MINISTRY OF ENVIRONMENT
PROVINCE OF BRITISH COLUMBIA

WATER QUALITY ASSESSMENT AND OBJECTIVES, OKANAGAN AREA, TRIBUTARIES TO OKANAGAN LAKE

(Peachland, Trepanier, Westbank, Powers, Faulkner and Lambly Creeks)

TECHNICAL APPENDIX

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1. INTRODUCTION

1.1 BACKGROUND

The British Columbia Ministry of Environment is preparing water quality assessments and objectives in priority water basins in British Columbia. This report describes the water quality within certain selected tributaries to the central portion of Okanagan Lake on its west shore (Figure 1). Presented in this report are data collected to April 1988. The objectives are being developed for tributaries to Okanagan Lake as part of a fisheries management plan. As well, objectives are required for Peachland and Trepanier creeks to be used in conjunction with mine abandonment plans for Brenda Mines.

Four additional reports evaluating water quality in other selected tributaries to Okanagan Lake are in preparation. One report deals with Kelowna and Mission creeks; a second deals with Lower Vernon, Equesis and Deep creeks; a third deals with Eneas, Trout, and Prairie creeks; while the fourth deals with Penticton and Naramata creeks.

1.2 PROVISIONAL WATER QUALITY OBJECTIVES - BASIC PHILOSOPHIES

Water quality objectives are established in British Columbia for waterbodies on a site-specific basis[1]. The objective can be a physical, chemical or biological characteristic of water, biota or sediment, which will protect the most sensitive designated water use at a specific location with an adequate degree of safety[1]. The objectives are aimed at protecting the most sensitive designated water use with due regard to ambient water quality, aquatic life, waste discharges and socio-economic factors[1].

Water quality objectives are based upon approved or working water quality criteria which are characteristics of water, biota, or sediment[1] that must not be exceeded to prevent specified detrimental effects from occurring to a water use[1]. The working criteria upon which many of the proposed provisional objectives are based come from the literature, and are referenced in the following chapters. The B.C. Ministry of Environment is in the process of developing approved criteria for water quality characteristics throughout British Columbia, to form part of the basis for permanent objectives.

As a general rule, objectives are only set for water bodies where man-made influences threaten a designated water use, either now or in the future. Provisional objectives are proposed in this report, and are to be reviewed as more monitoring information becomes available and as the Ministry of Environment establishes approved water quality criteria.

The provisional objectives take into account the use of the water to be protected and the existing water quality. They allow for changes from background which can be tolerated, or for upgrading which may be required. Any change from background which is allowed indicates that some waste assimilative capacity can be used while still maintaining a good margin of safety to protect designated water uses. In cases of water quality degradation, objectives will set a goal for corrective measures.

The objectives do not apply to initial dilution zones of effluents. These zones in rivers are defined as extending up to 100 m downstream from a discharge, and occupying no more than 50 percent of the width of the river, from its bed to the surface. In lakes, initial dilution zones are defined as extending up to 100 m horizontally in all directions from the discharge, but not to exceed 25% of the width of the water body.

In cases where there are many effluents discharged, there could be some concern about the additive effect of dilution zones in which water quality objectives may be exceeded. Permits issued pursuant to the Waste Management Act control effluent quality which in turn determines the extent of initial dilution zones and the severity of conditions within them. In practice, small volume discharges or discharges with low levels of contaminants will require mixing zones much smaller than the maximum dilution zone allowed. The concentrations of contaminants permitted in effluents are such that levels in the dilution zones will not be acutely toxic to aquatic life or create objectionable or nuisance conditions. Processes such as chemical changes, precipitation, adsorption and microbiological action, as well as dilution, take place in these zones to ensure that water quality objectives will be met at their border.

1.3 DESCRIPTION OF WATERSHEDS

1.3.1 PEACHLAND CREEK

Peachland Creek enters Okanagan Lake from the west near Peachland (Figure 2). It is about 22 km long between Okanagan and Peachland Lakes descending in an easterly direction at a slope of about 0.041 m/m. It flows through a relatively steep treed valley, with human activity along its banks for a distance of about two to three kilometres above Okanagan Lake. Peachland Creek has a drainage area of about 150 km^2.

Peachland Creek has been altered in its upper headwaters by Brenda Mines (Section 4.1.1) in an effort to secure sufficient quantities of fresh water for its operation.

Upper Peachland Creek (above Peachland Lake) is used as a conduit to convey fresh water to Peachland Lake from the original Peachland Creek watershed and from Brenda Lake. Upper Peachland Creek has been diverted so that it flows into Peachland Lake which acts as a water reservoir for Brenda Mines. Brenda Mines is required to release water downstream from Peachland Lake into Peachland Creek, as required for downstream water users.

1.3.2 TREPANIER CREEK

Trepanier Creek enters Okanagan Lake from the west, about three kilometres north from Peachland (Figure 2). It travels a distance of about 25 km from its headwaters at a small unnamed lake to Okanagan Lake, descending in an easterly direction at a rate of about 0.031 m/m.

There is considerably more human settlement near Trepanier Creek in its lower 2 to 3 kilometres than along Peachland Creek. The new Coquihalla Highway (Phase 3) is being constructed along its southern bank. Trepanier Creek near its mouth has a drainage area of 254 km^2.

Brenda Mines (Section 4.1.1) has altered the flows in one tributary (MacDonald Creek) to Trepanier Creek, but has not affected the main Trepanier Creek watershed.

MacDonald Creek has been used as the tailings impoundment for Brenda Mines, and the headwaters for lower MacDonald Creek start below Brenda's lower reclaim dam. Water from MacDonald Creek above the mine has been diverted into the Peachland Creek system.

1.3.3 POWERS CREEK

The headwaters for Powers Creek are Dobbin and Islaht Lakes, 28 km to the northwest from Okanagan Lake (Figure 2). Powers Creek descends at an average slope of 0.040 m/m, entering Okanagan Lake at the south side of Westbank. Powers Creek has a drainage area of 144 km^2. Human activity occurs for approximately five kilometres along its lower reaches where the creek slope is flatter (0.036 m/m).

1.3.4 WESTBANK CREEK

Westbank Creek is only about 750 m long; however, its major tributary (Smith Creek) is about two kilometres longer (Figure 2). Westbank Creek flows in a southerly direction through Westbank at an average slope of about 0.09 m/m. It has a drainage area of 14 km^2. Smith Creek descends in a southerly direction to Westbank Creek at a slope of about 0.048 m/m. Human activity is centered around both Westbank and Smith creeks.

1.3.5 MCDOUGALL CREEK

About 11.5 km upstream from Okanagan Lake to the west, Hidden and Hayman creeks join to form McDougall Creek (Figure 2). From this point, McDougall Creek descends in a southerly direction at an average slope of 0.047 m/m before entering Okanagan Lake just east from Westbank. It has a drainage area of about 39 km^2. There are small amounts of human activities in its lower five kilometres.

1.3.6 FAULKNER CREEK

Faulkner Creek is a short creek which enters Okanagan Lake on the west shore directly opposite Kelowna. No information was available on the creek slope, although it would likely be similar to that of McDougall or Lambly creeks.

1.3.7 LAMBLY CREEK

Lambly Creek enters Okanagan Lake about four kilometres to the north from Westside (Figure 2). From its headwaters about 20 km from Okanagan Lake, it flows first northerly, then easterly and finally in a south-easterly direction, descending at an average slope of about 0.036 m/m. Lambly Creek has a drainage area of 272 km^2. There is no human activity along the creek.

2. HYDROLOGY

Flows for creeks discussed in this technical appendix are regulated, so that frequency analysis cannot be performed. It is also difficult to discuss flow regimes; however, natural flows would likely see freshet occur during spring with snowmelt and flows would typically diminish during the hot summer months. Flows have not been recorded in Faulkner Creek.

2.1 PEACHLAND CREEK

Peachland Creek is regulated by Brenda Mines with a release structure on Peachland Lake. Historically, Peachland Creek upstream from Peachland Lake did not enter the lake itself. However, this was modified in the late 1960's (see Section 4.1.1) to augment water supplies for Brenda Mines. The headwaters for Peachland Creek is now really Peachland Lake since the flows from Peachland Creek above Peachland Lake (Upper Peachland Creek) are only a portion of the inflows to Peachland Lake. Portions of flow from Upper Peachland Creek can still be diverted along the old creek bed, thereby bypassing Peachland Lake if the need arises. However, this has never happened.

Flows in Peachland Creek are diverted by the Peachland Irrigation District for one of two water supply sources for Peachland. Flow station 08NM140 is just above the diversions. Mean monthly flows for the period 1966 to 1982 varied from 0.082 m^3/s in January to 1.27 m^3/s in May. For the period of record for years with complete records (9), seven-day low flows ranged from 0.025 m^3/s in 1978 to 0.073 m^3/s in 1975. The mean seven-day low flow for this period was 0.037 m^3/s.

Flow station 08NM159 is located at the mouth of Peachland Creek. Mean monthly flows for the period 1969 to 1982 ranged from 0.084 m^3/s in January to 0.790 m^3/s in May. For the same period of record for years with complete records (13), seven-day low flows ranged from 0.030 m^3/s in 1980 to 0.181 m^3/s in 1975. The mean seven-day low flow for this period was 0.071 m^3/s.

2.2 TREPANIER CREEK

Flows in Trepanier Creek, which passes near the Brenda Mines operation, have not been directly altered by the mining operation, although flows in a Trepanier Creek tributary (MacDonald Creek) have been. MacDonald Creek and Long Lake Creek above the mine were diverted in 1968/1969 into the Peachland Creek system as part of mine construction. Within the mine site any water collected in these creek beds flows into the tailings pond (Section 4.1.1) since they are exposed to contaminated runoff. Seepage from the tailings impoundment collects in the lower reclaim dam (downstream from the tailings dam). Any seepage from the lower reclaim dam is the headwaters for MacDonald Creek.

Flows in Trepanier Creek are diverted to be used as a portion of the water supply to Peachland. Flow station 08NM041 above the diversion had mean monthly flows for the period 1919 to 1927 and 1960 to 1980 of 0.193 m^3/s in February to 4.69 m^3/s in May. For the same period of record for years with complete records (10), seven-day low flows ranged from 0.088 m^3/s in 1980 to 0.203 m^3/s in 1974. The mean seven-day low flow for this period was 0.147 m^3/s.

Flow station 08NM155 is located near the mouth of Trepanier Creek. Mean monthly flows for the period 1969 to 1981 ranged from 0.102 m^3/s in January to 6.5 m^3/s in May. For the same period of record for years with complete records (12), seven-day low flows ranged from 0.0 m^3/s in 1970, 1973 and 1977 to 0.15 m^3/s in 1976. The mean seven-day low flow for this period was 0.033 m^3/s.

2.3 POWERS CREEK

Powers Creek is diverted by the Westbank Irrigation District. Mean monthly flows at station 08NM157 at the mouth in the period 1969 to 1981 ranged from 0.135 m^3/s in February to 4.31 m^3/s in May. Seven-day low flows for 1969 to 1982 for years with complete sets of data (12) ranged from 0.045 m^3/s in 1980 to 0.139 m^3/s in 1978. The mean seven-day low flow was 0.076 m^3/s.

2.4 WESTBANK CREEK

Flows in Westbank Creek were recorded at station 08NM198 from 1972 to 1975. Mean monthly flows at the mouth ranged from 0.025 m^3/s in June to 0.102 m^3/s in May. Seven-day low flows were 0.007 m^3/s in July 1973 and 0.014 m^3/s in January 1974, the only two years with complete records.

2.5 MCDOUGALL CREEK

Flows in McDougall Creek were gauged only in the period 1920 to 1926 at station 08NM014 near Westbank. However, there is not a complete data set for any of these years. Bearing in mind that flows were recorded only from April to September, mean monthly flows ranged from 0.010 m^3/s in September to 0.938 m^3/s in May. Seven-day low flows which were probably not the low flows for this creek ranged from 0.003 m^3/s to 0.215 m^3/s; however, it must be emphasized that these were not likely the true low flows.

2.6 LAMBLY CREEK

Flows were recorded at station 08NM003 near the mouth from 1919 to 1921 and from 1965 to 1975. Mean monthly flows ranged from 0.148 m^3/s in January to 8.87 m^3/s in May. Seven-day low flows for the same period of record with complete records (5) ranged from 0.0 m^3/s in 1970, 1971 and 1973 to 0.047 m^3/s in 1972. The average seven-day low flow was 0.013 m^3/s.

3. WATER USES

The following are the licensed withdrawals from the tributaries to Okanagan Lake covered in this report:

Watershed	No. of Licenses	Volume Permitted Waterworks (dam^3/an)	Domestic* (m^3/d)	Irrigation (dam^3/an)
Trepanier	95	1787	12.5	1421
Peachland	26	664	6.8	2806
Powers	46	0	47.7	3216
Westbank	3	0	2.27	262
Lambly	26	2605	9.1	8017
Faulkner	1	0	0	28
McDougall	0	-	-	-

* includes stock watering

Upstream from Okanagan Lake for about 2.5 km along Trepanier Creek, the land is suitable for agriculture. Upstream from this point, the land has slopes in excess of 30% and shallow soil veneer and bedrock outcrops[16]. Thus irrigation is only a use downstream in Trepanier Creek from this point. A similar situation exists for the other tributaries, although the distance increases to about 4 km for Powers, Faulkner, and McDougall creeks.

In addition, all these creeks except Westbank support spawning populations of kokanee and/or rainbow trout. In terms of Regional priority, Powers, Peachland and Trepanier creeks are ranked as numbers 2, 3, and 5 of 18 Okanagan Lake tributaries, while Lambly Creek is priority 8 and McDougall Creek is priority 16. Westbank Creek was not rated as a priority water body.

Salmon do not spawn or rear in tributaries to Okanagan Lake.

4. PERMITTED WASTE DISCHARGES

Discharges under permit that are still active are located on Figures 2 and 3 by their permit numbers.

4.1 PEACHLAND/TREPANIER CREEKS

4.1.1 BRENDA MINES (PE 211, PE 263)

4.1.1.1 General Description

Brenda Mines has an open-pit copper-molybdenum mine and concentrator operation on a divide between Peachland and Trepanier Creek watersheds, about 19 km northwest from Peachland. It began processing ore in 1970, and it was planned that the operation would be terminated in mid-1990. However, the pit wall collapsed in early 1990 causing an earlier than planned cessation of the operation.

Ore is crushed, screened, and ground before flotation. Initially, a rougher bulk concentrate containing all the molybdenum and copper values is made and the tailings of this rougher circuit are sent to the tailings pond. The rougher concentrate is upgraded in the bulk cleaner circuit, the concentrate of which is sent to the separation circuit. The tailings from the bulk cleaner circuit are returned to the rougher bulk flotation feed end. In the separation circuit, molybdenum is separated from the copper. The molybdenum comes out in the concentrate which is reground in a ball mill and upgraded in the molybdenum cleaner circuit. The copper is part of the tailings in the separation circuit. These are thickened and upgraded in the copper cleaning flotation circuit. The concentration from this circuit containing 27% copper (as $CuFeS_2$) is filtered and dried before shipping. The concentrate from the molybdenum cleaner circuit is filtered and then leached prior to drying. This concentrate contains about 56% molybdenum (as MoS_2).

In the milling and concentrating of the ore, the following reagents are used: sodium cyanide, xanthate, MIBC, fuel oil, sodium hydrosulphite, sodium chloride, and ferric chloride.

Mill tailings, treated domestic sewage from a two-celled 0.4 ha stabilization lagoon (covered in part by Waste Management Permit PE 211), water from the open pit (located at the west end of the site) and surface runoff from the mill and waste rock dump are discharged to a tailings pond located about 4 km from the mill at the east end of the site. Waste Management Permit PE 263 allows the discharge of 140 000 m^3/d to the tailings impoundment. There are two water reclaim dams which intercept seepage from the tailings pond through either the main tailings dam to the north (lower reclaim pond) or the saddle dam at the south (upper reclaim pond). Reclaim water is returned to the tailings dam using two -3.2 m^3/min pumps at the saddle dam and three pumps at the main tailings dam with a combined capacity of 12.0 m^3/min.

A large proportion of the water (over 90%) used in the concentrator is recycled from the tailings impoundment from where it is placed in a reclaim reservoir. The balance of the water used in the concentrator is withdrawn from Peachland Lake (Figure 3).

In order to ensure adequate supplies of freshwater to the mill, several diversions have taken place. Some flow from Brenda Creek was diverted into Peachland Creek, near its headwaters. MacDonald Creek downstream from MacDonald Lake was diverted into Peachland Creek about five kilometres below the Brenda Creek diversion but upstream from Peachland Lake. Some flow from Crescent Lake was diverted via the Crescent Canal into Peachland Lake. As well, a dam was constructed at the outlet from Peachland Lake to control flow in the lower end of Peachland Creek. This effectively resulted in the headwaters of MacDonald Creek originating downstream from the tailings impoundment, and the headwaters for Peachland Lake originating at the Peachland Lake Dam.

4.1.1.2 Seepage Water

Seepage from the tailings impoundment not recovered could enter either Peachland Creek or MacDonald Creek, the latter being a tributary to Trepanier Creek. Seepage through the drains from the tailings impoundment was sampled in 1983, 1984, and 1985. The characteristics of principal concern are shown in Table 1.

Weak-acid-dissociable cyanide values have been about 0.009 mg/L (median value) while total cyanide have been 0.027 mg/L, dissolved copper 0.002 mg/L, dissolved

molybdenum 1.11 mg/L, and sulphate 251 mg/L (mean values). The receiving water criterion to protect drinking water supplies is 0.2 mg/L strong-acid dissociable cyanide plus thiocyanate. Other criteria are 0.010 mg/L maximum weak-acid dissociable cyanide[3] to protect aquatic life, 0.05 mg/L maximum molybdenum to protect irrigation waters[4], about 0.004 mg/L copper based upon an assumed hardness of 100 mg/L to protect aquatic life[5], and 150 mg/L sulphate for aesthetics and 500 mg/L to protect health of consumers[2]. The data in Table 1 indicate that the maximum recorded values in the seepage water for weak-acid dissociable cyanide, copper, and molybdenum exceeded the ambient receiving water criteria; however, most of this seepage water is recycled. Concerns would only exist for that portion of the seepage water which made its way to MacDonald or Peachland creeks, and that seepage water would require only minimal additional dilution, except for molybdenum. The maximum recorded molybdenum value would require over 50:1 dilution to meet the ambient criteria for the maximum value in irrigation water.

4.1.1.3 Bypasses

Two bypasses have occurred during the life of the operation. For three days in April 1976, pump failures caused the discharge of about 45 m^3 of water from the reclaim reservoir into MacDonald Creek. From February to April, 1984, a discharge from the tailings impoundment into Peachland Creek was permitted in order to reduce water levels which were threatening dam stability of the tailings impoundment. The results of water quality monitoring related to this latter discharge have been reported by Bryan[6] and are summarized below.

For invertebrates collected from both Trepanier and Peachland creeks, Bryan reported[6] that "there was about the same number of kinds of invertebrates before as after (the discharge), although for both creeks the taxa collected differed slightly between the two times. Had the tailings wastewater been particularly toxic, some of the taxa such as mayflies and stoneflies would have been greatly reduced after the tailings release in Peachland but not Trepanier Creek". No toxic effects were evident.

Several water quality characteristics increased to a greater extent in Peachland Creek at the mouth in comparison to Trepanier Creek at the mouth. These included molybdenum,

copper, sulphate, sodium, and specific conductivity. Phosphorus, chlorophyll, iron, and ammonia were not increased[6].

4.1.1.4 Local Water Quality Impacts on MacDonald Creek

Samples have been collected from MacDonald Creek at Site 0500044 about 1.5 km downstream from the tailings impoundment and about 1 km further downstream at Site 0500351. At the latter site, MacDonald Creek widens and this location is sometimes called the "settlement pond". It would be anticipated that such an area would reduce contaminants attached to solids and measured in the total state, not dissolved materials. In fact data in Tables 2 and 3 for Sites 0500044 and 0500351 indicate that both dissolved and suspended fractions are reduced at the settlement pond. Data included below for dissolved molybdenum illustrate this (except for values near the detection limit of 0.01 mg/L).

	Dissolved Molybdenum MacDonald Creek	
Date	Site 0500044 at Tailings Dam	Site 0500351 At Settlement Pond
82.10.26	0.34	0.14
83.04.14	0.49	0.22
83.07.26	0.27	0.07
83.10.13	0.07	0.09
84.07.25	0.02	0.02
85.05.14	0.01	0.02
85.09.17	0.07	0.01

Due to the nature of the ore being milled, it would be anticipated that seepage from the tailings impoundment might impact on the following characteristics in MacDonald Creek: toxicity, cyanide, copper, molybdenum, lead, zinc, nitrogen, and phosphorus. No impact on toxicity seems to exist from the limited toxicity data, as measured using Daphnia or the microtox procedure. All measurements were > 100%. All cyanide (total and weak-acid dissociable) measurements at both sites in MacDonald Creek have been below the criterion of 0.010 mg/L[3] for the maximum allowed concentration of weak-acid dissociable cyanide to protect freshwater aquatic life.

The average water hardness in MacDonald Creek is in excess of 150 mg/L (Tables 2 and 3). At this hardness, allowable total copper concentrations are 0.006 mg/L as an average value and 0.016 mg/L as a maximum value according to approved B.C. criteria[5]. Values in Tables 2 and 3 for average and maximum dissolved copper concentrations greatly exceed these criteria for freshwater aquatic life, at concentrations of 0.016 mg/L (average) and < 0.1 mg/L (maximum) at Site 0500044 and 0.013 mg/L (average) and 0.14 mg/L (maximum) at Site 0500351. Copper values measured in MacDonald Lake, the original headwaters of MacDonald Creek upstream from the mine site, were < 0.01 mg/L in June 1983 and 1984. Data for Site 0500854 (Table 4), which reflect runoff from the waste rock pile plus some dilution by creek flow, were 0.013 mg/L as an average and 0.03 mg/L as a maximum. Copper values were virtually the same as these at Site 0500770 (Table 5) at the diversion to Peachland Lake. It is therefore evident that seepage from the tailings impacts copper concentrations in the MacDonald Creek and that these concentrations likely originate with the tailings and not drainage from the waste rock pile.

