

FEDERAL PROVINCIAL FLOODPLAIN MAPPING AGREEMENT

A DESIGN BRIEF ON THE  
FLOODPLAIN MAPPING STUDY

CHRISTINA LAKE

An Overview of the Studies Undertaken to  
Produce Floodplain Mapping for Christina Lake

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## FEDERAL PROVINCIAL FLOODPLAIN MAPPING AGREEMENT

### FLOODPLAIN MAPPING STUDY

#### CHRISTINA LAKE

##### Preface

The purpose of this design brief is to present a description of the methodologies used and the results of the study undertaken to delineate the floodplain of Christina Lake, as shown on Drawing 89-1, Sheets 1 to 5, (Appendix 3).

##### 1. Location

Figure 1 is a location plan of the study area. Christina Lake is situated on the east side of the Christina Range of the Monashee Mountains in south central British Columbia. The community of Christina Lake is located at the south-east end of the Lake, 5 km north of the Canada-U.S. border and approximately 20 km east of Grand Forks via Highway 3.

The community was originally the site of three individual settlements (Christina, Cascade and Fife) along the Dewdney Trail. The area was host to a combination of mining and forestry related activities in the late 1800's. The coming of the railroad in 1896 and highway construction resulted in the communities blending into one central business section served by one post office.

Christina Lake has become established as a recreation and retirement community and is the site of one of the few large warm water lakes between the Okanagan Valley and Kootenay Lake in southern British Columbia. Road access is limited to the southern half of the lake which is the predominately developed area. Private lots exist on the north half of the lake where access is by boat. (Appendix 1.1) Figure 2 is a key map indicating the location of the five floodplain mapping sheets for the study area.

##### 2. Background

###### 2.1 General

A report by the Planning Department of the Regional District of Kootenay Boundary (Appendix 1.1) provides information concerning land use in the Christina Lake drainage area. Topics covered in the report include access, wildlife, water supply, recreation, forestry, mining and residential development.

The drainage area of Christina Lake above the Water Survey of Canada Gauge 08NN014 is 492 sq. km. The gauge is located on Christina Creek near the lake outlet, as shown on Sheet 5, Dwg. 89-1. Major tributaries to the lake include Sutherland, McRae, Texas and Sandner Creeks.

Maximum lake levels occur in the April to June period due to snowmelt conditions. The maximum recorded daily lake level of 446.8 metres (G.S.C. datum) occurred on May 29, 1948.

A 1:200 year flood level (freeboard included) of 448.2 metres was adopted by the Ministry in April of 1975. This level has been used for administrative purposes by the Ministry with respect to subdivision approvals under Section 82.1 of the Land Title Act. The flood level of 448.2 metres has also been used in the Regional District of Kootenay Boundary, Electoral Area C, Zoning Bylaw No. 164, Section 407 adopted on July 27, 1978.

## 2.2 Present Studies

The Maps Production Division, Surveys and Resource Mapping Branch of the British Columbia Ministry of Environment produced 2 metre contour, 1:5000 scale mapping of Christina Lake as part of the Provincial Large Scale Mapping Program in 1986 (Appendix 1.2).

The base mapping, along with updated hydrology studies to review the 1:200 year flood level (freeboard included) was utilized to produce the floodplain mapping for Christina Lake. (Dwg. 89-1, Sheets 1 to 5, Appendix 3.)

## 3. Frequency Analysis

### 3.1 Christina Lake Levels

Christina Lake water levels were based on the Water Survey of Canada Gauge 08NN014, Christina Creek at outlet of Christina Lake. (See Photo 1, Appendix 2.)

Levels at Gauge 08NN014 are considered to accurately represent the high water lake level for the purpose of this study. An observer in the Nelson Branch of Water Survey of Canada estimates a water level difference of about 0.003 metres from the lake outlet to the gauge. The difference varies depending on the stage of the Kettle River and, under some conditions reverse flow can apparently occur (Appendix 1.3). Staff of the Special Projects Section measured a water level increase of 0.027 metres between the gauge (445.895 metres) and the lake outlet on May 18, 1989. (See Photo 2, Appendix 2.)

The peak annual daily water levels published in "Historical Water Levels Summary, British Columbia to 1987" by Water Survey of Canada is continuous for Gauge 08NN014 from 1945 to 1979 (except for a gap between 1946-47).

