywhere in the Kitimat River downstream from the PE 256 waste discharge, except for the initial dilution zones downstream from the waste discharges (PE 256 from the District of Kitimat sewage treatment plant, and PE 292 from Eurocan). Table 57 summarizes the provisional water quality objectives and defines the initial dilution zones.

Turbidity increases should not exceed 5 NTU when background levels are below 50 NTU. This is the situation in the Kitimat River most of the time. During freshet, however, natural turbidity may exceed 50 NTU in which case increased turbidity should not exceed 10% of background. Similarly, suspended solids should not exceed 10 mg/L when background is below 100 mg/L and should not exceed 10% of background when background is over 100 mg/L. These particulate objectives are required to protect aquatic life from smothering, abrasion and light extinction.

The concentration of pulp mill effluent in the river should not exceed 0.05 of the 96 h LC50 of the pulp mill effluent. This means that pulp mill effluent toxicity, as measured by the 96 h LC50 procedure, should not fall below 100% at dilutions less than 20:1. This is to protect the salmonid resources of the Kitimat River.

The pH objective for the Kitimat River is a value between 6.5 and 9.0, but pH should not vary from upstream background by more than 0.5 pH units within this range to protect aquatic life.

The dissolved oxygen objective is a minimum of 7.8 mg/L to protect both aquatic life and secondary contact recreation.

The sulphide objective (the undissociated H_2S portion) is a maximum of 2 μg/L to protect fish and other aquatic life. Higher pH and dissolved oxygen levels help to reduce the H_2S problem. It is recognized that there are sample handling and measurement problems in monitoring for this objective.

The nitrite objectives are a 30-day average of 20 μg/L and a maximum of 60 μg/L to protect aquatic life(18,48), see Table 60.

The total ammonia objectives are given in Tables 61 and 62(48) and protect fish which are quite sensitive to this form of nitrogen. Total ammonia is measured. The un-ionized portion can be calculated using temperature and pH, using tables found in a paper by Trussel(34).

Algal growth should be kept to acceptable levels by setting an objective for chlorophyll a in periphytic algae averaging 50 mg/m^2. The average is calculated from at least 5 to 10 randomly collected samples taken from the natural substrates at a sampling station in one day.

There should be no tainting of the taste of aquatic organisms, or objectionable amounts of settleable or floatable solids or oil and grease films due to the waste discharges. No objectives are set for these characteristics since there are no acceptable, objective monitoring techniques.

5.3.3 KITIMAT ARM, HARBOUR AND ESTUARY

5.3.3.1 Water

Kitimat Arm is used by spawning and juvenile fish, for primary and secondary recreation (including harvest of shellfish for human consumption), commercial and food fishery, dilution and dissemination of industrial and domestic effluent discharges and as a marine transportation corridor. It is recommended that the water quality in Kitimat Arm be protected for aquatic life, wildlife and primary contact recreation as well as shellfish harvesting. Because of the initial dilution and mixing zones for the industrial effluent, of marine traffic, and of loading and unloading and of other industrial activities, the area north of an east-west line between the end of the Eurocan dock and the western shoreline may have difficulty meeting the aquatic life, recreation and food fishery criteria. However, every effort should be made to reduce effluent loads to this harbour area, so that water masses leaving the harbour area to mix with the water in Kitimat Arm, or in the estuary, meet the relevant aquatic life, recreation and shellfish harvesting objectives.

The fecal coliform objectives in shellfish waters are a median of 14/100 mL with no more than 10% of the samples to exceed 43/100 mL. This protects shellfish from contamination with human pathogens of sewage origin. To protect primary contact recreation in other areas without shellfish harvesting, the objectives are a geometric mean of ≤200/100 mL over 30 days and a 90th percentile of ≤400/100 mL.

The turbidity objectives are expressed as not more than 5 NTU over background when the background is up to 50 NTU, and not more than 10% of background when background is over 50 NTU. The suspended solids objectives are given as not more than 10 mg/L over background when the background is up to 100 mg/L, and not more than 10% of background when the background is over 100 mg/L. These particulate objectives protect aquatic life and also recreational activities from a decrease in light penetration which affects primary production and therefore the whole food chain; they also affect safety and aesthetics of recreational users.

Colour, resulting from the Eurocan pulp mill discharge, may be a problem in Kitimat Arm and the estuary but no colour data have been collected. Colour should be measured in Kitimat Arm to define the situation and determine if a colour objective is needed.

The fluoride objective is a maximum of 1.5 mg/L to protect marine life. The background levels of fluoride in the ocean do not normally exceed 1.4 mg/L and there is little, if any, assimilative capacity in marine waters for fluoride additions.

The total aluminum objective is a 20% maximum increase over background to protect marine aquatic life.

The total cadmium objective is an average of 0.012 mg/L and a maximum of 0.038 mg/L to protect recreational uses of the water. The total lead objective is an average of 0.009 or a maximum of 0.22 mg/L to protect marine organisms. The averages for cadmium and lead, which are not to be exceeded, are calculated from at least 5 weekly samples taken in a 30-day period.

The total copper objective is 2 μg/L as a monthly mean, with a maximum of 3 μg/L, to protect marine life, Singleton(47).

The cyanide objective is a maximum of 1 μg/L of weak-acid dissociable cyanide expressed as CN^-, to protect marine life. There are technical difficulties in monitoring this objective. These are described by Singleton(12).

There should be no tainting of the taste of marine organisms, or objectionable amounts of settleable or floatable solids or oil and grease films due to the waste discharges. No objectives are set for these characteristics since there are no acceptable, objective monitoring techniques.

The copper and lead objectives may be exceeded due to natural levels in the Kitimat River or Kitimat Arm. More data are needed on background river values and a true marine background site is needed. In cases where the background exceeds objectives for copper or lead, a maximum increase of 20 percent of background will be allowed at any one time.

5.3.3.2 Sediment and Biota

The measured total concentrations of a contaminant in the sediment or in animals living in or on the sediment are not always good predictors of toxic conditions. It is the biologically available portion of the contaminant in the sediment and in the animal that determines potential toxicity, the ability of the animal to detoxify the contaminant, and whether or not the animal will survive. The necessary information on critical concentrations of biologically active forms of contaminants is not available for most animals, nor are there standard analytical techniques for determining 'biologically active' concentrations of most contaminants. The concentrations of contaminants in edible portions of biota do indicate the safety of the food for human consumption.

One useful technique is to determine the community structure at control sites and at test sites and note at what point the community changes as the concentration of a contaminant increases in the sediment and biota. The objective level for contaminants in the marine sediments should be such that the ability of the community to maintain itself from year to year by recruitment is not impaired, even though this level of contamination may be lower than that necessary to preserve an existing mature community.

5.4 MONITORING PROPOSALS

5.4.1 KITIMAT RIVER AND KITIMAT ARM

A regional committee has been set up to develop a monitoring plan for the Kitimat River and for Kitimat Arm[(45)]. It is composed of representatives from the Waste Management Branch of the Ministry of Environment, the Environmental Protection Service of Environment Canada, Alcan, Ocelot, Eurocan and the District of Kitimat. They will develop a comprehensive overall monitoring plan for the Kitimat area and apportion the work and expenses among themselves. This cooperative and coordinated program will determine if water quality objectives are being met, measure environmental effects of waste discharges, and use this information to advise the Regional Waste Manager on the regulation of waste loads to the environment in accordance with the Waste Management Act. This report recommends a minimum monitoring program, based on technical considerations, Tables 58 and 59, to check whether water quality objectives are being met. Some general guidelines of what a more comprehensive monitoring program should accomplish are outlined below. More complete and specific details as to what should be monitored, where, how often, by whom and at whose expense is left to the committee.

The location of sampling sites in the Kitimat River should be such that adequate upstream controls are available above each discharge, for each characteristic. Thus when downstream measurements are made below any discharge, the source of any water quality characteristics can be uniquely determined. The location of sampling sites in Kitimat Harbour and Kitimat Arm needs to be determined by the committee. It will likely require some on-site inspections of the area to find suitable, representative areas and should emphasize shellfish harvesting locations.

The frequency of measurement should take into account seasonal fluctuations in river flow, tidal cycles, seasonal use patterns of the water (by people, fish and other organisms) and seasonal fluctuations of waste discharge quantity and concentration. Also to be considered is the ratio of total waste discharge to stream flow or water exchange rates, particularly where the streamflow or exchange rates to waste discharge ratios drop below 20:1.

Some characteristics of concern or of monitoring value in the Kitimat River include conductivity, pH, temperature, turbidity, suspended solids, dissolved oxygen, hardness, ammonia, nitrite, nitrate, sulphide, colour, oil and grease, dissolved sodium, fecal coliforms, periphyton chlorophyll a, phosphorus and fluoride. The characteristics which should be monitored in Kitimat Arm include fecal coliforms, fluoride, total and dissolved metals including iron, aluminum, lead, cadmium, copper and mercury, cyanide, polyaromatic hydrocarbons, methanol, ammonia and oil and grease. Water sampling should be sufficient in the Kitimat River; but water, sediment, and tissue samples are needed in Kitimat Arm. An analysis of any changes in biological communities, attributable to effluent discharges, is needed in both the Kitimat River and Kitimat Arm. Eurocan is already doing this for benthic macro-invertebrates in the Kitimat River.

A monitoring program to determine whether or not there is any leachate problem in Hirsch Creek from the municipal landfill (PR 3608) should occur during low flows for one season and be dropped if no effects are seen. Some markers or indicators of leachate, such as conductivity, colour, phosphorus, nitrate, fecal coliforms and turbidity would be the characteristics to monitor for this trial period.

Taste testing of eulachon in the Kitimat River should take place as necessary. If tainting is detected then the specific contaminant responsible should be identified and the threshold concentration determined. Once these steps have occurred than an objective can be set which when met will prevent such tainting in the future.

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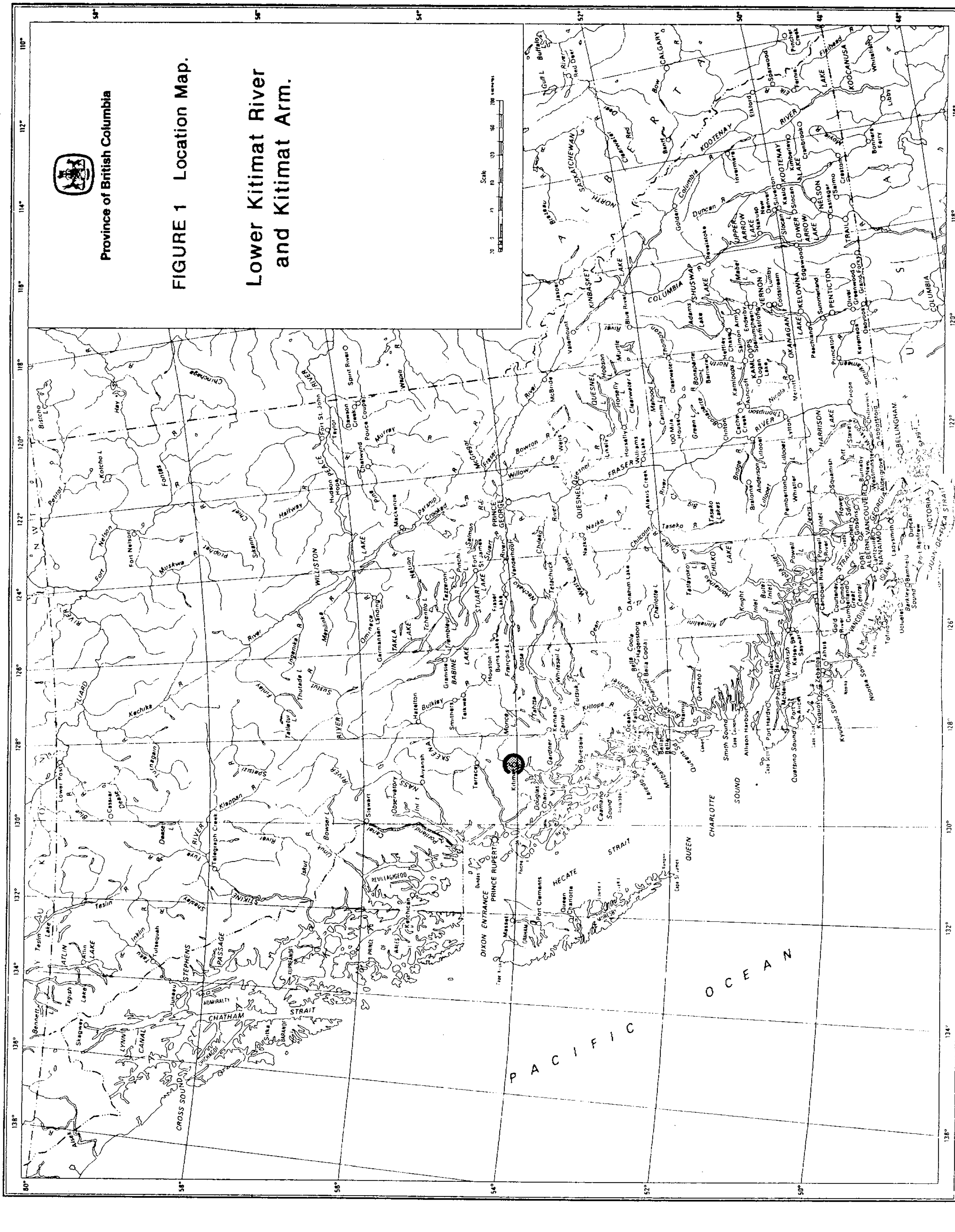

FIGURE 1 Location Map.

Lower Kitimat River and Kitimat Arm.

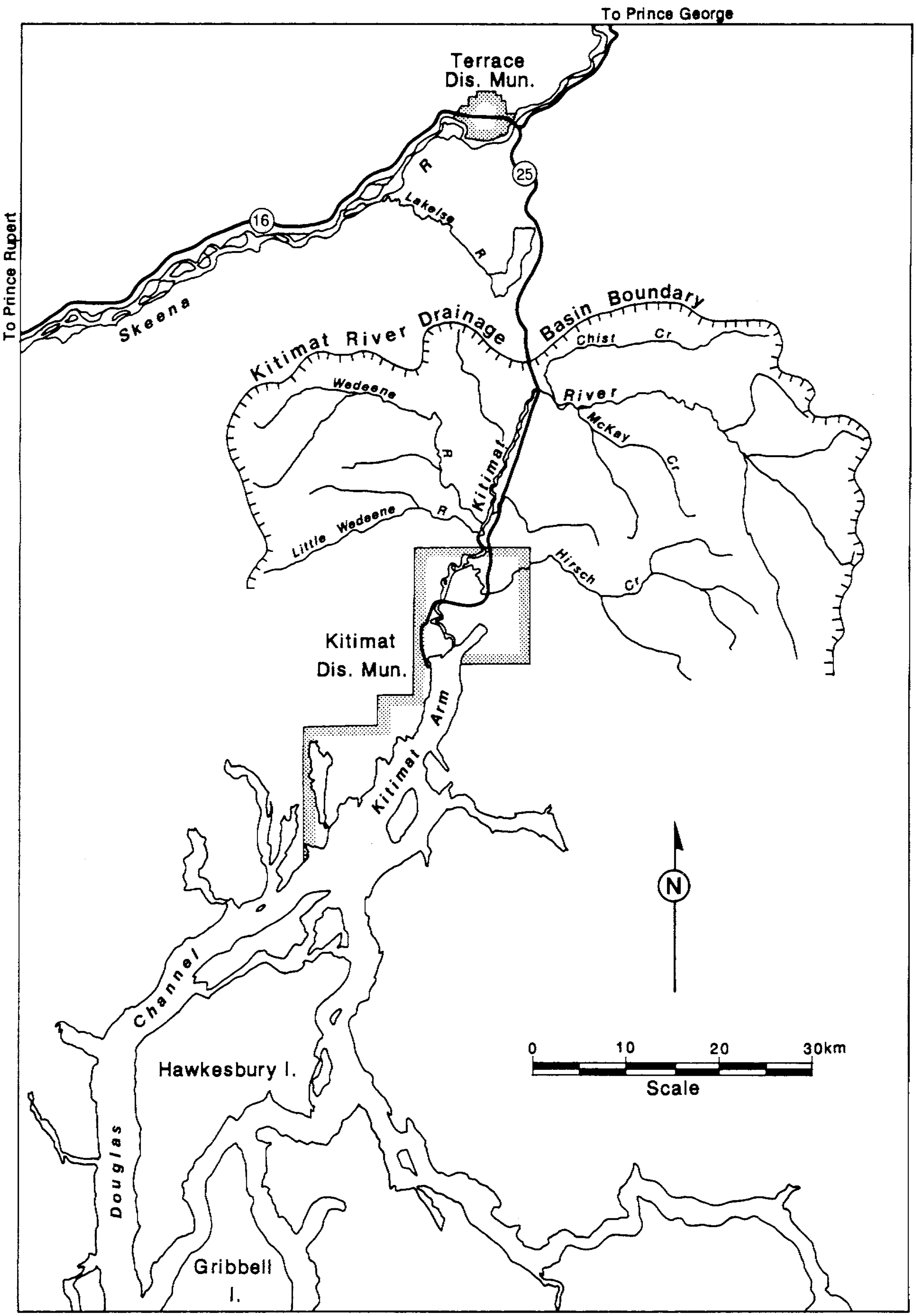

FIGURE 2 Kitimat River Basin, Kitimat Arm and Douglas Channel.

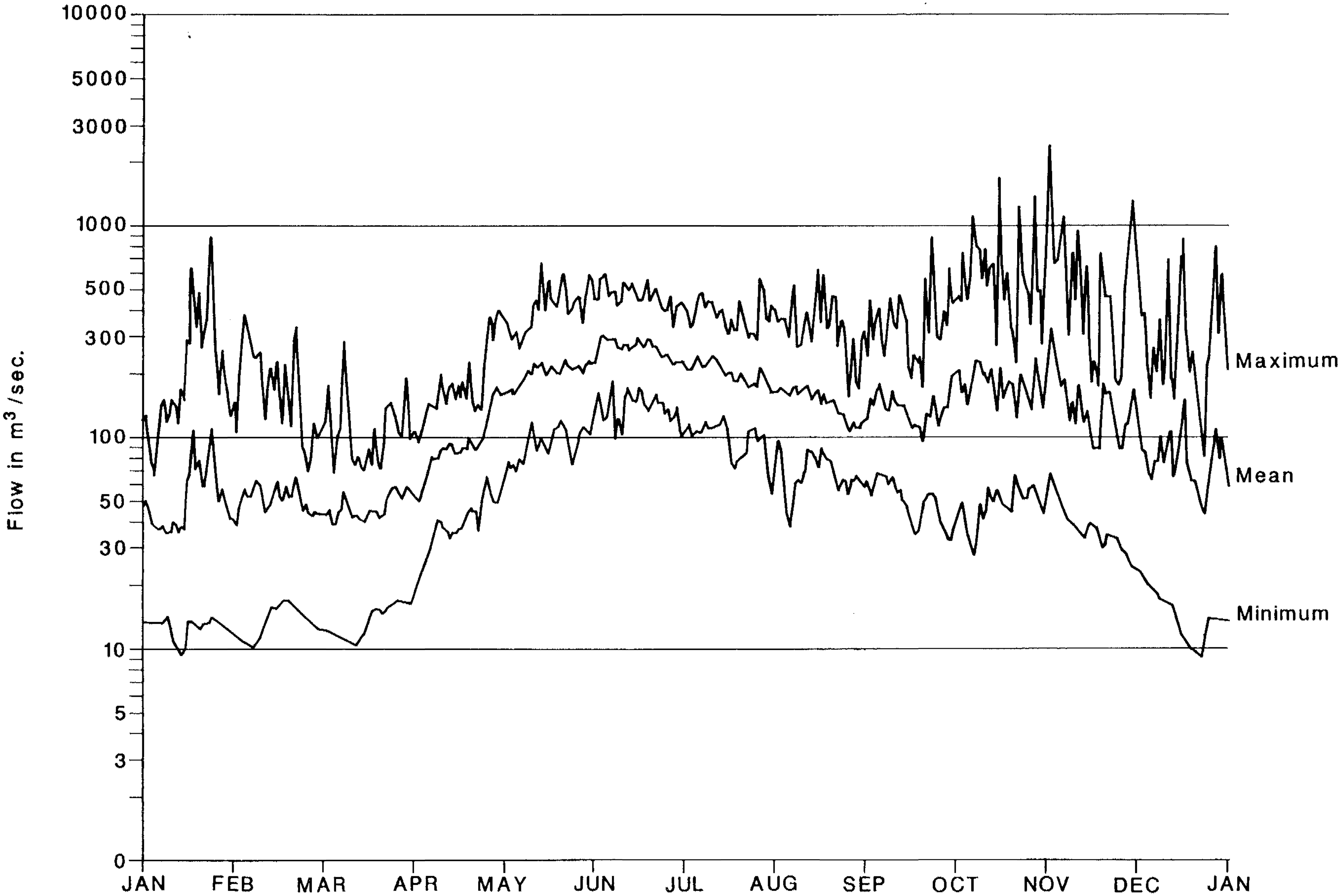

FIGURE 3 Streamflow Envelope for the Kitimat River at Kitimat, Daily Records, (1967–1981, Water Survey of Canada, Station 08FF001).

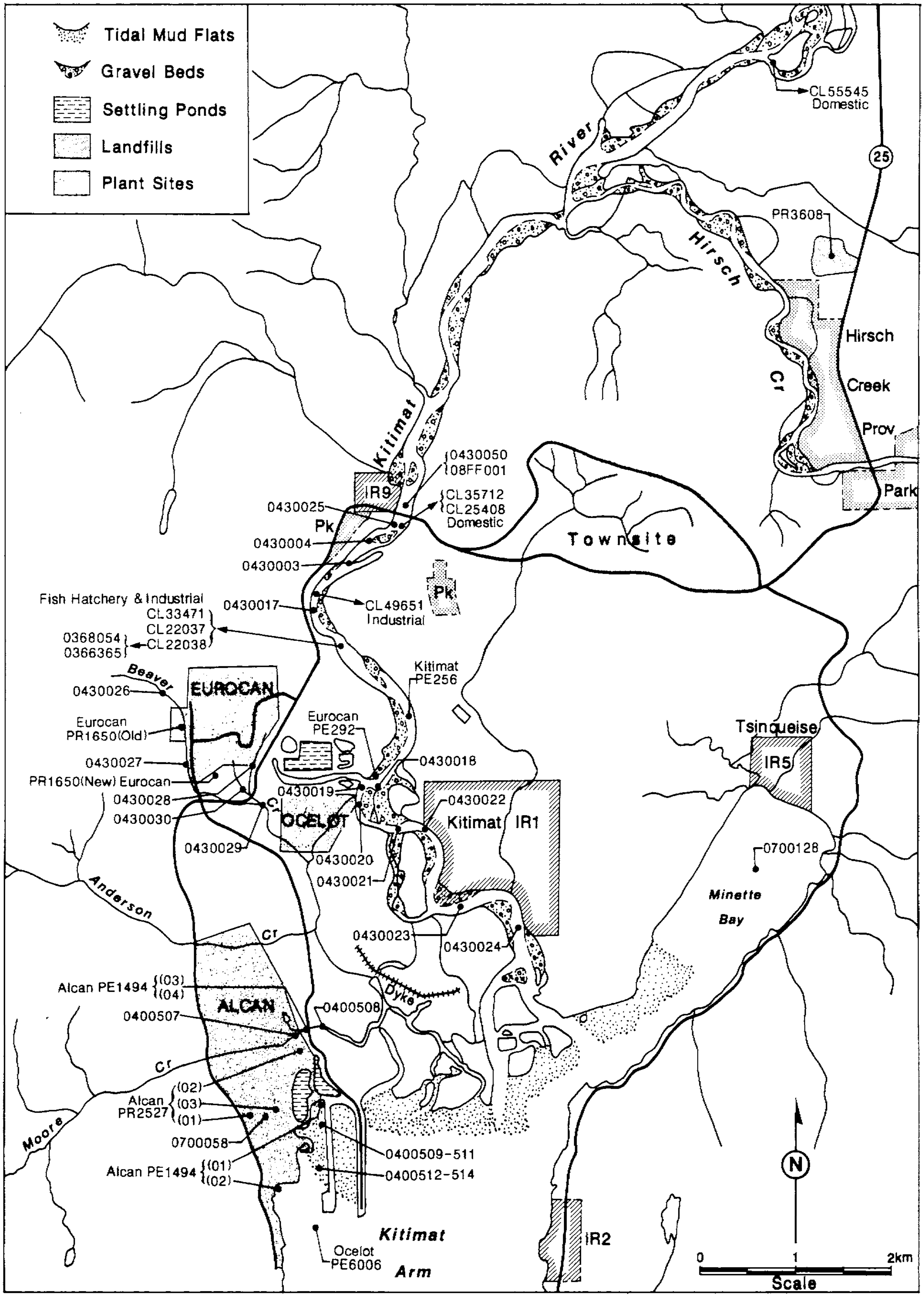

FIGURE 4 Map of the Kitimat Area showing Waste Discharges, Landfills, Water Quality Monitoring Sites, and Licenced Water Withdrawals.

