CANADA/BRITISH COLUMBIA FLOODPLAIN MAPPING AGREEMENT

Ministry of Environment, Lands and Parks
Hydrology Branch

A Design Brief on the Floodplain Mapping Project for the Chilako River

An Overview of the Study Undertaken
to produce Floodplain Mapping for
the Chilako River
near Prince George, B.C.

Floodplain Mapping Section
Victoria, British Columbia
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Preface

The purpose of this design brief is to present a description of the methodologies used and results of the study undertaken to delineate the floodplain of Chilako River near Prince George, Drawing 93-1, Sheets 1 to 3 ***(Appendix 4).***

1. Background

The Chilako River was identified as a potential floodplain mapping project area following the 1987 signing of the Canada-British Columbia Agreement Respecting Floodplain Mapping. Preparation of topographic base mapping was commenced in 1990. River surveys were conducted in 1993. The study area lies within the jurisdiction of the Regional Water Manager in Prince George.

Severe rainfall events occurred throughout the Cariboo region during June of 1990 and again in June of 1993 resulting in major flood damages on many watercourses in the area. Severe erosion occurred at many locations throughout the region during both of the events. Significant damage to roads, bridges and stream banks, estimated to exceed $1,000,000, were experienced ***(Appendix 1.10).***

The Chilako River study area lies approximately 20 kilometres south west of City of Prince George along the Yellowhead Highway 16 and is within the Fraser - Fort George Regional District. To date, little development has taken place within the floodplain, the current usage being primarily agriculturally related. Nearby Prince George, considered the hub of northern BC activities, has experienced a steady population growth over the years and has now become a mature dynamic city. As experienced in other areas, the lure of a peaceful rural atmosphere just minutes away from the city, becomes irresistible with ensuing development inevitable. There is evidence that subdivisions are already taking place in the study area.

2. Location

The study area is located about 15 kilometres west of Prince George and encompasses approximately a 12 kilometre reach of the Chilako River, beginning at the confluence with the Nechako River adjacent to the Salaquo Indian Reserve #4. The Chilako River is known locally as "Mud River". The reach of the study area below Highway 16 is accessed by Lower Mud River Road with the reach upstream of Highway 16 accessed by Upper Mud River Road. Also included in the study is a short reach of Beaverley Creek

from its juncture with the Chilako River in the vicinity of cross sections 31 and 32 upstream to Highway 16, a distance of about 2 kilometres ***(Drawing 91-3, Sheet3).*** The floodplain for the Nechako River was not determined in this study.

Figure 1 is a location plan of the study area. ***Figure 2*** is a key map at a scale of 1:250,000 showing the locations of the three floodplain mapsheets for the study area.

3. Drainage Basin

3.1 Description

The Chilako River begins its easterly flow originating as Finger Creek where it flows into Finger Lake then into Tatuk Lake draining the Nulki Hills and Tatuk Hills near the eastern slopes of the Nechako Range ***(Figure 3)***. Maximum elevation in this portion of the watershed is approximately 1370 metres. The Chilako River then flows through the Nechako Plateau draining portions of the Telegraph Range to the South and Bobtail Mountain, having an elevation of 1427m, to the North. It then continues in a south easterly direction until it meets the settlement of Punchaw where it swings to the North. From there it flows in a generally northerly direction through the Nechako Plain, draining the eastern slopes of Bobtail Mountain and the western slopes of Mt. Baldy Hughes (elevation 1117m) until it meets the Nechako River (elevation 592m) about 35km upstream of its confluence with the Fraser River.

The Chilako River travels in a tortuous route within the study area, flowing a channel distance of over 25 km as compared to it's "as the crow flies" distance of about 12 km. As evidenced on the mapping, especially on sheets 2 and 3 ***(Appendix 4),*** the many ox bows and meander loops are indicators of a long history of past and present channel avulsions. ***Figure 3*** identifies the boundaries of the Chilako River watershed and the locations of the Water Survey of Canada Gauge 08NJ005, Nazko snowcourse, and some of the climatological stations used in the study.

A review of the Geological Survey of Canada - Surficial Geology map 1288 ***(Appendix 1.8)*** and Soils Maps of the Nechako area indicates that below an average elevation of 2500 ft. (762m), the Chilako watershed is composed of lacustrine deposits. The floodplain within the study area was created by a glacial outwash and soil material consists of an alluvial silty loam classified as "Fraser Silt Loam". Upland of the floodplain these deposits are bounded by "Pineview" clays in the Nechako Plain area and "Chilako" stony sandy loams on the Nechako Plateau. Drainage is considered to be moderate to poor ***(Appendix 1.9)***.

3.2 Climatic Characteristics

There are five climate stations operated by Atmospheric Environment Services ***(Appendix 1.7)***, located in the general vicinity of the study area. These are located near Prince George, Hixon, Fort Fraser, Fraser Lake and Quesnel. All stations but Fort Fraser provide both temperature and precipitation data. Periods of record vary between stations. ***Table 1*** below, indicates the daily mean and extreme temperatures and extreme daily, monthly and annual precipitation figures for each of the stations.

TABLE 1 - Climatic Characteristics

	TEMPERATURE (°C)					PRECIPITATION			
STATION	MEAN			EXTREME (MAXIMUM)		RAINFALL MONTHLY	RAINFALL MONTHLY	RAINFALL EXTREME	MEAN ANNUAL
STATION (PERIOD OF RECORD)	JANUARY	MAY	JUNE	MAY	JUNE	MEAN MAY	MEAN JUNE	DAILY/DATE	SNOWFALL/ RAINFALL
PRINCE GEORGE (1942 - 1990)	-9.9	9.4	13.1	36.0	33.9	49.2 mm	64.5 mm.	(24.9mm 1984/05/13) 38.9 mm (1960/06/06) 29.4 mm (1972/06/10) 21.0 mm (1972/06/11)	233.8 cm snow 415.2 mm rain 614.7 mm total
HIXON (1970 - 1990)	-8.2	10.3	13.8	37.5	34.0	41.0 mm	65.0 mm	30.0 mm (1972/06/11)	212.0 cm snow 410.8 mm rain 622.9 mm total
FORT FRASER (1970 - 1990)	N/A	N/A	N/A	N/A	N/A	37.7 mm	54.5 mm	24.4 mm (1984/05/13) 28.7 mm (1972/06/11)	197.8 cm snow 330.2 mm rain 527.9 mm total
FRASER LAKE (1969 - 1990)	-11.3	8.7	12.1	32.5	31.0	34.6 mm	52.6 mm	22.6 mm 1989/05/17 30.7 mm (1972/06/11)	190.2 cm snow 313.3 mm rain 503.6 mm total
QUESNEL A (1946 - 1990)	-9.1	10.5	14.2	36.5	35.6	42.0 mm	56.7 mm	55.1 mm. (1955/06/25) 22.9 mm (1972/06/11)	189.4 cm snow 377.2 mm rain 538.5 mm total

As can been seen in the table, climatic conditions are generally similar in the areas bounding the Chilako watershed and thus the data is considered applicable. Intense rainstorms and extreme temperatures can occur during the freshet period and thus accelerate the freshet conditions. Of the total annual precipitation approximately two thirds falls as rain and one third as snow.

BC Environment does not have any active operating snow courses within the Chilako watershed. The closest stations to the study area are **Station 1A07 - Fort St. James** at an elevation of 810 metres, **1A10 - Prince George** at an elevation of 690 metres located in

the Upper Fraser Basin and **1C08 - Nazko** at an elevation of 1070 metres, located in the Middle Fraser Basin. These stations have been in operation since 1955, 1962 and 1957 respectively. A review of the snow survey summary ***(Appendix 1.6)*** for these stations indicates that in most years the snowpack is depleted by May 1. Because of this, the watershed it is not considered to be a major contributor when predicting Fraser River peak flows.

4. Present Studies

The 1996 studies undertaken to delineate the floodplains for the Chilako River are based on the following information:

- Survey data obtained by the Technical Support Section, Hydrology Branch, Water Management Division , Project 93 30 F043 (September 1993) ***(Appendix 1.1)*** and includes channel cross section data, longitudinal profiles, high water mark elevations, photographs and bridge details for the Chilako River and Beaverley Creek.

- Topographic base mapping of the study area issued in ***March 1993*** by the Mapping Section, Surveys and Resource Mapping Branch, Project 89-078T, NAD 83. The mapping is at a scale of 1:5,000 with 1 metre contour intervals and utilizes air photography obtained in June 1990 ***(Appendix 1.2).***

- Hydrology studies of the Chilako River watershed performed by the Surface Water Section, Hydrology Branch, Study No. 422, October 24, 1995, ***(Appendix 2).***

5. Designated Flood

In accordance with the policy of the Ministry of Environment, Lands and Parks, the flood levels and floodplain limits on the floodplain mapping sheets are based on a designated (1:200 year frequency) flow plus an allowance for hydraulic and hydrologic uncertainties. The mapping also includes 1:20 year flood frequency elevations to facilitate Public Health requirements for septic tank purposes ***(Table 2).***

6. Flood Magnitudes

6.1 Chilako River

As stated in ***Appendix 2***, annual peak flows in the Chilako River watershed occur generally between mid spring and summer as a result of snowmelt or rain on snow events. Water Survey of Canada (WSC) operated gauge 08JC005 - Chilako River near Prince George from 1961 to 1974 continuously except 1965. The published

drainage area for this gauge is 3390 km^2. Annual daily extremes are available from the published data; instantaneous annual maximum discharges are not available. The maximum daily discharges recorded at the gauge occurred on May 2, 1974 at 167 m3/s followed by 148 m3/s on May 18, 1972. These events are rated as having a 14 year and 7 year recurrence interval as published in Environment Canada's "Magnitude of Floods - British Columbia and Yukon Territory - 1982"***(Appendix 1.4).*** The 1:200 year daily discharge estimate by Environment Canada ranges from 192 m3/s to 255 m3/s depending upon the probability distribution.

6.2 Beaverley Creek

There is no active gauge on Beaverley Creek. Water Survey of Canada operated Gauge 08JC014 - Beaverley Creek near the mouth during April through September in 1982 only. A maximum daily flow of 17.4 m3/s was recorded on May 5. Published area for the gauge is 145 km^2. ***(Appendix 1.5).***

Peak flows for various points along the Chilako River and Beaverley Creek were determined using a regional approach to estimating peak flows. The method uses regional plots of 10-year return period instantaneous peak flow. All nearby stations with sufficient records are used as well as the HS Rational method. Table 3 below is a summary of the flows determined in the study.

Complete details of the hydrology study are contained in ***Appendix 2.***

Table 3 - Summary of Peak Flows

Stream Site	Drainage Area (km2)	Max. I/D	Recurrence Interval (years)					
			20			200		
			D	D	I	D	D	I
			L/s/km2	m3/s	m3/s	L/s/km2	m3/s	m3/s
1. Chilako R. at gauge 08JC005.	3390	1.04	52.2	177	186	73	251	261
2. Chilako R. below Beaverley Creek.	3535	1.04	51.2	181	189	72.1	256	266
3. Chilako R. at mouth.	3576	1.04	51.2	183	190	71.9	257	268
4. Beaverley Creek.	145	1.13	282	41	46	372	54	61

7. Hydraulic Analysis

7.1 General

The information sources listed in ***Appendix 1 and 2*** were utilized in the HEC 2 water surface profile computer program version 6.4, developed by the Hydrologic Engineering Centre, US Army Corps of Engineers in Davis, California and currently administered by Haestad Methods, Inc. The flood profile calculations employ a standard step method and assumed open channel flow conditions.

Flood profiles calculated for the Chilako River and Beaverley Creek in the study area are outlined as follows. A plot run of river cross sections was obtained. An assessment was made of the river channel survey data and cross section extensions which were obtained from the 1 metre contour topographic mapping. Output from the plot run was also used to review other data such as flow regime, loss coefficients, reach lengths, overbank information and relative Manning's "n" values. The selection of Manning's "n" values was made by utilizing colour photographs (see ***Appendix 3 - Photographs***) provided by the Surveys Section, experience gained in other studies and a review of the information provided in a book published by the United States Department of the Interior entitled "Roughness Characteristics of Natural Channels" ***(Appendix 1.3).***

7.2 Flood Level Calculations

As stated previously in ***Section 6.1***, WSC gauge 08JC005 was abandoned following 1975 and therefore no flow records are available for the 1990 and 1993 flood events. Stage discharge data was made available from WSC. A comparison plot of the latest WSC cross section for the gauge (1974) was made to the 1993 surveyed section. The change in cross sectional area did not permit an accurate estimate of the peak flow for the June1993 event. The data was only useful in providing an approximate estimate of the June 1993 event from the 1974 stage discharge curve.

High water mark evidence from the June 1993 event, was identified by the survey crew at the time of survey at most cross section locations on the Chilako River and Beaverley Creek. This information was used to assist with calibration of the HEC-2 model. Relative "n" values were selected for each cross section as described in ***Section 7.1.*** A number of preliminary runs were made, making minor changes to "n" values and discharge to provide a reasonable calibration of the model to the high water mark evidence obtained. The model output data, mapping and colour photographs were consulted to reconcile outliers to the calibration. At

several locations it was determined that the high water mark may have been caused by debris jamming or possibly the previous flood event in June 1990.

In accordance with standard ministry practice, an allowance for hydraulic and hydrologic uncertainties is applied to the water surface elevations computed by the model for each cross section. An allowance of 0.3 metres and 0.6 metres is applied to the instantaneous and daily levels respectively, and the flood level which dominates is selected for the particular cross section. For both the Chilako River and Beaverley Creek the daily flood levels were found to dominate at all cross sections using this criteria ***(Table 2 and Table 6)***.

As previously mentioned, the floodplain for the Nechako River was not determined in this study. Inquires were made to C.N. Railway personnel regarding the existance of historical high water mark data related to the railway bridge crossing the Chilako River at the confluence with the Nechako River. Such data was not available. As noted on Drawing 91-3, Sheet 1, the flood levels determined for the Chilako River in the confluence area may be exceeded by high flood levels on the Nechako River. The floodplain boundary in this area is shown dashed.

7.3 Sensitivity Studies

The total length of the Chilako River in the study area is approximately 25.4 km. In this length there are two distinct reaches. From the confluence with the Nechako River upstream to XS 13, the average gradient of the flood profile is 0.25 percent. For the reach from XS 13 to XS 49 the average gradient is considerably flatter at 0.055 percent. Manning's "n" values for the channel varied from 0.055 in the lower reach to 0.027 in the upper reach.

The following sensitivity studies were undertaken:

- Sensitivity to discharge (Q) studies were made using the estimated Q200 daily flow multiplied by factors of 1.1, 1.2, 1.3 and 1.4. The studies indicate that the selected flood levels are sufficient to withstand increases to Q averaging between 20% and 30%. These studies indicated an average water level increase of about 0.22m for each 10% increase to "Q" ***(Table 5).***

- Sensitivity studies were also undertaken to determine the effect of increased Manning's "n" values on flood levels. A comparative run using the Q200 instantaneous flow and factored by values of 1.1, 1.2 and 1.3 resulted in an average rise in levels of about 0.2m for each incremental increase in "n" value (Table 5).

From these studies it was determined that the floodplain for the Chilako River is moderately sensitive to increases in "Q" and "n" values. Due to the lack of WSC gauging stations on the Chilako River and therefore an unmeasured flow for calibrating the 1993 high water mark data, a conservative approach was adopted in the selected "n" values for determining the Q200 flood levels.

Starting water surface elevations for the Chilako River were estimated utilizing a number of methods as follows;

- a model option was selected to start the model with a minimum water surface elevation corresponding to critical depth,
- an estimate of the 200 year flood level based upon observed high water elevations upstream; and
- a slope/area model option was selected utilizing a variety of slopes.

The studies indicated that the model is relatively insensitive to starting water surface elevations as the profiles quickly balanced out at cross section 5 ***(Table 4)***. In addition, the Nechako River flood levels may dominate in the confluence area as noted in Section 7.2.

The previously mentioned criteria was also utilized in the analyses of Beaverley Creek. Results of the sensitivity studies ***(Table 7)*** indicate that the daily criteria chosen sufficiently contains increases of 30 % to both discharge and Manning's "n" values. Sensitivity to starting levels were not made for Beaverley Creek as the Chilako River flood levels dominate over Beaverley Creek in the confluence area.

8. Floodplain Mapping

The flood levels determined in the study were used to delineate the floodplain limits onto the existing 1 metre contour mapping for the study area. The studies were based on the information noted in ***Section 4.***

The floodplain mapping of the Chilako River, Drawing No. 93-1 sheets 1 to 3 ***(Appendix 4)*** was produced and provides the following information:

- the location of river cross sections,
- the designated floodplain limits,
- the flood levels determined in the study,
- the location of survey monuments established for the study, and
- notes pertaining to flood and erosion hazards.

9. Conclusions

1. This design brief presents an overview of the studies undertaken to produce the floodplain mapping sheets for the Chilako River. The floodplain limits shown correspond to the area which would be inundated by the designated flood.
2. The floodplain maps are not comprehensive floodplain management plans, nor do they provide solutions to site specific problems.
3. Flooding may occur outside the designated floodplain. Tributaries, ice jamming, channel obstructions, groundwater and larger flood events may cause flooding which exceeds the flood levels shown on the drawings. These limitations are noted on the floodplain mapping sheets under floodplain data and under notes of caution on individual sheets.