As indicated previously, molybdenum concentrations in MacDonald Creek are reduced at the settlement pond (Site 0500351). However, the maximum measured dissolved value at Site 0500351 (0.3 mg/L) exceeded B.C. criteria for total molybdenum of 0.25 mg/L for drinking water, 0.08 mg/L for some livestock uses or 0.05 mg/L for all other livestock uses or wildlife, as well as irrigation waters[4]. Measurements of dissolved molybdenum in MacDonald Lake above the mine operation, in June 1983 and 1984, were both <0.01 mg/L. Concentrations at Site 0500854 near the waste rock pile were 5.24 mg/L as an average and 8.11 mg/L as a maximum (Table 4). At the diversion to Peachland Lake (Site 0500770 - Table 5), concentrations were 0.12 mg/L as an average and 0.95 mg/L as a maximum. Thus, the mine operation is impacting molybdenum concentrations in MacDonald Creek; however, the settlement pond appears to be reducing the eventual impact on Trepanier Creek.

B.C. criteria for total lead to protect freshwater aquatic life at a hardness of 150 mg/L are 0.009 mg/L as an average and 0.137 mg/L as a maximum concentration. The average dissolved value was 0.035 mg/L at both Sites 0500044 (Table 2) and 0500351 (Table 3), which exceeds the criterion. Lead values in June 1983 and June 1984 in MacDonald Lake, upstream from the mine site and the original headwaters for MacDonald

Creek (Site 0500853), were both < 0.1 mg/L. All lead values at Site 0500854 and 0500770 (Tables 4 and 5) were below varying detection limits and were not included in the Tables. Thus drainage from the mine site and seepage from the tailings dam are impacting lead values in MacDonald Creek.

The working water quality criterion to protect freshwater aquatic life from zinc is a maximum concentration of 0.03 mg/L[8]. All dissolved and total zinc values at Sites 0500044 and 0500351 were less than this criterion. At Site 0500853 in MacDonald Lake, values in June 1983 and 1984 were < 0.01 mg/L. The average dissolved zinc concentration at the waste rock pile (Site 0500854) was 0.014 mg/L (Table 4) while it was 0.021 mg/L at Site 0500770 at the diversion. Therefore the mine operation is increasing zinc concentrations in MacDonald Creek.

The average nitrate nitrogen values were 0.28 mg/L at Site 0500044 and 0.25 mg/L at Site 0500351, above the maximum level of 0.04 mg/L measured in MacDonald Lake. Average ammonia nitrogen levels of 0.05 mg/L at Site 0500044 and 0.008 mg/L at Site 0500351 were higher than the level of <0.005 mg/L measured in MacDonald Lake. Nitrate-N concentrations near the waste rock piles were significantly higher (Table 4), with a maximum of 16.2 mg/L and an average of 12 mg/L. Values at Site 0500770 at the diversion (Table 5) were 0.3 mg/L as an average and 2.85 mg/L as a maximum. Ammonia concentrations at the waste rock pile were 0.007 mg/L (average) and 0.014 mg/L (maximum) compared to their respective values of 0.01 mg/L and 0.051 mg/L at the diversion (Table 5). Although an impact from the mine operation is apparent, all measured values in MacDonald Creek were below criteria of 10 mg/L nitrate-N and maximum ammonia-N (pH 8.5, temperature 20°C) of 1.92 mg/L and average ammonia-N of 0.261 mg/L[9].

Dissolved phosphorus and total phosphorus levels in MacDonald Lake have been as high as 0.006 mg/L and 0.022 mg/L, respectively, in June 1983. Average levels in MacDonald Creek were 0.096 mg/L and 0.012 mg/L (fewer measurements), respectively at Site 0500044 and 0.315 mg/L and <0.1 mg/L, respectively at Site 0500351. The impact that these increased phosphorus levels would have in promoting algal growths is not known. At the waste rock pile (Site 0500854: Table 4), average phosphorus values were 0.008 mg/L as dissolved and 0.017 mg/L as total, while maximum values were

0.013 mg/L and 0.044 mg/L, respectively. These are similar to levels measured at Site 0500770 at the diversion (Table 5).

During 1983, eight replicate rainbow trout were collected from Site 0500853 at MacDonald Lake (Table 6) and six from Site 0500351 at the settlement pond (Table 7). A comparison of the data for the fish using the F-test (P = 0.05) and t-test (P = 0.05) procedures indicated that calcium, aluminum, and iron concentrations in the muscle were significantly different, while magnesium, copper, manganese, and zinc were statistically similar. Statistical comparisons could not be made for mercury or molybdenum; however, values in fish from the settlement pond appeared to be considerably higher.

4.1.1.5 Local Water Quality Impacts on Trepanier Creek

In an attempt "to screen" which water quality characteristics might be impacted in Trepanier Creek from the input of water from MacDonald Creek, mean and maximum values at Site 0500362 upstream from MacDonald Creek (Table 8) and Site 0500079 (Table 9) were compared. Increases were only noticeable for mean concentrations for alkalinity, chloride, sodium and sulphate. For other characteristics, maximum concentrations were higher downstream for iron, zinc, ammonia, organic nitrogen, suspended solids, and sulphate. To further compare mean values, the F-test and Students t-test (P = 0.05) were applied, resulting in confirmation that the alkalinity and sulphate concentrations varied significantly going from upstream to downstream.

4.1.1.6 Local Water Quality Impacts on Peachland Creek

In an attempt to "screen" which water quality characteristics might be impacted in Peachland Creek from drainage from the Brenda Mines site, mean and maximum values were compared for Site 0500354 upstream from the mine site and MacDonald Creek diversion but downstream from the Brenda Creek diversion (Table 10) and Site 0500355 at the inlet to Peachland Lake (Table 11). Increases were noticeable for mean values for alkalinity, chloride, magnesium, barium, molybdenum, zinc, ammonia, Kjeldahl nitrogen, nitrate, nitrate/nitrite, organic and total nitrogen, dissolved and suspended solids, specific conductivity, sulphate, and turbidity. To further compare mean values, the F-test (P = 0.05) was applied where possible, resulting in confirmation that the variability in

data for alkalinity, Kjeldahl nitrogen, nitrate, nitrate/nitrite, total nitrogen, dissolved and suspended solids, specific conductivity, sulphate, and turbidity was significant.

4.1.1.7 Post-Abandonment

Brenda Mines is presently preparing plans for mine abandonment. These have included water quality assessments to predict concentrations when the operation has ceased, with the idea of installing adequate low-maintenance facilities to protect the environment[17].

The assessments have identified that high concentrations of molybdenum, sodium, and dissolved solids would be discharged, and that Trepanier Creek would be most adversely affected. Although drinking water criteria are considered achievable, those for irrigation water supplies for molybdenum are not[17]. Further work is being conducted in order to finalize the plans.

4.1.2 CORPORATION OF THE DISTRICT OF PEACHLAND (PR 2638)

The Corporation of the District of Peachland operates a refuse site located about seven kilometres west from Peachland and about one kilometre north from Peachland Creek. Soil in the area is comprised of sandy loam with large quantities of shale.

Permit PR 2638 allows the discharge of on an average 38.2 m^3 per week of municipal-type waste.

Due to the arid climate in the area and the distance to Peachland Creek, leachate from the site is not expected to be a problem.

4.2 POWERS CREEK WATERSHED

4.2.1 GORMAN BROTHERS LUMBER AND BOX LTD. (PR 5341)

This company had an industrial refuse site located about 1.6 kilometres southwest from Westbank used for disposal of log-yard refuse from a sawmill operation.

Permit PR 5341 allowed the disposal of 9.9 m^3/d. The landfill closed in 1980.

The landfill was underlaid by lacustrine clays. Due to the arid nature of the area and the fact that Powers Creek was over 750 m northeast from the landfill, leachate is not expected to be a problem.

4.3 WESTBANK CREEK WATERSHED

4.3.1 WESTBANK IRRIGATION DISTRICT (PE 1592)

The Westbank Irrigation District operates a mechanically-aerated lagoon, and stabilization pond with chlorination. To prevent wastewater from entering Westbank Creek, the Irrigation District is allowed by Waste Management permit PE 1592 to spray irrigate up to 365 m^3/d of disinfected effluent between May and October. However, spray irrigation has not occurred in recent years due to land not being available.

Westbank is actually in the process of preparing a Liquid Waste Management Plan, and is at the stage where engineering consultants will be designing a mini-Bardenpho technology wastewater treatment system consisting of a series of reactor cells with alternating anoxic and aerobic conditions. This new facility will be in operation at the earliest by 1990.

The existing discharge is being operated under permit PE 1592, which has actually expired (October 31, 1984) for the spray irrigation portion (as opposed to the direct discharge to Westbank Creek). The effluent is to have a maximum BOD_5 of 45 mg/L, suspended solids of 60 mg/L, and a chlorine residual after a one hour contact time of 0.1 to 1.0 mg/L. The maximum discharge would be about 730 m^3/d into Westbank Creek. A concern exists about the impact of the discharge on bacteriological quality at Westbank Beach on Okanagan Lake.

Seven-day low flows in Westbank Creek in the two years with complete records were 0.007 m^3/s and 0.014 m^3/s (Section 2.4). The minimum dilution available to the

maximum permitted discharge at these low flows would be 0.8:1. Thus there will be low flow conditions when effluent should not be discharged.

Effluent data are summarized in Table 12. Of concern in Westbank Creek during periods of low flow would be nitrite and ammonia. Water quality criteria for the protection of aquatic life would be a maximum 0.05 mg/L nitrite-N, and at pH 7.9 and temperature of 20°C, a maximum ammonia-N concentration of 6.64 mg/L[9]. The maximum concentrations reported in Table 12 would require minimum dilutions of 2.02:1 and 4.37:1, respectively to prevent acutely toxic effects on aquatic life.

It is also suspected that phosphorus and BOD_5 may be discharged at levels which may promote algal growths and reduce oxygen levels in Westbank Creek.

4.3.2 REGIONAL DISTRICT OF CENTRAL OKANAGAN (PR 2102)

The Regional District operates a 24 hectare landfill about 2.5 kilometres northeast from Westbank. Permit PR 2102 allows the discharge of 76 m^3/d of municipal and industrial (excluding toxic) wastes with burning to occur a maximum of four times per year.

It is unlikely that this landfill will affect water quality in Shannon Lake or Smith Creek, each of which are about 500 metres from the landfill, due to the arid nature of the area.

4.3.3 SHANNON LAKE ESTATES LTD. (PE 4301)

This company operates a municipal sewage treatment plant which receives water from a residential subdivision which is located 2.4 kilometres north from Westbank. Treatment is provided in an extended aeration plant with comminution, flow equalization and sludge storage. The effluent is discharged to 1 280 m of tile field located in sand and gravel which overlays silt and clay. The percolation rate is 25 seconds/cm.

Waste Management permit PE 4301 allows the discharge of 227 m^3/d with maximum concentrations of 20 mg/L BOD_5 and 30 mg/L suspended solids. A data

summary is in Table 13. Data for 1986 are the most recently collected for BOD_5 and suspended solids:

	BOD_5(mg/L)	**Suspended Solids (mg/L)**
86.01.30	12	4
86.04.29	< 10	3

Groundwater flows are towards Westbank Creek, 2.4 kilometres to the south. It is expected that the high quality-low volume effluent, discharged to a soil disposal system at over two kilometres from Westbank Creek, will not impact the water quality of Westbank Creek.

4.4 MCDOUGALL CREEK WATERSHED

4.4.1 BEDWELL BAY CONSTRUCTION LTD. (PE 421)

This company operates an 85-unit mobile home park located northeast from Westbank. Two sets of septic tanks are used to treat the domestic sewage; one system which has a 20.4 m^3 septic tank and 1.4 m^3 dosing chamber and 213 m of tile field and a second system using four septic tanks (116.5 m^3 capacity), one dosing chamber (6.8 m^3 capacity) and 1 219 m of tile field.

Permit PE 421 allows the discharge of a maximum of 55 m^3/d to the tile fields. The tile fields are located about one kilometre east from McDougall Creek. It is not expected that this discharge would impact the creek due to the low flow discharged to a soil disposal system.

4.4.2 MISSION HILL VINEYARDS INC. (PE 166)

This company operates a winery just east from Westbank (about 3 km). Wastewater consists primarily of washdown water used to clean various tanks, equipment, and floors. The wastewater passes through a screen prior to treatment in a 20.5 m^3

aeration tank (36 hours retention) and a 3.4 m^3 clarifier (6 hours retention), into two sets of two seepage pits (3.05 m deep by 1.2 m wide) used on alternate weeks, and located about 600 m northeast from McDougall Creek.

Waste Management permit PE 166 allows the discharge of a maximum of 14 m^3/d of effluent. Data are summarized in Table 14 for the effluent as discharged. The data indicate that the treated wastes had a high oxygen demand (minimum BOD_5 was 2 069 mg/L). It is not known if this wastewater could reach McDougall Creek, and if it did, whether the wastes were broken down sufficiently in the ground to minimize their impact on McDougall Creek.

4.4.3 KELOWNA PLATING AND BUMPER EXCHANGE LTD. (PE 3013)

This company operates a metal plating operation (bumpers) about four kilometres northeast from Westbank on the west side of Okanagan Lake.

Bumpers (used) are submerged in a strip tank (NaOH) to strip the previous coating prior to rinsing and repair. Once repaired, the bumpers are cleaned in a detergent tank, rinsed, passed through a tank containing 7 to 10% H_2SO_4 and rinsed prior to electroplating (copper tank). The bumper is again rinsed, acidified, and rinsed prior to electroplating in the nickel tank. It is then rinsed prior to electroplating in the chrome tank and then rinsed a final time.

Wastewater is generated from the rinse tanks (except chromium rinse tanks). Overflow from the chromium rinse tank is used as make-up for the chrome plating tank. The wastewater is treated in a neutralization tank (1.2 m by 0.6 m by 0.6 m) where lime is added to precipitate metal hydroxides. A three-compartment settling tank (7.9 m by 2.7 m by 1.5 m) is used prior to the effluent being discharged to an evaporation/exfiltration pond (18.3 m by 18.3 m by 1 m) located about one kilometre northeast from McDougall Creek.

Waste Management permit PE 3013 restricts the effluent to: pH from 7.0 to 9.0; maximum concentrations of suspended solids to 100 mg/L; dissolved chromium to 0.5 mg/L; dissolved copper to 1.0 mg/L; dissolved nickel to 2.0 mg/L; dissolved iron to 1.0 mg/L; dissolved zinc to 0.5 mg/L; and cyanide to 1.0 mg/L.

Data for this operation are summarized in Table 15. The data show that the neutralization facility has not operated satisfactorily, with extremely high dissolved metal levels due to widely fluctuating pH values. It is not known if this wastewater can reach McDougall Creek and if it does, whether there is an impact on McDougall Creek.

5. NON-POINT SOURCE DISCHARGES

The effects of forestry and residential developments have not been examined in this assessment. However, each would have some impact on water quality on all tributaries except Lambly Creek where only forestry would be a potential concern.

In an attempt to determine if cattle could affect any of these watersheds, statistics on the number of cattle registered with the Beef Assurance Program of the B.C. Ministry of Agriculture and Fisheries were examined. No cattle were registered to owners who might be located in these watersheds.

Other agricultural activities in the watersheds would be located near their confluence with Okanagan lake. Thus these potential impacts are considered more likely to affect Okanagan Lake than the creeks thereto.

6. AMBIENT WATER QUALITY AND PROPOSED PROVISIONAL WATER QUALITY OBJECTIVES

Designated water uses proposed for all tributaries to Okanagan Lake discussed in this report are for the protection of aquatic life and wildlife, for irrigation and livestock watering, and for use as a drinking water supply. In Trepanier Creek, irrigation will only be designated in the 2.5 km reach upstream from its confluence with Okanagan Lake.

6.1 PEACHLAND CREEK

Peachland Creek has been sampled at three locations, at Site 0500851 just downstream from Peachland Lake (Table 16); at Site 0500055 at the headwaters pond (Table 17); and at Site 0500056 at the mouth (Table 18).

6.1.1 pH AND ALKALINITY

The median pH value increased from 7.5 at Site 0500851 to 8.2 at the mouth. The maximum value of 9.0 was recorded at both Sites 0500055 and 0500056, while the minimum pH of 6.9 was recorded at Site 0500056 at the mouth. Working water quality criteria for pH are to be within a range of 6.5 to 8.5 for drinking water supply aesthetics[2] and 6.5 to 9.0 for freshwater aquatic life[8].

It is possible for seepage water from the upper reclaim dam to make its way to Peachland Creek. Since the water is already more basic at times than the maximum pH for drinking, water quality objectives are proposed for pH to protect aquatic life. The objective is that the pH should be in the range from 6.5 to 9.0 at all times. The objectives apply to Peachland Lake to its confluence with Okanagan Lake, except in initial dilution zones of effluents. In streams, the initial dilution zone is defined as extending 100 m downstream from the point of discharge, and extending no further than 50% across the stream.

Mean alkalinity values increased significantly (F-test and t-test: $P = 0.05$) from Site 0500851 to Site 0500055 and then to Site 0500056. This higher buffering capacity had also been reflected in increased median pH values.

6.1.2 HARDNESS AND METALS

Mean hardness values in Peachland Creek increased significantly (F-test and t-test: P = 0.05) between the three sites in a downstream direction from Peachland Lake, from 41.6 mg/L (Table 16) at Site 0500851 to 78.2 mg/L (Table 17) at Site 0500055 to 118.9 mg/L (Table 19) at Site 0500056 at the mouth. Desirable hardness levels are <100 mg/L for drinking water supplies[2]. Toxicity of several metals increases with decreasing hardness. Where required to compare measured concentrations of metals to water quality criteria, these mean hardness values will be used to determine appropriate criteria.

6.1.2.1 Aluminum

The mean dissolved aluminum value increased between Sites 0500851 (0.032 mg/L) and each of the two downstream sites (0.050 and 0.035 mg/L). Strictly speaking, the differences in the mean values could not be tested since the populations at the three sites were not homogeneous (F-test: P = 0.05). If the variability was homogeneous and the Students t-test was applied (P = 0.05), the differences in mean values would not be statistically significant. B.C. criteria[10] for dissolved aluminum are a maximum of 0.2 mg/L to protect drinking water supplies, and a maximum of 0.1 mg/L (pH ≥ 6.5) and an average of 0.05 mg/L to protect aquatic life. The maximum and average criteria to protect aquatic life were exceeded by only 1 of 8 values at Site 0500055. The maximum criterion was exceeded by 1 of 14 and the average criterion by 2 of 14 values measured at Site 0500056 at the mouth. Seepage from the tailings impoundment (Table 1) as measured at the lower reclaim pond contained a maximum of 0.05 mg/L dissolved aluminum. Aluminum can be used in the blasting formulation. Since seepage from the upper reclaim pond may be of similar quality and may reach Peachland Creek above Peachland Lake, a water quality objective is proposed for dissolved aluminum. The objective is that the maximum dissolved aluminum value in Peachland Creek should not exceed 0.1 mg/L and the average value should not exceed 0.05 mg/L. It must be recognized in proposing this objective that on 2 of 13 occasions, dissolved aluminum values have exceeded the maximum level of 0.1 mg/L at Site 0500354 (Table 10) upstream from Brenda Mines. Thus, upper Peachland Creek can have aluminum concentrations naturally higher than the

criterion, while lower Peachland Creek would reflect dissolved aluminum values coming out from Peachland Lake. Therefore, the proposed objective applies along all of Peachland Creek, except in initial dilution zones of effluents, described in Section 6.1.1. When dissolved aluminum values upstream from Brenda Mines exceed the objectives, values in upper Peachland Creek should not be increased significantly. Similarly, no significant increase in values in lower Peachland Creek should occur if values measured at the outlet from Peachland Creek exceed the proposed objective. To compare values on any date, and taking into account sampling vagaries and analytical precision and accuracy, a maximum increase of 20% over background levels should be permitted. This percentage increase is arbitrarily derived, but is conservative statistically since a significant increase at the 95% confidence level using five samples (the number of samples normally used by the Ministry of Environment to check objectives) with the F-test and Student's "t" test would only be measured with increases in excess of 80% going from upstream to downstream (see Reference 18). It is appropriate that the objective apply along the total length of Peachland Creek since water from upper Peachland Creek can be diverted directly into lower Peachland Creek without passing through Peachland Lake. This has never actually happened.

6.1.2.2 Copper

Criteria for total copper to protect drinking water supplies are a maximum concentration of 0.5 mg/L[5](5). To protect freshwater aquatic life, appropriate criteria for total copper using average hardness values cited earlier are as follows:

Allowable Total Copper[5] (mg/L)			
Peachland Creek Site	0500851 D/S Peachland Lake	0500055 Headwaters Pond	0500056 Mouth
Average	0.002	0.003	0.005
Maximum	0.006	0.009	0.011

Mean or median dissolved copper values increased going downstream from Peachland Creek, from a median 0.003 mg/L at Site 0500851 (Table 16), to a mean of

0.008 mg/L at Site 0500055 (Table 17), and then to a median of 0.01 mg/L Site 0500055 at the mouth (Table 18). The data are not adequate to determine if these increases are statistically significant. However, these dissolved values meet the criteria for maximum total values but do not meet criteria for average total values. Upon closer examination of the data at Site 0500851, however, 5 of 12 measurements used to determine the 0.003 mg/L median dissolved value were < 0.01 mg/L, indeterminate in terms of comparing to the criteria. If these five dissolved values are eliminated from the data set, the remaining seven dissolved values ranged from < 0.001 mg/L to 0.005 mg/L, with a mean dissolved copper value of 0.002 mg/L (median: 0.001 mg/L). Thus both criteria would be met if total values were similar to dissolved.