Peak annual lake level estimates were based on a frequency analysis using the program FREQAN. The 1:200 year lake levels for the 33 year period were determined for the distributions shown on Table 1 (See Columns 1 and 2).

The 1:200 year lake level varies from 446.9 to 447.6 depending on the distribution method used. As noted in Section 2.1, the 1:200 year flood level adapted in 1975 was 448.2 metres (447.6 metres without freeboard).

### 3.2 Kettle River Flows

Water Survey of Canada Gauge (08NN012), Kettle River near Laurier, has been in operation since 1930. The gauge, located on the Kettle River 3.5 km. south of the Christina Creek confluence near the international border, has a 9,840 sq. km. drainage area. The maximum recorded daily discharge of 968 cms. occurred on May 29, 1948, the same date as the Christina Lake maximum daily level was recorded (Table 2).

The computer program FREQAN was used to perform a frequency analysis of the Kettle River annual daily peak flows for the 59 year period from 1930 to 1988. Results of the analysis are summarized on Table 1, Column 3. Flow for a 1:200 year return period varied between 874 and 1261 cms. depending on the distribution method used in the analysis.

### 3.3 Kettle River Flows and Christina Lake Levels

In view of the reported reverse flow incidents along Christina Creek which connects Christina Lake to the Kettle River (Section 3.1), the relationship between Kettle River flows and Christina Lake levels was investigated.

Table 2 is a listing of annual daily extremes for the Kettle River discharge and the Christina Lake level for 33 years of records during which both gauges were in operation. During this 33 year period, the annual daily extremes for the Kettle River and Christina Lake have occurred on the same day, or within one day, on 18 occasions.

Figure 3 shows the relationship between Christina Lake levels and Kettle River flows for the period April 15 to June 25, 1948. Figure 4 is a plot of the annual daily extremes of the Kettle River flows versus Christina Lake levels for the 18 years where the peaks coincided. The data has been extended based on a best fit straight line extension of the existing data as indicated.

Utilizing the relationship between the Kettle River flows and Christina Lake levels shown in Figure 4, the corresponding lake level for the 1:200 year flows discussed in Section 3.2 was obtained. The resulting lake levels are shown in Table 1, Column 4.

A comparison of Column 2 with Column 4 on Table 1 indicates that the 1:200 year lake levels for the equivalent distribution method used average to within 0.17 metres. The maximum difference (Log Person Type III) amounts to 0.36 metres. The highest estimated 1:200 year lake level of 447.6 metres results from the Gumbel distribution.

#### 4.0 Christina Lake Flood Level

The 1:200 year flood level for Christina Lake, based on an analysis of the available lake level data has been estimated to vary between a low of 446.9 metres to a high of 447.6 metres depending on the distribution method used (Table 1, Column 2). The maximum recorded flood level (1948) is 446.8 metres.

A wave and wind set up study was undertaken by the Special Projects Section (Appendix 1.4) to determine the meteorological effects on lake level elevations. The study utilized available bathymetric information (Appendix 1.5). Estimates of wind set up indicates the effect of setup to be less than 0.1 metres. Wave run up will not cause an increase in stillwater levels and can be minimized by appropriate building setbacks from the natural boundary of the lake. Maximum summer waves would not exceed a significant height of about 0.5 metres, based on a sustained wind speed of 50 km. per hour.

Based on the above-noted information, it is recommended that the previously adopted designated flood level of 448.2 metres (freeboard included) as discussed in Section 2.1 be retained for administrative purposes.

### 5. Floodplain Mapping

#### 5.1 General

The designated flood level determined in the study was used to delineate the floodplain limits onto the existing 2 metre contour mapping of the study area. The floodplain mapping for Christina Lake, Dwg. 89-1, Sheets 1-5, indicates the floodplain limits and the flood level determined in the study.

### 5.2 Tributary Alluvial Fans

Several of the tributary alluvial fans in the study area are known to be active based on information on flooding problems related to sediment deposition, channel avulsion and/or bank erosion.