10. Recommendations

1. It is recommended that the floodplains delineated on Drawing 93-1, Sheets 1 to 3, ***(Appendix 4)*** be Interim Designated under the terms of the Federal Provincial Floodplain Mapping Agreement.
2. The drawings 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.
3. The Fraser - Fort George Regional District along with BC Environment, Hydrology Branch, should actively pursue the co-operation with Water Survey of Canada to re-establish gauges in the study area.
4. The floodplain maps should be reviewed to maintain the adequacy, accuracy and usefulness of the information when significant flood events, erosion, floodplain development or other changes occur within the study area.

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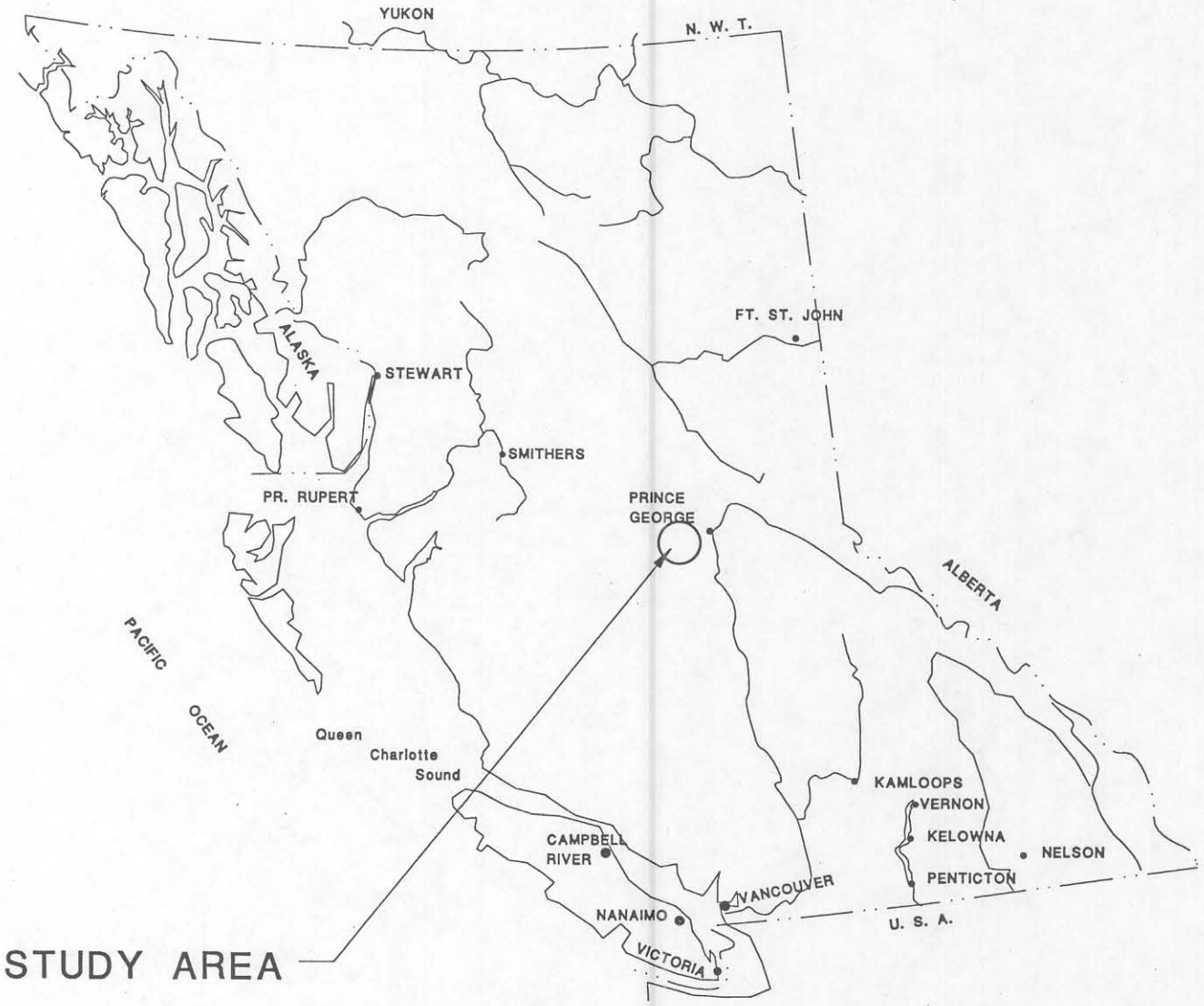
Floodplain Mapping Unit

R.W. Nichols, P.Eng
Project Engineer
Floodplain Mapping Unit

FIGURES



Province of British Columbia
Ministry of Environment, Lands and Parks
WATER MANAGEMENT DIVISION

TO ACCOMPANY A DESIGN BRIEF ON THE
FLOODPLAIN MAPPING

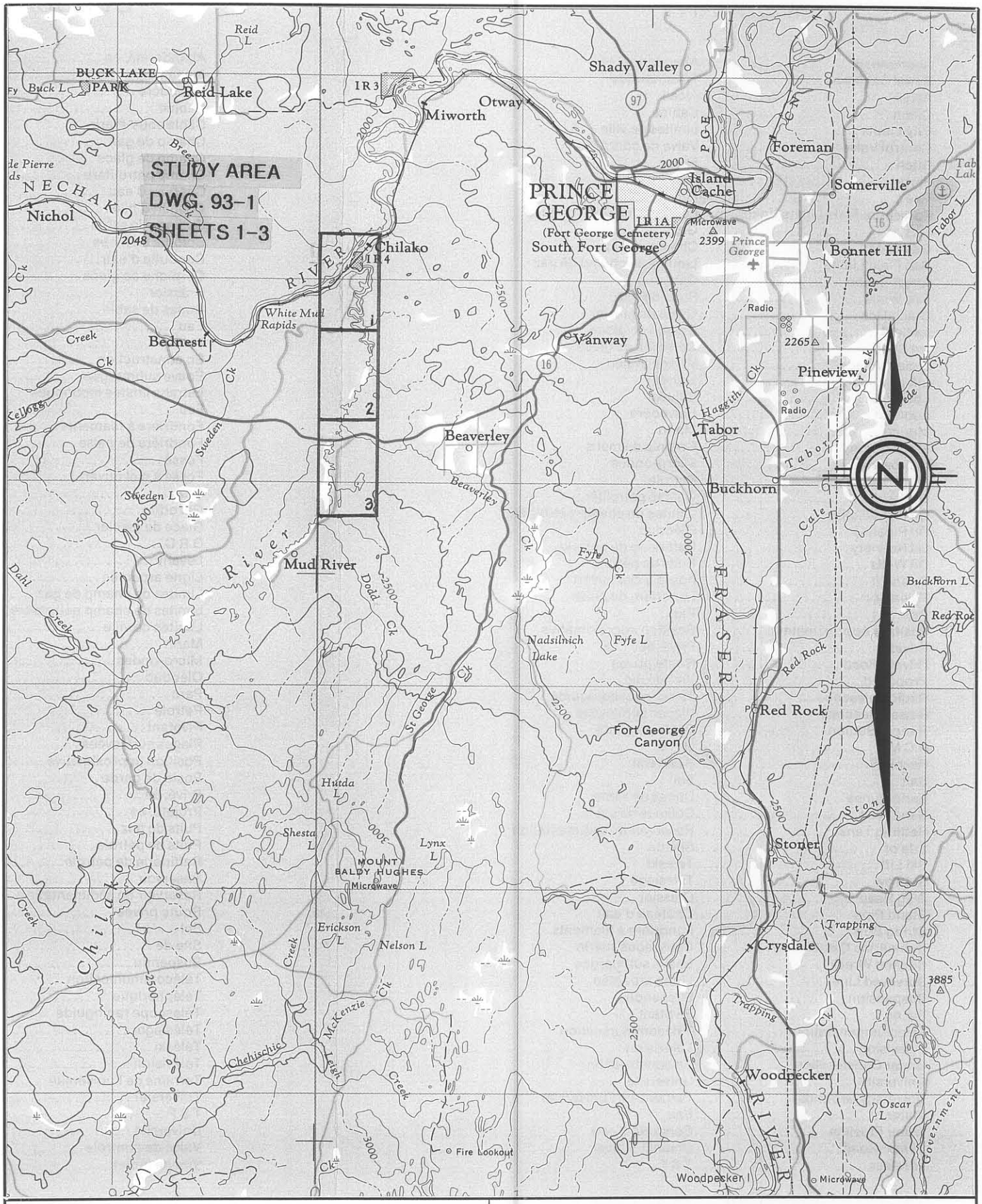
CHILAKO RIVER
STUDY AREA LOCATION

SCALE: VERT
HOR
NOT TO SCALE

DATE
APRIL 1996

R.W. NICHOLS ENGINEER

FILE No. 35100-30/180-0690 DWG. No. FIGURE 1



Province of British Columbia
Ministry of Environment, Lands and Parks
WATER MANAGEMENT DIVISION

TO ACCOMPANY A DESIGN BRIEF ON THE
FLOODPLAIN MAPPING STUDY

CHILAKO RIVER
KEY MAP

SCALE: VERT	DATE	R.W. NICHOLS ENGINEER
HOR 1 : 250,000	OCTOBER 1996	FILE No. 35100-30/180-0690 DWG. No. FIGURE 2

CHILAKO RIVER WATERSHED

PRINCE GEORGE

QUESNEL

FRASER LAKE

VANDERHOOF

FORT FRASER

Province of British Columbia
Ministry of Environment, Lands and Parks
WATER MANAGEMENT DIVISION

TO ACCOMPANY A DESIGN BRIEF ON THE
FLOODPLAIN MAPPING STUDY

CHILAKO RIVER

WATERSHED LOCATION

SCALE: VERT.	DATE
HOR. 1:633,600	OCTOBER 1996
	R.W. NICHOLS ENGINEER
FILE No. 180-0690 DWG No.	FIGURE 3

TABLES

(TABLES 2, 4, 5, 6, 7)

(TABLES 1 & 3 CONTAINED IN TEXT)

TABLE 2

CHILAKO RIVER FLOOD LEVEL SELECTION

SUMMARY PRINTOUT

XS	FRQ	Q	K*XNCH	CWSEL	FLD LVL	XS	FRQ	Q	K*XNCH	CWSEL	FLD LVL
1	Q 200 I	267	55	595.50	595.80	10		267	49.5	606.53	606.83
1	Q 200D	257	55	595.50	**596.10**	10		257	49.5	606.45	**607.05**
1	Q 20 I	190	55	595.50	595.80	10		190	49.5	605.92	606.22
1	Q 20 D	183	55	595.50	**596.10**	10		183	49.5	605.85	**606.45**
2		267	55	596.03	596.33	11	Q 200 I	267	55	608.08	608.38
2		257	55	595.98	**596.58**	11	Q 200D	257	55	608.00	**608.60**
2		190	55	595.74	596.04	11	Q 20 I	190	55	607.44	607.74
2		183	55	595.72	**596.32**	11	Q 20 D	183	55	607.38	**607.98**
3	Q 200 I	267	55	596.09	596.39	12		267	55	610.14	610.44
3	Q 200D	257	55	596.04	**596.64**	12		257	55	610.06	**610.66**
3	Q 20 I	190	55	595.79	596.09	12		190	55	609.52	609.82
3	Q 20 D	183	55	595.77	**596.37**	12		183	55	609.45	**610.05**
4 (1)		267	55	596.91	597.21	13	Q 200 I	267	49.5	611.25	611.55
4		257	55	596.85	**597.45**	13	Q 200D	257	49.5	611.18	**611.78**
4		190	55	596.43	596.73	13	Q 20 I	190	49.5	610.70	611.00
4		183	55	596.38	**596.98**	13	Q 20 D	183	49.5	610.64	**611.24**
5(2)	Q 200 I	267	55	598.51	598.81	14		267	46.2	612.06	612.36
5	Q 200D	257	55	598.45	**599.05**	14		257	46.2	611.99	**612.59**
5	Q 20 I	190	55	597.99	598.29	14		190	46.2	611.48	611.78
5	Q 20 D	183	55	597.94	**598.54**	14		183	46.2	611.41	**612.01**
6		267	55	600.82	601.12	15	Q 200 I	267	46.2	612.76	613.06
6		257	55	600.74	**601.34**	15	Q 200D	257	46.2	612.69	**613.29**
6		190	55	600.17	600.47	15	Q 20 I	190	46.2	612.14	612.44
6		183	55	600.10	**600.70**	15	Q 20 D	183	46.2	612.08	**612.68**
7	Q 200 I	267	55	602.84	603.14	16		267	46.2	613.19	613.49
7	Q 200D	257	55	602.76	**603.36**	16		257	46.2	613.11	**613.71**
7	Q 20 I	190	55	602.13	602.43	16		190	46.2	612.53	612.83
7	Q 20 D	183	55	602.06	**602.66**	16		183	46.2	612.46	**613.06**
8		267	55	604.25	604.55	17	Q 200 I	267	46.2	613.86	614.16
8		257	55	604.17	**604.77**	17	Q 200D	257	46.2	613.78	**614.38**
8		190	55	603.60	603.90	17	Q 20 I	190	46.2	613.11	613.41
8		183	55	603.53	**604.13**	17	Q 20 D	183	46.2	613.03	**613.63**
9	Q 200 I	267	55	605.64	605.94	18		267	46.2	614.73	615.03
9	Q 200D	257	55	605.56	**606.16**	18		257	46.2	614.64	**615.24**
9	Q 20 I	190	55	604.97	605.27	18		190	46.2	613.94	614.24
9	Q 20 D	183	55	604.90	**605.50**	18		183	46.2	613.86	**614.46**

(1) Limit of study at XS 4, as shown on Dwg. 93-1 Sheet 1

(2) Area near the confluence with the Nechako River may be subject to higher flood levels during high flows on the Nechako River (Dwg. 93-1 Sheet 1)

TABLE 2

CHILAKO RIVER FLOOD LEVEL SELECTION

SUMMARY PRINTOUT

XS	FRQ	Q	K*XNCH	CWSEL	FLD LVL
19	Q 200 I	267	46.2	615.29	615.59
19	Q 200D	257	46.2	615.20	**615.80**
19	Q 20 I	190	46.2	614.48	614.78
19	Q 20 D	183	46.2	614.39	**614.99**
20		267	46.2	615.69	615.99
20		257	46.2	615.59	**616.19**
20		190	46.2	614.87	615.17
20		183	46.2	614.79	**615.39**
21	Q 200 I	267	38.5	615.92	616.22
21	Q 200D	257	38.5	615.83	**616.43**
21	Q 20 I	190	38.5	615.13	615.43
21	Q 20 D	183	38.5	615.04	**615.64**
22		267	35.2	616.02	616.32
22		257	35.2	615.93	**616.53**
22		190	35.2	615.23	615.53
22		183	35.2	615.15	**615.75**
23	Q 200 I	267	29.7	616.11	616.41
23	Q 200D	257	29.7	616.02	**616.62**
23	Q 20 I	190	29.7	615.32	615.62
23	Q 20 D	183	29.7	615.24	**615.84**
24		267	29.7	616.23	616.53
24		257	29.7	616.14	**616.74**
24		190	29.7	615.47	615.77
24		183	29.7	615.39	**615.99**
25	Q 200 I	267	29.7	616.24	616.54
25	Q 200D	257	29.7	616.14	**616.74**
25	Q 20 I	190	29.7	615.47	615.77
25	Q 20 D	183	29.7	615.39	**615.99**
26		267	29.7	616.32	616.62
26		257	29.7	616.25	**616.85**
26		190	29.7	615.56	615.86
26		183	29.7	615.48	**616.08**
27	Q 200 I	267	29.7	616.55	616.85
27	Q 200D	257	29.7	616.46	617.06
27	Q 20 I	190	29.7	615.74	616.04
27	Q 20 D	183	29.7	615.66	616.26

XS	FRQ	Q	K*XNCH	CWSEL	FLD LVL
28		267	29.7	616.65	616.95
28		257	29.7	616.57	**617.17**
28		190	29.7	615.86	616.16
28		183	29.7	615.78	**616.38**
29	Q 200 I	267	33	616.72	617.02
29	Q 200D	257	33	616.63	**617.23**
29	Q 20 I	190	33	615.94	616.24
29	Q 20 D	183	33	615.86	**616.46**
30		267	39.6	616.95	617.25
30		257	39.6	616.88	**617.48**
30		190	39.6	616.30	616.60
30		183	39.6	616.23	**616.83**
31	Q 200 I	267	33	617.37	617.67
31	Q 200D	257	33	617.31	**617.91**
31	Q 20 I	190	33	616.85	617.15
31	Q 20 D	183	33	616.79	**617.39**
32		259	33	617.45	617.75
32		255	33	617.39	**617.99**
32		189	33	616.94	617.24
32		181	33	616.89	**617.49**
33	Q 200 I	259	39.6	618.01	618.31
33	Q 200D	255	39.6	617.95	**618.55**
33	Q 20 I	189	39.6	617.44	617.74
33	Q 20 D	181	39.6	617.37	**617.97**
34		259	33	618.42	618.72
34		255	33	618.38	**618.98**
34		189	33	617.80	618.10
34		181	33	617.72	**618.32**
35	Q 200 I	259	39.6	618.88	619.18
35	Q 200D	255	39.6	618.83	**619.43**
35	Q 20 I	189	39.6	618.24	618.54
35	Q 20 D	181	39.6	618.16	**618.76**
36		259	35.2	619.19	619.49
36		255	35.2	619.15	**619.75**
36		189	35.2	618.52	618.82
36		181	35.2	618.43	**619.03**