This was not the case at Site 0500055 where 3 of 14 dissolved copper values exceeded the maximum total value of 0.009 mg/L. However, these high dissolved values were all measured in 1971 or 1972, prior to surface water runoff from the mine site being diverted (in 1975) to the tailings impoundment. If values measured since 1975 at Site 0500055 are examined, the dissolved copper values were either measured at 0.001 mg/L (n = 4) or < 0.01 mg/L (n = 7). Thus the maximum criterion (and possibly the average criterion) has been met since 1975, if it is assumed that dissolved values reflect what total values would be.

At Site 0500056 at the mouth, if data since 1975 are examined, and duplicate analyses with higher detection limit are eliminated, dissolved values (n = 73) ranged from <0.001 mg/L to 0.05 mg/L. This high dissolved value of 0.05 mg/L (September 11, 1978) is the only dissolved value exceeding 0.01 mg/L on the computer data listing. Since a duplicate analysis on the same day had a reported value of < 0.01 mg/L, and since 0.05 mg/L was the higher analytical detection limit at that time, the maximum 0.05 mg/L is likely a problem of incorrect data entry. Using only detectable values or the absolute value of non-detectable values less than the average criterion, excluding pre-1976 data and the questionable value of 0.05 mg/L, the mean dissolved copper value at Site 0500056 (n = 39) was 0.0022 mg/L (Standard deviation: 0.0021 mg/L) with a range from < 0.001 mg/L to 0.01 mg/L dissolved copper.

Upstream from Peachland Lake, using similar data handling techniques, dissolved copper values (n = 10) at Site 0500354 upstream from Brenda Mines ranged from

< 0.001 mg/L to 0.05 mg/L (mean: 0.007 mg/L; standard deviation: 0.015 mg/L) while dissolved values at Site 0500355 at the inlet to Peachland Lake (n = 38) ranged from <0.001 mg/L to 0.11 mg/L (mean: 0.0075 mg/L; standard deviation: 0.0179 mg/L). The increase in mean dissolved values between the two sites was not statistically significant (F-test and t-test: p = 0.05). Water quality criteria for total copper for an average hardness of 42.1 mg/L (Table 11) would be ≤ 0.002 mg/L as an average and 0.006 mg/L as a maximum. Upstream from Peachland Lake, the maximum criterion level was exceeded by dissolved values on 7 of 38 occasions at Site 0500355 and on 2 of 10 occasions at Site 0500354.

Seepage water from the lower reclaim dam contained a maximum of 0.008 mg/L dissolved copper. However, only four measurements were made, therefore the data base is insufficient to speculate if seepage water from the upper reclaim dam might impact Peachland Creek above Peachland Lake.

In order to protect aquatic life from the effects of total copper, a provisional water quality objective is proposed. The objective is that the average total copper should not exceed 2 µg/L (hardness <50 mg/L) or ≤ (0.04 average hardness) µg/L if hardness ≥50 mg/L and the maximum total copper should not exceed (0.094 (hardness) + 2) µg/L. This objective applies along the length of Peachland Creek, except in the initial dilution zones of effluents described in Section 6.1.1. The average value is to be calculated from a minimum of five weekly samples collected in a period not to exceed thirty days. When total copper values upstream from Brenda Mines or at the outlet from Peachland Lake exceed the objective, values in upper Peachland Creek, or in lower Peachland Creek, respectively, should not be increased significantly. For the purpose of practicality, as discussed in Section 6.1.2.1, a significant increase will be defined as exceeding upstream values by 20%. This percentage increase is conservative from a statistical view point.

6.1.2.3 Molybdenum

In order to appreciate levels of dissolved molybdenum in Peachland Creek prior to the establishment of Brenda Mines, the data base for Site 0500354 on Peachland Creek (Table 10) upstream from Brenda Mines can be examined. Only 4 of 91 values have

exceeded 0.01 mg/L, the most restrictive ambient water quality criteria for the use in irrigation of forage crops[4].

The dates and levels of these excursions were:

Date	Dissolved Molybdenum (mg/L)
79.08.22	0.03
80.04.16	0.02
83.04.16	0.04
83.07.26	0.02

Downstream in Peachland Creek, both just above Peachland Lake and in lower Peachland Creek, the variability in data between Sites 0500354 and 0500851 was significant; therefore strictly speaking, statistical procedures should not be used to compare mean values at this Site and the other four. However, if the Student's t-test is used (ignoring F-test results), mean values were significantly higher statistically (t-test: $P = 0.05$) downstream at levels of 0.04 mg/L at Site 0500355 and values of 0.058 mg/L, 0.055 mg/L, and 0.052 mg/L going downstream at Sites 0500851 (Table 16), 0500055 (Table 17) and 0500056 (Table 18). These latter three mean values are not statistically different (F-test and t-test: $P = 0.05$) from each other.

Brenda Mines recognized that surface runoff from their property was carrying high concentrations of molybdenum to nearby streams, and diverted these contaminated sources to the tailings impoundment in 1978-1979. However, values in Peachland Lake were raised as a result of the input of molybdenum prior to 1978.

Seepage from the upper reclaim pond or uncollected surface runoff would appear to be affecting dissolved molybdenum values in Upper Peachland Creek. Dates for which samples were collected at both Site 0500354 upstream from Brenda Mines and 0500355 at the inlet to Peachland Lake are reported below:

Date	Dissolved Mo (mg/L) 0500354	Dissolved Mo (mg/L) 0500355
81.06.10	< 0.01	0.02
82.10.27	< 0.01	0.03
83.04.13	0.01	0.05
83.07.26	0.02	< 0.01
83.10.12	< 0.01	0.03
84.07.13	< 0.01	0.05
85.05.14	0.0052	0.04
85.09.17	0.0017	0.03
86.02.10	0.0018	0.02
86.06.17	0.0018	0.04
87.01.20	0.0034	0.02

These data verify that the mine operation is still impacting the water quality of upper Peachland Creek. This continued impact, in conjunction with past inputs to Peachland Lake, continues to be reflected in dissolved molybdenum concentrations downstream from the lake.

The most sensitive water uses upstream from Peachland Lake are for aquatic life and wildlife. Water quality criteria to protect these are for maximum molybdenum concentrations 2.0 mg/L and 0.05 mg/L, respectively[4]. Two of 15 values recorded at Site 0500355 have exceeded the criterion for protection of wildlife. It does not seem unreasonable that this should be the proposed water quality objective for upper Peachland Creek, i.e. that the maximum concentration in any sample from upper Peachland Creek should be 0.05 mg/L, except in initial dilution zones of effluents, described in Section 6.1.1.

In lower Peachland Creek, molybdenum concentrations are determined, for a large part, on concentrations of molybdenum in Peachland Lake. A record of monthly measurements made by Brenda Mines is included in Figure 4. These data illustrate that molybdenum values in the lake have been reduced dramatically since the earliest records,

likely due to surface water from the mine site being diverted to the tailings impoundment in 1978-1979.

The calculated mean yearly dissolved molybdenum concentrations in Peachland Lake are plotted in Figure 5. These illustrate that, generally, average values are being reduced on a yearly basis. This will be reflected in the future, downstream in lower Peachland Creek, and will be of benefit to downstream water users. It is not known if dissolved molybdenum concentrations in Peachland Lake will ever reach the unaffected level of 0.01 mg/L concentration found in Peachland Creek upstream from Brenda Mines.

Downstream from Peachland Lake, water uses most sensitive to molybdenum concentrations are wildlife, irrigation, and livestock watering, all of which can tolerate a maximum concentration of 0.05 mg/L[4]. During periods of irrigation, average concentrations should be ≤0.01 mg/L[4]. This latter level is unlikely to be achieved in the short-term, if at all. To protect downstream water users, a water quality objective is proposed for Peachland Creek between Peachland Lake and Okanagan Lake. The objective is that the maximum concentration should be 0.05 mg/L, and in the long-term, the average concentration during irrigation season (May-September) of five weekly samples should be ≤ 0.01 mg/L. Recognizing the role of Peachland Lake in determining downstream water quality, should total molybdenum concentrations in Peachland Lake exceed the proposed objectives, no significant increase in concentrations in lower Peachland Creek should occur. For the purpose of practicality, as discussed in Section 6.2.1, a significant increase will be defined as exceeding comparable values measured in Peachland Lake by 20%. This percentage increase is conservative from a statistical viewpoint (Section 6.1.2.1).

6.1.2.4 Zinc

Zinc concentrations in upper Peachland Creek upstream from Brenda Mines (Site 0500354) were always ≤ 0.01 mg/L, except for one value of 0.15 mg/L recorded on April 13, 1983. All detectable values measured at Site 0500355 at the inlet to Peachland Lake were ≤ 0.03 mg/L, the water quality criterion for protection of aquatic life[8]. In fact, values measured since 1980 have been <0.01 mg/L.

In lower Peachland Creek, all values since the implementation of surface drainage diversion works in 1979/1980 have been < 0.02 mg/L at all Sites. The high value of 0.15 mg/L at Site 0500055 was recorded in September 1971.

Water quality objectives are not proposed for zinc since Brenda Mines is unlikely to have an impact on zinc concentrations in Peachland Creek.

6.1.3 NUTRIENTS

The maximum ammonia-N concentration was 0.08 mg/L at Site 0500055, well below the criterion for maximum concentrations of 0.695 mg/L (Table 19) and average concentrations of 0.133 mg/L (Table 20) at pH 9.0 and temperature of 13.5 °C, values which yielded "worst-case" conditions for this Site.

The B.C. criterion for the maximum nitrite-N concentration in freshwater to protect aquatic life at a chloride concentration less than 2 mg/L is 0.06 mg/L. Only one nitrite value (of 94 measured) has been recorded at higher concentrations at any Site in Peachland Creek: 0.08 mg/L at Site 0500055 in April 1972, prior to drainage water from the mine being diverted to the tailings pond.

The most restrictive water quality criterion for nitrate-N is a maximum of 10 mg/L to protect drinking water supplies[9]. All nitrate or nitrate/ nitrite measurements in Peachland Creek have been well below this concentration.

Since nitrogen compounds are used in blasting at the open pit and can enter Peachland Creek with seepage water from the upper reclaim pond, provisional water quality objectives are proposed for nitrate, nitrite, and ammonia. The objectives are that the maximum nitrate-N concentration should not exceed 10 mg/L, the maximum nitrite-N concentration should not exceed 0.06 mg/L, the average nitrite-N concentration should not exceed 0.02 mg/L, and the maximum and average ammonia-N concentrations should not exceed the values listed in Tables 19 and 20. The objectives apply in both upper and lower Peachland Creeks, except in initial dilution zones of effluent described in Section 6.1.1. The average objective levels are to be determined from a minimum of five weekly samples collected in a thirty day period.

Chlorophyll-a measurements in flowing waters reflect the impact nutrients are having on a water body since there are more factors (e.g., turbidity, velocity) to consider other than just nitrogen or phosphorus concentrations. Chlorophyll-a concentrations (n = 4) have been measured only at Site 0500851, downstream from Peachland Creek. The maximum value was 0.4 mg/m^2, well below the criteria for recreation of 50 mg/m^2 and aquatic life of 100 mg/m^2[11]. To ensure that nutrients do not become a problem in Peachland Creek, a water quality objective is proposed for periphyton chlorophyll-a. The objective is that the average periphyton chlorophyll-a value should not exceed 100 mg/m^2, as calculated from at least five randomly located samples from natural substrate at each site on any one sampling date.

6.1.4 DISSOLVED OXYGEN

There are no approved British Columbia criteria for dissolved oxygen. The following is the rationale to derive working water quality criteria for dissolved oxygen to be used in this document.

The CCREM[8] has developed criteria for dissolved oxygen, based on EPA criteria[12]. The criteria are based on warm-water and cold-water biota being present in a system. Cold-water systems were defined as any waters with at least one salmonid species present. In British Columbia, this definition covers virtually the entire Province.

The EPA[12] has based its criteria, and discussed its findings, on the basis of salmonids and non-salmonids. Table 3-7 in CCREM (page 3-14) is from EPA[12]. The EPA[12] indicated that there was no impairment at 11.0 mg/L when embryo larvae were present or 8.0 mg/L for other life stages, and slight impairment at 9.0 mg/L and 6.0 mg/L, respectively. The EPA[12] based its criteria (accepted by CCREM) on the slight impairment levels, and then added 0.5 mg/L to arrive at its criteria. In British Columbia, we are fortunate enough to generally have high quality waters, and there is no need to accept the slight impairment level.

Therefore, the criteria which will be used will be based on salmonids and should provide for no impairment (i.e., 8.0 mg/L and 11.0 mg/L minima).

All dissolved oxygen concentrations in Peachland Creek have been well in excess of the 8.0 mg/L criteria, and mean values in lower Peachland Creek have been in excess of 11.0 mg/L. The minimum dissolved oxygen concentrations were 8.6 mg/L in lower Peachland Creek at Site 0500056 near the mouth and 9.0 mg/L in upper Peachland Creek at Site 0500354 upstream from Brenda Mines.

6.1.5 SOLIDS

Mean dissolved solids values in upper Peachland Creek increased significantly from 80 mg/L upstream from Brenda Mines at Site 0500354 to 150 mg/L at the inlet to Peachland Lake at Site 0500355. Results from the F-test (P = 0.05) indicated that the variability in the data between the two sites was significant. The t-test indicated that had the variability been similar, the mean values would have differed significantly (P = 0.05).

In lower Peachland Creek, dissolved solids were measured only at Site 0500056 near the mouth as often as in upper Peachland Creek. The mean value of 198 mg/L for the period 1969 to 1987 had an associated variance which was not similar to that at Site 0500355 at the inlet to Peachland Lake (F-test: P = 0.05). Had the variability been similar at the two sites, the mean values would have been significantly different (t-test: P = 0.05).

In lower Peachland Creek where drinking water is withdrawn, all values were less than the criterion of a maximum 500 mg/L dissolved solids for drinking water supplies (aesthetics)[2]. Consultants for Brenda Mines have advised that dissolved solids are one of their main concerns for post-abandonment (Section 4.1.1.7), especially for Trepanier Creek. To ensure that drinking and irrigation water supplies are protected, a provisional water quality objective is proposed for total dissolved solids in Peachland Creek. The objective is that the maximum total dissolved solids concentration in any sample should not exceed 500 mg/L, and applies in all Peachland Creek, except in initial dilution zones of effluents, described in Section 6.1.1.

One dissolved solid, sodium, is also projected to increase at mine abandonment (Section 4.1.1.7). The maximum concentration of 69 mg/L at Site 0500056 (Table 18) at the mouth exceeds the alert level of 20 mg/L for a very restricted sodium diet, but not

270 mg/L for a moderately restricted sodium diet. For irrigation, allowable sodium concentrations are related to calcium and magnesium concentrations also present, and are defined by the Sodium Adsorption Rates (SAR) as:

$$SAR = \frac{Na^{+}}{(\{Ca^{++} + Mg^{++}\}/2)^{1/2}}$$

where: ions are in meq/L.

The CCREM[8] has indicated that deciduous fruits are very sensitive to SAR values from 2 to 8, and that leaf tip burn and leaf scorch can result. Magnesium values in Peachland Creek at the mouth (Site 0500056) have ranged from 1.84 to 11.5 mg/L, and total hardness values to as high as about 200 mg/L. Using equal increases of 2 mg/L for magnesium , and 45 mg/L total hardness, resultant calcium concentrations were calculated, and sodium concentrations corresponding to a SAR ≤ 2 were calculated as follows:

Ca^{+} (mg/L)	Mg^{+} (mg/L)	Hardness (mg/L $CaCO_3$)	Na^{+} (mg/L) For SAR ≤ 2
4.7	2	20	20.5
19.4	4	65	37
34.2	6	110	48.2
48.9	8	155	57.2
59.6	10	190	63.3
74.3	12	235	70.4

These calculated values are less than requirements for drinking water supplies.

A provisional water quality objective is proposed for sodium in the four kilometre reach of Peachland Creek, immediately upstream from Okanagan Lake, during the irrigation season (May - September). The objective is that the maximum sodium concentration (mg/L) should be $<45.97\ [(0.0499\ Ca + 0.0823\ Mg)/2]^{0.5}$ where Ca and Mg are in mg/L. The objective applies in the four kilometre reach except in the initial dilution zones of effluents, described in Section 6.1.1. For the remaining months of the

year in this reach, and in the remainder of Peachland Creek for all periods, the maximum sodium concentration should not exceed 270 mg/L.

Mean concentrations of suspended solids increased in a downstream direction in upper Peachland Creek (3.4 mg/L at Site 0500354 to 12.7 mg/L at Site 0500355) as well as in lower Peachland Creek (1.4 mg/L at Site 0500851 to 10.9 mg/L at Site 0500055 to 14.7 mg/L at Site 0500056). The variability in the data sets at adjacent sites was significantly different (F-test: P = 0.05), therefore the differences of mean concentrations between sites was not tested.

Turbidity concentrations at Site 0500354 upstream from Brenda Mines were as high as 10 NTU. Downstream from Brenda Mines in upper Peachland Creek, values were as high as 240 NTU in April 1970 (Table 11), but since 1975, the maximum value (of 97) was 23 NTU. In lower Peachland Creek, turbidity levels have been as high as 115 NTU at Site 0500056 at the mouth.

However, since 1975, the maximum turbidity level at this Site (of 107 values) was 17 NTU, comparable to the maximum of 20 NTU measured at Site 0500055 (Table 17). Mean turbidity values at the three Sites in lower Peachland Creek were all less than 5 NTU (Tables 16, 17, 18), indicating that the raw untreated water could be used for a water supply.

The maximum colour value was 65 colour units at Site 0500056 in Peachland Creek at the mouth. At these levels, colour removal should be considered[2] for aesthetic considerations for drinking water supplies.

6.1.6 BACTERIOLOGICAL QUALITY

Fecal coliforms have been measured only at Site 0500056 in Peachland Creek at the mouth. Values (n = 10) were as high as 79 MPN/100 mL, with a median value of 5 MPN/100 mL. These levels were well below the B.C. criteria of $\leq$ 200/100 mL (geometric mean) for the protection of irrigation water supplies and primary contact recreation[13]. Based on this very limited data bases with a 90th percentile value of

11 MPN/100 mL, the water would be suitable for use as a drinking water supply with disinfection only (criterion is ≤ 10/100 mL as 90th percentile) value[13].

6.2 TREPANIER CREEK

MacDonald Creek, a tributary to Trepanier Creek, has been altered significantly by the Brenda Mines operation. In fact, the headwaters for MacDonald Creek is now seepage water from the lower reclaim dam. Water quality impacts have been discussed in Section 4.1.1.4.

For the purposes of this assessment, MacDonald Creek will not be considered to be a waterbody, but an open ditch carrying seepage water which is diluted as it proceeds downstream to Trepanier Creek. Since it is accessible to fish, the water quality should be such that acutely toxic conditions do not occur.

Objectives proposed in this watershed will be for Trepanier Creek, and not MacDonald Creek.

6.2.1 pH AND ALKALINITY

The median pH varied only slightly in Trepanier Creek, from upstream from MacDonald Creek (Table 8) where it was 8.05 to values at Peachland (Table 22) where it was 7.9. All values at both sites on Trepanier Creek have been in the range 6.5 to 8.5 to protect aesthetics of drinking water supplies[2]. Since post-abandonment plans[17] could result in some treatment which could alter the stream pH, a provisional water quality objective is proposed for pH in Trepanier Creek. The proposed provisional objective is that the pH in any sample collected in Trepanier Creek, exclusive of the 100 m section downstream from MacDonald Creek, should be in the range 6.5 to 8.5.

Mean alkalinity values increased in a downstream direction, from 13.8 mg/L at Site 0500362 upstream from MacDonald Creek to 30.9 mg/L at Site 0500079 downstream from MacDonald Creek to 75.9 mg/L at Site 0500078 at Peachland. The variability between Sites was significantly different (F-test: P = 0.05), therefore the statistical significance of the differences in mean values was not tested. The water in Trepanier Creek upstream from

MacDonald Creek would have a moderate sensitivity to acidic inputs, while those downstream from MacDonald Creek would usually have a low sensitivity to acidic inputs[14].

6.2.2 HARDNESS AND METALS

The average water hardness in Trepanier Creek was 80.6 mg/L at Site 0500362 (Table 8) upstream from MacDonald Creek, 82.5 mg/L at Site 0500079 (Table 9) downstream from MacDonald Creek, and 60.2 mg/L (Table 22) at Site 0500078 at Peachland. The variability (F-test: P = 0.05) and differences between mean values (t-test: P = 0.05) were not significantly different for Sites 0500362 and 0500079, although they were significantly different between either of these sites and Site 0500078 at Peachland. Thus, aquatic life further downstream from MacDonald Creek in Trepanier Creek and especially towards the mouth would be more susceptible to toxic effects from metals.

6.2.2.1 Aluminum

The most restrictive B.C. water quality criteria for dissolved aluminum are for the protection of aquatic life[10], requiring a maximum concentration of 0.1 mg/L for pH $\geq$ 6.5. The maximum recorded dissolved aluminum value was 0.07 mg/L at Site 0500362 (Table 8), upstream from MacDonald Creek. The maximum dissolved aluminum concentration in MacDonald Creek was 0.12 mg/L (Table 2) and the mean concentration was 0.03 mg/L. It would appear that this one (of 12) high value should not be of concern in Trepanier Creek.

Aluminum can be used in blasting compounds. For this reason, and since there is a small data base, a provisional water quality objective is proposed in Trepanier Creek for dissolved aluminum. The objective is that the maximum dissolved aluminum concentration in Trepanier Creek should not exceed 0.1 mg/L and the average value should not exceed 0.05 mg/L. The proposed objective applies along the total length of Trepanier Creek except in initial dilution zones of effluents, described in Section 6.1.1. The average value is to be calculated from 5 weekly samples collected in a 30-day period.

6.2.2.2 Copper

Dissolved copper concentrations in Trepanier Creek did not differ significantly (F-test and t-test: P = 0.05) between Sites 0500362 and 0500079, upstream and downstream from MacDonald Creek, although the variability between these sites and Site 0500079 at Peachland was statistically significant.

