CANADA / BRITISH COLUMBIA
FLOODPLAIN MAPPING AGREEMENT
Ministry of Environment, Lands and Parks
Water Management Division

Design Brief on the Floodplain Mapping Study

Sooke River

An Overview of the Study Undertaken
to Produce Floodplain Mapping
for the Sooke River in
the Capital Regional District

Flood Hazard Identification Section
Victoria, British Columbia
May 1994
File: 35100-30/930-0221

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DESIGN BRIEF ON THE FLOODPLAIN MAPPING STUDY

SOOKE RIVER

PREFACE

The purpose of this design brief is to present a description of the methodologies used and the results of the study undertaken to produce the floodplain mapping sheets for the Sooke River, Drawing No. 91-4, Sheets 1 and 2 (Appendix 4).

1. LOCATION

The Sooke River is located near the unincorporated community of Sooke on the southern tip of Vancouver Island, about 20 km west of the city of Victoria as shown on Figure 1. The study area comes under the jurisdiction of the Capital Regional District (CRD). The Sooke area, once the centre for a bustling forest and fishing industry, is renowned for its loggers sports event known as "All Sooke Days" and its accompanying salmon barbecue. More recently, as the population of the CRD is experiencing a rapid growth rate, the community of Sooke is being transformed into a bedroom community for Victoria. The production of floodplain mapping for this area appears to be timely as it allows cognizance to be taken of flood hazard lands in land use bylaws and subdivision approvals in an area where land development pressures are increasing.

Figure 2 is a Key Map of the study area which indicates the location of the floodplain mapping drawings produced from the study.

2. BACKGROUND TO STUDY

The Flood Hazard Identification Section (FHIS) of the Water Management Division, located in Victoria, received reports of flooding on the Sooke River in December of 1990 following heavy rains occurring in November and December. FHIS staff members attended the sites and obtained high water mark data throughout the developed area (Appendix 1.3). The Sooke River is listed as a potential study area for the Floodplain Mapping Program (Project A.3.55), partially due to the availability of existing mapping, its proximity to a major urban area and its potential for future development.

3. PRESENT STUDY

The floodplain mapping study utilizes 24 cross sections on the Sooke River from tidewater at Sooke Harbour upstream 6 km to the vicinity of the "Potholes" at Sooke Potholes Provincial Park (Appendix 1.1). The cross sections are shown on Drawing No. 93-6 sheets 1 and 2 and the floodplain mapsheets, Drawing No 91-4 sheets 1 and 2.

The topography of the Sooke watershed ranges from gently undulating slopes of up to 5% in the floodplain area to strongly rolling and hilly slopes up to 60% or more. Fluvial and fluvio-glacial deposits make up the general composition of soils in the floodplain area (Appendix 1.4). A shallow colluvial veneer overlaying bedrock is found throughout the majority of the watershed (Appendix 1.5).

The Sooke River watershed drains a total area of 340 km^2 of mainly forested, coastal western hemlock zone uplands and is approximately 26 km in length by 14 km wide. The watershed boundary is shown on Figure 3. The Leech River is the major tributary to the Sooke River and drains 104 km^2 of the total watershed. Rising from tidewater at Sooke Harbour (see photo Appendix 2, page 2), the highest points within the watershed are Survey Mountain to the north at an elevation of 941 metres, Trap Mountain at 711 metres on the western side and Empress Mountain at 673 metres on the eastern side of the watershed.

At the upper end of the study area the Sooke River disgorges from a narrow rock canyon into an area known as the "Potholes" which is a popular swimming spot in the summer time. From there it flows southward in a narrow, fairly well incised, boulder strewn channel to the vicinity of cross section 17 (see photo, Appendix 2 page 7) below Charters River. The floodplain in this reach averages 120 metres in width. Downstream from this location the floodplain broadens to between 200 and 300 metres wide, the gradient flattens and the channel begins a slight meander. Near the confluence with DeMamiel Creek the floodplain opens to tidal flats and then quickly narrows through the remainder of the fluvio-glacial deposits at the Highway 14 bridge (see photos, Appendix 2 pages 5 & 6). It then flows a short distance to tidewater at Sooke Harbour (Figure 2).

Topographic mapping, produced from air photos obtained in 1979, at 1:5000 scale with 2 metre contour intervals, was used in the study

(Appendix 1.2). Hydrology studies were requested in June, 1993 and completed in December, 1993 (Appendix 3). High water marks (Appendix 1.3) obtained in December 1990 following November and December high water events were used to evaluate the studies along with Water Survey of Canada (WSC) gauge data to calibrate the model.

4. FLOOD MAGNITUDES

4.1 General

Peak flow events on Vancouver Island, as with other coastal areas in British Columbia, usually occur in the late fall and early winter periods when warm temperatures and heavy rainfall is combined with an early snowpack.

As stated previously, the drainage area for the Sooke River is 340 km^2 with the Leech River providing the main tributary inflow at 104 km^2. As shown in Figure 3, Sooke Lake, which provides storage for the Greater Victoria Water District, accounts for approximately 20% of the drainage area. While the lake can provide some attenuation to flood flows, it does not provide significant flood control capabilities. Diversions during peak flow events are not significant (Appendix 3).

The floodplain was inundated during the November 23, 1990 peak flow. High water marks from this event were gathered by FHIS staff. From discussions with several long time residents of the area it was determined that this flood event was of a similar magnitude as an event which occurred in 1956, with a greater peak having occurred in 1935. WSC stream flow records for Sooke River near Sooke Lake concur with these observations.

Development of the valley, for the most part, has been at or above the floodplain fringe. A number of the riverside residents interviewed are no strangers to flooding events and were aware of the flood hazard. One resident near the confluence with Charters River took an innovative approach to the flood problem. The main floor of the house (see photo, Appendix 2 page 8) is elevated above grade (also above the calculated flood level), with an undeveloped basement, concrete below grade. The original wood siding below the main floor level has been replaced with stucco. The basement area is used as a laundry area and contains a washer and dryer and also a deepfreeze. These items are mounted on platforms which are connected with cables and pulleys and can be winched up to the ceiling. When the residents are going to be away from the home for extended periods, they simply raise them up off the floor. Should flooding occur, damage usually amounts to silt deposition in the basement area.

