MINISTRY OF THE ENVIRONMENT

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AIR AND WATER QUALITY STUDY
PHASE I

WATER QUALITY IN REGION 6,
THE SLOCAN RIVER BASIN

WATER INVESTIGATIONS BRANCH

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SUMMARY

This report is an evaluation of the water quality in the Slocan River Basin, up to the beginning of 1976. It is one of a series of 12 reports which describe air and water quality in the Kootenay region and constitute Phase I of the Kootenay Study.

Logging and mining were the major industries, but logging has had only a localized effect on water quality to date. Extensive mining was conducted in the region in the past. The only operation still discharging effluent was the mine and concentrator of Kam Kotia Mines Ltd. on Carpenter Creek, which flows into Slocan Lake. Drainage from abandoned mines and effluent from the Kam Kotia operation have contaminated Carpenter Creek and tributary streams with zinc and cadmium. The concentration of these heavy metals, although within drinking water standards, may have affected aquatic life. Information on the possible contamination of fish is being gathered and will be presented in a Phase II report for the region.

Slocan Lake had a low productivity and the water quality was good. Its zinc content was higher than usually found in the Kootenays, due to drainage from Carpenter Creek, but was at a level safe for aquatic life.

The short stretch of the Kootenay River in Region 6 contained five dams built for hydroelectric power. The water quality of the river was good although the phosphorus and fluoride content was influenced by a fertilizer plant at Kimberley, located over two hundred miles upstream. Supersaturation of the water with nitrogen was caused by water spilling over the dams. The supersaturation was below the range critical to fish although some unsatisfactory levels were recorded. The recently completed Kootenay Canal, which bypasses the first four dams, will reduce nitrogen supersaturation.

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Copies of this report, and of others in the series (Region location shown in Figure 6-9) can be obtained from the Environmental Studies Division, Water Investigations Branch, Parliament Buildings, Victoria, B.C.

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1. DESCRIPTION OF THE REGION

1.1 Introduction

The Slocan River Basin has an area of 1,350 square miles. The region lies entirely within the Selkirk Mountains and is drained by Slocan Lake, the Slocan River, and the Kootenay River. Mountain ranges, which rise steeply to heights of 5,000 feet above the valley floors, dominate the region. A general map of the Slocan River Basin is shown in Figure 6-1. More detailed maps are given in Figure 6-5 which shows the north section of Region 6, and Figure 6-6 which shows the south section.

1.2 Climate

The climate of the region is largely determined by its topography. The warmest and driest portions of the region lie in narrow bands along the valleys of Slocan Lake, Slocan River, and the Kootenay River. The climate becomes progressively cooler and moister up the mountain ranges bordering these valleys.

The valleys of Slocan Lake, Slocan River, and Kootenay River receive an annual average of 760 mm of precipitation. The Slocan and Valhalla Ranges, bordering these valleys on the east, west and north, receive 1,000 mm per year. Snowfall averages 200 cm per year in the valleys, while the surrounding mountains receive about 250 cm in the west, 250-380 cm in the east, and up to 500 cm in the north(1).

July temperatures average about 18°C over the entire region. The mean January temperature is -7°C with the exception of the Kootenay River valley where it is -4°C. The average frost-free period is 120 days along the Slocan Lake, Slocan River and Kootenay River valleys, and then decreases to 100 days in the Valhalla Ranges on the west, and to between 80 and 100 days in the Slocan Ranges on the east and north(1).

1.3 Geology

The entire Slocan River Basin lies within the Selkirk Mountains. The Slocan River and Slocan Lake occupy a deep, north-south valley, 70 miles long, which is dominated by steep mountain ranges that often rise to 8,000 feet[2]. The Valhalla Ranges are to the west of the basin, and the Slocan Ranges are to the east and north. The southern part of the basin is occupied by the narrow, deep valley of the Kootenay River which is flanked on the south by the Bonnington Range.

The Slocan and Bonnington Ranges are largely composed of the coarse-grained granitic rocks of the Nelson batholith which lies east of Slocan Lake and Slocan River, extending from Silverton to Trail[3]. North of Silverton, the Slocan Ranges are composed mainly of argillaceous rocks (phylites, shales, and schists), fine-grained slates, quartzite, and limestone[4]. On the west, the Valhallas are composed predominantly of gneiss and schist[2][3].

Slocan Lake and Slocan River lie at elevations between 1,700 and 1,800 feet in a U-shaped glaciated valley that is 1 to 2 miles wide. The region was glaciated to about 7,000 feet and the Slocan valley contains numerous glacial deposits[2].

1.4 Soils and Vegetation

Valley bottom soils in the Slocan Basin have developed on recent alluvial fan and floodplain deposits and on lacustrine, outwash, and kame deposits of glacial origin. Douglas fir predominates in the forested areas below 2,500 feet. Soils on the mountain slopes have been derived from glacial till and colluvium and are interrupted by bedrock outcrops, talus cones, and avalanche chutes. The main tree species between 2,500 and 5,000 feet elevation are western hemlock, white pine, western red cedar, western larch, and Douglas fir. A zone of Engelmann spruce and subalpine fir is found between elevations of 5,000 to 7,000 feet, with pockets of alpine vegetation occurring at higher elevations.

1.5 Hydrology

1.5.1 Streamflow

The major water bodies within the region are Slocan Lake, Slocan River and Kootenay River (Figure 6-1). Slocan Lake and Slocan River lie in a north-south valley in the centre of the region and receive runofff from numerous small tributaries. The Slocan River follows a meandering, 30 mile course southward from Slocan Lake through the glacial and alluvial deposits of the Slocan Valley to its confluence with the Kootenay River at Shoreacres. The Slocan River is not regulated and the freshet causes frequent flooding and loss of farmland due to erosion[2].

The Kootenay River enters the region at Corra Linn Dam and flows southwest for 14 miles to its confluence with the Columbia River. This reach of river is steep, dropping 360 feet in 14 miles. In its natural state, the reach contained waterfalls and rapids which have now been eliminated by the construction of 5 dams for hydro-electric power generation.

The mean annual flow leaving the region at the mouth of the Kootenay River is 31,350 CFS. The Slocan River contributes about 10 percent (3050 CFS) of this flow, while the remaining 90 percent (28,300 CFS) comes from the Kootenay River as it enters the region at the Corra Linn Dam[5].

The seasonal flow pattern of the Slocan River at the outlet of Slocan Lake (Slocan City) and at the mouth (Cresent Valley) is shown in Figure 6-2. About two thirds of the annual flow in the Slocan River occurs during May, June, and July.

The flow pattern in the Lower Kootenay River has been considerably altered by the combined operation of the Corra Linn, Libby and Duncan Dams, which control a volume of water equivalent to 36 percent of the mean annual flow in the Kootenay River at Corra Linn. Figure 6-3 compares the mean monthly flows of the Kootenay River at Corra Linn, with and without Libby and Duncan regulation.

1.5.2 Lakes

The only major lake within the region is Slocan Lake. The lake lies at an elevation of about 1,755 feet in a long, narrow valley between mountains that rise steeply to heights of 7,000 to 8,000 feet on each side. The lake is 24 miles long and averages 1-1½ miles in width. The maximum width is 1 3/4 miles. The maximum depth of the lake is 978 feet[6]. Lake levels are uncontrolled and have varied from 1,754 feet during winter to 1,764 feet during the spring freshet. Slocan Lake has a tributary drainage area of 640 square miles. Its largest tributary is Wilson Creek which drains 235 square miles in the northern end of the Slocan Basin[7]. The numerous small streams which are tributary to Slocan Lake vary from those receiving meltwater from mountain glaciers to those draining upland lakes. The outlet of Slocan Lake is at Slocan where the Slocan River drains the lake southward to the Kootenay River.

1.5.3 Groundwater

The use of groundwater in the region has been limited, probably because surface water supplies have been adequate. In the future, increasing population and development may strain existing surface water supplies. Groundwater will then be the source of new water supplies in many areas of the Slocan Basin.

The alluvial and glaciofluvial deposits along the valley bottoms are areas in which groundwater flows of 50 to 500 imperial gallons per minute are generally available[8]. The records of the Groundwater Section of the Water Investigations Branch indicate that there are 15 wells in the region located as follows: Cresent Valley - 5; Tarrys - 4; Shoreacres - 3; Thrums - 2; and Slocan Park - 1. (50 - 75 percent of groundwater wells are on record with the Groundwater Division). These wells are located in the surficial deposits bordering the Slocan and Kootenay Rivers. The well at Slocan Park is a 500 IGPM well developed to provide water for irrigation[9].

The Village of New Denver investigated the possibility of using the groundwater in the deltaic deposits beneath the village to augment their surface water supplies[10].

1.5.4 Dams

There are 5 dams and 7 powerplants on the short reach of the Kootenay River between the Corra Linn Dam and the confluence with the Columbia River. This reach drops 360 feet in 14 miles, and has been developed for hydro-electric power generation. Corra Linn is the first dam in the series, followed by Upper Bonnington, Lower Bonnington, South Slocan, and Brilliant. The Kootenay Canal, completed in 1976, has its intake at Corra Linn Dam, and supplies water to a powerplant located just downstream from South Slocan Dam[11]. The dams and their influence on water quality are discussed in Chapter 3, section 3.4.

1.6 Water Use

1.6.1 Water Licenses

Licensed water usage is allocated approximately as follows[12]:

	Acre-feet per year
Domestic	2525
Irrigation	4350 (3500 acres irrigated)
Industrial	936
Mining	500
Fish Culture	3620
Power Generation	69.5 million

A summary of the major water licences in the region is given in Table 6-1. Only those sources licensed for 10,000 GPD (13 acre-feet) or more are included.

The major domestic users are the Villages of Nakusp (Nakusp is located in Region 8, but obtains its water supply from Region 6), New Denver, Silverton, and Slocan, and the settlements of South Slocan and Krestova. They account for 82 percent of the domestic usage. The remaining 18 percent is distributed among numerous small users scattered throughout the region. The licensed irrigation is also distributed among many small users scattered throughout the arable lands of the region. There are a few larger irrigated holdings (400 acres, 295 acres, 180 acres, and 100 acres), but the majority of the holdings are less than 10 acres. About two thirds of the irrigation water is used on the farmland along the Slocan River.

The entire industrial water use was licensed to the contractors who built the Kootenay Canal Project. The quantity for mining is low since several licenses were issued jointly for mining, domestic and power purposes and these have not been included in the total. In any case, most of the mines in the Slocan Basin have been closed, and thus do not use the water licensed to them. The quantity allocated for fish culture is used by one private fish culture operation near Slocan.

Virtually all of the water licensed for power generation in the region is used by the 7 power plants located on the Kootenay River. (Corra Linn, Upper Bonnington, City of Nelson, Lower Bonnington, South Slocan, Kootenay Canal, and Brilliant).

1.6.2 Water Availability

Good quality water from small creeks, brooks and springs has been adequate to meet water supply needs. However, as population and development increase, some of these water sources are becoming fully utilized, so that more expensive or lower quality sources must be used.

There are three areas in the region where the readily available water supplies are becoming fully utilized. These are: The New Denver-Rosebery area on the east side of Slocan Lake, the Slocan River valley between Slocan and Krestova (particularily the west side of the Slocan River in the Perrys, Appledale, Vallican, and Slocan Park areas); and the west side of the Kootenay River valley in the Shoreacres, Glade, Tarrys and

Thrums areas. The water sources that are limited in these areas are shown in Table 6-2. A more detailed analysis of the water availability problems in the region will be presented in our Phase II report.

As outlined in Section 1.5.3, groundwater is generally available in large quantities (50 to 500 IGPM) along the valleys of the Slocan and Kootenay Rivers and has been used in several areas. Watercourses such as Slocan Lake, Slocan River, and Kootenay River could supply large quantities of water. However, they may require both treatment and pumping prior to use, and thus have provided only minor quantities of water to date.

1.7 Settlements and Industrial Centres

The largest incorporated settlements in the Slocan River Basin are the Villages of New Denver, Slocan, and Silverton which had populations of 647,347 and 251 respectively, in 1976[13]. The larger unincorporated settlements and their 1971 populations are Winlaw (383), Thrums (365), Slocan Park (360), and Shoreacres (345)[13,14,15]. The 1971 populations of other settlements in the region are listed in Table 6-3. We estimate that the total population of the region in 1971 was about 6,000 persons.

There are no major industrial centres in the region.

1.8 Land Use

1.8.1 Agriculture

The Slocan River Basin supports very little agricultural activity. The 1971 agricultural census indicated that there were about 40 farms located along the Slocan and Kootenay River valleys. Most of the farms were less than 100 acres in size, and the total cropland was only about 350 acres for the entire region.

The cultivated land is used primarily for hay production. Beef cattle is the predominant livestock enterprise[16]. Less than one farmer in ten is self-supporting from agriculture. The practice of part-time or subsistence farming is due to the scattered distribution of the better farming soils, the attraction of off-farm work, and the subdivision of land for non-farm use in more heavily populated areas[17].

1.8.2 Forestry

Much of the northern and eastern portions of the Slocan River Basin are committed to logging operations as shown in Figure 6-1[18]. The major drainages which may be influenced by logging are Bremner, Fitzstubbs, Wilson, Silverton, Springer, and Lemon Creeks. In the past, logging has also taken place in the Koch and Hoder Creek drainages in the southwest of the region[2]. Portions of these drainages will probably be logged again in the near future.

1.8.3 Mining

Mining activity has been relatively light in recent years. Only one property, Silmonac (Minniehaha), operated by Kam Kotia Mines Ltd. at Sandon, produced more than 1,000 tons of ore per year during 1972 to 1974. The Kam Kotia operation is discussed in detail in Chapter 2, section 2.2. From 1972 to 1974, eleven other properties produced small quantities of ore ranging from 2 to 834 tons per year. Ore from these small producers was shipped to the smelter at Trail[19]. Table 6-4 contains a summary of the mineral production in the Slocan Basin for the period 1972-1974.

Exploration in the Slocan Basin has been light. From 1972 to 1974, five to nine properties were explored each year, centering on the Carpenter Enterprise, Silverton and Springer Creek basins on the east side of Slocan Lake[19]. The B.C. Ministry of Mines has rated this area class 2C for mineral potential, indicating that there is a moderate possibility that small, economically viable deposits may be found[20].

In the past, the Slocan Basin was the scene of considerable mining activity. Some effects of this mining on water quality are discussed in Chapter 3, section 3.3.

1.8.4 Recreation

There is a diversity of lakes, streams and alpine areas offering opportunities for outdoor recreation. Areas with high recreational value are summarized below.

(a) Slocan Lake and Slocan River

Slocan Lake is scenically attractive. Although much of the shoreline is too steep for intensive recreation, there are several beaches and low lying areas near tributary inlets, particularly along the west side. Slocan Lake sport fishing success is regarded to be moderate to low[21].

The Canada Land Inventory (C.L.I.) rates shore-based recreation around Slocan Lake as good (Class 2) at the north end and near Rosebery[21,22]. Most of the shoreline has a moderate rating (Class 3, west side) or poor rating (Class 4 or 5, east side) for recreational capability. Rosebery Provincial Park (80 acres), three miles north of New Denver, provides picnicking and camping facilities[17].

The pastoral Slocan River Valley has received C.L.I. ratings of Class 4 and 5. Attractions include angling, camping, and scenery. The Little Slocan Lakes are rated Class 3 (angling and wetland wildlife viewing are major attractions) and have been named as a possible future campground location[2]. The Little Slocan River Valley (Class 4 and 5) provides opportunities for angling, camping, and canoeing.

(b) Kootenay River

There are moderately good recreational opportunities in the Region 6 portion of the Kootenay River Valley[21]. An overall C.L.I. Class 4 to 5 rating has been given to most of the shoreline between Corra Linn and the Kootenay-Columbia River confluence. Smaller Class 3 recreational units , emphasizing viewpoints, angling, camping, and boating opportunities, include the Kootenay River at Brilliant, Shoreacres and South Slocan. Brilliant Terrace Provincial Park (288 acres) near Castlegar provides additional organized camping facilities[17].

River-oriented recreation is controlled to some extent by upstream regulation, in particular by the Corra Linn dam. However, the Kootenay Canal Project dams and control structures are in themselves tourist attractions.

The lower Slocan River and the Kootenay River in Region 6 support a moderately good sport fishery[21,23]. Rainbow trout, Dolly Varden char, kokanee, cutthroat trout, whitefish, and eastern brook trout are widely distributed in these rivers and many of their tributaries as shown in Figure 6-4. Rainbow trout have been stocked in Slocan Pool (the Kootenay River below Slocan Dam) since 1967, with a positive effect on fishing success[23].

(c) Upland Areas

Kokanee Glacier Park (64,000 acres), which borders on Regions 6 and 5, is the only existing upland recreational development, apart from trails to Beatrice and Cahill Lakes west of Slocan Lake[2]. Other upland areas in Region 6 with high potential recreational value include: The Valhalla Range, Lemon and Koch Creek drainages, Summit and Wilson Lakes, and the abandoned mine and townsites of Sandon and Cody[2,17].

Several alternatives for managing the Valhalla area have been put forward[2,24]. These include retention under the Forest Service resource folio management, establishment of a 122,000 acre nature conservancy, or establishment of a 68,000 acre Class A Provincial Park to be named the Valhalla Wilderness Park. The Valhallas contain many scenic and unique lake settings, alpine meadows, and rugged peaks. Canada Land Inventory ratings of Class 4 to 5 recreation capability have been given to most of the lakes and valleys in the area, which are at 4,000 to 5,000 ft.

elevation[21]. Higher individual ratings were given to the east end of Evans Lake (Class 2-3), the east end of Beatrice Lake (Class 3) and New Denver Glacier (Class 3, winter sports). Wee Sandy, Cahill, the west end of Beatrice and Evans Lakes, Thor and Gwillim Lakes received Class 4 ratings.

Many creeks such as Beatrice, Gwillim and Nemo Creeks, which are tributary to Slocan Lake or Slocan River, act as access corridors to the upland as well as providing opportunities for camping and angling. These creeks have been given Class 4-5 C.L.I. ratings for recreation. Gladsheim and Gimli Peaks at the head of Mulvey Creek, and The Devil's Conch north of Gwillim Creek, are important for rock climbing. New Denver Glacier is the only significant ski area in Region 6.

Ecological Reserve 32 was established on March 7, 1972 (order in council No. 903). It preserves 458 acres of yellow cedar habitat at the western end of Evans Lake in the Valhalla Range.

1.8.5 Wildlife

Snow depth above 3,500 feet elevation, is the most important limiting factor to wildlife distribution in Region 6[25,26]. Significant wintering areas (C.L.I. classes 2-3) are restricted to south and west facing slopes below this elevation.

Mixed 2W and 3W potential winter range classes for ungulates (primarily deer) are situated along the north side of Kootenay River upstream from Slocan River[26]. Class 3W ungulate range is more generally distributed, along the south side of Kootenay River above Slocan River, along both sides of Kootenay River below Slocan River, up both sides of Slocan River Valley, partway up the east side of Little Slocan Valley, and along the east side of Slocan Lake[25,26]. Upland ungulate capability is rated at Class 5 and 6 in the Valhalla Range, and Kokanee Glacier areas, and predominantly Class 4 elsewhere.

Current wildlife distributions[2,17,24] include mule and whitetail deer wintering at lower elevations along Slocan River Valley and east side of Slocan Lake. Mountain goats utilize south-facing cliffs in the Valhallas (e.g., Nemo Creek headwaters) for winter range. Dwindling numbers of mountain caribou winter near Summit Lake and inhabit the area between Wilson Lake and Kuskanax Creek north of Slocan Lake[27]. They also may occur in the upper Silverton Creek drainage[26]. Black deer are common and widely distributed, and grizzly bear are also fairly numerous but restricted to the remoter valleys.

Waterfowl are limited by lack of wetlands[27]. A small area of C.L.I. Class 4 waterfowl habitat is situated at the north end of Slocan Lake at Bonanza Creek. Class 5 areas include Slocan and Little Slocan Lakes, and Class 6 areas include Slocan River, Beatrice and Evans Lakes, and various smaller lakes and ponds. Marshes along the Slocan and Little Slocan Rivers provide resting areas during periods of waterfowl migration[2].

2. INDUSTRIAL AND MUNICIPAL SOURCES OF EFFLUENT AND SOLID WASTE

2.1 Introduction

Mining, forestry, and construction of hydroelectric facilities are the major industrial activities in the region. The only significant source of industrial effluent is a small lead-zinc concentrator, operated by Kam Kotia Mines Ltd. Other sources of industrial effluent include a gravel washing plant and two ready-mix concrete plants used in the construction of the Kootenay Canal Project. Semlon Resources Ltd. has reactivated the old Ottawa Silver Mines silver-lead-zinc ore concentrator near the Village of Slocan employing total effluent recycle. Pollution Control Permits for the discharge of effluents are described in Table 6-5. The locations of discharges are denoted in Figures 6-5 and 6-6 by their Pollution Control Permit numbers.

The only source of industrial solid waste in the region is from a sawmill at Thrums.

The population of the region is small (section 1.7) and thus there are no major sources of municipal effluent or solid waste.

2.2 Kam Kotia Mines Ltd.

2.2.1 Description

Kam Kotia Mines Ltd. has operated a 150 ton/day lead-zinc ore concentrator at the confluence of Carpenter and Tributary Creeks since September 1970. The operation is located about 6 miles east-southeast of New Denver and is denoted in Figure 6-5 by its Pollution Control Permit number, PE-1203. The concentrator was formerly owned and operated by Carnegie Mines Ltd. Mining operations in the immediate area have been active since the 1890's.

A simplified flow diagram of the concentrator is given in Figure 6-7. Ore is hauled by truck from the Silmonac (Minniehaha) mine to the concentrator where it is crushed to minus 3/8 inch in primary and secondary crushers. The crushed ore is further reduced in size by two ball mills and the zinc and lead concentrates are separated in flotation cells. The lead and zinc concentrates are dewatered on a filter and shipped to the smelter at Trail. Underflow from the zinc flotation cells and filtrate from the concentrate filters are pumped to the tailing pond. Washdown water and spills are collected in sumps and returned to the process circuit. Peak production occurred in 1971 when 39,754 tons of ore were processed. Ore reserves have declined since 1971, so that in 1974 only 8,927 tons of ore were processed[19].

The tailing pond is located on top of old tailing deposited adjacent to Carpenter Creek by Carnegie Mines Ltd. Supernatant from the tailing pond is discharged directly to Carpenter Creek. However, most of the wastewater seeps to Carpenter Creek through the bottom of the pond. In the past, the raw tailing from the mining operations located in this area were discharged directly to Carpenter Creek and its tributaries.

Pollution Control Permit number PE-1203 was issued to Kam Kotia Mines Ltd. on November 16, 1972, authorizing the discharge of 90,000 IGPD (0.17 CFS) of tailing pond supernatant to Carpenter Creek. The effluent quality characteristics specified by the permit are summarized in Table 6-5.

2.2.2 Presentation of Effluent Sampling Data

The supernatant from the Kam Kotia tailing pond has been sampled 31 times between April 1971 and May 1976 (11 times by the Pollution Control Branch and 20 times by the Company). Results are given in Tables 6-6 and 6-7. The quantity of supernatant discharged from the tailing pond has not been measured because there was rarely more than a trickle from the decant structure.