The mean dissolved copper concentration at Site 0500351 in MacDonald Creek was 0.013 mg/L, while in Trepanier Creek upstream (Site 0500362) MacDonald Creek, it was 0.012 mg/L (Table 8). These values exceed the criteria of 0.006 mg/L and 0.003 mg/L as average values to protect aquatic life[5], based on average hardness concentrations of 150 mg/L and 80 mg/L, respectively.

Maximum dissolved copper concentrations at all Sites (Tables 8,9,21,22) exceeded the criteria for maximum total values of 0.008 mg/L with an average hardness of 60 mg/L and 0.009 mg/L with a hardness of 80 mg/L[5].

6.2.2.3 Iron

Iron values varied significantly (F-test: P = 0.05) between Sites 0500362 (Table 8) and 0500079 (Table 9) in Trepanier Creek, although if this were not the case, mean values could be considered to be statistically similar (t-test: P = 0.05). Between Sites 0500362 (Table 8) upstream from MacDonald Creek and Site 0500078 (Table 22) at Peachland, the variability and difference between the mean concentrations was not significant (F-test and t-test: P = 0.05).

Only 1 of 44 dissolved iron concentrations at Site 0500079 exceeded the water quality criterion of 0.3 mg/L total iron to protect aquatic life[8]; all dissolved iron values at all the other sites were less than the criterion.

6.2.2.4 Lead

The lowest average hardness in Trepanier Creek at any site was at Site 0500078 at Peachland, where it was 60.2 mg/L. The criteria[7] for total lead to protect aquatic life at

this hardness are 0.043 mg/L as a maximum and an average of 0.005 mg/L, while the maximum to protect drinking water supplies is 0.05 mg/L.

Maximum concentrations have been 0.1 mg/L (Site 050079) or indeterminate (<0.1 mg/L at Sites 0500362 and 0500078). Average values were 0.046 mg/L at Site 0500362 and 0.039 mg/L at Site 0500079, which are significantly (F-test and t-test: P = 0.05) different. The median value at Site 050078 was 0.012 mg/L. Values (dissolved) greater than the criteria for total lead of 0.043 mg/L have been recorded as follows: 4 values measured in 1970 of a total of 24 measurements at Site 0500362 (12 other values were <0.1 mg/L); 4 values measured in 1970 of a total of 31 measurements at Site 0500079 (12 other values were < 0.1 mg/L); and 0 of 24 measurements at Site 0500078 (15 other values were < 0.1 mg/L) at Peachland. Since the four upstream values exceeding the criteria at both sites coincided, they were likely reported incorrectly or the result of some natural fluctuation upstream from the mine. The average criterion of 0.005 mg/L was exceeded (where detection limits permitted comparison) for: 8 (all in 1970) of 10 measurements at Site 0500362; 8 (all in 1970) of 18 measurements at Site 0500079; and 6 (all in 1970) of 22 values at Site 0500078.

6.2.2.5 Molybdenum

Water quality criteria for B.C.[4] for total molybdenum are 0.05 mg/L as a maximum and < 0.01 mg/L as an average to protect irrigation water supplies, and a maximum of 0.25 mg/L to protect drinking water supplies. Criteria to protect aquatic life are considerably higher than these concentrations (2 mg/L as a maximum and ≤ 1 mg/L as an average)[4].

Irrigation occurs near Peachland, therefore data for Site 0500078 generally reflect water quality. Only 2 (both 0.02 mg/L) of 29 measurements for dissolved molybdenum exceeded the average criteria concentration of ≤ 0.01 mg/L total; while all values were less than the criteria for maximum concentration.

Going from upstream to downstream from MacDonald Creek, mean concentrations (both 0.012 mg/L) did not change significantly (F-test and t-test: P = 0.05) from Site 0500362 to Site 0500079. Values (dissolved) greater than the average criteria for total

molybdenum of 0.01 mg/L were measured on only 3 of 137 occasions (8 values had detection limits of < 0.03 mg/L) at Site 0500362 and on 3 of 128 occasions (8 values had detection limits of < 0.03 mg/L) at Site 0500079.

Increases were actually measured at Site 0500079 compared to Site 0500362 as follows:

Date	Dissolved Site 0500362	Dissolved Site 0500079
79.04.17	< 0.01	0.02
83.07.26	< 0.01	0.02
85.05.14	0.0028	0.02
86.06.17	0.004	0.0103
87.01.20	0.0044	0.005

Interestingly, decreases have also been measured between the sites, as follows:

Date	Dissolved Site 0500362	Dissolved Site 0500079
84.07.25	0.03	< 0.01
85.09.17	0.04	0.0064
86.02.10	0.0045	0.0029

Although the mean dissolved molybdenum concentration in MacDonald Creek was 0.059 mg/L at Site 0500351, sufficient dilution exists in Trepanier Creek to reduce concentrations so that molybdenum concentrations in Trepanier Creek meet water quality criteria. It must be ensured that the high molybdenum concentrations in MacDonald Creek are reduced quickly in Trepanier Creek, so that irrigation water supplies are not threatened, since it is believed that some cattle in the watershed have been affected by molybdenosis. A long-term provisional water quality objective is proposed for Trepanier Creek in the lowest 2.5 km reach, to protect irrigation waters. The long-term objective is that the maximum total molybdenum concentration should not exceed 0.05 mg/L and the average concentration should be ≤ 0.01 mg/L (May to September). In the remainder of Trepanier Creek, the maximum molybdenum concentration should not exceed 0.25 mg/L. For

purposes of checking attainment of the proposed objective, the maximum and average values should be determined from 5 weekly samples collected in a period of 30 days at Site 0500078 at Peachland, where irrigation using Trepanier Creek water generally takes place.

6.2.2.6 Zinc

The water quality criterion to protect freshwater aquatic life is a maximum concentration of total zinc of 0.03 mg/L[8]. This concentration has been exceeded for dissolved zinc at Sites 0500078 in Trepanier Creek, although the average concentration at all sites has been less than this criterion. However, this value was exceeded for only 1 of 100 measurements at Site 0500079 (September 1971) and 2 of 61 measurements at Site 0500078 (June 1970 and April 1976). The fact that the maximum recorded dissolved zinc value in MacDonald Creek at Site 0500351 was only 0.02 mg/L implies that Brenda Mines is not responsible for the one value higher than the criterion at Site 0500079.

6.2.3 NUTRIENTS

The maximum ammonia-N concentration in Trepanier Creek was 0.08 mg/L at Site 0500078 at Peachland (Table 22). This is below both the average and maximum criteria for ammonia-N (Tables 19 and 20) at a pH of 9.0 and temperature of 20°C. The maximum ammonia-N concentration at Site 0500351 in MacDonald Creek was 0.023 mg/L (Table 3), therefore ammonia concentrations in Trepanier Creek are not of concern.

Nitrite-N concentrations greater than the detection level of 0.005 mg/L were measured only at Site 0500078, with a maximum concentration of 0.009 mg/L. This is well below the criteria to protect aquatic life of 0.02 mg/L average and 0.06 mg/L as a maximum[9]. Nitrite was not detected in MacDonald Creek, therefore nitrite concentrations are not a concern in Trepanier Creek.

Nitrate-N (or nitrate/nitrite) concentrations were measured as high as 1.4 mg/L at Site 0500362 upstream from MacDonald Creek. A water quality criterion of a maximum of 10 mg/L is to protect drinking water supplies[9], the most sensitive water use. Since values in MacDonald Creek did not approach those measured in Trepanier Creek, nitrate concentrations in Trepanier Creek are not of concern.

Since the uptake of nutrients creates algal growth, and since algal growth in flowing waters depends on other factors such as substrate, channel slope and light availability, the B.C. criteria[11] apply to periphyton chlorophyll-a concentrations. None have been measured in Trepanier Creek. This type of monitoring is required to determine if algal growths are of concern in Trepanier Creek.

6.2.4 DISSOLVED OXYGEN

Only a limited data set compared to many other characteristics exists for dissolved oxygen concentrations in MacDonald or Trepanier creeks. Water quality criteria (Section 6.1.4) for dissolved oxygen are minima of 8 mg/L for most life stages of aquatic life except embryo, when concentrations should exceed 11.0 mg/L. Concentrations of dissolved oxygen at all sites were ≥ 9.0 mg/L in Trepanier Creek, with mean concentrations greater than 11.0 mg/L (Tables 8, 9, 21, and 22). Concentrations in MacDonald Creek were lower but still above the minimum criteria of 8.0 mg/L (Tables 2 and 3).

A small amount of treated domestic sewage from the Brenda Mines operation is discharged to the tailings pond where it would receive significant dilution. It is apparent that this treated and diluted wastewater is not affecting dissolved oxygen concentrations in Trepanier or MacDonald creeks to any great degree.

6.2.5 SOLIDS

Dissolved solids were found to be at a maximum at Site 0500078 at Peachland (Table 22) at a concentration of 197 mg/L. This is well below the criterion of 500 mg/L to protect drinking water supplies[9]. Mean values increased slightly in a downstream direction, from about 100 mg/L at Site 0500362 (Table 8) to about 106 mg/L at Site 0500079 to about 107 mg/L at Site 0500078. The variability (F-test: $P = 0.05$) and difference in mean concentrations (t-test: $P = 0.05$) were not significantly different.

Although dissolved solids concentrations in MacDonald Creek have been as high as 664 mg/L at Site 0500044 downstream from the tailings dam (Table 2), the large data set

for Trepanier Creek provides evidence that dissolved solids in Trepanier Creek are not affected by this input, and that water quality criteria are not exceeded.

Consultants for Brenda Mines have advised that dissolved solids are one of the three main water quality concerns for post-abandonment (Section 4.1.1.7), especially for Trepanier Creek. To ensure that drinking water and irrigation water supplies are protected, a provisional water quality objective is proposed for total dissolved solids. The objective is that the maximum concentration should not exceed 500 mg/L, and applies in all of Trepanier Creek, except in initial dilution zones of effluents described in Section 6.1.1.

Sodium is also projected to be a concern at mine abandonment. In Section 6.1.5, the maximum sodium concentration to protect very sensitive crops was developed as follows:

$$Na^{+} \leq 45.97\ [(0.0499\ Ca^{++} + 0.0823\ Mg^{++})/2]^{1/2}$$

:where ions are in mg/L, or

$$Na^{+} \leq 16.2\ (0.2\ Ca^{++} + 0.3\ Mg^{++})^{1/2}$$

:where ions are in meq/L, or

This is the proposed water quality objective for the 2.5 kilometre reach of Trepanier Creek immediately upstream from Okanagan Lake during the irrigation period (May - September). During the remaining months of the year in this reach, and upstream during all months, the maximum concentration should not exceed 270 mg/L. In reality, the irrigation objective will define for all intents and purposes the allowable upstream concentrations. The objectives apply in all areas except initial dilution zones of effluents.

6.2.6 BACTERIOLOGICAL QUALITY

Fecal coliforms have only been measured at Site 0500078 (Table 22) in Trepanier Creek at Peachland. The data, collected between 1977 and 1984 (n = 12), indicate that at least partial treatment of the water (≤100/100 mL 90th percentile) would be required[12] for drinking water supplies.

6.3 POWERS CREEK

Powers Creek has been monitored at only one location, Site 0500059 near the mouth (Table 23).

6.3.1 pH AND ALKALINITY

The pH in Powers Creek ranged from 7.4 to 8.7. Water quality criteria for pH are that it be in a range from 6.5 to 8.5 for aesthetics of drinking water supplies[2] and 6.5 to 9.0 to protect freshwater aquatic life[8]. Only 3 of 46 values exceeded the 8.5 level. Since there are no inputs to Powers Creek which would affect pH, no water quality objective is proposed.

Alkalinity values ranged from 26.5 mg/L to 224 mg/L (Table 23). These concentrations indicate that Powers Creek has a low sensitivity to acidic inputs[14].

6.3.2 HARDNESS AND METALS

The average hardness was 119.3 mg/L (Table 23). Water hardness values between 80 and 100 mg/L are desirable for water supplies[2], while those in excess of 200 mg/L are considered poor[2]. Three of 25 values at Site 0500059 have exceeded the 200 mg/L criterion.

The average water hardness is used to determine appropriate water quality criteria for certain metals to protect aquatic life. Based on a hardness of 119.3 mg/L, copper concentrations[5] should not exceed 0.013 mg/L as a maximum or 0.005 mg/L as an average, while lead concentrations[7] should not exceed 0.102 mg/L as a maximum or 0.0073 mg/L as an average.

All metals concentrations were less than water quality criteria for drinking water supplies and protection of aquatic life[2,3,5,7,8,10] except the maximum concentration for zinc, which exceeded the criterion of a maximum of 0.03 mg/L on 1 of 10 occasions. There are no known anthropogenic sources of zinc in the Powers Creek watershed.

6.3.3 NUTRIENTS

The maximum ammonia-N concentration of 0.04 mg/L was well below criteria for maximum and average concentrations of ammonia at pH 9.0 and temperature of 20°C (Tables 19 and 20).

Nitrite-N could not be detected (<0.005 mg/L), and was less than criteria[9] of 0.02 mg/L as an average value and 0.06 mg/L as a maximum to protect aquatic life.

The maximum nitrate-N concentration of 2.5 mg/L was below the most stringent criterion of 10 mg/L[9] to protect drinking water supplies. Values greater than 1.0 mg/L have been recorded generally between December and March of several years, when the groundwater contribution to flow likely would be significant. These nitrate concentrations likely reflect groundwater inputs of septic tank effluents and fertilizers.

Total and dissolved phosphorus concentrations were high enough to cause algal growths if phosphorus was the limiting factor and assuming other factors such as turbidity, stream velocity and substrate suitability were not. Only with measurements of periphyton chlorophyll-a will this become evident.

6.3.4 DISSOLVED OXYGEN

Dissolved oxygen concentrations were always greater than the minimum of 8.0 mg/L (Section 6.1.4) for the protection of all life stages of aquatic life except embryos. The mean concentration of 11.8 mg/L (Table 23) exceeded the criterion of 11.0 mg/L for periods when embryos are present. Values less than 11.0 mg/L generally occurred during the summer months when embryos would not be present.

Calculated percent saturation values ranged from 71.5% to 124.1%, indicating that algal growths are not likely a major concern in Powers Creek.

6.3.5 SOLIDS

Dissolved solids have been as high as 356 mg/L in Powers Creek (Table 23); however, the criteria for protection of drinking water aesthetics is 500 mg/L[2] as is that for irrigation water supplies[8]. Thus, dissolved solids concentrations should not adversely affect water users.

Suspended solids concentrations have been as high as 75 mg/L, although the average value was 7.4 mg/L. Suspended solids concentrations less than 80 mg/L provide a moderate level of protection to aquatic life while concentrations less than 20 mg/L provide a high level of protection.

6.3.6 BACTERIOLOGICAL QUALITY

Fecal coliform concentrations were only measured on nine occasions. On two of these, values were greater than 100 MPN/100 mL. When the 90th percentile value exceeds 100 MPN/100 mL, drinking water supplies should be provided complete treatment[13]. This is reinforced with the data for colour, where the maximum value exceeded the criterion[2] of a maximum of 15 colour units, the level above which water supplies should be provided with colour removal[2].

The geometric mean fecal coliform concentration was 35 MPN/100 mL, which is less than the criterion of 200/100 mL for irrigation use[13].

6.4 WESTBANK CREEK

Data have been collected at only one site on Westbank Creek, at Site 0500096 near the mouth. Westbank Creek receives the effluent from the Westbank lagoons.

6.4.1 pH AND ALKALINITY

The pH in Westbank Creek ranged from 7.9 to 8.9 (Table 24). Water quality criteria for pH are that it should be in the range from 6.5 to 8.5 for aesthetics of drinking

water supplies[2] and 6.5 to 9.0 to protect aquatic life[8]. Nine of 66 measurements exceeded the upper level of 8.5 for drinking water supplies; however, 8 of the 9 were measured at pH 8.6. Since there are no inputs to Westbank Creek which would affect pH, no water quality objective is proposed.

Alkalinity values ranged from 85.1 to 367 mg/L (Table 24). These concentrations indicate that Westbank Creek has a low sensitivity to acidic inputs[14].

6.4.2 HARDNESS AND METALS

The average hardness of Westbank Creek was 343 mg/L (Table 24). Water hardness values between 80 and 100 mg/L are considered desirable for drinking water supplies[2], while those in excess of 200 mg/L are considered poor[2]. Twenty-two of 26 measurements were in excess of the 200 mg/L criterion.

The average water hardness is used to determine appropriate water quality criteria for certain metals to protect aquatic life. Based on a hardness of 343 mg/L, copper concentrations[5] should not exceed 0.034 mg/L as a maximum and 0.014 mg/L as an average while lead concentrations[7] should not exceed 0.392 mg/L as a maximum and 0.015 mg/L as an average value. Maximum and average concentrations for these metals (Table 24) were less than these criteria.

Except for aluminum, iron, and zinc, all other metals were at concentrations less than water quality criteria for the protection of aquatic life[4,5,7,8,10]. The one dissolved aluminum value of 1.07 mg/L was far in excess of the criterion of 0.1 mg/L for the protection of aquatic life[10].

Only 1 of 16 dissolved iron values exceeded the criterion of 0.3 mg/L total iron for the protection of aquatic life[8], while 4 of 26 dissolved zinc values exceeded the criterion of a maximum concentration of 0.03 mg/L total zinc for the protection of aquatic life[8].

Very few data (n = 1) exist for metals in the discharge from the Westbank lagoons (Table 12). Those that do exist indicate that metals concentrations at or above these water quality criteria can occur for aluminum, iron, and zinc. Since dilutions as low as 0.8:1

have been calculated as potentially available (Section 4.3.1), the Westbank lagoon discharge can impact metals concentrations in Westbank Creek.

It is recognized that until the Westbank Liquid Waste Management Plan is completed (Section 4.3.1), there can be little control exercised over metals concentrations in Westbank Creek. However, the water quality in Westbank Creek must be improved for protection of aquatic life. Therefore, the following long-term water quality objectives are proposed for Westbank Creek:

Aluminum (dissolved)	: 0.1 mg/L maximum
	: <0.05 mg/L average
Copper (total)	: (0.094 hardness + 2) µg/L maximum
	: <(0.04 hardness) µg/L average, hardness >50 mg/L
	: <2 µg/L, hardness < 50 mg/L
Iron (total)	: 0.3 mg/L maximum
Zinc (total)	: 0.03 mg/L maximum

The long-term objectives will apply along the length of Westbank Creek except in initial dilution zones of effluents, described in Section 6.1.1. The average values are to be calculated from a minimum of 5 weekly samples collected in a period not to exceed 30 days.

6.4.3 NUTRIENTS

The maximum ammonia-N concentration of 5.98 mg/L can be of concern at certain pH concentrations and temperatures (above pH 8.0, temperature 8°C). This value was recorded in July 1985, with an associated pH of 8.1, but an unknown temperature. Temperatures during July in Westbank Creek have ranged from 13° to 16°C (n = 4). At any of these temperatures, ammonia concentrations exceeded both average and maximum criteria for the protection of aquatic life[9] in Tables 19 and 20.

Coincident pH, temperature and ammonia values were only available for two dates, as follows:

Date	Temperature	pH	Measured Ammonia-N	Criteria (mg/L) Max.	Criteria (mg/L) Avg.
79.12.11	4.5°C	8.6	3.92 mg/L	1.61	0.309
82.07.19	19°C	8.3	1.82 mg/L	2.91	0.424

These data, and the fact that the median ammonia-N concentration in the creek was 2.11 mg/L, indicate that ammonia toxicity can be a significant problem in Westbank Creek. The lowest concentration of ammonia-N measured in the Westbank lagoon discharge (Table 12) was 16.5 mg/L. Due to the low dilution provided to the effluent in the creek, the question of ammonia concentrations in Westbank Creek must be addressed in the Liquid Waste Management Plan. Recognizing that until steps are taken at the Westbank lagoon facility, ammonia concentrations in Westbank Creek are unlikely to improve, long-term provisional water quality objectives are proposed for ammonia-N in Westbank Creek. The objectives are that the average and maximum concentrations should not exceed the values in Tables 20 and 19, respectively. The objectives do not apply in the initial dilution zones of effluents, described in Section 6.1.1. The average value is to be calculated from a minimum of five samples collected in a period of 30 days.

Nitrite-N was analyzed only once, and was at a concentration of 0.03 mg/L. Values in the lagoon effluent were as high as 0.101 mg/L. The toxicity of nitrite varies with chloride concentration, with chloride concentrations generally greater than 6.0 mg/L. At these chloride concentrations, B.C. criteria for nitrite-N are an average concentration of 0.08 mg/L and a maximum of 0.24 mg/L (Table 25). To ensure that nitrite toxicity is not a problem in Westbank Creek, provisional water quality objectives are proposed for nitrite. The objectives are that the maximum and average nitrite-N concentrations should not exceed those concentrations outlined in Table 25 for the appropriate chloride concentration. The objectives do not apply in the initial dilution zones of effluents, described in Section 6.1.1. The average value is to be calculated from a minimum of five samples collected in a period of 30 days.

The maximum nitrate/nitrite-N concentration of 5.0 mg/L (Table 24) is below the most stringent criterion of 10 mg/L[9] to protect drinking water supplies. Ammonia, which is discharged in the lagoon effluent, can be oxidized to nitrate. For this reason, a long-term

provisional water quality objective is proposed for nitrate-N. The objective is that the maximum concentration should not exceed 10 mg/L. The objective does not apply in the initial dilution zones of effluents, described in Section 6.1.1.

Phosphorus concentrations (all forms) were high enough to likely cause algal growths, if phosphorus is the limiting factor and assuming other factors such as turbidity, stream velocity, or substrate availability are not. Only with measurements of periphyton chlorophyll-a will it be possible to determine if algal growths are a concern. The B.C. criterion to protect recreational use in lakes is a maximum concentration of 0.01 mg/L[11]. Thus the average stream concentration of total phosphorus of 0.791 mg/L (Table 24) will require a minimum dilution in Okanagan Lake of about 80:1 in order that the criterion is not exceeded.