TABLE 2

CHILAKO RIVER FLOOD LEVEL SELECTION

SUMMARY PRINTOUT

XS	FRQ	Q	K*XNCH	CWSEL	FLD LVL	XS	FRQ	Q	K*XNCH	CWSEL	FLD LVL
37	Q 200 I	259	29.7	619.25	619.55	43		259	38.5	620.59	620.89
37	Q 200D	255	29.7	619.20	**619.80**	43		255	38.5	620.56	**621.16**
37	Q 20 I	189	29.7	618.56	618.86	43		189	38.5	619.95	620.25
37	Q 20 D	181	29.7	618.47	**619.07**	43		181	38.5	619.87	**620.47**
37.1		259	35.2	619.35	619.65	44	Q 200 I	259	41.8	621.13	621.43
37.1		255	35.2	619.30	**619.90**	44	Q 200D	255	41.8	621.10	**621.70**
37.1		189	35.2	618.64	618.94	44	Q 20 I	189	41.8	620.56	620.86
37.1		181	35.2	618.55	**619.15**	44	Q 20 D	181	41.8	620.49	**621.09**
38	Q 200 I	259	39.6	619.53	619.83	45		259	33	621.14	621.44
38	Q 200D	255	39.6	619.48	**620.08**	45		255	33	621.10	**621.70**
38	Q 20 I	189	39.6	618.79	619.09	45		189	33	620.57	620.87
38	Q 20 D	181	39.6	618.69	**619.29**	45		181	33	620.50	**621.10**
39		259	39.6	619.86	620.16	46	Q 200 I	259	29.7	621.42	621.72
39		255	39.6	619.81	**620.41**	46	Q 200D	255	29.7	621.39	**621.99**
39		189	39.6	619.10	619.40	46	Q 20 I	189	29.7	620.90	621.20
39		181	39.6	619.00	**619.60**	46	Q 20 D	181	29.7	620.84	**621.44**
40	Q 200 I	259	37.4	620.01	620.31	47		259	29.7	621.78	622.08
40	Q 200D	255	37.4	619.97	**620.57**	47		255	29.7	621.75	**622.35**
40	Q 20 I	189	37.4	619.31	619.61	47		189	29.7	621.20	621.50
40	Q 20 D	181	37.4	619.22	**619.82**	47		181	29.7	621.13	**621.73**
41		259	37.4	620.09	620.39	48	Q 200 I	259	35.2	621.87	622.17
41		255	37.4	620.05	**620.65**	48	Q 200D	255	35.2	621.84	**622.44**
41		189	37.4	619.43	619.73	48	Q 20 I	189	35.2	621.30	621.60
41		181	37.4	619.35	**619.95**	48	Q 20 D	181	35.2	621.22	**621.82**
42	Q 200 I	259	29.7	620.18	620.48	49	Q 200 I	259	29.7	622.04	622.34
42	Q 200D	255	29.7	620.14	**620.74**	49	Q 200D	255	29.7	622.01	**622.61**
42	Q 20 I	189	29.7	619.55	619.85	49	Q 20 I	189	29.7	621.45	621.75
42	Q 20 D	181	29.7	619.48	**620.08**	49	Q 20 D	181	29.7	621.37	**621.97**

TABLE 4

CHILAKO RIVER

SENSITIVITY TO STARTING ELEVATIONS

XS	START METHOD	Q	10*KS	XLCH	CWSEL	SELECTED FLOOD LEVEL
1	CRITICAL DEPTH	257	261.71	0	595.07	N/A
1	ESTIMATE	257	259.40	0	595.08	
1	ESTIMATE	257	258.17	0	595.08	
1	ESTIMATE	257	261.41	0	595.07	
1	ESTIMATE	257	118.12	0	595.50	
1	SLOPE AREA 0.003	257	30.53	0	***596.50***	
1	SLOPE AREA 0.004	257	40.09	0	***596.27***	
1	SLOPE AREA 0.005	257	50.37	0	596.08	
1	SLOPE AREA 0.006	257	60.79	0	595.94	
2		257	82.40	35	596.03	N/A
2		257	82.59	35	596.03	
2		257	82.69	35	596.03	
2		257	82.42	35	596.03	
2		257	87.21	35	595.98	
2		257	43.32	35	***596.61***	
2		257	53.04	35	596.42	
2		257	62.19	35	596.27	
2		257	68.89	35	596.18	
3	CRITICAL DEPTH	257	82.79	8	596.08	N/A
3	ESTIMATE	257	82.97	8	596.08	
3	ESTIMATE	257	83.07	8	596.08	
3	ESTIMATE	257	82.80	8	596.08	
3	ESTIMATE	257	86.28	8	596.04	
3	SLOPE AREA 0.003	257	45.61	8	***596.64***	
3	SLOPE AREA 0.004	257	54.99	8	596.45	
3	SLOPE AREA 0.005	257	63.29	8	596.31	
3	SLOPE AREA 0.006	257	69.80	8	596.22	
4		257	35.24	111	596.86	597.45 (1)
4		257	35.27	111	596.86	
4		257	35.28	111	596.86	
4		257	35.25	111	596.86	
4		257	35.99	111	596.85	
4		257	24.85	111	597.12	
4		257	28.34	111	597.01	
4		257	31.27	111	596.95	
4		257	33.07	111	596.91	
5	CRITICAL DEPTH	257	22.97	562	598.45	599.05
5	ESTIMATE	257	22.97	562	598.45	
5	ESTIMATE	257	22.97	562	598.45	
5	ESTIMATE	257	22.97	562	598.45	
5	ESTIMATE	257	22.90	562	598.45	
5	SLOPE AREA 0.003	257	23.36	562	598.44	
5	SLOPE AREA 0.004	257	23.45	562	598.44	
5	SLOPE AREA 0.005	257	23.24	562	598.45	
5	SLOPE AREA 0.006	257	23.14	562	598.45	

(1) "Limit of Study" at XS-4 as shown on Dwg. 93-1, Sheet 1

TABLE 5

CHILAKO RIVER SENSITIVITY STUDIES

"Q" SENSITIVITY				FLD LVL	FLD LVL	"n" SENSITIVITY				
XS	Q	FCTR	CWSEL	I+0.3	D+0.6	XS	Q	K*XNCH	FCTR	CWSEL
1	267	200 I	595.50	N/A	N/A	1	257	50	1	595.50
1	257	200 D	595.50			1	257	55	1.1	595.50
1	282.7	D x 1.1	595.50			1	257	60	1.2	595.50
1	308.4	D x 1.2	595.50			1	257	65	1.3	595.50
1	334.1	D x 1.3	595.50			1	257	70	1.4	595.50
2	267		596.03	N/A	N/A	2	257	50		595.91
2	257		595.98			2	257	55		595.98
2	282.7		596.10			2	257	60		596.05
2	308.4		596.23			2	257	65		596.12
2	334.1		596.37			2	257	70		596.19
3	267	200 I	569.09	N/A	N/A	3	257	50	1	595.97
3	257	200 D	596.04			3	257	55	1.1	596.04
3	282.7	D x 1.1	596.16			3	257	60	1.2	596.12
3	308.4	D x 1.2	596.29			3	257	65	1.3	596.20
3	334.1	D x 1.3	596.43			3	257	70	1.4	596.27
4 (1)	267		596.91	597.21	**597.45**	4	257	50		596.73
4	257		596.85			4	257	55		596.85
4	282.7		597.01			4	257	60		596.95
4	308.4		597.16			4	257	65		597.05
4	334.1		597.32			4	257	70		597.15
5 (2)	267	200 I	598.51	598.81	**599.05**	5	257	50	1	598.30
5	257	200 D	598.45			5	257	55	1.1	598.45
5	282.7	D x 1.1	598.61			5	257	60	1.2	598.60
5	308.4	D x 1.2	598.75			5	257	65	1.3	598.74
5	334.1	D x 1.3	598.88			5	257	70	1.4	598.86
6	267		600.82	601.12	**601.34**	6	257	50		600.54
6	257		600.74			6	257	55		600.74
6	282.7		600.95			6	257	60		600.94
6	308.4		601.14			6	257	65		601.13
6	334.1		601.32			6	257	70		601.30
7	267	200 I	602.84	603.14	**603.36**	7	257	50	1	602.57
7	257	200 D	602.76			7	257	55	1.1	602.76
7	282.7	D x 1.1	602.97			7	257	60	1.2	602.93
7	308.4	D x 1.2	603.18			7	257	65	1.3	603.11
7	334.1	D x 1.3	603.38			7	257	70	1.4	603.27
8	267		604.25	604.55	**604.77**	8	257	50	1	603.96
8	257		604.17			8	257	55	1.1	604.17
8	282.7		604.37			8	257	60	1.2	604.36
8	308.4		604.56			8	257	65	1.3	604.54
8	334.1		604.74			8	257	70	1.4	604.71

(1) Limit of Study at XS-4 as shown on Dwg.93-1, Sheet 1.

(2) Area near the confluence with the Nechako River may be subject to higher flood levels during high flow on the Nechako River (Dwg. 93-1, Sheet 1).

TABLE 5

CHILAKO RIVER SENSITIVITY STUDIES

"Q" SENSITIVITY				FLD LVL	FLD LVL	"n" SENSITIVITY				
XS	Q	FCTR	CWSEL	I+0.3	D+0.6	XS	Q	K*XNCH	FCTR	CWSEL
9	267	200 I	605.64	605.94	**606.16**	9	257	50		605.38
9	257	200 D	605.56			9	257	55		605.56
9	282.7	D x 1.1	605.76			9	257	60		605.73
9	308.4	D x 1.2	605.95			9	257	65		605.89
9	334.1	D x 1.3	606.13			9	257	70		606.04
10	267	200 I	606.53	606.83	**607.05**	10	257	45	1	606.27
10	257		606.45			10	257	49.5	**1.1**	606.45
10	282.7		606.64			10	257	54	1.2	606.63
10	308.4		606.80			10	257	58.5	1.3	606.78
10	334.1		606.95			10	257	63	1.4	606.93
11	267	200 I	608.08	608.38	**608.60**	11	257	50		607.83
11	257	200 D	608.00			11	257	55		608.00
11	282.7	D x 1.1	608.19			11	257	60		608.17
11	308.4	D x 1.2	608.37			11	257	65		608.33
11	334.1	D x 1.3	608.54			11	257	70		608.48
12	267		610.14	610.44	**610.66**	12	257	50	1	609.89
12	257		610.06			12	257	55	**1.1**	610.06
12	282.7		610.25			12	257	60	1.2	610.22
12	308.4		610.42			12	257	65	1.3	610.37
12	334.1		610.58			12	257	70	1.4	610.51
13	267	200 I	611.25	611.55	**611.78**	13	257	45		611.03
13	257	200 D	611.18			13	257	49.5		611.18
13	282.7	D x 1.1	611.35			13	257	54		611.33
13	308.4	D x 1.2	611.51			13	257	58.5		611.47
13	334.1	D x 1.3	611.67			13	257	63		611.60
14	267		612.06	612.36	**612.59**	14	257	42	1	611.83
14	257		611.99			14	257	46.2	**1.1**	611.99
14	282.7		612.16			14	257	50.4	1.2	612.15
14	308.4		612.32			14	257	54.6	1.3	612.29
14	334.1		612.47			14	257	58.8	1.4	612.43
15	267	200 I	612.76	613.06	**613.29**	15	257	42		612.52
15	257	200 D	612.69			15	257	46.2		612.69
15	282.7	D x 1.1	612.87			15	257	50.4		612.85
15	308.4	D x 1.2	613.03			15	257	54.6		613.00
15	334.1	D x 1.3	613.18			15	257	58.8		613.15
16	267		613.19	613.49	**613.71**	16	257	42	1	612.92
16	257		613.11			16	257	46.2	1.1	613.11
16	282.7		613.30			16	257	50.4	1.2	613.28
16	308.4		613.47			16	257	54.6	1.3	613.45
16	334.1		613.64			16	257	58.8	1.4	613.60

TABLE 5

CHILAKO RIVER SENSITIVITY STUDIES

"Q" SENSITIVITY				FLD LVL	FLD LVL	"n" SENSITIVITY				
XS	Q	FCTR	CWSEL	I+0.3	D+0.6	XS	Q	K*XNCH	FCTR	CWSEL
17	267	200 I	613.86	614.16	**614.38**	17	257	42		613.56
17	257	200 D	613.78			17	257	46.2		613.78
17	282.7	D x 1.1	613.99			17	257	50.4		613.98
17	308.4	D x 1.2	614.20			17	257	54.6		614.17
17	334.1	D x 1.3	***614.39***			17	257	58.8		614.34
18	267		614.73	615.03	**615.24**	18	257	42	1	614.41
18	257		614.64			18	257	46.2	**1.1**	614.64
18	282.7		614.86			18	257	50.4	1.2	614.84
18	308.4		615.07			18	257	54.6	1.3	615.04
18	334.1		***615.27***			18	257	58.8	1.4	615.22
19	267	200 I	615.29	615.59	**615.80**	19	257	42		614.98
19	257	200 D	615.20			19	257	46.2		615.20
19	282.7	D x 1.1	615.43			19	257	50.4		615.40
19	308.4	D x 1.2	615.65			19	257	54.6		615.60
19	334.1	D x 1.3	***615.85***			19	257	58.8		615.78
20	267		615.69	615.99	**616.19**	20	257	42	1	615.38
20	257		615.59			20	257	46.2	**1.1**	615.59
20	282.7		615.83			20	257	50.4	1.2	615.80
20	308.4		616.05			20	257	54.6	1.3	615.99
20	334.1		***616.26***			20	257	58.8	1.4	616.17
21	267	200 I	615.92	616.22	**616.43**	21	257	35		615.62
21	257	200 D	615.83			21	257	38.5		615.83
21	282.7	D x 1.1	616.06			21	257	42		616.02
21	308.4	D x 1.2	616.27			21	257	45.5		616.21
21	334.1	D x 1.3	***616.48***			21	257	49		616.38
22	267		616.02	616.32	**616.53**	22	257	32	1	615.73
22	257		615.93			22	257	35.2	**1.1**	615.93
22	282.7		616.16			22	257	38.4	1.2	616.13
22	308.4		616.38			22	257	41.6	1.3	616.31
22	334.1		***616.59***			22	257	44.8	1.4	616.49
23	267	200 I	616.11	616.41	**616.62**	23	257	27		615.81
23	257	200 D	616.02			23	257	29.7		616.02
23	282.7	D x 1.1	616.25			23	257	32.4		616.22
23	308.4	D x 1.2	616.47			23	257	35.1		616.41
23	334.1	D x 1.3	***616.68***			23	257	37.8		616.58
24	267	200 I	616.23	616.53	**616.74**	24	257	27	1	615.93
24	257		616.14			24	257	29.7	**1.1**	616.14
24	282.7		616.37			24	257	32.4	1.2	616.34
24	308.4		616.58			24	257	35.1	1.3	616.53
24	334.1		***616.78***			24	257	37.8	1.4	616.71