4.2 Hydrometric Data

Water Survey of Canada (WSC) Gauge 08HA005 (Sooke River near Sooke Lake) has been in operation from 1916 to 1966. Maximum recorded daily discharge (QD) at this station occurred on October 28, 1921 at 96.8 m^3/s. Other annual peaks of significance have been recorded in 1935, 1956 and 1961.

Water Survey of Canada has been operating Gauge 08HA059 - Sooke River above Charters River, located at the upstream end of the study area, since 1989. This gauge was installed primarily as a low flow recorder, however it does have the capability to record high peaks. The highest recorded peaks occurred on November 8, 23 and December 3, 1990. Flow estimates for these peaks were not provided by WSC, as a rating curve has not been established for the station for flow events above 160 m^3/s.

4.3 Hydrology Studies

The hydrology study estimates for the Q20 and Q200 daily discharges at the mouth are 270 m^3/s and 370 m^3/s respectively and were based on a regional analyses of long term record gauging stations in neighbouring watersheds. The study estimates an Instantaneous to Daily (I/D) ratio of 2.5 for the both the 1:20 year and 1:200 year events. This value yields corresponding instantaneous Q's of 750 m^3/s and 930 m^3/s.

Details of the Hydrology studies requested are located in the Hydrology Section report received December 14, 1993 as Study No. 402 (Appendix 3).

5. FLOOD LEVELS

5.1 Ocean Flood Levels

The flood level for the ocean for the purposes of floodplain mapping is based on higher high water large tide (HHWLT) plus an allowance for storm surge and wave runup.

The Institute of Ocean Sciences (IOS) supplied tidal information for the gauge at Sooke Harbour. The HHWLT is 1.7 metres GSC datum and the recorded extreme ocean water level is 2.0 metres GSC datum. The largest recorded storm surge based on the difference between the extreme observed and the predicted tide level is 0.53 metres.

The sheltering of Sooke Harbour from prevailing winds, Figure 2, by Whiffin Spit (see photo, Appendix 2 page 1) protects the inner area of Sooke Harbour from local wind and wave effects. The storm surge in Sooke Harbour is essentially that of the Juan de Fuca Strait. Sooke River mouth area is not directly exposed to ocean wave attack. An analysis of storm surge was carried out by Mr. B.J. Holden, P. Eng, of the Flood Hazard Identification Section (Appendix 1.7). Results of this analysis, which utilized standard methodologies, are summarized below:

HHWLT	1.7 metres
Storm Surge	0.8 metres
Ocean Still Water Flood Level	2.5 metres

Based on the above assessment, the ocean still water flood level is 2.5 metres, GSC datum. For administrative purposes, an allowance of 0.3 metres has been added for wind chop, wave runup and local drainage resulting in a Sooke Harbour and Basin flood level of 2.8 metres GSC.

The ocean flood level adopted for Sooke Harbour governs the designated flood level for the Sooke River up to cross section 5 as indicated on the mapping sheet Dwg. No. 91-4-1 and Table 2.

A tsunami or seismic sea wave is a long period wave caused by an underwater disturbance such as a volcanic eruption or earthquake. Sooke Harbour is not located in a "most vulnerable" region for tsunami sea wave effects. Sooke Harbour has a relatively protected inlet system and it is not expected that there will be a significant tsunami wave in this area, assuming an underwater disturbance on the Pacific Rim (Appendix 1.7).

5.2 River Flood Levels

Information sources listed in Appendix 1 were utilized in the PC micro-computer version 6.4 of the HEC-2 water surface profile computer program developed by the Hydrologic Engineering Centre, U.S. Army Corps of Engineers in Davis, California and currently administered by Haestad Methods, Inc. The flood profile calculations employ a standard step method and assume open water flow conditions.

Plot runs of the 24 cross sections were reviewed to assess model input data such as flow regime, loss coefficients, reach lengths and relative Manning's "n" values. The Highway 14 bridge located at cross section 2 and 3 was not coded as it is located above the floodplain and well within the influence of the ocean flood level for Sooke Harbour.

The roughness characteristics (Manning's "n" values) at each cross section were estimated using the colour photographs provided by the Technical Support Section (Appendix 1.1), site visits, experience gained from previous studies and a review of the information in a guide published by the United States Geological Survey (Appendix 1.6). Table 2 lists the channel "n" values for each cross section in the study area.

Using the high water mark data collected throughout the study area, multiple profile runs were made to ascertain the flow for the Nov. 23, 1990 event. After a detailed review of the results, it was concluded that the instantaneous peak flow for this event was in the order of 700 m^3/s at the WSC gauge 08HA059. The model was then run with a variety of flows and corresponding elevations selected from the existing WSC rating curve at the gauge. The results of this run were used to confirm the calibration of the model. The stage discharge curve established for WSC Gauge 08HA059 is shown in Figure 4.

Copies of the WSC recorder charts for the various Nov/Dec 1990 peaks were used to determine the I/D ratios. From these it was determined that the daily flow for the November 23, 1990 event was about 270 m^3/s which is equal to the Hydrology study 1:20 year estimate. This produces an I/D ratio of 2.6 using the modelled instantaneous "Q" of 700 m^3/s for that day. Examination of the water level recorder chart for the event indicated that a discrepancy existed between the recorded water level and the elevation of the high water mark evidence found on the ground. Discussions with Mr. Ed. Mayert of WSC in Nanaimo indicated that the recorder chart was stuck for an indeterminate time during this event and that this could account for this discrepancy.

The standard ministry allowance for hydraulic and hydrologic uncertainties of I + 0.3m or D + 0.61m, whichever is the greater level, was applied to the calculated water surface elevations (CWSEL). The instantaneous Q200 flood levels were found to dominate over the daily levels at all cross sections for both the 20 year and 200 year flows.