In Westbank Creek, the growth of periphyton chlorophyll-a must be minimized so that aquatic life are not impeded. Therefore a long-term provisional water quality objective is proposed to protect freshwater aquatic life from excess periphyton chlorophyll-a. The objective is that the maximum concentration of periphyton chlorophyll-a on natural substrate be 100 mg/m^2. This is to be based on a mean of five randomly collected samples in all areas of Westbank Creek, except the initial dilution zones of effluents, described in Section 6.1.1.

6.4.4 DISSOLVED OXYGEN AND OXYGEN-CONSUMING MATERIALS

The criterion for minimum dissolved oxygen concentrations used in this report (Section 6.1.4) of 8.0 mg/L was not achieved on 3 of 17 occasions, although dissolved oxygen concentrations have not been recorded since July 1982. In the period from July 1982 to July 1985, BOD_5 measurements were made, and on six occasions (of 16) values greater than the detection limit of 10 mg/L were recorded. In waterbodies exhibiting good oxygen regimes, it should not be possible to detect BOD_5 levels. Since excess BOD_5 can be present in the lagoon discharge (Table 12), a long-term water quality objective is proposed for dissolved oxygen to protect aquatic life. The short- and long-term objectives are that the minimum dissolved oxygen concentration in Westbank Creek should not be lower than 8.0 mg/L for all life stages, except when embryos are present. At those times, the long-term objective is that minimum concentration should be 11.0 mg/L. It is realized

that the 8.0 mg/L may not be achieved on occasion in the short-term. The objectives apply in all areas except initial dilution zones of effluents, described in Section 6.1.1.

Wide fluctuations in percent saturation levels can indicate the presence of algal growths, and that aquatic life is under stress. Fluctuations of ± 42% have been observed in Westbank Creek, indicating that aquatic life can be susceptible to other stresses which may occur in the system.

6.4.5 SOLIDS

Dissolved solids have been as high as 778 mg/L in Westbank Creek (Table 24), higher than the criteria of 500 mg/L for protection of drinking water aesthetics[2] and irrigation water supplies[3]. Only 2 of 28 values were less than the criteria. It is unlikely that these high dissolved solids concentrations occur due to anthropogenic activity, but are more likely a result of evaporation.

The average suspended solids concentration was about 70 mg/L (Table 24). The B.C. criteria to protect aquatic life for induced concentrations of suspended solids are a maximum increase of 10 mg/L for background concentrations less than 100 mg/L and not more than 10% of background when background is in excess of 100 mg/L[15]. Since suspended solids concentrations as high as 594 mg/L have been discharged from the lagoons (Table 12) and induced concentrations at a 20:1 dilution would be about 30 mg/L, a long-term objective is proposed for suspended solids as stated in the B.C. criteria, above. The objective does not apply in the initial dilution zones of effluents, described in Section 6.1.1.

Suspended solids measurements indicate concentrations of material which can inflict damage to membranes of fish gills or siltation of spawning beds. Turbidity measures the transmission of light through water.

Turbidity has been as high as 42 NTU (Table 24). Only 5 of 41 measurements have been less than 5 NTU. The B.C. criteria to protect aquatic life from turbidity are for a maximum increase of 1 NTU for background levels less than 5 NTU, 5 NTU for background levels of 5 to 50 NTU, and 10 % of background when background is greater

than 50 NTU. These criteria are proposed as the long-term objectives for turbidity. The increases in turbidity or suspended solids (mg/L or %) are based on going from upstream to downstream of a discharge or series of discharges, and do not apply in initial dilution zones of effluents, described in Section 6.1.1.

To protect salmonid spawning grounds from siltation, a long-term provisional water quality objective is proposed for induced benthic sedimentation. The objective is that there should be no significant (95% confidence level) accumulation by weight for particles ≤ 3 mm. The term "no significant increase" will, for the purpose of checking attainment of the objective, be a maximum 10% increase.

6.4.6 BACTERIOLOGICAL QUALITY

Fecal coliform values have been as high as 16 000 MPN/100 mL in Westbank Creek (Table 24) while values in the lagoon discharge have been as high as >240 000 MPN/100 mL. B.C. criteria[13] for primary contact recreation (which occurs in Okanagan Lake) is for the geometric mean fecal coliform concentration to be ≤200/100 mL. Given the short distance along Westbank Creek between the lagoon discharge and the lake, and the potential health implications, and since it is unlikely that a significant die-off of bacteria would occur along this short distance in the creek, a provisional water quality objective is proposed for fecal coliforms in Westbank Creek. The objective is that the geometric mean fecal coliform concentration, calculated from a minimum of five weekly samples in a 30-day period, should not exceed 200/100 mL. The proposed objective does not apply in initial dilution zones of effluents, described in Section 6.1.1. In addition, the geometric mean Escherichia coli should not exceed 77/100 mL, the geometric mean enterococci should not exceed 20/100 mL, and the 75th percentile pseudomonas aeruginosa should not exceed 2/100 mL.

If chlorine is used as a disinfectant at the lagoons, the contact time should be sufficient to ensure that there is no residual chlorine or alternately, that dechlorination should be undertaken to ensure that aquatic life is not subjected to possible chlorine toxicity. The working criterion for total residual chlorine is a maximum concentration of 0.002 mg/L[8]. This is the proposed water quality objective in all areas, except the initial dilution zones of effluents described in Section 6.1.1.

6.5 FAULKNER CREEK

A limited data base, collected in 1982, exists for Faulkner Creek (Table 26). There are no point source waste discharges which can affect water quality in Faulkner Creek.

6.5.1 pH AND ALKALINITY

The pH in Faulkner Creek ranged from 8.0 to 8.5. Water quality criteria for pH are that it be in a range from 6.5 to 8.5 for aesthetics of drinking water supplies[2] and 6.5 to 9.0 to protect freshwater aquatic life[8]. Since there are no inputs to Faulkner Creek which would affect pH, no water quality objective is proposed.

Alkalinity values ranged from 218 to 295 mg/L (Table 26). These concentrations indicate that Faulkner Creek has a low sensitivity to acidic inputs[14].

6.5.2 HARDNESS AND METALS

One hardness measurement was 301 mg/L (Table 26). Water hardness in excess of 200 mg/L is considered to produce a poor drinking water supply[2].

No measurements of metals were made in Faulkner Creek.

6.5.3 NUTRIENTS

The maximum ammonia-N concentration of 0.007 mg/L was well below criteria for maximum and average concentrations of ammonia at a pH of 8.5 and a temperature of 20°C (Tables 19 and 20).

Nitrite-N was detected only once at 0.007 mg/L, well below the criteria of 0.06 mg/L as an average and 0.18 mg/L as a maximum value[9] for chloride concentrations 4-6 mg/L (Table 25). The maximum nitrate-N concentration of 0.56 mg/L was well below the most stringent criterion of 10 mg/L [9] to protect drinking water supplies.

Total and dissolved phosphorus concentrations were high enough to cause algal growths if phosphorus is the limiting factor and assuming other factors such as turbidity, stream velocity, and substrate suitability are not. Only with measurements of periphyton chlorophyll-a will it become evident that algal growths are a concern.

6.5.4 DISSOLVED OXYGEN

Dissolved oxygen concentrations have not been measured in Faulkner Creek.

6.5.5 SOLIDS

Direct measurements of solids were not made. However, measurements were made of specific conductivity and turbidity.

Specific conductivity values ranged from 588 µS/cm to 673 µS/cm, indicating that dissolved solids were likely at a concentration of about 500 mg/L, the criteria for the protection of drinking water supplies[2] and irrigation water supplies[8].

Turbidity levels were as high as 30 NTU; however, the mean value of 7.5 NTU means that some treatment of the water would be required prior to its use as a drinking water supply.

6.5.6 BACTERIOLOGICAL QUALITY

The maximum fecal coliform concentration was 110 MPN/100 mL (Table 26). If this water is used as a drinking water supply, at least partial treatment plus disinfection would be required prior to consumption[13].

The criteria for primary-contact recreation and irrigation water supplies (≤200/100 mL geometric mean) were achieved[13].

6.6 LAMBLY CREEK

Lambly Creek has been monitored at Site 0500041 near the mouth in the period 1972 to 1982. There are no point source wastewater discharges in this watershed. Water quality data are summarized in Table 27.

6.6.1 pH AND ALKALINITY

The pH in Lambly Creek ranged from 7.0 to 9.0 (Table 27). Water quality criteria for pH are that it be in a range of 6.5 to 8.5 for aesthetics of drinking water supplies[2] and 6.5 to 9.0 to protect freshwater aquatic life[8]. Nine of 45 values exceeded the 8.5 level. Since there are no known point source discharges into Lambly Creek which would affect pH, no water quality objective is proposed.

Alkalinity concentrations ranged from 26.5 to 140 mg/L (Table 27). These concentrations indicate that Lambly Creek has a low sensitivity to acidic inputs[14].

6.6.2 HARDNESS AND METALS

The average hardness was 96.2 mg/L (Table 27). Water hardness concentrations between 80 mg/L and 100 mg/L are desirable for water supplies[2] while those in excess of 200 mg/L are considered to be poor[2]. All hardness concentrations were less than 200 mg/L.

The average water hardness can be used to determine the appropriate water quality criteria for certain metals to protect aquatic life. Based on a hardness of 96.2 mg/L, copper concentrations[5] should not exceed 0.011 mg/L as a maximum or 0.004 mg/L as an average, while lead concentrations[7] should not exceed 0.078 mg/L as a maximum or 0.006 mg/L as an average.

The maximum concentration for cadmium, copper, iron, and zinc was recorded on one day in May 1972. These maximum concentrations exceeded maximum criteria levels[5,8]. When data for this one date are excluded, the only metals at concentrations greater than allowed by water quality criteria was one mercury value in April 1973 which

exceeded the concentration of 0.0001 mg/L to protect aquatic life. All other metal concentrations met the water quality criteria for drinking water supplies and protection of aquatic life.

6.6.3 NUTRIENTS

The maximum ammonia-N concentration of 0.038 mg/L was well below criteria for maximum and average concentrations of ammonia at pH 9.0 and a temperature of 20°C (Tables 19 and 20).

Nitrite-N could not be detected (<0.005 mg/L), and was less than the criteria[9] of 0.02 mg/L as an average and 0.06 mg/L as a maximum to protect aquatic life at chloride concentrations of less than 2 mg/L. The maximum nitrate concentration of 0.18 mg/L was below the most stringent criterion of 10 mg/L[9] to protect drinking water supplies.

Total phosphorus concentrations were high enough to cause algal growths if phosphorus was the limiting factor and assuming other factors such as turbidity, stream velocity, and substrate suitability were not. Measurements of periphyton chlorophyll-a would help to address the question of whether algal growths were a problem in the creek.

6.6.4 DISSOLVED OXYGEN

Only 2 of 20 dissolved oxygen concentrations were less than the minimum of 8.0 mg/L (Section 6.1.4) for the protection of all life stages of aquatic life except embryos. The mean concentration of 11.2 mg/L (Table 27) exceeded the criterion of 11.0 mg/L for periods when embryos are present. The two values which did not meet the minimum 8.0 mg/L criterion were 7.9 mg/L in May 1980 and 4.8 mg/L in July 1973.

Percent saturation values were as low as 51.2% (July 1973). This may indicate that there was oxygen consuming material present, or algal growths were affecting oxygen concentrations. At such low percent saturation levels of oxygen, aquatic life can be susceptible to other stress factors.

6.6.5 SOLIDS

Dissolved solids concentrations have been as high as 220 mg/L (Table 27) in Lambly Creek. The criteria for protection of irrigation water supplies[8] and drinking water aesthetics[2] is 500 mg/L. Thus dissolved solids concentrations should not adversely affect water uses.

Suspended solids concentrations have been as high as 299 mg/L (Table 27); however, only 3 of 21 values exceeded 50 mg/L. The maximum concentration occurred in January 1974.

6.6.6 BACTERIOLOGICAL QUALITY

The maximum fecal coliform concentration was 5 MPN/100 mL (Table 27). Drinking water supplies with a 90th percentile value less than 10/100 mL require disinfection only[13].

6.7 McDOUGALL CREEK

There are no water quality data for this creek. It is recommended that a monitoring program be initiated since there are three permitted discharges in this watershed.

7.0 MONITORING PROGRAM

It is recommended that monitoring to check attainment of the proposed provisional water quality objectives be carried out both at low flow period (January/February) and during the summer period (July/August) when variables such as nutrients or those related to irrigation are a concern. On all the creeks, samples should be collected near their mouths while on Peachland, Westbank, and Trepanier creeks, samples should also be collected at sites upstream. Access to upstream sites on Peachland and Trepanier creeks may necessitate that the winter sampling be conducted only at the downstream site.

The lack of data, or the age of the existing data sets, also requires that monitoring programs should be established for the other creeks referenced in this technical appendix. Sampling at one site on each during the summer months would improve their data bases significantly.

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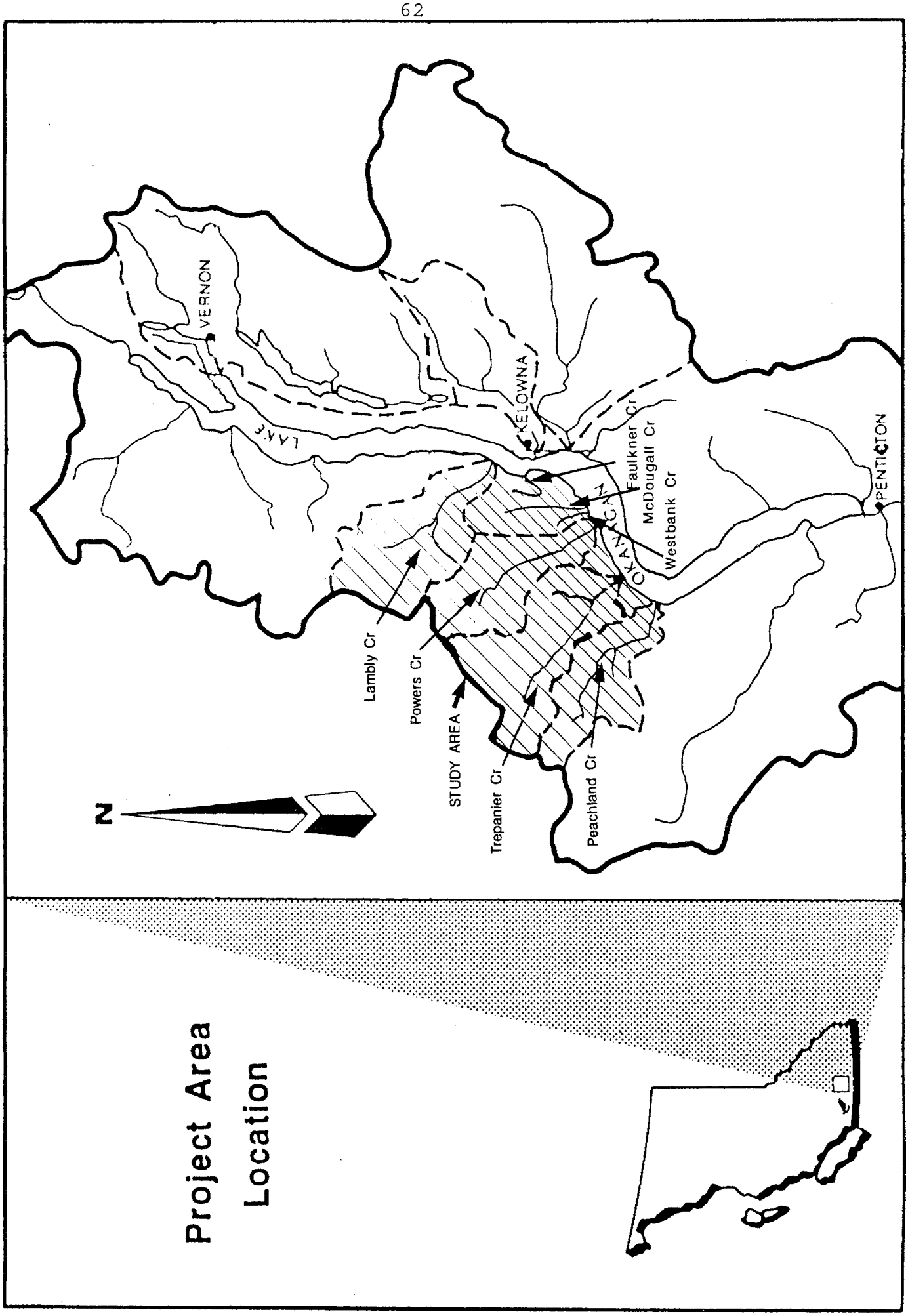

FIGURE 1 : STUDY AREA FOR THIS ASSESSMENT

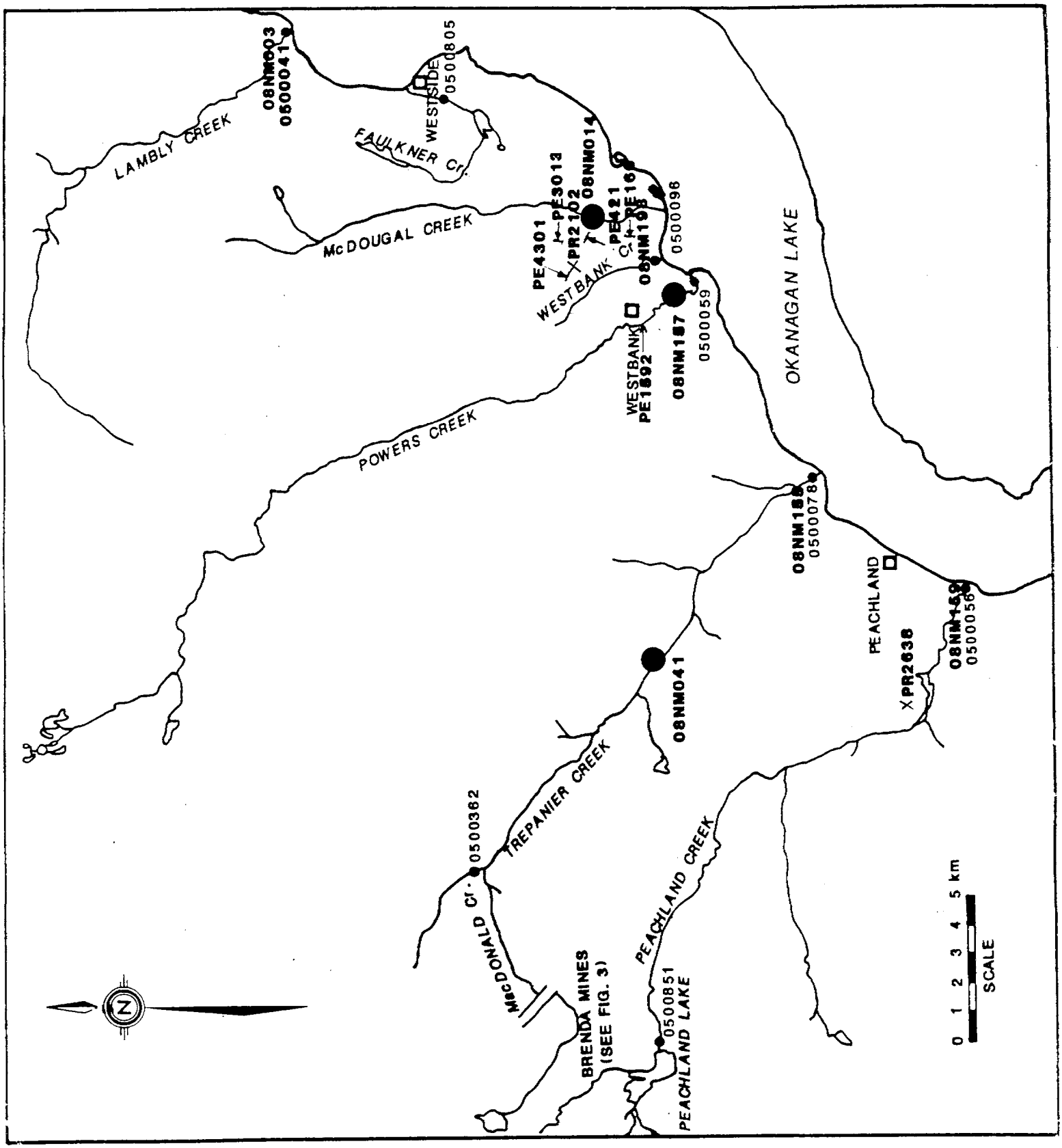

FIGURE 2 : ENLARGEMENT OF STUDY AREA

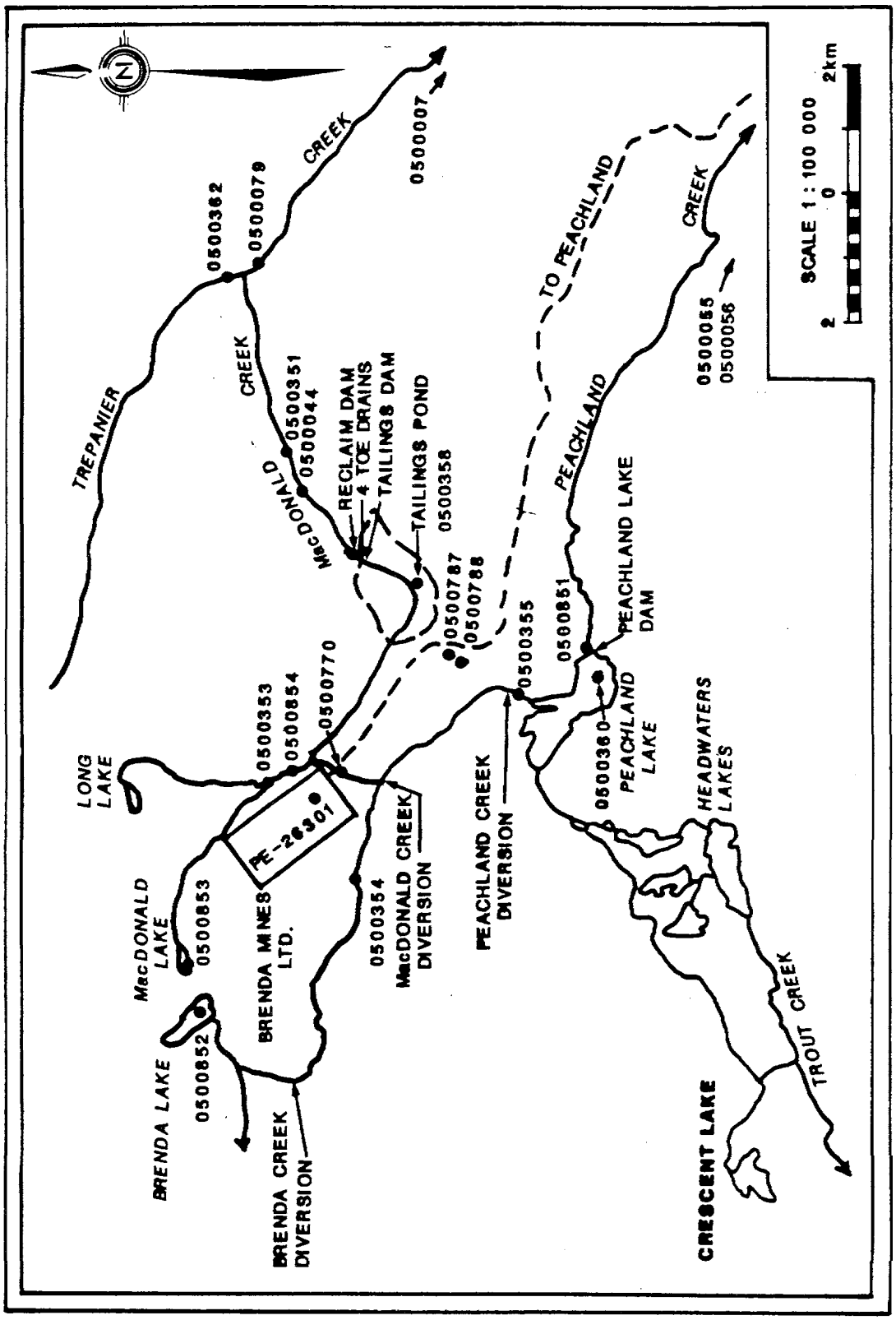

FIGURE 3 : BRENDA MINES AND LOCATIONS OF SAMPLING SITES IN TREPANIER AND PEACHLAND WATERSHEDS.