Following is a list of fans noted on the mapping sheets which are known to be active. The limits of these fans have not been delineated due to a lack of detailed topography or limited background study information. These are:

Texas Creek	Sheet 3, Dwg. 89-1
McRae Creek	Sheet 3, Dwg. 89-1
Sutherland Creek	Sheet 5, Dwg. 89-1

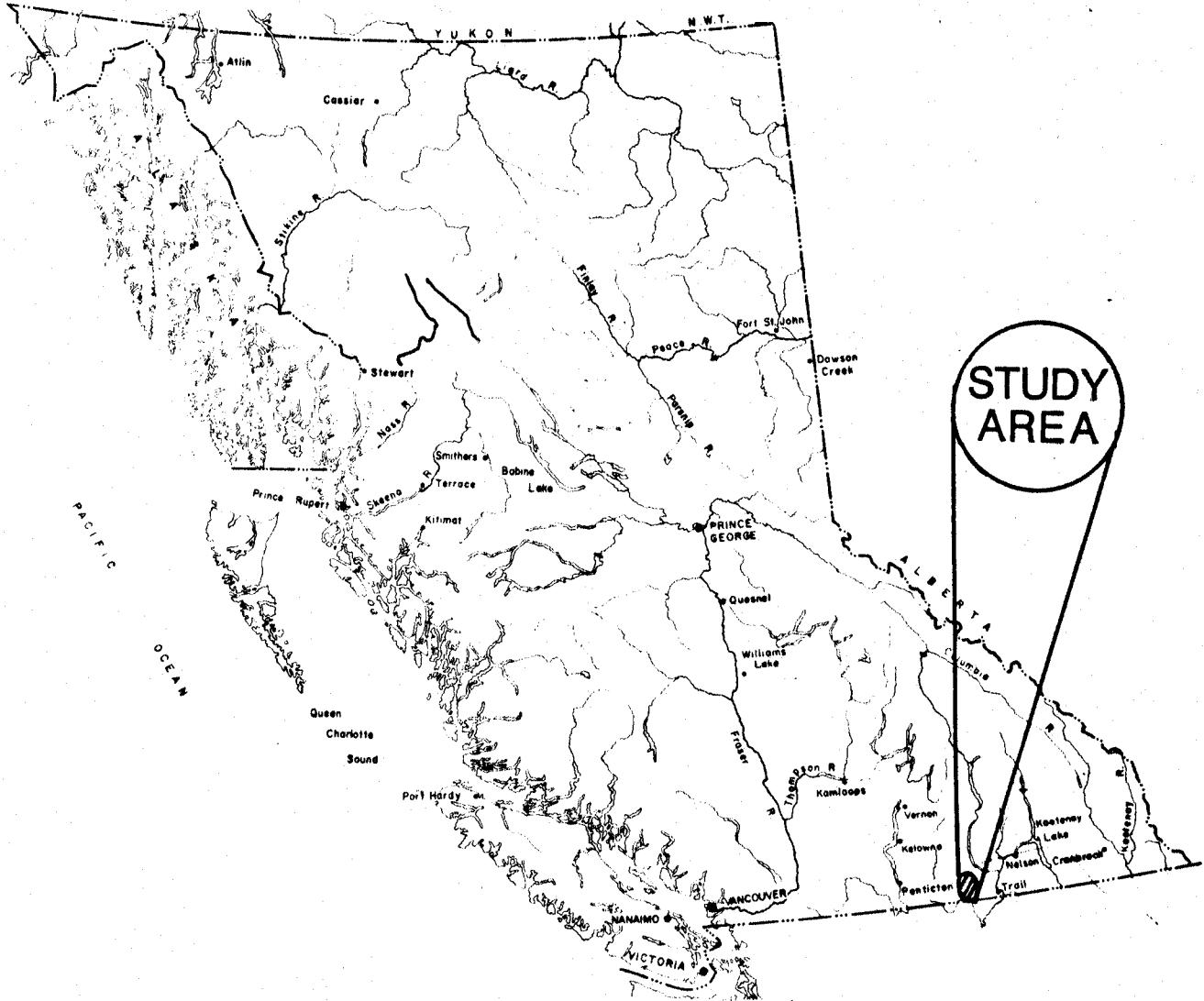
### 6. Recommendations

1. Pursuant to the terms of the Federal Provincial Floodplain Mapping Agreement, it is recommended that the floodplain delineated on Dwg. 89-1, Sheets 1 to 5 be interim designated.
2. The floodplain mapping may be used for administrative purposes related to the preparation of hazard map schedules for official plans; floodproofing requirements in zoning and building bylaws; and the identification of floodable lands by Subdivision Approving Officers.