The Q200 and Q20 flows provided by the hydrology study (Section 4.3) at tidewater were decreased progressively upstream to the WSC gauge 08HA059 based on the information shown in Appendix 3, Figures 1 and 2. The calculated Q200 flood levels average 0.66m above the 1990 flood levels, as shown in Table 1.

Sensitivity studies were undertaken to determine the tolerance of the selected flood levels to changes in "Q" and "n" values. Table 2 is a listing by cross section which compares the selected flood levels (with 0.3 metre allowance) to calculated levels for increases to the Q200I flow of 10%, 20% and 30% respectively. The study indicates that in most cases the selected flood levels are sufficient to withstand a 10% increase to the designated Q200 I. The reach above Charters River (XS 22) is somewhat more sensitive; the flood levels would be slightly exceeded with a 10% increase due to the narrowing of the floodplain.

Table 3 is a listing of flood levels indicating the sensitivity of the model to changes in Manning's "n" values. The model was run with 10% and 20% increases to the "n" values. The results indicate that the model can withstand a 20% increase up to cross section 8 and thereafter a 10% increase.

Figure 5 indicates water surface profiles from XS 1 at tidewater to XS 24 at the WSC Gauge for flows ranging from 350 m^3/s to 1000 m^3/s. Figures 6 and 7 are stage discharge curves at XS 18 and 24 respectively.

6. FLOODPLAIN MAPPING

The floodplain mapping incorporates existing base mapping produced by the Surveys and Resource Mapping Branch in 1979 under project 79-087, and is 1:5000 scale with 2 metre contour intervals. The mapping indicates the location of information such as interpreted flood levels and floodplain limits, cross section locations, WSC gauge locations etc.

As part of the river survey project, field checks were made at a number of locations to assess the accuracy of spot height elevations and contours indicated on the base map sheets. A listing of the results of this assessment is contained in Appendix 1.1.

The topographic mapping was based on 2 metre contour intervals as noted above. Past experience indicates that floodplain limits based on 2 metre contours may not be as reliable as that based on 1 metre contour intervals. Consequently, care was taken to ensure that the survey of the river cross sections extended across the entire floodplain so that the calculated flood levels and limits of the floodplain boundary could be indicated with a greater level of confidence. In addition, a field inspection was undertaken to verify the location of the floodplain boundary shown on the drawings.

In accordance with the policy of the Ministry of Environment, Lands and Parks, the flood levels and floodplain limits shown on floodplain mapping sheets are based on a designated (1:200 year frequency) flood level plus an allowance for hydraulic and hydrologic uncertainties.

7. CONCLUSIONS

1. This report presents an overview of the studies undertaken to produce the floodplain mapping sheets for the Sooke River from tidewater at Sooke Harbour upstream to the vicinity of the "Potholes" a distance of about 6 km. The floodplain limits shown correspond to the area which would be inundated by the designated flood.

2. The floodplain mapping employs existing 2m contour interval base mapping. Site specific ground elevations within or adjacent to the floodplain limits should be confirmed by legal survey.

3. The Planning and Standards Section, Floodplain Management Branch should seek the cooperation of the Capital Regional District in adopting floodproofing requirements in the designated floodplain areas.

8. RECOMMENDATIONS

1. It is recommended that flood levels and floodplain limits delineated on Drawing No. 91-4, Sheets 1 and 2 be Interim Designated under terms of the Canada/British Columbia Floodplain Mapping Agreement.

2. The drawings should be reviewed when 1 metre contour interval base mapping becomes available and/or when a flood event of a significant magnitude occurs.

3. 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 identification of floodable lands by subdivision approving officers.

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FIGURES

Province of British Columbia
MINISTRY OF ENVIRONMENT, LANDS AND PARKS
WATER MANAGEMENT DIVISION

TO ACCOMPANY A DESIGN BRIEF ON THE

FLOODPLAIN MAPPING
SOOKE RIVER
STUDY AREA LOCATION

SCALE: VERT. ...
HOR. NOT TO SCALE

DATE MARCH 1994

R.W. NICHOLS ENGINEER

FILE No. 35100-30/930-0221 DWG. No. FIGURE 1

BCIL 7673-M E

TO ACCOMPANY A DESIGN BRIEF ON THE

FLOODPLAIN MAPPING
SOOKE RIVER
KEY MAP

Province of British Columbia

Ministry of Environment, Lands and Parks

WATER MANAGEMENT DIVISION

SCALE: VERT .... HOR 1 : 50,000	DATE MARCH 1994	R.W. NICHOLS ENGINEER
		FILE No. 35100-30/930-0221 DWG No. FIGURE 2

VAN CAL 15712

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

TO ACCOMPANY A DESIGN BRIEF ON THE
FLOODPLAIN MAPPING
SOOKE RIVER
WATERSHED BOUNDARY

SCALE: VERT ....
HOR 1 : 250,000

DATE
MARCH 1994

R.W. NICHOLS ENGINEER

FILE No 35100-30/930-0221 DWG No. FIGURE 3

FIGURE 4

SOOKE RIVER STAGE DISCHARGE CURVE
XS 24 (WSC 08HA059)