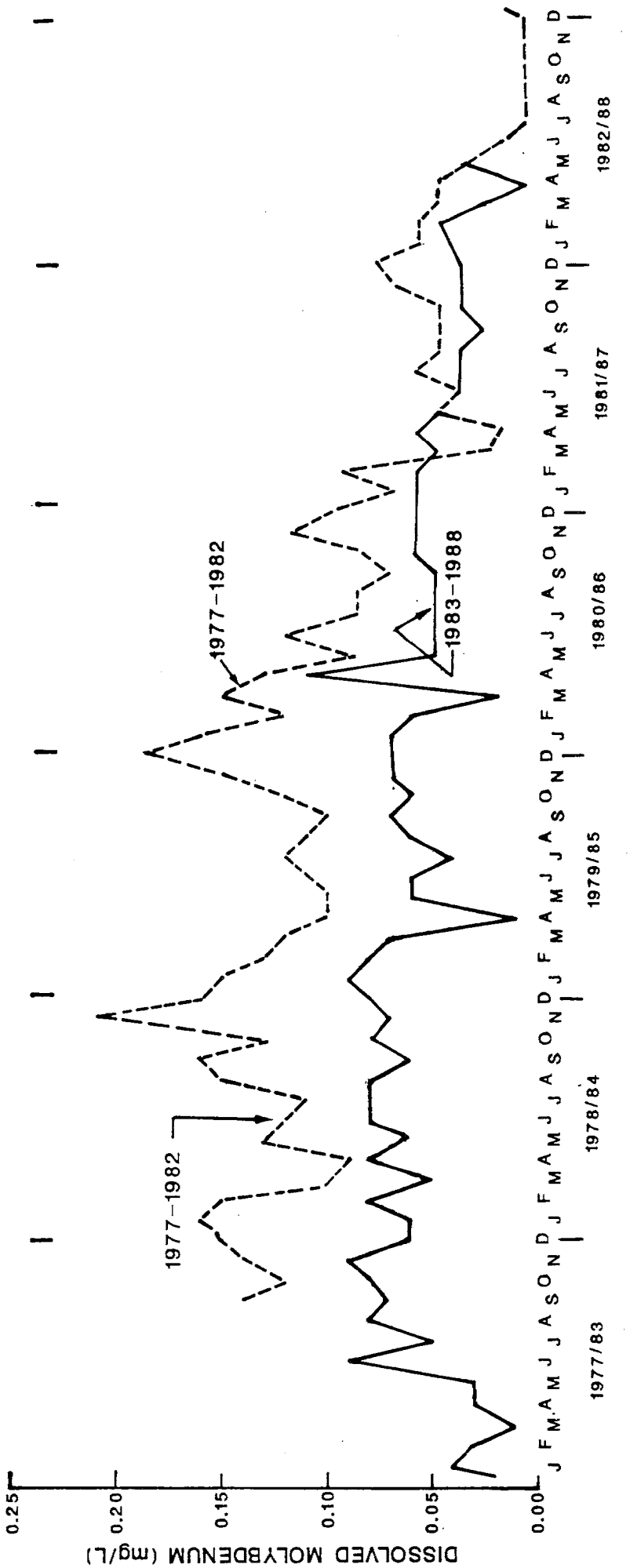

FIGURE 4 : RECENT MOLYBDENUM CONCENTRATIONS IN PEACHLAND LAKE

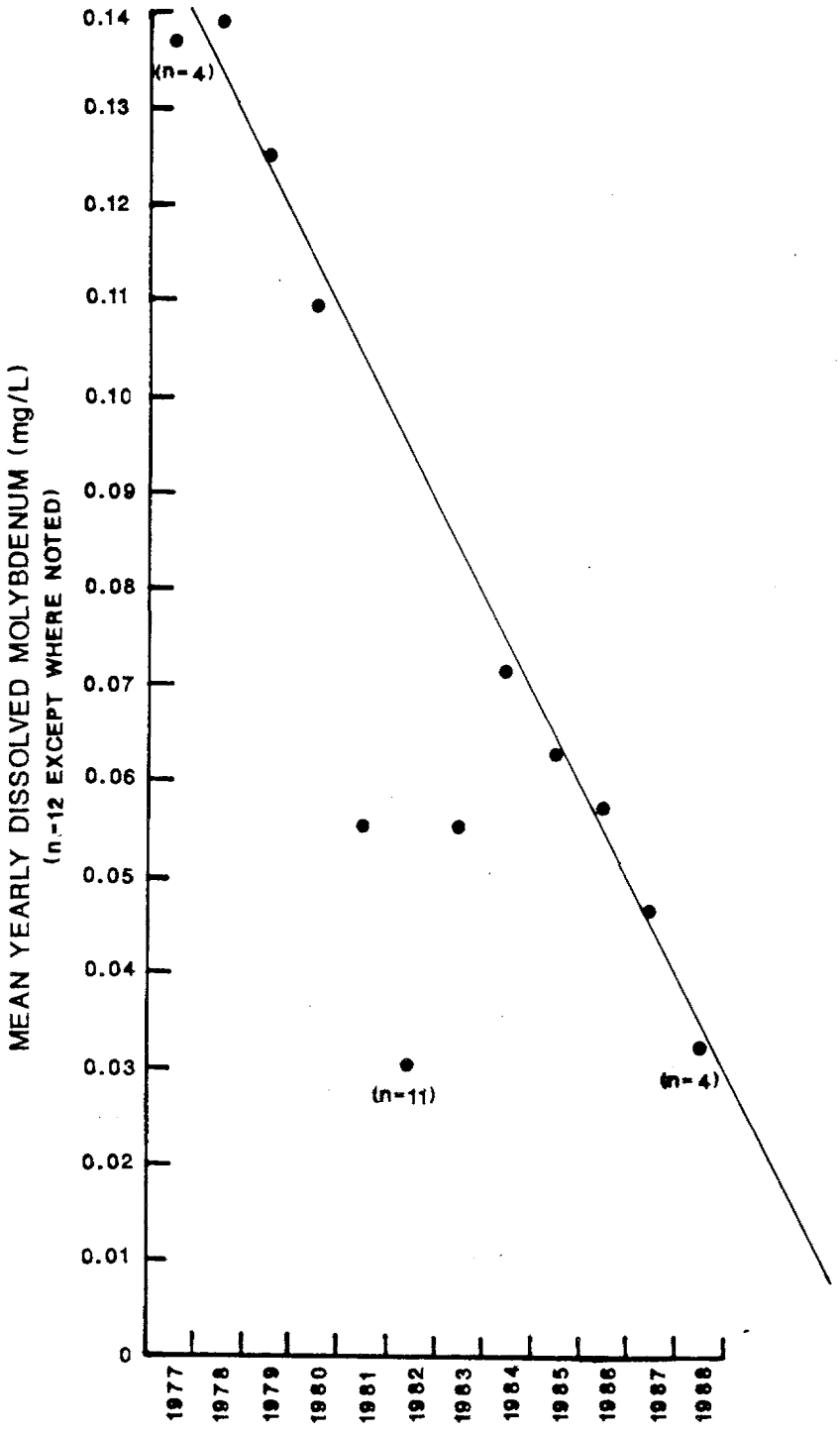

FIGURE 5 : MEAN YEARLY DISSOLVED MOLYBDENUM CONCENTRATIONS IN PEACHLAND LAKE

TABLE 1

EFFLUENT DATA SUMMARY
SEEPAGE WATER
BRENDA MINES TAILINGS IMPOUNDMENT

CHARACTERISTIC	NO. OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STD. DEV.
Alkalinity	4	185	162	170.5	10.7
Bioassay-daphnia	1	>100	-	-	-
Chloride	4	156	133	145	11.7
Cyanide-total	11	0.057	0.007	0.027	0.021
-weak acid diss	4	0.012	<0.005	0.008	0.003
Microtox	7	>100	>100	>100	-
Metals (dissolved) :					
aluminum	15	0.05	<0.02	<0.02+	-
boron	15	0.06	0.02	0.04	0.015
copper	4	0.008	<0.001	0.002+	-
molybdenum	15	2.8	0.55	1.11	0.53
Nitrogen-ammonia	7	1.03	0.45	0.75	0.212
nitrate	8	0.41	0.04	0.21	0.15
pH	11	8.0	7.6	7.9+	-
Phosphorus(dissolved)	3	0.008	0.007	0.007+	-
Phosphorus(total)	3	0.042	0.017	0.031+	-
Specific Conductivity	11	1450	1190	1324	87.9
Sulphate	7	303	168	251	46

Period of Record : 1983-1985

+Median Value

*All units are as mg/L except :
1) Bioassay as %
2) Microtox as %
3) pH
4) Specific Conductivity as uS/cm

DATA SOURCE: B.C. MINISTRY OF ENVIRONMENT
SEAM DATA RETRIEVAL SYSTEM

TABLE 2
AMBIENT WATER QUALITY DATA SUMMARY
SITE 0500044:MACDONALD CREEK (D/S TAILINGS DAM)

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Alkalinity	44	161	5.8	43.4	58.9
Bioassay(daphnia)	3	>100	>100	>100	-
Carbon-Organic	4	12	2	7.5	4.8
Chloride	13	93	3.5	27	24.6
Colour	6	25	5	14.2	8.6
Cyanide	25	<0.01	0.0	0.009	-
Cyanide(WAD)	1	0.008	-	-	-
Hardness-Total	47	252	30.2	165.6	59.7
-Calcium	4	97.5	44	65.4	26.1
-Magnesium	6	12.7	2	6.3	4.0
Metals (Diss)					
-Aluminum	12	0.12	<0.02	0.03	0.03
-Boron	50	0.5	<0.01	0.19	0.13
-Cadmium	18	<0.01	<0.0001	<0.01+	-
-Chromium	53	0.01	<0.005	0.1	0.001
-Copper	176	<0.1	<0.001	0.016	0.019
-Iron	51	6.5	0.01	0.3	0.9
-Lead	50	0.1	<0.001	0.035	0.040
-Manganese	20	0.29	<0.01	0.04	0.07
-Mercury(tot)	3	0.00017	<0.00005	0.00009	-
-Molybdenum	158	0.63	<0.01	0.18	0.15
-Nickel	17	0.05	<0.01	0.04	0.018
-Zinc	103	<0.05	0.0031	0.016	0.014
-Zinc(tot)	27	0.012	<0.005	0.010	0.002
Microtox	7	>100	>100	>100	-
Nitrogen					
-Ammonia	4	0.12	<0.01	0.05	0.05
-Kjeldahl	20	0.3	0.07	0.18	0.06
-Nitrate	75	2.0	<0.02	0.28	0.36
-Nitrite	1	<0.005	-	-	-
-Nitrate/ Nitrite	19	0.48	<0.02	0.06	0.1
-Organic	16	0.41	0.07	0.17	0.08
-Total	18	0.78	0.09	0.30	0.21
Oxygen -Dissolved	9	13.6	8.7	11.2	1.4
pH	186	8.5	7.1	8.0+	-
Phosphorus					
-Ortho Diss	5	0.015	<0.003	0.006	0.005
-Total Diss	101	1.7	0.004	0.096	0.171
-Total	23	0.034	0.006	0.012	0.006

TABLE 2 (CONT'D)

	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Sodium	19	37.3	<0.5	11.3	11.0
Solids-Dissolved	169	664	116	358	119
-Suspended	175	362	0	8.5	30.6
-Total	53	566	158	289	9
Specific Conductivity	44	800	164	422	167
Sulphate	50	122	20	53.8	27.3
Temperature	10	9.0	0.0	5.3	3.2
Turbidity	153	23	<0.01	1.53	2.93

PERIOD OF RECORD :1970-1987

+Median Value

*All values are as mg/L except:
1) Bioassay as % effluent
2) Colour as Colour units
3) pH
4) Specific Conductivity as uS/cm
5) Temperature as °C
6) Turbidity as NTU

DATA SOURCE : B.C. MINISTRY OF ENVIRONMENT
DATA RETRIEVAL STSTEM (SEAM)

TABLE 3
AMBIENT WATER QUALITY DATA SUMMARY
SITE 0500351:MACDONALD CREEK AT SETTLEMENT POND

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Alkalinity	34	99.2	5.2	9.3	15.9
Arsenic	3	<0.01	0.005	0.008	0.003
Bioassay(Daphnia)	1	>100	-	-	-
Chloride	44	12	<0.01	5.9	3.5
Cyanide	86	<0.01	<0.01	<0.01	-
Hardness-Total	25	216	120	151.9	21.7
-Calcium	54	138	30.2	48.7	15.3
-Magnesium	10	7.12	2.5	5.1	1.5
Metals (Diss)					
-Aluminum	1	0.06	-	-	-
-Chromium	45	0.01	<0.01	<0.01+	-
-Copper	142	0.14	<0.001	0.013	0.016
-Iron	43	1.16	0.03	0.41	0.29
-Lead	43	0.1	<0.001	0.035	0.038
-Manganese	9	0.14	0.03	0.068	0.038
-Molybdenum	153	0.3	<0.01	0.059	0.057
-Zinc	80	0.02	<0.005	0.01	0.002
Microtox	5	>100	>100	>100	-
Nitrogen					
-Ammonia	13	0.023	<0.005	0.008	0.006
-Kjeldahl	13	0.31	0.12	0.21	0.05
-Nitrate	73	<1	<0.02	0.25	0.3
-Nitrite	13	<0.005	<0.005	<0.005	-
-Nitrate/ Nitrite	13	0.12	<0.02	0.042	0.038
-Organic	11	0.29	0.12	0.20	0.06
-Total	12	0.34	0.18	0.24	0.05
Oxygen					
-Dissolved	4	10.3	8.2	9.5	0.9
pH	159	8.5	7.1	7.93+	-
Phosphorus					
-Total Diss	96	2.8	0.005	0.315	<0.1+
-Total	25	<0.5	0.008	<0.1+	-
Sodium	2	8.2	5.7	6.95	-
Solids-Dissolved	141	410	33	242.5	67.1
-Suspended	144	59	0	3.2	6.0
-Total	35	297	158	212	36
Specific Conductivity	18	550	220	360	97.9
Sulphate	63	145	5.8	36.5	30.9
Temperature	5	10	0	4.5	4.7
Turbidity	113	20	0.2	2.1	3.1

PERIOD OF RECORD : 1970-1987

+ Median Value

*All values are as mg/L except:
1) pH
2) Specific Conductivity as uS/cm
3) Temperature as °C
4) Toxicity (Microtox or Bioassay) as % effluent
5) Turbidity as NTU

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT
DATA RETRIEVAL SYSTEM (SEAM)

TABLE 4
AMBIENT WATER QUALITY DATA SUMMARY
SITE 0500854:MACDONALD CREEK U/S TAILINGS POND

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Alkalinity	6	87	47.1	70.9	13.2
Chloride	4	3.7	1.7	3	0.9
Chlorophyll-a	1	<0.0003	-	-	-
Hardness-Calcium	8	225	77.6	156.2	48.1
-Magnesium	8	35.9	13.7	25.5	6.85
Metals (Diss)					
-Aluminum	8	0.31	<0.02	0.084	0.1
-Boron	8	<0.01	<0.01	<0.01	-
-Barium	8	0.05	0.02	0.03	0.01
-Chromium	8	0.01	<0.01	<0.01+	-
-Copper	9	0.03	0.006	0.013	0.008
-Iron	8	0.17	0.02	0.08	0.055
-Manganese	8	1.09	0.15	0.39	0.30
-Molybdenum	9	8.11	1.66	5.24	2.06
-Zinc	9	0.02	0.006	0.014	0.006
Nitrogen					
-Ammonia	8	0.014	<0.005	0.007	0.003
-Kjeldahl	8	0.25	0.14	0.21	0.04
-Nitrate	4	16.2	7.35	12	4.85
-Nitrite	9	0.008	<0.005	<0.005+	-
-Nitrate/ Nitrite	9	16.2	3.06	9.26	4.25
-Organic	3	0.24	0.14	0.2	0.05
-Total	3	16.44	7.49	13.4	5.13
pH	9	7.9	7.7	7.8+	-
Phosphorus					
-Total Diss	8	0.013	0.005	0.008	0.002
-Total	8	0.044	0.008	0.017	0.011
Solids-Dissolved	1	721	-	-	-
-Suspended	3	9	2	4.7	3.8
-Total	3	1158	730	891	233
Specific Conductivity	10	1390	380	934	305
Sulphate	7	617	205	431	141
Temperature	1	2	-	-	-
Turbidity	8	8	1	3.7	2.8

PERIOD OF RECORD : 1983-1987
+ Median Value
*All values are as mg/L except:
1) pH
2) Specific Conductivity as uS/cm
3) Temperature as °C
4) Turbidity as NTU
DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT
DATA RETRIEVAL SYSTEM (SEAM)

TABLE 5
AMBIENT WATER QUALITY DATA SUMMARY
SITE 0500770:MACDONALD CREEK AT DIVERSION

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Alkalinity	3	26.7	16.3	20	5.8
Carbon-Inorganic	2	13	6	9.5	-
-Organic	1	2	-	-	-
-Total	1	18	-	-	-
Chloride	3	4.9	<0.5	2.2	2.36
Cyanide	4	<0.01	<0.005	<0.01+	-
Hardness-Calcium	11	42.5	3.89	16.8	14.6
-Magnesium	11	7.41	0.05	2.5	2.5
Metals (Diss)					
-Aluminum	11	0.14	<0.02	0.043	0.036
-Barium	11	0.08	0.02	0.034	0.017
-Chromium	11	<0.01	<0.01	<0.01	-
-Copper	21	0.03	0.003	0.011	0.005
-Iron	11	0.96	0.02	0.17	0.27
-Manganese	12	0.53	<0.01	0.068	0.147
-Mercury(tot)	1	<0.00005	-	-	-
-Molybdenum	20	0.95	<0.01	0.12	0.27
-Zinc	12	0.05	0.005	0.021	0.013
Microtox	2	>100	>100	>100	-
Nitrogen					
-Ammonia	13	0.051	<0.005	0.01	0.013
-Kjeldahl	13	0.63	0.04	0.17	0.15
-Nitrate	18	2.85	<0.02	0.3	0.73
-Nitrite	13	0.006	<0.005	<0.005+	-
-Nitrate/ Nitrite	13	2.85	<0.02	0.37	0.86
-Organic	10	0.22	0.02	0.13	0.05
-Total	10	2.99	0.09	0.59	0.98
Oxygen-Dissolved	2	12.3	10.6	11.5	-
pH	24	8.1	6.8	7.4+	-
Phosphorus					
-Total Diss	13	0.021	0.003	0.007	0.005
-Total	13	0.044	0.004	0.012	0.011
Potassium	1	1.2	-	-	-
Sodium	1	6.4	-	-	-
Solids-Dissolved	8	90	25	50	25.5
-Suspended	10	4.2	0.8	2.4	1.3
-Total	2	256	50	153	-
Specific Conductivity	16	364	31	107	98
Sulphate	9	123	1.4	32.6	44.3
Temperature	4	5	0	2	2.2
Turbidity	20	3.6	0.37	0.94	0.70

PERIOD OF RECORD : 1980-1986

+ Median Value

*All values are as mg/L except:
1) pH
2) Specific Conductivity as uS/cm
3) Temperature as °C
4) Toxicity (Microtox) as % effluent
5) Turbidity as NTU

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT
DATA RETRIEVAL SYSTEM (SEAM)

TABLE 6
FISH MUSCLE DATA SUMMARY
SITE 0500853:MACDONALD LAKE WEST BASIN

	VALUES*			
CHARACTERISTIC	MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Arsenic	<46	<21	<26.5	-
Hardness				
-Calcium	937	222	509	292
-Magnesium	1110	527	846	259
Metals (Total)				
-Aluminum	39	<2	9	12.7
-Boron	3	<1	<1+	-
-Barium	7	<1	2.5	2.07
-Cadmium	4	<1	1.9	1.13
-Chromium	2	<1	1.25	0.46
-Copper	102	2	18.6	34
-Iron	1080	26	387	419
-Lead	2	<1	<1+	-
-Manganese	9	<1	3.88	3.52
-Mercury(wet)	0.08	<0.05	<0.05+	-
-Molybdenum	<2	<1	<1+	-
-Nickel	<9	<5	<5+	-
-Zinc	138	19	60.3	46.2
Phosphorus				
-Total	15500	8320	10843	2054