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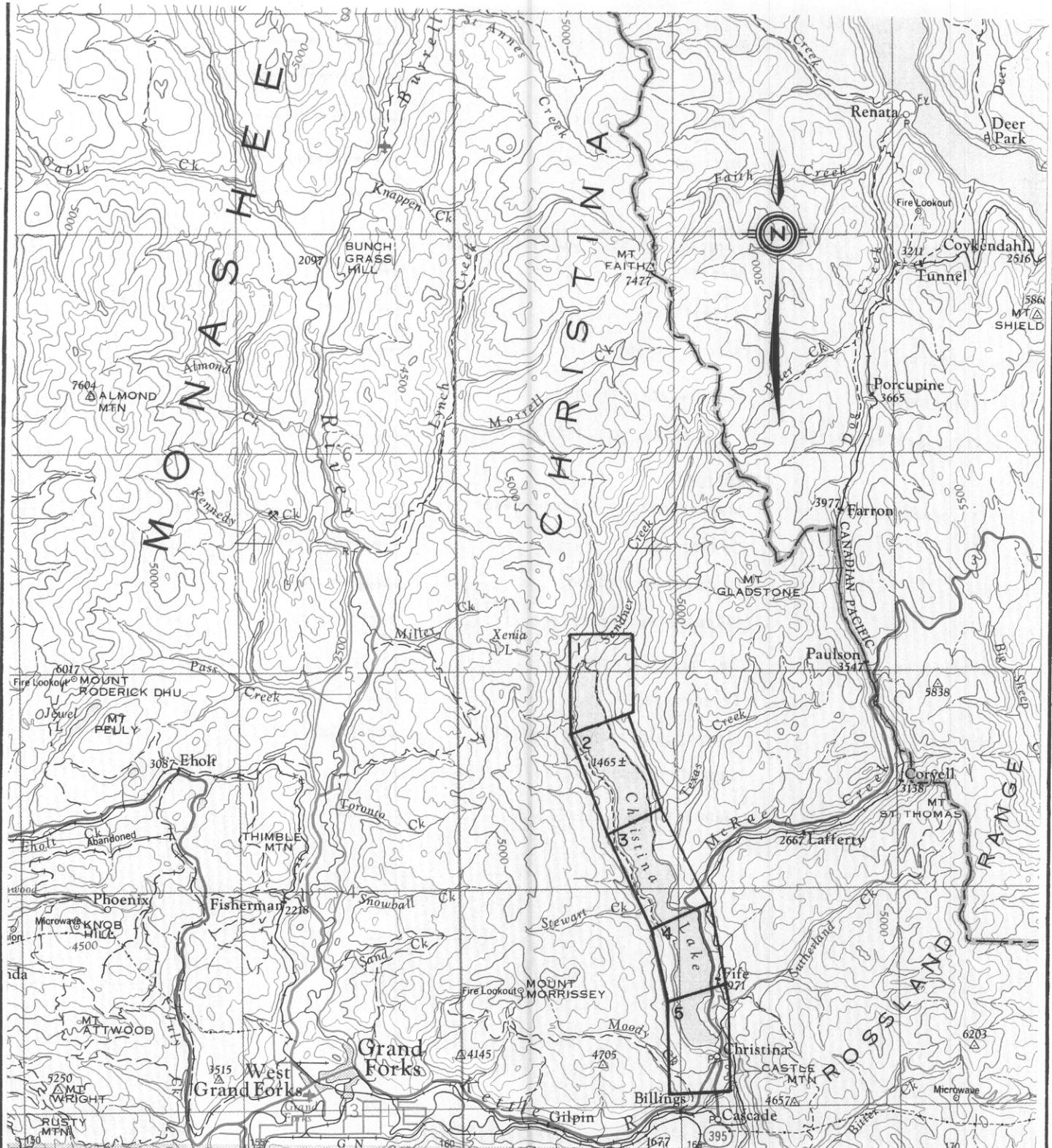
100 0 100 200 300 400 km