TABLE 5

CHILAKO RIVER SENSITIVITY STUDIES

"Q" SENSITIVITY				FLD LVL	FLD LVL	"n" SENSITIVITY				
XS	Q	FCTR	CWSEL	I+0.3	D+0.6	XS	Q	K*XNCH	FCTR	CWSEL
25	267	200 I	616.24	616.54	**616.74**	25	257	27		615.91
25	257	200 D	616.14			25	257	29.7		616.14
25	282.7	D x 1.1	616.38			25	257	32.4		616.36
25	308.4	D x 1.2	616.59			25	257	35.1		616.56
25	334.1	D x 1.3	***616.80***			25	257	37.8		616.75
26	267	200 I	616.32	616.62	**616.85**	26	257	27	1	616.03
26	257		616.25			26	257	29.7	**1.1**	616.25
26	282.7		616.46			26	257	32.4	1.2	616.43
26	308.4		616.69			26	257	35.1	1.3	616.63
26	334.1		***616.88***			26	257	37.8	1.4	616.82
27	267	200 I	616.55	616.85	**617.06**	27	257	27		616.27
27	257	200 D	616.46			27	257	29.7		616.46
27	282.7	D x 1.1	616.69			27	257	32.4		616.64
27	308.4	D x 1.2	616.92			27	257	35.1		616.82
27	334.1	D x 1.3	***617.13***			27	257	37.8		617.00
28	267	200 I	616.65	616.95	**617.17**	28	257	27	1	616.38
28	257		616.57			28	257	29.7	**1.1**	616.57
28	282.7		616.79			28	257	32.4	1.2	616.74
28	308.4		617.02			28	257	35.1	1.3	616.92
28	334.1		***617.22***			28	257	37.8	1.4	617.09
29	267	200 I	616.72	617.02	**617.23**	29	257	30		616.44
29	257	200 D	616.63			29	257	33		616.63
29	282.7	D x 1.1	616.86			29	257	36		616.81
29	308.4	D x 1.2	617.09			29	257	39		617.00
29	334.1	D x 1.3	***617.29***			29	257	42		617.17
30	267	200 I	616.95	617.25	**617.48**	30	257	36	1	616.70
30	257		616.88			30	257	39.6	**1.1**	616.88
30	282.7		617.07			30	257	43.2	1.2	617.04
30	308.4		617.28			30	257	46.8	1.3	617.21
30	334.1		617.47			30	257	50.4	1.4	617.37
31	267	200 I	617.37	617.67	**617.91**	31	257	30		617.14
31	257	200 D	617.31			31	257	33		617.31
31	282.7	D x 1.1	617.47			31	257	36		617.46
31	308.4	D x 1.2	617.63			31	257	39		617.62
31	334.1	D x 1.3	617.79			31	257	42		617.76
32	259		617.45	617.75	**617.99**	32	249	30	1	617.23
32	255		617.39			32	249	33	**1.1**	617.39
32	280.5		617.54			32	249	36	1.2	617.55
32	306		617.70			32	249	39	1.3	617.71
32	331.5		617.85			32	249	42	1.4	617.86

TABLE 5

CHILAKO RIVER SENSITIVITY STUDIES

"Q" SENSITIVITY				FLD LVL	FLD LVL	"n" SENSITIVITY				
XS	Q	FCTR	CWSEL	I+0.3	D+0.6	XS	Q	K*XNCH	FCTR	CWSEL
33	259	200 I	618.01	618.31	**618.55**	33	249	36		617.76
33	255	200 D	617.95			33	249	39.6		617.94
33	280.5	D x 1.1	618.13			33	249	43.2		618.10
33	306	D x 1.2	618.31			33	249	46.8		618.26
33	331.5	D x 1.3	618.47			33	249	50.4		618.42
34	259		618.42	618.72	**618.98**	34	249	30	1	618.18
34	255		618.38			34	249	33	1.1	618.34
34	280.5		618.57			34	249	36	1.2	618.50
34	306		618.77			34	249	39	1.3	618.66
34	331.5		618.95			34	249	42	1.4	618.81
35	259	200 I	618.88	619.18	**619.43**	35	249	36		618.61
35	255	200 D	618.83			35	249	39.6		618.80
35	280.5	D x 1.1	619.04			35	249	43.2		618.97
35	306	D x 1.2	619.24			35	249	46.8		619.14
35	331.5	D x 1.3	619.43			35	249	50.4		619.30
36	259		619.19	619.49	**619.75**	36	249	32	1	618.91
36	255		619.15			36	249	35.2	1.1	619.10
36	280.5		619.37			36	249	38.4	1.2	619.29
36	306		619.58			36	249	41.6	1.3	619.47
36	331.5		***619.78***			36	249	44.8	1.4	619.65
37	259	200 I	619.55	619.85	**619.80**	37	249	27		618.97
37	255	200 D	619.20			37	249	29.7		619.16
37	280.5	D x 1.1	619.43			37	249	32.4		619.34
37	306	D x 1.2	619.64			37	249	35.1		619.52
37	331.5	D x 1.3	***619.85***			37	249	37.8		619.69
37.1	259		619.35	619.65	**619.90**	37.1	249	32	1	619.05
37.1	255		619.30			37.1	249	35.2	1.1	619.25
37.1	280.5		619.53			37.1	249	38.4	1.2	619.45
37.1	306		619.75			37.1	249	41.6	1.3	619.64
37.1	331.5		***619.97***			37.1	249	44.8	1.4	619.83
38	259	200 I	619.53	619.83	**620.08**	38	249	36		619.23
38	255	200 D	619.48			38	249	39.6		619.43
38	280.5	D x 1.1	619.73			38	249	43.2		619.63
38	306	D x 1.2	619.96			38	249	46.8		619.82
38	331.5	D x 1.3	***620.18***			38	249	50.4		620.00
39	259		619.86	620.16	**620.41**	39	249	36	1	619.55
39	255		619.81			39	249	39.6	1.1	619.76
39	280.5		620.06			39	249	43.2	1.2	619.95
39	306		620.30			39	249	46.8	1.3	620.14
39	331.5		***620.52***			39	249	50.4	1.4	620.32

TABLE 5

CHILAKO RIVER SENSITIVITY STUDIES

"Q" SENSITIVITY				FLD LVL	FLD LVL	"n" SENSITIVITY				
XS	Q	FCTR	CWSEL	I+0.3	D+0.6	XS	Q	K*XNCH	FCTR	CWSEL
40	259	200 I	620.01	620.31	**620.57**	40	249	34		619.72
40	255	200 D	619.97			40	249	37.4		619.91
40	280.5	D x 1.1	620.20			40	249	40.8		620.10
40	306	D x 1.2	620.42			40	249	44.2		620.28
40	331.5	D x 1.3	***620.63***			40	249	47.6		620.45
41	259		620.09	620.39	**620.65**	41	249	34	1	619.81
41	255		620.05			41	249	37.4	1.1	620.00
41	280.5		620.27			41	249	40.8	1.2	620.18
41	306		620.49			41	249	44.2	1.3	620.35
41	331.5		***620.69***			41	249	47.6	1.4	620.52
42	259	200 I	620.18	620.48	**620.74**	42	249	27		619.91
42	255	200 D	620.14			42	249	29.7		620.09
42	280.5	D x 1.1	620.35			42	249	32.4		620.27
42	306	D x 1.2	620.56			42	249	35.1		620.44
42	331.5	D x 1.3	***620.76***			42	249	37.8		620.60
43	259		620.59	620.89	**621.16**	43	249	35	1	620.31
43	255		620.56			43	249	38.5	1.1	620.51
43	280.5		620.77			43	249	42	1.2	620.69
43	306		620.98			43	249	45.5	1.3	620.87
43	331.5		***621.18***			43	249	49	1.4	621.04
44	259	200 I	621.53	621.83	**621.70**	44	249	38		620.90
44	255	200 D	621.10			44	249	41.8		621.06
44	280.5	D x 1.1	621.30			44	249	45.6		621.23
44	306	D x 1.2	621.48			44	249	49.4		621.37
44	331.5	D x 1.3	621.65			44	249	53.2		621.51
45	259		621.14	621.44	**621.70**	45	249	30	1	620.90
45	255		621.10			45	249	33	1.1	621.06
45	280.5		621.31			45	249	36	1.2	621.23
45	306		621.48			45	249	39	1.3	621.38
45	331.5		621.66			45	249	42	1.4	621.52
46	259	200 I	621.42	621.72	**621.99**	46	249	27		621.19
46	255	200 D	621.39			46	249	29.7		621.35
46	280.5	D x 1.1	621.58			46	249	32.4		621.53
46	306	D x 1.2	621.73			46	249	35.1		621.68
46	331.5	D x 1.3	621.88			46	249	37.8		621.82
47	259		621.78	622.08	**622.35**	47	249	27	1	621.53
47	255		621.75			47	249	29.7	1.1	621.70
47	280.5		621.95			47	249	32.4	1.2	621.88
47	306		622.12			47	249	35.1	1.3	622.03
47	331.5		622.29			47	249	37.8	1.4	622.17

TABLE 5

CHILAKO RIVER SENSITIVITY STUDIES

"Q" SENSITIVITY				FLD LVL	FLD LVL	"n" SENSITIVITY				
XS	Q	FCTR	CWSEL	I+0.3	D+0.6	XS	Q	K*XNCH	FCTR	CWSEL
48	259	200 I	621.87	622.17	**622.44**	48	249	32		621.63
48	255	200 D	621.84			48	249	35.2		621.80
48	280.5	D x 1.1	622.05			48	249	38.4		621.98
48	306	D x 1.2	622.22			48	249	41.6		622.13
48	331.5	D x 1.3	622.39			48	249	44.8		622.28
49	259		622.04	622.34	**622.61**	49	249	27	1	621.80
49	255		622.01			49	249	29.7	**1.1**	621.96
49	280.5		622.21			49	249	32.4	1.2	622.13
49	306		622.39			49	249	35.1	1.3	622.28
49	331.5		622.56			49	249	37.8	1.4	622.43

TABLE 6

BEAVERLEY CREEK FLOOD LEVEL SELECTION					
SUMMARY PRINTOUT					
XS	FRQ	Q	K*XNCH	CWSEL	FLD LVL
1	Q 200 I	61	38.5	617.00	617.30
1*	Q 200 D	54	38.5	617.00	**617.60**
1	Q20 I	46	38.5	617.00	617.30
1 *	Q20 D	41	38.5	617.00	**617.60**
2		61	44	619.13	619.43
2		54	44	619.01	**619.61**
2		46	44	618.83	619.13
2		41	44	618.70	**619.30**
3	Q 200 I	61	44	621.13	621.43
3	Q 200 D	54	44	621.04	**621.64**
3	Q20 I	46	44	621.03	621.33
3	Q20 D	41	44	621.02	**621.62**
4		61	33	623.65	623.95
4		54	33	623.57	**624.17**
4		46	33	623.40	623.70
4		41	33	623.28	**623.88**
5	Q 200 I	61	33	626.32	626.62
5	Q 200 D	54	33	626.22	**626.82**
5	Q20 I	46	33	626.10	626.40
5	Q20 D	41	33	626.01	**626.61**
6		61	38.5	629.25	629.55
6		54	38.5	629.18	**629.78**
6		46	38.5	629.09	629.39
6		41	38.5	629.02	**629.62**
7	Q 200 I	61	44	631.56	631.86
7	Q 200 D	54	44	631.46	**632.06**
7	Q20 I	46	44	631.33	631.63
7	Q20 D	41	44	631.26	**631.86**

* Chilako River flood level dominates at this section.

TABLE 7

BEAVERLEY CREEK SENSITIVITY STUDIES

"Q" SENSITIVITY				FLD LVL	FLD LVL	"n" SENSITIVITY				
XS	Q	FCTR	CWSEL	I+0.3	D+0.6	XS	Q	K*XNCH	FCTR	CWSEL
1*	54	1	617.00	617.30	**617.60**	1	54	38.5	1.1	617.00
1	59.4	1.1	617.00			1	54	42	1.2	617.00
1	64.8	1.2	617.00			1	54	45.5	1.3	617.00
1	70.2	1.3	617.00			1	54	49	1.4	617.00
2	54		619.01	619.43	**619.61**	2	54	44		619.01
2	59.4		619.10			2	54	48		619.09
2	64.8		619.20			2	54	52		619.16
2	70.2		619.27			2	54	56		619.22
3	54	1	621.04	621.43	**621.64**	3	54	44	1.1	621.04
3	59.4	1.1	621.11			3	54	48	1.2	621.03
3	64.8	1.2	621.18			3	54	52	1.3	621.03
3	70.2	1.3	621.26			3	54	56	1.4	621.05
4	54		623.57	623.95	**624.17**	4	54	33		623.57
4	59.4		623.63			4	54	36		623.64
4	64.8		623.69			4	54	39		623.72
4	70.2		623.74			4	54	42		623.77
5	54	1	626.22	626.62	**626.82**	5	54	33	1.1	626.22
5	59.4	1.1	626.30			5	54	36	1.2	626.22
5	64.8	1.2	626.37			5	54	39	1.3	626.22
5	70.2	1.3	626.44			5	54	42	1.4	626.22
6	54		629.18	629.55	**629.78**	6	54	38.5		629.18
6	59.4		629.23			6	54	42		629.22
6	64.8		629.28			6	54	45.5		629.32
6	70.2		629.33			6	54	49		629.40
7	54	1	631.46	631.86	**632.06**	7	54	44	1.1	631.46
7	59.4	1.1	631.54			7	54	48	1.2	631.54
7	64.8	1.2	631.62			7	54	52	1.3	631.56
7	70.2	1.3	631.70			7	54	56	1.4	631.60

* Chilako River flood level dominates at this section.

APPENDICES

APPENDIX 1

Detailed Information Sources

No.	Source	Contents
1.	Technical Support Section, Water Management Division - Project No. 93 30 F043 dated September 1993	50 cross sections on the Chilako River, including photos of each section and bridge details
2.	Map Production Division, Surveys and Resource Mapping Branch, Project No. 89-078T, dated 1992	Base mapping for the Chilako River - 1:5000 scale, 1 metre contour intervals, NAD83 from 1990 Air photography
3.	United States Geological Survey Water Supply Paper #2339	Guide for selecting Manning's Roughness Coefficients for Natural Channels and Floodplains
4.	Environment Canada - Magnitude of Floods - British Columbia and Yukon Territory - September 1982	Flood frequency rankings and estimates for Water Survey of Canada stream gauges.
5.	Environment Canada - Historical Streamflow Summary - British Columbia to 1990	Streamflow records for Water Survey of Canada stream gauges.
6.	Hydrology Branch, Water Management Division	Snow Survey Measurements Summary 1935 to 1985
7.	Atmospheric Environment Services Environment Canada - Canadian Climate Normals	British Columbia Normals and Extreme Climate conditions.
8.	Geodetic Survey of Canada Bulletin # 6 by H.W. Tipper	Glacial Geomorphology and Pleistocene History - Central B.C.
9.	Soil Survey Report #4 - British Columbia by L. Farstad and D.G. Laird	Soil classifications and history in Central B.C.
10.	Prince George Regional Water Management Files	Background information on flood and erosion complaints.

APPENDIX 2

APPENDIX 2

Study No. 422
May 1996
file: 76840-40

SURFACE WATER SECTION REPORT

CHILAKO RIVER NEAR PRINCE GEORGE

DETERMINATION OF 20 AND 200 YEAR PEAK FLOWS

At the request of the Floodplain Mapping Unit, a hydrology study was carried out to determine the 20-year and 200-year peak flows on the Chilako River below and above the mouth of the Beaverley Creek and on Beaverley Creek at the mouth.

The Chilako River is one of the major tributaries of the Nechako river entering the Nechako 35 km upstream from the mouth at Prince George. Its watershed drains a portion of the Nechako Plateau. Beaverley Creek is tributary to the Chilako River entering approximately 10 km above the mouth of the Chilako. The major portion of the annual runoff is the result of melting of the annual snowpack. The annual peak flows are the result of snowmelt or rain combined with snowmelt with most of the annual peaks occurring in April or May.

Hydrometric data are available from five gauges in the vicinity of the study area. These gauges with their period of record of annual peak flows used in this study are shown below.

Chilako River near Prince George	8JC005	1961 to 1974
Nazko River above Michelle Creek	8KF001	1965 to 1994
West Road River near Cinema	8KG001	1960 to 1994
Little Swift at the mouth	8KE024	1972 to 1994
Baker Creek at Quesnel	8KE016	1964 to 1994

Beaverley Creek was measured April to September 1982 only at gauge:

Beaverley Creek near the mouth	8JC014

The method used for determining peak flows at the required locations was based on a regional approach using the above data in the study area plus data from other stations in the two hydrologic zones including estimates based on short term rainfall at the Prince George weather station.

1. Data Analysis

A regional analysis of hydroclimatic zones is currently being carried out by the Surface Water Section. The datasheets from the regional analysis for the Nechako Lowland and Central Interior Plateau zones were utilized for the Chilako study. The datasheets for the five nearby stations are included in this report. The datasheets include an analysis of peak flow.

2. Frequency Analysis of Instantaneous Peak Flows

The frequency analysis results were extracted from the datasheets. For these particular zones, the Pearson type III and log-Pearson type III distributions were selected. The following table provides a summary of instantaneous peak flow for applicable stations as taken from the datasheets.

		inst peak flow m^3/s				
Station	da km^2	10-yr	20-yr	100-yr	200-yr	1982
West Road	12400	289	337	438	480	174
Stellako	3600	119	139	183	201	70
Chilako	3390	136	159	213	235	na
Nazko	3240	73	88	119	132	37
MacIvor	53	11	12	14	14	na
Little Swift	133	46	53	70	77	49
Baezaeko	992	22	25	31	34	11
Chuchinka	311	74	82	97	103	54
Big - Graveyard	232	38	49	75	87	23
Big - Groundhog	1020	78	98	147	169	54
Tsilcoh	414	44	49	62	67	40
Nautley	6030	175	202	258	282	124
Baker	1570	76	92	124	137	51
Rational (moderate)	25	16	17	22	na	na
Rational (moderate)	10	9	10	13	na	na

The 10-year return period instantaneous peak flows were plotted against drainage area and a best fit curve was drawn through the points (see attached graph). This curve was then used to estimate the 10-year peak flow at the required locations. The ratios of the other return period flows to the 10-year flow were also plotted against drainage area and regional curves fitted (attached). These curves were also used for estimates at the required locations.