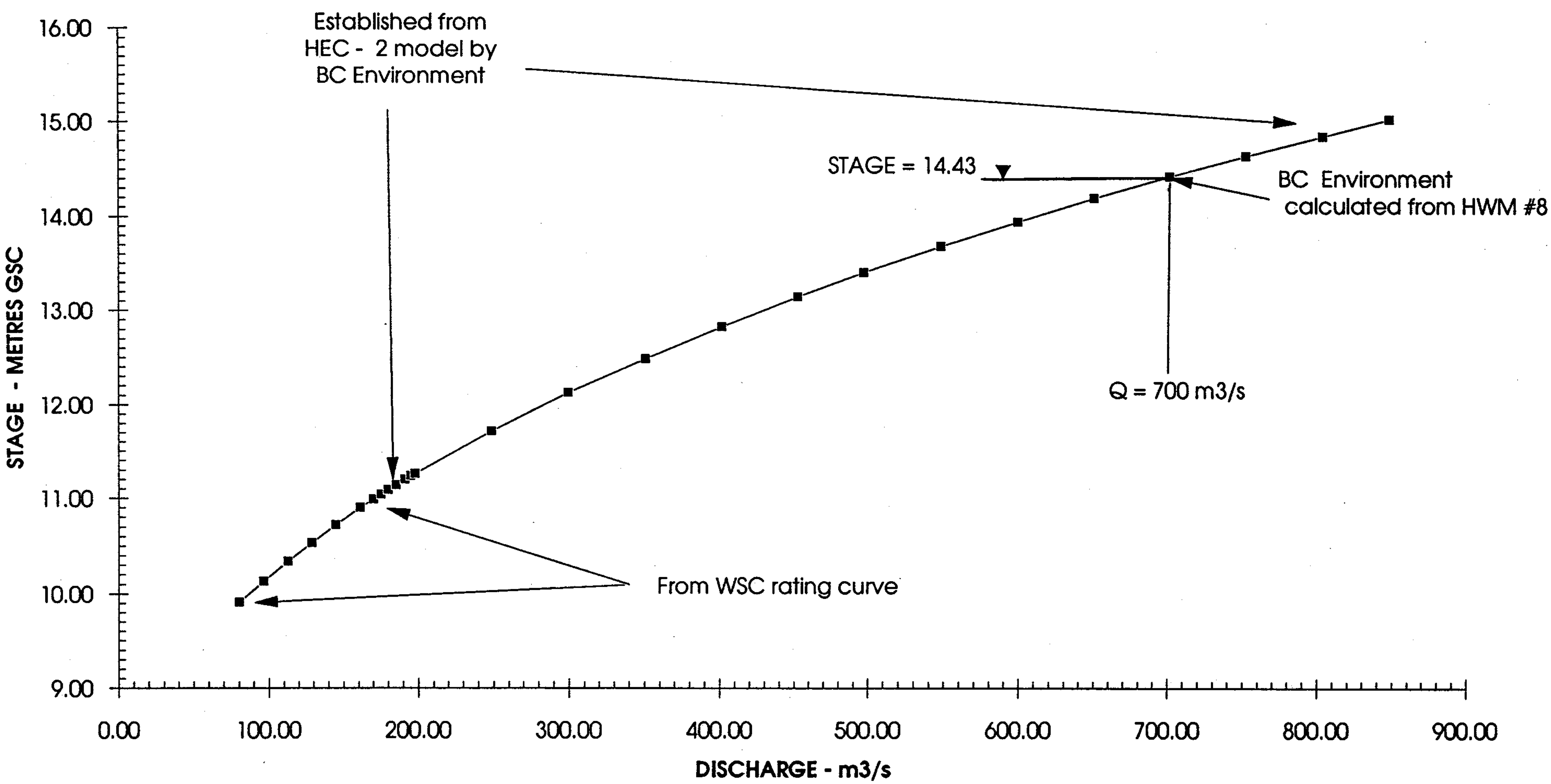


FIGURE 5

SOOKE RIVER PROFILES
TIDEWATER (XS1) TO WSC GAUGE (XS24)