SCALE IN KILOMETRES



**Province of British Columbia**  
Ministry of Environment  
WATER MANAGEMENT BRANCH

TO ACCOMPANY A DESIGN BRIEF ON THE  
FLOODPLAIN MAPPING STUDY  
**CHRISTINA LAKE**  
**STUDY AREA LOCATION**



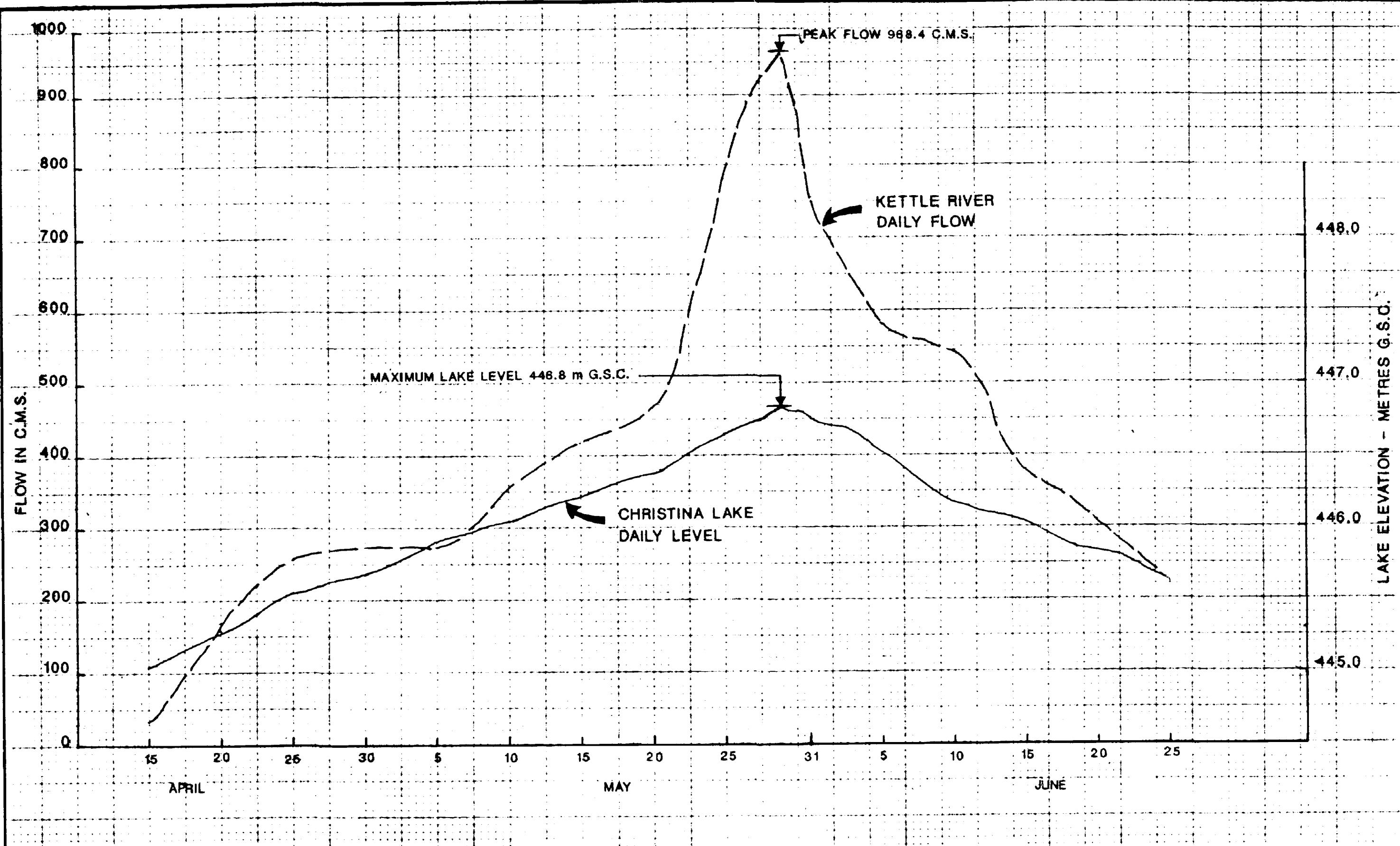
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SCALE IN KILOMETRES