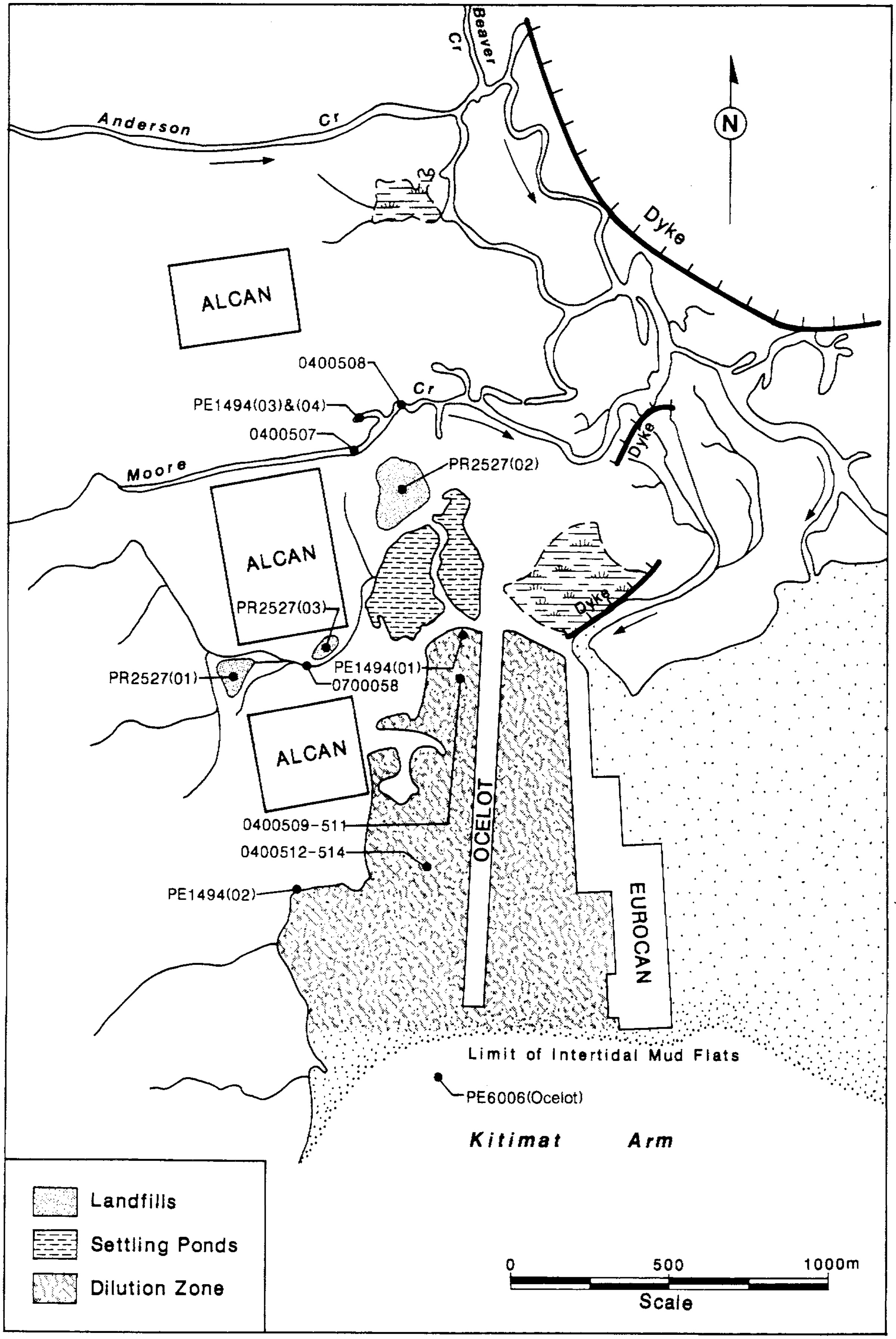

FIGURE 5 The Location of Alcan Waste Discharges, PR2527 Landfill Sites and PE1494 Discharge Points in relation to Watercourses in the Kitimat Estuary.

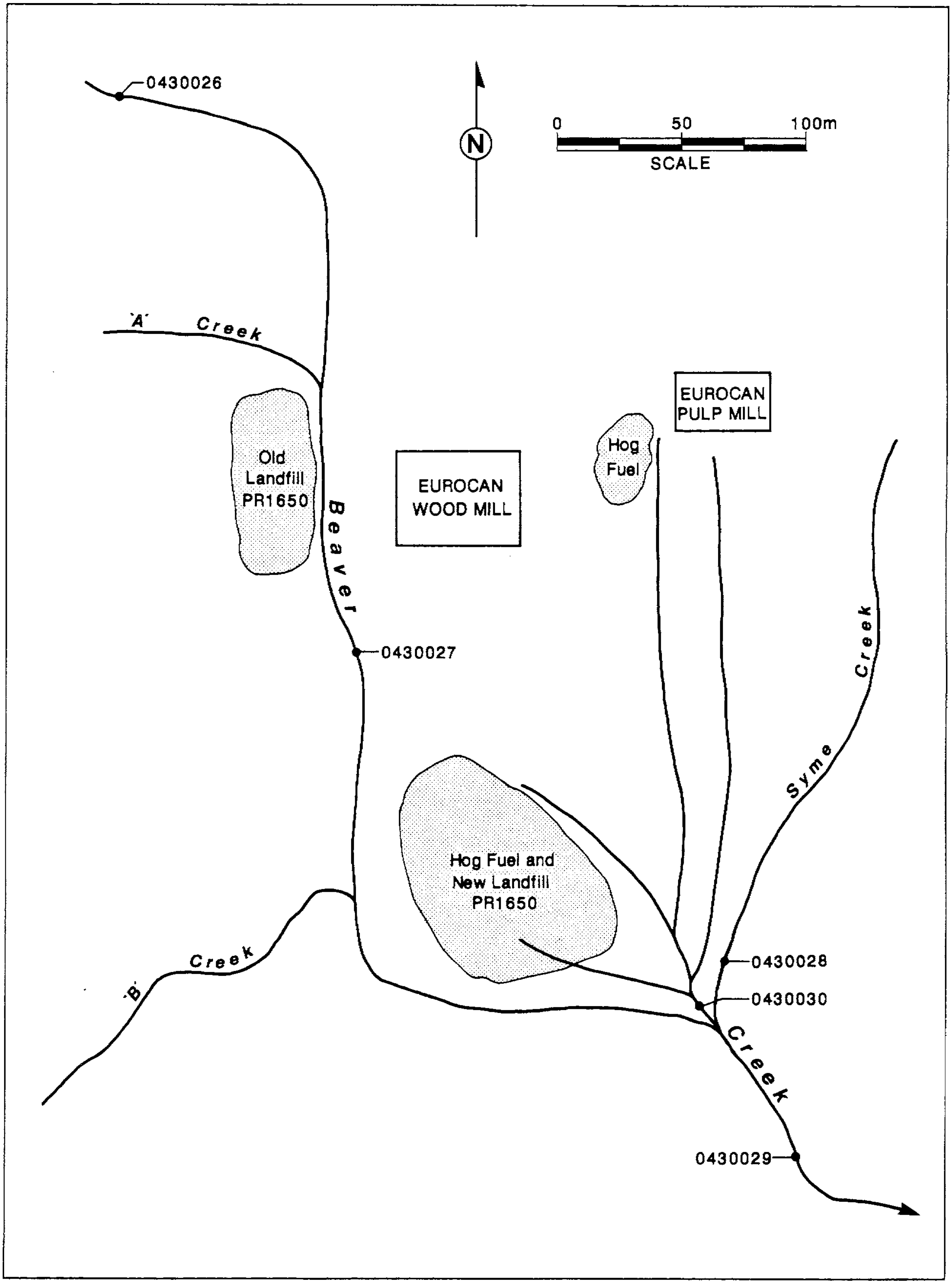

FIGURE 6 The Location of Water Quality Sites 0430026-30 on Beaver and Syme Creeks in relation to Eurocan Pulp and Paper Landfill PR1650 Old and New.

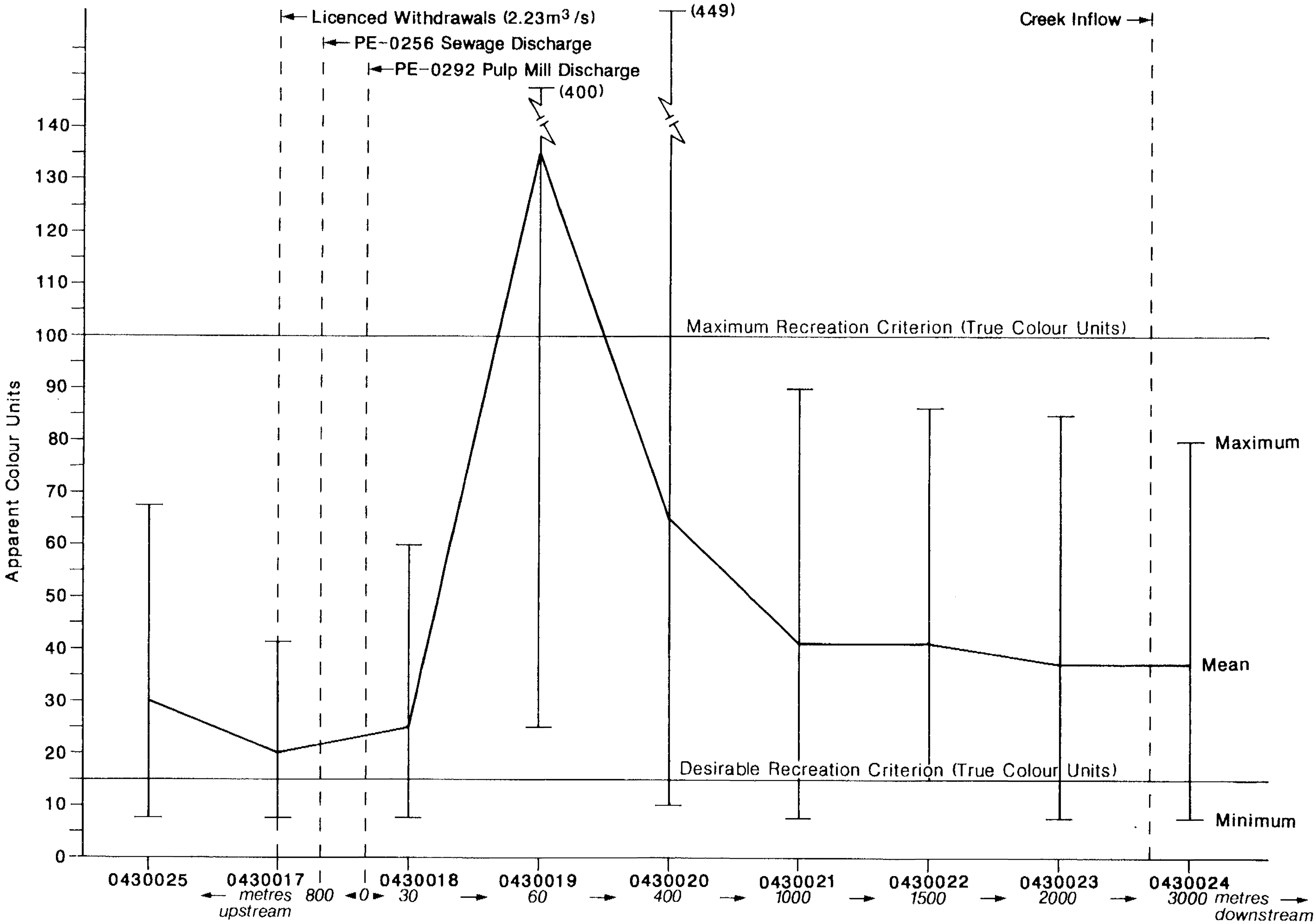

FIGURE 7 Apparent Colour in the Kitimat River.

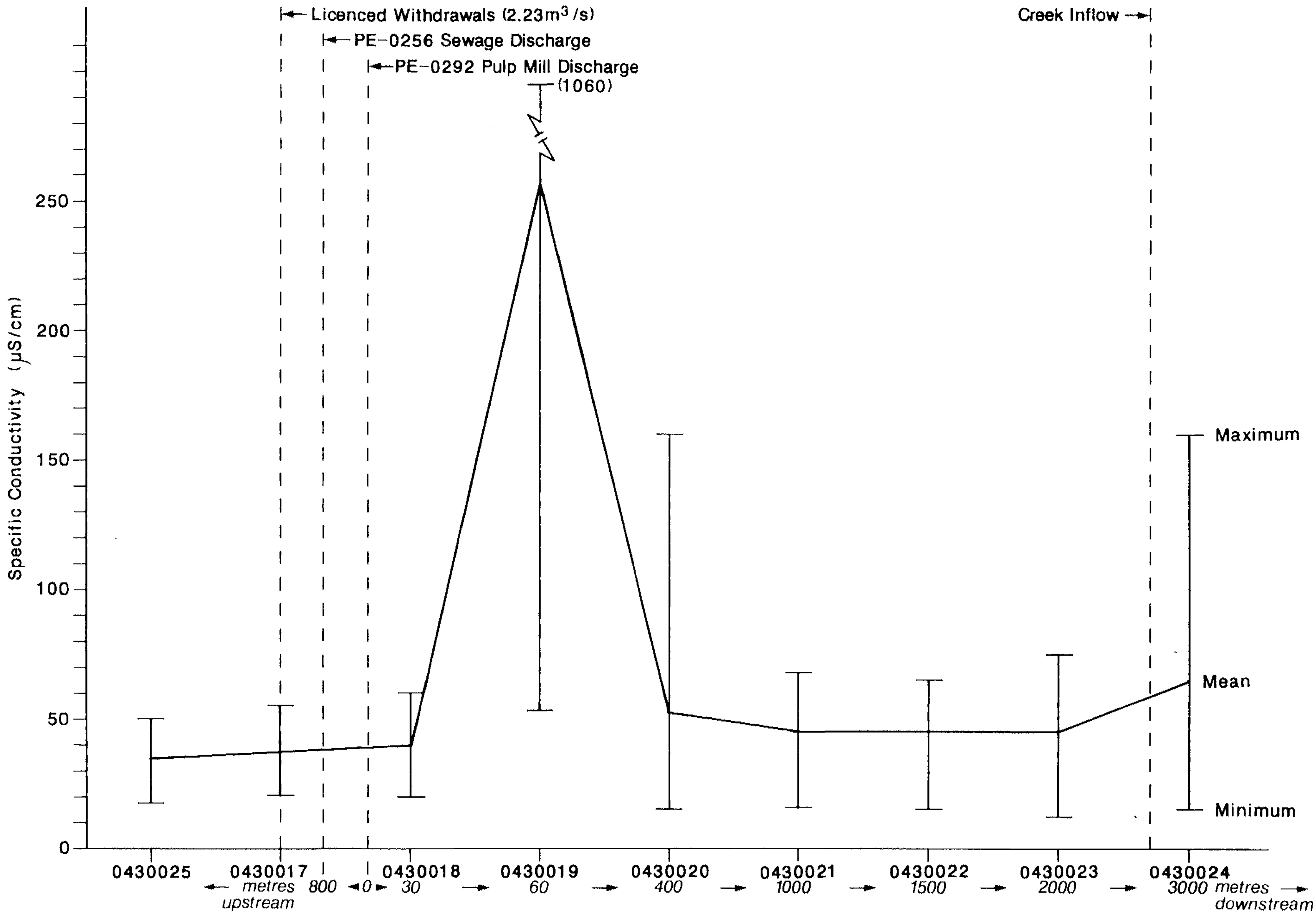

FIGURE 8 Specific Conductivity in the Kitimat River.

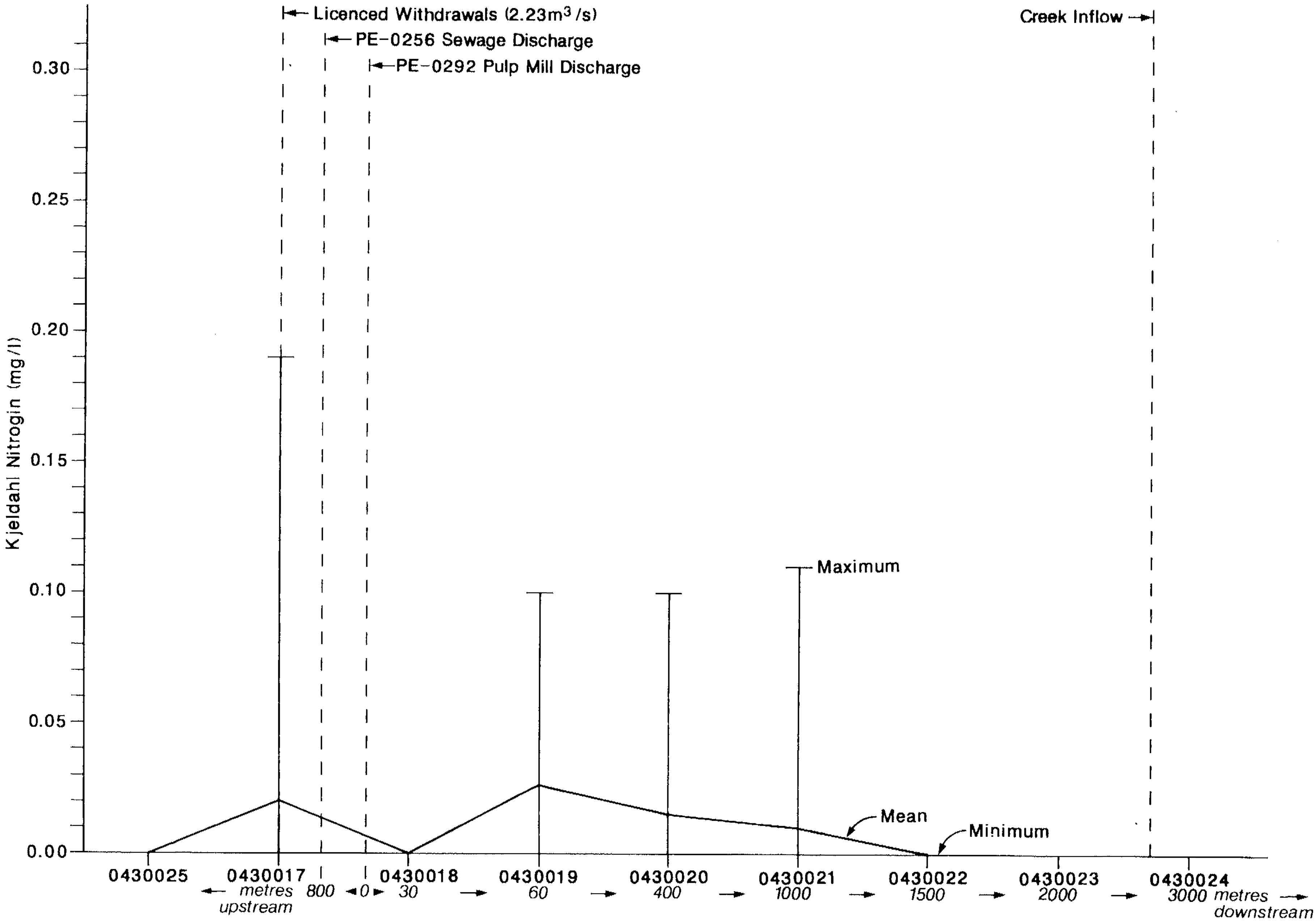

FIGURE 9 Kjeldahl Nitrogen in the Kitimat River.

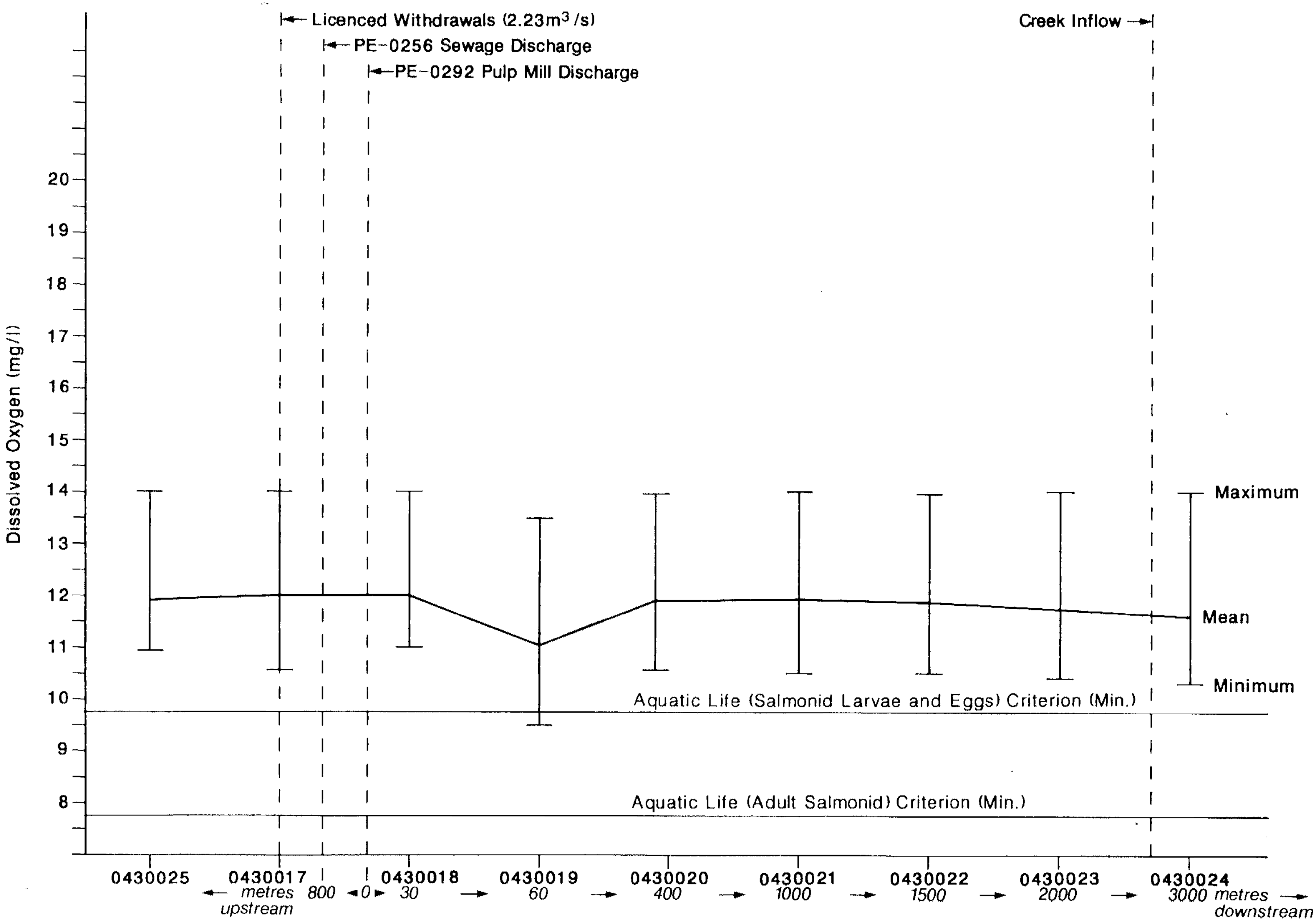

FIGURE 10 Dissolved Oxygen in the Kitimat River.