Between November 1972 and December 1975, the tailing inflow to the pond exceeded 90,000 IGPD on only 2 days (maximum of 97,000 IGPD). Monthly averages ranged from 30,000 to 70,000 IGPD. To prevent ice build-up during winter months, 85,000 to 229,000 IGPD of clean water from Tributary Creek was added to the tailing ponds. The minimum flow in Carpenter Creek occurs during the winter and is estimated to be about 5 CFS at the tailing pond[5] (minimum daily flow in 8 years of record).

2.2.3 Discussion of Effluent Data

Permit PE-1203 was issued before the Mining Objectives[28] were established, and the effluent characteristics on the permit are more stringent than Level A objectives, particularily for zinc. We have used the Mining Objectives in assessing the quality of the effluent since the minimum dilution of effluent in Carpenter Creek was about 30:1 and the objectives are directly applicable if the minimum dilution is 20:1 or greater.

The effluent data collected by the Company (Table 6-6) and the Pollution Control Branch (Table 6-7) were the same for most parameters. The Company's values were higher for dissolved zinc and most total metal analyses, but were lower for suspended solids. These discrepancies were probably caused by the difference in the number of samples analyzed, and by the distorting effect of a few high values.

In Table 6-8, we have listed the percentages of all effluent analyses which exceeded Levels A, B, and C of the Mining Objectives[28]. Dissolved copper, total cyanide, and suspended solids frequently exceeded Levels A and B. Only dissolved copper exceeded Level C. Dissolved manganese and sulphate exceeded Level A frequently, but sulphate was not high enough to be environmentally significant[29], and there were too few manganese analyses to determine if the values were representative. Dissolved lead, pH, and dissolved zinc exceeded Levels A or B occasionally.

The frequent occurrence of high copper and cyanide levels was thought to be due to overdoses of copper sulphate and cyanide in the flotation process from manually controlled feeders. These contaminants appeared to be stabilized by the tailing since they did not affect the downstream water quality of Carpenter Creek (Chapter 4, section 4.2).

The effect of the supernatant discharge on Carpenter Creek was believed to be small. Concentrations of certain parameters in the supernatant have been high, but the overflow was small due to high exfiltration rates through the bottom of the pond. The quantity of contaminants that this seepage contributed to Carpenter Creek is difficult to measure directly.

The water quality data for Carpenter Creek (Chapter 4, section 4.2) showed that the main effect of the Kam Kotia operation was to increase dissolved zinc and cadmium in the creek. These increases were not due to the supernatant from the tailing pond, because the concentrations in the supernatant were equal to or lower than those in Carpenter Creek upstream from Kam Kotia. The average dissolved zinc concentration increased from 0.3 mg/l upstream from Kam Kotia to 0.5 mg/l downstream. The average dissolved cadmium concentration increased from 0.002 mg/l to 0.004 mg/l. Thus, Kam Kotia contributed 40 to 50 percent of the zinc and cadmium in Carpenter Creek. The data also indicate that there were important sources of zinc and cadmium upstream from the mine.

The seepage from the tailing pond was believed to be the main source of cadmium and zinc from the mine. Samples taken in Carpenter Creek immediately downstream from the tailing pond showed the highest concentrations, indicating that the tailing pond was definitely a source of these metals.

Galbraith[30] has described a process by which metals are leached from mine tailing and we believe that this process is in operation in the Kam Kotia tailing pond. The major step in this process is the action of sulphur-oxidizing and sulphide-oxidizing bacteria which form sulphuric acid from sulphides. The acid produces metal sulphates which are soluble in the groundwater and eventually seep to the creek.

It may be feasible to seal the tailing pond and to employ total effluent recycle. This would reduce the leaching of zinc and cadmium to Carpenter Creek and eliminate the discharge of supernatant. Sealing of the tailing pond without total recycle would reduce the leaching of zinc and cadmium but would create a direct discharge of effluent which may contain high copper and cyanide concentrations.

The costs and benefits of upgrading the treatment works are being weighed, especially in view of the marginal nature of the Kam Kotia operation. The recycle scheme could, at best, reduce the average dissolved zinc and cadmium concentrations in the creek from 0.5 to 0.3 mg/l and 0.004 to 0.002 mg/l, respectively. Thus, unless the other sources of zinc and cadmium can be controlled, the recycle scheme may not significantly improve Carpenter Creek for aquatic life.

2.2.4 Recommendations

We recommend that the Company adhere to its present effluent treatment system until Phase II of the Kootenay Study is complete. This study will attempt to identify the other zinc and cadmium sources in the Carpenter Creek basin, assess the feasibility of controlling these sources, and assess the effect of the zinc and cadmium levels on the aquatic life of Carpenter Creek.

In the interim, we recommend that monitoring of the tailing pond supernatant be discontinued. The supernatant flow is too small to warrant further monitoring under present operating conditions. The Company should modify the mill reagent feeders to prevent overdosing of cyanide and copper sulphate. The practice of diluting tailing with water from Tributary Creek to prevent ice build-up in the tailing pond should be terminated if possible to reduce leaching through the bottom of the pond.

2.3 Industrial Sources of Solid Waste

There is only one Pollution Control Permit for industrial refuse disposal in Region 6. The permit (No. PR-1794) is held by Kalesnikoff Lumbering Co. Ltd. at Thrums and authorizes the discharge to the ground of 6 cubic yards per day of wood-wastes. It is unlikely that this discharge will adversely affect groundwater or surface water since the quantity of refuse is relatively small, the nearest surface water is 3,000 feet away, the nearest well is 2 miles away, and the topography and geology are such that the existence of an aquifer beneath the site is improbable. A summary of the information regarding this site is contained in Table 6-9, and its location is denoted in Figure 6-5 by its Pollution Control Permit number 1794.

2.4 Municipal Sources of Effluent and Solid Waste

There are no municipal sewage collection and treatment systems in the region. Domestic sewage is disposed of in individual septic tank and tile field systems authorized by the British Columbia Ministry of Health.

There is only one solid waste disposal site in the region under permit or application to the Pollution Control Branch. This site is operated by the Village of Slocan and is authorized by permit number PR-2197 which allows the discharge to the ground of 2.5 cubic yards per day of municipal refuse (including septic tank sludge). This site is unlikely to affect groundwater or surface water adversely since the quantity of refuse is small, the water table is 20 feet deep at the site, the nearest surface water is 900 feet away, and there are no wells nearby. A summary of information regarding this site is contained in Table 6-9, and its location is denoted in Figure 6-5 by its Pollution Control permit number, 2197.

There are other settlements in the region that dispose of their solid wastes in small landfills without Pollution Control permits or applications, but the quantities involved are small, and it is unlikely that these landfills are affecting groundwater or surface water.

3. MISCELLANEOUS INFLUENCES ON WATER QUALITY

3.1 Forestry

The Final Report of the Slocan Valley Community Forest Management Project [2] indicated that about 20 miles of new logging road are built each year and that the high costs of road building make it economically expedient to take as much timber out of one area as possible. As a result, extremely large areas have been clearcut. Single openings as large as 1,600 acres have been created in some cases. Forests in the Fennell, Shannon, and Lemon Creek drainages have all been logged in this manner. Field studies [2,31] have found many examples of poor planning and maintenance of logging roads with subsequent erosion, slumping, and stream siltation problems.

The Ministry of Forests and other resource agencies are improving logging practices. Measures used include the introduction of the Folio planning system, review of logging company plans and increased field supervision.

3.2 Agriculture

Agricultural activity in the Slocan River Basin is very limited (see Chapter 1, section 1.8.1). The cultivated land is primarily used for the production of hay crops while the livestock in the area is predominantly beef cattle[16]. Table 6-10 shows that the actual irrigated acreage is substantially less than the acreage for which irrigation water licences have been issued. This indicates that a large portion of the irrigation water rights is not being used.

3.2.1 Estimation of Nutrient Loading from Agricultural Activities

We estimated the annual nutrient loadings to the Slocan River and Kootenay River from fertilized, irrigated cropland and from livestock operations (Table 6-10). All other agricultural nutrient sources were considered to be insignificant.

(a) Nutrients from Irrigated Cropland

All the irrigated land was assumed to be fertilized, although the 1971 Agricultural Census indicated a lower fertilized acreage[16]. The irrigated acreages were obtained from the irrigation water licences issued in the region[12], since they reflect the potential irrigated acreage.

Nutrients contributed by fertilizer on non irrigated land were assumed to be insignificant. Nutrients from irrigated land were assumed to reach the receiving waters via groundwater transport. Nutrients contributed by fertilized land via surface runoff can be significant during a fast spring thaw. However, due to the small number and size of the agricultural operations in this area, this contribution was assumed to be minimal. Annual fertilizer application rates of 50 lb of nitrogen and 10 lb of phosphorus per acre were used as estimates of the potential source loadings. The method used to estimate the fraction of the source loading which reached the receiving waters has been described in a previous report[32]. Each irrigated acre was assumed to release 6.7 lb of nitrogen and 0.17 lb of phosphorus per year. The calculated nitrogen and phosphorus loadings are presented in Table 6-10.

(b) Nutrients from Livestock

Nutrient contributions from livestock were estimated using methods developed in the Okanagan Basin Study[33]. We assumed that the following nutrient loadings per animal reached the receiving waters:

Cattle:	9.8 lb of nitrogen/animal/year
	0.242 lb of phosphorus/animal/year
Poultry:	0.154 lb of nitrogen/animal/year
	0.008 lb of phosphorus/animal/year

The calculated nitrogen and phosphorus loadings from livestock are presented in Table 6-10.

In this region, the most common cattle enterprises were cow-calf operations. Nutrient contributions could be high during spring thaw, via surface runoff, especially where cattle had been wintered near streams. The effect of surface runoff was expected to be minimal because of the small number of farms and the small livestock population.

The annual agricultural nutrient loading was assumed to reach the Slocan and Kootenay Rivers during the growing season (May to September) via groundwater transport. The calculated nitrogen and phosphorus concentrations in the Slocan and Kootenay Rivers, resulting from these loadings, are presented in Table 6-11.

3.2.2 Discussion of Results

Table 6-11 shows that the agricultural activity in the region could cause an average concentration of nitrogen of 0.006 mg/l or less, and of phosphorus of 0.0002 mg/l or less, in the Slocan River.

We conclude that agriculture in the region was a negligible source of nutrient loading to the Slocan and Kootenay Rivers.

3.3 Mining

The Slocan Basin was the scene of extensive mining activity in the past. Virtually all of the mining took place on the east side of Slocan Lake, from Wilson Creek to Lemon Creek. There are about 190 old mining properties in this area[34]. At least 15 of these old mines are known or suspected to have abnormal mine drainage[35]. The locations of the old mines are shown on inventory maps provided by the Ministry of Mines and Petroleum Resources[34].

The Slocan Mining Camp was located within a 6 to 8 mile radius of the mining town of Sandon, and included most of the Carpenter and Silverton Creek drainage basins[36]. There are about 100 old mines in these two basins, 13 of which have known or suspected abnormal drainage[34,35]. Ore was discovered near Sandon in 1891, and by 1898 Sandon had a population of 5,000[37]. After 1898, mining steadily declined and by 1940 most of the mines were closed. The largest mine was the Lucky Jim at Zincton on Seaton Creek which produced 1.2 million tons of ore between 1893 and 1959. Silver, lead, and zinc were the principal minerals produced in the Slocan, with lesser amounts of gold, copper, and cadmium[20,36].

Tailing from the concentrators at the old mines in the Carpenter Creek basin were discharged directly to the streams without treatment[38]. Concentrators were located at the Lucky Jim mine at Zincton on Seaton Creek, and at Alamo, Payne Siding, Sandon, and Cody on Carpenter Creek[37,38]. There were probably other concentrators in the basin that we do not know about. Noticeable tailing deposits are located at Zincton and Sandon, but we assume that most of the old tailing were washed into Slocan Lake at the mouth of Carpenter Creek.

Drainage from the old mines has caused higher than normal zinc and cadmium concentrations in Carpenter Creek, and above normal zinc concentrations in Slocan Lake and Slocan River. Other tributaries on the east side of the Slocan system which drain old mines may also have above normal levels of these metals. The effect of mining on water quality is discussed in detail in Chapter 4. There has been no reclamation of the old mining disturbances and these disturbances may contribute to the suspended sediment load in Carpenter Creek. Suspended solids however, were not particularily high in Carpenter Creek since the maximum value recorded was 168 mg/l.

3.4 Dams

3.4.1 Introduction

The reach of the Kootenay River contained in Region 6 is 14 miles long, running from the Corra Linn Dam to the confluence with the Columbia River. This reach is steep, dropping 360 feet in 14 miles, and has been developed for hydro-electric power generation by a series of 5 dams and 7 powerplants.

Corra Linn is the first dam in the series (Figure 6-6), providing about 800,000 acre-feet of storage in Kootenay Lake for the use of its own powerplant and for each of the downstream powerplants. Upper Bonnington is the next dam downstream, followed by Lower Bonnington, South Slocan, and Brilliant. The last 4 dams have only small headponds and thus, depend on Corra Linn Dam to provide seasonal storage. Duncan and Libby Dams, completed in 1967 and 1972 respectively, supply an additional 6.4 million acre-feet of upstream storage. The Kootenay Canal Project, which became operational during 1975 and 1976, consists of a canal, with its intake at Corra Linn Dam, supplying water to a powerplant located just downstream from South Slocan Dam[11].

These dams and powerplants are closely related, with the operation of one affecting the operation of each one downstream. Consequently, each project will be discussed briefly, followed by a discussion of the overall effect of these projects on the Kootenay River. Data describing the projects are presented in Table 6-12.

3.4.2 Corra Linn Dam

The Corra Linn Dam is located 7 miles downstream from the City of Nelson, and is owned by Cominco. It was built in 1931 and has controlled the level of Kootenay Lake since 1939, except under high flow conditions. A discussion of the history, operation and upstream effects on Kootenay Lake and River were presented in our Phase I report on Region 5, Chapter 3, section 3.6.2[39].

3.4.3 Upper Bonnington Dam

Upper Bonnington Dam is located one mile downstream from Corra Linn, and is owned by Cominco. There are two powerplants at the dam: one owned by Cominco (55 MW capacity), and one owned by the City of Nelson (8.67 MW capacity)[11]. The original powerhouse was built in 1897 and was then removed and rebuilt in 1907. The last extension to the powerhouse was completed in 1940. The purpose of the project was to produce electricity for Cominco's Trail operations and the City of Nelson.

Upper Bonnington is a run-of-the-river plant with upstream storage in Kootenay Lake provided by Corra Linn. The headpond behind the dam is very small, extending upstream for one mile to the Corra Linn Dam, with a maximum width of one quarter mile. Pondage water levels normally fluctuate over a range of 7 feet, between elevations 1683 and 1690, with a maximum design water level of 1697[40].

3.4.4 Lower Bonnington Dam

Lower Bonnington Dam is located one half mile downstream from Upper Bonnington, and is owned by West Kootenay Power and Light Co. Ltd.[41], a subsidiary of Cominco. This was the location of the first hydro installation on the Kootenay River, which was replaced in 1924 by the present installation. The present installation was reconstructed in 1964[41]. The powerplant has a capacity of 42 MW[11] and was developed to generate electricity for Cominco's Trail operations.

Because of the small size of the headpond, Lower Bonnington may be classed as a run-of-the-river plant. The headpond behind the dam is very small, extending upstream for one half mile to Upper Bonnington Dam, with a maximum width of about 800 feet. Pondage water levels normally fluctuate over a range of 14 feet between elevations 1610 and 1624, with a maximum design water level of 1627[40].

3.4.5 South Slocan Dam

South Slocan Dam is located three quarters of a mile downstream from Lower Bonnington, and is owned by Cominco. The dam and powerplant were completed in 1928 to provide power for Cominco's Trail operations[41]. The powerplant has a capacity of 47 MW[11]. South Slocan is a run-of-the-river plant with upstream storage provided by the Corra Linn Dam. The headpond is small, extending upstream for three quarters of a mile to Lower Bonnington, with a maximum width of about 1000 feet. Pondage water levels normally fluctuate over a range of 14 feet between elevations 1554 and 1540, while the maximum design water level is 1560[40].

3.4.6 Brilliant Dam

Brilliant Dam is located 11 miles downstream from South Slocan Dam, and is owned by Cominco. The project was completed in 1944 to generate electricity for Cominco's various operations, and consists of a 112 foot high concrete dam with a spillway and a powerplant with 109 MW of installed capacity[11,41].

Brilliant may be classed as a run-of-the-river plant. The headpond behind Brilliant is larger than those of South Slocan, Upper Bonnington and Lower Bonnington Dams, but is still too small to provide storage for any more than a part of one day's operation. The headpond is about 10 miles long, has a maximum width of a half mile and a usable storage capacity of 9875 acre-feet[41]. The creation of the headponds drowned out a 10 mile stretch of rapids in the Kootenay River. Pondage water levels normally fluctuate over a 10 foot range between elevations 1468 and 1478, while the maximum design water level is 1486[40,41].

3.4.7 Kootenay Canal Project

The Kootenay Canal was constructed by B.C. Hydro to use the flow in the Kootenay River, now made more uniform by the operation of the Libby and Duncan storages. The project consists of a 3 mile canal, with its intake at the Corra Linn Dam, supplying water to a powerplant (capacity of 500 MW) just downstream from South Slocan Dam. Water flowing in the canal bypasses the powerplants at Corra Linn, Upper Bonnington, Lower Bonnington, and South Slocan Dams. The hydraulic capacity of the Kootenay Canal plant is 25,000 CFS. The operating plan for the Kootenay Canal project is to send 5,000 CFS down the Kootenay River via Corra Linn and to take the remainder (up to 25,000 CFS) through the canal. When the discharge in the Kootenay River at Corra Linn exceeds 30,000 CFS, the excess water will be routed through the Kootenay River via Corra Linn.

Construction of the Kootenay Canal project began in September 1971, and the plant was fully operational in October 1976.

3.4.8 Influence of Dams on the Kootenay River

(a) Flow Patterns

Prior to 1939, the dams on the Kootenay River were operated on a run-of-the-river basis, and thus had no effect on the flows in the Kootenay River. In 1939, the International Joint Commission allowed West Kootenay Power and Light Company to store six feet of water (0.8 million acre-feet) in Kootenay Lake behind the Corra Linn Dam. This storage was equivalent to about 4 percent of the mean annual flow in the Kootenay River at Corra Linn and had only a small effect on the flows. Flows during December through March were increased by an average of 1000 to 4000 CFS, while flows during August and September were decreased by a similar amount.

The operation of the Duncan (1967) and Libby (1972) storages under the Columbia River Treaty had a far greater effect on flow in the Kootenay River than did the Corra Linn storage. Duncan and Libby have a combined storage of 6.4 million acre-feet or 32 percent of the mean annual flow at Corra Linn. In Figure 6-8, the natural flows in the Kootenay River at the mouth from 1913 to 1944(5) (includes 4.5 years of Corra Linn regulation) are compared with the predicted flows with Corra Linn, Duncan, and Libby regulation (based on 1929-1958 flows)(42). With Duncan and Libby, spring flood peaks will be reduced and winter low flows will be increased.

Regulation will improve the capacity of the Kootenay River to assimilate wastes by reducing the duration of low winter flows. With regulation, the minimum monthly flow predicted is 8572 CFS, whereas prior to regulation (1913-1938) monthly flows of less than 8572 CFS occurred 24 percent of the time, or an average of 3 months per year(5).

The dams downstream from Corra Linn (Upper Bonnington, Lower Bonnington, South Slocan, and Brilliant) do not have sufficient storage capacity to alter the pattern of flows released by Corra Linn (or the Kootenay Canal Plant), except on an hourly or daily basis.

(b) Dissolved Gases

Water must be discharged over the spillways of the five dams on the Lower Kootenay River when the flow in the river exceeds the hydraulic capacities of the powerhouses and any other low level outlets. Depending on the height of the spillway and the depth of the pool downstream from the dam, the discharge of water over a spillway may cause the water downstream from the dam to become supersaturated with dissolved gases. Excessive supersaturation of dissolved gases is detrimental to aquatic life.

The hydraulic capacity of the powerplants at the five dams on the Lower Kootenay River ranges from 10,000 to 14,000 CFS at the four oldest dams (Corra Linn, Upper Bonnington, Lower Bonnington, and South Slocan) to 18,000 CFS at Brilliant[41]. Prior to regulation by Libby and Duncan Dams, this meant that in a year of average flow, between 54 and 63 percent of the annual flow had to be discharged over the spillways at the four oldest dams, while about 51 percent had to be spilled at Brilliant. Combined Libby and Duncan regulation (commencing in the spring of 1972) reduced the quantity of water that was discharged over the spillways in an average flow year to between 47 and 61 percent for the four oldest dams, and to 40 percent for Brilliant.

Dissolved gas measurements taken below the dams on the Lower Kootenay River during the freshets of 1972 to 1975 showed that the dissolved gas concentrations were sometimes at levels that could be detrimental to aquatic life. A detailed discussion of dissolved gases in the Kootenay River is presented in Chapter 4, section 4.4.

The completion of the Kootenay Canal Plant in 1976 further reduced the quantity of water which was spilled at the four oldest dams on the Kootenay, by adding 25,000 CFS to the hydraulic capacity of the system. Thus, in a year of average flow, only 2.5 to 5 percent of the annual flow will have to be discharged over the spillways of the four oldest dams. This will reduce the supersaturation of dissolved gases below the dams. The quantity of water which must be spilled at Brilliant Dam is not affected by the Kootenay Canal Plant. However, there is potential for adding additional generating units at Brilliant, which would increase the hydraulic capacity to 22,500 CFS (1 unit) or 27,000 CFS (2 units). In an average flow year, this could reduce the amount of water spilled from 40 percent of the annual flow to 27 percent (1 unit) or 18 percent (2 units).

4. WATER SAMPLING DATA

4.1 Introduction

The waters of Region 6 comprise the Slocan River basin and the mainstem of the Kootenay River between the Corra Linn Dam and its confluence with the Columbia River. These waters have been sampled by the Pollution Control Branch since 1971. During 1975, the Pollution Control Branch and the Water Investigations Branch conducted a joint water sampling program in the region. Approximately 300 samples involving a total of 6000 analyses were collected between 1971 and the end of 1975. The results of these analyses are discussed in this chapter, together with data from other sources. To facilitate the presentation and discussion of data we have divided the Region as follows:

- Carpenter Creek and it tributaries
- Slocan Lake and Slocan River
- The Kootenay River

4.2 Carpenter Creek and Tributaries

4.2.1 Presentation of Data

Carpenter Creek and its tributaries drain the western slopes of the Slocan Ranges to Slocan Lake at New Denver. The Carpenter Creek basin has a drainage area of 65 square miles[7] and there are icefields and glaciers in its headwaters. Kane and Seaton Creeks are the major tributaries of Carpenter Creek. Logging activity in the Carpenter Creek basin is light, since only a relatively small area in the Kane Creek watershed is being logged[18].

Portions of the Carpenter Creek basin, particularily Seaton Creek and Carpenter Creek upstream from Kane and Seaton Creeks, were the scene of extensive mining activity which began in the early 1890's. There are about 80 old mining properties in the Carpenter Creek basin, but only one property, Silmonac (Minniehaha), operated by Kam Kotia Mines Ltd. is still producing a significant amount of ore[19,20,34]. The effluent discharged from the Kam Kotia operation is discussed in Chapter 2, section 2.2. The B.C. Ministry of Mines has reported that there are 9 old mines in the Carpenter Creek basin which may have abnormal mine drainage[35]. These potential sources of abnormal mine drainage are discussed in Chapter 3, section 3.3.