**Province of British Columbia**  
Ministry of Environment  
WATER MANAGEMENT BRANCH

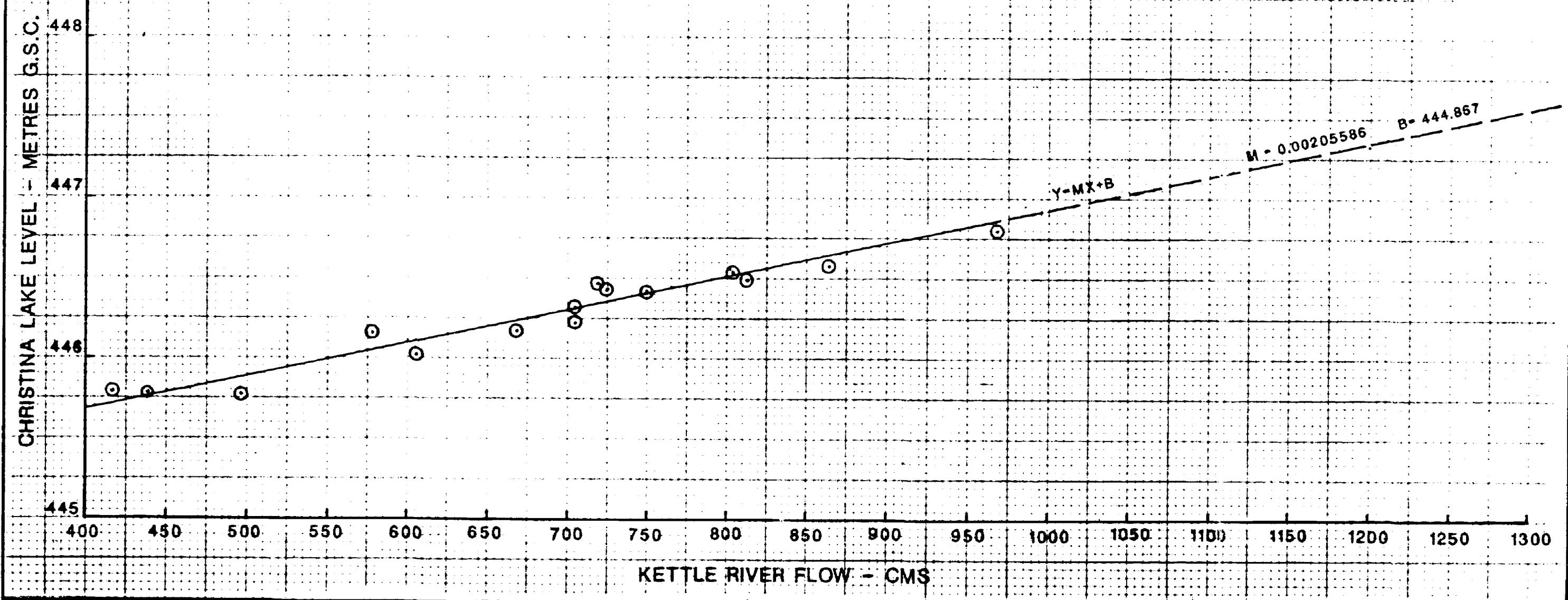
TO ACCOMPANY A DESIGN BRIEF ON THE  
FLOODPLAIN MAPPING STUDY  
**CHRISTINA LAKE**  
KEY MAP



Province of British Columbia  
Ministry of Environment  
WATER MANAGEMENT BRANCH

TO ACCOMPANY A DESIGN BRIEF ON THE  
FLOODPLAIN MAPPING STUDY  
CHRISTINA LAKE  
CHRISTINA LAKE LEVELS AND KETTLE RIVER FLOWS  
APRIL 15 TO JUNE 25, 1948

SCALE: VERT.	DATE
HOR.	APRIL, 1990
R.W. NICHOLS ENGINEER	
FILE No. 32-0300-8	DWG No. FIGURE 3



 Province of British Columbia Ministry of Environment WATER MANAGEMENT BRANCH	TO ACCOMPANY A DESIGN BRIEF ON THE FLOODPLAIN MAPPING STUDY <b>CHRISTINA LAKE</b> ANNUAL COINCIDENT DAILY EXTREMES CHRISTINA LAKE LEVELS v.s. KETTLE RIVER FLOWS	SCALE: VERT.	DATE
		HOR.	APRIL, 1980
	R.W. NICHOLS ENGINEER	FILE NO. 32-0300-S	FIGURE 4
		DWG NO.	B