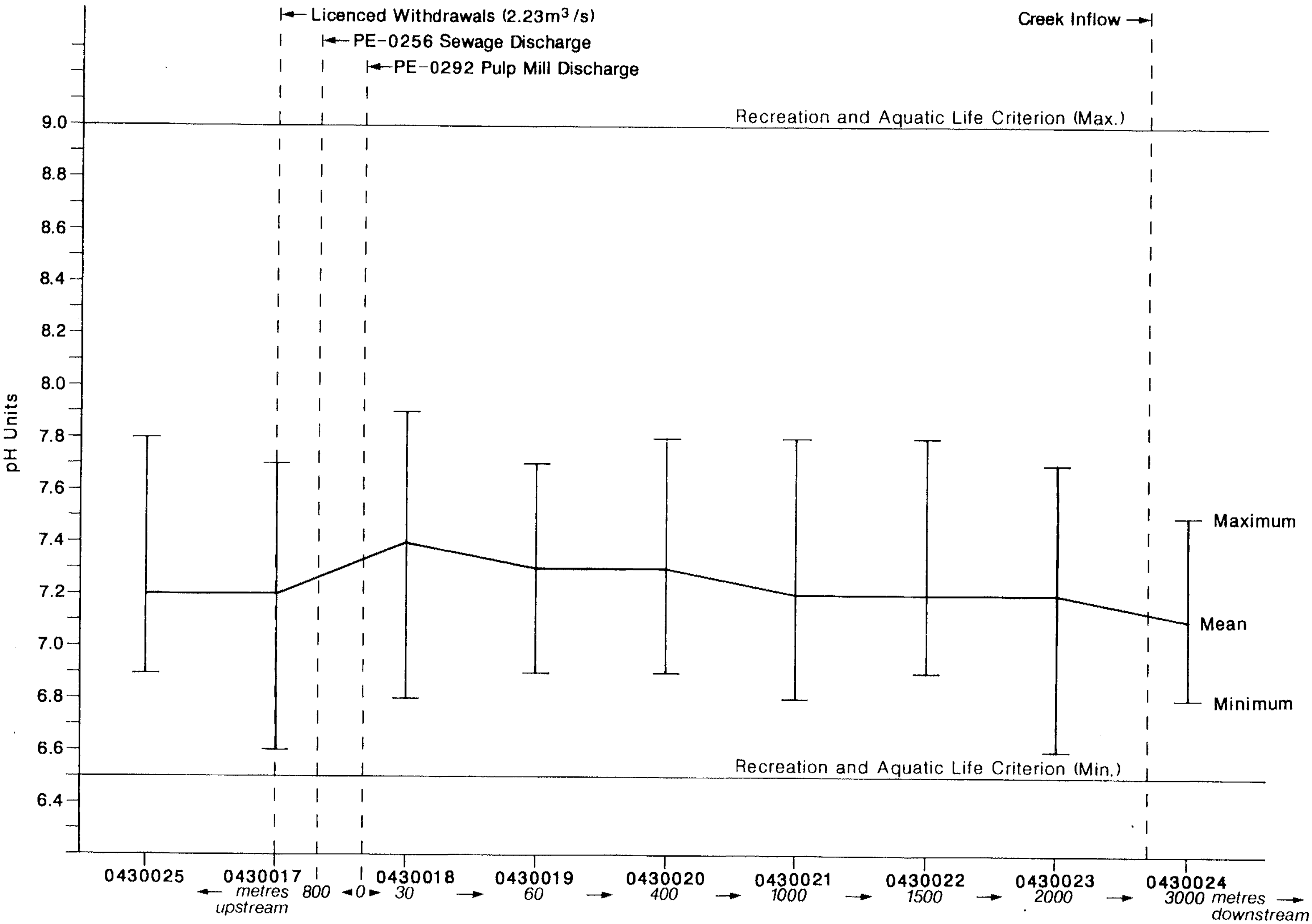

FIGURE 11 pH in the Kitimat River.

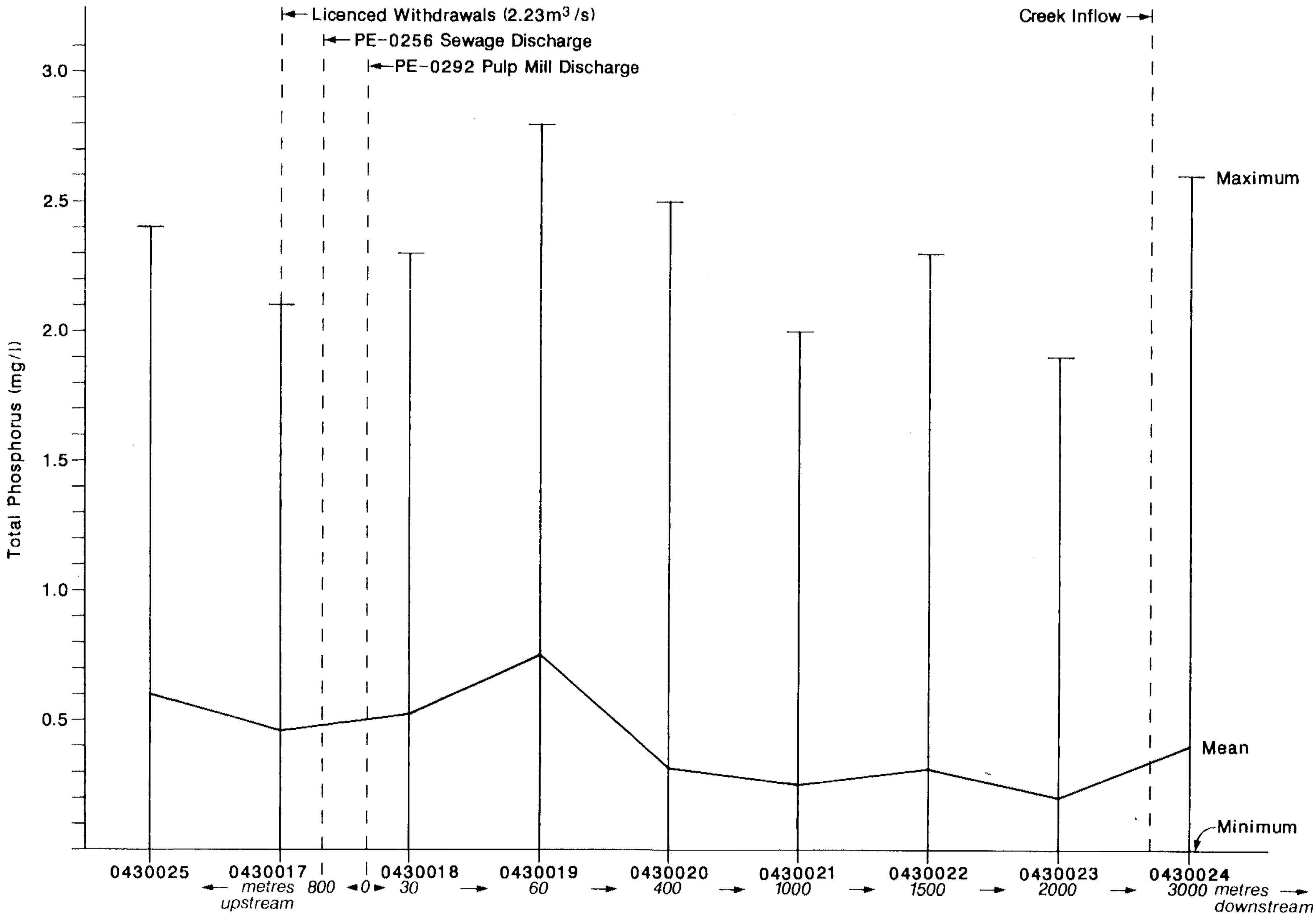

FIGURE 12 Total Phosphorus in the Kitimat River.

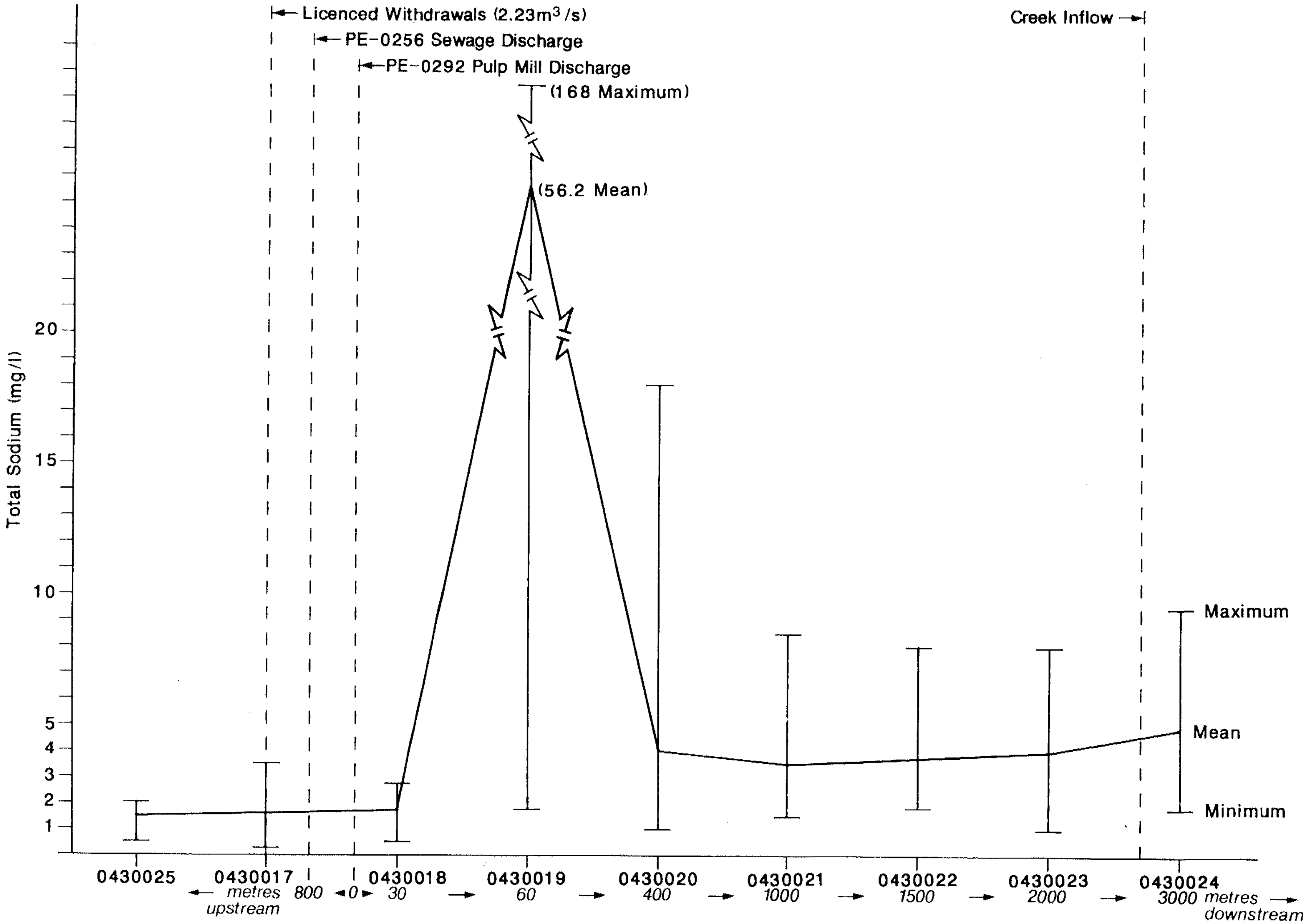

FIGURE 13 Total Sodium in the Kitimat River.

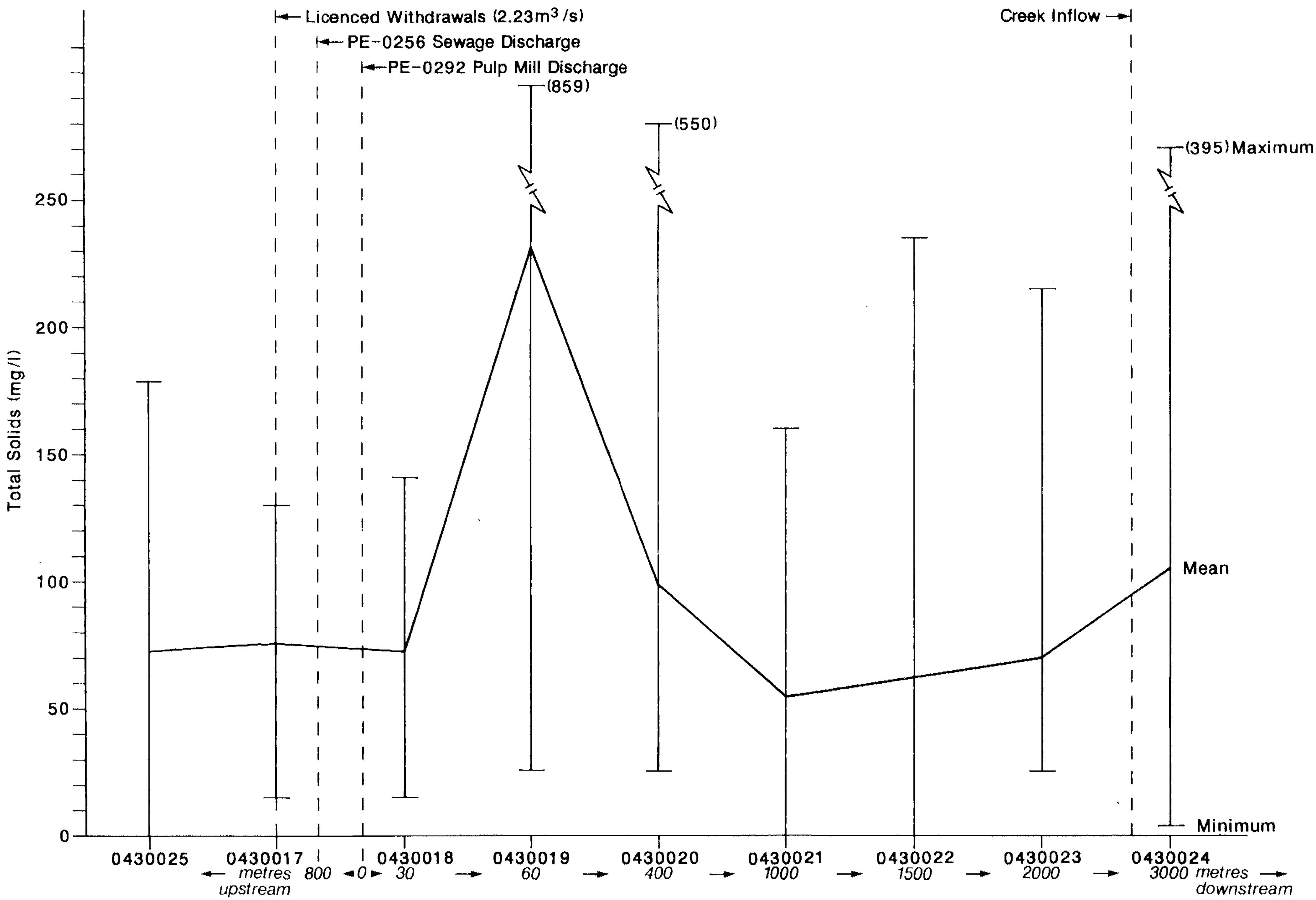

FIGURE 14 Total Solids in the Kitimat River.

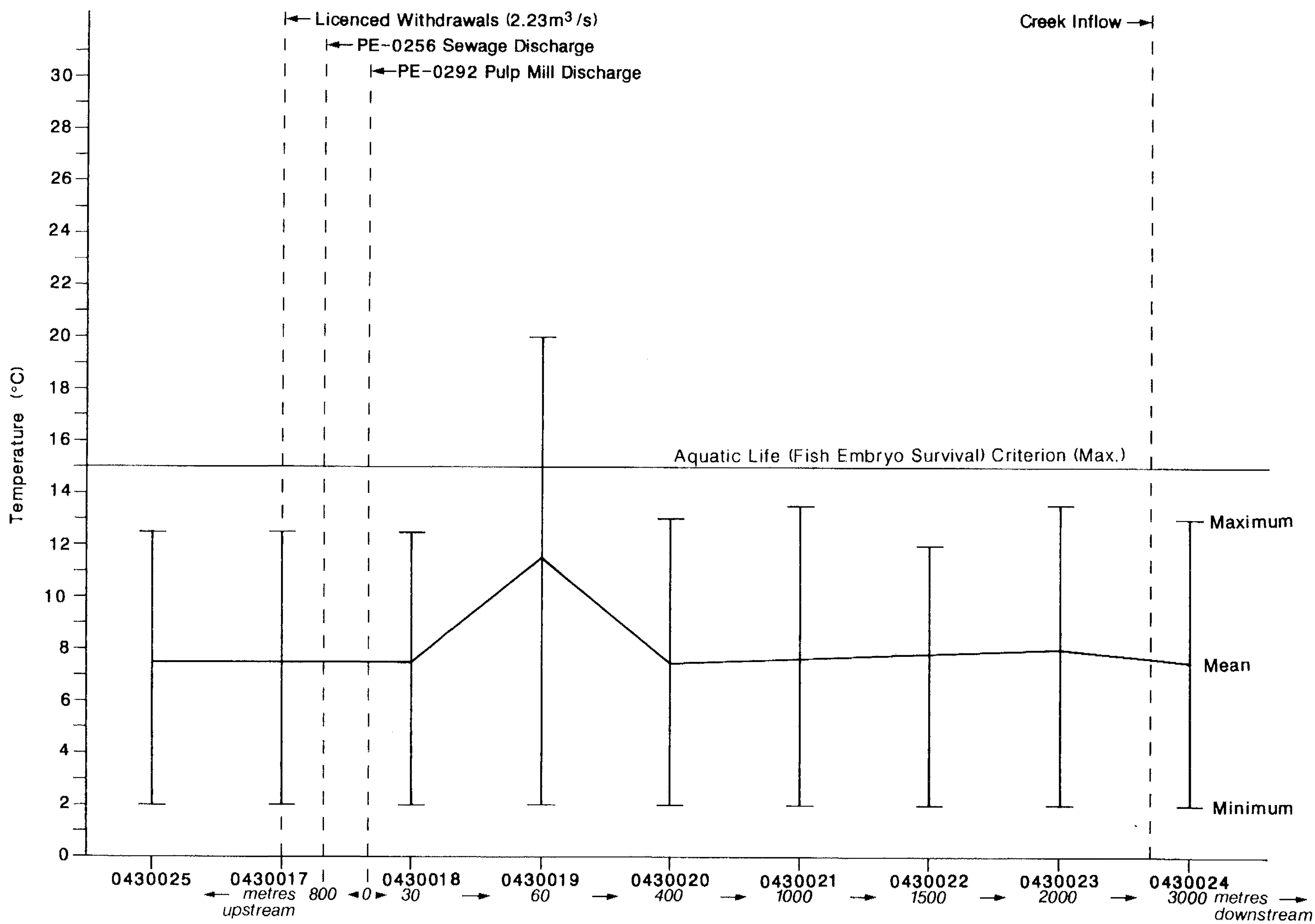

FIGURE 15 Temperature in the Kitimat River.

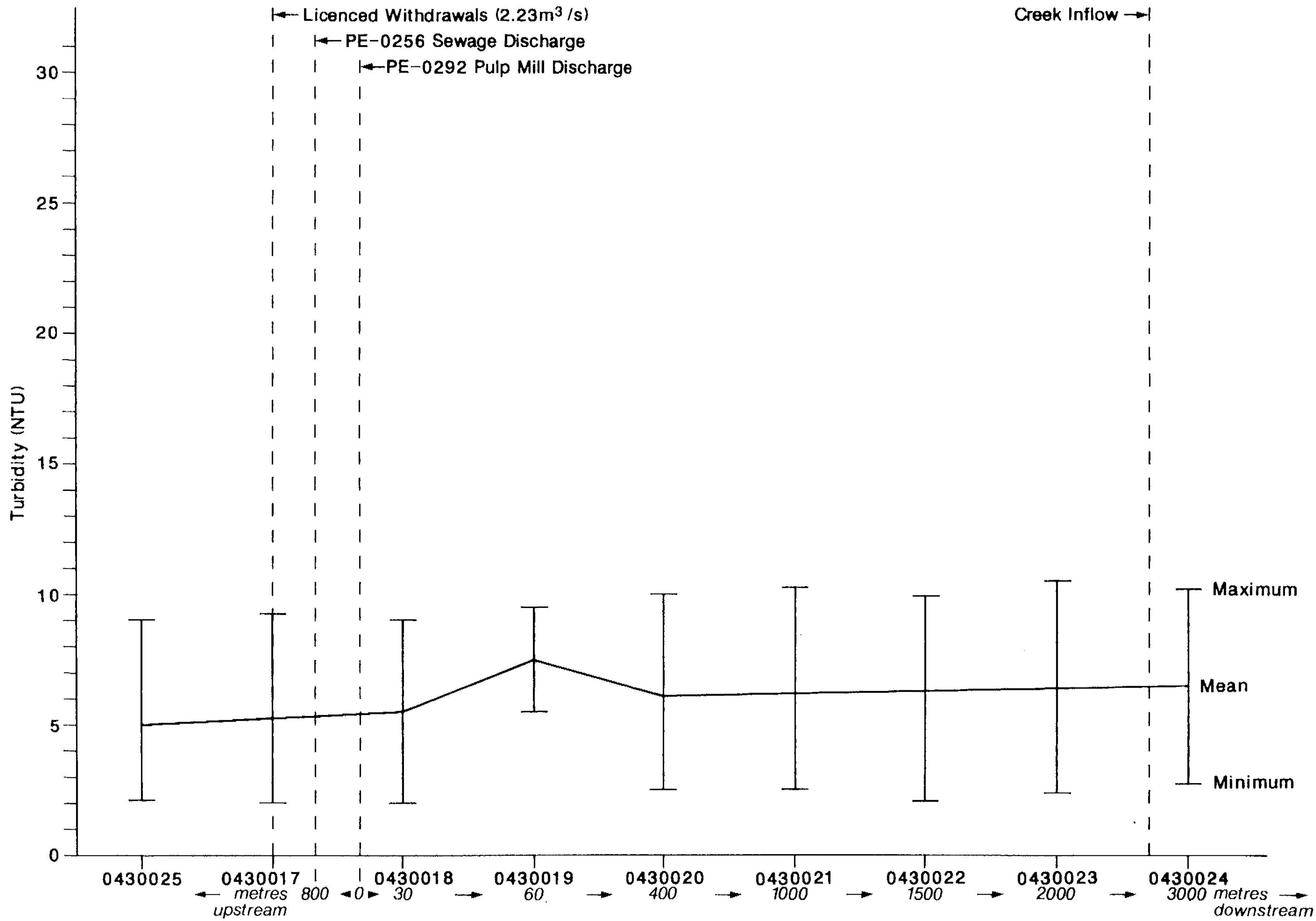

FIGURE 16 Turbidity in the Kitimat River.

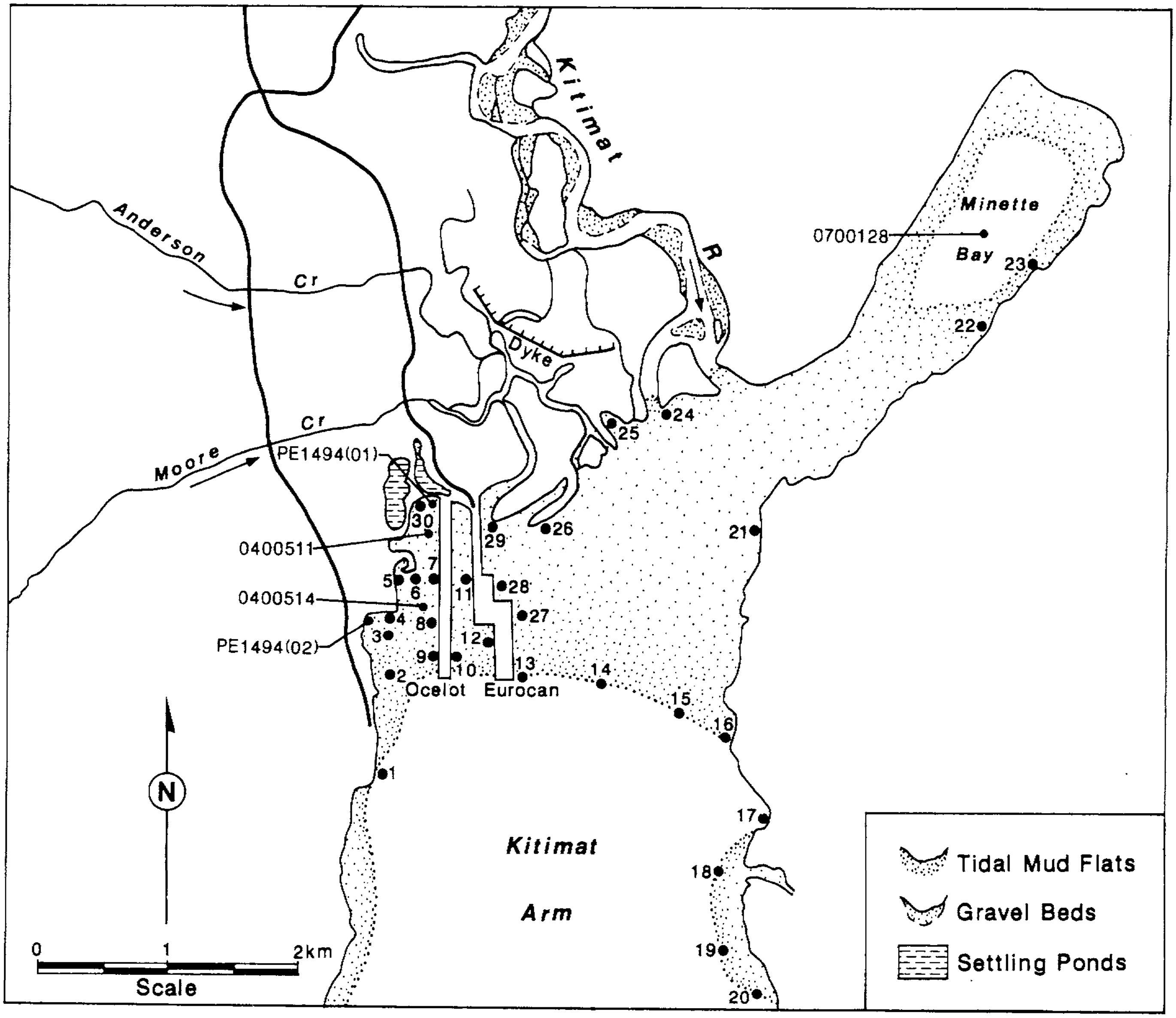

FIGURE 17 Location of Sediment Sampling Sites in the Kitimat Arm (1976 and 1983).