PERIOD OF RECORD : June 7,1983 (8 Replicates : Rainbow trout)

+ Median Value

*All values are as ug/g dry

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT
DATA RETRIEVAL SYSTEM (SEAM)

TABLE 7
FISH MUSCLE DATA SUMMARY
SITE 0500351:MACDONALD CREEK AT SETTLEMENT POND

	VALUES*			
CHARACTERISTIC	MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Arsenic	<44	<19	<24+	-
Hardness				
-Calcium	1620	157	1049	631
-Magnesium	1030	682	873	134.2
Metals (Total)				
-Aluminum	11	2	6	3.92
-Boron	<2	<1	<1+	-
-Cadmium	<2	<1	<1+	-
-Chromium	2	<1	<2	-
-Copper	104	<1	24.5	40.5
-Iron	2240	10	754.7	934.3
-Lead	<2	<1	<1+	-
-Manganese	10	<1	3.83	3.60
-Mercury(wet)	0.15	<0.05	0.125	0.039
-Molybdenum	6	<1	2.67	1.86
-Nickel	<9	<5	<5	-
-Zinc	83	13	47.8	37.
Phosphorus				
-Total	19400	9100	12290	399

PERIOD OF RECORD :April 18 and May 12 ,1983 (6 Replicates :Rainbow trout)

+ Median Value

*All values are as ug/g dry

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT
DATA RETRIEVAL SYSTEM (SEAM)

TABLE 8
AMBIENT WATER QUALITY DATA SUMMARY
SITE 0500362:TREPANIER CREEK U/S MACDONALD CREEK

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Alkalinity	26	88.1	4	13.8	24.5
Carbon-Organic	1	2	-	-	-
Chloride	33	7	<0.01	1.38	1.27
Colour	2	20	5	12.5	-
Cyanide(Diss)	86	<0.01	<0.01	<0.01	-
Hardness-Total	14	92	75	80.6	5.07
-Calcium	46	111	8.3	30.1	18.7
-Magnesium	14	3.93	0.57	2.39	1.01
Metals (Diss)					
-Aluminum	12	0.07	<0.02	0.03	0.017
-Barium	12	0.06	0.01	0.04	0.015
-Cadmium	3	<0.0005	<0.0005	<0.0005	-
-Chromium	49	0.01	<0.005	0.01	0.0007
-Copper	134	0.12	<0.001	0.012	0.015
-Iron	35	0.2	0.01	0.06	0.04
-Lead	36	<0.1	<0.001	0.046	0.042
-Manganese	13	0.03	<0.01	<0.01	<0.01
-Molybdenum	145	<0.1	0.0019	0.012	0.009
-Zinc	93	<0.1	<0.005	0.013	0.016
Microtox	4	>100	>100	>100	-
Nitrogen					
-Ammonia	17	0.014	<0.005	0.007	0.003
-Kjeldahl	17	0.26	0.04	0.108	0.07
-Nitrate	73	1.4	<0.02	0.26	0.32
-Nitrite	16	<0.005	<0.005	<0.005	-
-Nitrate/ Nitrite	17	0.12	<0.02	0.06	0.04
-Organic	11	0.25	0.03	0.11	0.074
-Total	12	0.33	0.07	0.16	0.09
Oxygen-Dissolved	3	12.1	10.8	11.3	0.7
pH	148	8.4	7.3	8.05+	-
Phosphorus					
-Total Diss	97	1.6	0.003	0.1	0.18
-Total	28	<0.5	0.003	0.1	0.14
Sodium	2	3.2	1.6	2.4	-
Solids-Dissolved	127	182	25	100.3	28.2
-Suspended	131	10	0	1.42	1.45
-Total	26	186	66	113	27.9
Specific Conductivity	20	172	61	123.8	38.4
Sulphate	53	20.6	<1	3.7	2.9
Temperature	4	10	3	6.4	3.04
Turbidity	112	12	0.15	1.05	2.09

PERIOD OF RECORD : 1970-1987

+ Median Value

*All values are as mg/L except:
1) Colour as Colour units
2) pH
3) Specific Conductivity as uS/cm
4) Temperature as °C
5) Toxicity (Microtox) as % effluent
6) Turbidity as NTU

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT
DATA RETRIEVAL SYSTEM (SEAM)

TABLE 9
AMBIENT WATER QUALITY DATA SUMMARY
SITE 0500079:TREPANIER CREEK D/S MACDONALD CREEK

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Alkalinity	35	96.3	4	30.9	37.1
Bioassay(Daphnia)	2	>100	>100	-	-
Carbon-Organic	8	9	2	6	2.27
Chloride	35	7	<0.01	7	1.39
Colour	5	25	5	9	8.9
Cyanide	87	<0.01	<0.01	<0.01	-
Hardness-Total	14	92	77	82.5	3.84
-Calcium	54	42.5	9	24.4	5.72
-Magnesium	20	4.5	0.79	2.94	1.00
Metals (Diss)					
-Aluminum	12	0.05	<0.02	0.03	0.013
-Barium	12	0.06	0.02	0.04	0.013
-Cadmium	5	0.0002	<0.0001	<0.0001+	-
-Chromium	54	0.01	<0.005	-	-
-Copper	139	0.11	<0.001	0.012	0.014
-Iron	44	0.38	<0.01	0.059	0.062
-Lead	43	0.1	<0.001	0.039	0.042
-Manganese	19	<0.02	<0.01	-	-
-Mercury(tot)	5	0.00017	<0.00005	<0.00005+	-
-Molybdenum	136	<0.1	0.0008	0.012	0.009
-Zinc	100	0.14	<0.005	0.011	0.013
Microtox	6	>100	>100	>100	-
Nitrogen					
-Ammonia	18	0.022	<0.005	0.007	0.004
-Kjeldahl	21	0.22	<0.01	0.105	0.058
-Nitrate	75	<1	<0.01	0.244	0.3
-Nitrite	21	<0.005	<0.005	<0.005	-
-Nitrate/ Nitrite	20	0.13	<0.02	0.05	0.04
-Organic	19	0.45	0.03	0.13	0.10
-Total	19	0.59	<0.02	0.16	0.12
Oxygen -Dissolved	13	14.2	9.3	11.3	1.44
pH	150	8.4	7.1	8.08+	-
Phosphorus					
-Ortho Diss	5	0.003	<0.003	<0.003+	-
-Total Diss	100	0.8	0.003	0.083	0.083
-Total	36	<0.2	<0.003	0.009+	-
Potassium	8	1.7	0.9	1.35	0.3
Sodium	11	4.3	2.1	3.4	0.68

TABLE 9 (CONT'D)

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Solids-Dissolved	123	180	29	105.9	28.7
-Suspended	129	35	0	1.61	3.37
-Total	36	179	72	118.2	25.7
Specific Conductivity	35	200	73	140	41.1
Sulphate	53	29.8	<1	5.4	4.26
Temperature	15	16	3	8.17	3.76
Turbidity	122	12	0.98	2.01	0.18

PERIOD OF RECORD : 1970-1987

+Median Value

*All values are as mg/L except:
1) Colour as Colour unit
2) pH
3) Specific Conductivity as uS/cm
4) Temperature as °C
5) Toxicity (Bioassay or Microtox) as % effluent
6) Turbidity as NTU

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT
DATA RETRIEVAL SYSTEM (SEAM)

TABLE 10
AMBIENT WATER QUALITY DATA SUMMARY
SITE 0500354:PEACHLAND CREEK U/S BRENDA MINE

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Alkalinity	7	57.6	31.4	48.8	10.1
Chloride	5	0.5	<0.5	<0.5+	-
Chlorophyll-a	2	<0.0003	<0.0003	<0.0003	-
Cyanide	73	<0.01	<0.01	<0.01	-
Hardness-Calcium	14	51.8	8.52	18.4	10.2
-Magnesium	13	4.85	0.43	1.94	1.10
Metals (Diss)					
-Aluminum	13	0.17	<0.02	0.05	0.04
-Barium	13	0.03	<0.01	0.014	0.007
-Chromium	50	0.01	<0.005	<0.01+	-
-Copper	89	0.05	<0.001	<0.01+	-
-Iron	13	0.74	0.02	0.15	0.19
-Manganese	13	0.39	<0.01	0.04	0.11
-Molybdenum	99	0.04	0.0009	<0.01	0.004
-Uranium	1	0.0003	-	-	-
-Zinc	72	0.15	<0.005	<0.01+	-
Microtox	2	>100	>100	>100	-
Nitrogen					
-Ammonia	15	0.008	<0.005	<0.005+	-
-Kjeldahl	15	0.18	0.03	0.08	0.05
-Nitrate	60	1	<0.02	0.27	0.34
-Nitrite	15	<0.005	<0.005	<0.005+	-
-Nitrate/ Nitrite	15	0.11	<0.02	0.04	0.03
-Organic	10	0.18	0.02	0.08	0.06
-Total	10	0.2	0.06	0.10	0.05
Oxygen-Dissolved	2	11	9	10	-
pH	107	8.3	6.7	7.8+	-
Phaeophyton-a	2	<0.0003	<0.0003	<0.0003	-
Phosphorus					
-Total Diss	88	0.7	0.003	0.081	0.083
-Total	16	0.1	0.004	0.016	0.023
Solids-Dissolved	96	224	33	80	26
-Suspended	99	56.2	<0.1	3.4	8
-Total	3	78	68	74	5.3
Specific Conductivity	19	131	<50	106	24
Sulphate	24	21	4.2	7.4	3.2
Temperature	6	7	0	4.7	2.7
Turbidity	113	10	<0.1	1.6	2.3

PERIOD OF RECORD : 1971-1987

+ Median Value

*All values are as mg/L except:
1) Chlorophyll-a and Phaeophyton-a as g/m^2
2) pH
3) Specific Conductivity as uS/cm
4) Temperature as °C
5) Toxicity (Microtox) as % effluent
6) Turbidity as NTU

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT
DATA RETRIEVAL SYSTEM (SEAM)

TABLE 11
AMBIENT WATER QUALITY DATA SUMMARY
SITE 0500355:PEACHLAND CREEK AT INLET TO PEACHLAND LAKE

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Alkalinity	4	73.6	24.5	55.1	23.2
Carbon-Organic	1	2	-	-	-
Chloride	8	9	0.7	3.8	3.4
Colour	2	30	5	17.5	-
Cyanide	1	<0.01	-	-	-
Hardness-Total	40	77	9	42.1	17.4
-Calcium	43	32	3.6	16.2	6.8
-Magnesium	14	4.71	0.51	2.9	1.19
Metals (Diss)					
-Aluminum	12	0.07	<0.02	0.033	0.019
-Barium	12	0.03	0.01	0.021	0.007
-Copper	126	<0.5	0.0	0.01+	-
-Iron	13	0.25	0.06	0.14	0.05
-Manganese	14	0.03	<0.01	0.019	0.006
-Molybdenum	15	0.16	<0.01	0.04	0.039
-Zinc	61	<0.05	0.002	0.03	0.02
Microtox	2	>100	>100	>100	-
Nitrogen					
-Ammonia	18	0.018	<0.005	0.009	0.005
-Kjeldahl	18	0.41	0.06	0.15	0.10
-Nitrate	15	4.6	<0.02	0.81	1.56
-Nitrite	18	<0.005	<0.005	<0.005	-
-Nitrate/ Nitrite	19	2.08	<0.02	0.25	0.58
-Organic	12	0.32	0.07	0.14	0.09
-Total	11	2.41	0.07	0.52	0.85
Oxygen-Dissolved	2	11	10.6	10.8	-
pH	153	8.95	6.4	7.7+	-
Phosphorus					
-Total Diss	14	0.011	0.005	0.008	0.002
-Total	17	0.033	0.007	0.014	0.006
Potassium	1	1.3	-	-	-
Sodium	33	27.3	<0.5	5.2	4.8
Solids-Dissolved	132	902	12	150	99.4
-Suspended	135	279	0.1	12.7	31.1
-Total	24	420	30	115	80.6
Specific Conductivity	42	593	50	199	146
Sulphate	11	46.7	<5	13.1	11.4
Temperature	4	5.5	0.5	2.5	2.3
Turbidity	148	240	0.1	4.32	20.2

PERIOD OF RECORD : 1967-1987

\+ Median Value

*All values are as mg/L except:
1) pH
2) Specific Conductivity as uS/cm
3) Temperature as °C
4) Toxicity (Microtox) as % effluent
5) Turbidity as NTU

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT AND PARKS
DATA RETRIEVAL SYSTEM (SEAM)

TABLE 12
EFFLUENT DATA SUMMARY
WESTBANK IRRIGATION DISTRICT (PE 1592)

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN
Coliforms-Fecal	32	>240000	<2	<2+
Hardness-Calcium	1	24.4	-	-
-Magnesium	1	3.17	-	-
Metals (Total)				
-Aluminum	1	0.24	-	-
-Cadmium	1	<0.0005	-	-
-Chromium	1	0.005	-	-
-Copper	1	0.03	-	-
-Iron	1	0.86	-	-
-Lead	1	0.001	-	-
-Manganese	1	0.05	-	-
-Mercury	1	0.00082	-	-
-Molybdenum	1	0.0013	-	-
-Nickel	1	<0.01	-	-
-Zinc	1	0.03	-	-
Nitrogen				
-Ammonia	22	29	16.5	22.7
-Nitrite	20	0.101	0.002	0.005
-Nitrate/ Nitrite	24	0.21	0.04	0.08
Oxygen-BOD	32	144	<10	34.5
pH	21	7.9	6.7	7.6+
Phosphorus				
-Ortho Diss	13	5.9	4.24	4.86
-Total	33	320	1.9	17.5
Solids-Suspended	26	594	13	66.8

PERIOD OF RECORD : 1980-1986

+ Median Value

*All values are as mg/L except:
1) Coliforms as MPN/100 mL
2) pH

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT DATA RETRIEVAL SYSTEM

TABLE 13
EFFLUENT DATA SUMMARY
SHANNON LAKE STP (PE 4301)

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN
Nitrogen				
-Ammonia	3	38.6	9.04	29.9
-Nitrite	4	0.377	0.006	0.144
-Nitrate/ Nitrite	2	8.3	3.35	5.83
Oxygen-BOD	13	99	<10	29.3
pH	13	8.0	7.3	7.6+
Phosphorus				
-Diss	3	7.02	6.95	7.0
-Total	6	15.1	6.12	9.4
Solids-Suspended	12	147	1.0	21.7

PERIOD OF RECORD : 1978-1986

+ Median Value

*All values are as mg/L except:
1) pH

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT
DATA RETRIEVAL SYSTEM

TABLE 14
EFFLUENT DATA SUMMARY
MISSION HILL WESTBANK (PE 166)

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN
Coliforms-Fecal	2	1100	<200	-
Nitrogen				
-Ammonia	4	7.05	0.031	2.01
-Nitrite	4	0.067	0.017	0.032
-Nitrate/ Nitrite	4	1.52	0.24	0.63
Oxygen-BOD	10	11500	2069	5409
pH	7	5.3	4.1	5.0+
Phosphorus				
-Total Diss	4	25.4	4.47	14.59
-Total	4	26	11.8	18.38
Solids-Suspended	10	773	28	281.4
-Total	9	3230	960	2130

PERIOD OF RECORD : 1971-1983

+ Median Value

*All values are as mg/L except:
1) Coliforms as MPN/100 mL
2) pH

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT DATA RETRIEVAL SYSTEM

TABLE 15
EFFLUENT DATA SUMMARY
KELOWNA PLATING (PE 3013)

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN
Alkalinity	5	153	34.4	92.3
Cyanide	8	8	<0.01	4.33
Hardness-Calcium	5	39.1	30	33.6
-Magnesium	5	6.8	4.97	5.91
-Total	4	126	97.1	109
Metals (Dissolved)				
-Boron	6	9.64	1.25	3.55
-Cadmium	4	0.03	0.01	0.018
-Chromium	19	17	0.06	5.98
-Copper	14	13.9	<0.01	4.65
-Iron	10	13.6	<0.01	2.62
-Lead	7	4.38	<0.001	0.66
-Manganese	4	0.21	0.08	0.14
-Nickel	12	92.8	12	36.4
-Zinc	10	6.35	0.5	3.14
pH	19	9.9	2.1	6.66+
Solids-Suspended	18	53	7	23.2
-Total	12	674	306	543

PERIOD OF RECORD : 1973-1983

+ Median Value

*All values are as mg/L except pH

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT DATA RETRIEVAL SYSTEM

TABLE 16
AMBIENT WATER QUALITY DATA SUMMARY
SITE 0500851:PEACHLAND CREEK D/S PEACHLAND LAKE

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Alkalinity	6	45.9	35.9	39.9	3.8
Chloride	6	1.5	0.9	1.15	0.23
Chlorophyll-a	4	0.0004	<0.0003	0.00033	0.00005
Hardness-Calcium	10	15.4	12.4	13.7	0.88
-Magnesium	10	2.04	1.48	1.78	0.18
-Total	10	45.8	38.9	41.6	2.34
Metals (Diss)					
-Aluminum	10	0.06	<0.02	0.032	0.015
-Barium	10	0.02	0.01	0.016	0.005
-Copper	12	<0.01	<0.001	0.003+	-
-Iron	10	0.11	0.02	0.053	0.026
-Manganese	10	0.28	<0.01	0.043	0.084
-Molybdenum	11	0.08	0.03	0.058	0.019
-Zinc	11	0.03	<0.005	<0.01+	-
Nitrogen					
-Ammonia	10	0.019	<0.005	0.008	0.005
-Kjeldahl	10	0.18	0.12	0.14	0.02
-Nitrate	6	0.06	<0.02	0.04	0.015
-Nitrite	11	<0.005	<0.005	<0.005	-
-Nitrate/ Nitrite	11	0.07	<0.02	0.04	0.02
-Organic	5	0.16	0.1	0.13	0.02
-Total	5	0.2	0.17	0.18	0.01
pH	13	7.7	7.0	7.5+	-
Phaeophyton-a	3	0.0003	<0.0003	<0.0003+	-
Phosphorus					
-Total Diss	10	0.01	0.004	0.006	0.002
-Total	10	0.016	0.006	0.01	0.003
Sodium	1	2.8	-	-	-
Solids-Dissolved	1	70	-	-	-
-Suspended	5	2	1	1.4	0.5
-Total	5	72	68	71	1.7
Specific Conductivity	12	109	80	99.7	7.6
Sulphate	6	9.6	8.4	8.9	0.5
Temperature	4	6.5	4	5	1.2
Turbidity	11	2.5	0.7	1.2	0.6

PERIOD OF RECORD : 1983-1987

\+ Median Value

*All values are as mg/L except:
1) Chlorophyll-a and Phaeophyton-a as g/m^2
2) pH
3) Specific Conductivity as uS/cm
4) Temperature as °C
5) Turbidity as NTU

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT DATA RETRIEVAL SYSTEM

TABLE 17
AMBIENT WATER QUALITY DATA SUMMARY
SITE 0500055:PEACHLAND CREEK AT HEADWATERS POND

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Alkalinity	14	118	35	65.1	19.8
Carbon-Organic	9	13	4	8.9	3.3
Chloride	11	1.4	0.5	1.09	0.28
Colour	7	55	5	20	17.6
Cyanide	4	<0.01	<0.01	<0.01	<0.01
Hardness-Total	9	110	54.7	78.2	18.9
-Calcium	19	40.9	15.4	22.9	7.17
-Magnesium	17	5.55	1.07	3.15	1.27
Metals (Diss)					
-Aluminum	8	0.22	<0.02	0.05	0.07
-Barium	8	0.02	0.01	0.015	0.005
-Copper	21	0.04	0.001	0.008	0.008
-Iron	20	0.16	<0.01	0.057	0.038
-Manganese	19	0.06	<0.01	0.014	0.012
-Mercury(tot)	7	0.00005	<0.00005	<0.00005+	-
-Molybdenum	14	0.1	0.0176	0.055	0.028
-Zinc	20	0.15	<0.005	0.019	0.032
Nitrogen					
-Ammonia	8	0.08	<0.01	0.045	0.032
-Kjeldahl	15	0.56	0.13	0.24	0.13
-Nitrate	13	0.71	<0.02	0.16	0.22
-Nitrite	19	0.08	<0.005	0.012	0.021
-Nitrate/ Nitrite	14	2.6	<0.02	0.28	0.68
-Organic	21	0.89	0.12	0.28	0.18
-Total	20	6.01	0.14	1.20	1.51
Oxygen-Dissolved	12	13.6	9.6	11.2	1.4
pH	29	9.0	7.1	8.0+	-
Phosphorus					
-Ortho Diss	8	0.012	<0.003	0.006	0.004
-Total Diss	9	0.01	0.005	0.007	0.002
-Total	23	0.046	<0.003	0.015	0.011
Potassium	11	2.3	1.5	1.9	0.2
Sodium	12	5	3.2	4.02	0.53
Solids-Dissolved	4	150	76	97.5	35.2
-Suspended	12	41	0.9	10.9	12.7
-Total	15	190	80	138.5	34.4
Specific Conductivity	32	273	125	166	37.9
Sulphate	19	28	8.1	13.2	5.4
Temperature	14	13.5	2.5	6.2	3.2
Turbidity	19	20	0.6	3.5	5.1

PERIOD OF RECORD : 1971-1986

+ Median Value

*All values are as mg/L except:
1) Colour as Colour units
2) pH
3) Specific Conductivity as uS/cm
4) Temperature as °C
5) Turbidity as NTU