3. Instantaneous Peak Flows Estimates

The determination of instantaneous peak flows at the required locations was done using the regional curves described above. Instantaneous peak flows on Chilako River at the gauge, below Beaverley Creek and at the mouth as well as Beaverley Creek at the mouth were determined for the 10, 20, 100 and 200 year return periods. The results are in the following table.

		inst peak flow m^3/s				
Station	da km^2	10-yr	20-yr	100-yr	200-yr	1982
Chilako (gauge)	3390	158	186	238	261	93
Beaverley	145	41	46	56	61	20
Chilako below Beaverley	3535	160	189	242	266	95
Chilako (mouth)	3576	161	190	243	268	95

The instantaneous peak flow for 1982 was also estimated by the regional method in order to compare with the observed flow on Beaverley Creek.

4. Daily Peak Flows Estimates

The new regional methods do not use daily peak flows so ratios of instantaneous to daily peak flows were determined from an earlier procedure. These I/D ratios and the resulting estimates of return period daily peak flows are shown in the table below.

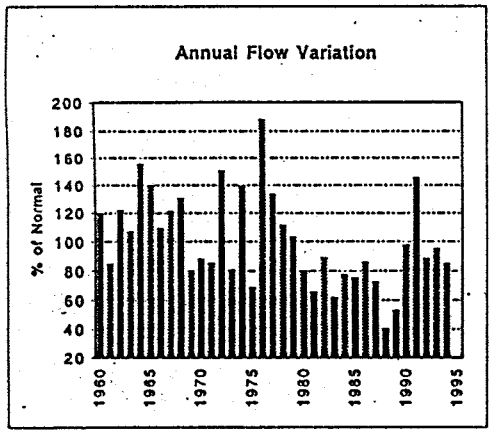
Station	I/D ratio	daily peak flow m^3/s 20-yr	200-yr
Chilako (gauge)	1.04	179	251
Beaverley	1.13	41	54
Chilako below Beaverley	1.04	182	256
Chilako (mouth)	1.04	183	257

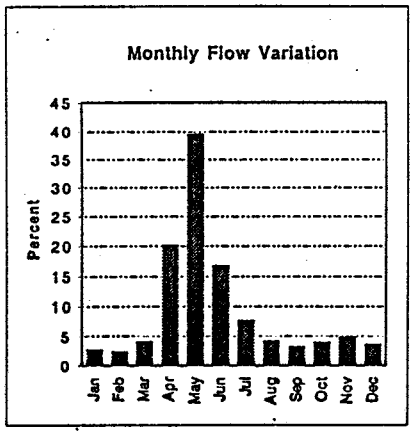
C.H. Coulson
Surface Water Section

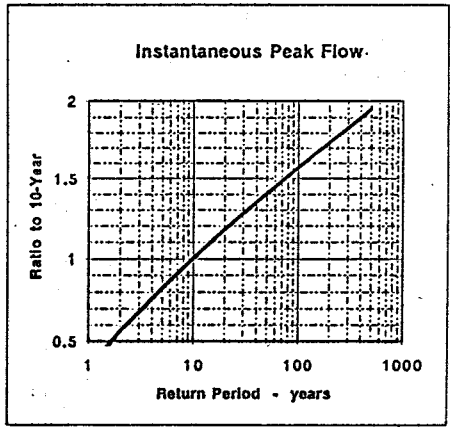
CHILAKO RIVER NEAR PRINCE GEORGE 8JC005

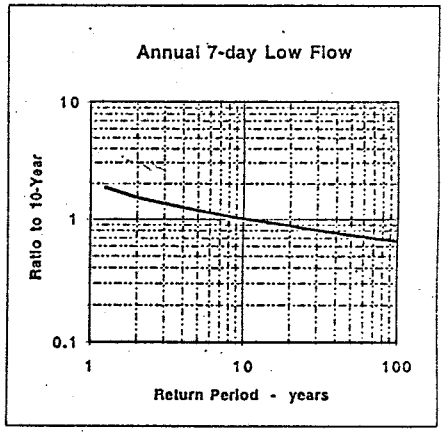
Monthly and Annual Flow in m3/s — d.a. = 3370 km2 — median elevation = 902 m

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Instantaneous Peak Flow date	m3/s	7-Day Low Flow Jun-Sep	Annual	Year
1960	9.8	8.0	10.3	58.1	33.8	32.0	8.4	3.6	3.4	4.3	3.5	2.4	14.7			2.64	2.41	1960
1961	2.4	2.8	5.9	33.1	50.7	11.5	4.7	1.8	1.6	2.5	3.2	4.4	10.4	May 09	76.9	1.35	1.35	1961
1962	4.3	3.4	3.6	39.2	38.6	26.2	12.8	6.4	4.0	11.5	16.6	12.8	15.0	Apr 21	58.7	3.51	3.40	1962
1963	9.3	7.4	11.4	41.9	45.0	14.4	7.0	4.4	4.1	4.7	4.2	3.6	13.1	Apr 19	77.5	3.88	3.09	1963
1964	2.8	3.2	4.2	17.7	46.6	48.0	33.9	26.7	17.6	11.2	8.7	7.8	19.1	Jun 07	71.2	11.9	2.75	1964
1965	6.6	6.4	10.2	41.6	84.8	26.3	7.5	5.0	3.8	4.8	4.4	3.7	17.2			3.39	3.37	1965
1966	3.5	3.4	5.5	38.9	52.0	21.2	10.5	4.9	4.2	4.6	6.2	5.4	13.4	May 13	81.3	3.52	2.98	1966
1967	4.1	3.8	4.1	20.3	82.8	33.2	7.7	4.5	3.3	4.5	6.0	3.3	14.9	May 12	98.9	2.92	2.74	1967
1968	2.9	3.3	7.3	22.5	55.1	28.8	13.5	7.5	9.3	12.0	21.2	8.2	16.0	May 27	71.2	6.36	2.51	1968
1969	4.1	3.6	4.4	27.7	25.4	10.4	4.0	2.6	5.7	8.4	10.9	8.8	9.7	Apr 13	37.4	2.36	2.36	1969
1970	4.2	3.4	5.9	22.9	51.4	22.1	5.2	3.7	2.8	3.2	2.6	1.9	10.8	May 19	75.4	2.59	1.85	1970
1971	2.1	3.0	3.1	18.4	49.3	15.3	15.1	4.2	3.3	3.6	3.8	3.7	10.5	May 02	75.4	2.94	1.93	1971
1972	3.5	3.6	10.8	31.7	84.8	38.6	17.0	7.9	4.5	4.7	9.3	4.3	18.4	May 18	153.9	4.12	3.38	1972
1973	4.2	3.1	3.0	21.9	42.1	20.9	7.6	2.9	2.3	4.1	3.4	2.9	9.9	May 12	56.9	1.88	1.88	1973
1974	2.7	3.2	4.5	43.3	92.8	33.7	9.7	3.8	2.4	2.5	1.8	3.7	17.1	May 02	173.7	2.03		1974
1975													8.4					1975
1976													23.1					1976
1977													16.4					1977
1978													13.7					1978
1979													12.7					1979
1980													9.8					1980
1981													8.1					1981
1982													10.9					1982
1983													7.6					1983
1984													9.5					1984
1985													9.2					1985
1986													10.6					1986
1987													8.9					1987
1988													5.0					1988
1989													6.5					1989
1990													12.0					1990
1991													17.9					1991
1992													10.9					1992
1993													11.7					1993
1994													10.4					1994
1995																		1995
normal	4.1	3.8	6.0	30.1	57.2	25.0	11.2	6.2	4.9	5.9	7.3	5.3	12.3	average	85.3	3.69	2.57	average
mm	3	3	5	23	45	19	9	5	4	5	6	4	115	10-year	135.7	1.78	1.72	10-year





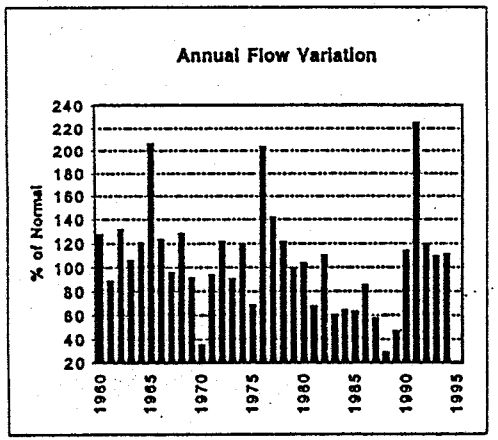


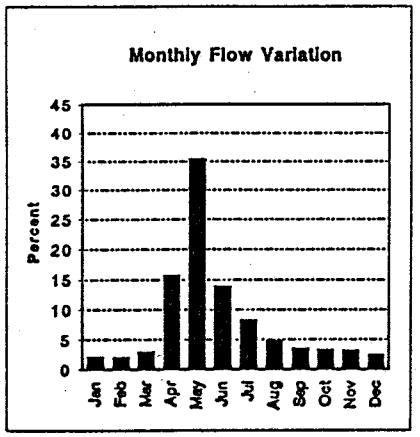


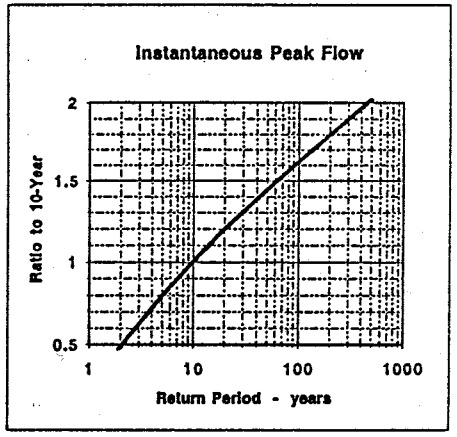
NAZKO RIVER ABOVE MICHELLE CREEK 8KF001

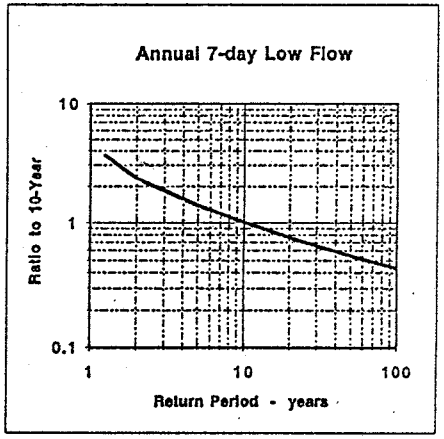
Monthly and Annual Flow in m3/s | d.a. = 3240 km2 | median elevation = m | Instantaneous Peak Flow | 7-Day Low Flow

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	date	m3/s	Jun-Sep	Annual	Year
1960													5.99					1960
1961													4.18					1961
1962													6.17					1962
1963													4.98					1963
1964													5.67					1964
1965	1.77	2.30	2.65	28.60	47.50	14.50	5.45	3.14	2.06	3.09	2.62	2.04	9.68	Apr 29	115.0	1.650	1.510	1965
1966	1.68	1.49	1.25	19.00	18.70	9.51	5.85	4.58	1.81	2.07	1.86	1.60	5.79	May 07	26.4	1.540	1.090	1966
1967	1.72	1.71	1.56	3.25	34.70	6.57	1.11	0.41	0.21	0.76	0.91	0.63	4.50	May 09	53.8	0.168	0.168	1967
1968	0.76	0.80	1.34	4.99	33.60	15.60	3.91	3.10	2.24	1.63	2.33	1.63	6.02	May 26	43.6	1.800	0.565	1968
1969	1.36	1.18	1.46	15.00	13.00	3.31	6.08	1.18	1.96	2.34	2.90	1.72	4.30	Apr 14	28.9	0.512	0.512	1969
1970	1.38	1.21	0.99	3.14	6.97	2.63	0.69	0.42	0.61	0.83	0.52	0.69	1.68	May 17	9.9	0.364	0.364	1970
1971	0.86	0.96	1.13	8.28	24.90	5.95	3.10	2.03	1.29	1.28	1.46	1.30	4.41	May 05	43.3	0.928	0.783	1971
1972	1.08	0.88	2.29	6.61	34.30	13.30	3.44	1.12	0.81	1.09	1.93	1.37	5.71	May 16	59.0	0.588	0.553	1972
1973	1.51	2.05	2.83	9.58	23.20	4.50	1.68	0.82	0.79	1.35	1.23	1.25	4.25	May 05	40.6	0.702	0.702	1973
1974	1.06	1.14	1.62	13.60	33.00	9.55	2.97	0.66	0.43	0.89	0.90	1.03	5.60	May 02	73.8	0.385	0.385	1974
1975	1.05	0.96	1.25	4.26	14.20	5.44	2.52	1.40	1.52	1.31	2.95	1.80	3.24	May 13	20.1	1.150	0.929	1975
1976	1.66	1.76	1.89	14.10	30.90	15.60	7.85	17.10	9.87	5.23	4.56	3.99	9.55	May 06	67.7	3.820	1.580	1976
1977	2.36	2.62	2.53	11.30	25.47	7.10	11.30	5.42	4.13	3.51	2.24	1.62	6.67			3.560	1.380	1977
1978	1.44	1.65	1.85	15.80	28.10	9.21	1.95	1.71	2.06	1.59	1.55	1.45	5.71	May 12	32.8	1.240	1.240	1978
1979	1.29	1.34	2.10	5.68	29.70	7.70	3.51	1.02	0.59	0.88	0.79	0.97	4.67	May 05	51.8	0.513	0.513	1979
1980	0.74	0.61	0.79	5.86	4.59	11.70	19.90	3.47	4.07	2.52	2.35	1.78	4.88	Jun 28	41.7	3.080	0.570	1980
1981	1.53	1.66	2.68	4.56	7.86	8.86	3.95	2.42	1.24	1.22	1.27	1.07	3.20	May 28	16.1	0.978	0.971	1981
1982	0.88	0.78	0.64	2.00	24.70	5.15	5.68	4.91	6.24	5.52	3.42	1.51	5.16	May 16	37.4	2.230	0.599	1982
1983	0.89	1.13	1.66	3.62	2.80	3.47	9.42	3.32	1.57	1.92	2.77	1.38	2.84	Jul 23	21.3	1.300	0.868	1983
1984	1.04	1.08	1.70	6.67	10.10	7.04	2.95	0.79	1.07	1.75	1.16	1.05	3.03	May 16	16.5	0.538	0.538	1984
1985	1.02	1.28	1.98	11.20	12.70	3.89	0.42	0.34	0.44	1.24	0.86	0.49	2.99	Apr 15	23.9	0.156	0.156	1985
1986	0.88	0.98	1.90	7.23	14.69	10.47	4.04	1.94	1.22	1.90	1.56	1.18	4.01					1986
1987	1.04	1.35	1.95	8.74	12.20	2.05	0.99	0.68	1.06	0.94	0.83	0.56	2.70	May 03	31.5			1987
1988	0.40	0.44	0.77	3.51	3.37	2.67	1.48	0.92	0.46	0.81	1.05	0.58	1.37	Apr 20	6.7	0.323	0.323	1988
1989	0.55	0.42	0.37	3.48	3.70	1.81	2.90	4.92	3.65	1.53	1.73	1.34	2.21	Aug 24	10.1	0.896	0.360	1989
1990	1.15	0.97	1.17	13.50	14.00	18.70	6.68	1.58	1.07	1.54	1.97	1.87	5.35	Jun 14	46.6	0.735	0.730	1990
1991	1.80	1.53	1.39	29.50	34.30	32.00	15.70	2.96	1.48	1.57	2.35	2.30	10.57	Apr 26	90.9	1.270	1.140	1991
1992	1.99	2.06	6.85	31.50	13.30	4.41	2.42	0.81	0.63	0.89	1.44	1.23	5.61	Apr 06	46.2	0.434	0.434	1992
1993	1.04	0.85	0.98	13.40	19.20	6.38	10.20	3.21	1.34	1.73	1.71	1.33	5.14	Apr 27	30.3	1.120	0.775	1993
1994	1.09	0.94	1.33	31.10	10.60	4.81	6.40	1.38	0.95	1.81	1.32	0.99	5.21	Apr 23	42.3	0.864	0.853	1994
1995																		1995
normal	1.20	1.26	1.62	8.98	19.57	7.93	4.61	2.67	2.02	1.87	1.84	1.38	4.68	average	40.3	1.173	0.735	average
mm	1	1	1	7	16	6	4	2	2	2	1	1	46	10-year	73.4	0.299	0.291	10-year