TABLE 1  
FREQUENCY ANALYSIS SUMMARY

(1) DISTRIBUTION	(2) 1:200 YEAR DAILY (i) CHRISTINA LAKE LEVEL (metres)	(3) 1:200 YEAR DAILY (ii) KETTLE RIVER DISCHARGE (cms)	(4) EQUIVALENT(iii) LAKE LEVEL (SEE FIGURE 4) (metres)
Gumbel	447.57	1261	447.46 (iv)
Pearson Type III	446.97	953	446.83
Log Pearson Type III	447.02	874	446.66
Log Normal	446.94	952	446.82

(i) 33 years of data, Gauge 08NN014

(ii) 59 years of data, Gauge 08NN012

(iii) Equivalent lake level based on frequency analysis of the Kettle River gauge.

(iv) 1:200 year level adopted in April 1975 = 447.6 (free board excluded)

TABLE 2

ANNUAL DAILY MAXIMUMS  
KETTLE RIVER FLOWS AND CHRISTINA LAKE LEVELS

Kettle River Gauge 08NN012			Christina Lake Gauge 08NN014	
Year	Flows (cms)	Date	Lake Level (metres)	Date
1945	614	June 1	446.304	
1948	968 *	May 29	446.804 *	
1949	705 #	May 14	446.222 #	
1950	556	June 15	445.938	
1951	725 #	May 13	446.438 #	
1952	682	May 20	446.572	
1953	578 #	June 14	446.158 #	
1954	750 #	May 20	446.420 #	
1955	668 #	June 14	446.164 #	
1956	858 #	May 21	446.578 #	
1957	705 #	May 21	446.328 #	
1958	614	May 21	446.292	
1959	595	June 4	446.307	
1960	521	May 13	446.081	
1961	719 #	May 28	446.478 #	
1962	439 #	May 29	445.783 #	
1963	496 #	May 25	445.777 #	
1964	606 #	June 7	446.014 #	
1965	493	May 30	446.072	
1966	385	May 10	445.667	
1967	640 #	June 4	446.188 #	
1968	589 #	June 3	445.905 #	
1969	722 #	May 13	446.712 #	
1970	416 #	May 27	445.798 #	
1971	804 #	May 14	446.535 #	
1972	813 #	June 1	446.493 #	
1973	493	May 18	445.962	
1974	719	June 16	446.596	
1975	617	June 3	446.343	
1976	634	May 11	446.444	
1977	439	May 4	445.712	
1978	515	June 6	446.234	
1979	481	May 6	445.911	

\* = Maximum recorded during period of record

# = Coincident annual peaks occur within 1 day

## APPENDIX 1

### DETAILED INFORMATION SOURCES

<u>Source</u>	<u>Contents</u>
1) "Christina Lake Study" Planning Department Regional District of Kootenay Boundary, 1975	Study of Christina Lake Watershed and surrounding area regarding future land use developments.
2) Map Production Division, Surveys and Resource Mapping Branch, Project No. 86-017.	1:5000 scale, 2 metre contour mapping of the study area based on 1986 air photography.
3) Christina Lake Peak Water Water Levels" - Hydrology Section, Water Management Branch File S2105, Study 296, June 23, 1989.	Hydrology Study to determine 1:200 year lake levels.
4) "Christina Lake Wind and Wave Setup", File: 32-0300-S dated February 14, 1990.	Ministry of Environment, Special Studies Section, an investigation of the potential for wind and wave setup on Christina Lake by B.J. Holden, P. Eng.
5) "Christina Lake" Dwg. No. 83 E1/-W, Sheets 1-3, dated September 27, 1979.	Ministry of Environment, Fish and Wildlife Branch, Inventory Section, Bathymetric Drawings of Christina Lake.