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT DATA RETRIEVAL SYSTEM

TABLE 18
AMBIENT WATER QUALITY DATA SUMMARY
SITE 0500056:PEACHLAND CREEK AT MOUTH

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Alkalinity	45	202	69.3	129.6	34.2
Carbon-Inorganic	53	47	7	31.5	9.0
-Organic	101	24	<0.5	5.9	3.7
-Total	2	30	22	26	-
Chloride	38	36.4	0.6	2.22	5.71
Coliforms-Fecal	10	79	<2	5+	-
Colour	21	65	<5	16.3	14.1
Cyanide	1	0.006	-	-	-
Hardness-Total	49	196	5.7	118.9	51.7
-Calcium	83	72.7	4.1	41.1	15.2
-Magnesium	32	11.5	1.84	5.99	2.00
Metals (Diss)					
-Aluminum	14	0.12	<0.02	0.035	0.028
-Barium	14	0.03	0.01	0.022	0.006
-Copper	168	0.1	<0.001	0.01+	-
-Iron	48	0.28	<0.001	0.047	0.05
-Lead	31	<0.1	<0.001	0.003+	-
-Manganese	32	<0.02	<0.01	<0.01+	-
-Mercury(tot)	12	0.00009	<0.00005	<0.00005+	-
-Molybdenum	63	0.13	0.01	0.052	0.025
-Uranium	11	0.0039	0.0013	0.0020	0.0009
-Zinc	90	0.14	<0.001	0.01+	-
Nitrogen					
-Ammonia	7	0.07	<0.01	0.029	0.029
-Kjeldahl	34	1.0	<0.01	0.22	0.19
-Nitrate	55	1.0	0.07	0.39	0.27
-Nitrite	31	0.045	<0.005	0.008	0.009
-Nitrate/ Nitrite	115	1.7	0.009	0.481	0.279
-Organic	28	0.99	0.08	0.30	0.23
-Total	31	4.22	0.3	1.0	0.84
Oxygen-Dissolved	105	13.7	8.6	11.3	1.3
pH	290	9.0	6.9	8.2+	-
Phosphorus					
-Ortho Diss	96	0.062	<0.003	0.016	0.011
-Total Diss	61	0.359	0.005	0.073	0.057
-Total	120	0.297	0.007	0.038	0.04
Potassium	18	8.4	1.6	2.5	1.5
Sodium	70	69	1	8.2	8.6

TABLE 18 (CONT'D)

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUN	MINIMUM	MEAN	STANDARD DEVIATION
Solids-Dissolved	161	305	65	198	46.5
-Suspended	189	296	0	14.7	37.4
-Total	48	552	72	220.5	84.3
Specific Conductivity	173	1250	110	289	104
Sulphate	49	87.5	8.8	21.2	11.1
Temperature	97	27	2	16.3	6.1
Turbidity	282	115	<0.1	4.8	12.2

PERIOD OF RECORD :1969-1987

+ Median Value

*All values are as mg/L except:
1) Coliforms as MPN/100mL
2) Colour as Colour units
3) pH
4) Specific Conductivity as uS/cm
5) Temperature as °C
6) Turbidity as NTU

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT
DATA RETRIEVAL SYSTEM

TABLE 19
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	.871	.863	.856	.849	.844	.839	.836	.833	.832	.831	.831
9.0	.703	.697	.692	.683	.685	.682	.681	.681	.680	.681	.682

	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	23.6	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

	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
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	1.02	1.02	1.02	1.03	1.03	1.04	1.05	1.06	1.07
8.9	.832	.834	.838	.842	.847	.853	.861	.870	.880	.891
9.0	.684	.688	.692	.698	.704	.711	.720	.729	.740	.752

TABLE 20
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	.989	.976	.963	.952	.942	.932	.922	.914	.906	.899
8.2	.799	.788	.777	.768	.759	.751	.743	.736	.730	.724	.718
8.3	.636	.628	.620	.613	.606	.599	.594	.588	.583	.579	.575
8.4	.508	.501	.495	.489	.484	.479	.475	.471	.467	.464	.461
8.5	.405	.400	.396	.381	.387	.384	.380	.377	.375	.372	.370
8.6	.324	.320	.317	.313	.310	.308	.305	.303	.301	.300	.298
8.7	.260	.257	.254	.251	.249	.247	.246	.244	.243	.242	.241
8.8	.208	.206	.204	.202	.201	.200	.198	.197	.197	.196	.196
8.9	.168	.166	.165	.163	.162	.161	.161	.160	.160	.160	.160
9.0	.135	.134	.133	.132	.132	.131	.131	.131	.131	.131	.131

	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	1.78	1.66	1.54	1.43	1.33	1.24
7.7	1.84	1.83	1.81	1.80	1.78	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	.970	.904

	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
8.0	1.12	1.11	1.10	1.10	1.09	1.02	.944	.878	.818	.762
8.1	.893	.887	.882	.878	.874	.812	.756	.704	.655	.611
8.2	.714	.709	.706	.703	.700	.651	.606	.565	.527	.491
8.3	.571	.568	.566	.564	.562	.523	.487	.455	.424	.396
8.4	.458	.456	.455	.453	.452	.421	.393	.367	.343	.321
8.5	.369	.367	.366	.366	.365	.341	.318	.298	.278	.261
8.6	.297	.297	.296	.296	.296	.277	.259	.242	.227	.213
8.7	.241	.240	.240	.241	.241	.226	.212	.198	.186	.175
8.8	.196	.196	.196	.197	.198	.185	.174	.164	.154	.145
8.9	.160	.161	.161	.162	.163	.153	.144	.136	.128	.121
9.0	.132	.132	.133	.134	.135	.128	.121	.114	.108	.102

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

TABLE 21
AMBIENT WATER QUALITY DATA SUMMARY
SITE 0500352:TREPANIER CREEK AT IRRIGATION DITCH

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Alkalinity	4	92.1	30.5	61.6	25.8
Arsenic(tot)	4	0.006	<0.005	<0.005+	-
Carbon-Organic	2	4	<1	-	-
Chloride	3	1	0.5	0.5+	-
Colour	3	50	5	20	26
Cyanide	2	<0.01	<0.01	-	-
Hardness-Total	66	96.8	4.2	56.2	24
-Calcium	56	28.4	1.4	14	7.2
-Magnesium	4	4.7	1.2	2.85	1.48
Metals (Diss)					
-Cadmium	4	<0.0005	<0.0005	<0.0005	-
-Chromium	1	<0.005	-	-	-
-Copper	36	0.05	0.0004	0.005	0.010
-Iron	2	<0.1	<0.1	<0.1	-
-Lead	2	<0.001	<0.001	<0.001	-
-Manganese	2	<0.02	<0.02	0.02	-
-Mercury(tot)	1	<0.00005	-	-	-
-Molybdenum	3	0.0053	0.0038	0.0044	0.0008
-Zinc	14	0.02	0.0033	0.01	0.006
Nitrogen					
-Ammonia	6	0.016	<0.005	0.008	0.004
-Kjeldahl	6	0.34	0.12	0.25	0.09
-Nitrate	6	0.42	0.12	0.26	0.11
-Nitrite	4	<0.005	<0.005	<0.005	-
-Nitrate/ Nitrite	6	0.08	<0.02	0.03	0.02
-Organic	5	0.32	0.12	0.22	0.09
Oxygen-Dissolved	1	11.6	-	-	-
pH	145	8.6	6.6	7.9+	-
Phosphorus					
-Total Diss	2	0.008	0.006	0.007	-
-Total	5	0.038	0.008	0.015	0.013
Potassium	2	1.8	1.2	1.5	-
Sodium	36	8.1	<0.5	3.8	1.8
Solids-Dissolved	135	208	13	107	32
-Suspended	137	70	0	7.2	12.2
-Total	36	232	35	112.8	46
Specific Conductivity	41	806	53	258	227
Sulphate	3	<5	<5	<5	-
Temperature	2	7.5	7.5	7.5	-
Turbidity	139	4.8	0	0.56	0.66

PERIOD OF RECORD :1967-1987

\+ Median Value

*All values are as mg/L except:
1) Colour as Colour units
2) pH
3) Specific Conductivity as uS/cm
4) Temperature as °C
5) Turbidity as NTU

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT
DATA RETRIEVAL SYSTEM

TABLE 22
AMBIENT WATER QUALITY DATA SUMMARY
SITE 0500078 : TREPANIER CREEK AT PEACHLAND

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Alkalinity	44	117	32.3	75.9	22.1
Carbon-Inorganic	7	24	12	20.4	4.11
-Organic	12	10	2	5.9	2.9
-Total	1	24	-	-	
Chloride	20	3	<0.5	0.95	0.5
Coliforms-Fecal	12	70	<2	10+	-
Colour	17	30	0	9.41	8.46
Hardness-Total	74	101	5	60.2	25.2
-Calcium	83	33	3.9	19.5	7.0
-Magnesium	32	6.4	1.13	3.78	1.37
Metals (Diss)					
-Aluminum	15	0.06	<0.02	0.04	0.01
-Boron	19	<0.1	<0.01	<0.01+	-
-Chromium	5	<0.005	<0.005	<0.005	-
-Copper	160	0.1	0.0	0.026	0.025
-Iron	35	0.2	<0.01	0.053	0.047
-Lead	39	<0.1	0	0.012+	-
-Manganese	24	0.27	<0.01	0.022	0.053
-Mercury(tot)	6	0.00014	<0.00005	0.00007	0.00004
-Molybdenum	29	0.02	0.0008	0.0077	0.0045
-Radium(tot)	9	0.02	<0.01	0.013	0.005
-Uranium	11	0.0039	0.0007	0.0021	0.0009
-Zinc	96	0.05	0	0.026	0.02
Microtox	3	>100	>100	>100	-
Nitrogen					
-Ammonia	14	0.08	0.0	0.02	0.02
-Kjeldahl	31	0.35	<0.01	0.13	0.08
-Nitrate	28	0.06	<0.02	0.03	0.012
-Nitrite	6	0.009	0.0	0.005	0.003
-Nitrate/ Nitrite	31	0.06	<0.02	0.027	0.013
-Organic	36	0.33	0.01	0.12	0.08
-Total	32	0.36	0.03	0.15	0.09
Oxygen-Dissolved	18	14	9	11.7	1.5
pH	184	8.7	6.6	7.9+	-
Phosphorus					
-Ortho Diss	7	0.028	0.004	0.009	0.009
-Total Diss	21	0.094	0.003	0.013	0.019
-Total	44	0.098	0.0	0.016	0.018
Potassium	15	1.9	0.8	1.45	0.38

TABLE 22 (CONT'D)

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Sodium	62	8.8	<0.5	4.04	1.52
Solids-Dissolved	145	197	22	107.4	30.5
-Suspended	146	102	<0.5	6.6	14.1
-Total	61	179	29	113.6	30.3
Specific Conductivity	87	923	53	210	183.6
Sulphate	34	7	3.5	5.2	0.8
Temperature	27	20.5	0	7.9	5.4
Turbidity	165	5.8	0	0.6	0.7

PERIOD OF RECORD : 1968-1987

+ Median Value

*All values are as mg/L except:
1) Coliforms as MPN/100mL
2) Colour as Colour units
3) pH
4) Specific Conductivity as uS/cm
5) Temperature as °C
6) Toxicity (Microtox) as % effluent
7) Turbidity as NTU
8) Radium as Bq/L

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT
DATA RETRIEVAL SYSTEM

TABLE 23
AMBIENT WATER QUALITY DATA SUMMARY
SITE 0500059:POWERS CREEK AT GELLATLY RD.

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Alkalinity	24	224	26.5	112.8	60.1
Carbon-Organic	17	22	<1	8.4	5.5
Chloride	16	4.1	0.8	1.9	0.93
Coliforms-Fecal	9	540	8	17+	-
Colour	12	70	5	27.1	17.5
Cyanide	2	<0.01	<0.01	<0.01	-
Hardness-Total	25	242	30	119.3	69.9
-Calcium	26	61.9	9.5	30.8	16.4
-Magnesium	25	22.4	1.4	10.5	6.7
Metals (Diss)					
-Aluminum	1	0.03	-	-	-
-Cadmium	15	0.0013	<0.0001	<0.0005+	-
-Chromium	9	<0.005	<0.005	<0.005	-
-Copper	10	0.01	0.001	0.004	0.003
-Iron	20	0.23	0.01	0.08	0.06
-Lead	12	0.003	<0.001	<0.001+	-
-Manganese	17	0.02	<0.01	0.015	0.005
-Mercury(tot)	8	0.00017	<0.00005	<0.00005+	-
-Molybdenum	1	0.02	-	-	-
-Zinc	10	0.04	<0.005	0.015	0.013
Nitrogen					
-Ammonia	18	0.04	<0.005	0.017	0.009
-Kjeldahl	24	0.59	0.13	0.27	0.09
-Nitrate	10	2.5	0.1	1.04	0.79
-Nitrite	20	<0.005	<0.005	<0.005	-
-Nitrate/ Nitrite	20	2.5	0.05	0.92	0.7
-Organic	24	0.55	0.15	0.28	0.09
-Total	27	2.79	0.33	1.02	0.63
Oxygen-Dissolved	27	14.8	8.3	11.8	1.7
-% Sat	21	124.1	71.5	101.7	12.8
pH	46	8.7	7.4	8.1+	-
Phosphorus					
-Ortho Diss	8	0.047	0.01	0.026	0.010
-Total Diss	13	0.032	0.014	0.023	0.005
-Total	30	0.093	0.017	0.036	0.016
Potassium	17	7.2	0.9	1.9	1.45
Sodium	21	24	2.2	11	6.4
Solids-Dissolved	8	356	98	230	82.9
-Suspended	24	75	<1	7.4	14.8
-Total	20	350	74	186	80.5
Specific Conductivity	46	540	20	257	151
Sulphate	19	75	<5	31.2	21
Temperature	29	19.5	2	8.1	5.1
Turbidity	21	30	0.3	2.9	6.3

PERIOD OF RECORD : 1972-1982

+ Median Value

*All values are as mg/L except:
1) Coliforms as MPN/100mL
2) Colour as Colour units
3) % Sat as %
4) pH
5) Specific Conductivity as uS/cm
6) Temperature as °C
7) Turbidity as NTU

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT
DATA RETRIEVAL SYSTEM

TABLE 24
AMBIENT WATER QUALITY DATA SUMMARY
SITE 0500096:WESTBANK CREEK AT MOUTH

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Alkalinity	26	367	85.1	300.2	71.4
Carbon-Organic	23	15	<1	7.9	4.2
Chloride	18	17	<0.3	9.1	3.6
Coliforms-Fecal	36	16000	<2	103+	-
Colour	14	15	<5	9.3	3.9
Cyanide	2	<0.01	<0.01	<0.01	-
Hardness-Total	26	487	85.7	343	99.8
-Calcium	28	106	24.1	78.7	18.7
-Magnesium	28	54	6.2	37.9	11.5
Metals (Diss)					
-Aluminum	1	1.07	-	-	-
-Cadmium	10	0.001	<0.0001	<0.0005+	-
-Chromium	8	<0.005	<0.005	<0.005	-
-Copper	10	0.02	0.001	0.008	0.007
-Iron	16	1.37	0.02	0.16	0.33
-Lead	10	0.01	<0.001	<0.001+	-
-Manganese	11	0.08	<0.01	0.03	0.02
-Mercury(tot)	9	0.00012	<0.00005	<0.00005+	-
-Molybdenum	1	<0.01	-	-	-
-Zinc	10	0.08	<0.005	0.017	0.023
Nitrogen					
-Ammonia	41	5.98	<0.005	2.08	1.77
-Kjeldahl	50	8.52	0.23	3.01	2.48
-Nitrate	30	4.39	0.53	1.4	0.69
-Nitrite	1	0.03	-	-	-
-Nitrate/ Nitrite	45	5	0.53	1.42	0.67
-Organic	42	5.39	0.11	1.13	1.08
-Total	54	12.89	0.88	4.0	2.65
Oxygen-BOD(det'ble)	11	104	0.4	22.3	29.3
-Dissolved	17	12.8	7.4	10.2	1.6
-% Sat	16	142.1	58.3	92	18.3
pH	66	8.9	7.9	8.4+	-
Phosphorus					
-Ortho Diss	15	1.07	0.019	0.32	0.34
-Total Diss	36	1.66	0.023	0.606	0.447
-Total	60	3.4	0.029	0.791	0.682
Potassium	17	7.8	3.2	4.7	1
Sodium	23	70.4	7.1	51.9	15.8

TABLE 24 (CONT'D)

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Solids-Dissolved	28	778	140	575	141
-Suspended	35	743	6	69.6	122.3
-Total	27	1378	150	645	215
Specific Conductivity	71	1170	200	861	153
Sulphate	21	253	15.5	160	58.5
Temperature	22	19	3	9.3	5.1
Turbidity	41	42	1.1	16	8.8

PERIOD OF RECORD : 1972-1985

+ Median Value

*All values are as mg/L except:
1) Coliforms as MPN/100mL
2) Colour as Colour units
3) pH
4) Specific Conductivity as uS/cm
5) Temperature as °C
6) Turbidity as NTU

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT
DATA RETRIEVAL SYSTEM

TABLE 25

MAXIMUM AND 30-d AVERAGE NITRITE (N) CONCENTRATIONS

Chloride Concentration (mg/L)	Maximum Nitrite-N Concentration (mg/L)	30-d Average Nitrite-N Concentration* (mg/L)
<2	0.06	0.02
2-4	0.12	0.04
4-6	0.18	0.06
6-8	0.24	0.08
8-10	0.30	0.10
>10	0.60	0.20

*the 30-d average chloride concentration should be used to determine the appropriate 30-d average nitrite objective.

TABLE 26
AMBIENT WATER QUALITY DATA SUMMARY
SITE 0500805:FAULKNER CREEK AT WESTSIDE ROAD

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Alkalinity	10	295	218	241.7	27.5
Chloride	4	12.6	4.7	7.5	3.6
Coliforms-Fecal	8	110	8	23+	-
Colour	6	8	2	5.8	2.2
Hardness-Total	1	301	-	-	-
-Calcium	1	86	-	-	-
-Magnesium	1	21	-	-	-
Nitrogen					
-Ammonia	10	0.007	<0.005	0.005	-
-Kjeldahl	10	1.23	0.13	0.336	0.328
-Nitrate	10	0.56	0.24	0.356	0.107
-Nitrite	10	0.007	<0.005	<0.005	-
-Nitrate/ Nitrite	10	0.56	0.24	0.357	0.107
-Organic	10	1.22	0.13	0.332	0.325
-Total	10	1.54	0.37	0.69	0.345
pH	10	8.5	8.0	8.3+	-
Phosphorus					
-Total Diss	10	0.051	0.027	0.039	0.008
-Total	10	0.14	0.046	0.067	0.030
Potassium	4	3.2	3.1	3.175	0.050
Sodium	2	21.1	21	21.05	0.070
Specific Conductivity	10	673	588	620	28.5
Sulphate	1	67.6	-	-	-
Temperature	6	13	6	8.9	3.0
Turbidity	10	30	1.2	7.5	10.0

PERIOD OF RECORD : 1982

+ Median Value

*All values are as mg/L except:
1) Coliforms as MPN/100mL
2) Colour as Colour units
3) pH
4) Specific Conductivity as uS/cm
5) Temperature as °C
6) Turbidity as NTU

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT DATA RETRIEVAL SYSTEM

TABLE 27
AMBIENT WATER QUALITY DATA SUMMARY
SITE 0500041:LAMBLY CREEK AT WESTSIDE ROAD BRIDGE

CHARACTERISTIC	NUMBER OF VALUES	VALUES* MAXIMUM	MINIMUM	MEAN	STANDARD DEVIATION
Alkalinity	22	140	26.5	93.9	36.7
Arsenic	1	0.006	-	-	-
Carbon -Organic	15	24	2	9	5.2
Chloride	15	1.3	0.6	0.97	0.23
Coliforms-Fecal	6	5	2	2+	-
Colour	12	52	5	20.4	18
Hardness-Total	22	163	32.1	96.2	37.7
-Calcium	22	50.4	9.4	29.1	12.2
-Magnesium	22	9.07	1.4	4.92	2.3
Metals (Diss)					
-Cadmium	12	0.01	<0.0001	0.0012	0.0028
-Chromium	10	<0.005	<0.005	<0.005	-
-Copper	11	0.02	<0.001	0.003	0.006
-Iron	18	0.75	<0.01	0.112	0.169
-Lead	10	0.07	<0.001	0.0015+	-
-Manganese	15	<0.02	<0.01	<0.01+	-
-Mercury(Tot)	13	0.00024	<0.00005	<0.00005+	-
-Nickel	9	0.04	<0.01	0.013	0.01
-Zinc	13	0.2	<0.005	0.026	0.053
Nitrogen					
-Ammonia	14	0.038	0.005	0.014	0.009
-Kjeldahl	20	0.45	0.03	0.18	0.10
-Nitrate	5	0.18	0.05	0.086	0.054
-Nitrite	22	<0.005	<0.005	<0.005	-
-Nitrate/ Nitrite	7	0.18	0.03	0.07	0.05
-Organic	28	0.68	0.02	0.20	0.14
-Total	25	0.68	0.03	0.24	0.16
Oxygen-Dissolved	20	14.5	4.8	11.2	2.2
-% Sat	20	118.7	51.2	93.2	15.7
pH	45	9.0	7.0	8.1+	-
Phosphorus					
-Ortho Diss	13	0.045	0.011	0.018	0.010
-Total Diss	13	0.026	0.011	0.015	0.004
-Total	29	0.479	0.014	0.048	0.087
Potassium	16	1.9	0.8	1.5	0.37
Sodium	18	7.7	2.2	5.4	2.0
Solids-Dissolved	19	220	70	149	37.9
-Suspended	21	299	<1	26	65.5
-Total	26	454	100	173	65.2
Specific Conductivity	55	620	60	219	108.6
Sulphate	14	18.8	6	13.7	3.8
Temperature	31	17	0	7.2	4.5
Turbidity	22	100	0.2	7.2	21.2

PERIOD OF RECORD : 1972-1982

\+ Median Value

*All values are as mg/L except:
1) Coliforms as MPN/100mL
2) Colour as Colour units
3) pH
4) Specific Conductivity as uS/cm
5) Temperature as °C
6) Turbidity as NTU

DATA SOURCE :B.C. MINISTRY OF ENVIRONMENT AND PARKS
DATA RETRIEVAL SYSTEM