Figure 6-5 shows the locations of Pollution Control Branch sampling sites. A more detailed description of the sampling sites is given below:

Site Number	Description
198	Carpenter Creek upstream from Sandon Creek
197	Sandon Creek at the mouth (Sandon)
71	Carpenter Creek 0.25 miles upstream from Kam Kotia mill (Sandon)
150	Carpenter Creek 300 feet upstream from Kam Kotia mill (Sandon)
196	Tributary Creek at the mouth
70	Carpenter Creek downstream from Kam Kotia mill, between Sandon and Kane Creek
72	Kane Creek at the mouth (upstream Seaton Creek)
69	Carpenter Creek at the mouth (New Denver)

Pollution Control or Water Investigations Branch sites which were sampled but not assigned site numbers are described below:

Carpenter Creek upstream from Cody Creek

Cody Creek at the mouth

Carpenter Creek immediately downstream from Kam Kotia tailing pond

Carpenter Creek 0.2 miles downstream from Kam Kotia tailing pond

The data collected at Provincial Government sites are summarized in Tables 6-13, 6-14, 6-15, and 6-16.

Water quality data collected by Kam Kotia Mines Ltd. upstream and downstream from their mining operation are summarized in Table 6-17.

4.2.2 Discussion of Results

The discussion proceeds from upstream sites to downstream sites, assessing the influence of tributaries and discharges as they occur along Carpenter Creek.

(a) Carpenter Creek Upstream from Cody Creek

One sample was taken at this site (Table 6-13) and showed low dissolved iron (<0.1 mg/l) and dissolved zinc (0.013 mg/l). However, the zinc concentration was higher than that normally found (<0.0005 mg/l) in the headwater streams of the Kootenay Region. This higher zinc concentration may have been due to drainage from the seven old mines located upstream from the site.

(b) Cody Creek at the Mouth

The dissolved zinc concentration in Cody Creek was below the detectable limit of 0.005 mg/l (Table 6-13). There was therefore no abnormal drainage from the four old mining properties located in its drainage.

(c) Carpenter Creek Upstream from Sandon Creek (Site 198)

Table 6-13 shows that the water at this site is slightly hard[46] (50 to 82 mg/l hardness), and very low in nutrients and heavy metals with the exception of zinc. The dissolved zinc concentrations at this site ranged from 0.03 to 0.07 mg/l, compared to 0.013 mg/l upstream from Cody Creek. The sources of the additional zinc may have been the thirteen old mining properties located between these two sites. The old Bluebird and Reco mines are suspected of having abnormal mine drainage[35].

(d) Sandon Creek at the Mouth (Site 197)

Table 6-13 shows that the water quality at this site was the same as at site 198 with the exception of dissolved cadmium, dissolved and total zinc and dissolved sulphate. The higher concentrations of these parameters in Sandon Creek were probably caused by abnormal drainage from the three old mines in the Sandon Creek drainage basin. The old Silversmith mine located adjacent to Sandon Creek is suspected of having abnormal effluent[35]. Aerial photographs of Sandon Creek taken in 1972[43] show that there were several waste rock or tailing piles located adjacent to Sandon Creek and its tributary, White Creek. At least one of the piles was actively eroding into Sandon Creek.

The dissolved zinc concentrations in Sandon Creek ranged from 0.1 to 0.47 mg/l, with an average of 0.32 mg/l (Table 6-13). These concentrations were well within the acceptable limit of 5.0 mg/l for drinking water[44], but were at a level which could have caused sublethal effects in some components of the aquatic community[29,45].

The dissolved cadmium concentration (0.0027 mg/l) was higher than that normally found in headwater streams of the Kootenays (0.0005 mg/l), and exceeded a recommended safe level (0.0004 mg/l) for sensitive aquatic organisms in soft waters.[29] The cadmium concentration was within the acceptable limit of 0.01 mg/l for drinking water[29,44]. It is probable that higher concentrations of cadmium were present in Sandon Creek during low flow periods, since the only sample analyzed for cadmium was taken during July when flow and dilution were relatively high.

The dissolved sulphate (SO_4) concentration at site 197 (29 mg/l average) was double that at site 198 (12.5 mg/l), but this increase was not environmentally significant[29]. The mechanism by which zinc, cadmium, and sulphate are believed to be leached from the old mining deposits is outlined in Chapter 2, section 2.2.3.

(e) Carpenter Creek Upstream from Kam Kotia Mill (Sites 71 and 150)

Tables 6-14 and 6-16 show that the water quality at sites 71 and 150 was essentially the same as at site 198, with the exception of dissolved zinc, dissolved cadmium and dissolved sulphate which were higher. The increase in sulphate was not environmentally significant[29], but indicated that leaching of old mining deposits was taking place[30]. The dissolved cadmium concentrations (0.0004-0.0052 mg/l, average 0.0032 mg/l) exceeded the safe level of 0.0004 mg/l for sensitive aquatic organisms[29] but were well within the acceptable limit of 0.01 mg/l for drinking water. Similarly, the dissolved zinc concentrations (0.06-0.74 mg/l, average 0.28 mg/l) were well within the acceptable level for drinking water (5.0 mg/l), but were at a level which could cause sublethal effects among some components of the aquatic community[29,45].

On December 9, 1975, the concentrations of dissolved zinc were measured at sites 198, 197, and 150 and the flow was estimated at sites 198 and 197. These measurements indicated that roughly 8 percent of the zinc in Carpenter Creek at site 150 was coming from Sandon Creek (Site 197), and that 23 percent was coming from Carpenter Creek above Sandon Creek (Site 198). The source of the remaining 70 percent of the dissolved zinc at site 150 was not known.

The zinc may have been leaching from tailing which were deposited in Carpenter Creek and on its bank, between sites 198 and 150, by old mining operations[38]. Aerial photographs of Carpenter Creek[43] indicate that the old tailing may be located between the mouth of Sandon Creek and site 71 on the south side of Carpenter Creek.

(f) Carpenter Creek Immediately Upstream and Downstream from Kam Kotia Mines Ltd.

As part of their monitoring program for Pollution Control Permit No. PE-1203, Kam Kotia Mines Ltd. collected 20 sets of samples in Carpenter Creek immediately upstream and downstram from their mining operation (Table 6-17).

Their data show a consistent increase in dissolved zinc from upstream (0.05-0.63 mg/l, 0.33 mg/l average) to downstream (0.115-1.52 mg/l, 0.54 mg/l average). The source of this zinc was probably seepage from the

Kam Kotia tailing pond (Chapter 2, section 2.2). The concentrations of dissolved zinc reported by Kam Kotia for their stations upstream and downstream from the mill were quite similar to those reported by the Pollution Control Branch at sites 71 and 150 (upstream) and site 70 (downstream). The Kam Kotia data indicated that, on average, the mining operation contributed 40 to 50 percent of the dissolved zinc in Carpenter Creek, downstream from Kam Kotia.

Total cyanide was not detectable upstream from the mill, but one out of the twenty samples taken downstream from the mill showed an unusually high value of 0.021 mg/1. This value was probably due to contamination of the sample or incomplete mixing downstream from the tailing pond. On the day the sample was taken (June 14, 1973) the total cyanide concentration in the tailing pond supernatant was 0.38 mg/1. The supernatant flow was not known, but inflow to the tailing pond was about 36,000 IGPD (0.067 CFS). The flow in Carpenter Creek was probably at least 70 CFS[5], since the creek was in freshet. The creek would have provided a 1000:1 dilution of the total inflow to the tailing pond. Under these conditions, the maximum concentration in the creek would have been 0.0004 mg/1. The Pollution Control Branch sampled Carpenter Creek at site 70 on June 14, 1973 and found a total cyanide concentration of <0.01 mg/1.

There have been occasional increases in dissolved copper and lead between sites upstream and downstream from the mill. The highest values measured were below or at the safe levels recommended for drinking water and aquatic life[29]. The highest dissolved copper and lead values reported by Kam Kotia were consistently an order of magnitude greater than those reported by the Pollution Control Branch, suggesting differences in sampling and analytical methods.

(g) Tributary Creek (Site 196)

The data for Tributary Creek (Table 6-14) show very low values for dissolved zinc (0.005 mg/1). Thus, the creek did not contribute significant amounts of zinc to Carpenter Creek.

(h) Carpenter Creek Downstream from Kam Kotia Tailing Pond (Site 70 and Others)

Dissolved zinc concentrations upstream from the tailing pond (Sites 71 and 150, Table 6-14) ranged from 0.06 to 0.74 mg/l, with an average of 0.28 mg/l, whereas concentrations downstream from the tailing pond (Site 70, Tables 6-15 and 6-16) ranged from <0.005 to 0.78 mg/l, with an average of 0.44 mg/l. Samples taken immediately downstream from the tailing pond (Table 6-16) had dissolved zinc concentrations of up to 3.5 mg/l. These high concentrations were attributed to incomplete mixing of the tailing pond seepage with Carpenter Creek, and show that the tailing pond contributed zinc to Carpenter Creek.

There may also be other sources of zinc located between the tailing pond and Kane Creek. A series of samples taken on December 9, 1975, showed that the dissolved zinc concentration was 0.29 mg/l upstream from the tailing pond (Site 150), 0.42 mg/l 0.2 miles downstream from the pond, and 0.52 mg/l just upstream from Kane Creek. Sources of zinc along this reach of Carpenter Creek could include: abnormal drainage from about 20 old mining properties in this portion of the watershed, particularily Payne and Victor (Violamac) which are suspected of having abnormal drainage[35], and old zinc tailing which have been deposited in the stream sediments of Carpenter Creek. The dissolved zinc concentrations in this reach of Carpenter Creek were at a level which could have caused sublethal effects among some components of the aquatic community[29,45], but were well within the acceptable limit for drinking water[44].

Dissolved cadmium concentrations at Site 70 ranged from <0.0005 to 0.007 mg/l, with an average of 0.0037 mg/l (Table 6-15), whereas concentrations at Sites 71 and 150 ranged from 0.0004 to 0.0052 mg/l, with an average of 0.0023 mg/l (Table 6-14). The highest cadmium concentrations (up to 0.017 mg/l) were found immediately downstream from the Kam Kotia tailing pond (Table 6-16). The sources of cadmium between sites 71 and 150 and site 70 were believed to be the same as the sources of zinc. The cadmium concentrations at site 70 have exceeded the safe levels for sensitive and immature aquatic organisms (0.003 mg/l in hard water and 0.0004 mg/l in soft water)[29].

Other parameters which increased in concentration at Site 70, downstream from the Kam Kotia tailing pond, include dissolved manganese (<0.01-0.06 mg/1, 0.02 mg/1 average), total iron (0.1-0.9 mg/1, 0.45 mg/1 average), dissolved sulphate (35.4 mg/1 average), and suspended solids (2-168 mg/1, 31 mg/1 average). These increased values were probably due in part to the discharge and seepage from the tailing pond. The increased values occurred infrequently and did not represent a significant deterioration in the water quality of Carpenter Creek.

(i) Kane Creek at the Mouth (Site 72)

Table 6-15 shows that the water quality of Kane Creek was similar to that of Carpenter Creek for most parameters, and better than Carpenter and Sandon Creeks for dissolved zinc and cadmium. Dissolved zinc concentrations in Kane Creek were usually at or below the detectable limit of 0.005 mg/1, except for one high value of 0.3 mg/1. Dissolved cadmium concentrations ranged from <0.0001 to 0.0028 mg/1, with an average of <0.0007 mg/1.

There were only 4 old mining properties in the Kane Creek watershed, and only one of these, McAllister, was suspected of having abnormal drainage[35]. The low concentrations of zinc and cadmium in Kane Creek indicate that drainage from the old mines was not having a significant effect on water quality.

(j) Carpenter Creek at the Mouth (Site 69)

Tables 6-15 and 6-16 show that the water in Carpenter Creek at Site 69 was of good quality for most parameters. Dissolved zinc concentration was still moderately high (0.21 mg/1 average), but was 50 percent lower than the concentration at site 70 (0.44 mg/1 average). This reduction was due to dilution by the low zinc content waters of Kane Creek. The zinc concentrations were well below the recommended objective (<1.0 mg/1) and acceptable (5.0 mg/1) limits for drinking water in Canada[44], but were at or near the threshold at which sublethal effects could occur in some aquatic organisms[29,45].

The dissolved cadmium concentrations (0.0007-0.0028 mg/l, 0.0017 mg/l average) were well below the maximum permissible limit in drinking water (0.01 mg/l)[47], but at times exceeded the safe limit of 0.0004 mg/l in soft water (<100 mg/l, total hardness) for sensitive and immature aquatic organisms[29]. Cadmium concentrations at Site 69 were also 50 percent lower than at Site 70, due to dilution by Kane Creek.

The data indicate that the water in Carpenter Creek at site 69 was suitable for domestic water supply, although treatment for the removal of suspended solids (up to 94 mg/l) and turbidity (up to 6.7 J.T.U.) during spring freshet would be necessary. The hardness of the water at Site 69 ranged between 58 and 130 mg/l $CaCO_3$, which means the water was of good quality for drinking[44].

4.2.3 Recommendations

We recommend a water sampling program during Phase II of this study to locate the main sources of zinc and cadmium in the Carpenter Creek basin. We also recommend a survey of the aquatic populations of Carpenter Creek to determine their condition.

The sites and parameters recommended for the water sampling program are detailed in Table 6-18. Water samples should be taken on two occasions during low flow conditions.

4.3 Slocan Lake and Slocan River

4.3.1 Presentation of Data

Slocan Lake and Slocan River drain the Slocan basin to the Kootenay River at Shoreacres. Slocan Lake has a drainage area of 640 square miles, and its largest tributaries are Wilson Creek (235 mi^2) and Carpenter Creek (65 mi^2). The Slocan River drains an additional 630 square miles between the outlet of Slocan Lake at Slocan to the confluence with the Kootenay River, yielding a total drainage area of 1270 square miles[7].

Figures 6-5 and 6-6 show the locations of Pollution Control Branch sampling sites. A more detailed description of the sampling sites is given below:

Site Number	Description
68	Slocan Lake, 1.5 miles north of Carpenter Creek, 1/4 of the width of the lake from the east shore.
67	Slocan Lake, opposite Red Deer Valley Coal Company mill (about 1 mile south of Silverton), 1/4 of the width of the lake from the east shore.
66	Slocan River at Slocan bridge, 0.25 miles downstream from Slocan Lake.
10	Slocan River at the mouth, CPR bridge at Shoreacres.

The data collected at these sites are summarized in Table 6-19 for the significant parameters and Table 6-20 for parameters which do not affect water quality adversely. The data for the Slocan Lake sites (67 and 68) were summarized for all sampling depths since the various parameters varied little with depth, except for temperature and dissolved oxygen.

Dissolved gas measurements have been collected in the Slocan River near the mouth by the Pollution Control Branch and the Fish and Wildlife Branch. These data are summarized in Table 6-24.

4.3.2 Discussion

Table 6-19 shows that Slocan Lake (sites 67 and 68) and Slocan River (sites 66 and 10) had similar water quality at all four sampling sites. These waters were low in dissolved solids (50-70 mg/l), suspended solids (2-20 mg/l) turbidity (0.1-2.5 J.T.U.), nutrients (total nitrogen: 0.15 mg/l average, total phosphorus: 0.005 mg/l average), and fecal coliforms (23/100 ml maximum). Heavy metals, such as cadmium, chromium, copper, iron, lead, manganese, and mercury, were all very low.

The zinc concentrations (0.007 to 0.06 mg/l, average: 0.015 to 0.04 mg/l) were higher than those normally found in the waters of the Kootenay Region (0.005 mg/l or less). Zinc levels were well within the objective for drinking water (<1.0 mg/l)[44] and within the level which could cause sublethal effects among some components of the aquatic community (0.03 to 0.18 mg/l)[29, 45]. The higher than normal zinc concentrations in Slocan Lake and Slocan River were probably due to zinc-rich mine drainage which was entering Slocan Lake via Carpenter Creek (section 4.2) and possibly via Silverton, Enterprise, and Springer Creeks (section 3.3).

The hardness of Slocan Lake and Slocan River water was less than 50 mg/l, so that for domestic use the water would be classified as soft[46].

The dissolved gas in the Slocan River at the mouth (Table 6-29) ranged from 100 to 104 percent saturation, which is normal for natural waters. There are no waterfalls or dams on the Slocan system and thus elevated dissolved gas concentrations are not expected.

The data in Tables 6-19, 6-20, and 6-24 indicate that the waters of Slocan Lake and Slocan River are safe for aquatic life and wildlife, and should be suitable for all purposes, including domestic water supply (after disinfection), irrigation, recreation, and industrial water.

4.3.3 Recommendations

We recommend that Silverton, Enterprise, and Springer Creeks be sampled for zinc and cadmium, since old mines in the area are suspected of having abnormal drainage. The Wilson Creek basin does not contain old mines with abnormal drainage, but its zinc and cadmium levels should also be checked since site 68 on Slocan Lake, north of Carpenter Creek, has above normal zinc levels.

Further monitoring of Slocan Lake and Slocan River will not be necessary during Phase II of the Kootenay Study.

4.4 Kootenay River

4.4.1 Presentation of Data

Region 6 contains the short reach (14 miles) of the Kootenay River between the Corra Linn Dam and the confluence with the Columbia River. The Kootenay River at Corra Linn has a drainage area of 17,800 square miles and a mean annual flow of 28,300 CFS. In Region 6, the Kootenay drains an additional 1350 square miles (1270 mi^2 from the Slocan River and roughly 80 mi^2 from small tributaries) which contribute a mean annual flow of about 3050 CFS. Thus, only 10 percent of the flow in the Kootenay River at the mouth originates in Region 6.

The Kootenay River has been sampled by the Pollution Control Branch at Taghum (site 11), 4 miles above the Corra Linn Dam, and at the mouth (site 178). The locations of these sites are shown in Figure 6-6 and a more detailed description of the sites is given below:

Site number	Description
11	Kootenay River at Taghum, highway No. 6 bridge.
178	Kootenay River at the mouth, 1/4 mile below Brilliant bridge on south shore beside Sunset Drive-In moviescreen.

The data collected at these sites are summarized in Table 6-21 for the significant parameters, and Table 6-22 for parameters which do not affect water quality adversely.

The B.C. Ministry of Health has conducted sanitary surveys of the Kootenay and Columbia Rivers. The sites on the Kootenay River included Taghum Bridge and Brilliant Bridge which were essentially the same as Pollution Control Branch sites 11 and 178, respectively. The most probable number (MPN) of total coliform organisms was monitored at these two sites. A summary of the data collected during 1971-72 and 1974-75 is presented in Table 6-23[47].

4.4.2 Discussion

The water quality of the Kootenay River in Region 6 is largely determined by influences that lie upstream from the Corra Linn Dam.

The water quality at Taghum and at the mouth was essentially the same for the parameters listed in Tables 6-21, 6-22, and 6-23. Small differences in the range of values were due to variations in the number of samples taken and in the period of record at the two sites. The uniform water quality was due to the lack of waste discharges, the good quality of the Slocan River, and the fact that inflow to the Kootenay in the region was only 10 percent of the total flow.

The Kootenay River had very low levels of heavy metals and other toxic substances. It was low in color, turbidity and suspended solids. The low total organic carbon values (<3.0 mg/l) indicate that the water was free from oxygen-demanding organic material. The fluoride levels (0.2 mg/l, average) were higher than naturally occurring levels in the Kootenays, because of the discharge of fluoride from Cominco's mining operation at Kimberley[49]. The fluoride levels were, however, safe for drinking water, livestock watering, and aquatic life[29,50].

The nutrient levels in the Kootenay River were relatively low. The total phosphorus level (0.02 mg/l, average) was lower than the desirable objective of 0.10 mg/l for flowing waters and of 0.025 mg/l for lakes and reservoirs[51]. Dissolved phosphorus (0.01 mg/l, average) was at the critical level above which algal blooms may occur[52]. Nitrogen concentrations were below levels which could contribute to the growth of aquatic plants. As a general guideline, these levels are 0.3 mg/l nitrate plus nitrite and 0.6 mg/l total Kjeldahl nitrogen[53]. The hardness of Kootenay River water averaged 70 mg/l and thus the water may be classed as of very good quality for domestic purposes[44].

The total coliform data in Table 6-23 indicate that the sanitary quality of the Kootenay River improved significantly between 1971-72 and 1974-75. This was due to the inception of primary sewage treatment at the

City of Nelson in June 1973[39]. The total coliform data for 1974-75 and the data in Tables 6-21 and 6-22 indicate that the Kootenay River water was suitable for drinking after disinfection and minimum treatment[54]. The fecal coliform data in Table 6-21 support this conclusion, although more samples should be taken to confirm the result.

Dissolved gas measurements (Table 6-24) are expressed as percent saturation of total dissolved gases. The following guidelines were used to evaluate the data:

Percent Saturation	Approximate Potential Effects on Fish
100-110	Satisfactory. Possible sublethal effects.
110-120	Borderline. Increased probability of sublethal effects. Some mortality especially in shallow water
120-140	Unsatisfactory. Increased probability of significant mortality, especially in water shallower than 3 metres.
>140	Critical. High probability of extensive fish mortality.

Upstream from Corra Linn Dam, the 12 dissolved gas measurements ranged from 100 to 111 percent saturation. These levels were satisfactory and occurred naturally in the Kootenay River. Forty-three measurements were made downstream from the Corra Linn, Upper Bonnington, Lower Bonnington, South Slocan, and Brilliant Dams. Five of these measurements were satisfactory, 23 were borderline, and 15 were unsatisfactory. There were no critical values, the highest measurement being 133 percent. Thus dissolved gas levels which could cause sublethal effects or mortality in fish have frequently occurred downstream from the dams. It is difficult, however, to predict susceptibility of wild fish to gas bubble disease, because they may change their water depth and level of activity to compensate for the supersaturation[29]. Also, when fish move in and out of supersaturated water, the effects of exposure are erased provided that no physical damage has yet occurred[55].

Completion of the Kootenay Canal Plant in 1976 will have reduced dissolved gas supersaturation below the Corra Linn, Upper Bonnington, Lower Bonnington, and South Slocan Dams by greatly reducing the amount of water which was discharged over the spillways. The Canal Plant does not affect the amount of water which must be spilled at Brilliant Dam, but the possible installation of one or two more units at the Brilliant powerplant could reduce the quantity of water spilled by one-half.

4.4.3 Recommendations

We recommend that during Phase II of this study, fecal coliform densities should be measured monthly at sites 11 and 178 to document the sanitary quality of the Kootenay River. If possible, fish should be caught downstream from the Kootenay River dams (especially Brilliant) and examined for symptoms of gas bubble disease. Measurements should be made at the same time to document the dissolved gas conditions.

5. AQUATIC BIOLOGY

In general, the present level of development of Region 6 has had a small impact on aquatic biology. The impact has been mainly from forestry and mining.