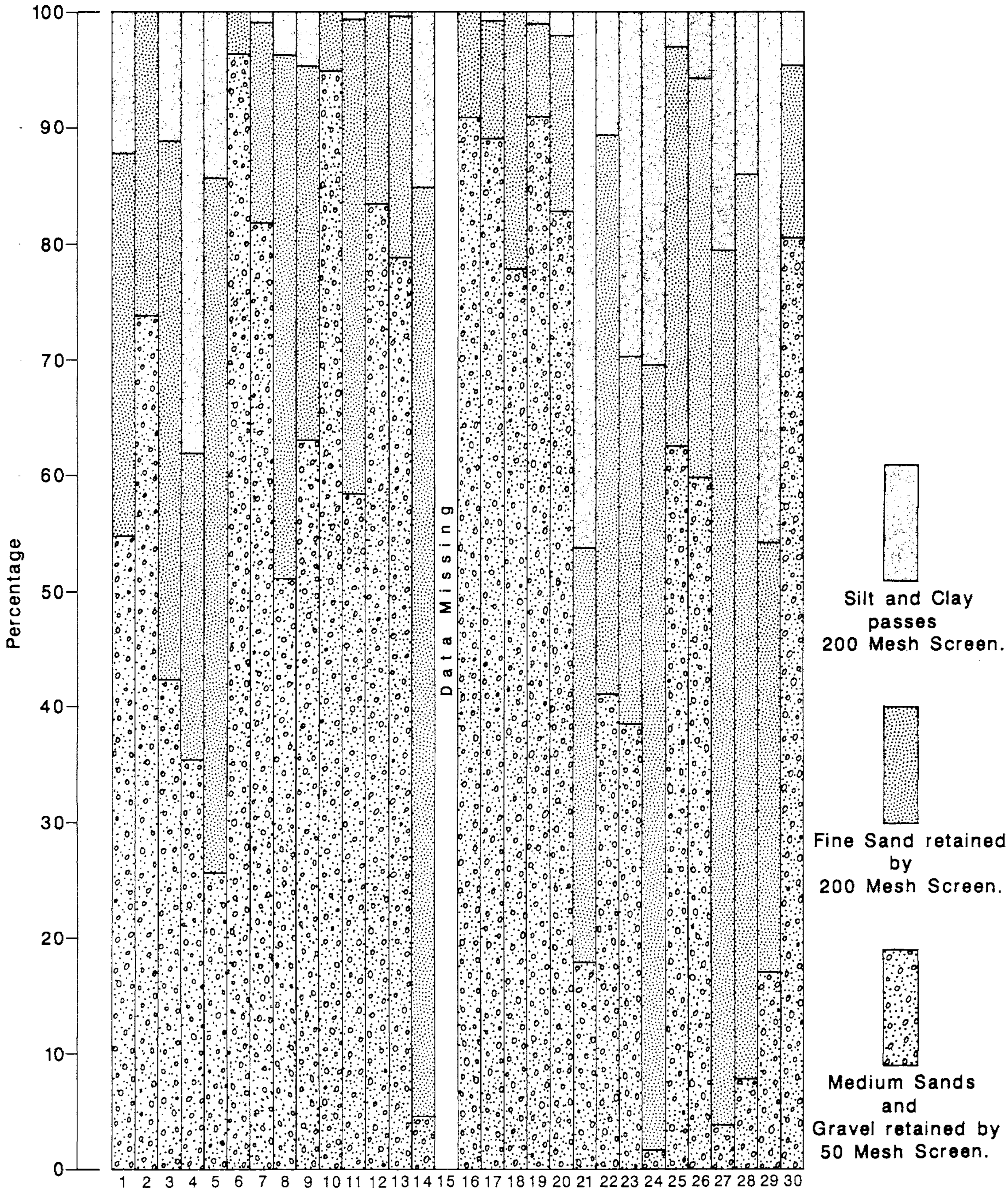

FIGURE 18 Particle Size Distribution in Kitimat Harbour Sediment Samples.

TABLE 1

SEVEN DAY AVERAGE LOW FLOWS (m^3/s) IN THE KITIMAT RIVER, OBEDKOFF, 1983
(WATER SURVEY OF CANADA HYDROMETRIC STATION 08FF001)

SEASON	RETURN PERIOD			
	10 Year	20 Year	30 Year	50 Year
August/September (based on 1965-1981 data)	39.3** 29.9-51.8*	33.6 24.5-46.1	31.0 22.1-43.4	28.1 19.5-40.6
November/April (based on 1967--1981 data)	9.79 4.93-14.7	8.05 2.67-13.4	7.25 1.60-12.9	6.41 0.47-12.4

** mean
* 95% confidence limits

TABLE 2

SUMMARY OF VELOCITIES (m/s) IN THE KITIMAT RIVER BETWEEN
THE HIGHWAY BRIDGE AND KITIMAT ARM, 1976-1982

	Velocity in m/s			
Site Number	Maximum	Mean	Minimum	#of Samples
0430025 (upstream)	1.27	0.92	0.27	6
17	0.91	0.56	0.27	6
18	1.22	0.94	0.70	6
19	1.03	0.93	0.73	5
20	2.00	1.42	0.64	6
21	1.07	0.66	0.33	6
22	1.37	1.06	0.73	6
23	1.92	0.97	0.21	6
24(downstream)	-	-	-	-
Means	1.35	0.93	0.49	
Residence times from PE 292 (Eurocan) discharge to Kitimat Arm (hours)	Mean 1.0 Range 0.7-1.5	Mean 1.5 Range 1.0-2.5	Mean 2.8 Range 1.9-6.6	

Data from EQUIS

TABLE 3

LICENCED WATER USE ON THE LOWER KITIMAT RIVER

LICENCE	m^3/d	USE	LICENCEE AND LOCATION
CL55545	364	domestic	District of Kitimat, Community Waterworks, Cablecar Subdivision. Infiltration from the river at DL 6194 on the south bank, 1.5 km upstream from Hirsch Ck.
CL35712 CL25408	13 638 4 546	domestic domestic	District of Kitimat, community waterworks, Kitimat Townsite. Deep water intake wells at DL 6046 on the east bank at the Haisla Bridge.
0368054	110 142	fish hatchery	Department of Fisheries and Oceans Fish Hatchery. Pumping station at DL 6267 on the west bank at the south end of Sandhill.
CL33471	171 260	industrial processes, cooling and wash water	Eurocan Pulp and Paper Co. Ltd. Pulp and Paper Mill. Pumping station at DL 6267 on the west bank at the south end of Sandhill.
0366365	14 686	industrial processes	Ocelot Industries Ltd. Methanol Plant. Pumping station at DL 6267 on the west bank at the south end of Sandhill.
CL49651	114	industrial processes	L.G. Scott and Sons Construction Ltd. Asphalt Paving Plant. Pumped from DL 6265 on the west bank at Sandhill.
CL22038 CL22037	122 380	industrial processes, wash and cooling water	Aluminum Co. of Canada Ltd. Aluminum Smelter. Pumping station at DL 6267 on the west bank at the south end of Sandhill.

Total 437 130 m^3/d (5.06 m^3/s)

TABLE 4

POINT SOURCE WASTE DISCHARGES IN THE KITIMAT AREA

PERMIT	PERMITTEE AND TYPE OF WASTE
PE-256	District of Kitimat, treated Municipal sewage discharged to the Kitimat River.
PE-292	Eurocan Pulp and Paper Co. Ltd., Kraft Pulp Mill and Sawmill wastes. Effluent from a settling pond and aeration lagoon containing mercaptans, sulphides, resin acids, foam, colour, suspended solids and BOD is discharged to the Kitimat River.
PE-1494	Aluminum Co. of Canada Ltd., aluminum smelter waste. Cooling water, smelter 'B' surface runoff and carwash runoff discharged to Moore Creek. Cooling water and surface runoff from coke calciner discharged to Kitimat Arm. Wet scrubbers, cooling water and smelter 'A' surface runoff discharged to Kitimat Arm via a settling lagoon.
PE-6006	Ocelot Industries Ltd., Methanol plant waste. Treated effluent containing methanol, sodium and methyl formates, cyanide and other waste chemicals discharged to Kitimat Arm.

TABLE 5

SUMMARY OF EFFLUENT MONITORING RESULTS FOR DISTRICT OF KITIMAT (PE-256) 1972 TO AUGUST 1982

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN**	PERMIT LIMITS
BOD_5	mg/L	515	>195*	0	14	45
Chlorine residual	mg/L	3	0	0	0	
Coliforms, fecal	MPN/100 mL	15	<20 000	0	1 410	
Coliforms, total	MPN/100 mL	13	160 000	<200	10 589	
Conductivity, specific	uS/cm	17	313	178	251	
Flow	m^3/d	2 296	109 930*	434	20 388*	18 200
Flow	m^3/s	2 296	1.27	0.005	0.24	
Nitrogen, ammonia	mg/L	2	7.4	7.2	7.3	
Nitrogen, kjeldahl	mg/L	3	16	10	12	
Nitrogen, organic	mg/L	1	2.8	2.8	2.8	
Nitrogen, nitrate	mg/L	6	0.16	0.09	0.12	
Nitrogen, nitrite	mg/L	6	0.103	0.012	0.031	
Nitrogen, nitrite/nitrate	mg/L	7	0.27	0.12	0.18	
Nitrogen, total	mg/L	3	16	10	12	
Oxygen, dissolved	mg/L	640	13	0.1	3.5	
pH	pH	815	7.4	6.6	6.9	
Phosphorus, dissolved, ortho	mg/L	3	2.02	1.15	1.52	
Phosphorus, total	mg/L	4	2.07	1.38	1.69	
Solids, dissolved	mg/L	3	150	138	146	
Solids, fixed, dissolved	mg/L	797	32	<1	7	
Solids, settleable	mL/L	801	0.70	0.02	0.11	
Solids, suspended	mg/L	878	36	0	13	60
Sulphate	mg/L	2	11.6	10.0	10.8	
Temperature	°C	802	25.5	0.0	11.3	
Turbidity	NTU	1	8.7	8.7	8.7	

** except coliforms which are geometric means
* exceeds permit limits
Data taken from EQUIS

TABLE 6

SUMMARY OF EFFLUENT MONITORING RESULTS FOR EUROCAN PULP AND PAPER CO. LTD. (PE-292)
1972 TO AUG. 1982

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN**	PERMIT LIMITS
Alkalinity, phenolphthalein	mg/L	2	9	0	4.2	
Alkalinity, total	mg/L	2	131	109	120	
BOD_5	mg/L	37	251	17	79	
BOD_5	kg/ADT	399	49.5	1.5	7.8	
BOD_5	kg/d	401	21 600*	96	5 205	16 770
COD	mg/L	4	380	230	307	
Coliforms, fecal	MPN/100 mL	6	<2 000	<20	<144	
Coliforms, total	MPN/100 mL	5	4 900	200	1 623	
Colour, apparent	ACU	330	1 400.0	6.6	627.6	
Colour, TAC	TAC	2	740	472	606	
Colour, true	TCU	110	2 000	85	531	
Conductivity, specific	uS/cm	3100	1 900	190	836	
Flow	m^3/d	2882	124 160*	0	66 126	68 190
Flow	m^3/s	2882	1.44	0.0	0.77	
Mercaptan, total	mg/L	196	3.5*	0.0	0.1	<0.5
Nitrogen, kjeldahl	mg/L	25	7.0	0.1	2.8	
Nitrogen, nitrate, dissolved	mg/L	9	0.07	<0.02	<0.03	
Nitrogen, nitrate, total	mg/L	147	3.5	0.0	0.8	
Nitrogen, nitrite	mg/L	9	0.048	<0.005	<0.017	
Nitrogen, nitrate/nitrite	mg/L	11	0.07	<0.02	<0.04	
Nitrogen, total	mg/L	184	9.7	0.0	1.0	
Oxygen, dissolved	mg/L	1664	11.9	0.2*	5.5	>2.0
pH	pH	3120	9.8*	5.9*	7.6	6.5-8.0
Phenol, total	mg/L	2	0.560	0.025	0.293	
Phosphorus, dissolved, ortho	mg/L	3	0.025	0.011	0.020	
Phosphorus, dissolved, total	mg/L	24	3.5	0.008	0.887	
Phosphorus, total	mg/L	180	5.6	0.0	1.2	
Resin Acids	mg/L	392	18*	0.1	3.6	<5.0
Sodium, dissolved	mg/L	14	223	82	166	
Sodium, total	mg/L	11	275	125	194	
Solids, dissolved	mg/L	4	892	810	857	
Solids, fixed, dissolved	kg/ADT	54	417.4	42.7	97.7	
Solids, fixed, dissolved	mg/L	4	41	11.2	32.3	
Solids, fixed, dissolved	kg/ADT	398	67.8	0.6	9.4	
Solids, fixed, suspended	mg/L	1	6	6	6	
Solids, fixed, total	mg/L	1	602	602	602	
Solids, floatable	mL/L	190	0	0	0	
Solids, settleable	mL/L	3040	200.0*	0.0	0.328	0.5
Solids, suspended	kg/d	386	19 800*	181	7 510*	6 770
Solids, suspended	mg/L	37	190	27	102	
Sulphate, dissolved	mg/L	11	330	158	248	
Sulphide, dissolved	mg/L	69	28.67	<0.14	<0.70	
Sulphide, total	mg/L	291	2.5*	0.0	0.3	<0.5
Tannin and lignin, total	mg/L	24	176	20	69	
Temperature	°C	2546	33.0	9.5	24.8	<35
Turbidity	NTU	6	26	12	16	

** except coliforms which are geometric means
* exceeds permit limits
Data taken from EQUIS
ADT=air dried tonne
The most recent 96h LC50 measurements are all >100%

TABLE 7
SUMMARY OF EFFLUENT MONITORING RESULTS FOR OCELOT INDUSTRIES LTD., PE-6006, 1982

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN**	PERMIT LIMITS
Alkalinity, total	mg/L	1	71.4	71.4	71.4	
Aluminum, total	mg/L	5	0.57	0.17	0.36	
Arsenic, total	mg/L	5	<0.25	<0.25	<0.25	
BOD	mg/L	1	41*	41*	41*	30
Cadmium, total	mg/L	5	<0.01	<0.01	<0.01	
Calcium, total	mg/L	5	26.10	9.05	18.29	
Chlorine, residual	mg/L	1	0	0	0	
Chromium, total	mg/L	21	<0.1	<0.01	<0.08	
Cobalt, total	mg/L	5	<0.1	<0.1	<0.1	
C.O.D.	mg/L	41	10600*	22	421*	100
Coliforms, fecal	MPN/100 mL	1	33000	33000	33000	
Coliforms, total	MPN/100 mL	1	54000	54000	54000	
Conductance, specific	μS/cm	7	2480	188	948	
Copper, total	mg/L	21	0.09	0.02	0.05	
Cyanide, total	mg/L	17	<0.05	<0.05	<0.05	0.05
Flow	m^3/d	241	3088*	1090*	1663*	750+ av.
Iron, total	mg/L	22	2.532	0.702	1.06	
Lead, total	mg/L	5	<0.01	<0.01	<0.01	
Magnesium, total	mg/L	5	3.33	1.22	2.23	
Manganese, total	mg/L	5	0.16	0.05	0.10	
Methanol	mg/L	15	4200	<10	315	
Molybdenum, total	mg/L	24	<0.2	<0.01	<0.15	
Nickel, total	mg/L	24	<0.1	<0.05	<0.08	
Nitrogen, ammonia	mg/L	3	25.400	0.107	10.059	
Nitrogen, Kjeldahl	mg/L	5	25.50	1.24	12.69	
Nitrogen, NO_2	mg/L	2	0.733	0.012	0.373	
Nitrogen, NO_2/NO_3	mg/L	5	7.35	0.08	1.67	
Nitrogen, NO_3	mg/L	2	6.62	0.29	3.45	
Nitrogen, total	mg/L	5	25.88	2.32	14.50	
Oil and grease	mg/L	16	1150*	0.0	90*	10
Organic carbon, total	mg/L	21	1230	9	100	
pH	pH	471	11.3*	2.2*	7.3	6.5-8.5
Phosphorus, total	mg/L	5	5.680	0.626	3.025	
Potassium, dissolved	mg/L	2	7.2	1.3	4.3	
Sodium, dissolved	mg/L	1	211	211	211	
Solids, dissolved	mg/L	26	1740	102	632	
Solids, total	mg/L	26	1800	134	658	
Sulphate, total	mg/L	3	1040	9.6	493.9	
Suspended solids, total	mg/L	42	106*	2	25	30
Temperature	°C	241	50.0*	10.5	29.1*	22
Total inorganic carbon	mg/L	18	16.0	3.0	8.1	
Vanadium, total	mg/L	5	<0.01	<0.01	<0.01	
Zinc, total	mg/L	21	0.40	0.01	0.06	

**except coliforms which are geometric means
* exceeds permit limits
+ this is the mean value, the maximum value is 1 000
Data taken from coding form supplied by Region.

TABLE 8

SOURCE AND PERMITTED LIMITS OF THE EFFLUENTS FROM THE FOUR ALUMINUM SMELTER OUTFALLS, PE 1494(01) - PE 1494(04)

	PERMIT LIMITS FOR PE 1494 OUTFALLS			
Outfall #	(01)	(02)	(03)	(04)
discharge point	discharged to Kitimat Arm via a settling lagoon	discharged to Kitimat Arm	discharged to Moore Creek	discharged to Moore Creek
source of effluent	wet scrubbers, cooling water and Smelter 'A' surface runoff	cooling water, and surface runoff from the coke calciner	cooling water and Smelter 'B' surface runoff	the car wash and storm sewer
CHARACTERISTICS				
soap and detergents	-	-	-	0
flow (m^3/d)	33 000*	1 360	17 700	68
suspended solids (mg/L)	50	50	50	50
pH	6.0 - 8.5	6.0 - 8.5	6.0 - 8.5	-
temperature (°C)	38	38	rise of 3**	-
oil and grease (mg/L)	15	15	15	15
dissolved fluoride (mg/L)	15	15	5	-
dissolved aluminum (mg/L)	10	10	1	-
dissolved iron (mg/ L)	1	1	1	-
total cyanide (mg/L)	20	20	20	-

* increased to 50 000 m^3/d in wet season
** Moore Creek is not to rise by more than 3°C

TABLE 9

SUMMARY OF EFFLUENT MONITORING RESULTS FOR ALCAN SMELTER, PE-1494(01), 1976-1982 (OUTFALL #1, WET SCRUBBERS, COOLING WATER AND SMELTER 'A' SURFACE RUNOFF)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN**	PERMIT LIMITS
Aluminum, dissolved	mg/L	86	18.2*	<0.01	<4.4	10
Aluminum, total	mg/L	15	10.5	1.2	3.5	
Arsenic, total	mg/L	1	<0.25	<0.25	<0.25	
BOD_5	mg/L	1	<10	<10	<10	
Cadmium, total	mg/L	1	<0.01	<0.01	<0.01	
Calcium, dissolved	mg/L	54	9.4	0.6	4.9	
Calcium, total	mg/L	12	17.8	3.3	6.8	
Carbon, inorganic, total	mg/L	2	16	<1	<8.5	
Carbon, organic, total	mg/L	2	8	2	5	
Chlorine residual	mg/L	1	0	0	0	
Chromium, dissolved	mg/L	3	<0.01	<0.005	<0.008	
Chromium, total	mg/L	1	<0.01	<0.01	<0.01	
Cobalt, total	mg/L	1	<0.1	<0.1	<0.1	
Coliforms, fecal	MPN/100 mL	2	<2	<2	<2	
Coliforms, total	MPN/100 mL	2	<2	<2	<2	
Conductivity, specific	uS/cm	19	2 160	57	339	
Copper, dissolved	mg/L	4	0.01	0.006	0.009	
Copper, total	mg/L	12	0.04	0.005	0.015	
Cyanide, total	mg/L	87	2.3	<0.01	<0.29	20
Flow	m^3/d	301	74 528*	327	26 379	33 000 (dry) 50 000 (wet)
Flow	m^3/s	301	0.86	0.0038	0.31	
Fluoride, dissolved	mg/L	266	256*	0.9	62.2*	15
Fluoride, total	mg/L	80	150	2.4	25.5	
Hardness ($CaCO_3$), dissolved	mg/L	1	12.5	12.5	12.5	
Iron, dissolved	mg/L	86	10.7*	<0.03	<0.09	1.0
Iron, total	mg/L	15	2.67	0.3	0.92	
Lead, dissolved	mg/L	4	0.069	<0.03	<0.048	
Lead, total	mg/L	2	0.1	<0.001	<0.03	
Magnesium, dissolved	mg/L	1	0.62	0.62	0.62	
Magnesium, total	mg/L	1	0.74	0.74	0.74	
Manganese, dissolved	mg/L	3	0.04	<0.005	<0.018	
Manganese, total	mg/L	1	0.03	0.03	0.03	
Mercury, dissolved	µg/L	3	0.37	0.20	0.27	
Mercury, total	µg/L	1	0.17	0.17	0.17	
Molybdenum, total	mg/L	1	<0.01	<0.01	<0.01	
Nickel, dissolved	mg/L	3	0.04	<0.01	<0.02	
Nickel, total	mg/L	1	<0.05	<0.05	<0.05	
Oil and grease	mg/L	84	14.9	<0.2	<1.8	15
pH	pH	266	8.8*	2.3*	4.3*	6.0-8.5
Silica, dissolved	mg/L	1	5.5	5.5	5.5	
Solids, dissolved	mg/L	51	307	9	119	
Solids, suspended	mg/L	264	85*	0.4	7.5	50
Temperature	°C	285	26.5	0.0	11.6	38
Titanium, dissolved	mg/L	2	<0.1	<0.1	<0.1	
Vanadium, dissolved	mg/L	3	0.1	0.085	0.095	
Vanadium, total	mg/L	1	<0.01	<0.01	<0.01	
Zinc, dissolved	mg/L	3	0.03	<0.001	<0.011	
Zinc, total	mg/L	2	0.02	0.005	0.013	

* Exceeds permit limits
** Except coliforms which are geometric means
Data taken from Equis

TABLE 10

SUMMARY OF EFFLUENT MONITORING RESULTS FOR ALCAN SMELTER, PE-1494(02), 1976-1982
(OUTFALL #2 COOLING WATER AND SURFACE RUNOFF FROM COKE CALCINER)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN**	PERMIT LIMITS
Alkalinity, total	mg/L	1	7.3	7.3	7.3	
Aluminum, dissolved	mg/L	83	13.9*	<0.01	<1.08	10
Aluminum, total	mg/L	14	77.5	0.2	8.4	
Arsenic, total	mg/L	1	<0.25	<0.25	<0.25	
BOD_5, total	mg/L	1	<10	<10	<10	
Cadmium, total	mg/L	1	<0.01	<0.01	<0.01	
Calcium, dissolved	mg/L	55	42.4	1.2	8.8	
Calcium, total	mg/L	12	23.1	3.5	10.4	
Carbon, inorganic	mg/L	3	8	<1	3.7	
Carbon, organic	mg/L	2	108	30	69	
Chlorine residual	mg/L	1	0	0	0	
Chromium, dissolved	mg/L	2	<0.1	<0.01	<0.06	
Chromium, total	mg/L	1	<0.01	<0.01	<0.01	
Cobalt, total	mg/L	1	<0.1	<0.1	<0.1	
Coliforms, fecal	MPN/100 mL	11	2 400	<2	<36	
Coliforms, total	MPN/100 mL	13	2 400	<2	<186	
Conductivity, specific	uS/cm	17	1 470	22	271	
Copper, dissolved	mg/L	51	0.14	<0.01	<0.02	
Copper, total	mg/L	12	0.12	0.007	0.024	
Cyanide, total	mg/L	78	4.4	·0.03	1.04	20
Flow	m^3/d	305	3 273*	65	396	1360
Flow	m^3/s	305	0.0379	0.0008	0.0046	
Fluoride, dissolved	mg/L	260	410*	<0.1	15.46*	15
Fluoride, total	mg/L	81	410	0.8	28.2	
Hardness ($CaCO_3$)	mg/L	1	8.4	8.4	8.4	
Iron, dissolved	mg/L	8	2.8*	0.2	1.2*	1.0
Iron, total	mg/L	14	75	0.2	7.3	
Lead, dissolved	mg/L	2	<0.04	<0.03	<0.04	
Lead, total	mg/L	3	0.022	<0.001	<0.009	
Magnesium, dissolved	mg/L	1	0.28	0.28	0.28	
Magnesium, total	mg/L	1	0.44	0.44	0.44	
Manganese, dissolved	mg/L	2	0.94	0.01	0.48	
Manganese, total	mg/L	1	0.02	0.02	0.02	
Mercury, dissolved	µg/L	2	0.50	0.24	0.37	
Molybdenum, total	mg/L	1	<0.01	<0.01	<0.01	
Nickel, dissolved	mg/L	2	<0.01	<0.01	<0.01	
Nickel, total	mg/L	1	<0.05	<0.05	<0.05	
Oil and grease	mg/L	78	385*	0.1	8.4	15
pH	pH	262	10.0*	3.3*	7.3	6.0-8.5
Silica, dissolved	mg/L	1	1.9	1.9	1.9	
Solids, dissolved	mg/L	57	3 326	30	201	
Solids, suspended	mg/L	257	5 680*	0.3	170*	50
Temperature	°C	265	28	2	15	38
Titanium, dissolved	mg/L	2	<0.1	<0.1	<0.1	
Vanadium, dissolved	mg/L	2	0.1	<0.01	<0.06	
Vanadium, total	mg/L	1	<0.01	<0.01	<0.01	
Zinc, dissolved	mg/l	2	0.022	<0.001	<0.012	
Zinc, total	mg/L	1	<0.01	<0.01	<0.01	