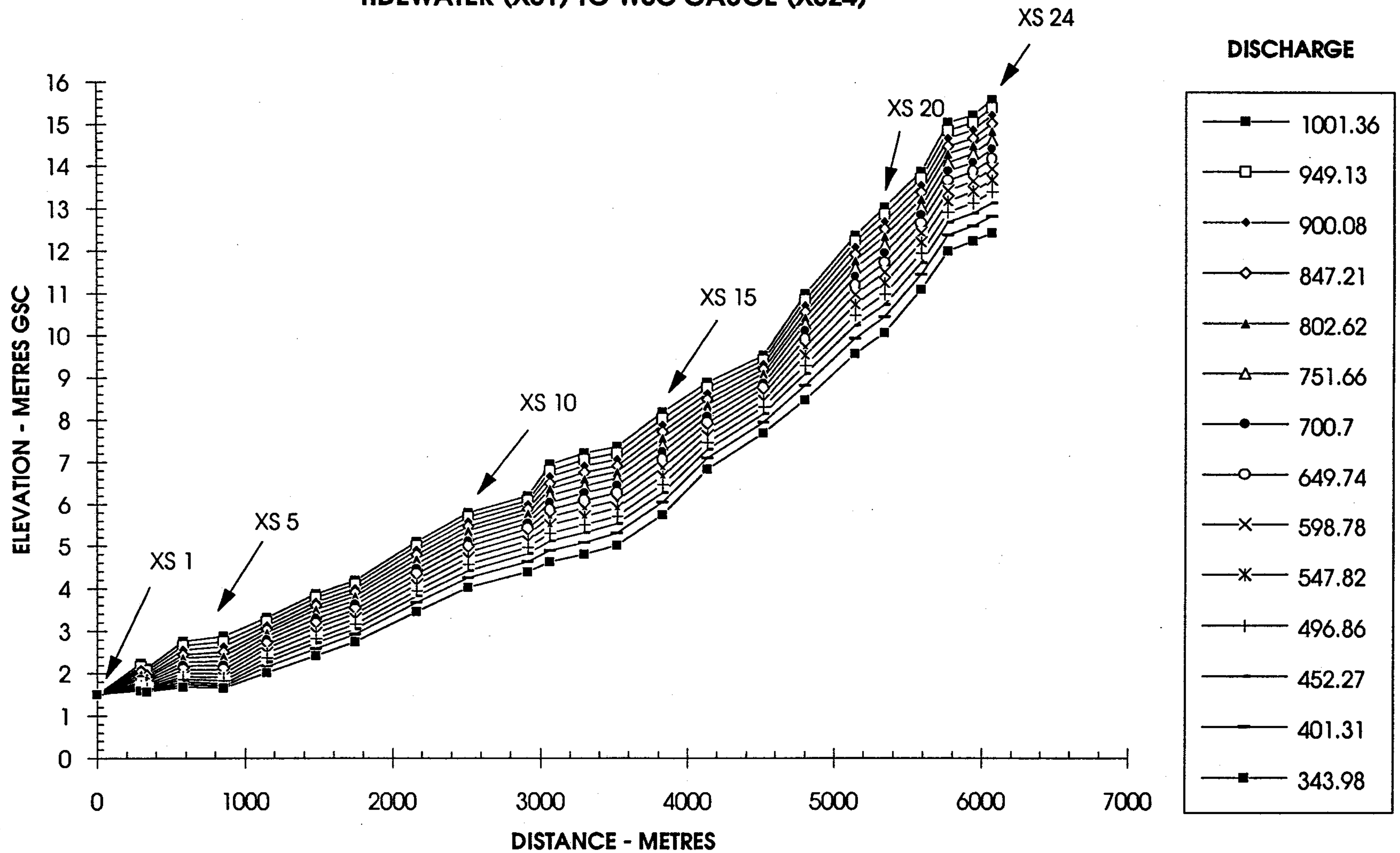


FIGURE 6

SOOKE RIVER - XS 18
STAGE DISCHARGE CURVE

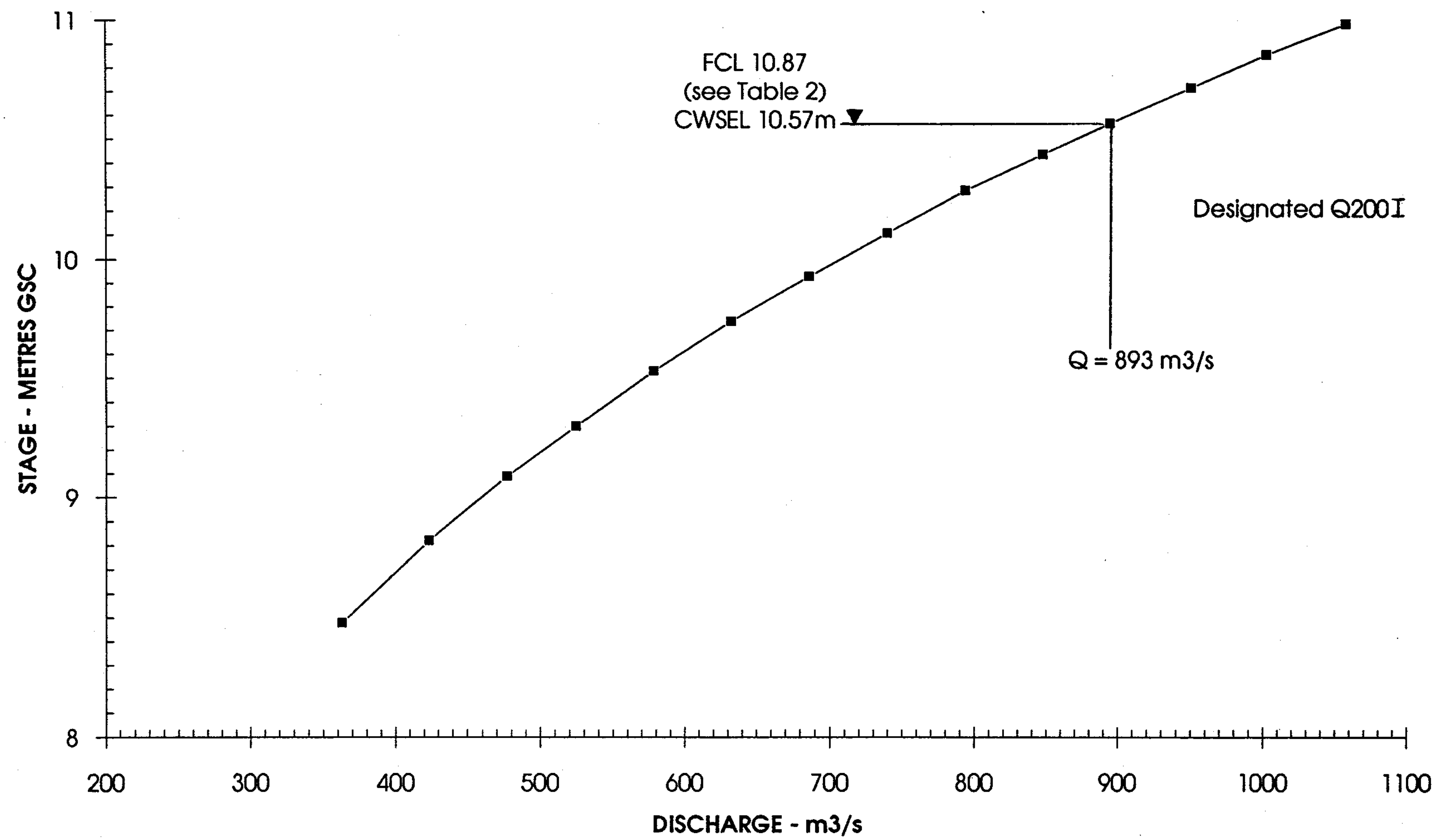
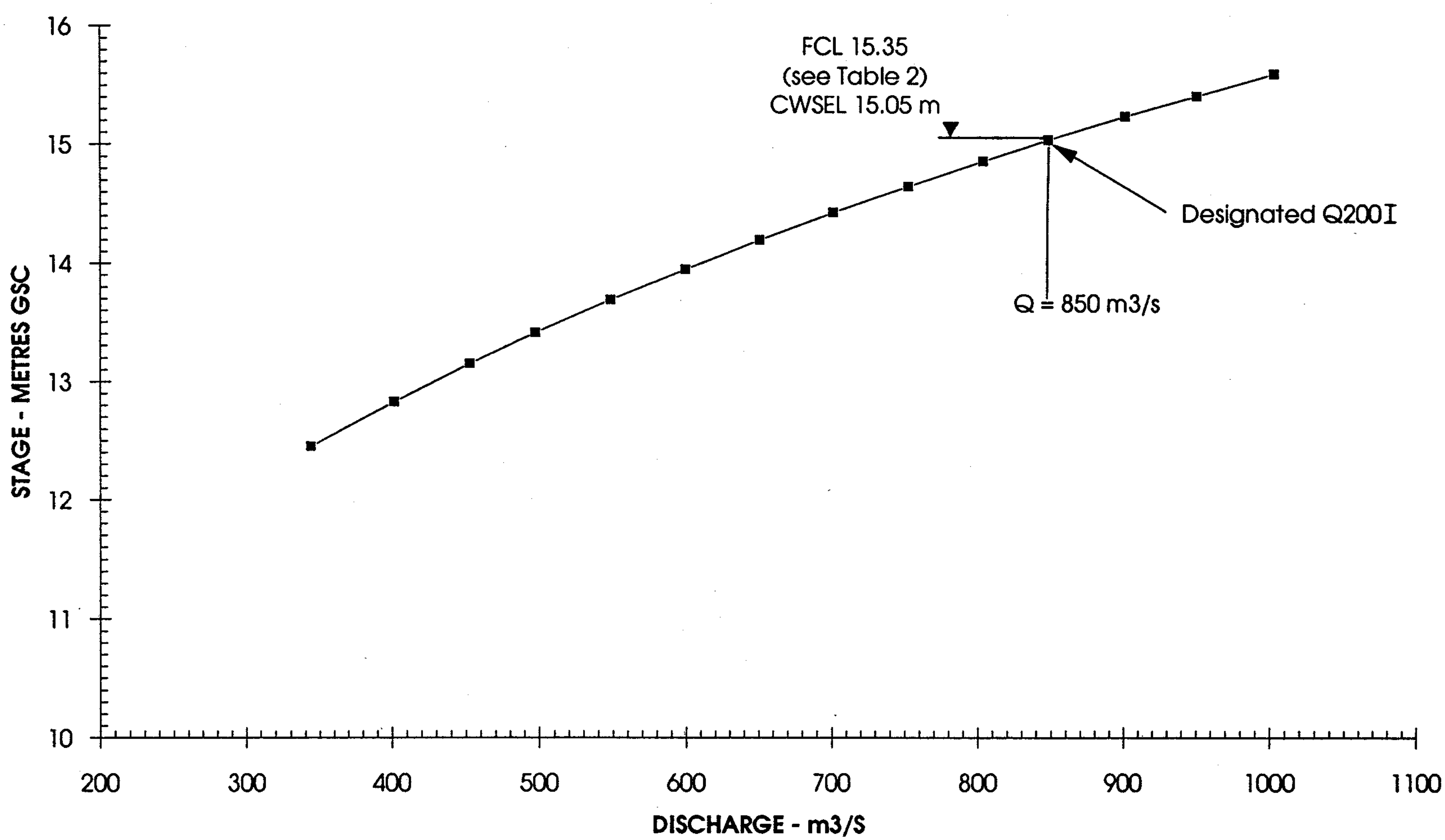