5.1 Effect of Forestry

Forest harvesting has reduced recreational and wildlife uses of some parts of the Slocan Public Sustained Yield Unit (PSYU)[2]. There is concern that large clearcuts already present in some tributary drainages (e.g., Shannon Creek Valley) will be extended to further mar the landscape and possiby affect aquatic resources[24]. Several examples of poor planning and maintenance of access roads and subsequent watercourse siltation problems have been identified, as mentioned in Chapter 3, section 3.1. Specific problem areas included Koch, Trozzo, Monument, Shannon, Wilson, Dennis and Pedro Creeks. Since most creeks in the Slocan PSYU contain sport fish (Chapter 1, section 1.8.4), improperly managed forestry activities could degrade fish habitat and reduce productivity. Indirectly, unregulated access development could allow certain unexploited streams and lakes to become rapidly "fished out". Stream protection guidelines should include variable leave strips, avoidance of unstable or biologically sensitive areas, removal of logging debris, and design of access roads for efficient drainage control.

5.2 Effect of Mining

5.2.1 Carpenter Creek

As discussed in Chapter 4, section 4.2,the Carpenter Creek drainage was a source of heavy metals which could affect aquatic life.

Seepage from tailing deposited adjacent to the creek produced relatively high zinc and cadmium concentrations in Carpenter Creek both above and below Kam Kotia Mines Ltd. The seepage also contributed to above normal zinc concentrations in Slocan Lake. Average dissolved cadmium in Sandon Creek (0.0027 mg/l) and Carpenter Creek at the mouth (0.0017 mg/l) exceeded the acceptable limit of 0.0004 mg/l for some species or lifestages[29]. In addition, the abandoned minesites probably contributed to periodically high suspended sediment levels in Carpenter Creek, since there has been no reclamation of these areas.

Kam Kotia Mines Ltd. was the only significant source of industrial effluent in Region 6. As discussed in Chapter 4, section 4.2, the Kam Kotia tailing pond contributed zinc and cadmium to Carpenter Creek at concentrations which could affect aquatic life. Concentrations which could be damaging are in the range of 0.03 to 0.18 mg/l for zinc and 0.0004 to 0.03 mg/l for cadmium[29]. Dilution by Kane Creek reduced dissolved zinc and cadmium levels in Carpenter Creek at the mouth although the concentrations were still high enough to produce possible sublethal effects. The increased heavy metal content in Carpenter Creek below Kam Kotia Mines was caused by seepage from the tailing pond, which was constructed on a former tailing pile, and from tailing deposited in other areas, rather than by supernatant discharge.

There were no data on aquatic biology in the Carpenter Creek drainage. The system is an important fish producing stream, supporting populations of rainbow trout and Dolly Varden char. Some work is needed to assess the effect of heavy metal contamination on fish and invertebrates.

5.2.2 Slocan Lake

The lake water was generally of high quality, as discussed in Chapter 4, section 4.3. There were no quantitative data on biological productivity of Slocan Lake, apart from reports of a low to moderate fishery[2].

The dissolved metal content was generally low and well within acceptable criteria for aquatic life except for dissolved zinc which, at an average lake concentration of 0.043 mg/l, was marginally higher than the national average of 0.04 mg/l. Safe limits for aquatic life are considered to be 0.03-0.18 mg/l dissolved zinc, depending on species and lifestage[29]. The data on zinc suggest some local accumulation in the lake waters from past and present mining operations since the zinc concentration in the Kootenay region averages about 0.005mg/l. Although the average dissolved zinc concentration ranged from 0.18 to 0.27 mg/l at the mouth of Carpenter Creek, the concentrations in Slocan Lake immediately off Carpenter Creek, near the opposite side of the Lake from Carpenter Creek, and downlake near Silverton, all averaged about 0.04 mg/l dissolved zinc.

A few analyses have been made on the metal content of fish tissue and lake sediments[56,57]. Data are presented in Table 6-25 which, for comparison, includes data on metals in fish from other lakes in B.C.[58]. These data suggest that the metal content of Slocan Lake fish was similar to average regional levels. The levels were also well within Federal guidelines.

When the fish and sediments were sampled in 1971, Semiahmoo Enterprises and W.H. McLeod (Red Deer Valley Coal Company) were depositing tailing into Slocan Lake near Silverton. Sediment samples taken near these points of discharge reflect the high metal content of the tailing (Table 6-25). These operations have now ceased discharging. However, sediment samples collected off Carpenter Creek (below Kam Kotia Mines) exhibit much lower metal content levels, which were near or below those of a background site off Nemo Creek. Since Kam Kotia Mines is the only operating mine with drainage to Slocan Lake, and since tailing deposited by the former Semiahmoo and McLeod operations have not degraded overall water quality, we can assume that the mine tailing is not having a serious effect on Slocan Lake biology as a whole. Toxicity to bottom organisms and deleterious changes in substrate will be caused by tailing. These effects will be localized and the indirect impact on fish is likely to be minor.

5.3 The Trophic State of Slocan Lake

Slocan Lake was considered to be in the oligotrophic, or low productivity range. Nutrient concentrations were low (nitrate N: 0.07 mg/1, orthophosphate P: <0.003 mg/1, ammonia N: <0.01 mg/1), as were suspended solids and turbidity. There appears to be little likelihood of cultural eutrophication of the lake, projecting present land use patterns and rate of watershed development into the foreseeable future.

Waste disposal and mining do not appear to have seriously degraded lake water quality or its capability to sustain aquatic life. Minor effects, if any, have not been documented. The impact on Slocan Lake of forest harvesting in tributary drainages has not been monitored. Local siltation of tributaries has been observed, but the contribution of sediment and nutrients from this source to Slocan Lake is probably minor at present. The expansion of forest operations into new drainages or the enlargement of existing clearcuts could have a greater impact on lake productivity, unless precautions to minimize runoff and prevent stream blockage and siltation are taken.

Urban development in the Slocan Lake watershed is unlikely to accelerate to the point of seriously affecting lake productivity in the foreseeable future. Development of recreational facilities, and in particular marina development, could create contamination from sewage and fuel spills. Plans for an 80-boat marina were abandoned in 1973 due to local opposition[2], and there is local support for a ban on power boat operation on Slocan Lake[59].

5.4 Effects of the Kootenay River Dams and the Kootenay Canal

The quality of Kootenay River water was well within recommended criteria for aquatic life[29], with the possible exception of dissolved phosphorus. At an average concentration of 0.01 mg/1 dissolved phosphorus was at the threshold above which excessive algae growth could occur.

The section of the Kootenay River in Region 6, as well as the West Arm of Kootenay Lake, supported a significant sport fishery for rainbow trout, Dolly Varden char, and kokanee[60,61]. Two especially heavily fished areas are Slocan Pool below South Slocan dam, and Kootenay River between Corra Linn and Upper Bonnington dams. Rainbow trout have been stocked in these areas since 1967, with a positive effect on fishing success.

By reducing dissolved gas supersaturation, the Kootenay Canal Project should be of benefit to the important Kootenay River fishery. Measurements of gas supersaturation, taken above Corra Linn dam and in the Slocan River mouth from 1972 to 1975(Table 6-24), were within satisfactory background limits (100-110 percent). Below Brilliant Dam, 38 out of 43 measurements were either borderline (110-120 percent) or unsatisfactory (120-140 percent, highest actual value 133 percent). However, actual effects on fish have not been documented for this area.

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FIGURE 6-1
REGION 6, THE SLOCAN RIVER BASIN

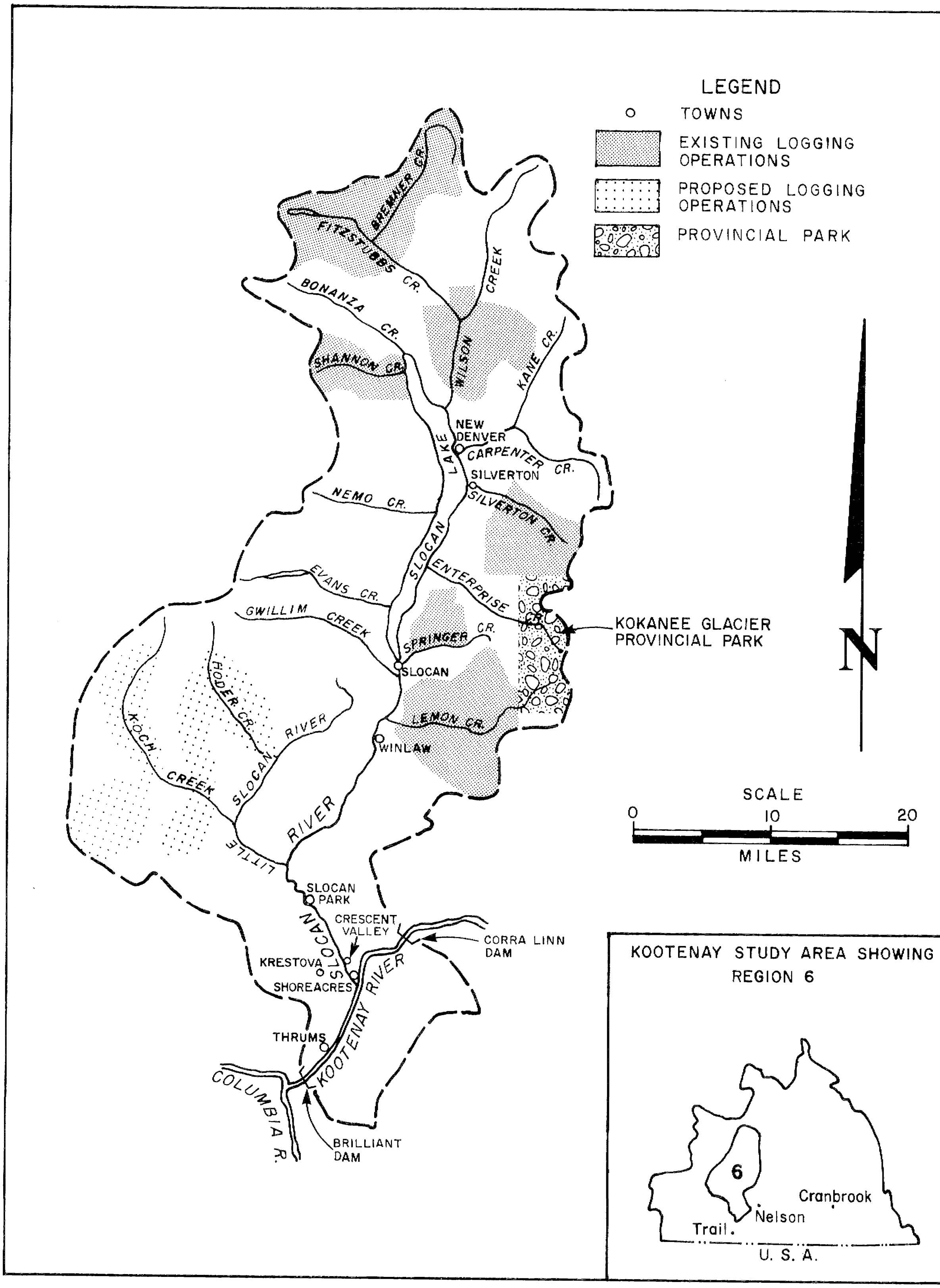

FIGURE 6-2

MEAN MONTHLY DISCHARGE IN THE SLOCAN RIVER AT SLOCAN CITY AND CRESCENT VALLEY(5)

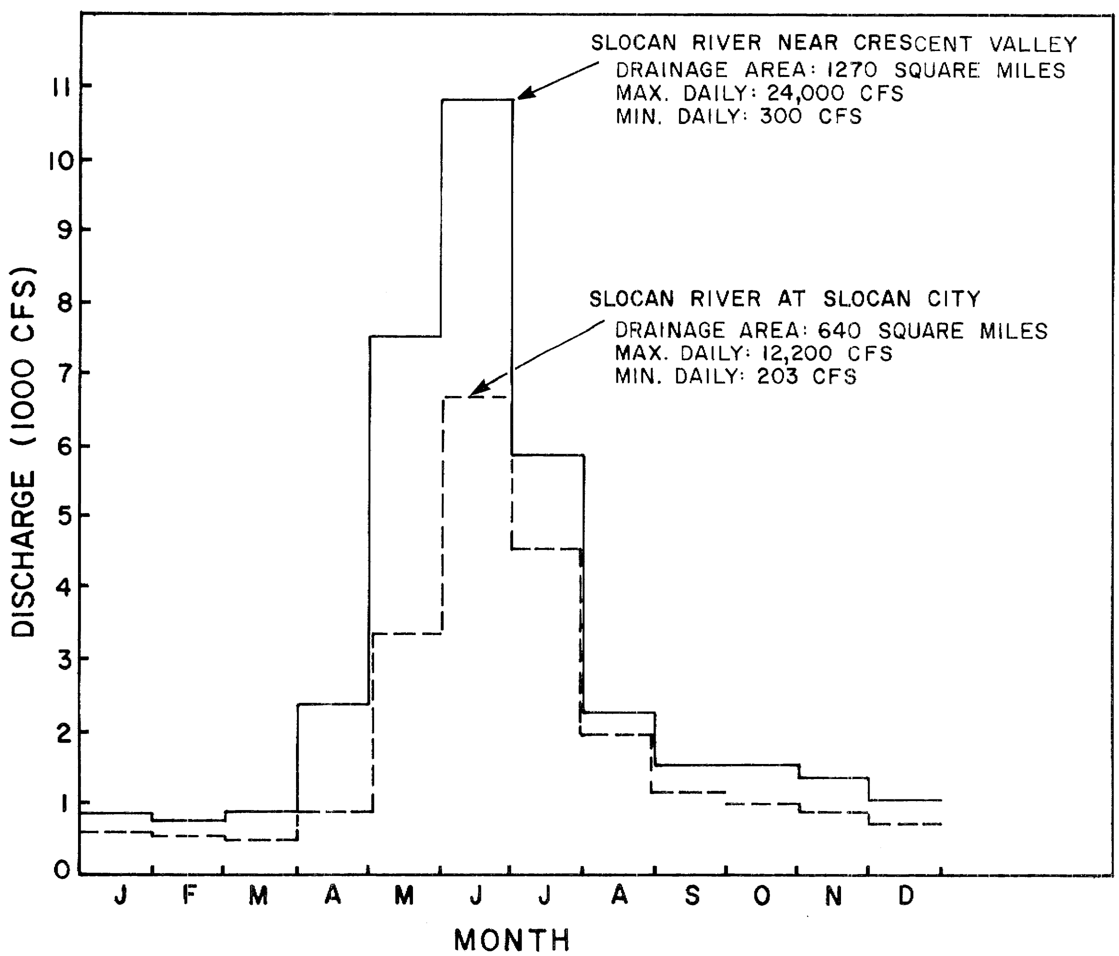

FIGURE 6-3
EFFECT OF LIBBY AND DUNCAN REGULATION ON KOOTENAY RIVER FLOWS AT CORRA LINN

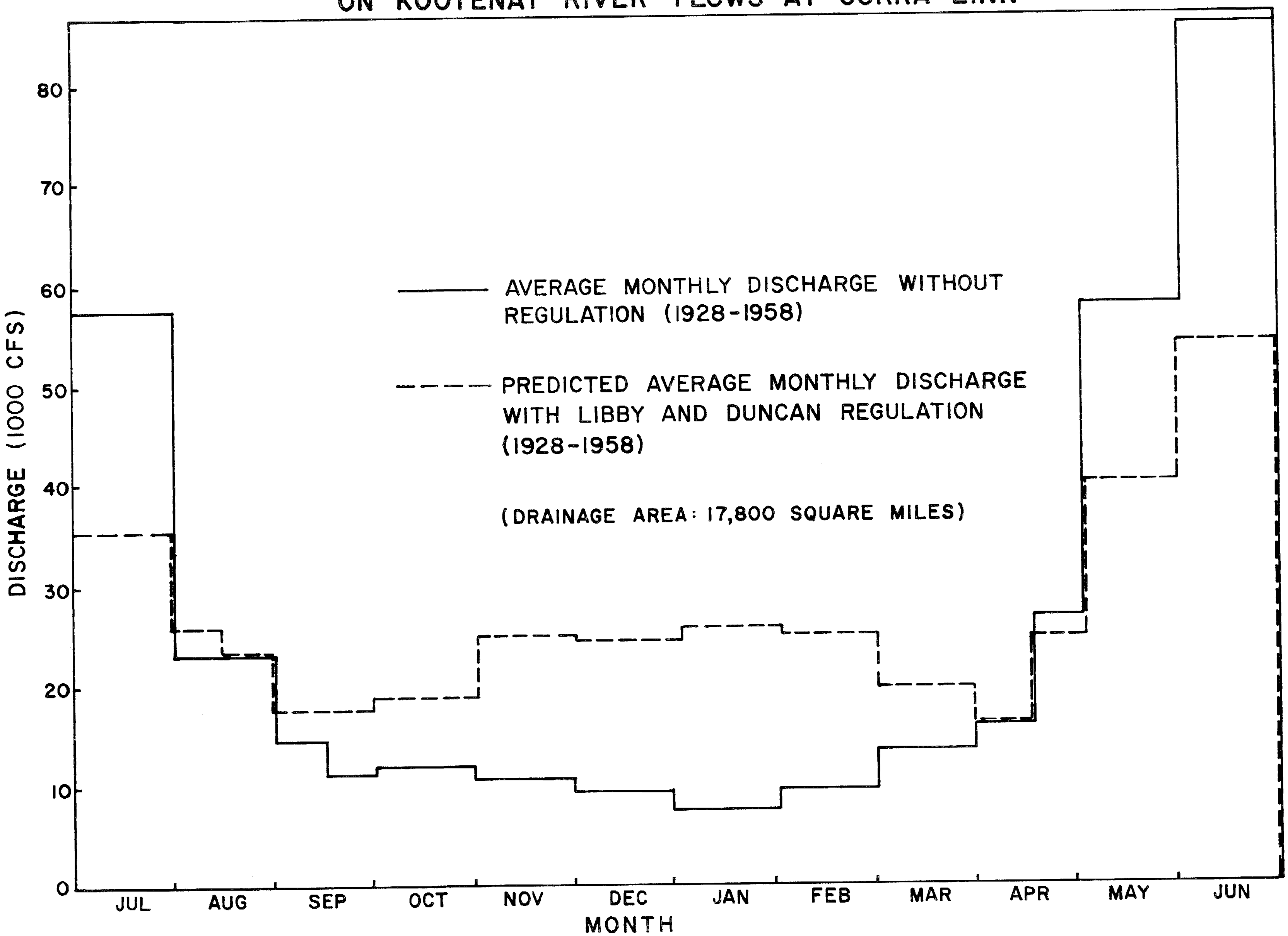

FIGURE 6-4
APPROXIMATE FISH DISTRIBUTION IN THE SLOCAN VALLEY[2]