* Exceeds permit limits
** Except coliforms which are geometric means
Data taken from Equis

TABLE 11

SUMMARY OF EFFLUENT MONITORING RESULTS FOR ALCAN SMELTER, PE-1494(03), 1976-1982 (OUTFALL #3 COOLING WATER AND SURFACE RUNOFF FROM SMELTER 'B')

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN**	PERMIT LIMITS
Aluminum, dissolved	mg/L	65	5.78*	0.01	0.73	1.0
Aluminum, total	mg/L	15	5.3	0.1	0.9	
Arsenic, total	mg/L	1	<0.25	<0.25	<0.25	
BOD_5	mg/L	1	<10	<10	<10	
Cadmium, total	mg/L	1	<0.01	<0.01	<0.01	
Calcium, dissolved	mg/L	55	7.6	2.6	4.7	
Calcium, total	mg/L	12	8.5	2.8	5.3	
Carbon, inorganic, total	mg/L	1	3	3	3	
Carbon, organic, total	mg/L	1	14	14	14	
Chlorine residual	mg/L	1	0	0	0	
Chromium, dissolved	mg/L	2	<0.01	<0.01	<0.01	
Chromium, total	mg/L	1	<0.01	<0.01	<0.01	
Cobalt, total	mg/L	1	<0.1	<0.1	<0.1	
Coliform, fecal	MPN/100 mL	3	<2	<2	<2	
Coliform, total	MPN/100 mL	4	210	<2	<10.8	
Conductivity, specific	uS/cm	18	77	23	50	
Copper, dissolved	mg/L	52	0.19	<0.01	<0.02	
Copper, total	mg/L	12	0.02	0.003	0.009	
Cyanide, total	mg/L	47	0.36	<0.01	<0.10	
Flow	m^3/d	318	19 639*	1964	7187	17 700
Flow	m^3/s	318	0.23	0.023	0.083	
Fluoride, dissolved	mg/L	234	86*	<0.1	<2.79	1.0
Fluoride, total	mg/L	10	11.7	<1.0	<3.6	
Hardness ($CaCO_3$), dissolved	mg/L	1	11.2	11.2	11.2	
Iron, dissolved	mg/L	6	0.6	0.18	0.35	1.0
Iron, total	mg/L	15	2.1	0.3	0.8	
Lead, dissolved	mg/L	2	0.05	<0.03	<0.04	
Lead, total	mg/L	4	<0.1	<0.001	<0.026	
Magnesium, dissolved	mg/L	1	0.36	0.36	0.36	
Magnesium,total	mg/L	1	0.46	0.46	0.46	
Manganese, dissolved	mg/L	2	0.083	<0.01	<0.05	
Manganese, total	mg/L	1	0.02	0.02	0.02	
Mercury, dissolved	µg/L	2	0.15	0.11	0.13	
Molybdenum, total	mg/L	1	<0.01	<0.01	<0.01	
Nickel, dissolved	mg/L	2	<0.01	<0.01	<0.01	
Nickel, total	mg/L	1	<0.05	<0.05	<0.05	
Oil and grease	mg/L	62	6.0	<0.1	<1.3	15.0
pH	pH	244	7.9	3.1*	6.5	6.0-8.5
Silica, dissolved	mg/L	1	2.1	2.1	2.1	
Solids, dissolved	mg/L	55	162	4	47	
Solids, suspended	mg/L	241	77*	0.1	6.1	50
Temperature	°C	276	28.0	6.5	16.6	
Titanium, dissolved	mg/L	2	<0.1	<0.1	<0.1	
Vanadium, dissolved	mg/L	2	0.1	<0.01	<0.06	
Vanadium, total	mg/L	1	<0.01	<0.01	<0.01	
Zinc, dissolved	mg/L	2	0.032	<0.001	<0.017	
Zinc, total	mg/L	1	<0.01	<0.01	<0.01	

* Exceeds permit limits
** Except coliforms which are geometric means
Data taken from EQUIS

TABLE 12

SUMMARY OF EFFLUENT MONITORING RESULTS FOR ALCAN SMELTER, PE-1494(04), 1976-1984 (OUTFALL #4, CARWASH)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	PERMIT LIMITS
Oil and Grease	mg/L	37	1.37	<0.1	0.6	15
pH	pH	39	9.5	2.1	6.8	
Solids, suspended	mg/L	38	34.4	0.1	5.3	50
Temperature	°C	39	24.0	4.0	12.1	

Data taken from EQUIS

TABLE 13

CHARACTERISTICS EXCEEDING PERMIT LIMITS IN PE-1494 OUTFALLS, 1976-1982

CHARACTERISTICS	OUTFALL-01	OUTFALL-02	OUTFALL-03
aluminum, dissolved	√	√	√
flow	√	√	√
fluoride, dissolved	√ +	√ +	√
iron, dissolved	√	√ +	
oil and grease		√	
pH	√ X +	√ X	X
solids, suspended	√	√ +	√

√ - exceeds maximum value
X - exceeds minimum value
\+ - exceeds mean value

TABLE 14

SUMMARY OF WATER QUALITY DATA FOR MOORE CREEK BOTH UPSTREAM AND DOWNSTREAM FROM ALCAN LANDFILL PR 2527(02) AND ALCAN DISCHARGES PE 1494(03) AND PE 1494(04). SITES 0400507 AND 0400508, 1978-1981

		UPSTREAM - SITE 0400507				DOWNSTREAM - SITE 0400508				
CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN**	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN**	AQUATIC LIFE CRITERIA
Aluminum, dissolved	mg/L	29	1.00*	<0.01	<0.18*	30	1.00*	0.01	0.20*	0.05-0.1
Calcium, dissolved	mg/L	17	8.60	0.01	3.55	17	5.50	<0.01	3.58	
Chromium, dissolved	mg/L	16	0.020	<0.005	<0.010	16	<0.100	<0.005	<0.015	0.05
Coliforms, fecal	MPN/100 mL	2	17	<2	<5.8	2	5	<2	<3.2	
Coliforms, total	MPN/100 mL	12	79	<2	<6.2	13	79	<2	<10	
Copper, dissolved	mg/L	16	<0.100	<0.010	<0.016	16	0.01*	<0.01	<0.01	0.002
Flow	m³/d	49	130 922	7855	33 897	213	137 730	12 438	40 024	
Flow	m³/s	215	1.5	0.09	0.39	213	1.59	0.14	0.46	
Fluoride, dissolved	mg/L	29	4.8*	<0.1	0.9	70	6.4*	0.1	1.0	1.5
Iron, dissolved	mg/L	20	1.33*	<0.01	<0.16	20	0.81	0.02	0.27	1.0
Lead, dissolved	mg/L	17	<0.05	<0.03	<0.04	17	<0.05	<0.03	<0.04	0.005
Manganese, dissolved	mg/L	17	<0.010	<0.001	<0.006	17	0.06	<0.005	<0.011	0.1
Mercury, dissolved	µg/L	17	0.1*	<0.005	<0.018	17	0.08*	<0.005	<0.018	0.05
Nickel, dissolved	mg/L	17	<0.02	<0.01	<0.01	17	<0.02	<0.01	<0.01	0.025
Oil and Grease	mg/L	28	3.06	<0.20	<0.88	29	5	<0.2	1.2	
pH	pH	227	8.0	5.3*	6.7	225	8.2	3.6*	6.6	6.5-9.0
Solids, dissolved	mg/L	16	94	1	37	16	89.0	16.0	47.6	
Solids, suspended	mg/L	28	16.4	0.1	2.3	28	18.2	<0.4	<2.4	<+10
Temperature	°C	224	25.0	0.0	7.0	223	25.0	0.0	8.5	<15
Titanium, dissolved	mg/L	17	<0.1	<0.1	<0.1	17	<0.1	<0.1	<0.1	0.1
Vanadium, dissolved	mg/L	17	<0.10	<0.01	<0.06	17	0.10	<0.01	0.06	
Zinc, dissolved	mg/L	17	0.052*	<0.001	<0.012	17	0.060*	<0.001	<0.018	0.02

** Except for Coliforms which are geometric means
* Outside aquatic life criterion
Data taken from EQUIS

TABLE 15

SEDIMENT ANALYSES AT SITE 0700128 IN THE CENTER OF MINETTE BAY
JULY 6, 1983

CHARACTERISTIC	Units*	Eckman Dredge Grab Sample	Core Depths in cm				
			0-8	8-16	16-24	24-32	32-40
Aluminum	mg/g	13.6	11.4	12.2	11.5	11.3	12.0
Calcium	mg/g	4.82	4.06	4.47	4.22	4.12	4.45
Cadmium	µg/g	<1	<1	<1	<1	<1	<1
Chromium	mg/g	0.032	0.034	0.035	0.035	0.035	0.037
Copper	mg/g	0.053	0.036	0.034	0.034	0.034	0.035
Fluoride	mg/g	-	0.39	0.41	0.23	0.26	0.43
Iron	mg/g	27	19.4	19.1	19.5	20.0	20.9
Lead	mg/g	0.017	0.032	0.014	0.032	0.019	0.027
Magnesium	mg/g	8.8	8.54	8.49	8.56	8.60	9.2
Manganese	mg/g	0.922	0.302	0.314	0.316	0.309	0.329
Phosphorus, total	mg/g	0.50	0.932	0.954	0.912	0.971	1.090
Zinc	mg/g	0.121	0.054	0.053	0.053	0.055	0.058

*All units expressed on a dry weight basis

PARTICLE SIZE ANALYSIS OF THE ECKMAN DREDGE GRAB SAMPLE.
(THE SAMPLE IS SANDY WITH VERY FEW FINES)

Mesh mm	16 1.19	30 0.59	50 0.297	100 0.149	140 0.105	200 0.074	270 0.053	400 0.037	Less than 0.037
Percent retained	7.4	28.9	37.9	18.3	2.1	3.3	0.9	0.3	0.8
Cumulative % retained	7.4	36.3	74.2	92.5	94.6	97.9	98.8	99.1	100

TABLE 16

FLUORIDE LEVELS IN KITIMAT ARM, 1975-1981

SITE DESCRIPTION	SITE NUMBER	DEPTH m **	# OF SAMPLES	FLUORIDE LEVELS IN mg/L		
				Minimum	Maximum	Mean
150 m from Alcan PE 1494 (01) outfall	0400509	0	54	<0.2	50.6*	<4.5*
	0400510	4	51	0.3	8.6*	1.7*
	0400511	8	53	0.3	8.4*	1.5
800 m from Alcan PE 1494 (01) outfall	0400512	0	55	<0.2	4.0*	<1.2
	0400513	2	52	<0.2	1.7*	<0.8
	0400514	3	53	<0.2	1.2	<0.8

** Maximum depth at these sites is about 9 m, and thus the 8 m sample for site 0400511 is very near the bottom

* These values exceed the 1.5 mg/L fluoride criterion for marine aquatic life

TABLE 17

REFUSE PERMITS IN THE KITIMAT AREA

PERMIT	PERMITTEE AND TYPE OF WASTE
PR-3608	District of Kitimat Municipal Refuse Site. Household and business waste, septic tank pumpage.
PR-1650	Eurocan Pulp and Paper Co. Ltd. Kraft Pulp Mill and Saw Mill Waste. Power boiler ash, green liquor dregs, slaker dregs and wood mill waste.
PR-2527	Alcan Smelter and Chemicals Ltd. Aluminum Smelter Waste. Pot linings, carbon and brick impregnated with fluoride, concrete, wood scrap, road sweepings and domestic waste.

TABLE 18

SUMMARY OF WATER QUALITY DATA FOR BEAVER CREEK UPSTREAM FROM EUROCAN LANDFILL PR-1650 (SITE 0430026)1978-1982

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	AQUATIC LIFE CRITERIA
BOD_5	kg/d	12	63.0	0.9	13.5	
BOD_5	mg/L	16	2.6	0.1	0.9	
Carbon, organic, total	mg/L	1	52	52	52	
Colour, apparent	ACU	16	30	0	17	
Conductance, specific	µS/cm	1	365	365	365	
Flow	m^3/d	12	52 500	400	18 325	
Flow	m^3/s	12	0.60764	0.00463	0.21209	
Nitrogen, ammonia**	mg/L	1	1.59	1.59	1.59	**
Nitrogen, kjeldahl	mg/L	1	3	3	3	
Nitrogen, nitrate	mg/L	1	<0.02	<0.02	<0.02	40.0
Nitrogen, nitrite	mg/L	1	0.006	0.006	0.006	0.02-0.06+
Nitrogen, nitrite/nitrate	mg/L	1	<0.02	<0.02	<0.02	40
Nitrogen, organic, total	mg/L	1	1.41	1.41	1.41	
Oxygen, dissolved	mg/L	16	13.9	8.9	11.6	≥7.8
pH	pH	17	7.7	6.1*	7.0	6.5-9.0
Sodium, total	mg/L	16	4.2	1.0	2.1	
Solids, fixed, dissolved	mg/L	16	19.2	0.3	3.3	
Solids, fixed, total	mg/L	1	218	218	218	
Solids, suspended	mg/L	16	32.2	0.3	4.1	<+10
Solids, dissolved	mg/L	16	550.2	8.6	94.1	
Tannin and lignin	mg/L	1	15	15	15	
Temperature	°C	16	13.0	1.5	6.8	±1
Turbidity	NTU	9	2	0	1	<+5

* Outside of aquatic life criteria
** See Tables 61 and 62
\+ See Table 60
Data taken from EQUIS

TABLE 19

SUMMARY OF WATER QUALITY DATA FOR BEAVER CREEK UPSTREAM FROM EUROCAN LANDFILL PR-1650 (SITE 0430027) AND DOWNSTREAM FROM THE OLD LANDFILL 1978-1982

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	AQUATIC LIFE CRITERIA
BOD_5	kg/d	12	706	5	194	
BOD_5	mg/L	17	32.3	0.1	7.4	
Colour, apparent	ACU	16	362	16	76	
Colour, TAC	TAC	1	34	34	34	
Conductivity, specific	uS/cm	1	146	146	146	
Flow	m^3/d	12	53 500	2200	23 825	
Flow	m^3/s	12	0.61921	0.02546	0.2755	
Nitrogen, kjeldahl	mg/L	1	0.25	0.25	0.25	
Nitrogen, nitrite/nitrate	mg/L	1	0.07	0.07	0.07	40/200+
Nitrogen, total	mg/L	1	0.32	0.32	0.32	
Oxygen, dissolved	mg/L	17	12.7	8.2	10.6	≥7.8
pH	pH	18	7.3	6.1*	6.9	6.5-9.0
Sodium, total	mg/L	16	29.0	4.3	13.0	
Solids, fixed, dissolved	mg/L	16	312.0	0.1	32.7	
Solids, suspended	mg/L	17	597.2*	0.1	53.4*	<+10
Solids, dissolved	mg/L	17	184.4	10.2	109.6	
Tannin and lignin	mg/L	1	1.6	1.6	1.6	
Temperature	°C	17	16.5	1.8	8.0	±1
Turbidity	NTU	8	56*	2	20*	<+5

*Outside aquatic life criterion
Data taken from EQUIS
+30-day and maximum respectively

TABLE 20

SUMMARY OF WATER QUALITY DATA FOR A BEAVER CREEK TRIBUTARY DOWNSTREAM FROM EUROCAN LANDFILL PR-1650 (SITE 0430030, 1978-1982)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	AQUATIC LIFE CRITERIA
BOD_5	kg/d	10	302	0	80	
BOD_5	mg/L	16	255	11	94	
Colour, apparent	ACU	16	807	85	310	
Flow	m^3/d	12	3600	0	1133	
Flow	m^3/s	12	0.04167	0	0.01311	
Oxygen, dissolved	mg/L	16	9.1	0.5*	3.3*	≥7.8
pH	pH	16	7.5	6.1*	7.0	6.5-9.0
Sodium, total	mg/L	16	464	33	134	
Solids, fixed, dissolved	mg/L	16	68	5	33	
Solids, suspended	mg/L	16	136	5	44	<+10
Solids, dissolved	mg/L	16	3196.4	148.2	1085	
Temperature	°C	16	19.0	1.0	10.6	±1
Turbidity	NTU	8	56	6	24	<+5

*Outside of aquatic life criterion
Data taken from EQUIS

TABLE 21

SUMMARY OF WATER QUALITY DATA FOR SYME CREEK DOWNSTREAM FROM EUROCAN LANDFILL PR-1650 (SITE 0430028, 1978-1982)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	AQUATIC LIFE CRITERIA
BOD_5	mg/L	17	370	9	59	
BOD_5	kg/d	12	376	8	143	
Colour, apparent	ACU	16	1190	68	373	
Colour, TAC	TAC	1	208	208	208	
Conductivity, specific	uS/cm	1	392	392	392	
Flow	m^3/d	12	9500	900	4436	
Flow	m^3/s	12	0.10995	0.01042	0.05134	
Nitrogen, kjeldahl	mg/L	1	0.5	0.5	0.5	
Nitrogen, nitrite/nitrate	mg/L	1	0.04	0.04	0.04	40/200+
Nitrogen, total	mg/L	1	0.54	0.54	0.54	
Oxygen, dissolved	mg/L	16	8.5	0.7*	4.3*	≥7.8
pH	pH	17	7.4	6.1*	6.9	6.5-9.0
Sodium, total	mg/L	16	75	22	40	
Solids, fixed, dissolved	mg/L	15	133	8	38	
Solids, suspended	mg/L	16	133	13	42	<+10
Solids, dissolved	mg/L	16	457.4	18	276.3	
Tannin and lignin	mg/L	1	1.5	1.5	1.5	
Temperature	°C	16	17.0	4.0	10.9	±1
Turbidity	NTU	8	23	10	15	<+5

*Outside of aquatic life criterion
Data taken from EQUIS
+30-day and maximum respectively

TABLE 22

SUMMARY OF WATER QUALITY DATA FROM BEAVER CREEK DOWNSTREAM FROM EUROCAN LANDFILL PR-1650 (SITE 0430029, 1978-1982)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	AQUATIC LIFE CRITERIA
BOD_5	kg/d	12	1 175	20	411	
BOD_5	mg/L	17	67	4	19	
Colour, apparent	ACU	16	248	40	113	
Colour, TAC	TAC	1	44	44	44	
Conductivity, specific	µS/cm	1	174	174	174	
Flow	m^3/d	12	64 200	3100	28 403	
Flow	m^3/s	12	0.74306	0.03588	0.32874	
Nitrogen, kjeldahl	mg/L	1	0.31	0.31	0.31	
Nitrogen, nitrite/nitrate	mg/L	1	0.04	0.04	0.04	40/200+
Nitrogen, total	mg/L	1	0.35	0.35	0.35	
Oxygen, dissolved	mg/L	17	11.8	6.3*	9.0	≥7.8
pH	pH	18	7.3	6.3*	7.0	6.5-9.0
Sodium, total	mg/L	16	39	2	21	
Solids, fixed, dissolved	mg/L	16	54	1	16	
Solids, suspended	mg/L	17	70*	1	19*	<+10
Solids, dissolved	mg/L	17	298.1	23.5	180.0	
Tannin and lignin	mg/L	1	2.8	2.8	2.8	
Temperature	°C	17	16.5	0.8	8.5	±1
Turbidity	NTU	8	34*	4	15*	<+5

*Outside of aquatic life criterion
+30-day and maximum respectively

TABLE 23

FLOW RATES IN m^3/d FOR WATER QUALITY SITES 0430026-30
SUBJECT TO LEACHATE FROM EUROCAN LANDFILL PR 1650

SITE	SAMPLING DATES								
	1980			1981				1982	
	April 8	July 16	Nov. 12	Feb. 17	May 20	Sept. 9	Nov. 25	May 5	July 14
0430026	18 300	400	52 500	27 600	15 600	13 000	9 400	43 500	11 600
0430027	28 200	2 200	53 500	28 800	16 400	21 400	22 800	43 600	11 500
0430030	1 300	0	3 500	3 600	350	0	1 200	500	800
0430028	3 900	900	7 200	7 900	1 800	9 500	6 700	6 100	3 400
Subtotal	33 400	3 100	64 200	40 300	18 600	30 900	30 700	50 200	15 700
0430029	33 400	3 100	64 200	40 200	18 800	31 000	30 600	50 200	15 700

TABLE 24

LOADINGS IN kg/d, FOR SELECTED CHARACTERISTICS AT SITES 0430026-30
SUBJECT TO LEACHATE FROM PR 1650

SITE	MEAN LOADINGS IN kg/d				
	BOD_5	Sodium Total	Oxygen Dissolved	Solids	
				Suspended	Dissolved
0430026	17	39	210	75	1700
0430027	180	310	250	1300	2600
0430030	110	150	3.7	50	1200
0430028	260	180	19	190	1200
Subtotal	550	640	270	1500	5000
0430029	540	600	260	540	5100

TABLE 25

SUMMARY OF POTLINING LANDFILL, PR-2527 (01) LEACHATE MONITORING RESULTS, 1980-1981 (SITE 0700058)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN
Cyanide, total	mg/L	86	144.0	0.2	12.1
Flow	m^3/d	88	1954.8	63.6	331.5
Flow	m^3/s	88	0.02263	0.00074	0.00384
Fluoride, dissolved	mg/L	85	1500	12	523

CHARACTERISTICS	UNITS	# OF SAMPLES	MEAN LOADING IN kg/d	MAXIMUM LOADING IN kg/d	% OF MEAN LOAD FROM PE 1494(01)
Cyanide, total	mg/L	86	3.38	32.6	41
Flow	m^3/d	88	-	-	-
Flow	m^3/s	88	-	-	-
Fluoride, dissolved	mg/L	85	146	982	11

Data from EQUIS

TABLE 26

SUMMARY OF WATER QUALITY DATA FOR THE KITIMAT RIVER UPSTREAM FROM THE WASTE DISCHARGES, 1976-1984 (SITE 0430025)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	DRINKING WATER CRITERIA	RECREATION CRITERIA	AQUATIC LIFE CRITERIA
Alkalinity, total	mg/L	11	15.8*	9.2*	12.8*			20-130
Arsenic, total	mg/L	13	0.029	<0.001	<0.004	0.05	0.05	0.05
Arsenic, dissolved	mg/L	5	<0.001	<0.001	<0.001	0.05	0.05	0.05
Aluminum, total	mg/L	11	4.43*	<0.02	<0.94*		0.1	0.05-0.1
Aluminum, dissolved	mg/L	5	0.24*	<0.02	<0.11*		0.1	0.05-0.1
Cadmium, total	mg/L	13	<0.0005	<0.0005	<0.0005		0.01	0.0002
Cadmium, dissolved	mg/L	5	<0.0005	<0.0005	<0.0005		0.01	0.0002
Calcium, Total	mg/L	12	6.89	3.20	4.78			
Carbon, inorganic	mg/L	12	5	2	3.5			
Carbon, organic	mg/L	12	8	<1	3			
Chloride, dissolved	mg/L	11	2.0	<0.5	1.0	250.0		
Chromium, total	mg/L	13	<0.01	<0.01	<0.01	0.05	0.1	0.02-0.04
Chromium, dissolved	mg/L	5	<0.01	<0.01	<0.01	0.05	0.1	0.02-0.04
Cobalt, total	mg/L	13	0.12*	<0.1	<0.1			0.05
Conductivity, specific	μS/cm	22	58	19	35			
Copper, total	mg/L	13	0.009*	<0.001	<0.003*	0.5-1.0	0.5	0.002
Copper, dissolved	mg/L	5	<0.001	<0.001	<0.001	0.5-1.0	0.5	0.002
Fluoride, dissolved	mg/L	1	<0.1	<0.1	<0.1	1.0-1.5		1.0
Hardness, total ($CaCO_3$)	mg/L	9	19.9*	10.7*	14.5*	80-100		
Iron, total	mg/L	13	5.28*	0.26	1.15*	0.3		0.3-1.0
Iron, dissolved	mg/L	5	0.25	0.14	0.19	0.3		0.3-1.0
Lead, total	mg/L	13	0.021*	<0.001	<0.003	0.05	0.05	0.005
Lead, dissolved	mg/L	5	<0.001	<0.001	<0.001	0.05	0.05	0.005
Magnesium, total	mg/l	12	1.87	0.49	0.82	100-500		
Manganese, total	mg/L	13	0.14*	0.01	0.03	0.05		0.1-1.0
Manganese, dissolved	mg/L	5	0.03	0.01	0.02	0.05		0.1-1.0
Molybdenum, total	mg/L	13	<0.01	<0.01	<0.01	0.25		0.5-3.0
Molybdenum, dissolved	mg/L	5	<0.01	<0.01	<0.01	0.25		0.5-3.0
Nickel, total	mg/L	13	<0.05	<0.05	<0.05	0.2	0.2	0.025
Nickel, dissolved	mg/L	5	<0.05	<0.05	<0.05	0.2	0.2	0.025