FIGURE 7

SOOKE RIVER XS - 24
STAGE DISCHARGE CURVE



TABLES

TABLE 1

X-SEC	FLOOD LEVEL* Q200 I at Tidewater = 930 m^3/s	1990 OBSERVED FLOOD LEVEL = 700 m^3/s	DIFF.
6	3.34	2.20	1.14**
8	4.21	3.68	0.53
10	5.77	5.42	0.35
11	6.18	5.63	0.55
13	7.06	6.33	0.73
16	8.79	8.31	0.48
18	10.87	10.21	0.66
21	13.70	13.01	0.69
22	14.79	14.05	0.74
23	14.99	14.02	0.97
24	15.34	14.43	0.91
		AVERAGE	0.66

* includes 0.3m allowance for uncertainties
** Tidal influences - anomaly not used in average

TABLE 2

SOOKE RIVER -SENSITIVITY TO "Q" INCREASES											
"Q 200" x 1.0, 1.1, 1.2, 1.3											
SECNO	CWSEL	Q	K*XNCH	FCL	DIFF	SECNO	CWSEL	Q	K*XNCH	FCL	DIFF
1	1.5	931	28	1.8	0.3	13	6.76	893.76	52	7.06	0.3
1	1.5	1024.1	28		0.3	13	7.02	983.14	52		0.04
1	1.5	1117.2	28		0.3	13	7.27	1072.5	52		-0.21
1	1.5	1210.3	28		0.3	13	7.51	1161.9	52		-0.45
2	2.04	931	28	2.34	0.3	14	6.92	893.76	52	7.22	0.3
2	2.15	1024.1	28		0.19	14	7.17	983.14	52		0.05
2	2.27	1117.2	28		0.07	14	7.41	1072.5	52		-0.19
2	2.4	1210.3	28		-0.06	14	7.65	1161.9	52		-0.43
3	1.95	931	28	2.25	0.3	15	7.72	893.76	55	8.02	0.3
3	2.05	1024.1	28		0.2	15	7.99	983.14	55		0.03
3	2.15	1117.2	28		0.1	15	8.24	1072.5	55		-0.22
3	2.27	1210.3	28		-0.02	15	8.48	1161.9	55		-0.46
4	2.45	931	28	2.75	0.3	16	8.49	893.76	55	8.79	0.3
4	2.62	1024.1	28		0.13	16	8.72	983.14	55		0.07
4	2.79	1117.2	28		-0.04	16	8.93	1072.5	55		-0.14
4	2.97	1210.3	28		-0.22	16	9.14	1161.9	55		-0.35
5	2.51	931	32	2.81	0.3	17	9.21	893.76	55	9.51	0.3
5	2.71	1024.1	32		0.1	17	9.39	983.14	55		0.12
5	2.91	1117.2	32		-0.1	17	9.57	1072.5	55		-0.06
5	3.11	1210.3	32		-0.3	17	9.73	1161.9	55		-0.22
6	3.04	893.76	35	3.34	0.3	18	10.57	893.76	59	10.87	0.3
6	3.18	983.14	35		0.16	18	10.81	983.14	59		0.06
6	3.34	1072.5	35		0	18	11.03	1072.5	59		-0.16
6	3.49	1161.9	35		-0.15	18	11.23	1161.9	59		-0.36
7	3.59	893.76	38	3.89	0.3	19	11.93	850	60	12.23	0.3
7	3.74	983.14	38		0.15	19	12.19	935	60		0.04
7	3.9	1072.5	38		-0.01	19	12.43	1020	60		-0.2
7	4.06	1161.9	38		-0.17	19	12.64	1105	60		-0.41
8	3.91	893.76	42	4.21	0.3	20	12.54	850	60	12.84	0.3
8	4.06	983.14	42		0.15	20	12.83	935	60		0.01
8	4.21	1072.5	42		0	20	13.1	1020	60		-0.26
8	4.36	1161.9	42		-0.15	20	13.36	1105	60		-0.52
9	4.79	893.76	48	5.09	0.3	21	13.41	850	60	13.71	0.3
9	4.96	983.14	48		0.13	21	13.68	935	60		0.03
9	5.13	1072.5	48		-0.04	21	13.94	1020	60		-0.23
9	5.3	1161.9	48		-0.21	21	14.19	1105	60		-0.48
10	5.47	893.76	50	5.77	0.3	22	14.5	850	58	14.8	0.3
10	5.65	983.14	50		0.12	22	14.82	935	58		-0.02
10	5.83	1072.5	50		-0.06	22	15.12	1020	58		-0.32
10	6.01	1161.9	50		-0.24	22	15.42	1105	58		-0.62
11	5.88	893.76	55	6.18	0.3	23	14.7	850	40	15	0.3
11	6.06	983.14	55		0.12	23	15.01	935	40		-0.01
11	6.22	1072.5	55		-0.04	23	15.3	1020	40		-0.3
11	6.38	1161.9	55		-0.2	23	15.58	1105	40		-0.58
12	6.5	893.76	55	6.8	0.3	24	15.05	850	37	15.35	0.3
12	6.75	983.14	55		0.05	24	15.36	935	37		-0.01
12	6.99	1072.5	55		-0.19	24	15.66	1020	37		-0.31
12	7.23	1161.9	55		-0.43	24	15.94	1105	37		-0.59