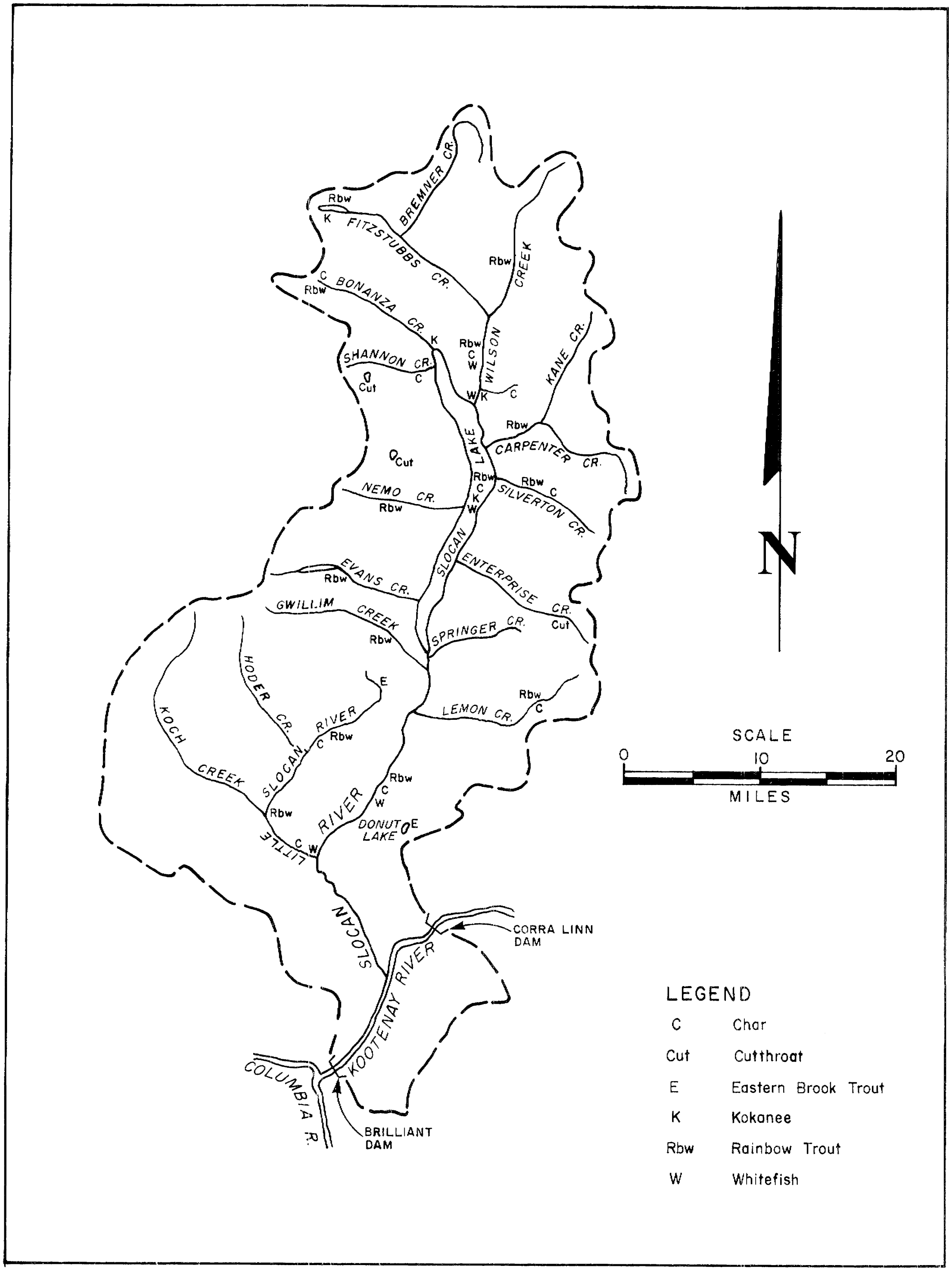

FIGURE 6-5
REGION 6, NORTH SECTION DISCHARGES AND SAMPLING SITES

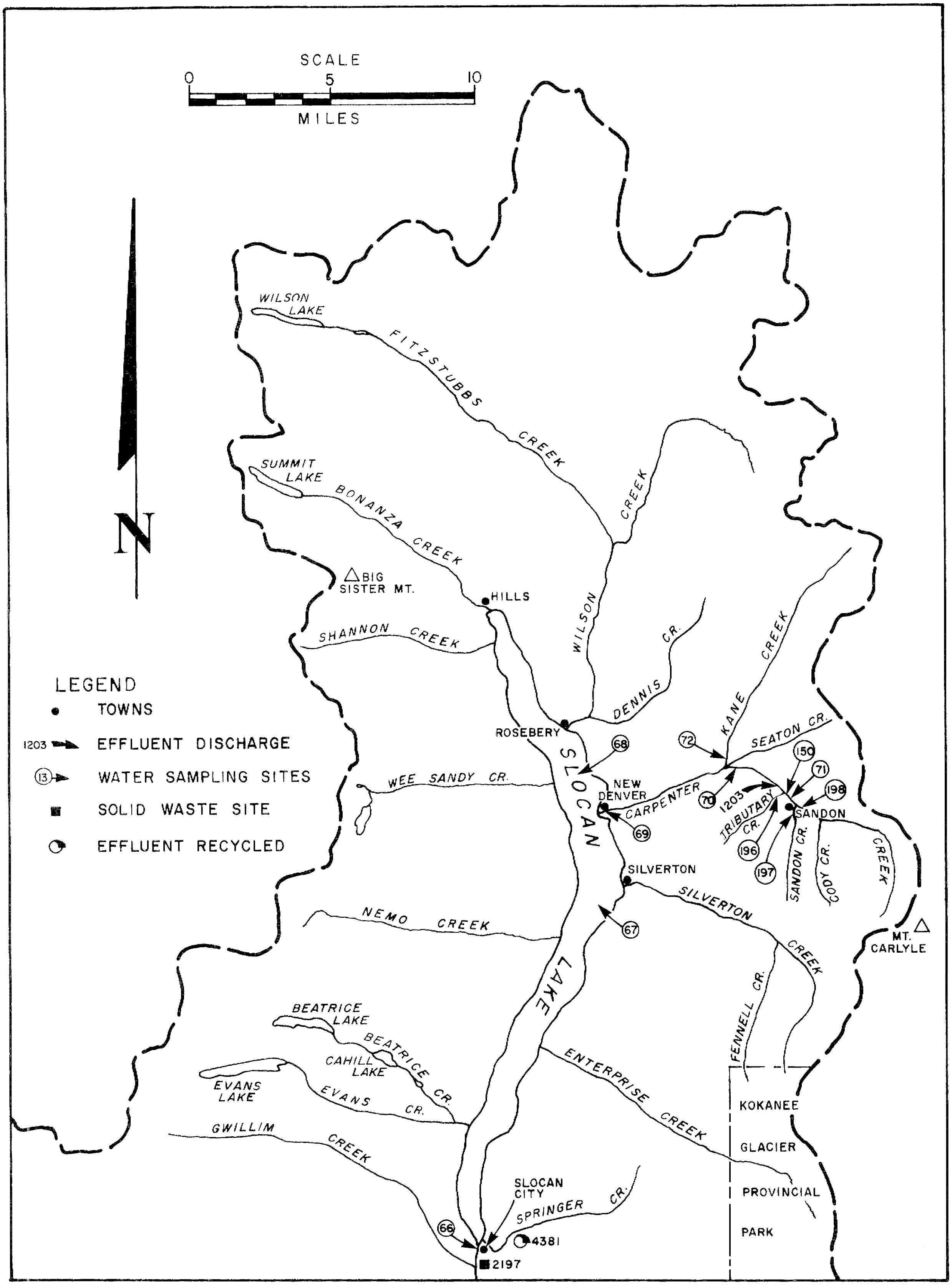

FIGURE 6-6
REGION 6, SOUTH SECTION DISCHARGES AND SAMPLING SITES

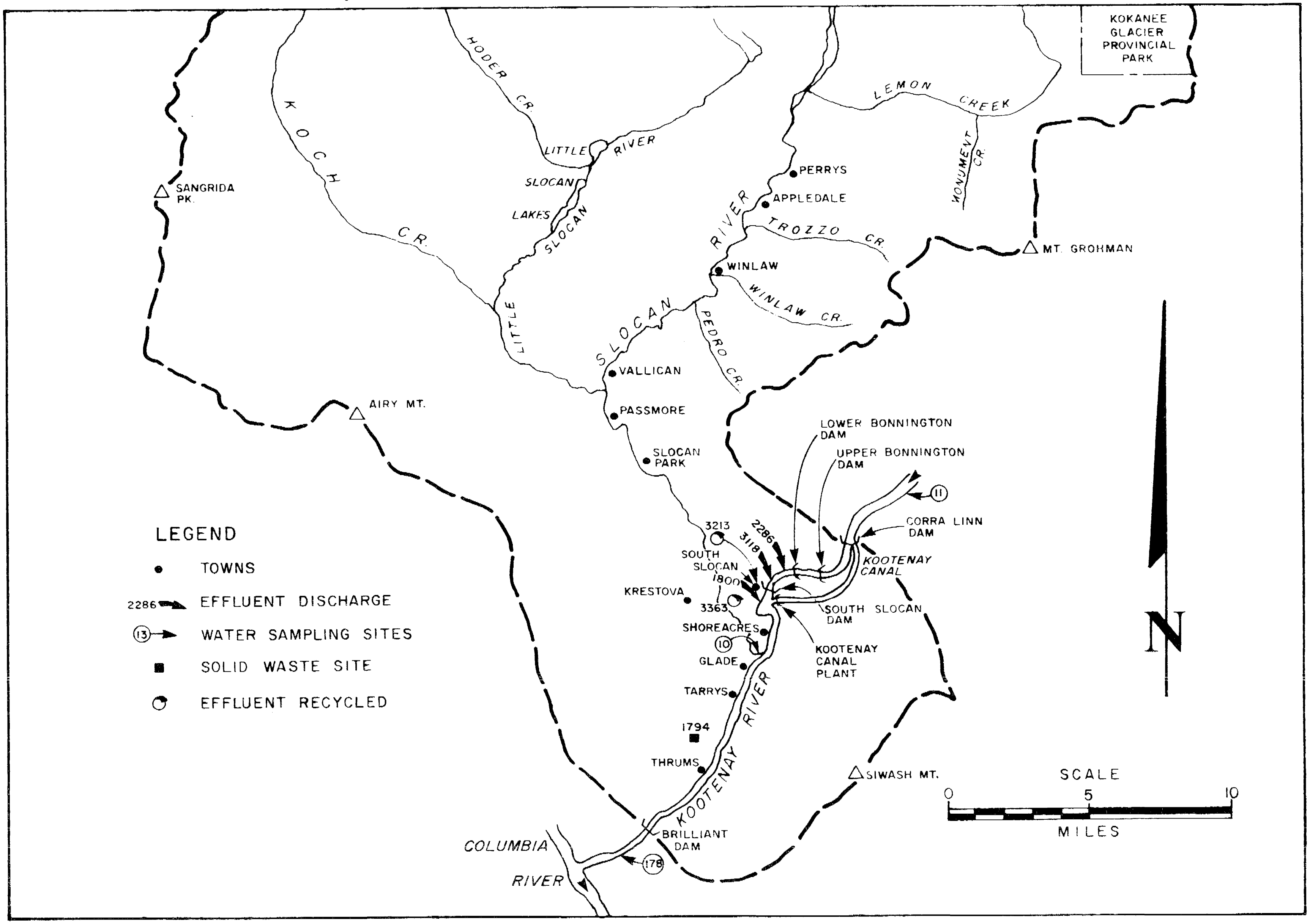

FIGURE 6-7
KAM KOTIA MINES LTD.
SIMPLIFIED FLOW DIAGRAM OF THE LEAD-ZINC CONCENTRATOR

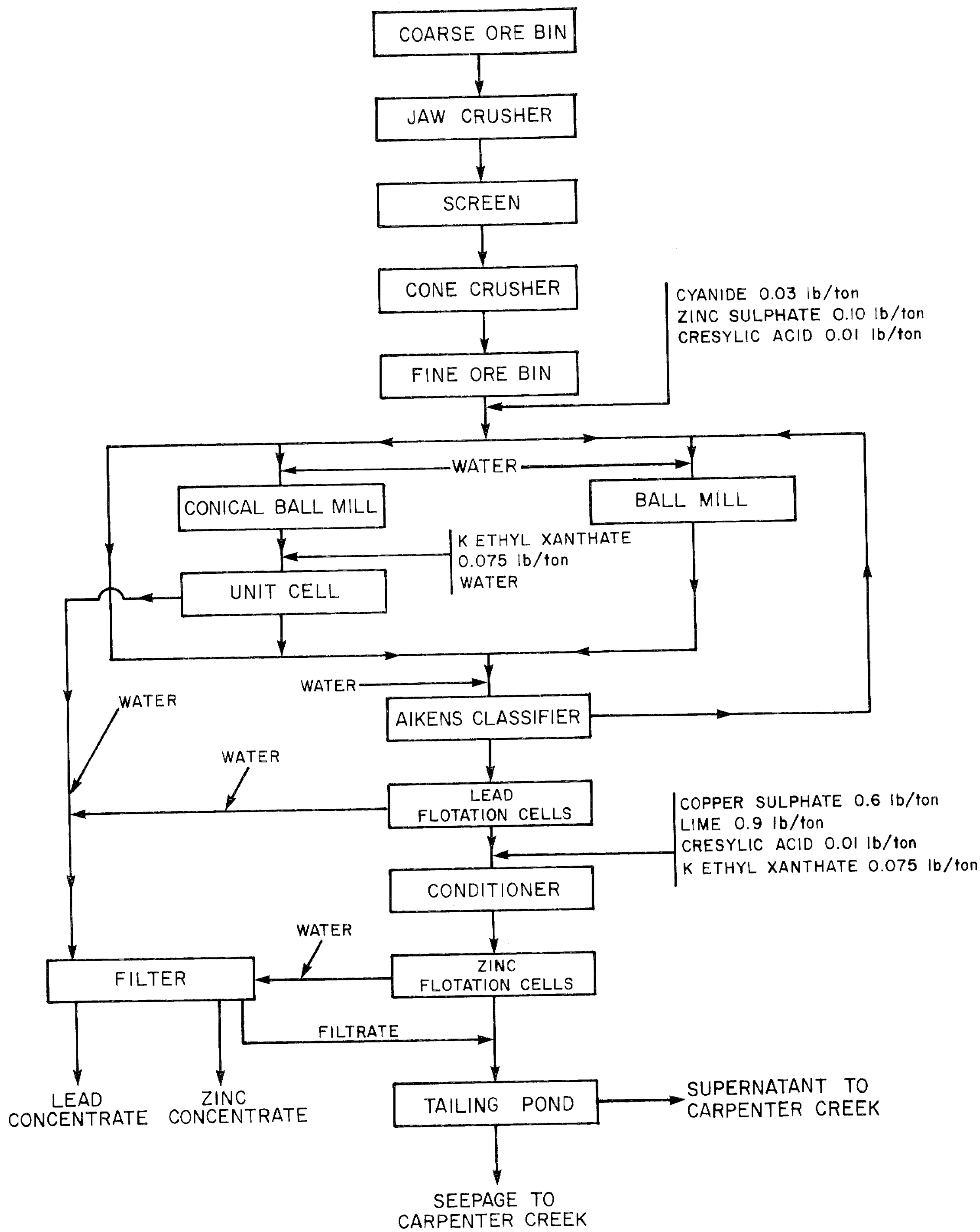

FIGURE 6-8

EFFECT OF REGULATION ON THE FLOW IN THE KOOTENAY RIVER AT THE MOUTH

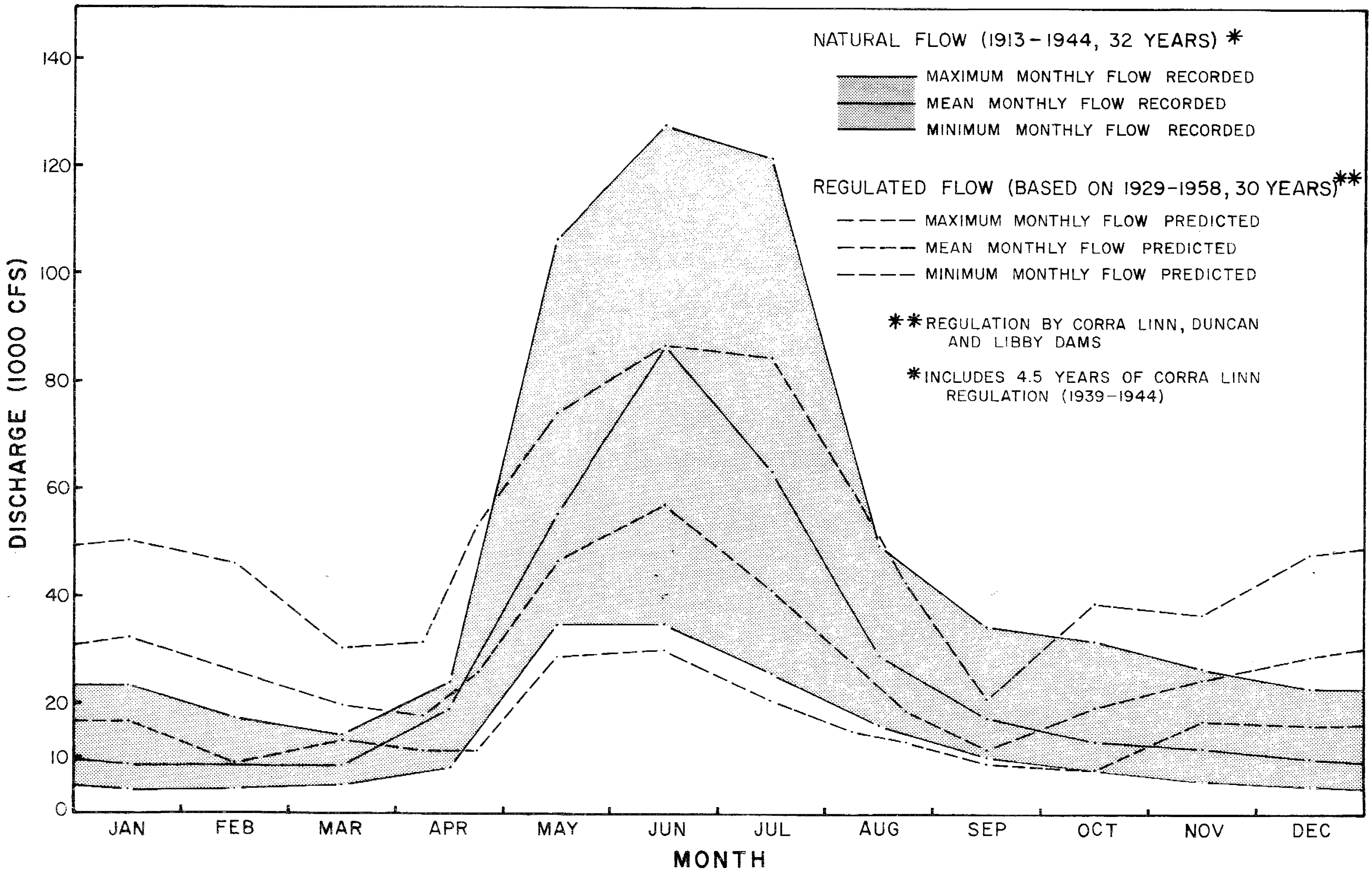

FIGURE 6–9
KOOTENAY REGION SHOWING WATERSHED AREAS

1. FLATHEAD RIVER BASIN
2. ELK RIVER BASIN
3. UPPER KOOTENAY RIVER BASIN
4. LOWER KOOTENAY RIVER BASIN
5. KOOTENAY LAKE BASIN
6. SLOCAN RIVER BASIN
7. UPPER COLUMBIA RIVER BASIN
8. LOWER COLUMBIA RIVER BASIN
9. KETTLE RIVER BASIN

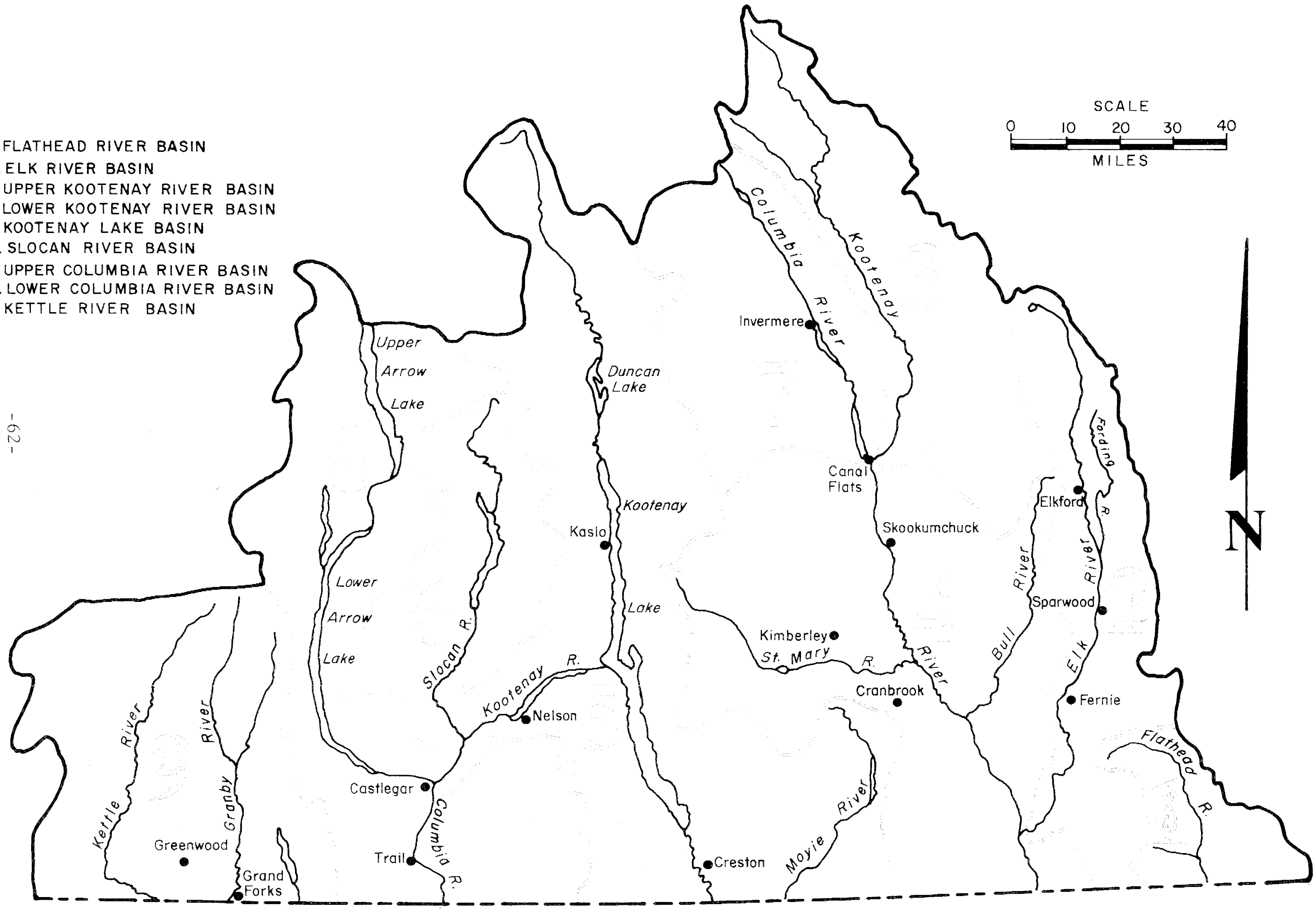

TABLE 6-1

SUMMARY OF WATER LICENSES IN REGION 6[12]

Source	No. of Licenses	Quantity	Purpose	Owner	Location*	Comments
NELSON WATER DISTRICT, NEW DENVER PRECINCT						
Angel Cr.	1	15,000 GPD***	Domestic	Village of New Denver	New Denver	Waterworks
Arthur Cr.	10	54 AF** 5000 GPD	Irrigation Domestic		(Hills) L's 389, 7634, 8127	43 Acres Irrigated
Aylard Cr.	1	35,000 GPD	Domestic	Village of New Denver	New Denver	Waterworks (Possible Water Shortage)
Bird Cr.	1	10,000 GPD	Domestic	Parks Branch	(Summit Lake) L. 11340	Park
Bluebird Cr.	1	1000 GPD 9000 GPD	Mining Domestic	Reco Silver Mines Ltd.	(Zincton) L. 456	
Cadden Cr.	24	77 AF 10,500 GPD	Irrigation Domestic		(Hills) L's 8127 & 7547	61 Acres Irrigated
Capella Cr.	1	50,000 GPD	Domestic	Village of New Denver	(New Denver) L's 485, 549,625, 550 & 432	Waterworks
Carpenter Cr.	2	2.58×10^6 GPD	Mining & Power	Carnegie Mines Ltd.	(Cody) L's 482 & 590	
Cody Cr.	2	2.07×10^6 GPD	Power	Carnegie Mines Ltd.	(Cody) L's 482 & 590	Mining
Cropps Cr.	7	83 AF 4000 GPD	Irrigation Domestic		(Rosebery-New Denver) L's 6529 & 2106	47 Acres Irrigated Fully Recorded

See last page for footnotes.