TABLE 26 (Continued)

SUMMARY OF WATER QUALITY DATA FOR THE KITIMAT RIVER UPSTREAM FROM THE WASTE DISCHARGES, 1976-1984 (SITE 0430025)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	DRINKING WATER CRITERIA	RECREATION CRITERIA	AQUATIC LIFE CRITERIA
Nitrogen, ammonia (total)	mg/L	11	0.010	<0.005	0.006	0.5		**
Nitrogen, Kjeldahl	mg/L	11	0.37	0.03	0.11			
Nitrogen, nitrite/nitrate	mg/L	11	0.11	0.02	0.07	10.0		40.0-200+
Nitrogen, total	mg/L	11	0.44	0.09	0.18			
Oxygen, dissolved	mg/L	11	13.9	10.9	11.8			≥7.8
pH	pH	22	7.8	6.6	7.0	6.5-8.5	5.0-9.0	6.5-9.0
Phosphorus, diss., ortho	mg/L	6	<0.003	<0.003	<0.003			
Phosphorus, diss., total	mg/L	11	0.014	<0.003	0.006			
Phosphorus, total	mg/L	19	2.4*	0.0	0.28*	0.1		
Potassium, dissolved	mg/L	11	0.6	0.3	0.4			
Silica, reactive	mg/L	11	6.2	2.8	4.2			
Sodium, dissolved	mg/L	22	2.4	0.5	1.3	20-270		
Solids, dissolved	mg/L	11	321	3	48	500		
Solids, suspended	mg/L	11	44	17	30			<+10
Sulphate, dissolved	mg/L	11	4.9	1.5	3.3	150-500		
Temperature	°C	14	12.3	0.0	6.2	≤15	>15-<35	±1, <24
Turbidity	NTU	13	44	2.1	9.0	<+5.0	<+5.0	<+5.0
Vanadium, total	mg/L	13	<0.01	<0.01	<0.01	0.1		
Vanadium, dissolved	mg/L	5	<0.01	<0.01	<0.01	0.1		
Zinc, total	mg/L	13	0.02	<0.005	<0.007	5.	5	0.05
Zinc, dissolved	mg/L	5	0.02	<0.005	<0.008	5.	5	0.05

* Outside of criteria
** See Tables 61 and 62
+ 30-day and maximum respectively

TABLE 27

SUMMARY OF WATER QUALITY DATA FOR THE KITIMAT RIVER UPSTREAM FROM THE WASTE DISCHARGES, 1976-1982 (SITE 0430017)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	DRINKING WATER CRITERIA	RECREATION CRITERIA	AQUATIC LIFE CRITERIA
Colour, apparent	ACU	11	42*	8	20.5*	15 (True)	15-100 (true)	
Conductivity, specific	uS/cm	12	55	21	37.5			
Nitrogen, kjeldahl	mg/L	12	0.19	0.0	0.16			
Oxygen, dissolved	mg/L	12	13.9	10.9	11.9		>2.0	≥7.8
pH	pH	12	7.7	6.6	7.2	6.5-8.5	5.0-9.0	6.5-9.0
Phosphorus, total	mg/L	10	2.1*	0.0	0.45*	0.1		
Sodium, total	mg/L	12	3.0	0.2	1.4	20-270		
Temperature	°C	12	12.4	2.0	7.5	<15	>15-<35	±1
Turbidity, total	NTU	5	9.0	2.2	5.1*	<+5	<+5	<+5

Data from EQUIS
* Outside of criteria

TABLE 28

SUMMARY OF WATER QUALITY MONITORING RESULTS FOR SITES 0430003 AND 0430004 COMBINED, LOCATED ON THE KITIMAT RIVER UPSTREAM FROM THE MAJOR DISCHARGES BETWEEN SITES 0430025 AND 0430017, 1974 DATA

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	DRINKING WATER CRITERIA	RECREATION CRITERIA	AQUATIC LIFE CRITERIA
Alkalinity, total	mg/l	6	11.0*	10.0*	10.3*			20-130
Arsenic, dissolved	mg/l	1	<0.005	<0.005	<0.005	0.05	0.05	0.05
BOD_5	mg/l	1	<10	<10	<10			
Calcium, dissolved	mg/l	3	3.2	2.9	3.0			
Carbon, organic, total	mg/l	1	3	3	3			
Chloride, dissolved	mg/l	1	0.6	0.6	0.6	250		
Colour, TAC	TAC	1	8	8	8			
Colour, True	TCU	1	15	15	15	15	15-100	
Conductivity, specific	uS/cm	6	25	23	23.8			
Fluoride, dissolved	mg/l	6	<0.1	<0.1	<0.1	1.0-1.5		1.0
Hardness, dissolved	mg/l	3	10.2*	9.4*	9.9*	80-100		
Magnesium, dissolved	mg/l	1	0.35	0.35	0.35	100-500		
Magnesium, total	mg/l	2	<1	<1	<1	100-500		
Nitrogen, ammonia (total)	mg/l	1	<0.005	<0.005	<0.005	0.5		**
Nitrogen, kjeldahl	mg/l	1	<0.01	<0.01	<0.01			
Nitrogen, nitrate, dissolved	mg/l	1	0.07	0.07	0.07	10.0		40.0
Nitrogen, nitrite, dissolved	mg/l	1	<0.005	<0.005	<0.005	1.0		0.02-0.06
Nitrogen, total	mg/l	1	0.07	0.07	0.07			
pH	pH	6	7.2	6.4*	6.9	6.5-8.5	5.0-9.0	6.5-9.0
Phosphorus, ortho, dissolved	mg/l	1	<0.003	<0.003	<0.003			
Phosphorus, total	mg/l	1	0.018	0.018	0.018	0.1		
Potassium, dissolved	mg/l	1	0.3	0.3	0.3			
Silica, dissolved	mg/l	1	2.8	2.8	2.8			
Sodium, dissolved	mg/l	1	0.7	0.7	0.7	20-270		
Solids, suspended	mg/l	6	13.0	2.0	5.0			+10 or +10%
Solids, dissolved	mg/l	6	17.0	14.0	15.7	500		
Sulphate, dissolved	mg/l	1	<5	<5	<5	150-500		
Tannin and lignin	mg/l	1	0.2	0.2	0.2	0.4		
Turbidity	NTU	6	6.3	1.5	2.8	<+5	<+5	<+5

Data from EQUIS
* Outside of criteria.
** See Tables 61 and 62

TABLE 29

SUMMARY OF WATER QUALITY DATA FOR KITIMAT RIVER,
30 m DOWNSTREAM FROM THE EUROCAN PULP AND PAPER MILL DISCHARGE, 1976-1982, (SITE 0430018)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	RECREATION CRITERIA	AQUATIC LIFE CRITERIA
Colour, apparent	ACU	11	59*	8	24.5*	15-100 (true)	
Conductivity, specific	uS/cm	12	60	20	38.7		
Nitrogen, kjeldahl	mg/L	12	0.0	0.0	0.0		
Oxygen, dissolved	mg/L	12	13.9	11.0	11.9	>2.0	≥7.8
pH	pH	12	7.9	6.8	7.4	5.0-9.0	6.0-9.0
Phosphorus, total	mg/L	10	2.3	0.0	0.5		
Sodium, total	mg/L	12	2.3	0.4	1.4		
Solids, total	mg/L	11	142	18.3	70.7		
Temperature	°C	12	12.5	2.0	7.5	15-35	±1
Turbidity	NTU	5	8.9	2.2	5.3	<+5	<+5

Data from EQUIS
* Outside of criteria

TABLE 30

MAXIMUM POTENTIAL CONCENTRATION INCREASES IN THE KITIMAT RIVER DUE TO DISTRICT OF KITIMAT TREATED SEWAGE EFFLUENT (PE 256)

CHARACTERISTICS	MAXIMUM EFFLUENT LOADINGS CALCULATED FROM PE 256			MAXIMUM POTENTIAL CONCENTRATION INCREASE IN THE KITIMAT RIVER CALCULATED FROM PE 256			ACTUAL CONCENTRATIONS AT SITE 0430018 (first downstream site) At Present**	ACTUAL CONCENTRATIONS AT SITE 0430025 (upstream control) At Present**
	Units	Present*	Future	Units	Present	Future		
Coliforms , fecal	MPN/d	3.6×10^{11}	4.8×10^{11}	MPN/100 mL	549	1187	N.D.	N.D.
Conductivity, specific	-	-	-	µS/cm	9.9	21.4	38.7	35.0
Nitrogen , ammonia	kg/d	7.3	9.6	mg/L	0.01	0.02	N.D.	0.006
Nitrogen , kjeldahl	kg/d	107	141	mg/L	0.16	0.35	0.0	0.11
Nitrogen , NO_2/NO_3	kg/d	2	3	mg/L	0.003	0.007	N.D.	0.07
Nitrogen , organic	kg/d	30	40	mg/L	0.05	0.09	N.D.	N.D.
Nitrogen , total	kg/d	110	145	mg/L	0.16	0.36	N.D.	0.18
Phosphorus , dissolved	kg/d	12	16	mg/L	0.02	0.04	N.D.	0.006
Phosphorus , total	kg/d	26	34	mg/L	0.04	0.08	0.5	0.28
Solids , suspended	kg/d	434	573	mg/L	0.6	1.7	N.D.	30.0
Turbidity	-	-	-	NTU	0.3	0.7	5.3	9.0

N.D. No data, not measured
* maximum loading values used
Data base used includes November through April records between 1973 and 1981
A river flow of 7.6 m^3/s was used for present dilution; 4.7 m^3/s for future dilution; mean flows from the sewage treatment plant were used.
The population increase assumed is 32% by 1993 (from 13 546 to 17 942), and present effluent loadings were multiplied by 1.32 to estimate future loadings. Future flows were also multiplied by 1.32.
Complete mixing of the effluent and river water is assumed to occur by 0430018
Conductivity and turbidity were calculated by dividing the maximum value in the effluent (Table 5) by the ratio of river flow over mean sewage treatment plant flow (Table 5).
** means

TABLE 31

SUMMARY OF WATER QUALITY DATA FOR THE KITIMAT RIVER, 60 m DOWNSTREAM FROM THE EUROCAN PULP AND PAPER MILL DISCHARGE, 1976-1982, (SITE 0430019)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	AQUATIC LIFE CRITERIA	RECREATION CRITERIA
Colour, apparent	ACU	11	400*	26*	137.8*	15-100 (true)	
Conductivity, specific	uS/cm	12	1060	54	255.4		
Nitrogen, kjeldahl	mg/L	11	0.1	0.0	0.02		
Oxygen, dissolved	mg/L	12	13.6	9.5	11.2	≥7.8	>2.0
pH	pH	12	7.7	6.9	7.3	6.5-9.0	5.0-9.0
Phosphorus, total	mg/L	10	2.8	0.0	0.74		
Sodium, total	mg/L	12	168	1.6	56.2		
Solids, total	mg/L	11	858.8	25.0	229.9		
Temperature	°C	12	20.0	2.0	11.4	±1	>15-<30
Turbidity	NTU	5	9.4	5.4	7.3	<+5	<+5

Data from EQUIS
* Outside criteria

TABLE 32

SUMMARY OF WATER QUALITY DATA FOR THE KITIMAT RIVER, 400 m DOWNSTREAM FROM THE EUROCAN PULP AND PAPER MILL DISCHARGE, 1976-1982, (SITE 0430020)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	AQUATIC LIFE CRITERIA	RECREATION CRITERIA
Colour, apparent	ACU	31	449*	10	64.0*		15-100 (true
Conductivity, specific	uS/cm	34	160	18	51.5		
Nitrogen, kjeldahl	mg/L	24	0.1	0.0	0.01		
Oxygen, dissolved	mg/L	34	13.8	10.6	11.8	≥7.8	>2.0
pH	pH	34	7.8	6.9	7.3	6.5-9.0	5.0-9.0
Phosphorus, total	mg/L	21	2.5	0.0	0.3		0.1
Sodium, total	mg/L	34	18.0	0.8	3.9		
Solids, total	mg/L	25	549.5	25.5	93.8		
Temperature	°C	34	13.0	2.0	7.7	±1	>15-<30
Turbidity	NTU	15	9.8	2.6	6.2	<+5	<+5

Data from EQUIS
* Outside criteria

TABLE 33

SUMMARY OF WATER QUALITY DATA FOR THE KITIMAT RIVER, 1000 m DOWNSTREAM FROM THE EUROCAN PULP AND PAPER MILL DISCHARGE, 1976-1982, (SITE 0430021)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	AQUATIC LIFE CRITERIA	RECREATION CRITERIA
Colour, apparent	ACU	31	90*	8	42.4*		15-100 (true)
Conductivity, specific	uS/cm	34	69	19	47.0		
Nitrogen, kjeldahl	mg/L	25	0.1	0.0	0.01		
Oxygen, dissolved	mg/L	34	13.9	10.5	11.8	≥7.8	>2.0
pH	pH	34	7.8	6.8	7.2	6.5-9.0	5.0-9.0
Phosphorus, total	mg/L	19	2.0	0.0	0.24		
Sodium, total	mg/L	34	8.2	1.2	3.4		
Solids, total	mg/L	25	161	1	53.4		
Temperature	°C	34	13.4	2.0	7.8	±1	>15-<30
Turbidity	NTU	15	10.1	2.8	6.2	<+5	<+5

Data from EQUIS
* Outside criteria

TABLE 34

SUMMARY OF WATER QUALITY DATA FOR THE KITIMAT RIVER, ~1500 m DOWNSTREAM FROM THE EUROCAN PULP AND PAPER MILL DISCHARGE, 1976-1982, (SITE 0430022)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	AQUATIC LIFE CRITERIA	RECREATION CRITERIA
Colour, apparent	ACU	34	86*	16*	42.1*		15-100 (true)
Conductivity, specific	uS/cm	34	66	18	47.8		
Nitrogen, kjeldahl	mg/L	25	0	0	0		
Oxygen, dissolved	mg/L	35	13.9	10.5	11.8	≥7.8	>2.0
pH	pH	34	7.8	6.9	7.2	6.5-9.0	5.0-9.0
Phosphorus, total	mg/L	20	2.3*	0.0	0.34		
Sodium, total	mg/L	35	7.9	1.7	3.5		
Solids, total	mg/L	29	234	1	61.6		
Temperature	°C	34	12.9	2.0	7.9	±1	>15-<30
Turbidity	NTU	15	9.9	2.4	6.3	<+5	<+5

Data from EQUIS
* Outside or criteria

TABLE 35

SUMMARY OF WATER QUALITY DATA FOR THE KITIMAT RIVER, ~2000 m DOWNSTREAM FROM THE EUROCAN PULP AND PAPER MILL DISCHARGE, 1976-1982, (SITE 0430023)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	AQUATIC LIFE CRITERIA	RECREATION CRITERIA
Colour, apparent	ACU	31	85*	8	36.5*		15-100 (true)
Conductivity, specific	uS/cm	34	75	16	48.1		
Nitrogen, kjeldahl	mg/L	25	0	0	0		
Oxygen, dissolved	mg/L	35	13.9	10.4	11.7	≥7.8	>2.0
pH	pH	34	7.7	6.6	7.2	6.5-9.0	5.0-9.0
Phosphorus, total	mg/L	19	1.9	0.0	0.21		
Sodium, total	mg/L	34	7.7	1.8	3.6		
Solids, total	mg/L	25	218	28	70.9		
Temperature	°C	35	13.3	2.0	8.0	±1	>15-<30
Turbidity	NTU	15	10.6	2.4	6.3	<+5	<+5

Data from EQUIS
* Outside criteria

TABLE 36

SUMMARY OF WATER QUALITY DATA FOR THE KITIMAT RIVER, ~3000 m DOWNSTREAM FROM THE EUROCAN PULP AND PAPER MILL DISCHARGE, 1976-1982, (SITE 0430024)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	AQUATIC LIFE CRITERIA	RECREATION CRITERIA
Colour, apparent	ACU	10	78*	8	37*		15-100 (true)
Conductivity, specific	uS/cm	11	160	19	62.5		
Nitrogen, kjeldahl	mg/L	10	0	0	0		
Oxygen, dissolved	mg/L	11	13.9	10.3	11.7	≥7.8	>2.0
pH	pH	11	7.5	6.8	7.1	6.5-9.0	5.0-9.0
Phosphorus, total	mg/L	7	2.6	0.0	0.39		
Sodium, total	mg/L	11	9.1	1.6	4.4		
Solids, total	mg/L	10	395	6	103.7		
Temperature	°C	11	12.8	2.0	7.6	±1	>15-<30
Turbidity	NTU	5	10.2	2.8	6.3	<+5	<+5

Data from EQUIS
* Outside or criteria

TABLE 37

DILUTION RATIOS FOR THE EUROCAN PULP MILL EFFLUENT IN THE KITIMAT RIVER AT LOW FLOWS

KITIMAT RIVER LOW FLOW* m^3/s	EUROCAN EFFLUENT FLOW m^3/s	MINIMUM DILUTION RATIOS (COMPLETE MIXING)
Present 7.8	Maximum 1.4	6:1
	Mean 0.8	10:1
Future 5.1	Maximum 1.4	4:1
	Mean 0.8	6:1

*7-day average low flow with a 10-year return period, above the Eurocan effluent discharge point

TABLE 38

MAXIMUM POTENTIAL CONCENTRATION INCREASE OF SELECTED CONTAMINANTS IN THE KITIMAT RIVER AT MINIMUM DILUTION RATIOS. CALCULATED FROM MAXIMUM EUROCAN PULP AND PAPER (PE 292) EFFLUENT CONCENTRATIONS

CHARACTERISTICS	UNITS	DILUTION RATIO**			CRITERIA	
		6:1	10:1	4:1	AQUATIC LIFE	RECREATION
BOD_5	mg/L	41.8	25.1	62.8		
Colour, true	TCU	330*	200*	500*		15-100
Mercaptan	mg/L	0.58	0.35	0.88		
Resin acids	mg/L	3.0	1.8	4.5		
Solids, suspended	mg/L	31.7*	19.0*	47.5*	+10	
Sulphate, dissolved	mg/L	55.0	33.0	82.5		
Sulphide, total	mg/L	0.42	0.25	0.63	≤0.002***	
Tannin and lignin	mg/L	29.3	17.6	44.0		
Temperature	°C	5.5*	3.3*	8.3*	±1	15-35

***The aquatic life criterion for sulphide refers only to the free H_2S portion

** Assumes complete mixing

* Outside of criteria

TABLE 39

MAXIMUM POTENTIAL CONCENTRATION INCREASE OF SELECTED CONTAMINANTS IN THE KITIMAT RIVER RESULTING FROM MAXIMUM EUROCAN PULP AND PAPER (PE 292) EFFLUENT LOADINGS AT MINIMUM RIVER FLOWS BELOW THE PULP MILL EFFLUENT DISCHARGE (LOADING CALCULATED FROM PAIRED EFFLUENT FLOW AND CONCENTRATION DATA)

CHARACTERISTICS	UNITS	MINIMUM RIVER FLOWS m^3/s		CRITERIA	
		Present 9.1**	Future 8.2**	Aquatic Life	Recreation
BOD_5	mg/L	21.49	24.09		
Mercaptan	mg/L	0.13	0.15		
Resin acids	mg/L	1.73	1.94		
Solids, suspended	mg/L	18.70*	20.95*	+10	
Sulphate, dissolved	mg/L	30.4	34.1		
Sulphide, total	mg/L	0.25	0.28	≤0.002***	
Tannin and lignin	mg/L	15.2	17.0		

***The aquatic life criterion for sulphide refers only to the free H_2S portion
** Complete mixing is assumed
* Outside of criteria

TABLE 40

MEAN LOADINGS IN kg/d OF DISSOLVED ALUMINUM, DISSOLVED FLUORIDE, DISSOLVED IRON AND TOTAL CYANIDE TO KITIMAT ARM AND MOORE CREEK FROM THE ALCAN ALUMINUM SMELTER AND THE OCELOT METHANOL PLANT

CHARACTERISTICS	PE-1494 (01) (directly to Kitimat Arm) Alcan	PE-1494 (02) (directly to Kitimat Arm) Alcan	TOTAL LOAD (directly to) Kitimat Arm) Alcan	PE 6006 (directly to Kitimat Arm) Ocelot	TOTAL LOAD (directly to Kitimat Arm) Ocelot & Alcan
Aluminum	93.6	0.35	93.95	0.6	94.55
Fluoride	1390.0	5.19	1395.19	-	1395.19
Iron	20.7	0.32	21.02	1.76	22.78
Cyanide	8.26	0.23	8.49	<0.08	<8.57

CHARACTERISTICS	PE 1494(03) (to Moore Creek) Alcan	DIFFUSE INPUT* (To Moore Creek) Alcan	TOTAL LOAD (to Moore Creek) Alcan	TOTAL LOAD (from Alcan and Ocelot) to Kitimat Arm
Aluminum	4.90	21.02	25.92	119.87
Fluoride	13.5	23.21	36.71	1431.90
Iron	2.2	10.75	12.95	33.97
Cyanide	-	-	-	8.49

Data from EQUIS

*Diffuse input is calculated from 0400508 by subtracting known PE 1494(03) contributions

TABLE 41

PARTICLE SIZE ANALYSES OF SEDIMENT SAMPLES 1-30 TAKEN IN KITIMAT HARBOUR, 1976.

% RETAINED ON EACH SCREEN

	mesh	16	30	50	100	140	200	270	400	<400
	mm	1.19	0.59	0.297	0.149	0.105	0.074	0.053	0.037	<0.037
Site	1	6.9	15.0	33.0	22.5	2.6	8.2	3.1	3.3	5.4
	2	4.7	18.3	51.1	24.5	0.7	0.6	<0.1	<0.1	<0.1
	3	5.9	14.9	21.7	31.1	5.5	9.8	2.5	3.1	5.5
	4	8.6	14.5	12.2	10.3	3.2	13.1	7.6	7.2	23.3
	5	3.8	5.7	16.2	23.3	5.6	31.2	9.1	3.4	1.7
	6	14.6	49.2	32.9	3.0	<0.1	0.2	<0.1	<0.1	<0.1
	7	2.8	21.2	58.3	15.5	0.7	1.0	0.3	0.2	<0.1
	8	10.4	18.8	21.2	29.4	7.9	9.2	1.2	0.8	1.1
	9	2.6	14.0	46.8	25.9	2.6	4.0	1.2	1.3	1.6
	10	14.9	46.5	33.6	4.8	<0.1	<0.1	<0.1	<0.1	<0.1
	11	1.3	11.8	45.4	35.5	3.3	2.4	0.2	<0.1	<0.1
	12	12.7	28.1	42.8	14.9	0.7	0.6	0.1	<0.1	<0.1
	13	1.0	10.7	67.2	19.6	0.6	0.5	<0.1	0.1	0.2
	14	<0.1	0.4	14.6	63.2	8.2	9.3	1.5	1.6	1.1
	15	MISSING DATA								
	16	26.4	37.6	26.9	7.3	0.6	1.0	0.1	<0.1	<0.1
	17	22.7	46.1	20.1	4.8	1.7	3.9	0.4	0.2	<0.1
	18	4.1	18.8	55.1	20.1	0.9	0.9	<0.1	<0.1	<0.1
	19	29.1	39.9	22.2	6.3	0.5	1.0	0.2	0.4	0.4
	20	17.4	37.8	27.7	10.7	1.6	2.7	0.5	0.7	0.9
	21	1.4	7.7	8.9	9.5	4.3	21.9	12.1	11.5	22.7
	22	<0.1	2.9	37.9	32.1	5.2	11.3	2.8	3.1	4.6
	23	4.2	13.2	21.2	21.9	3.0	7.0	4.4	6.9	18.2
	24	<0.1	0.3	1.5	18.2	13.4	36.4	11.2	8.6	10.3
	25	9.2	18.5	34.9	27.3	3.0	4.1	0.9	1.0	1.1
	26	4.9	16.7	38.2	23.9	3.8	7.0	1.8	1.4	2.3
	27	<0.1	0.8	2.9	25.9	12.9	37.2	10.0	3.0	7.2
	28	0.1	0.4	7.2	24.6	11.8	42.2	6.2	3.8	3.7
	29	0.6	4.5	11.9	15.7	5.2	16.8	12.9	11.0	21.4
	30	7.9	27.9	44.8	11.6	1.2	2.2	1.0	1.1	2.3

TABLE 41 (Continued)

PARTICLE SIZE ANALYSES OF SEDIMENT SAMPLES 1-30 TAKEN IN KITIMAT HARBOUR, 1976.