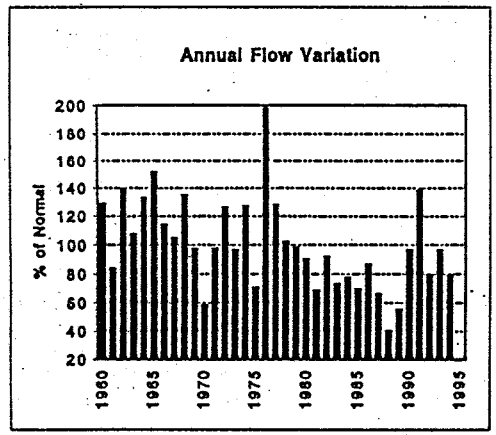


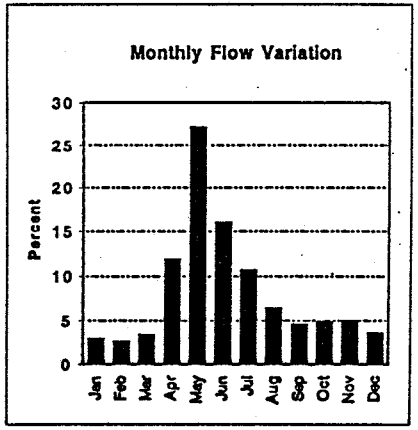


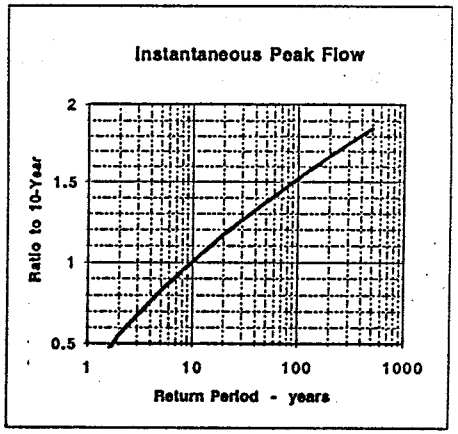
WEST ROAD RIVER NEAR CINEMA 8KG001

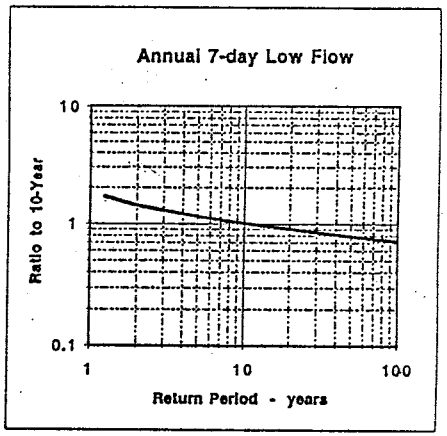
Monthly and Annual Flow in m3/s — d.a. = 12 400 km2 — median elevation = m

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Instantaneous Peak Flow date	m3/s	7-Day Low Flow Jun-Sep	Annual	Year
1960	29.6	24.9	24.1	95.6	81.7	131.0	55.8	23.0	20.7	20.2	16.3	7.9	44.1	Jun 10	178	19.10		1960
1961	8.0	9.1	14.5	59.7	115.0	45.1	25.7	13.8	11.2	14.3	11.7	14.4	28.7	May 12	155	10.50		1961
1962	14.0	11.2	8.8	70.7	93.1	87.0	67.9	53.7	25.5	35.7	60.8	41.7	47.7	Jun 01	148	21.00		1962
1963	30.7	24.6	28.2	75.6	79.7	52.1	50.0	28.0	21.8	21.1	17.1	11.8	36.8			20.10		1963
1964	9.3	10.5	10.4	31.9	76.9	109.0	93.3	62.8	39.4	48.2	32.0	21.5	45.5	Jul 02	146	28.00		1964
1965	21.8	21.2	25.3	68.4	205.0	103.0	52.2	31.6	24.5	28.5	26.5	12.0	51.9	Apr 29	379	21.10		1965
1966	11.6	11.3	13.7	100.0	110.0	67.5	44.8	29.8	18.2	19.4	22.9	17.6	39.0	May 11	154	15.90		1966
1967	13.6	12.6	10.2	36.6	184.0	78.7	23.0	14.4	11.2	16.4	17.4	10.6	35.9	May 11	245	10.10		1967
1968	9.6	10.9	18.1	40.6	132.0	93.1	49.0	31.9	32.5	31.6	77.7	26.9	46.2	May 24	181	23.60		1968
1969	13.5	12.0	10.8	70.2	83.6	38.7	35.4	14.6	21.8	29.0	40.0	28.8	33.3	May 19	105	12.70		1969
1970	14.0	11.1	14.5	30.9	67.6	33.1	11.9	12.0	11.4	12.5	11.7	9.2	20.1	May 19	87	10.80		1970
1971	8.5	8.5	10.1	36.4	150.0	59.6	54.4	17.9	12.7	13.4	13.9	12.6	33.4	May 07	204	11.00	8.00	1971
1972	10.9	9.2	16.8	48.8	180.0	115.0	55.4	25.1	15.7	17.4	30.1	13.0	43.2	May 16	238	14.50	7.94	1972
1973	11.3	11.1	12.5	50.6	146.0	58.7	31.4	19.2	12.9	19.9	10.5	9.8	33.0	May 09	215	10.80	9.07	1973
1974	10.6	13.6	13.5	72.3	194.0	92.5	46.9	22.4	13.9	13.5	12.5	12.2	43.5	May 02	306	12.20	9.08	1974
1975	12.0	10.5	11.0	22.5	77.9	46.9	32.9	18.7	13.5	11.3	18.0	14.6	24.3	May 16	108	11.10	10.30	1975
1976	13.4	13.7	13.5	59.6	230.0	139.0	82.5	112.0	59.1	36.7	30.0	20.2	67.7	May 08	399	41.20	12.90	1976
1977	18.3	20.6	18.5	95.8	146.0	58.8	50.8	29.2	27.4	27.3	18.2	13.4	43.8	Apr 30	228	21.40	12.50	1977
1978	12.5	12.2	13.6	69.8	153.0	63.3	23.2	14.5	15.4	14.1	13.7	13.3	35.0	May 19	185	12.90	11.60	1978
1979	11.4	11.3	13.9	29.3	171.0	72.9	35.2	14.5	10.3	11.5	10.6	9.3	33.6	May 08	294	9.59	8.79	1979
1980	7.4	8.1	10.0	34.2	44.2	62.0	73.9	28.2	40.0	24.4	20.1	18.7	31.0	Jun 30	125	24.50	6.63	1980
1981	15.9	12.7	15.3	26.2	48.4	63.3	30.3	18.6	11.4	12.7	15.0	12.6	23.6	May 30	94	9.77	9.51	1981
1982	11.6	10.5	10.2	19.7	125.0	52.2	39.2	27.2	30.9	23.6	14.6	9.9	31.4	May 19	174	19.00	8.11	1982
1983	9.5	11.4	11.7	23.0	24.1	33.9	78.7	38.2	17.9	17.2	20.5	13.9	25.1	Jul 24	115	17.40	9.19	1983
1984	11.5	12.9	19.9	42.5	64.3	64.0	32.7	15.3	14.5	17.6	12.4	11.3	26.6	May 20	98	12.60	9.78	1984
1985	8.5	9.7	11.4	55.5	82.9	48.4	16.0	9.3	8.2	15.1	12.7	7.9	23.8	Apr 17	99	7.32	7.32	1985
1986	8.8	9.1	16.1	38.6	84.2	86.7	35.6	17.4	11.2	18.5	16.7	11.5	29.6	Jun 03	123	8.17	7.94	1986
1987	10.9	13.7	19.7	56.5	79.7	28.7	17.8	12.4	9.8	9.1	8.8	5.5	22.8	May 05	136	9.11	5.03	1987
1988	5.6	6.1	7.0	24.9	33.4	29.0	15.6	9.7	8.4	9.0	9.3	8.5	13.9	Apr 29	46	7.99	4.92	1988
1989	8.5	7.9	8.6	25.6	48.3	28.0	25.2	23.2	18.2	11.0	11.4	11.1	19.0	May 06	60	12.40	7.64	1989
1990	12.4	10.2	11.8	68.7	74.0	92.5	58.4	15.6	11.5	11.8	14.1	15.7	33.1	Jun 15	165	9.50	8.94	1990
1991	14.3	13.8	14.7	111.0	143.0	114.0	71.7	21.9	13.0	12.7	19.7	16.8	47.3	Apr 26	325	12.40	11.20	1991
1992	14.9	15.5	38.4	93.6	58.2	30.9	19.8	10.7	9.3	10.8	13.4	11.8	27.2	Apr 07	126	8.16	8.16	1992
1993	11.3	9.9	10.7	51.7	101.0	55.6	71.3	26.2	16.2	13.8	14.2	12.3	33.0	Jul 02	134	13.50	9.21	1993
1994	12.3	11.6	14.5	94.7	58.0	31.1	42.9	13.2	10.3	13.7	12.2	9.3	27.0	Apr 24	136	9.96	8.01	1994
1995																		1995
normal	12.2	11.9	14.0	49.5	109.4	66.6	43.0	26.0	19.3	19.7	21.0	14.7	34.1	average	174	14.84	8.82	average
mm	3	2	3	10	24	14	9	6	4	4	4	3	87	10-year	289	8.40	6.29	10-year





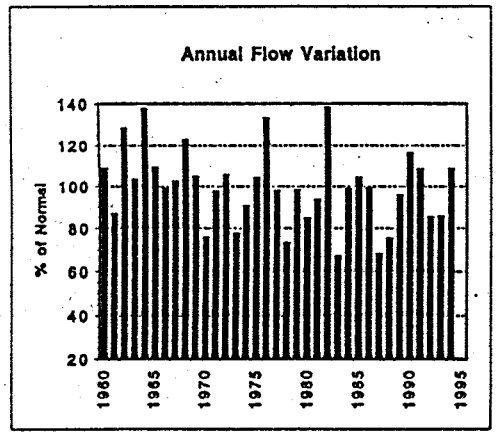


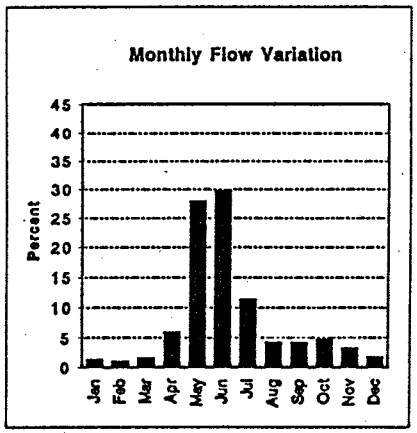


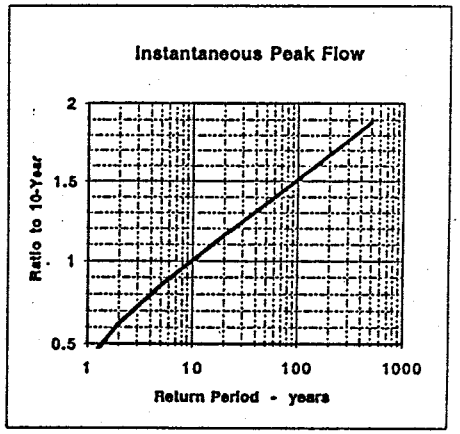
LITTLE SWIFT RIVER AT THE MOUTH 8KE024

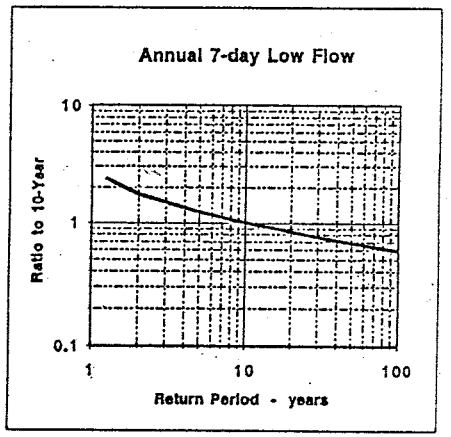
Monthly and Annual Flow in m3/s — d.a. = 133 km2 — median elevation = m — Instantaneous Peak Flow — 7-Day Low Flow

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	date	m3/s	Jun-Sep	Annual	Year
1960													3.07					1960
1961													2.45					1961
1962													3.62					1962
1963													2.91					1963
1964													3.88					1964
1965													3.08					1965
1966													2.80					1966
1967													2.89					1967
1968													3.46					1968
1969													2.95					1969
1970													2.14					1970
1971										1.37	1.49	0.93	2.75					1971
1972	0.40	0.35	1.06	1.41	10.60	13.20	3.35	0.63	0.64	2.09	1.32	0.65	2.98	May 29	37.7	0.369	0.306	1972
1973	0.43	0.32	0.32	0.68	9.57	8.08	2.09	0.64	0.69	1.98	0.84	0.46	2.19	May 24	24.2	0.325	0.310	1973
1974	0.31	0.30	0.31	1.32	6.71	13.00	6.04	0.82	0.39	0.68	0.41	0.35	2.56	Jun 16	25.8	0.263	0.263	1974
1975	0.35	0.21	0.19	0.59	6.73	15.00	3.95	2.93	1.21	1.83	1.51	0.71	2.94	Jun 13	23.7	0.642	0.159	1975
1976	0.63	0.60	0.56	1.32	13.20	13.70	6.70	3.98	1.79	1.02	0.76	0.70	3.76	May 10	39.9	0.986	0.510	1976
1977	0.58	0.59	0.55	4.39	9.05	8.36	3.45	1.57	2.16	1.17	0.71	0.51	2.76	Apr 26	23.7	0.710	0.400	1977
1978	0.35	0.27	0.25	1.94	6.40	5.57	1.85	1.47	3.04	2.16	1.03	0.31	2.06	May 20	17.7	0.336	0.199	1978
1979	0.22	0.22	0.53	1.07	11.20	13.00	3.32	0.72	0.65	1.54	0.38	0.22	2.77	May 26	38.8	0.269	0.191	1979
1980	0.14	0.12	0.19	3.16	7.39	4.68	3.76	2.08	3.51	1.40	1.18	1.07	2.39	Apr 29	19.0	1.050	0.109	1980
1981	1.35	0.97	0.72	1.61	11.40	6.54	2.16	0.78	0.90	1.01	2.86	0.64	2.64	May 31	36.3	0.438	0.438	1981
1982	0.51	0.48	0.38	0.95	8.42	14.60	10.20	3.35	3.14	2.51	1.28	0.82	3.90	Jul 22	46.5	1.680	0.321	1982
1983	0.55	0.43	0.42	2.06	5.64	5.51	4.43	0.70	1.00	0.83	0.75	0.33	1.89	Jun 18	14.9	0.375	0.177	1983
1984	0.19	0.21	0.46	1.97	4.90	13.20	6.00	0.98	2.43	1.84	0.77	0.58	2.79	Jun 12	25.5	0.701	0.173	1984
1985	0.34	0.29	0.29	1.35	11.70	12.60	1.49	0.65	1.47	3.68	0.98	0.41	2.95	Jun 05	34.3	0.422	0.269	1985
1986	0.47	0.39	1.20	2.04	9.52	11.70	3.21	0.79	0.92	1.16	1.33	0.75	2.80	Jun 01	39.6	0.505	0.331	1986
1987	0.61	1.06	2.37	2.77							0.58	0.31	1.92	May 08	17.7		0.252	1987
1988	0.21	0.22	0.26	4.22	9.38	5.65	1.48	1.31	0.69	0.65	0.95	0.48	2.13	May 14	39.0	0.489	0.195	1988
1989	0.40	0.39	0.32	2.38	13.10	5.73	2.21	1.78	0.88	1.05	2.88	1.10	2.70	May 09	22.8	0.652	0.315	1989
1990	0.81	0.51	0.56	4.04	12.00	13.80	2.40	0.73	0.73	1.85	1.16	0.67	3.28	Jun 12	60.9	0.450	0.429	1990
1991	0.34	1.06	0.88	3.41	11.50	10.40	3.41	1.22	1.15	1.31	1.19	0.77	3.06	May 19	27.4	0.718	0.312	1991
1992	0.59	0.68	1.59	5.34	7.83	4.53	0.92	1.01	1.80	2.37	1.69	0.56	2.41	Apr 30	23.6	0.462	0.387	1992
1993	0.30	0.30	0.39	2.86	12.70	4.90	3.24	1.06	0.58	0.77	0.96	0.70	2.41	May 15	45.1	0.485	0.289	1993
1994	0.67	0.63	0.80	6.35	11.77	7.36	4.48	0.94	0.94	1.47	0.69	0.51	3.06	May 11	24.2	0.662	0.454	1994
1995																		1995
normal	0.47	0.42	0.58	2.07	9.27	10.22	3.78	1.44	1.46	1.60	1.16	0.60	2.81	average	30.9	0.600	0.295	average
mm	9	8	12	40	187	199	76	29	28	32	23	12	667	10-year	46.4	0.309	0.164	10-year