TABLE 6-1 (continued)

SUMMARY OF WATER LICENSES IN REGION 6[12]

Source	No. of Licenses	Quantity	Purpose	Owner	Location	Comments
Dardanelles Cr.	1	1.51×10^6 GPD	Power, Mining, & Domestic	G.A. MacMillan	(Zincton) L. 819	
Dennis Cr.	3	200 AF	Irrigation		(Rosebery) L's 6529 & 11909	130 Acres Irrigated
Drebet Brook	2	0.161×10^6 GPD 12 AF 1000 GPD	Power Irrigation Domestic		L's 11339 & 11337 (Summit Lake)	10 Acres Irrigated
Fitzstubbs Cr.	1	500,000 GPD	Domestic	Nakusp Improvement District	North End of Slocan Basin	Waterworks
Florence Cr.	1	30,000 GPD	Domestic	Village of New Denver	(New Denver) L's 485, 625, 550, 549 & 432	Waterworks
Lloyd, Malloy & Esthwaite Springs	1	20,000 GPD	Domestic	Village of New Denver	New Denver	Waterworks (Possible Water Shortage)
McGuigan Cr.	2	4.2×10^6 GPD	Power, Mining, & Domestic	G.A. MacMillan	Carpenter Creek Tributary (Zincton) L. 819	Fully Recorded
Mountain Chief Cr.	2	230,000 GPD	Domestic	Village of New Denver	(New Denver) L's 485, 549, 625, 550 & 432	Waterworks
Owl Cr.	2	36 AF 1000 GPD	Irrigation Domestic		(Hills) L's 8506 & 8507	28 Acres Irrigated

TABLE 6-1 (continued)

SUMMARY OF WATER LICENSES IN REGION 6[12]

Source	No. of Licenses	Quantity	Purpose	Owner	Location	Comments
Rashdale Cr.	2	22,000 GPD	Domestic	Village of New Denver	New Denver	Waterworks
Simpson Cr.	1	50,000 GPD	Domestic	Village of New Denver	(New Denver) L's 485, 625, 550, 549 & 432	Waterworks
South Harris Cr.	4	66 AF 1500 GPD	Irrigation Domestic		(New Denver-Silverton) L's 1799 & 1800	53 Acres Irrigated
Tributary Cr.	1	150,000 GPD 1000 GPD	Mining Domestic	Carnegie Mines Ltd.	(Sandon) L's 809 & 810	
Turris Cr.	2	40 AF 1500 GPD	Irrigation Domestic		(New Denver) L. 625	32 Acres Irrigated
NELSON WATER DISTRICT, SLOCAN CITY PRECINCT						
Anderson Cr.	1	500 AF 1000 GPD	Irrigation Domestic		(Lemon Creek) L. 5223	400 Acres Irrigated Fully Recorded
Gwillim Cr.	2	14 AF 100,000 GPD	Irrigation Domestic	Village of Slocan	(Slocan) L. 381	12 Acres Irrigated Waterworks
Hasty Cr.	1	100,000 GPD	Mining	Slonex Resources Ltd.	L. 1535 (Silverton)	Formerly Red Deer Valley Coal Co.
Lemon Cr.	6	271 AF 5,000 GPD	Irrigation Domestic		(Lemon Creek) L's 5223, 8253, 5222 & 382	217 Acres Irrigated

TABLE 6-1 (continued)

SUMMARY OF WATER LICENSES IN REGION 6[12]

Source	No. of Licenses	Quantity	Purpose	Owner	Location	Comments
Lime Kiln Cr.	2	38 AF 2750 GPD	Irrigation Domestic		(Slocan) L. 381	26 Acres Irrigated Fully Recorded
Middleton Cr.	1	21 AF	Irrigation		(Slocan) L. 381	16 Acres Irrigated
Mulvey Cr.	4	29 AF 1500 GPD 0.97×10^6 GPD 2.69×10^6 GPD	Irrigation Domestic Power Fish Culture		(Slocan) L. 381	23 Acres Irrigated
O'Shea Cr.	4	47 AF 2000 GPD	Irrigation Domestic		(Slocan) L. 381	37 Acres Irrigated
Ringrose Cr.	4	40 AF 2000 GPD	Irrigation Domestic		(Lemon Creek) L. 382	34 Acres Irrigated
Shook Cr.	2	86,000 GPD 500 GPD 8 AF	Power Domestic Irrigation		(Slocan) L. 395	6 Acres Irrigated
Silverton Cr. & Tributaries	2	200,000 GPD	Domestic	Village of Silverton	Silverton	Waterworks
	4	10,000 GPD	Domestic		Silverton Creek Area	
Springer Cr. & Tributaries	1	100,000 GPD	Domestic	Village of Slocan	Slocan	Waterworks
	1 1	125 AF 0.538×10^6 GPD	Irrigation Power	Slocan Ottawa Mines Ltd.	L's 395 & 381 L. 8770	100 Acres Irrigated
	2	120,000 GPD	Mining	Slocan Ottawa Mines Ltd. & Dominion Dev. Ltd.	Millside Mineral Claim	Milling Ore
	3	3000 GPD	Domestic			

TABLE 6-1 (continued)

SUMMARY OF WATER LICENSES IN REGION 6[12]

Source	No. of Licenses	Quantity	Purpose	Owner	Location	Comments
Vevey Cr.	1	60 AF 1500 GPD	Irrigation Domestic		(Slocan Lookout) L's 7776 & 8550	48 Acres Irrigated
NELSON WATER DISTRICT, SLOCAN JUNCTION PRECINCT						
Arvid Cr.	1	34 AF 500 GPD	Irrigation Domestic		L. 7523 (Slocan Park)	26 Acres Irrigated
Bird Cr.	4	59 AF 12,000 GPD 500 GPD	Irrigation Domestic Domestic	City of Nelson	(Corra Linn Dam) L's 7874, 5282, 8257, 8258 & 12327	47 Acres Irrigated
Cant Cr.	3	6 AF 1000 GPD 0.538×10^6 GPD	Irrigation Domestic Power		(Krestova) L's 7368 & 8351	4 Acres Irrigated
Cowie Cr.	2	34 AF 500 GPD	Irrigation Domestic		L. 7890 (Passmore)	27 Acres Irrigated
Davis Spring	1	12,000 GPD	Domestic	Cominco	L. 6300 (Bonnington)	Waterworks
Durham Cr.	10	30 AF 3750 GPD	Irrigation Domestic		(Glade) L. 302A	24 Acres Irrigated Fully Recorded
Galloway & E. Galloway Cr's.	4	300 AF 3500 GPD 0.81×10^6 GPD	Irrigation Domestic Power		(Pass Valley) L's 8430, 8941, 8943 & 10430	240 Acres Irrigated
Goose, S. Goose, & Gander Cr's.	7	189 AF 4500 GPD	Irrigation Domestic		(Pass Valley Krestova) L's 9409, 8352 & 16417	151 Acres Irrigated

TABLE 6-1 (continued)

SUMMARY OF WATER LICENSES IN REGION 6[12]

Source	No. of Licenses	Quantity	Purpose	Owner	Location	Comments
Hiram Cr.	1	50 AF	Irrigation		(Pass Valley) L's 8430, 8941, 8943 & 10430	40 Acres Irrigated
Kootenay R.	3	6889×10^6 GPD (12,800 CFS)****	Power	Cominco	Upper Bonnington Dam	
	2	5597×10^6 GPD (10,400 CFS)	Power	West Kootenay Power & Light Co.	Lower Bonnington Dam	
	1	768×10^6 GPD (1428 CFS)	Power	City of Nelson	Upper Bonnington Dam	
	1	6781×10^6 GPD (12,600 CFS)	Power	Cominco	Corra Linn Dam	
	1	5812×10^6 GPD (10,800 CFS)	Power	Cominco	South Slocan Dam	
	1	$16,145 \times 10^6$ GPD (30,000 CFS)	Power	B.C. Hydro	Kootenay Canal Project To Be Completed in 1975-1976	
	1	840,000 AF	Storage	Cominco	Storage in Kootenay provided by Corra Linn Dam	Total Storage (840,000 + 210,000)AF is Equivalent to Elevation 1747.32 on Kootenay Lake, but Storage is Limited to Elevation 1745.32 by International Joint Commision
	1	210,000 AF	Storage	West Kootenay Power & Light Co.		
	2	500,000 GPD	Industrial	Kootenay Power Plant Contractors	Kootenay Canal Project	Construction

TABLE 6-1 (continued)

SUMMARY OF WATER LICENSES IN REGION 6[12]

Source	No. of Licenses	Quantity	Purpose	Owner	Location	Comments
Langill Lake & Creek	4	7000 GPD 20,000 GPD	Domestic Domestic	Krestova Improvement District	Krestova	Waterworks (30 AF of Storage in Langill Lake)
McDermid Cr.	10	20,000 GPD	Domestic	Krestova Improvement District	Krestova	Waterworks (Water Available only for Domestic Use)
		9000 GPD	Domestic			
Rover Cr.	1	25,000 GPD	Domestic	Cominco	(Bonnington Falls) L's 303, 396 & 4024	Waterworks
	2	185,000 GPD	Industrial	Kootenay Power Plant Contract-ors		Construction
Schiavon Cr.	34	84 AF 13,000 GPD	Irrigation Domestic		(Glade-Shoreacres) L. 302A	66 Acres Irrigated Fully Recorded
Slocan R.	8	100 AF 11,500 GPD	Irrigation Domestic		(Crescent Valley-Shoreacres) L's 6882, 303 & 302A	91 Acres Irrigated
Smoky Cr.	2 1	60,000 GPD 500 GPD	Domestic Domestic	South Slocan Waterworks District	South Slocan	Waterworks
Watts Brook	1	80,000 GPD	Domestic	South Slocan Waterworks District	South Slocan	Waterworks
Winstanley Cr.	1	49 AF 1500 GPD	Irrigation Domestic		L. 6446 (Koseanices Spur)	39 Acres Irrigated

TABLE 6-1 (continued)

SUMMARY OF WATER LICENSES IN REGION 6[12]

Source	No. of Licenses	Quantity	Purpose	Owner	Location	Comments
Wolverton Cr.	10	84 AF 4500 GPD	Irrigation Domestic	Slocan Park Improvement District	(Slocan Park) L's 7065 & 9265	78 Acres Irrigated Fully Recorded
NELSON WATER DISTRICT, LITTLE SLOCAN PRECINCT						
Airy Creek	8	24 AF 2000 GPD	Irrigation Domestic		(Passmore) L's 10804, 10805 & 12110	19 Acres Irrigated
Angus Cr.	4	24 AF 500 GPD	Irrigation Domestic		(Winlaw-Appledale) L's 3461, 3460 & 3462	20 Acres Irrigated
Brogan Cr.	4	58 AF 2250 GPD	Irrigation Domestic		(Perrys) L's 7357, 7706, & 5583	49 Acres Irrigated Fully Recorded
Christian Cr.	25	109 AF 10,750 GPD 15 AF	Irrigation Domestic Industrial		(Perrys) L. 383	87 Acres Irrigated Golf Course
Draw Cr.	4	37 AF 2000 GPD	Irrigation Domestic		(Vallican) L's 7688 & 8126	30 Acres Irrigated
Elliott Cr.	18	24 AF 6500 GPD	Irrigation Domestic		(Perrys) L's 7357 & 8243	20 Acres Irrigated
Hird Cr.	10	42 AF 6000 GPD	Irrigation Domestic		(Winlaw) L's 3819, 6881 & 8785	32 Acres Irrigated

TABLE 6-1 (continued)

SUMMARY OF WATER LICENSES IN REGION 6[12]

Source	No. of Licenses	Quantity	Purpose	Owner	Location	Comments
Jerome Cr.	15	85 AF 6500 GPD	Irrigation Domestic		(Appledale) L. 383	69 Acres Irrigated Fully Recorded After June 30th
McFayden Cr.	17	38 AF 8500 GPD	Irrigation Domestic		(Vallican) L. 8126	30 Acres Irrigated Fully Recorded
Nelly Cr.	5	20 AF 2000 GPD	Irrigation Domestic		(Perrys) L. 8338	20 Acres Irrigated Fully Recorded
Nixon Cr.	2	43 AF 1000 GPD	Irrigation Domestic		(Appledale) L. 383	35 Acres Irrigated
Pedro Cr.	10	21 AF 4000 GPD	Irrigation Domestic		(Lebahdo) L's 7702 & 7701	16 Acres Irrigated
Rice, Percy & Richards Cr.'s	35	94 AF 11,500 GPD	Irrigation Domestic		(Appledale) L's 3460, 3462 & 383	81 Acres Irrigated Percy & Richards Cr. are Fully Recorded
Trainor Brook	2	35 AF 1000 GPD	Irrigation Domestic		(Perrys) L's 5583 & 7357	28 Acres Irrigated
Trozzo Cr.	19	76 AF 9500 GPD	Irrigation Domestic		(Appledale) L. 383	59 Acres Irrigated
Watson & Benninger Cr.'s	6	36 AF 1000 GPD	Irrigation Domestic		(Winlaw) L's 8861, 5965, 7161 & 3819	34 Acres Irrigated
Winlaw & Glenwood Cr.'s	14	40 AF 7000 GPD	Irrigation Domestic		(Winlaw) L's 3463, 8865, 9784 & 5964	32 Acres Irrigated

TABLE 6-1 (continued)

SUMMARY OF WATER LICENSES IN REGION 6[12]

Source	No. of Licenses	Quantity	Purpose	Owner	Location	Comments
NELSON WATER DISTRICT, CASTLEGAR PRECINCT						
Coutts Cr.	50	52 AF 31,000 GPD	Irrigation Domestic		(Thrums) L. 1239	47 Acres Irrigated Fully Recorded
Ezra Cr.	16	23 AF 5940 GPD	Irrigation Domestic		(Thrums) L. 6893	19 Acres Irrigated Fully Recorded
Glade Cr.	1	300 AF	Irrigation		(Tarrys) L. 1239	295 Acres Irrigated
Kootenay R.	2	9687×10^6 GPD (18,000 CFS)	Power	Cominco	Brilliant Dam S.L's 28 & 67 of D.L. 4598	
McPhee Cr.	1	280 AF	Irrigation		(Ootischenia) S.L.'s 11, 13, 14, 15, 60 & 66 of D.L. 4598	180 Acres Irrigated McPhee Cr. is in Region 6, but Land Irrigated is in Region 8.
Tarrys Cr.	40	75 AF 17,000 GPD	Irrigation Domestic		(Tarrys-Thrums)	76 Acres Irrigated Fully Recorded
Thrums Cr.	20	41 AF 5250 GPD	Irrigation Domestic		Thrums	35 Acres Irrigated

In addition to those sources previously listed, there are numerous sources of water supply for domestic and irrigation purposes which are smaller than those listed. Only those sources providing 10,000 GPD (13 AF) or more were listed.

* All lots are located in the Kootenay Land District
** AF - acre - feet
***GPD - Imperial gallons per day
****CFS - Cubic feet per second

TABLE 6-2

AREAS IN REGION 6 WITH LIMITED WATER AVAILABILITY[12]

Location	Limited Sources of Water Supply	Comments
Slocan River Valley		
Slocan	Limekiln Creek	FR*
Lemon Creek	Anderson Creek	FR
Perrys	Brogan & Nelly Creeks	FR
Appledale	Jerome, Percy & Richards Creeks	FR
Vallican	McFayden Creek	FR
Slocan Park	Wolverton Creek	FR, 500 IGPM Well Developed For Irrigation Purposes
Krestova	McDermid Creek	Water Available for Domestic Use Only
Kootenay River Valley		
Shoreacres	Schiavon Creek	FR
Glade	Durham Creek	FR 9 Wells Located in
Tarrys	Tarrys Creek	FR This Area
Thrums	Ezra & Coutts Creeks	FR
Slocan Lake		
New Denver	Aylard Creek, Lloyd, Malloy & Esthwaite Springs	PS**, New Denver May Develop Ground-Water Supplies
New Denver-Rosebery	Cropps Creek	FR
Carpenter Creek	McGuigan Creek	FR

* FR - Fully Recorded

** PS - Possible Storage

TABLE 6-3

POPULATIONS OF SETTLEMENTS IN REGION 6[2,13,14,15]

Settlement	1971	1976
New Denver	644	647
Winlaw	383	
Thrums	365	
Slocan Park	360	
Slocan	346	347
Shoreacres	345	
South Slocan	278	
Silverton	246	251
Perrys	245	
Tarrys	176	
Appledale	155	
Passmore	148	
Hills	123	
Vallican	117	
Glade	85	
Crescent Valley	57	
Bonnington	54	
Rosebery	37	
Corra Linn	31	
Krestova	27	

TABLE 6-4

MINERAL PRODUCTION IN THE SLOCAN RIVER BASIN, 1972-1974 [19]

Property	Owner or Agent	Location	Minerals	Ore Production (Tons) 1972	1973	1974	Comments
Silmonac (Minniehaha)	Kam-Kotia-Burkam Joint Venture	Sandon	Silver, Lead, Zinc, Cadmium	27,429	13,949	8,927	Ore Milled On-Site, Lead and Zinc Concentrates Shipped to Trail Smelter
Enterprise	L.M. Fried, O. Swenrude, T. Mazure	Slocan	Silver, Copper, Lead, Zinc	834	67	99	Crude Ore Shipped to Trail Smelter (Enterprise through Best)
Ottawa	M. Poznikoff	Springer Creek	Silver, Lead, Zinc	81	28	0	
Victor (Violamac)	E. Peterson	Sandon	Gold, Silver, Copper, Lead, Zinc	14	30	15	
Washington	J.O.H. Nesbitt	Retallack-Three Forks	Silver, Lead, Zinc, Copper	?	17	29	
Silver Galance, Panama	United Hearne Resources	New Denver	Gold, Silver, Copper, Lead, Zinc	0	0	81	
Bosun	A.E. Avison	New Denver	Silver, Copper, Lead, Zinc	0	0	16	
Freddy	V. Hansen	Silverton	Gold, Silver, Lead, Zinc	0	33	0	
Little Tim (V-Day)	W. Turley	Slocan	Silver, Copper, Lead, Zinc	0	2	0	
Marmion, Maryland	M.R. Maze	Slocan	Gold, Silver, Lead, Zinc	0	7	0	
Mary	S. Berisoff	Enterprise Creek	Gold, Silver, Lead, Zinc	0	14	0	
Best	T. Eccles	New Denver	Silver, Lead, Zinc	0	10	0	

TABLE 6-5

SUMMARY OF POLLUTION CONTROL EFFLUENT PERMITS IN THE SLOCAN BASIN

Permit Number	PE-1203	PE-1800	PE-2286
Permittee	Kam Kotia Mines Ltd. Burkam Mines Ltd.	Cominco Ltd. (West Kootenay Power & Light Co. Ltd.)	Kootenay Powerplant Contractors
Date Issued	November 16, 1972	May 8, 1973	June 27, 1973
Location	Sandon	South Slocan	South Slocan
Type of Effluent	Lead-Zinc ore Con-Centrator Tailing Pond Supernatant	Treated Domestic Sewage	Treated Domestic Sewage
Quantity of Effluent Allowed	90,000 IGPD	9,700 IGPD Maximum	25,000 IGPD Maximum
Quality of Effluent Allowed	TS $\leq$400 mg/1 SS $\leq$50 mg/1 pH: 8.0-9.0 Lead $\leq$0.03 mg;/1 Zinc $\leq$0.04 mg/1 Copper $\leq$ 0.04 mg/1 Cyanide $\leq$0.04 mg/1	BOD_5 $\leq$45 mg/1 SS $\leq$60 mg/1 Chlorine Residual of 0.1-1.0 mg/1	BOD_5 $\leq$45 mg/1 SS $\leq$60 mg/1 Chlorine Residual of 0.1-1.0 mg/1
Type of Treatment	Tailing Pond, Decant System, Outfall	Extended Aeration Treatment Plant, Clarifier, Chlorination Facilities, Outfall	Extended Aeration Treatment Plant, Chlorination Facilities, Outfall
Discharged To	Carpenter Creek	Kootenay River (2000 Feet Downstream From South Slocan Dam)	Kootenay River (1000 Feet Downstream From Lower Bonnington Dam)
Comments			Closed in 1976

TABLE 6-5 (continued)

SUMMARY OF POLLUTION CONTROL EFFLUENT PERMITS IN THE SLOCAN BASIN

Permit Number	PE-3363	PE-3213
Permittee	Kootenay Powerplant Contractors	Kootenay Powerplant Contractors
Date Issued	January 28, 1975	January 10, 1975
Location	Cresent Valley	South Slocan
Type of Effluent Allowed	Gravel Washing Plant	Ready-Mix Concrete Plant
Quantity of Effluent Allowed	54,000 IGPD Maximum (Recycled-No Discharge)	39,000 IGPD Maximum (Recycled-No Discharge)
Quality of Effluent Allowed	Typical Gravel Washing Effluent	Typical Batch Plant and Washout, Wet Scrubber, and Aggregate Washing Effluent
Type of Treatment	Four Settling Ponds, Supernatant Recycle System	Settling Pond, Supernatant Recycle System
Discharged To	Recycled	Recycled
Comments	Closed in 1976	Closed in Late 1975

TABLE 6-5 (continued)

SUMMARY OF POLLUTION CONTROL EFFLUENT PERMITS IN THE SLOCAN BASIN

Permit Number	PE-3118	PE-4381
Permittee	Dillingham Corporation Canada Ltd.	Selmon Resources Ltd.
Date Issued	January 8, 1975	November 2, 1976
Location	South Slocan	1.5 Miles East of Village of Slocan
Type of Effluent	Ready-Mix Concrete Plant	Silver-Lead-Zinc Ore Dressing Plant
Quantity of Effluent Allowed	2,700 IGPD Maximum	50,000 IGPD Average 75,000 IGPD Maximum (Recycled-No Discharge)
Quality of Effluent Allowed	Typical Concrete Truck Washout Effluent	Typical Ore Dressing Plant Tailings
Type of Treatment	Settling Ponds (Exfiltration/Evaporation Ponds)	Tailings Pond, Water Reclaim System, Seepage Pond, Seepage Return System
Discharged To	Ground, Atmosphere (Exfiltration/Evaporation)	Recycled
Comments	Closed in Late 1975	Expected Life of Tailings Pond is 120 Days of Production After Which Time a Dry Disposal Method Will Be Used

TABLE 6-6

ANALYSIS OF TAILING POND SUPERNATANT FROM KAM KOTIA MINES LTD.,

OBTAINED BY THE COMPANY FROM NOVEMBER 1971 TO NOVEMBER 1975

Parameter \ Type of Value		Maximum	Minimum	Average	Number Of Values
Copper, Dissolved	mg/1	3.24	<0.001	0.38	20
Copper, Total	mg/1	6.28	0.006	0.88	20
Cyanide, Total	mg/1	1.8	<0.004	0.21	20
Lead, Dissolved	mg/1	0.15	<0.001	0.02	20
Lead, Total	mg/1	11.55	0.006	1.43	20
pH		9.6	6.5	7.6	20
Solids, Suspended	mg/1	755	0.4	105	20
Solids, Total	mg/1	964	162	356	20
Sulphate, Dissolved	mg/1	314	7.8	103	20
Zinc, Dissolved	mg/1	1.13	0.002	0.21	20
Zinc, Total	mg/1	5.4	0.02	1.03	20

TABLE 6-7

ANALYSIS OF TAILING POND SUPERNATANT FROM KAM KOTIA MINES LTD., OBTAINED BY THE POLLUTION CONTROL BRANCH FROM APRIL 1971 TO MAY 1976

Parameter \ Type of Value		Maximum	Minimum	Average	Number Of Values
Alkalinity, Total	mg/l	61	56	58	3
Arsenic, Dissolved	mg/l	0.003	0.003	0.003	1
Cadmium, Dissolved	mg/l	0.0006	0.0002	0.00035	4
Chromium, Dissolved	mg/l	<0.001	<0.001	<0.001	4
Copper, Dissolved	mg/l	1.02	0.04	0.33	11
Copper, Total	mg/l	0.17	0.11	0.15	3
Cyanide, Total	mg/l	0.71	<0.01	0.25	9
Iron, Dissolved	mg/l	0.04	<0.01	0.01	5
Lead, Dissolved	mg/l	0.018	<0.001	0.006	11
Lead, Total	mg/l	0.2	0.027	0.11	3
Manganese, Dissolved	mg/l	0.2	0.16	0.18	4
Mercury, Total	μg/l	<0.05	<0.05	<0.05	1
pH		9.6	7.5	8.3	16
Solids, Suspended	mg/l	898	9	164	11
Solids, Total	mg/l	1120	228	368	11
Sulphate, Dissolved	mg/l	106	67	93	3
Turbidity	JTU	67	7	29	3
Zinc, Dissolved	mg/l	0.16	<0.005	0.05	11
Zinc, Total	mg/l	0.64	0.07	0.27	3

TABLE 6-8

PERCENTAGE OF ANALYSES FROM KAM KOTIA MINES LTD. TAILING POND EXCEEDING MINING OBJECTIVES

Parameter	Number of Analyses	Percentage Exceeding Mining Objectives(28)		
		Level A	Level B	Level C
Arsenic, Dissolved	1	0	0	0
Cadmium, Dissolved	4	0	0	0
Chromium, Dissolved	4	0	0	0
Copper, Dissolved	31	61	32	10
Cyanide, Total	29	34	21	0
Iron, Dissolved	5	0	0	0
Lead, Dissolved	31	10	3	0
Manganese, Dissolved	4	100	0	0
Mercury, Total	1	0	0	0
pH	36	17	6	0
Solids, Suspended	31	42	19	
Solids, Total	31	0	0	0
Sulphate, Dissolved	23	87	4	0
Zinc, Dissolved	31	3	0	0

TABLE 6-9

DESCRIPTION OF REFUSE DISPOSAL SITES IN REGION 6

	Permit No. / Description	PR-1794	PR-2197
	Operator and Location	Kalesnikoff Lumbering Co. Ltd., Thrums	Village of Slocan
	Status of Refuse Disposal Site and Level of Operation*	Site in Operation Level C	Site in Operation Level C
	Quantity and Type of Refuse	6 cu yd/day of Wood-Wastes	2.5 cu yd/day Municipal (Including Septic Tank Sludge)
Site Suitability Factors	Depth to Groundwater	Unknown (Minor Seepage May Occur)	20
	Underlying Soils	Gravelly Silt	Clay, Sandy Loan with Rocks & Gravel
	Surface Runoff or Flooding	None	None
	Distance to Surface Water	3,000	900 to Slocan River (site is 45 ft. above Slocan R.)
	Distance to Wells	10,000	
	MAP/PE**	28/24	30/22
	Potential for Adverse Effects on Groundwater or Surfacewater	Groundwater: Nil Surfacewater: Nil	Groundwater: Nil Surfacewater: Nil
	Comments	Site Located on Areas Subject to Landslides	Contributing Population of 350 People

* As defined in the Operational Guidelines for the Discharge of Refuse on Land, Pollution Control Branch, October, 1971.