CUMULATIVE % RETAINED ON EACH SCREEN SIZE

	mesh	16	30	50	100	140	200	270	400	<400
	mm	1.19	0.59	0.297	0.149	0.105	0.074	0.053	0.037	<0.037
Site	1	6.9	21.9	54.9	77.4	80.0	88.2	91.3	94.6	100.0
	2	4.7	23,9	74.1	98.6	99.3	99.9	100.0	100.0	100.0
	3	5.9	20.8	42.5	73.6	79.1	88.9	91.4	94.5	100.0
	4	8.6	23.1	35.3	45.6	48.8	61.9	69.5	76.7	100.0
	5	3.8	9.5	25.7	49.0	54.6	85.8	94.9	98.3	100.0
	6	14.6	63.8	96.7	99.7	97.8	100.0	100.0	100.0	100.0
	7	2.8	24.0	82.3	97.8	98.5	99.5	94.8	100.0	100.0
	8	10.4	29.2	50.4	79.8	87.7	96.9	98.1	98.9	100.0
	9	2.6	16.6	63.4	89.3	91.9	95.9	97.1	98.4	100.0
	10	14.9	61.4	95.0	99.8	99.9	100.0	100.0	100.0	100.0
	11	1.3	13.1	58.5	94.0	97.3	99.7	99.9	100.0	100.0
	12	12.7	40.8	83.6	98.5	99.2	99.8	94.9	100.0	100.0
	13	1.0	11.7	78.9	98.5	99.1	99.6	99.7	99.8	100.0
	14	<0.1	0.5	15.1	78.3	86.5	95.8	97.3	98.9	100.0
	15	MISSING DATA								
	16	26.4	64.0	90.9	98.2	98.3	99.8	99.9	100.0	100.0
	17	22.7	68.8	88.9	93.7	85.4	99.3	99.7	99.9	100.0
	18	4.1	22.9	78.0	98.1	99.0	99.9	100.0	100.0	100.0
	19	29.1	69.0	91.2	97.5	98.0	99.0	99.2	99.6	100.0
	20	17.4	55.2	82.9	93.6	95.2	97.9	98.4	99.1	100.0
	21	1.4	9.1	18.0	27.5	31.8	53.7	65.8	77.3	100.0
	22	<0.1	3.0	40.9	73.0	78.2	89.5	92.3	95.4	100.0
	23	4.2	17.3	38.6	60.5	63.5	70.5	74.9	81.8	100.0
	24	<0.1	0.4	1.9	20.1	33.5	69.9	81.1	89.7	100.0
	25	9.2	27.7	62.6	89.9	92.9	97.0	97.9	98.9	100.0
	26	4.9	21.6	59.8	83.7	87.5	94.5	96.3	97.7	100.0
	27	<0.1	0.9	3.8	29.7	42.6	79.8	89.8	92.8	100.0
	28	0.1	6.5	7.7	32.3	44.1	86.3	92.5	96.3	100.0
	29	0.6	5.1	17.0	32.7	37.9	54.7	67.6	78.6	100.0
	30	7.9	35.8	80.6	92.2	93.4	95.6	96.6	97.7	100.0

TABLE 42

CHEMICAL ANALYSES OF SEDIMENT SAMPLES 1-30 TAKEN IN KITIMAT HARBOUR, 1976, EXPRESSED AS μg/g OF SEDIMENT, DRY WEIGHT

Site	Cd	Cr	Cu	Fe	Pb	Mg	Hg	Mo	Ni	Zn	F
1	0.7	18.2	16.7	16600	10.1	6600	-	<5.0	15.4	35.8	60
2	0.7	13.8	12.7	12500	8.4	5550	-	<5.0	12.5	28.5	80
3	0.8	17.8	18.2	15900	9.4	6600	<.05	<5.0	16.3	34.7	70
4	1.0	35.3	43.1	28500	16.1	10800	<.05	5.9	27.1	59.1	120
5	1.5	14.6	21.1	13200	28.5	7750	<.05	<5.0	16.0	46.5	850
6	0.7	15.3	12.5	17800	9.7	6190	<.05	<5.0	14.7	34.0	130
7	0.6	14.9	13.8	15700	9.6	5390	<.05	<5.0	13.7	34.1	90
8	0.8	18.6	13.9	10600	11.3	6550	<.05	<5.0	15.7	37.9	120
9	0.7	18.4	13.5	16600	10.1	6050	<.05	<5.0	14.9	35.3	60
10	0.6	12.8	13.3	13700	7.8	5990	<.05	<5.0	13.0	33.6	70
11	0.7	15.7	17.5	16500	10.8	4790	<.05	<5.0	14.1	42.5	50
12	0.7	14.6	12.7	15100	12.3	5070	<.05	<5.0	14.2	36.9	60
13	0.6	13.1	11.4	13300	7.7	5100	<.05	<5.0	13.4	28.7	60
14	0.6	15.8	14.5	16200	7.4	4200	0.06	<5.0	13.1	32.0	80
15	0.7	19.4	14.5	21400	9.4	5580	<.05	<5.0	16.6	32.6	60
16	1.0	14.6	11.7	19700	17.5	5560	<.05	<5.0	15.6	37.2	70
17	0.9	10.4	11.6	15600	12.5	5200	<.05	<5.0	14.0	34.7	70
18	0.9	21.1	24.0	28200	9.9	7970	<.05	<5.0	16.4	38.2	70
19	1.1	21.1	23.6	24400	12.3	8420	<.05	<5.0	17.5	45.3	80
20	1.0	11.8	14.8	16300	18.9	5040	0.05	<5.0	14.3	40.0	70
21	1.2	33.8	51.6	28500	21.9	9570	0.06	<5.0	26.7	60.0	140
22	0.9	19.7	19.8	18100	14.1	6220	<.05	<5.0	17.2	38.7	70
23	1.0	21.6	23.8	21100	14.8	6790	<.05	<5.0	19.4	43.9	80
24	0.9	23.2	21.6	20800	14.1	6350	<.05	<5.0	20.3	41.9	70
25	0.9	21.6	17.1	20900	8.2	5920	<.05	<5.0	17.5	36.3	60
26	0.9	30.6	15.6	25600	8.5	2990	<.05	<5.0	19.7	35.6	80
27	1.4	26.7	20.3	20500	12.6	3830	0.05	<5.0	21.4	41.6	110
28	1.0	25.2	13.0	20700	11.5	2800	<.05	<5.0	15.8	30.8	90
29	1.0	26.0	23.1	21500	12.2	3840	0.07	<5.0	20.9	43.1	10
30	1.0	12.4	14.0	9920	22.3	1630	0.13	<5.0	11.8	16.6	2830

Data from EQUIS

TABLE 43

THE PERCENTAGE OF THE TOTAL FLUORIDE, IRON, ALUMINUM AND CYANIDE LOADINGS FROM ALCAN AT EACH OF THE THREE DISCHARGE POINTS PE 1494(01)-(03) AND FROM DIFFUSE SOURCES TO MOORE CREEK

Percentage of Total Load

Characteristics	PE 1494(01)	PE 1494(03)	PE 1494(02)	Moore Creek diffuse load	Total Load in kg/d
Iron	60.9	6.5	0.9	31.7	33.97
Fluoride	97.1	0.9	0.4	1.6	1431.90
Aluminum	78.1	4.1	0.3	17.5	119.87
Cyanide	97	3	-	-	8.5

TABLE 44

A COMPARISON OF WATER QUALITY IN BEAVER CREEK BETWEEN SITE 0430026, WHICH IS UPSTREAM FROM THE EUROCAN LANDFILL SITE PR 1650, AND SITE 0430029 WHICH IS DOWNSTREAM. 1978 - 1982 DATA

Characteristics	Units	Arithmetic Mean Values of Characteristics			Aquatic Life Criteria
		Upstream	Downstream	Difference	
BOD_5	kg/d	13.5	411	+397.5	
BOD_5	mg/L	0.9	19	+ 18.1	
Flow	m^3/d	18325	28403	+10078	
Flow	m^3/d	0.2121	0.3287	+0.1166	
Oxygen, dissolved	mg/L	11.6	9.0	-2.6	≥7.8
pH	pH	7.0	7.0	±0	6.0-9.0
Sodium, total	mg/L	2.1	21	+18.9	
Solids, fixed, dissolved	mg/L	3.3	16	+12.7	
Solids, suspended	mg/L	4.1	19	+14.9*	<+10
Solids, dissolved	mg/L	94.1	180.0	+85.9	
Temperature	°C	6.8	8.5	+1.7	±1
Turbidity	NTU	1	15	+14*	<+5

*Outside of criteria

TABLE 45

COMPARISON OF WASTE LOADINGS FROM EUROCAN PULP AND PAPER IN BEAVER CREEK AND IN THE PE 292 EFFLUENT FOR SELECTED CHARACTERISTICS

Characteristics	Mean Load in kg/d		Total Load	% Load in Beaver Creek
	Beaver Creek Site 0430029	PE 292 Effluent		
BOD_5	540	5200	5740	9
Sodium , Total	600	12800	13400	4.5
Solids , fixed, dissolved	450	2100	2550	17.5
Solids , suspended	540	6700	7240	7.5
Solids , dissolved	5100	51000	56100	9

TABLE 46

BACKGROUND LEVELS OF HEAVY METALS IN MARINE SEDIMENTS

Element	Concentration in µg/g dry weight (reference)
Lead (Pb)	20 (Chester & Stoner. 1975)
Mercury (Hg)	0.09-0.11 (Thompson et al., 1980)
Cadmium (Cd)	0.4 (B.C. Research. 1977)
Copper (Cu)	1.9-16.8 (Taylor. 1976); 80 (Thompson and McComas. 1974)
Zinc (Zn)	25-65 (Taylor, 1976); 110-140 (Thompson and Paton. 1978)

TABLE 47

WATER QUALITY IN THE CENTRE OF MINETTE BAY,
SITE 0700128, JULY 6, 1983

Characteristics	Units	Depth**			Criteria	
		2 m	18 m	38 m	Aquatic Life	Recreation
Aluminum , dissolved	mg/L		0.02	<0.01	0.2	0.1
Aluminum , total	mg/L	0.03	0.03	<0.02	0.2	0.1
Arsenic , dissolved	mg/L	<0.001	<0.001	<0.001	0.05	0.05
Arsenic , total	mg/L	<0.001	<0.001	0.001	0.05	0.05
Cadmium , dissolved	mg/L	0.0007	0.0005	0.008	0.012-0.038	0.01
Copper , dissolved	mg/L	0.001	<0.001	0.002	0.002-0.003	0.5
Copper , total	mg/L	0.001	0.001	0.002	0.002-0.003	0.5
Fluoride	mg/L	0.14	1.0	1.12	1.5	
Iron , dissolved	mg/L	–	–	0.003	0.3-1.0	
Iron , total	mg/L	0.02	0.09	1.2*	0.3-1.0	
Lead , dissolved	mg/L	–	–	0.003	0.009-0.220	
Lead , total	mg/L	<0.001	<0.001	0.003	0.009-0.220	
Magnesium , dissolved	mg/L	75	1025	1000		
Magnesium , total	mg/L	77.5	1075	1025		
Nitrogen , ammonia	mg/L	0.01	0.146	0.79	+	
Nitrogen , Kjeldahl	mg/L	0.07	0.21	0.94		
Nitrogen , NO_2/NO_3	mg/L	<0.02	0.23	0.04		
Nitrogen , total	mg/L	0.07	0.44	0.98		
pH	pH	7.0	7.6	7.5	6.5-8.5	5.0-9.0
Phosphorus , dissolved	µg/L	8	36	17		
Phosphorus , ortho	µg/L	8	30	14		
Phosphorus , total	µg/L	18	40	51		
Solids , suspended	mg/L	4	<1.0	8		
Salinity***	g/L	2.5	29	29.8	<+10	
Specific conductivity	uS/cm	4210	44400	46000		
Temperature***	°C	14	8	6.5	±4	
Turbidity	NTU	4.2	0.8	16	<+5	<+5
Zinc , dissolved	mg/L	<0.005	<0.005	0.007		5
Zinc , total	mg/L	0.007	0.006	0.009		5

* outside criteria
** maximum depth at the sites is about 40 m
***Salinity at 13 m was 23.0 g/L and temperature at 13 m was 10.0°C
Salinity at 9 m was 3.5 g/L and temperature at 9 m was 14°C
\+ See Tables 61 and 62

TABLE 48

WATER QUALITY IN THE CENTRE OF MINETTE BAY,
SITE 0700128, SEPTEMBER 27, 1983

Characteristics	Units	Depth**				Criteria	
		2 m	9 m	18 m	38 m	Aquatic Life	Recreation
Aluminum , dissolved	mg/L	-	0.08	0.02	<0.01	0.2	0.1
Aluminum , total	mg/L	3.5*	0.22*	0.06	0.01	0.2	0.1
Copper , dissolved	mg/L	-	0.005*	0.0007	0.005*	0.002-0.003	
Copper , total	mg/L	0.012*	0.035*	0.037*	0.02*	0.002-0.003	
Fluoride	mg/L	0.1	1.64*	1.86*	0.65	1.5	
Iron , dissolved	mg/L	0.1	0.005	0.026	1.20*	0.3-1.0	
Iron , total	mg/L	2.4*	0.15	0.10	1.25*	0.3-1.0	
pH	pH	7.4	7.8	7.6	7.3	6.5-8.5	5.0-9.0
Salinity	g/L	2.5	23.0	21.5	26.0	±4	
Specific conductivity	uS/cm	1600	2700	36000	4600		
Temperature	°C	10.0	9.0	9.0	11.0		
Turbidity	NTU	52	2.6	1.0	18	<+5	<+5
Zinc , dissolved	mg/L	<0.005	<0.005	<0.005	<0.005		5
Zinc , total	mg/L	<0.005	0.005	<0.005	<0.005		5

* Outside criteria
** Maximum depth at the site is about 40 m

TABLE 49

SEDIMENT SAMPLES IN KITIMAT HARBOUR JUST OFFSHORE OF ALCAN'S PE 1494(01) DISCHARGE. SITES 0400511 and 0400514, JULY 5, 1983

Characteristics	Values in µg/g dry weight	
	0400511 (150 m from PE 1494(01)	0400514 (800 m from PE 1494(01)
Aluminum, total	9 390	14 200
Copper, total	13	34
Fluoride	290	140
Iron, total	12 400	22 200
Lead, total	51	25
Magnesium, total	5 200	8 700
Manganese, total	203	303
Zinc, total	25	43

TABLE 50

WATER QUALITY IN KITIMAT HARBOUR, 1983

		Distance out from PE 1494(01)							
		150 m		800 m					
		0400510		0400512	0400513				
		July 5	Sept. 28	July 5	Sept. 28		July 5		
Characteristics	Units	1 m	2 m	0 m	2 m	9 m	10 m	Aquatic Life Criteria	Recreation Criteria
Aluminum , dissolved	mg/L	0.06	0.15*	0.09	0.12*	0.03	0.01	0.2	0.1
Aluminum , total	mg/L	0.25*	2.6*	0.21*	1.3*	0.12*	0.05	0.2	0.1
Copper , dissolved	mg/L	0.003*	0.01*		0.008*	0.005*	0.009*	0.002-0.003	
Copper , total	mg/L		0.014*	0.003*	0.010*	0.011*	0.004*	0.002-0.003	
Cyanide, weak-acid dissoc.	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		
Cyanide, strong-acid dissoc.	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.0005	
Fluoride	mg/L		0.98		0.49	0.96		1.5	
Iron , dissolved	mg/L	0.05	0.15	0.068	0.098	<0.005	0.020	0.3-1.0	
Iron , total	mg/L	0.2	1.3*	0.2	1.4*	0.1	0.107	0.3-1.0	
Lead , total	mg/L	<0.001		<0.001			0.001	0.009-0.220	
Magnesium , dissolved	mg/L	60		50.3			950		
Magnesium , total	mg/L	75		50.3			1000		
Manganese , dissolved	mg/L	0.008		0.010			0.004	0.1	
Manganese , total	mg/L	0.014		0.014				0.1	
pH	pH	-	7.4	-	7.4	7.9		6.5-8.5	5.0-9.0
Phenol	mg/L	<0.002							
Salinity	g/L		4	1.5	4.5	28	27		
Sodium	mg/L	576		435			8850		
Specific Conductivity	uS/cm		9790		8400	41000			
Temperature	°C		7.5		9	11	13		
Turbidity	NTU		38		35	1.5		<+5	<+5
Zinc , dissolved	mg/L		<0.005		<0.005	<0.005	0.009		5
Zinc , total	mg/L	0.006	<0.005	0.005	<0.005	0.005	0.009		5

*outside of criteria

TABLE 51

MEAN LOADINGS IN kg/d OF DISSOLVED FLUORIDE, ALUMINUM AND IRON, SUSPENDED SOLIDS, TOTAL CYANIDE AND OIL AND GREASE TO MOORE CREEK FROM PE 1494(03) BETWEEN 1974 and 1981

CHARACTERISTICS	UNITS	# OF SAMPLES	MEAN LOAD
Dissolved fluoride	kg/d	222	13.5
Dissolved iron	kg/d	5	2.2
Dissolved aluminum	kg/d	54	4.9
Oil and grease	kg/d	52	7.8
Suspended solids	kg/d	220	28.3
Total cyanide	kg/d	36	0.06

Data from EQUIS

TABLE 52

SUMMARY OF EFFLUENT MONITORING RESULTS FOR ALCAN SMELTER, PE 1494(01). 1982-1984 (Outfall #1, WET SCRUBBER, COOLING WATER AND SMELTER 'A' SURFACE RUNOFF)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	PERMIT LIMITS
Aluminum, total	mg/L	28	6.6	0.9	2.2	
Arsenic, total	mg/L	2	<0.25	<0.25	<0.25	
Cadmium, total	mg/L	2	<0.01	<0.01	<0.01	
Calcium, total	mg/L	2	5.62	5.46	5.54	
Chromium, total	mg/L	2	0.01	<0.01	<0.01	
Cobalt, total	mg/l	2	<0.1	<0.1	<0.1	
Conductivity, specific	µS/cm	2	172	170	171	
Copper, total	mg/L	2	0.01	<0.01	<0.01	
Cyanide, total	mg/L	26	1.60	<0.01	0.29	20
Flow	m^3/d	95	52 716*	14 111	23 131	33 000 (dry) 50 000 (wet)
Fluoride, dissolved	mg/L	28	48*	1.4	24.8*	15
Iron, total	mg/L	25	0.76	0.05	0.40	
Lead, total	mg/L	2	<0.1	<0.1	<0.1	
Magnesium, total	mg/L	2	0.75	0.74	0.75	
Manganese, total	mg/L	2	0.03	0.02	0.03	
Molybdenum, total	mg/L	2	<0.01	<0.01	<0.01	
Nickel, total	mg/L	2	<0.05	<0.05	<0.05	
Oil and grease	mg/L	27	3.9	0.2	1.3	15
pH	pH	30	8.5	3.7*	6.0	6.0-8.5
Solids, dissolved	mg/L	2	6	5	6	
Solids, suspended	mg/L	27	20.5	0.7	11.2	50
Solids, total	mg/L	1	100	100	100	
Temperature	°C	84	23.0	0.5	11.5	
Vanadium, total	mg/L	2	0.01	<0.01	<0.01	
Zinc, total	mg/L	2	0.02	0.01	0.02	

*exceeds permit limits

TABLE 53

SUMMARY OF EFFLUENT MONITORING RESULTS FOR ALCAN SMELTER, PE 1494(02), 1982-1984 (Outfall #2, COOLING WATER AND SURFACE RUNOFF FROM COKE CALCINER)

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	PERMIT LIMITS
Aluminum, total	mg/L	28	4.02	<0.10	<0.48	
Arsenic, total	mg/L	2	<0.25	<0.25	<0.25	
Cadmium, total	mg/L	2	<0.01	<0.01	<0.01	
Calcium, total	mg/L	2	3.45	3.30	3.38	
Chromium, total	mg/L	2	0.01	<0.01	<0.01	
Cobalt, total	mg/L	2	<0.1	<0.1	<0.1	
Conductivity, specific	µS/cm	2	70	33	52	
Copper, total	mg/L	2	0.02	<0.01	<0.02	
Cyanide, total	mg/L	25	2.0	<0.1	<0.2	20
Flow	m^3/d	96	1309.3	163.7	350.7	1 360
Fluoride, dissolved	mg/L	29	16*	<1.0	<4.4	15
Iron, total	mg/L	19	2.08	<0.10	<0.38	
Lead, total	mg/L	2	<0.1	<0.1	<0.1	
Magnesium, total	mg/L	2	1.02	0.44	0.73	
Manganese, total	mg/L	2	0.10	0.02	0.06	
Molybdenum, total	mg/L	2	<0.01	<0.01	<0.01	
Nickel, total	mg/L	2	0.07	<0.05	<0.06	
Oil and grease	mg/L	27	6.8	<0.1	1.7	15
pH	pH	29	8.0	5.5*	7.3	6.0-8.5
Solids, dissolved	mg/L	2	430	5	218	
Solids, suspended	mg/L	29	165.2*	0.4	27.8	50
Solids, total	mg/L	2	452	50	251	
Temperature	°C	109	19.5	2.0	11.3	38
Vanadium, total	mg/L	2	0.09	<0.01	<0.05	
Zinc, Total	mg/L	2	0.06	<0.01	<0.04	

*exceeds permit limits

TABLE 54

SUMMARY OF EFFLUENT MONITORING RESULTS FOR ALCAN SMELTER, PE 1494(03), 1982-1984 (Outfall #3, COOLING WATER AND SURFACE RUNOFF FROM SMELTER 'B')

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	PERMIT LIMITS
Aluminum, total	mg/L	11	4.29	<0.10	0.60	
Arsenic, total	mg/L	2	<0.25	<0.25	<0.25	
Cadmium, total	mg/L	2	<0.01	<0.01	<0.01	
Calcium, total	mg/L	2	4.98	3.85	3.92	
Chromium, total	mg/L	2	<0.01	<0.01	<0.01	
Cobalt, total	mg/L	2	<0.1	<0.1	<0.1	
Conductivity, specific	µS/cm	2	64	40	52	
Copper, total	mg/L	2	0.01	<0.01	<0.01	
Flow	m^3/d	84	17 248	4 396	10 087	17 700
Fluoride, dissolved	mg/L	9	3.1	0.27	1.8	5.0
Iron, total	mg/L	9	2.0*	<0.1	<0.6	1.0
Lead, total	mg/L	2	<0.1	<0.1	<0.1	
Magnesium, total	mg/L	2	0.58	0.46	0.52	
Manganese, total	mg/L	2	0.04	0.02	0.03	
Molybdenum, total	mg/L	2	<0.01	<0.01	<0.01	
Nickel, total	mg/L	2	<0.05	<0.05	<0.05	
Oil and grease	mg/L	9	1.8	<0.1	0.9	
pH	pH	10	7.9	6.5	7.0	6.0-8.5
Solids, dissolved	mg/L	2	10	2	6	
Solids, suspended	mg/L	10	49	0.8	10.8	50
Solids, total	mg/L	2	59	30	45	
Temperature	°C	87	23	2	13.8	
Vanadium, total	mg/L	2	0.01	<0.01	<0.01	
Zinc, Total	mg/L	2	0.02	<0.01	<0.02	

*exceeds permit limits

TABLE 55

CALCULATED ALUMINUM, IRON AND CYANIDE LEVELS AT SITES 0400509-0400514 IN KITIMAT HARBOUR RESULTING FROM ALCAN DISCHARGES PE 1494(01) and PE 1494(02)

Site	Depth	Dissolved Aluminum mg/L		Total Cyanide mg/L		Total Iron mg/L	
	m	max.	mean	max.	mean	max.	mean
0400509	0	3.4*	0.3*	0.308*	0.027*	0.76*	0.06
0400510	4	0.6*	0.1	0.052*	0.010*	0.13	0.03
0400511	8	0.6*	0.6*	0.051*	0.009*	0.13	0.02
0400512	0	0.3*	0.1	0.024*	0.009*	0.06	0.02
0400513	2	0.1	0.1	0.010*	0.005*	0.03	0.02
0400514	3	0.1	0.1	0.009*	0.005*	0.02	0.02

*exceeds marine aquatic life criteria of 0.2 mg/L for aluminum, 1.0 µg/L for weak-acid dissociable cyanide, 0.3-1.0 mg/L for total iron or marine recreational criterion for aluminum of 0.1 mg/L (eye irritation)