Photos - Christina Lake Area

May, 1989

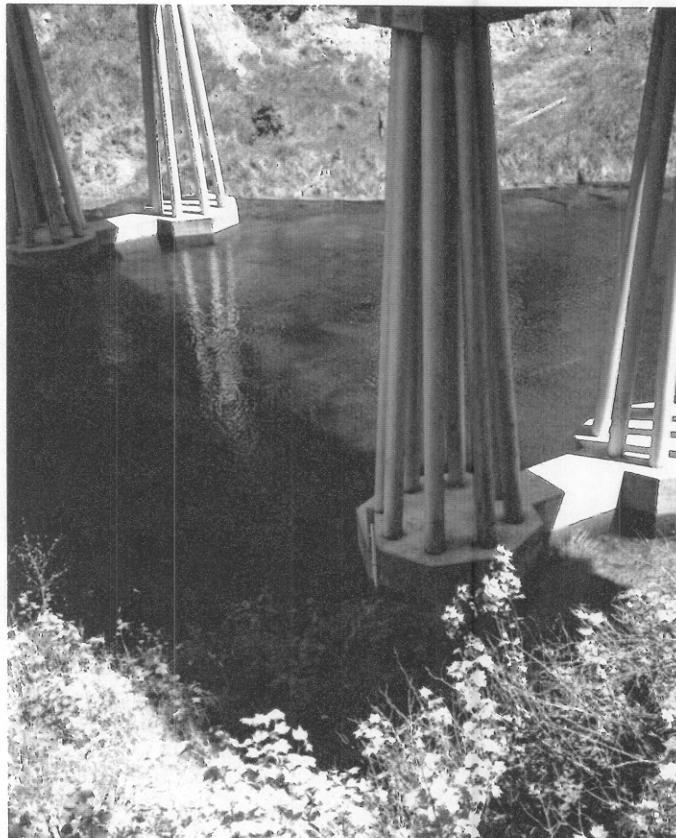


PHOTO 1

Gauge 08NN014 on Christina Creek near outlet of lake (at Hwy 3 Bridge, Sheet 5, Dwg. 89-1).



PHOTO 2

Looking upstream on Christina Creek from Hwy 3 Bridge looking towards Christina Lake. (Sheet 5, Dwg. 89-1).

APPENDIX 2

Sheet 2 of 2

Photos - Christina Lake Area

May, 1989

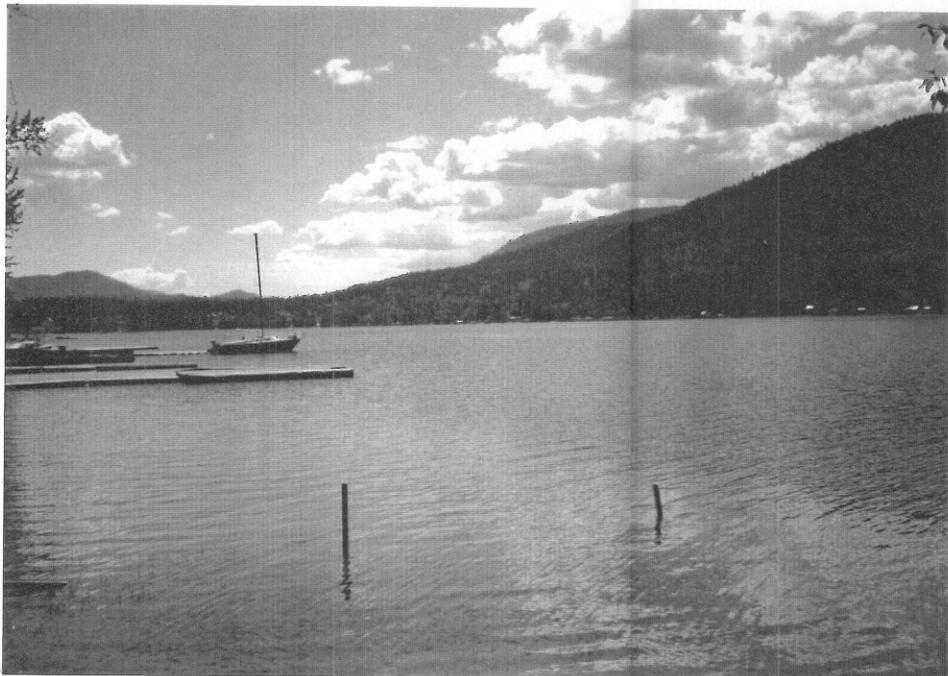


PHOTO 3

View looking towards south end of Christina Lake from Lavalle Point (Sheet 5, Dwg. 89-1).



PHOTO 4

View looking downstream along Texas Creek near lake confluence (Sheet 3, Dwg. 89-1).