** MAP/PE: Mean annual precipitation/Average annual potential evapotranspiration.

TABLE 6-10

NUTRIENT CONTRIBUTION TO THE SLOCAN AND KOOTENAY RIVERS FROM LIVESTOCK AND FERTILIZED, IRRIGATED CROPLAND

Statistic / Area	Slocan River	Kootenay River	Totals
Farms Reporting Cropland[a]	24	14	38
Cropland Area (Acres)[a]	267	50	317
Hayland Area (Acres)[a]	234	42	276
Irrigated Land (Acres)[a]	111	42	153
Irrigated Land (Acres)[b]	2,700	800	3,500
Fertilized Area (Acres)[a]	5	5	10
Nitrogen Contribution to the River from Irrigated Cropland[c] (lb N/Year, Calculated)	18,090	5,360	23,450
Phosphorus Contribution to the River from Irrigated Cropland[d] (lb P/Year, Calculated)	460	140	600
Number of Cattle (Older Than 1 Year)[a]	383	37	420
Number of Poultry (Older Than 5 Months)[a]	2,300	200	2,500
Nitrogen Contribution to the River from Cattle and Poultry[c] (lb N/Year, Calculated)	4,110	395	4,505
Phosphorus Contribution to the River from Cattle and Poultry (lb P/Year, Calculated)[d]	110		121
Total Nutrient Contribution to the River From Irrigated Cropland and Cattle:			
Nitrogen lb/Year	22,200	5,760	27,960
Phosphorus lb/Year	570	150	720

a - Data from 1971 Agricultural Census[16]
b - Data from Irrigation Water Licences[12]
c - Nitrogen Loadings - Cattle: 9.8 lb N/Animal/Year
Poultry: 0.154 lb N/Animal/Year
Cropland: 6.7 lb N/Acre/Year
d - Phosphorus Loadings - Cattle: 0.242 lb P/Animal/Year
Poultry: 0.008 lb P/Animal/Year
Cropland: 0.17 lb P/Acre/Year

TABLE 6-11

ESTIMATED NUTRIENT LOADINGS AND CONCENTRATIONS IN THE KOOTENAY AND SLOCAN RIVERS FROM AGRICULTURAL OPERATIONS

	Mean Flow May Through August	Loading Lb/Year		Concentration mg/l	
	CFS	Nitrogen	Phosphorus	Nitrogen	Phosphorus
Slocan River	5,600	222,000	570	0.006	0.0002
Kootenay River Above Slocan R.	54,400	5,760	150	0.0002	0.000004
Kootenay River Below Slocan R.	60,000	27,960	720	0.0006	0.00002

TABLE 6-12

STATISTICS ON THE KOOTENAY RIVER DAMS[11,40,41]

Dam or Project	Corra Linn	Upper Bonnington	Lower Bonnington	South Slocan	Kootenay Canal	Brilliant
Height (Feet)	70	50	58	70		112
Crest Length (Feet)	1,700	1,400	730	2,235		624
Spillway Capacity (CFS)	275,000	220,000	215,000	215,000		256,000
Spillway Height (Feet)	33	16-22	38	35		94
Spillway Type	Overflow at Crest Gates	Overflow	Overflow with Gates	Overflow		Overflow with Gates
Sluiceway Capacity (CFS)		Included in Spillway Capacity				
Powerhouse Installed Capacity (MW)	40.5	55 & 8.67	42	47	500	109
Hydraulic Capacity (CFS)	12,600	12,800 & 1,428	10,400	10,800	25,000	18,000
Reservoir Usable Storage Capacity (acre-feet)	800,000*	Pondage Only	Pondage Only	Pondage Only	800,000*	9,875
Area ($Miles^2$)	161*				161*	
Length (Miles)	65 & 22*	1	0.5	0.8	65 & 22*	10

TABLE 6-12 (continued)

STATISTICS ON THE KOOTENAY RIVER DAMS[11,40,41]

Dam or Project	Corra Linn	Upper Bonnington	Lower Bonnington	South Slocan	Kootenay Canal	Brilliant
Maximum Width (Miles)	4	0.25	0.15	0.2	4	0.5
Watershed Area (Miles)	17,800	17,800	17,800	17,800	17,800	19,100
Normal Range of Water Levels (Feet) High Water	1,745	1,690	1,624	1,554	1,745	1,478
Low Water	1,739	1,683	1,610	1,540	1,739	1,468

* Kootenay Lake is the reservoir of Corra Linn Dam and the Kootenay Canal Project

TABLE 6-13

SUMMARY OF WATER QUALITY DATA FOR CARPENTER, SANDON AND CODY CREEKS, OBTAINED BY THE POLLUTION CONTROL BRANCH

Site Number		198				197			
Site Description		Carpenter Cr. u/s Sandon Cr.				Sandon Cr. at the Mouth			
Sampling Period		June 75-Dec. 75				June 75-Dec. 75			
Parameter \ Type of Value		Max.	Min.	Mean	No. of Values	Max.	Min.	Mean	No. of Values
Alkalinity, Total	mg/1	60	45	52	2	52	45	48	2
Cadmium, Dissolved	mg/1	<0.0005	<0.0005	<0.0005	1	0.0027	0.0027	0.0027	1
Carbon, Organic	mg/1	<1.0	<1.0	<1.0	1	<1.0	<1.0	<1.0	1
Color, True		5.0	5.0	5.0	1	5.0	5.0	5.0	1
Copper, Dissolved	mg/1	<0.001	<0.001	<0.001	1	<0.001	<0.001	<0.001	1
Cyanide, Total	mg/1	<0.01	<0.01	<0.01	1	<0.01	<0.01	<0.01	1
Hardness, Dissolved	mg/1	82	50	66	2	94	68	81	2
Iron, Dissolved	mg/1	<0.1	<0.1	<0.1	4	<0.1	<0.1	<0.1	4
Iron, Total	mg/1	0.1	0.1	0.1	4	0.1	<0.1	0.1	4
Lead, Dissolved	mg/1	<0.001	<0.001	<0.001	1	0.005	0.005	0.005	1
Mercury, Dissolved	µg/1	<0.05	<0.05	<0.05	1	<0.05	<0.05	<0.05	1
Mercury, Total	µg/1	<0.05	<0.05	<0.05	1	<0.05	<0.05	<0.05	1
Nitrogen, Kjeldahl	mg/1	0.03	0.03	0.03	1	0.06	0.06	0.06	1
Nitrogen, Nitrate	mg/1	0.04	0.04	0.04	1	0.05	0.05	0.05	1
Nitrogen, Nitrite	mg/1	<0.005	<0.005	<0.005	1	<0.005	<0.005	<0.005	1
Nitrogen, Total	mg/1	0.07	0.07	0.07	1	0.11	0.11	0.11	1
Oxygen, Dissolved	mg/1	11.8	9.8	10.8	2	11.2	9.8	10.5	2
pH		8.3	7.6	8.0	6	8.4	7.7	8.0	6
Phosphorus, Dissolved	mg/1	<0.003	<0.003	<0.003	1	<0.003	<0.003	<0.003	1
Phosphorus, Total	mg/1	0.006	0.006	0.006	1	0.003	0.003	0.003	1
Solids, Dissolved	mg/1	68	68	68	1	98	98	98	1
Solids, Suspended	mg/1	2	2	2	1	4	4	4	1
Solids, Total	mg/1	70	70	70	1	102	102	102	1
Sulphate, Dissolved	mg/1	12.5	12.5	12.5	1	29.1	29.1	29.1	1
Turbidity	J.T.U.	0.55	0.40	0.48	2	1.0	0.23	0.62	2
Zinc, Dissolved	mg/1	0.07	0.028	0.047	4	0.47	0.1	0.32	4
Zinc, Total	mg/1	0.07	0.041	0.06	3	0.48	0.26	0.40	3

TABLE 6-13 (continued)

SUMMARY OF WATER QUALITY DATA FOR CARPENTER, SANDON AND CODY CREEKS, OBTAINED BY THE POLLUTION CONTROL BRANCH

Site Description		Carpenter Cr. u/s Cody Cr.				Cody Cr. at the Mouth			
Sampling Period		Oct. 1, 1975				Oct. 1, 1975			
Parameter / Type of Value		Max.	Min.	Mean	No. of Values	Max.	Min.	Mean	No. of Values
Iron, Dissolved	mg/1	<0.1	<0.1	<0.1	1	<0.1	<0.1	<0.1	1
Iron, Total	mg/1	0.1	0.1	0.1	1	0.1	0.1	0.1	1
pH		8.3	8.3	8.3	1	8.2	8.2	8.2	1
Zinc, Dissolved	mg/1	0.013	0.013	0.013	1	<0.005	<0.005	<0.005	1
Zinc, Total	mg/1	0.013	0.013	0.013	1	0.005	0.005	0.005	1

TABLE 6-14

SUMMARY OF WATER QUALITY DATA FOR CARPENTER AND TRIBUTARY CREEKS,

OBTAINED BY THE POLLUTION CONTROL BRANCH

Site Number		71				150			
Site Description		Carpenter Cr. 0.25 Miles u/s Kam Kotia Mill				Carpenter Cr. 300 Feet u/s Kam Kotia Mill			
Sampling Period		April 72-Oct. 75				Oct. 73-Dec. 75			
Parameter / Type of Value		Max.	Min.	Mean	No. of Values	Max.	Min.	Mean	No. of Values
Alkalinity, Total	mg/l	72	32	60	9	73	31	52	10
Arsenic, Dissolved	mg/l	<0.005	<0.005	<0.005	1	<0.005	<0.005	<0.005	1
Cadmium, Dissolved	mg/l	0.0034	0.0005	0.0024	4	0.0052	0.0004	0.0023	7
Carbon, Organic	mg/l	4	<1	1.8	7	1	1	1	1
Color True		5	<5	5	8	5	<5	5	7
Copper, Dissolved	mg/l	0.002	<0.001	0.001	8	0.002	<0.001	0.001	6
Cyanide, Total	mg/l	<0.01	<0.01	<0.01	4	<0.01	<0.01	<0.01	7
Hardness, Dissolved	mg/l	109	40	83	3	82	51	72	3
Iron, Dissolved	mg/l	0.10	0.02	0.07	9	<0.10	<0.04	0.07	9
Iron, Total	mg/l	0.10	0.10	0.10	1	0.10	<0.10	0.10	4
Lead, Dissolved	mg/l	<0.003	<0.001	0.002	8	<0.003	<0.001	0.0014	7
Manganese, Dissloved	mg/l	0.01	<0.01	0.01	5	<0.02	<0.01	0.01	6
Mercury, Total	μg/l	<0.05	<0.05	<0.05	3				
Nitrogen, Ammonia	mg/l					0.006	0.006	0.006	1
Nitrogen, Kjedahl	mg/l	0.26	0.08	0.14	3	0.04	0.04	0.04	1
Nitrogen, Nitrate	mg/l	0.17	0.05	0.13	3	0.04	0.04	0.04	1
Nitrogen, Nitrite	mg/l	<0.005	<0.005	<0.005	3	<0.005	<0.005	<0.005	1
Nitrogen, Total	mg/l	0.43	0.13	0.27	3	0.08	0.08	0.08	1
Oxygen, Dissolved	mg/l	12.7	10.6	11.4	6	12.4	9.4	11.2	7
pH		8.3	7.1	7.9	13	8.2	7.1	7.8	13
Phosphorus, Dissolved	mg/l	<0.003	<0.003	<0.003	3	<0.003	<0.003	<0.003	1
Phosphorus, Total	mg/l	0.007	0.005	0.006	3	0.005	0.005	0.005	1
Solids, Dissolved	mg/l	144	54	112	8	142	54	93	7
Solids, Suspended	mg/l	12	2	4	8	12	2	4	7
Solids, Total	mg/l	146	58	116	8	144	56	97	7
Sulphate, Dissolved	mg/l	40.6	12.5	27.8	6	41.8	11.3	26.0	6
Turbidity	J.T.U.	2.2	0.2	0.8	6	0.8	0.15	0.51	8
Zinc, Dissolved	mg/l	0.46	0.06	0.28	9	0.74	0.08	0.30	9
Zinc, Total	mg/l	0.26	0.26	0.26	1	0.29	0.09	0.22	3

TABLE 6-14 (continued)

SUMMARY OF WATER QUALITY DATA FOR CARPENTER AND TRIBUTARY CREEKS, OBTAINED BY THE POLLUTION CONTROL BRANCH

Site Number		196							
Site Description		Tributary Cr. at the Mouth				Carpenter Cr. 0.2 Miles d/s Kam Kotia Tailing Pond			
Sampling Period		June 75-Dec. 75				Dec. 9, 1975			
Parameter / Type of Value		Max.	Min.	Mean	No. of Values	Max.	Min.	Mean	No. of Values
Alkalinity, Total	mg/1	62	57	60	2	59	59	59	1
Cadmium, Dissolved	mg/1	<0.0005	<0.0005	<0.0005	1				
Carbon, Organic	mg/1	<1	<1	<1	1				
Color, True		5	5	5	1				
Copper, Dissolved	mg/1	<0.001	<0.001	<0.001	1				
Cyanide, Total	mg/1	<0.01	<0.01	<0.01	1				
Hardness, Dissolved	mg/1	81	68	74	2	83	83	83	1
Iron, Dissolved	mg/1	<0.10	<0.10	<0.10	5	<0.1	<0.1	<0.1	1
Iron, Total	mg/1	0.10	<0.10	0.10	4	0.1	0.1	0.1	1
Lead, Dissolved	mg/1	<0.001	<0.001	<0.001	1				
Mercury, Total	µg/1	<0.05	<0.05	<0.05	1				
Nitrogen, Kjeldahl	mg/1	<0.01	<0.01	<0.01	1				
Nitrogen, Nitrate	mg/1	0.07	0.07	0.07	1				
Nitrogen, Nitrite	mg/1	<0.005	<0.005	<0.005	1				
Nitrogen, Total	mg/1	0.07	0.07	0.07	1				
Oxygen, Dissolved	mg/1	11.2	9.6	10.4	3				
pH		8.3	7.7	8.1	7	8.1	8.1	8.1	1
Phosphorus, Dissolved	mg/1	<0.003	<0.003	<0.003	1				
Phosphorus, Total	mg/1	0.01	0.01	0.01	1				
Solids, Dissolved	mg/1	98	98	98	1				
Solids, Suspended	mg/1	2	2	2	1				
Solids, Total	mg/1	100	100	100	1				
Sulphate, Dissolved	mg/1	<5.0	<5.0	<5.0	1				
Turbidity	J.T.U.	1.1	0.63	0.86	2				
Zinc, Dissolved	mg/1	<0.005	<0.005	<0.005	5	0.42	0.42	0.42	1
Zinc, Total	mg/1	0.006	<0.005	0.005	3	0.43	0.43	0.43	1

TABLE 6-15

SUMMARY OF WATER QUALITY DATA FOR CARPENTER AND KANE CREEKS, OBTAINED BY THE POLLUTION CONTROL BRANCH

Site Number		70				72			
Site Description		Carpenter Cr. Between Sandon & Kane Cr.				Kane Cr. at the Mouth			
Sampling Period		April 72- Dec. 75				April 72-Dec. 75			
Parameter / Type of Value		Max.	Min.	Mean	No. of Values	Max.	Min.	Mean	No. of Values
Alkalinity, Total	mg/1	84	36	64	15	93	45	66	15
Arsenic, Dissolved	mg/1	0.008	<0.005	0.0065	2	0.005	<0.005	0.005	2
Cadmium, Dissolved	mg/1	0.007	<0.0005	0.0037	8	0.0028	<0.0001	0.0007	9
Carbon, Organic	mg/1	3	<1	1.8	6	4	<1	1.5	8
Color, True		5	<5	5	13	5	<5	5	14
Copper, Dissolved	mg/1	0.004	<0.001	0.002	12	0.003	<0.001	0.0015	13
Cyanide, Total	mg/1	<0.01	<0.01	<0.01	13	<0.01	<0.01	<0.01	10
Hardness, Dissolved	mg/1	137	73	105	3	105	50	75	11
Iron, Dissolved	mg/1	<0.1	0.02	0.06	14	<0.1	0.02	0.06	15
Iron, Total	mg/1	0.9	0.1	0.45	4	0.2	<0.1	0.12	4
Lead, Dissolved	mg/1	<0.003	<0.001	0.002	12	<0.003	<0.001	0.002	13
Manganese, Dissolved	mg/1	0.06	<0.01	0.02	11	<0.01	<0.01	<0.01	10
Mercury, Total	μg/1	<0.05	<0.05	<0.05	1	<0.05	<0.05	<0.05	3
Nitrogen, Ammonia	mg/1	<0.005	<0.005	<0.005	1	0.03	<0.005	0.015	5
Nitrogen, Kjeldahl	mg/1	0.14	<0.01	0.075		0.16	<0.01	0.06	4
Nitrogen, Nitrate & Nitrite	mg/1	0.10	0.05	0.075	2	0.13	<0.02	0.07	8
Nitrogen, Organic	mg/1					0.11	0.03	0.05	4
Nitrogen, Total	mg/1	0.24	0.05	0.14	2	0.27	0.06	0.12	8
Oxygen, Dissolved	mg/1	12.6	9.8	11.2	10	14.4	10.1	11.8	11
pH		8.3	7.3	7.9	19	8.4	6.5	7.9	22
Phosphorus, Dissolved	mg/1	0.004	<0.003	0.0035	2	<0.003	<0.003	<0.003	4
Phosphorus, Total	mg/1	0.16	0.02	0.09	2	0.01	0.004	0.006	4
Solids, Dissolved	mg/1	182	64	131	13	148	60	93	14
Solids, Suspended	mg/1	168	2	31	13	22	2	7	14
Solids, Total	mg/1	348	78	162	13	152	64	100	14
Sulphate, Dissolved	mg/1	61.1	13.2	35.4	11	36.6	6.5	15.1	10
Turbidity	J.T.U.	57	0.3	7.4	12	2.3	0.1	1.2	13
Zinc, Dissolved	mg/1	0.78	<0.005	0.41	14	0.3	<0.005	0.036	14
Zinc, Total	mg/1	0.52	0.23	0.40	3	0.006	<0.005	0.005	3

TABLE 6-15 (continued)

SUMMARY OF WATER QUALITY DATA FOR CARPENTER AND KANE CREEKS, OBTAINED BY THE POLLUTION CONTROL BRANCH

Site Number		69			
Site Description		Carpenter Cr. at the Mouth			
Sampling Period		April 72-Dec. 75			
Parameter / Type of Value		Max.	Min.	Mean	No. of Values
Alkalinity, Total	mg/1	94	49	77	16
Arsenic, Dissolved	mg/1	<0.005	<0.005	<0.005	2
Cadmium, Dissolved	mg/1	0.0028	0.0007	0.0017	9
Cadmium, Total	mg/1	0.0024	0.002	0.0022	2
Carbon, Organic	mg/1	4	<1	1.8	8
Color, True		5	<5	5	13
Copper, Dissolved	mg/1	0.005	<0.001	0.0016	13
Copper, Total	mg/1	0.001	<0.001	0.001	2
Cyanide, Total	mg/1	<0.01	<0.01	<0.01	13
Hardness, Dissolved	mg/1	130	58	95	11
Iron, Dissolved	mg/1	0.44	<0.04	0.09	15
Iron, Total	mg/1	3.0	<0.04	0.5	8
Lead, Dissolved	mg/1	<0.003	<0.001	0.002	13
Manganese, Dissolved	mg/1	0.01	<0.01	0.01	9
Mercury, Total	µg/1	<0.05	<0.05	<0.05	3
Nitrogen, Ammonia	mg/1	0.06	<0.005	0.027	5
Nitrogen, Kjeldahl	mg/1	0.08	<0.01	0.045	4
Nitrogen, Nitrite & Nitrate	mg/1	0.12	0.02	0.065	8
Nitrogen, Organic	mg/1	0.2	0.02	0.07	4
Nitrogen, Total	mg/1	0.35	0.04	0.14	8
Oxygen, Dissolved	mg/1	14.3	10.0	11.9	11
pH		8.7	7.3	8.0	22
Phosphorus, Dissolved	mg/1	0.004	<0.003	0.003	8
Phosphorus, Total	mg/1	0.069	0.004	0.018	8
Solids, Dissolved	mg/1	160	74	126	12
Solids, Suspended	mg/1	94	2	14	12
Solids, Total	mg/1	182	90	135	13
Sulphate, Dissolved	mg/1	38.6	12.0	25.0	13
Turbidity	J.T.U.	6.7	0.4	2.5	12
Zinc, Dissolved	mg/1	0.33	0.09	0.21	14
Zinc, Total	mg/1	0.26	0.14	0.21	3

TABLE 6-16

SUMMARY OF DATA FOR CARPENTER CREEK, FROM A SURVEY CARRIED OUT BY THE POLLUTION CONTROL BRANCH APRIL 1971 AND AUGUST 1971 (38)

Site Description		Carpenter Creek Upstream Kam Kotia Tailing Pond (Sandon Bridge) (71)				Carpenter Creek Immediately Downstream From Kam Kotia Tailing Pond			
Parameter / Type of Value		Max.	Min.	Mean	No. of Values	Max.	Min.	Mean	No. of Values
Alkalinity, Total	mg/1	69	52	61	6	61	54	56	3
Arsenic, Total	mg/1	0.001	N.D.		4				
Cadmium, Dissolved	mg/1	0.0015	0.0008	0.0011	6	0.017	0.0015	0.007	3
Chromium, Dissolved	mg/1	<0.001	<0.001	<0.001	3				
Copper, Dissolved	mg/1	<0.01	<0.01	<0.01	6	<0.01	<0.01	<0.01	3
Cyanide, Total	mg/1	N.D.	N.D.	N.D.	4	N.D.	N.D.	N.D.	3
Iron, Dissolved	mg/1	0.04	N.D.		4	0.04	0.04	0.04	1
Lead, Dissolved	mg/1	0.006	<0.003		6	0.004	<0.003		3
Manganese, Dissolved	mg/1	<0.01	<0.01	<0.01	6	<0.01	<0.01	<0.01	3
pH		8.2	7.6	7.9	6	8.0	7.1	7.5	3
Solids, Dissolved	mg/1	132	80	107	6				
Solids, Suspended	mg/1	7	5	6	6				
Solids, Total	mg/1	137	86	114	6				
Zinc, Dissolved	mg/1	0.35	0.13	0.24	6	3.5	0.25	1.58	3