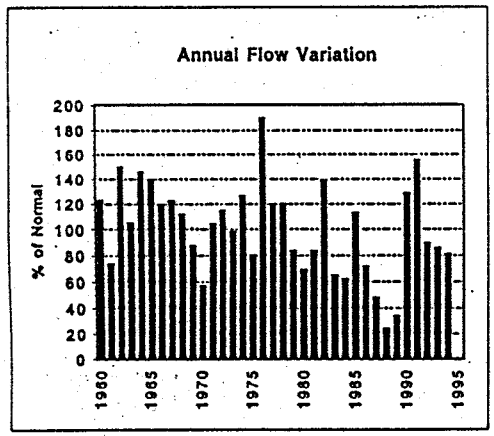


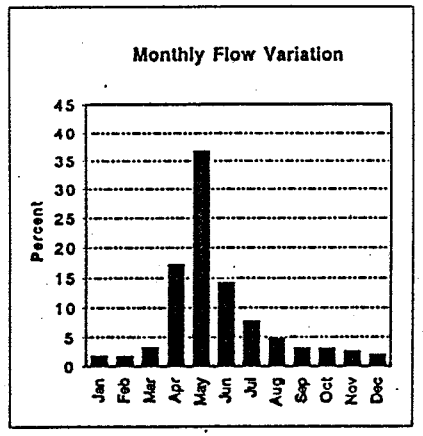


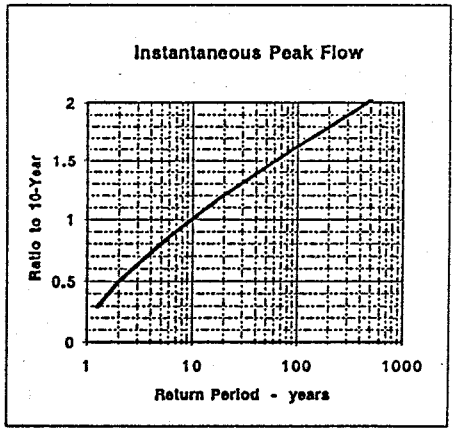
BAKER CREEK AT QUESNEL 8KE016

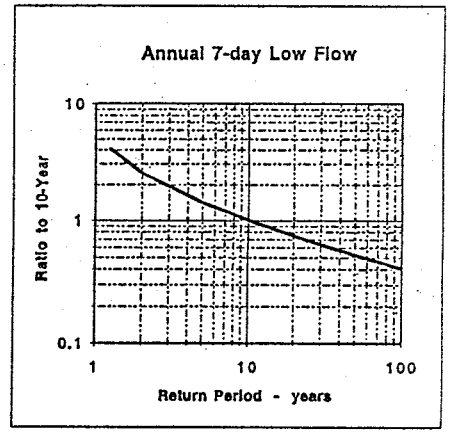
Monthly and Annual Flow in m3/s — d.a. = 1570 km2 — median elevation = m

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Instantaneous Peak Flow date	Instantaneous Peak Flow m3/s	7-Day Low Flow Jun-Sep	7-Day Low Flow Annual	Year
1960													5.91					1960
1961													3.54					1961
1962													7.18					1962
1963							3.92	1.89	1.43	1.33	1.07	0.73	5.03			1.280		1963
1964	0.67	0.84	1.03	4.83	19.20	17.30	11.00	12.40	6.04	5.47	2.52	2.20	6.98	May 11	30.0	2.570	0.623	1964
1965	1.98	1.93	2.10	19.10	33.50	10.40	4.09	2.23	1.28	1.31	1.15	1.24	6.72	Apr 29	72.9	1.140	1.010	1965
1966	1.19	1.18	1.56	15.90	24.50	9.19	5.55	3.79	1.41	1.65	1.45	1.26	5.74	May 10	42.2	1.040	1.000	1966
1967	1.46	1.40	1.25	4.69	41.90	10.50	2.94	1.18	0.26	1.20	2.33	0.81	5.88	May 09	70.1	0.146	0.146	1967
1968	0.65	0.70	4.08	5.55	25.50	13.50	5.84	2.20	1.59	1.82	1.70	0.98	5.36	May 24	34.2	1.330	0.347	1968
1969	0.50	0.68	1.04	15.90	12.20	2.95	3.17	1.52	3.43	3.13	3.55	2.30	4.20	Apr 16	32.4	1.110	0.449	1969
1970	1.51	1.26	1.39	5.85	14.10	4.43	0.77	0.56	0.64	1.01	0.41	0.78	2.74	May 18	19.0	0.269	0.264	1970
1971	0.83	0.87	0.90	8.22	30.40	8.57	5.02	1.12	0.71	0.98	0.93	0.95	5.00	May 06	60.1	0.496	0.496	1971
1972	1.07	1.07	3.30	9.46	29.30	11.00	3.24	1.74	0.81	1.13	2.39	1.22	5.50	May 17	52.9	0.676	0.676	1972
1973	1.13	1.04	1.27	12.40	26.70	5.94	1.56	0.58	0.54	1.21	0.92	0.89	4.71	May 06	49.0	0.389	0.389	1973
1974	0.77	0.99	1.14	18.40	35.90	9.90	2.26	0.49	0.48	0.62	0.65	0.97	6.07	May 02	70.8	0.332	0.332	1974
1975	0.94	0.56	0.91	4.59	19.90	6.76	3.50	2.59	1.78	1.10	1.95	1.41	3.86	May 13	30.7	1.070	0.454	1975
1976	1.53	1.42	1.36	17.40	33.50	13.90	7.05	17.80	6.39	3.10	2.90	2.34	9.09	May 06	71.1	2.850	1.200	1976
1977	1.84	2.40	2.20	16.60	21.00	7.55	5.29	2.11	3.33	4.13	1.65	0.89	5.76	Apr 29	38.3	1.370	0.834	1977
1978	0.99	1.56	5.94	15.80	23.40	10.60	3.22	1.24	2.27	1.66	1.19	1.07	5.76	May 02	38.3	0.759	0.759	1978
1979	0.88	0.88	1.68	7.34	24.90	6.35	2.76	0.49	0.32	0.60	0.76	0.93	4.02	May 06	58.4	0.195	0.195	1979
1980	0.77	0.52	0.75	4.92	5.14	7.85	7.02	2.49	4.76	2.37	1.85	1.49	3.33	Jul 03	14.7	1.860	0.463	1980
1981	1.32	1.66	3.12	6.40	12.50	13.10	4.13	2.12	0.75	0.85	1.12	1.06	4.02	May 31	24.6	0.598	0.598	1981
1982	1.08	0.85	0.81	3.19	32.20	6.86	11.40	7.66	7.53	4.37	2.02	1.22	6.66	May 17	50.7	2.130	0.738	1982
1983	1.02	1.25	1.56	5.52	4.13	3.51	9.34	3.75	1.87	1.81	2.39	1.18	3.12	Jul 25	16.3	1.690	0.773	1983
1984	0.75	0.88	1.93	7.79	10.10	6.09	2.32	0.86	1.36	1.61	1.21	1.11	3.00	May 18	17.3	0.555	0.555	1984
1985	1.17	1.24	2.04	17.30	30.80	6.42	0.88	0.37	0.44	2.09	1.21	0.66	5.41	May 21	44.7	0.145	0.145	1985
1986	0.82	1.33	3.31	6.99	12.80	5.69	3.09	1.19	0.72	1.91	1.89	1.55	3.45	May 24	24.7	0.418	0.418	1986
1987	1.25	1.46	2.78	8.05	10.20	1.75	0.48	0.32	0.16	0.32	0.65	0.34	2.32	May 03	31.6	0.101	0.101	1987
1988	0.23	0.46	0.86	4.17	4.40	1.71	0.53	0.28	0.16	0.28	0.61	0.51	1.18	Apr 25	9.1	0.124	0.124	1988
1989	0.49	0.30	0.48	3.69	4.92	1.47	1.29	2.85	1.09	0.68	1.35	0.97	1.64	May 02	9.3	0.570	0.258	1989
1990	1.13	1.02	1.16	20.20	14.40	19.80	10.90	0.93	0.49	1.34	1.44	1.15	6.16	Jun 13	63.0	0.344	0.336	1990
1991	1.25	3.54	2.37	35.80	24.50	9.13	5.87	1.33	0.85	1.24	1.99	1.81	7.46	Apr 26	135.5	0.642	0.610	1991
1992	1.85	2.01	11.80	21.40	8.23	2.28	0.63	0.30	0.37	0.71	1.14	0.94	4.30	Apr 06	34.9	0.213	0.213	1992
1993	0.73	0.64	0.92	13.60	18.80	3.79	6.02	1.51	0.52	0.82	0.95	0.87	4.12	May 03	31.3	0.453	0.441	1993
1994	0.79	0.79	1.42	21.20	8.64	3.66	6.19	0.81	0.67	1.27	0.79	0.65	3.90	Apr 23	40.5	0.517	0.517	1994
1995																		1995
normal	1.04	1.10	1.85	10.01	20.72	8.26	4.38	2.74	1.86	1.75	1.54	1.15	4.78	average	42.5	0.856	0.499	average
mm	2	2	3	17	35	14	7	5	3	3	3	2	96	10-year	76.4	0.182	0.179	10-year

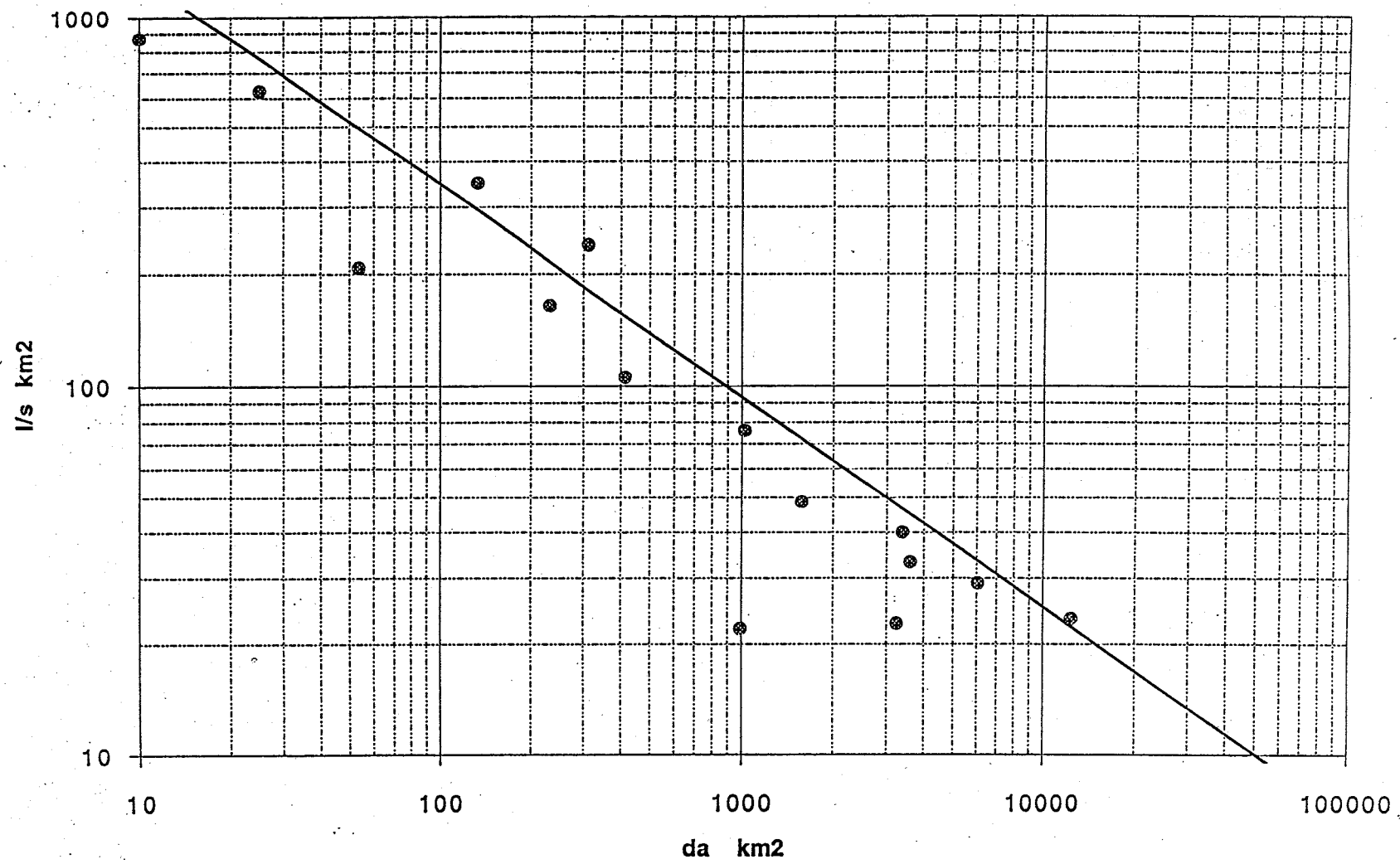


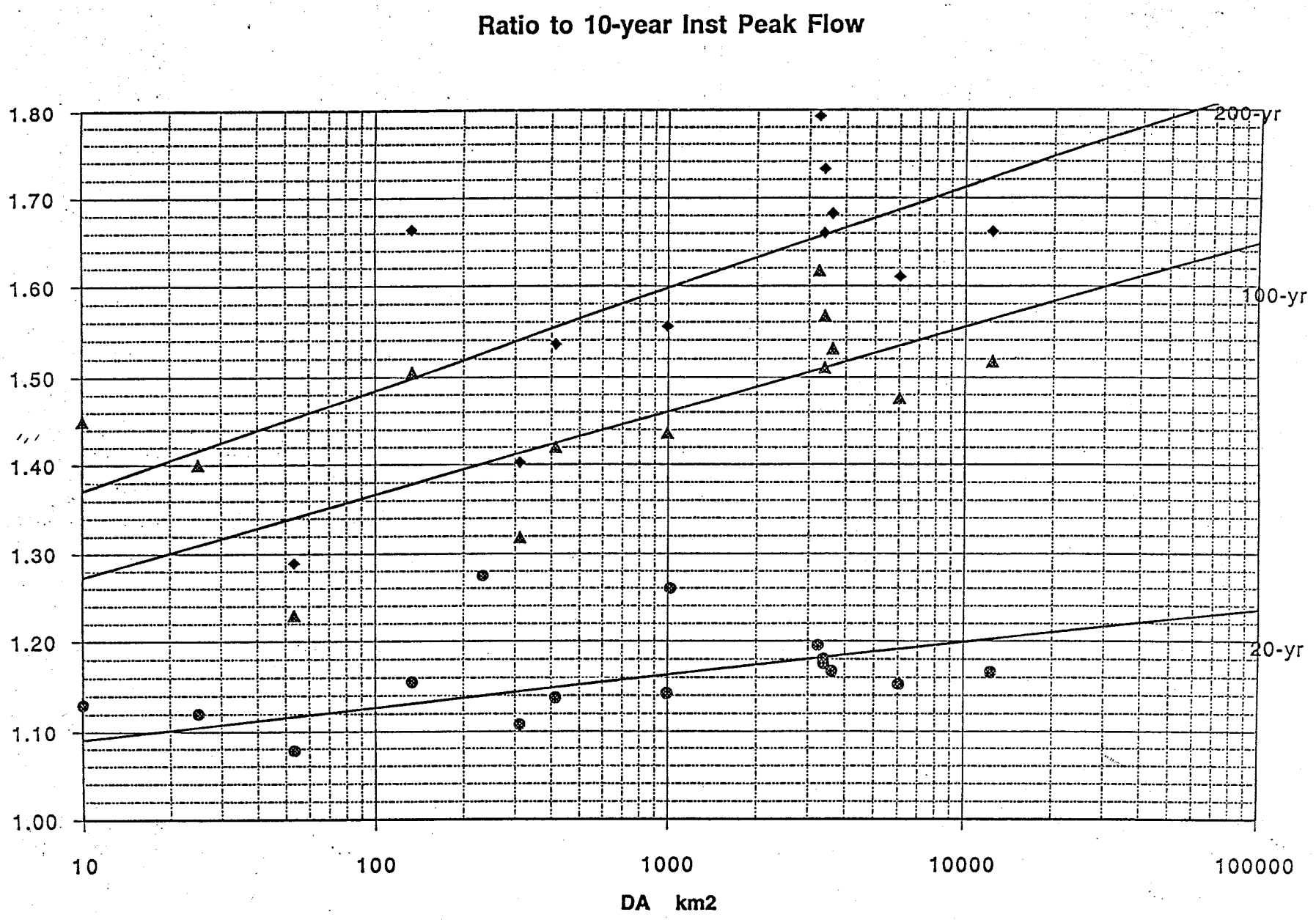






10-year Inst Peak Flow




Ratio to 10-year Inst Peak Flow
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
200-yr
100-yr
20-yr
10
100
1000
10000
100000
DA km2