TABLE 56

CRITERIA LEVELS AND REFERENCES FOR WATER QUALITY CHARACTERISTICS

Characteristics	Criteria and (reference); mg/L, except as noted				
	Fresh Water			Marine Water	
	Drinking Water	Aquatic Life	Recreation	Aquatic Life	Recreation
Alkalinity, total		20-130 (2,3)			
Aluminum, total		0.05-0.1 (3)	0.1 (36)	0.2 (3)	0.1 (36)
Arsenic, total	0.05 (2,4,7)	0.05 (2,15)	0.05 (37)	0.05 (2,15)	0.05 (37)
Cadmium, total	0.005 (4,7)	0.0002 (9,37)	0.010 (37)	0.012-0.038 (39)	0.010 (37)
Calcium, total	[see hardness]				
Chloride, total	250(7,10)				
Chlorine, residual		2-10 (2,15)		10-20 (2,15)	
Chromium, total	0.05 (4,7)	0.02-0.04 (37)	0.1 (37)		0.1 (37)
Cobalt, total		0.05 (3)			
Coliforms, fecal* MPN/100 mL			200/400* (38)	14/43^{+} (2)	200/400*(38)
Colour, true TCU	15 (7)		15-100 (5,11)	50 (11)	15-100 (5,11)
Copper, total	0.5-1.0 (7,37)	0.002 (37)	0.5 (37)	0.002-0.003 (37)	0.5 (37)
Cyanide, weak-acid diss.	0.2 (12)	0.004-0.010 (12)		0.001 (12)	
Fluoride, total+++	1.0-1.5 (7)	1.0 (37)		1.5 (3)	
Hardness ($CaCO_3$)	80-100 (4,7)				
Iron, total	0.3 (7,10)	0.3-1.0 (2,15,37)			
Lead, total	0.005 (4,7)	0.005-0.030 (37)	0.05 (37)	0.009-0.220 (39)	0.05 (37)
Magnesium, total	100-500 (40)				
Manganese, total	0.05 (7,10)	0.1-1.0 (15)		0.1 (2)	
Mercury, total	0.001 (37)	0.0001-0.0002 (37)	0.001 (37)		0.001 (37)
Molybdenum, total	0.25 (41)	0.5-3.0 (3,17)			
Nickel, total	0.2 (37)	0.025-0.25 (37)	0.2 (37)		0.2 (37)
Nitrogen, ammonia (as N)	0.5 (14)	See Tables 61-62		0.016-0.041 (48)++	
Nitrogen, nitrate (as N)	10 (4,7,48)	200-40 (19,48)			
Nitrogen, nitrite (as N)	1 (4,7,48)	0.02-0.06 (18,48)		See Table 60	
Nitrogen, NO_2+NO_3 (as N)	10 (7,48)	40 (18)			
Oxygen, dissolved		4-9.75 (20)	2 (36)	6.5-9.0 (20)	2 (36)
Oil and grease			N.D.** (8,9)		N.D.** (8,9)

TABLE 56 (Continued)

Characteristics	Criteria and (reference); mg/L, except as noted				
	Fresh Water			Marine Water	
	Drinking Water	Aquatic Life	Recreation	Aquatic Life	Recreation
pH, pH units	6.5-8.5 (7)	6.5-9.0 (2)	5.0-9.0 (3,13)	6.5-8.5 (2)	5.0-9.0 (3)
Phosphorus, total	0.1 (2)				
Salinity (as NaCl) g/L		(5,6)		±4 (5,6)	
Sodium, total	20-270 (2)	<6, ±1			
Solids, dissolved	500 (7)				
Solids, floatable			ND** (8,35)		ND** (8,35)
Solids, settleable			ND** (8)		ND** (8)
Solids, suspended		+10 or +10% (1)		+10 or +10% (1)	
Sulphate, total	150-500 (4,7)				
Sulphide *** (as H_2S)	0.05 (7)	0.002 (2,9,15)			
Tannin and lignin	0.4 (23)				
Temperature °C	15 max. (7)	±1°, <24 (2)	15-35 (3)		
Titanium, total	0.1 (17)	0.1 (17)			
Turbidity, NTU	+5, or +10% (1)	+5 or +10% (1)	+5 or +10% (1)	+5 or +10% (1)	+5 or +10% (1)
Vanadium, total	0.1 (17)				
Zinc, total	5 (7)	0.05-0.3 (37)	5 (37)		5 (37)

* geometric mean and 90th percentile respectively, organisms/100 mL

** non detectable by sight or smell

***the criteria for sulphide is for the undissociated hydrogen sulphide component, which is a function of ambient pH, temperature and dissolved oxygen levels.

\+ median and 90th percentile, respectively

++ un-ionized NH_3

+++A fluoride criteria document is in preparation. The values given in the table are interim working values and are subject to change

TABLE 57

PROVISIONAL WATER QUALITY OBJECTIVES FOR THE KITIMAT RIVER DOWNSTREAM FROM THE DISTRICT OF KITIMAT SEWAGE DISCHARGE AND FOR KITIMAT ARM AND KITIMAT HARBOUR

Water Bodies	Kitimat River downstream from the District of Kitimat sewage discharge (PE 256)	Kitimat Arm
Designated Water Uses	aquatic life, (spawning salmonid migration corridor) wildlife, secondary-contact recreation	aquatic life, wildlife, primary contact recreation (recreational harvesting of shell-fish and fin-fish)
Fecal Coliforms[1]	not applicable	≤14/100 mL MPN median ≤43/100 mL MPN 90th percentile ≤200/100 mL MPN geometric mean, ≤400/100 mL MPN 90th percentile
Turbidity[2]	5 NTU maximum increase when background is less than 50 NTU and 10% maximum increase when background exceeds 50 NTU	
pH	pH between 6.5 and 9.0	not applicable
Suspended Solids[2]	10 mg/L maximum increase when background is less than 100 mg/L and 10% maximum increase when background exceeds 100 mg/L	
Periphyton Chlorophyll *a*[4]	≤50 mg/m² average	not applicable
Undissociated H_2S	0.002 mg/L maximum	not applicable
Toxicity[3]	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	not applicable
Fluoride	not applicable	1.5 mg/L maximum
Aluminum (total)[2]	not applicable	a 20% maximum increase

TABLE 57 (Continued)

Water Bodies	Kitimat River downstream from the District of Kitimat sewage discharge (PE 256)	Kitimat Harbour and Kitimat Arm
Iron (total)	not applicable	0.3 mg/L maximum
Oxygen, dissolved	7.8 mg/L minimum	not applicable
Nitrite-N[5]	≤0.020 mg/L average 0.060 mg/L maximum	not applicable
Ammonia-N[5] total	see Tables 61 and 62	≤ 1.0 mg/L average 2.5 mg/L maximum
Lead (total)[2,5]	not applicable	≤0.009 mg/L average 0.22 mg/L maximum or 20% maximum increase, whichever is greater
Cadmium (total)[5]	not applicable	≤0.012 mg/L average 0.038 mg/L maximum
Copper (total)[2,5]	not applicable	≤0.002 mg/L average 0.003 mg/L maximum or 20% maximum increase, whichever is greater
Cyanide[6] (weak-acid dissociable)	not applicable	0.001 mg/L maximum

Note: The objectives apply to discrete samples from all parts of the water body except from the initial dilution zones. The initial dilution zone in the Kitimat River is defined as extending up to 100 m downstream from a discharge and up to 50% of the width of the river, from the surface to the bottom. Marine initial dilution zones are cylinders with a maximum 100 m radius around a discharge point, extending from the sediment to the water surface. Kitimat Harbour is also defined as an initial dilution zone.

[1] the geometric mean, median and 90th percentile are calculated from a minimum of 5 samples taken in a 30-day period. The recreational objective applies only during the recreational season. The shellfish objectives (14-43/100 ml) apply only to areas where harvesting of shellfish occurs; in other areas of Kitimat Arm the recreational objectives (200-400/100 mL) will apply.

[2] the increase is over levels measured at a site upstream from a discharge, or series of discharges, and as close to them as possible, or in an unaffected part of the marine environment. The increase applies to downstream or affected levels.

[3] the percent concentration of pulp mill effluent in the river is calculated by dividing 100 by the effluent dilution ratio. The dilution ratio is calculated by dividing the concentration of sodium in the effluent by the increase in sodium between sites upstream and downstream from the outfall. After complete mixing, the dilution ratio may also be calculated by dividing the river flow by the effluent flow.

[4] the average is calculated from at least 5 samples collected at random from natural substrates, at any station on any one day.

[5] the average is calculated from at least 5 weekly samples taken in a 30-day period.

[6] the minimum detectable concentration for cyanide is 0.005 mg/L at this time; until detection limits can be improved, measurements reported as <0.005 mg/L (as CN) will be acceptable. However, calculated receiving water cyanide concentrations should not exceed the objective. Measurements of strong-acid dissociable cyanide should also be made to check whether the possible photolysis of iron-cyanide complexes may produce unacceptable levels of weak-acid dissociable cyanide.

TABLE 58

RECOMMENDED WATER QUALITY MONITORING FOR THE KITIMAT RIVER, KITIMAT ARM, KITIMAT HARBOUR AND HIRSCH CREEK

Sites	Frequency/Timing	Characteristics to be Monitored
Hirsch Creek both upstream and downstream of PR 3608	during low flow for one season only if results show negligible leachate	specific conductivity, colour, turbidity, fecal coliforms, phosphorus and nitrate
Kitimat River at the upstream control site at the bridge, site 0430025 (08FF001).	continuous flow measurements, monthly for the water quality characteristics	turbidity, suspended solids, temperature, pH, ammonia, dissolved oxygen, nitrite, nitrate, hardness, fecal coliforms, sulphide, colour, dissolved sodium, total and dissolved copper, aluminum, phosphorus, iron, fluoride, cadmium and lead, oil and grease, cyanide
Kitimat River at sites above and below discharge points	during low river flows (less than 30 m³/s), when fish or people are using the river, frequently enough to determine if the objectives are being met	fecal coliforms, turbidity, pH, suspended solids, nitrite, ammonia, dissoled oxygen, dissolved sodium
Kitimat Arm	at least 5 samples in a 30-day period during the shellfish harvesting season	fecal coliforms
	annually in the shellfish harvesting season	turbidity, pH, fluoride, suspended solids, total and dissolved iron, copper, lead and cadmium and strong and weak acid dissociable cyanide

TABLE 59

RECOMMENDED SEDIMENT AND TISSUE MONITORING IN KITIMAT ARM

Sites	Frequency/Timing	Characteristics to be Monitored
Selected shellfish harvesting sites	annually in the shell-fish harvesting season	fluoride, aluminum, iron, cadmium, copper, lead, cyanide and fecal coliforms

TABLE 60

RECOMMMENDED CRITERIA FOR NITRITE-N

Chloride Concentration mg/L	Maximum Nitrite Concentration mg/L	30-d average mg/L
less than 2	0.060	0.020
2-4	0.120	0.040
4-6	0.180	0.060
6-8	0.240	0.080
8-10	0.300	0.100
greater than 10	0.600	0.200

TABLE 61

MAXIMUM CONCENTRATION OF TOTAL AMMONIA NITROGEN FOR PROTECTION OF AQUATIC LIFE (mg/L-N)

pH	Temp. 0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
6.5	27.7	28.3	27.9	27.5	27.2	26.8	26.5	26.2	26.0	25.7	25.5
6.6	27.9	27.5	27.2	26.8	26.4	26.1	25.8	25.5	25.2	25.0	24.7
6.7	26.9	26.5	26.2	25.9	25.5	25.2	24.9	24.6	24.4	24.1	23.9
6.8	25.8	25.5	25.1	24.8	24.5	24.2	23.9	23.6	23.4	23.1	22.9
6.9	24.6	24.2	23.9	23.6	23.3	23.0	22.7	22.5	22.2	22.0	21.8
7.0	23.2	22.8	22.5	22.2	21.9	21.6	21.4	21.1	20.9	20.7	20.5
7.1	21.6	21.3	20.9	20.7	20.4	20.2	19.9	19.7	19.5	19.3	19.1
7.2	19.9	19.6	19.3	19.0	18.8	18.6	18.3	18.1	17.9	17.8	17.6
7.3	18.1	17.8	17.5	17.3	17.1	16.9	16.7	16.5	16.3	16.2	16.0
7.4	16.2	16.0	15.7	15.5	15.3	15.2	15.0	14.8	14.7	14.5	14.4
7.5	14.4	14.1	14.0	13.8	13.6	13.4	13.3	13.1	13.0	12.9	12.7
7.6	12.6	12.4	12.2	12.0	11.9	11.7	11.6	11.5	11.4	11.3	11.2
7.7	10.8	10.7	10.5	10.4	10.3	10.1	10.0	9.92	9.83	9.73	9.65
7.8	9.26	9.12	8.98	8.88	8.77	8.67	8.57	8.48	8.40	8.32	8.25
7.9	7.82	7.71	7.60	7.51	7.42	7.33	7.25	7.17	7.10	7.04	6.98
8.0	6.55	6.46	6.37	6.29	6.22	6.14	6.08	6.02	5.96	5.91	5.86
8.1	5.21	5.14	5.07	5.01	4.95	4.90	4.84	4.80	4.75	4.71	4.67
8.2	4.15	4.09	4.04	3.99	3.95	3.90	3.86	3.83	3.80	3.76	3.74
8.3	3.31	3.27	3.22	3.19	3.15	3.12	3.09	3.06	3.03	3.01	2.99
8.4	2.64	2.61	2.57	2.54	2.52	2.49	2.47	2.45	2.43	2.41	2.40
8.5	2.11	2.08	2.06	2.03	2.01	1.99	1.98	1.96	1.95	1.94	1.93
8.6	1.69	1.67	1.65	1.63	1.61	1.60	1.59	1.58	1.57	1.56	1.55
8.7	1.35	1.33	1.32	1.31	1.30	1.29	1.28	1.27	1.26	1.26	1.25
8.8	1.08	1.07	1.06	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02
8.9	0.871	0.863	0.856	0.849	0.844	0.839	0.836	0.833	0.832	0.831	0.831
9.0	0.703	0.697	0.692	0.688	0.685	0.682	0.681	0.681	0.680	0.681	0.682

pH	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
6.5	25.2	25.0	24.8	24.6	24.5	24.3	24.2	24.0	23.9	23.8
6.6	24.5	24.3	24.1	23.9	23.8	24.6	23.5	23.3	23.3	23.2
6.7	23.7	23.5	23.3	23.1	23.0	22.8	22.7	22.6	22.5	22.4
6.8	22.7	22.5	22.3	22.2	22.0	21.9	21.8	21.7	21.6	21.5
6.9	21.6	21.4	21.3	21.1	21.0	20.8	20.7	20.6	20.5	20.4
7.0	20.3	20.2	20.0	19.9	19.7	19.6	19.5	19.4	19.3	19.2
7.1	18.9	18.8	18.7	18.5	18.4	18.3	18.2	18.1	18.0	17.9
7.2	17.4	17.3	17.2	17.1	16.9	16.8	16.8	16.7	16.6	16.5
7.3	15.9	15.7	15.6	15.5	15.4	15.3	15.2	15.2	15.1	15.1
7.4	14.2	14.1	14.0	13.9	13.9	13.8	13.7	13.6	13.6	13.5
7.5	12.6	12.5	12.4	12.4	12.3	12.2	12.2	12.1	12.1	12.0
7.6	11.1	11.0	10.9	10.8	10.8	10.7	10.7	10.6	10.6	10.5
7.7	9.57	9.50	9.43	9.37	9.31	9.26	9.22	9.81	9.15	9.12
7.8	8.18	8.12	8.07	8.02	7.97	7.93	7.90	7.87	7.84	7.82
7.9	6.92	6.88	6.83	6.79	6.75	6.72	6.69	6.67	6.65	6.64
8.0	5.81	5.78	5.74	5.71	5.68	5.66	5.64	5.62	5.61	5.60
8.1	4.64	4.61	4.59	4.56	4.54	4.53	4.51	4.50	4.49	4.49
8.2	3.71	3.69	3.67	3.65	3.64	3.63	3.62	3.61	3.61	3.61
8.3	2.97	2.96	2.94	2.93	2.92	2.92	2.91	2.91	2.91	2.91
8.4	2.38	2.37	2.36	2.36	2.35	2.35	2.35	2.35	2.35	2.36
8.5	1.92	1.91	1.91	1.90	1.90	1.90	1.90	1.90	1.91	1.92
8.6	1.55	1.54	1.54	1.54	1.54	1.54	1.55	1.55	1.56	1.57
8.7	1.25	1.25	1.25	1.25	1.25	1.26	1.26	1.27	1.28	1.29
8.8	1.02	1.11	1.02	1.02	1.03	1.03	1.04	1.05	1.06	1.07
8.9	0.832	0.834	0.838	0.842	0.847	0.853	0.861	0.870	0.880	0.891
9.0	0.684	0.688	0.692	0.698	0.704	0.711	0.720	0.729	0.740	0.752

TABLE 62

AVERAGE 30-DAY CONCENTRATION OF TOTAL AMMONIA NITROGEN FOR PROTECTION OF AQUATIC LIFE (mg/L-N)

pH	Temp. 0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
6.5	2.08	2.05	2.02	1.99	1.97	1.94	1.92	1.90	1.88	1.86	1.84
6.6	2.08	2.05	2.02	1.99	1.97	1.94	1.92	1.90	1.88	1.86	1.84
6.7	2.08	2.05	2.02	1.99	1.97	1.94	1.92	1.90	1.88	1.86	1.84
6.8	2.08	2.05	2.02	1.99	1.96	1.94	1.92	1.90	1.88	1.86	1.84
6.9	2.08	2.05	2.02	1.99	1.97	1.94	1.92	1.90	1.88	1.86	1.84
7.0	2.08	2.05	2.02	1.99	1.97	1.94	1.92	1.90	1.88	1.86	1.84
7.1	2.08	2.05	2.02	1.99	1.97	1.94	1.92	1.90	1.88	1.86	1.84
7.2	2.08	2.05	2.02	1.99	1.96	1.95	1.92	1.90	1.88	1.86	1.85
7.3	2.08	2.05	2.02	1.99	1.97	1.95	1.92	1.90	1.88	1.86	1.85
7.4	2.08	2.05	2.02	2.00	1.97	1.95	1.92	1.90	1.88	1.87	1.85
7.5	2.08	2.05	2.02	2.00	1.97	1.95	1.93	1.91	1.88	1.87	1.85
7.6	2.09	2.05	2.03	2.00	1.97	1.95	1.93	1.91	1.89	1.87	1.85
7.7	2.09	2.05	2.03	2.00	1.98	1.95	1.93	1.91	1.89	1.87	1.86
7.8	1.78	1.75	1.73	1.71	1.69	1.67	1.65	1.63	1.62	1.60	1.59
7.9	1.50	1.48	1.46	1.44	1.43	1.41	1.39	1.38	1.36	1.35	1.34
8.0	1.26	1.24	1.23	1.21	1.20	1.18	1.17	1.16	1.15	1.14	1.13
8.1	1.00	0.989	0.976	0.963	0.952	0.942	0.932	0.922	0.914	0.906	0.899
8.2	0.799	0.788	0.777	0.768	0.759	0.751	0.743	0.736	0.730	0.724	0.718
8.3	0.636	0.628	0.620	0.613	0.606	0.599	0.594	0.588	0.583	0.579	0.575
8.4	0.508	0.501	0.495	0.489	0.484	0.479	0.475	0.471	0.467	0.464	0.461
8.5	0.405	0.400	0.396	0.381	0.387	0.384	0.380	0.377	0.375	0.372	0.370
8.6	0.324	0.320	0.317	0.313	0.310	0.308	0.305	0.303	0.301	0.300	0.298
8.7	0.260	0.257	0.254	0.251	0.249	0.247	0.246	0.244	0.243	0.242	0.241
8.8	0.208	0.206	0.204	0.202	0.201	0.200	0.198	0.197	0.197	0.196	0.196
8.9	0.168	0.166	0.165	0.163	0.162	0.161	0.161	0.160	0.160	0.160	0.160
9.0	0.135	0.134	0.133	0.132	0.132	0.131	0.131	0.131	0.131	0.131	0.131

pH	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
6.5	1.82	1.81	1.80	1.78	1.77	1.64	1.52	1.41	1.31	1.22
6.6	1.82	1.81	1.80	1.78	1.77	1.64	1.52	1.41	1.31	1.22
6.7	1.83	1.81	1.80	1.78	1.77	1.64	1.52	1.41	1.31	1.22
6.8	1.83	1.81	1.80	1.78	1.77	1.64	1.52	1.42	1.32	1.22
6.9	1.82	1.81	1.80	1.78	1.77	1.64	1.53	1.42	1.32	1.22
7.0	1.83	1.81	1.80	1.79	1.77	1.64	1.53	1.42	1.32	1.22
7.1	1.83	1.81	1.80	1.79	1.77	1.65	1.53	1.42	1.32	1.23
7.2	1.83	1.81	1.80	1.79	1.78	1.65	1.53	1.42	1.32	1.23
7.3	1.83	1.82	1.80	1.79	1.78	1.65	1.53	1.42	1.32	1.23
7.4	1.83	1.82	1.80	1.79	1.78	1.65	1.53	1.42	1.32	1.23
7.5	1.83	1.82	1.81	1.80	1.78	1.66	1.54	1.43	1.33	1.23
7.6	1.84	1.82	1.81	1.80	1.79	1.66	1.54	1.43	1.33	1.24
7.7	1.84	1.83	1.81	1.80	1.79	1.66	1.54	1.44	1.34	1.24
7.8	1.57	1.56	1.55	1.54	1.53	1.42	1.32	1.23	1.14	1.07
7.9	1.33	1.32	1.31	1.31	1.30	1.21	1.12	1.04	0.970	0.904
8.0	1.12	1.11	1.10	1.10	1.09	1.02	0.944	0.878	0.818	0.762
8.1	0.893	0.887	0.882	0.878	0.874	0.812	0.756	0.704	0.655	0.611
8.2	0.714	0.709	0.706	0.703	0.700	0.651	0.606	0.565	0.527	0.491
8.3	0.571	0.568	0.566	0.564	0.562	0.523	0.487	0.455	0.424	0.396
8.4	0.458	0.456	0.455	0.453	0.452	0.421	0.393	0.367	0.343	0.321
8.5	0.369	0.367	0.366	0.366	0.365	0.341	0.318	0.298	0.278	0.261
8.6	0.297	0.297	0.296	0.296	0.296	0.277	0.259	0.242	0.227	0.213
8.7	0.241	0.240	0.240	0.241	0.241	0.226	0.212	0.198	0.186	0.175
8.8	0.196	0.196	0.196	0.197	0.198	0.185	0.174	0.164	0.154	0.145
8.9	0.160	0.161	0.161	0.162	0.163	0.153	0.144	0.136	0.128	0.121
9.0	0.132	0.132	0.133	0.134	0.135	0.128	0.121	0.114	0.108	0.102

- the average of the measured values must be less than the average of the corresponding individual values in Table 4.
- each measured value is compared to the corresponding individual values in Table 4. No more than one in five of the measured values can be greater than one-and-a-half times the corresponding criteria values in Table 4.

TABLE 63

SUMMARY OF EFFLUENT MONITORING RESULTS FOR OCELET INDUSTRIES LTD., PE-6006, 1984

CHARACTERISTICS	UNITS	# OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	ARITHMETIC MEAN	PERMIT LIMITS
Aluminum	mg/L	1	0.12	0.12	0.12	
Calcium, total	mg/L	2	24.6	7.3	16.0	
Chromium, total	mg/L	21	<0.1	<0.1	<0.1	
C.O.D.	mg/L	12	1065*	36*	192*	30
Conductance, specific	μS/cm	1	2480	2480	2480	
Copper, total	mg/L	12	0.05	<0.05	<0.05	
Flow	m^3/d	343	2766*	848*	1536*	750**
Iron, total	mg/L	12	4.13	0.70	1.49	
Lead, total	mg/L	2	<0.01	<0.01	<0.01	
Magnesium, total	mg/L	2	3.33	1.04	2.19	
Manganese, total	mg/L	2	0.05	0.02	0.04	
Methanol	mg/L	11	427	<10	78	
Molybdenum, total	mg/L	12	<0.1	<0.2	<0.2	
Nickel, total	mg/L	12	<0.1	<0.1	<0.1	
Oil and grease	mg/L	12	25*	0	12*	10
Organic carbon, total	mg/L	12	163*	12	44	
pH	pH	343	10.9*	2.2*	7.3	6.5-8.5
Phosphorus, total	mg/L	1	5.68	5.68	5.68	
Solids, total	mg/L	12	1175	209	618	
Sulphate, total	mg/L	1	1040	1040	1040	
Suspended solids, total	mg/L	12	50*	10	2.9*	30
Temperature	°C	344	51.5*	10.5	29.1*	22
Total inorganic carbon	mg/L	12	21	2	12	
Zinc, total	mg/L	12	0.07	<0.05	<0.05	

* Exceeds permit limits
** Mean value, maximum value is 1 000