TABLE 3

SOOKE RIVER - SENSITIVITY TO "n" INCREASES											
"n" VALUES x 1.0, 1.1, 1.2											
SECNO	CWSEL	Q	K*XNCH	FCL	DIFF	SECNO	CWSEL	Q	K*XNCH	FCL	DIFF
1	0.66	931	28	1.80	1.14	13	6.76	893.76	52	7.06	0.30
1	0.66	931	30.8		1.14	13	6.97	893.76	57.2		0.09
1	0.66	931	33.6		1.14	13	7.18	893.76	62.4		-0.12
2	1.95	931	28	2.34	0.39	14	6.92	893.76	52	7.22	0.30
2	2.05	931	30.8		0.29	14	7.16	893.76	57.2		0.06
2	2.15	931	33.6		0.19	14	7.38	893.76	62.4		-0.16
3	1.86	931	28	2.25	0.39	15	7.72	893.76	55	8.02	0.30
3	1.98	931	30.8		0.27	15	7.97	893.76	60.5		0.05
3	2.09	931	33.6		0.16	15	8.20	893.76	66		-0.18
4	2.40	931	28	2.75	0.35	16	8.49	893.76	55	8.79	0.30
4	2.50	931	30.8		0.25	16	8.69	893.76	60.5		0.10
4	2.61	931	33.6		0.14	16	8.88	893.76	66		-0.09
5	2.45	931	32	2.81	0.36	17	9.21	893.76	55	9.51	0.30
5	2.60	931	35.2		0.21	17	9.44	893.76	60.5		0.07
5	2.75	931	38.4		0.06	17	9.65	893.76	66		-0.14
6	3.03	893.76	35	3.34	0.31	18	10.57	893.76	59	10.87	0.30
6	3.15	893.76	38.5		0.19	18	10.80	893.76	64.9		0.07
6	3.28	893.76	42		0.06	18	11.00	893.76	70.8		-0.13
7	3.58	893.76	38	3.89	0.31	19	11.93	850	60	12.23	0.30
7	3.71	893.76	41.8		0.18	19	12.17	850	66		0.06
7	3.83	893.76	45.6		0.06	19	12.40	850	72		-0.17
8	3.90	893.76	42	4.21	0.31	20	12.54	850	60	12.84	0.30
8	4.05	893.76	46.2		0.16	20	12.81	850	66		0.03
8	4.19	893.76	50.4		0.02	20	13.07	850	72		-0.23
9	4.79	893.76	48	5.09	0.30	21	13.41	850	60	13.71	0.30
9	4.96	893.76	52.8		0.13	21	13.72	850	66		-0.01
9	5.12	893.76	57.6		-0.03	21	14.01	850	72		-0.30
10	5.47	893.76	50	5.77	0.30	22	14.50	850	58	14.80	0.30
10	5.64	893.76	55		0.13	22	14.76	850	63.8		0.04
10	5.80	893.76	60		-0.03	22	15.02	850	69.6		-0.22
11	5.88	893.76	55	6.18	0.30	23	14.70	850	40	15.00	0.30
11	6.10	893.76	60.5		0.08	23	14.98	850	44		0.02
11	6.30	893.76	66		-0.12	23	15.26	850	48		-0.26
12	6.50	893.76	55	6.80	0.30	24	15.05	850	37	15.35	0.30
12	6.71	893.76	60.5		0.09	24	15.31	850	40.7		0.04
12	6.91	893.76	66		-0.11	24	15.56	850	44.4		-0.21