APPENDIX 3

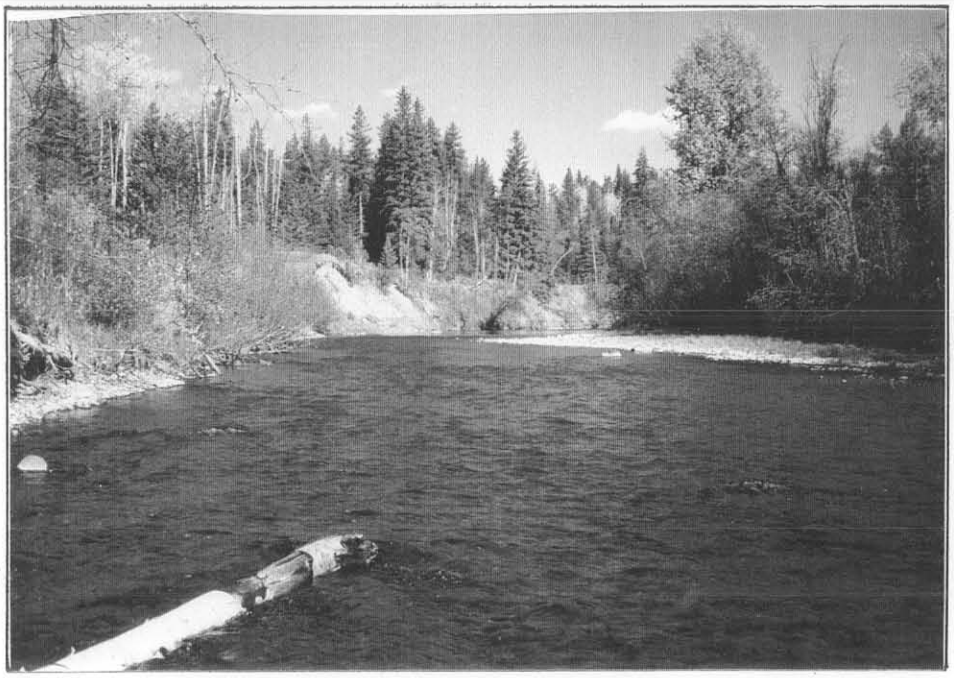
PHOTOGRAPHS

CHILAKO RIVER at BEAVERLEY PROJECT No. 93 30 F 043 SEPTEMBER 1993

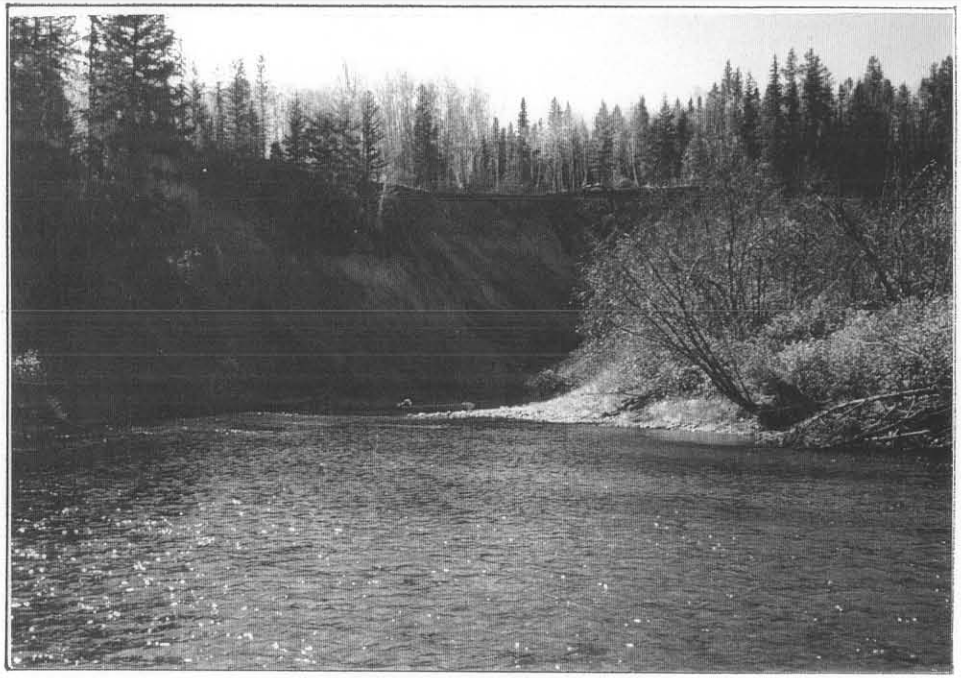
LEFT BANK VIEW

XS-5

RIGHT BANK VIEW



UPSTREAM VIEW

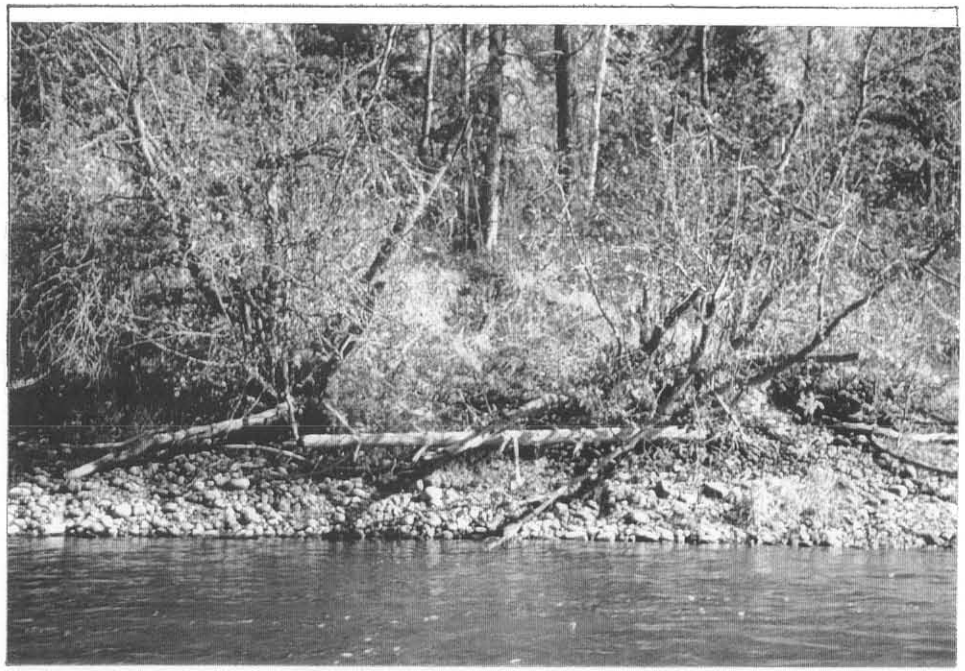


DOWNSTREAM VIEW

CHILAKO RIVER at BEAVERLEY PROJECT No. 93 30 F 043 SEPTEMBER 1993

LEFT BANK VIEW

XS-11



RIGHT BANK VIEW

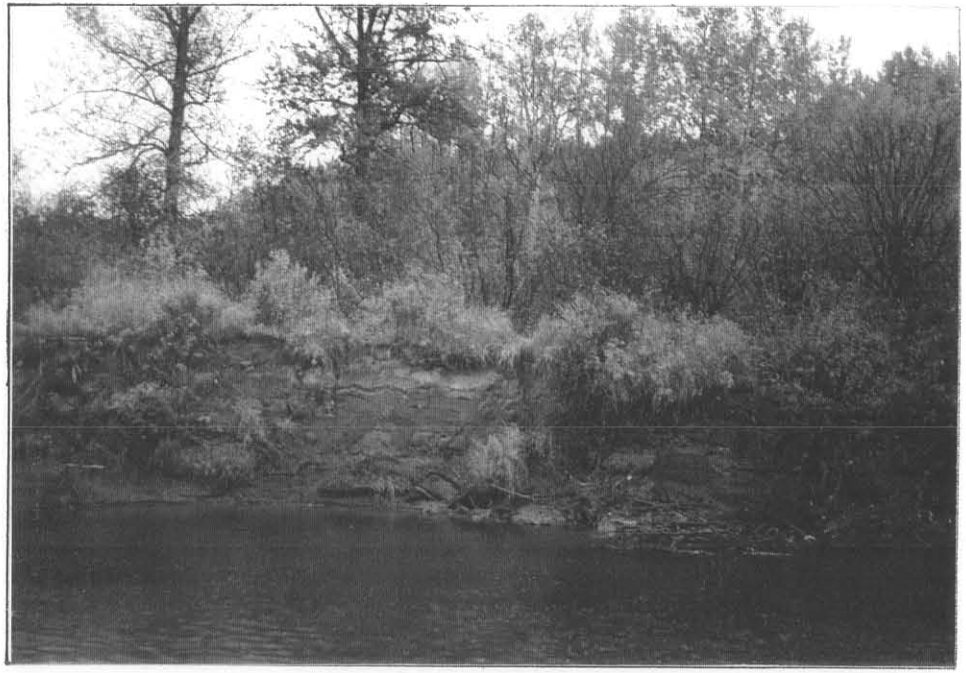
UPSTREAM VIEW

DOWNSTREAM VIEW

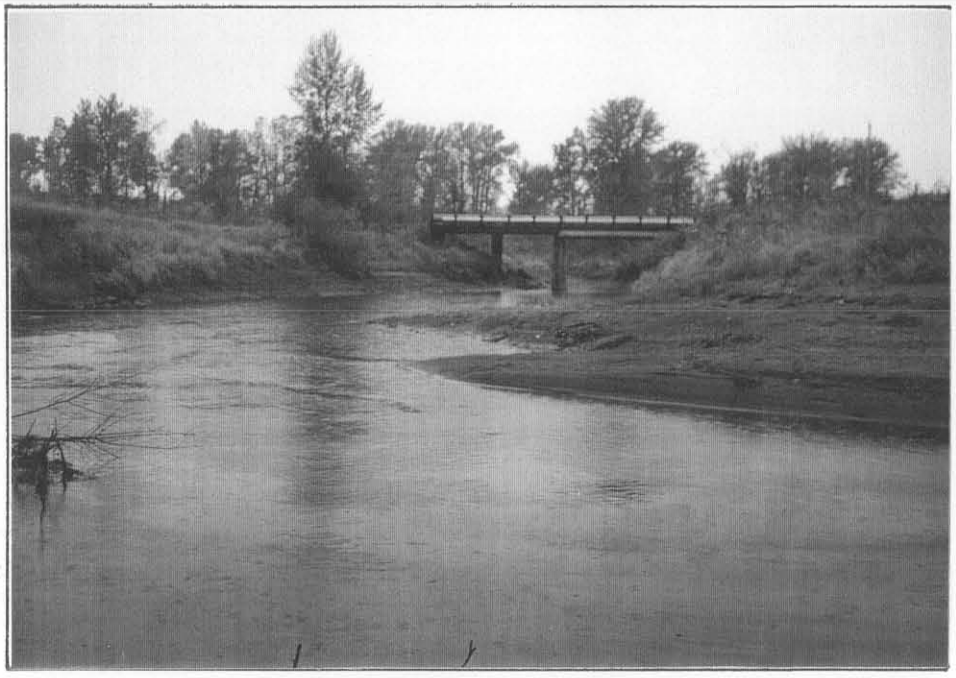
CHILAKO RIVER at BEAVERLEY PROJECT No. 93 30 F 043 SEPTEMBER 1993

LEFT BANK VIEW

XS-24



RIGHT BANK VIEW



UPSTREAM VIEW

DOWNSTREAM VIEW

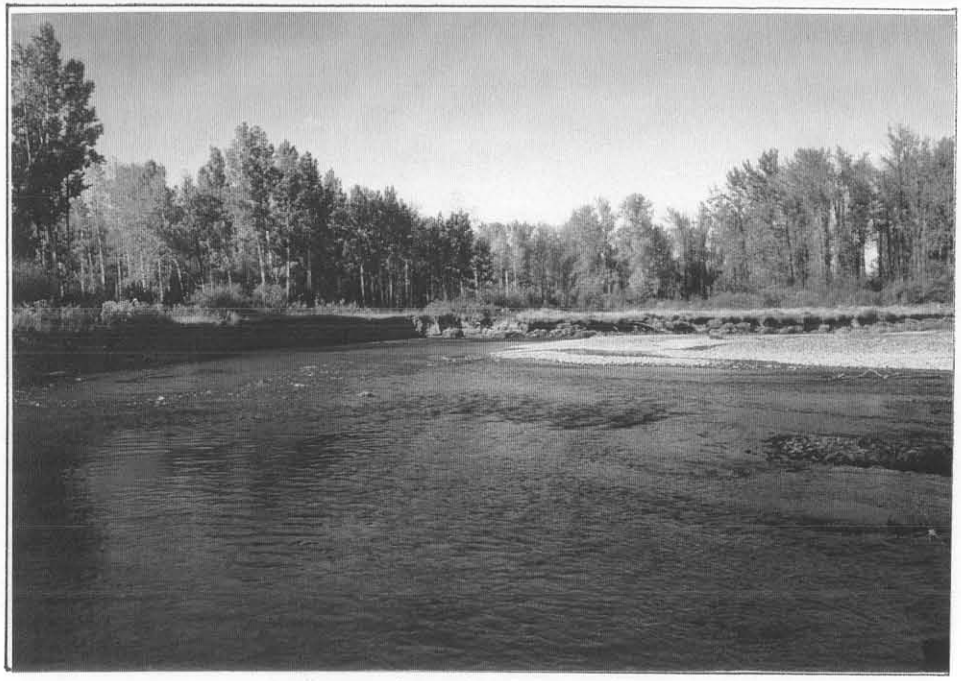
CHILAKO RIVER at BEAVERLEY PROJECT No. 93 30 F 043 SEPTEMBER 1993

LEFT BANK VIEW

XS-30

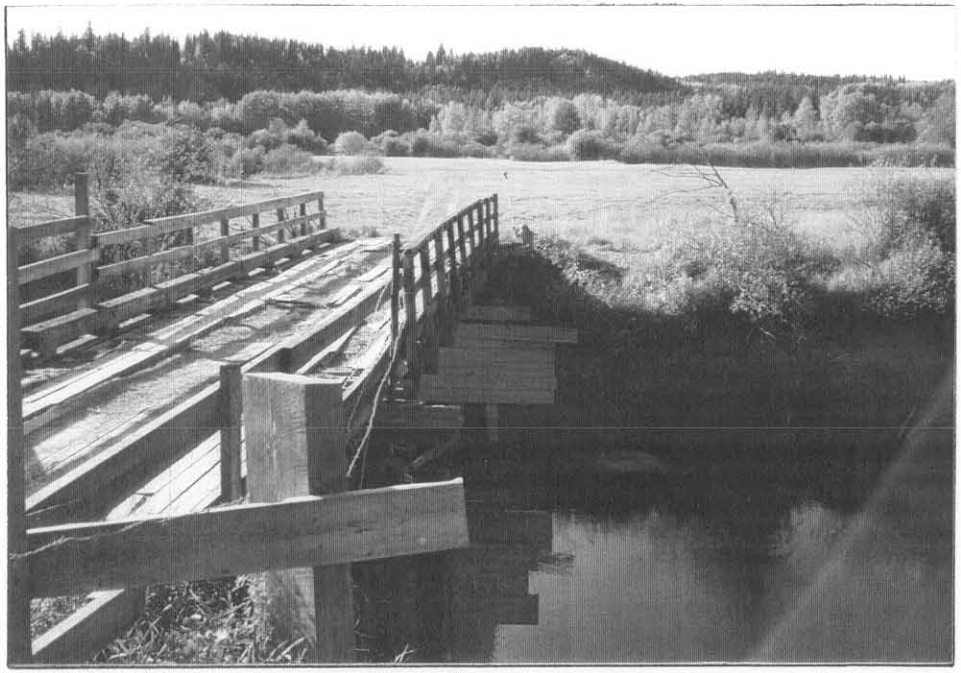
RIGHT BANK VIEW

UPSTREAM VIEW



DOWNSTREAM VIEW

CHILAKO RIVER at BEAVERLEY PROJECT No. 93 30 F 043 SEPTEMBER 1993

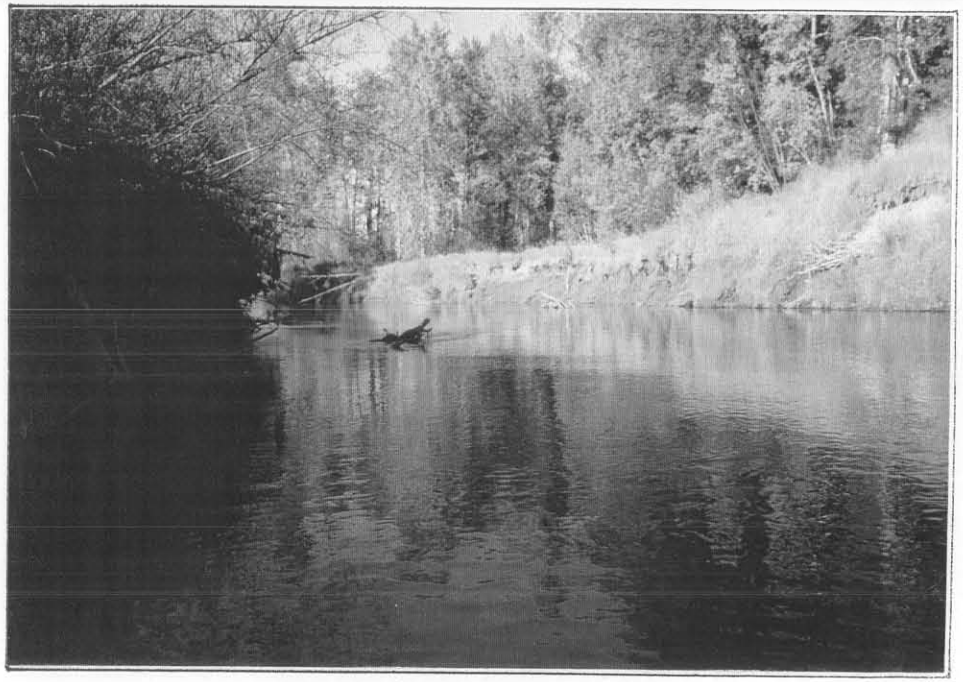


LEFT BANK VIEW

XS-44

RIGHT BANK VIEW

UPSTREAM VIEW



DOWNSTREAM VIEW

APPENDIX 4