Note: N.D. = Not Detectable

TABLE 6-16 (continued)

SUMMARY OF DATA FOR CARPENTER CREEK, FROM A SURVEY CARRIED OUT BY THE POLLUTION CONTROL BRANCH APRIL 1971 AND AUGUST 1971[38]

Site Description		Carpenter Creek Downstream From Kam Kotia Tailings Pond (70)				Kane Creek Near the Mouth			
Parameter / Type of Value		Max.	Min.	Mean	No. of Values	Max.	Min.	Mean	No. of Values
Alkalinity, Total	mg/1	81	64	74	7	86	46	66	6
Arsenic, Total	mg/1	0.002	N.D.		4	N.D.	N.D.	N.D.	4
Cadmium, Dissolved	mg/1	0.0033	0.0023	0.0028	6	0.006	0.0001	0.0016	5
Chromium, Dissolved	mg/1	<0.001	<0.001	<0.001	4	<0.001	<0.001	<0.001	3
Copper, Dissolved	mg/1	<0.01	<0.01	<0.01	7	0.02	<0.01		6
Cyanide, Total	mg/1	N.D.	N.D.	N.D.	6	N.D.	N.D.	N.D.	2
Iron, Dissolved	mg/1	0.28	N.D.		5	0.04	N.D.		4
Lead, Dissolved	mg/1	0.006	<0.003		7	0.005	<0.003		6
Manganese, Dissolved	mg/1	0.03	<0.01		7	0.01	<0.01		6
pH		8.6	7.7	8.1	7	8.4	7.8	8.1	6
Solids, Dissolved	mg/1	180	97	149	7	126	52	89	6
Solids, Suspended	mg/1	101	2	35	7	12	1	5	6
Solids, Total	mg/1	271	126	183	7	127	56	94	6
Zinc, Dissolved	mg/1	0.70	0.36	0.51	7	0.06	<0.005	0.02	6

TABLE 6-16 (continued)

SUMMARY OF DATA FOR CARPENTER CREEK, FROM A SURVEY CARRIED OUT BY THE POLLUTION CONTROL BRANCH APRIL 1971 AND AUGUST 1971[38]

Site Description		Carpenter Creek Near the Mouth			
Parameter / Type of Value		Max.	Min.	Mean	No. of Values
Alkalinity, Total	mg/l	97	62	79	6
Arsenic, Total	mg/l	N.D.	N.D.	N.D.	4
Cadmium, Dissolved	mg/l	0.0018	0.0011	0.0013	5
Chromium, Dissolved	mg/l	<0.001	<0.001	<0.001	3
Copper, Dissolved	mg/l	<0.01	<0.01	<0.01	6
Cyanide, Total	mg/l	N.D.	N.D.	N.D.	2
Iron, Dissolved	mg/l	0.04	N.D.		4
Lead, Dissolved	mg/l	<0.003	<0.003	<0.003	6
Manganese, Dissolved	mg/l	0.01	<0.01		6
pH		8.3	7.9	8.0	6
Solids, Dissolved	mg/l	174	50	118	4
Solids, Suspended	mg/l	57	5	24	4
Solids, Total	mg/l	211	76	138	6
Zinc, Dissolved	mg/l	0.29	0.16	0.22	6

TABLE 6-17

SUMMARY OF WATER QUALITY DATA FOR CARPENTER CREEK, OBTAINED BY KAM KOTIA MINES LTD.[38]

Site Description		Carpenter Creek, 300 Feet Upstream Mill				Carpenter Creek 1000 Feet Downstream Tailing Ponds			
Sampling Period		Nov. 71-Nov. 75				Nov. 71-Nov. 75			
Parameter / Type of Value		Max.	Min.	Mean	No. of Values	Max.	Min.	Mean	No. of Values
Copper, Dissolved	mg/l	0.022	<0.001	<0.006	20	0.024	<0.001	<0.008	20
Copper, Total	mg/l	0.072	<0.001	<0.014	20	0.09	<0.001	<0.015	20
Cyanide, Total	mg/l	<0.01	<0.004	<0.005	20	0.021	0.0017	<0.006	20
Lead, Dissolved	mg/l	<0.01	<0.001	<0.005	20	0.042	<0.001	<0.007	20
Lead, Total	mg/l	0.02	<0.001	<0.008	20	3.12	<0.001	<0.20	20
pH		7.9	6.8	7.4	20	8.0	6.55	7.4	20
Solids, Suspended	mg/l	15.9	0.1	1.8	20	8.3	0.2	2.1	20
Solids, Total	mg/l	344	93	149	20	350	60	159	20
Sulphate, Dissolved	mg/l	43.5	9.0	28.7	20	53.4	10.0	33.8	20
Zinc, Dissolved	mg/l	0.63	0.05	0.33	20	1.52	0.115	0.54	20
Zinc, Total	mg/l	1.42	0.075	0.45	20	2.39	0.125	0.67	20

TABLE 6-18

RECOMMENDED WATER SAMPLING FOR THE CARPENTER CREEK BASIN DURING PHASE II

Site Description and No. \ Parameter	Hardness, Total	Zinc, Dissolved	Cadmium, Dissolved	Flow
Carpenter Cr. u/s Sandon Cr. (198)	√	√	√	√
Sandon Cr. at the Mouth (197)	√	√	√	√
Sandon Cr. d/s White Cr.		√	√	√
White Cr. u/s Silversmith Mine		√	√	√
Sandon Cr. u/s Silversmith Mine D/S Richmond-Eureka Mine		√	√	√
Sandon Cr. u/s Richmond-Eureka & Slocan King Mines		√	√	√
Drainage from Silversmith, Richmond-Eureka & Slocan King Mines		√	√	√
Carpenter Cr. Just d/s Sandon Cr.		√	√	
Carpenter Cr. Midway Between Sandon & Site 71		√	√	
Carpenter Cr. at Sandon Bridge (71)	√	√	√	√
Carpenter Cr. u/s Tributary Cr. (150)		√	√	
Carpenter Cr. d/s Tributary Cr. u/s Tailing Pond		√	√	√
Carpenter Cr. at Mid-Point of u/s Tailing Pond		√	√	
Carpenter Cr. at End of Tailing Pond		√	√	
Carpenter Cr. 0.2 Mi. d/s Tailing Pond	√	√	√	
Tailing Pond Effluent Discharge		√	√	√
Carpenter Cr. d/s Miller Cr.		√	√	√
Unnamed Cr. from Washington Mine		√	√	√
Carpenter Cr. u/s Shea Cr. D/S Cr. from Washington Mine		√	√	
Shea Cr. at the Mouth		√	√	√
Drainage from Victor (Violamac) Mine		√	√	√
Carpenter Cr. d/s Victor Mine		√	√	√
Carpenter Cr. u/s Kane Cr.	√	√	√	√
Seaton Cr. at the Mouth	√	√	√	√
Kane Cr. at the Mouth		√	√	√
Carpenter Cr. d/s Kane Cr.		√	√	
Carpenter Cr. at the Mouth (69)		√	√	

TABLE 6-19

SUMMARY OF WATER QUALITY DATA FOR SLOCAN LAKE AND SLOCAN RIVER

OBTAINED BY THE POLLUTION CONTROL BRANCH

Site Number		68				67			
Site Description		Slocan Lake 1.5 Miles North of Carpenter Cr.				Slocan Lake 1 Mile South of Silvertown			
Sampling Period		May 71-June 75				April 72-July 75			
Parameter / Type of Value		Max.	Min.	Mean	No. of Values	Max.	Min.	Mean	No. of Values
Alkalinity, Total	mg/l	51	33	39	30	46	32	38	31
Carbon, Total Organic	mg/l	42	<1	3	30	3	<1	1.7	31
Color, True		10	<5	5.3	30	15	<5	5.3	30
Copper, Dissolved	mg/l	0.01	<0.001	0.002	30	0.017	<0.001	0.003	31
Depth, Extinction	ft.	65	6	33	8	62	6	33	11
Hardness, Total Dissolved	mg/l	49	39	44	30	49	36	43	31
Iron, Dissolved	mg/l	0.12	<0.02	0.06	30	0.12	<0.02	0.06	31
Iron, Total	mg/l	0.4	<0.02	0.10	30	0.26	<0.02	0.07	31
Lead, Dissolved	mg/l	0.012	<0.001	0.002	30	0.012	<0.001	0.002	31
Manganese, Dissolved	mg/l	<0.02	<0.01		30	<0.02	<0.01		30
Nitrogen, Ammonia	mg/l	0.05	0.005	0.014	28	0.11	<0.005	0.02	29
Nitrogen, Kjeldahl	mg/l	0.06	<0.01	0.027	3	0.05	<0.01	0.02	4
Nitrogen, Nitrate & Nitrite	mg/l	0.12	0.03	0.09	30	0.17	0.03	0.09	31
Nitrogen, Organic	mg/l	0.25	<0.01	0.04	28	0.25	<0.01	0.06	29
Nitrogen, Total	mg/l	0.34	0.07	0.14	28	0.37	0.07	0.16	29
Oxygen, Dissolved	mg/l	12.3	7.9	10.8	183	13.4	7.8	10.8	181
Oxygen, Dissolved, % Saturation		123	78	93	154	118	73	94	151
pH		7.9	6.9	7.5	38	8.1	6.9	7.5	41
Phosphorus, Dissolved Ortho Phosphate	mg/l	<0.003	<0.003	<0.003	30	0.005	<0.003	0.003	31
Phosphorus, Total	mg/l	0.005	<0.003	0.003	30	0.013	<0.003	0.004	31
Solids, Dissolved	mg/l	72	54	60	30	64	50	58	31
Solids, Suspended	mg/l	20	2	6	30	10	2	4	29
Solids, Total	mg/l	86	58	66	30	70	52	62	29
Turbidity	J.T.U.	1.0	0.2	0.5	24	0.95	<0.1	0.5	24
Zinc, Dissolved	mg/l	0.06	0.02	0.04	30	0.06	0.02	0.04	31

TABLE 6-19 (continued)

SUMMARY OF WATER QUALITY DATA FOR SLOCAN LAKE AND SLOCAN RIVER

OBTAINED BY THE POLLUTION CONTROL BRANCH

Site Number		66				10			
Site Description		Slocan River at Slocan				Slocan River at the Mouth (Shoreacres)			
Sampling Period		April 72-Sept. 75				April 72-Sept. 75			
Parameter / Type of Value		Max.	Min.	Mean	No. of Values	Max.	Min.	Mean	No. of Values
Alkalinity, Total	mg/1	43	30	36	16	47	25	35	15
Arsenic, Dissolved	mg/1	<0.005	<0.005	<0.005	4	<0.005	<0.005	<0.005	1
Cadmium, Dissolved	mg/1	<0.0005	<0.0005	<0.0005	3	<0.0005	<0.0005	<0.0005	6
Carbon, Total Organic	mg/1	4	<1	2.3	12	4	<1	2.4	15
Chromium, Dissolved	mg/1					<0.005	<0.005	<0.005	1
Coliforms, Fecal	MPN/ 100 ml	<2	<2	<2	1	23	<2	7	7
Color, True		5	<5	5	14	10	<5	5.3	15
Copper, Dissolved	mg/1	<0.01	<0.001	0.002	12	0.004	<0.001	0.002	6
Cyanide, Total	mg/1	<0.01	<0.01	<0.01	5	<0.01	<0.01	<0.01	4
Fluoride, Dissolved	mg/1					0.16	0.11	0.14	9
Hardness, Total Dissolved	mg/1	48	34	41	14	51	27	38	15
Iron, Dissolved	mg/1	<0.10	<0.02	0.06	14	<0.10	<0.10	<0.10	6
Iron, Total	mg/1	0.24	<0.02	0.08	12	0.35	<0.04	0.14	13
Lead, Dissolved	mg/1	0.004	<0.001	0.002	14	<0.001	<0.001	<0.001	6
Manganese, Dissolved	mg/1	<0.02	<0.01		10	<0.02	<0.01		12
Mercury, Total	μg/1	<0.05	<0.05	<0.05	3	<0.05	<0.05	<0.05	1
Nitrogen, Ammonia	mg/1	0.10	<0.005	0.03	12	0.01	<0.005	0.007	5
Nitrogen, Kjeldahl	mg/1	0.13	<0.01	0.06	4	0.10	<0.01	0.04	4
Nitrogen, Nitrate & Nitrite	mg/1	0.27	<0.02	0.09	14	0.11	<0.02	0.05	6
Nitrogen, Organic	mg/1	0.13	<0.01	0.05	12	0.10	<0.01	0.04	4
Nitrogen, Total	mg/1	0.37	0.02	0.15	16	0.14	0.03	0.07	4
Oxygen, Dissolved	mg/1	12.3	8.0	10.9	11	14.0	8.1	11.5	12
pH		8.4	7.1	7.7	17	8.2	6.9	7.6	18
Phosphorus, Dissolved Ortho Phosphate	mg/1	<0.003	<0.003	<0.003	14	<0.003	<0.003	<0.003	5
Phosphorus, Total	mg/1	0.035	<0.003	0.006	16	0.02	<0.003	0.007	8
Solids, Dissolved	mg/1	62	50	55	14	68	40	55	14
Solids, Suspended	mg/1	12	2	4	14	2	2	2	6
Solids, Total	mg/1	68	52	59	14	66	44	57	6
Turbidity	J.T.U.	1.4	0.2	0.5	12	2.5	0.4	1.0	12
Zinc, Dissolved	mg/1	0.05	0.02	0.03	14	0.023	0.007	0.015	6
Zinc, Total	mg/1	0.04	0.02	0.03	2	0.016	0.007	0.011	2

TABLE 6-20

SUMMARY OF PARAMETERS WHICH DO NOT AFFECT WATER QUALITY IN SLOCAN LAKE AND SLOCAN RIVER, OBTAINED BY THE POLLUTION CONTROL BRANCH AT SITES 10, 66, 67 AND 68

Parameter \ Type of Value		Range	Average
Calcium, Dissolved	mg/l	9 - 17	14
Chloride, Dissolved	mg/l	0.3 - 7	0.7
Conductance, Specific	μmho/cm	60 - 125	94
Magnesium, Dissolved	mg/l	1.1 - 2.3	2.0
Potassium, Dissolved	mg/l	0.3 - 0.9	0.6
Silica, Dissolved	mg/l	5.2 - 8.7	6.5
Sodium, Dissolved	mg/l	0.9 - 5.8	1.3
Sulphate, Dissolved	mg/l	5 - 14.5	9
Tannin & Lignin, Total	mg/l	<0.1 - 0.2	0.1
Temperature	°C	0 - 21	

TABLE 6-21

SUMMARY OF WATER QUALITY DATA FROM THE KOOTENAY RIVER,

OBTAINED BY THE POLLUTION CONTROL BRANCH

Site Number		11				178			
Site Description		Kootenay River at Taghum Bridge				Kootenay River at the Mouth (Brilliant)			
Sampling Period		April 72-Jan. 76				Feb. 74-Jan. 76			
Parameter / Type of Value		Max.	Min.	Mean	No. of Values	Max.	Min.	Mean	No. of Values
Alkalinity, Total	mg/l	71	50	61	24	69	45	60	11
Arsenic, Dissolved	mg/l	<0.005	<0.005	<0.005	3	0.007	<0.005	0.005	5
Cadmium, Dissolved	mg/l	<0.0005	<0.0005	<0.0005	4	<0.0005	<0.0005	<0.0005	5
Carbon, Total Organic	mg/l	6	<1	2.8	20	3	<1	1.8	6
Chromium, Dissolved	mg/l	<0.005	<0.005	<0.005	1	<0.005	<0.005	<0.005	1
Coliforms, Fecal	MPN/ 100ml	<20	<2		4	79	2	24	4
Color, True		10	<5	5.5	21	10	5	5.7	7
Copper, Dissolved	mg/l	0.002	<0.001	0.001	11	0.002	<0.001	0.001	5
Fluoride, Dissolved	mg/l	0.27	0.12	0.21	22	0.27	0.16	0.20	9
Hardness, Total Dissolved	mg/l	80	59	70	21	79	54	68	9
Iron, Dissolved	mg/l	<0.10	<0.04		13	<0.10	<0.10	<0.10	9
Iron, Total	mg/l	0.3	<0.04	0.1	19	0.10	<0.10	0.10	7
Lead, Dissolved	mg/l	0.002	<0.001	0.001	11	<0.001	<0.001	<0.001	7
Manganese, Dissolved	mg/l	0.02	<0.01	0.013	20	<0.02	<0.01	<0.02	5
Mercury, Total	µg/l	<0.05	<0.05	<0.05	1	<0.05	<0.05	<0.05	1
Nitrogen, Ammonia	mg/l	0.31	0.006	0.03	23	0.013	0.009	0.01	9
Nitrogen, Kjeldahl	mg/l	0.18	0.02	0.10	7	0.10	0.02	0.07	7
Nitrogen, Nitrates & Nitrite	mg/l	0.14	<0.02	0.06	23	0.13	<0.02	0.06	9
Nitrogen, Organic	mg/l	0.25	0.01	0.12	19	0.09	0.01	0.05	6
Nitrogen, Total	mg/l	0.45	0.06	0.19	23	0.20	0.04	0.12	9
Oxygen, Dissolved	mg/l	19.0	8.3	11.8	23	14.8	9.6	12.8	8
pH		8.8	7.0	8.0	30	8.4	7.7	8.0	15
Phenols, Total	mg/l					<0.002	<0.002	<0.002	1
Phosphorus, Dissolved Ortho Phosphate	mg/l	0.033	<0.003	0.01	20	0.024	<0.003	0.01	6
Phosphorus, Total	mg/l	0.042	0.005	0.02	28	0.029	0.003	0.016	10

TABLE 6-21 (continued)

SUMMARY OF WATER QUALITY DATA FROM THE KOOTENAY RIVER

OBTAINED BY THE POLLUTION CONTROL BRANCH

Site Number		11				178			
Site Description		Kootenay River at Taghum Bridge				Kootenay River at the Mouth (Brilliant)			
Sampling Period		April 72-Jan. 76				Feb. 74-Jan. 76			
Parameter / Type of Value		Max.	Min.	Mean	No. of Values	Max.	Min.	Mean	No. of Values
Solids, Dissolved	mg/1	102	72	87	24	98	70	85	6
Solids, Suspended	mg/1	14	2	4	24	4	1	2	8
Solids, Total	mg/1	112	74	92	24	100	72	88	9
Tannin & Lignin, Total	mg/1	0.1	<0.1	0.1	9	0.2	<0.10	0.13	7
Turbidity	J.T.U.	1.9	0.4	0.9	22	1.5	0.5	0.9	8
Zinc, Dissolved	mg/1	0.007	<0.005	0.006	4	0.005	<0.005	0.005	5
Zinc, Total	mg/1	0.008	<0.005	0.006	4	<0.005	<0.005	<0.005	4

TABLE 6-22

SUMMARY OF PARAMETERS WHICH DO NOT AFFECT WATER QUALITY IN THE KOOTENAY RIVER, OBTAINED BY THE POLLUTION CONTROL BRANCH AT SITES 11 AND 178

Parameter \ Type of Value		Range	Average
Calcium, Dissolved	mg/l	16 - 23	20
Chloride, Dissolved	mg/l	0.6 - 3.2	1.0
Conductance, Specific	μmho/cm	90 - 195	140
Boron, Dissolved	mg/l	<0.10 - 0.4	<0.10
Magnesium, Dissolved	mg/l	3.0 - 5.4	4.3
Potassium, Dissolved	mg/l	0.5 - 1.1	0.6
Silica, Dissolved	mg/l	2.2 - 4.7	3.4
Sodium, Dissolved	mg/l	1.3 - 3.0	1.6
Sulphate, Dissolved	mg/l	8.5 - 14.5	11.5
Temperature	°C	3 - 20	

TABLE 6-23

MEAN NUMBER OF TOTAL COLIFORM ORGANISMS FOR EACH QUARTER DURING 1971-72 AND 1974-75, OBTAINED BY THE HEALTH BRANCH[47]

Sampling Period / Site	1971-72					1974-75				
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1st to 4th Quarter	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1st to 4th Quarter
Kootenay River at Taghum Bridge	224	41	188	1408	115	3	5	5	15	5
Kootenay River at Brilliant Bridge	326	206	227	305	270	14	5	45	57	13

Note: Values expressed as harmonic mean in MPN/100 ml.

TABLE 6-24

SUMMARY OF DISSOLVED GAS MEASUREMENTS IN THE KOOTENAY AND SLOCAN RIVERS IN REGION 6, 1972-75[48]

(Values expressed as percent saturation)

Site Description \ Sampling Date	1972							1973	
	11/6	12/6	22/6	26/7	25/8	13/9	25/9	14/6	21/8
Kootenay River:									
Taghum Bridge		104.6		106.8				107.6 107.3	104.0
d/s South Slocan Dam				115.6	117.7		114.5	120.7	122.5
u/s Brilliant Dam	131.2				112.8 116.0	112.2 108.3			
d/s Brilliant Dam	132.5		132.9	115.3	115.7	115.3		122.1	120.1
Slocan River:									
At the Mouth					103.5		100.6		

Site Description \ Sampling Date	1974				1975		
	17/6	19/6	4/7	24/10	10/6	11/6	27/7
Kootenay River:							
Taghum Bridge	110.8	103.3	100.3	100.6 100.6			
1.3 Mi. d/s Taghum Bridge						110.3	111.3
300 m d/s Corra Linn Dam	106.0			110.0			
350 m u/s Upper Bonnington						116.6	
d/s Upper Bonnington	121.0	114.8			128.1	128.4	
d/s Lower Bonnington	119.1				132.8		111.7
d/s South Slocan Dam	117.5	118.9	99.7	113.8	128.4		
u/s Brilliant Dam	120.7	117.7 114.7		113.1	127.5		
d/s Brilliant Dam	119.7	119.3	100.4	112.3	132.1		114.2
Slocan River:							
At the Mouth		100.2			102.9		

TABLE 6-25

HEAVY METALS IN FISH TISSUE AND SEDIMENTS FROM SLOCAN LAKE

Agency	Type of Sample	Sampling Date	Location	No. of Samples	Metal Content - mg/1 Wet Weight As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Zn
Fish and Wildlife Branch(56)	Rainbow Trout Muscle	March 1971	Slocan Lake	2		<0.2		0.2		<0.2		0.03		4
	Rainbow Trout Liver					2.0		23		<0.5		0.03		38
Ministry of Mines and Petroleum Resources (57)	Sediment	April 6, 1971	Control, 800 ft. off Nemo Cr., Depth 280 ft.	1	23	22	52	8	2,800	400	810		33	1,500
			300 ft. off Carpenter Cr., Depth 50 ft.	1	16	5	26	23	18,300	50	760		17	600
			300 ft. off Semiahmoo Enterprises, Depth 80 ft.	1	810	80	36	175	33,200	3,200	3,300		17	13,300
			75 ft. off Red Deer Valley Coal, Depth 50 ft.	1	738	235	90	413	42,000	14,600	3,500		59	13,200
Fish and Wildlife Branch(58)	Rainbow Trout Liver		5 Lakes in Kootenay Region					15-92 Av.54		0.3-0.6 Av. 0.45				19-32 Av. 25
	Rainbow Trout Liver		5 Lakes in Northern B.C.									0.3-1.15 Av. 0.6		
	Rainbow Trout Muscle											0.05-0.21 Av. 0.13		