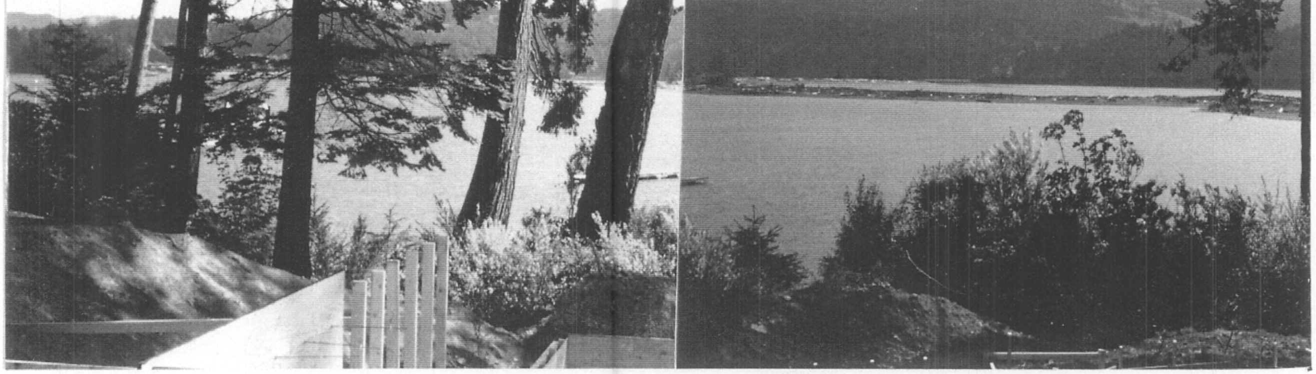
APPENDICES

APPENDIX 1

Detailed Information Sources

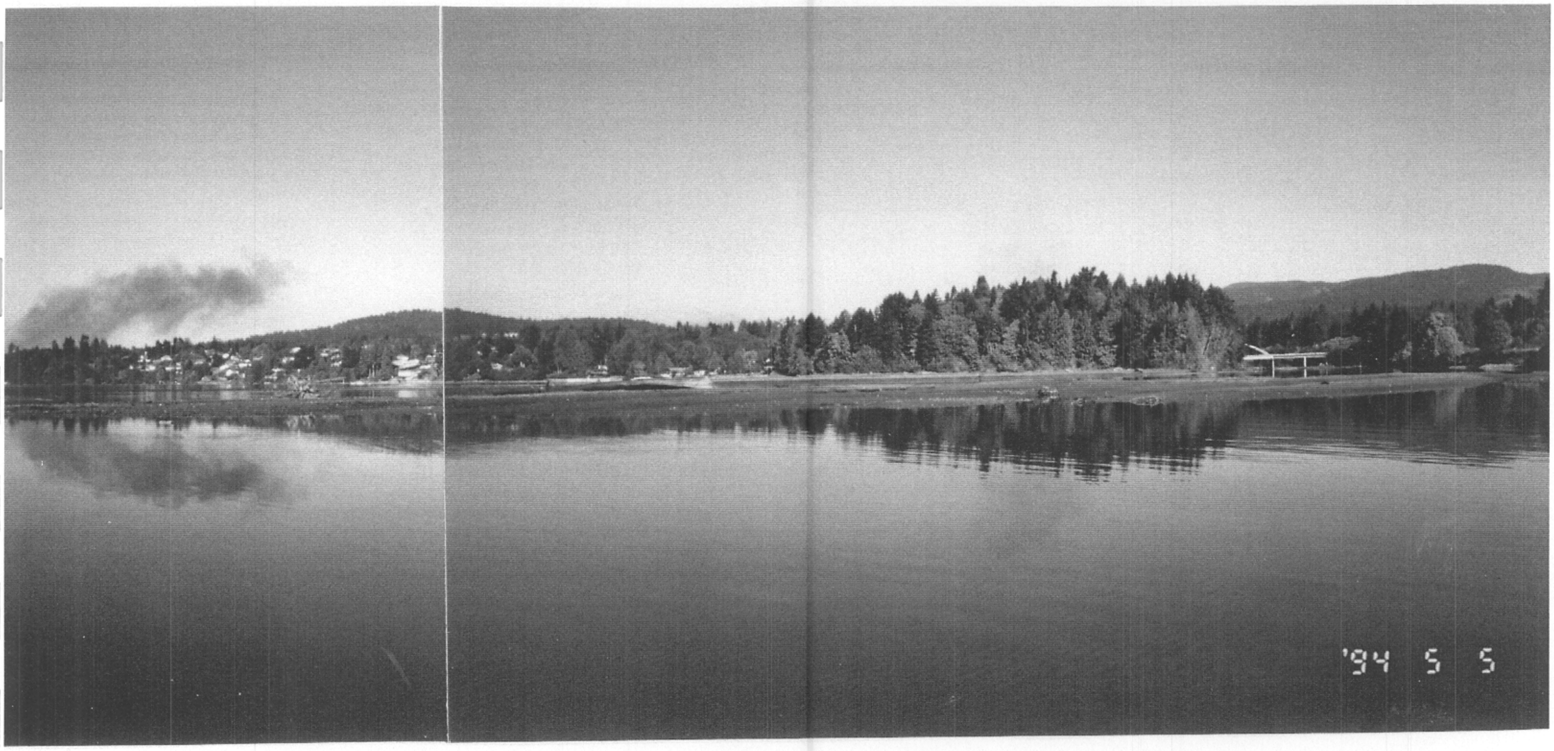
No.	Source	Contents
1.	Technical Support Section, Water Management Division Project No. 92 07 F019, field survey carried out April 1992	24 cross sections on the Sooke River including photographs at each cross section
2.	Map Production Division, Surveys and Resource Mapping Branch, Project No. 79-087	Base mapping of the Sooke River (1:5000 scale, 2 metre contours) from 1979 airphotos
3.	Flood Hazard Identification Section, Sooke River HWM November 1990	Photographic locations of high water mark locations
4.	Terrestrial Studies Branch, Cartography Unit, Ministry of Environment - Soils of Southern Vancouver Island	Soils Map 92B/5 - Soils - Sooke, (1:50,000 scale)
5.	Resource Analyses Branch, Ministry of Environment - Terrain	Landforms/Slope Map 92B/5 - Terrain - Sooke, (1:50,000 scale)
6.	United States Geological Survey Water-Supply Paper #2339	Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains
7.	"Ocean Water Level, Sooke Harbour, Sooke River Mouth" by B.J. Holden, P. Eng., FHIS, File 930-0221, 1994	Ocean Water Levels in Sooke Harbour

Appendix 2
Photographs

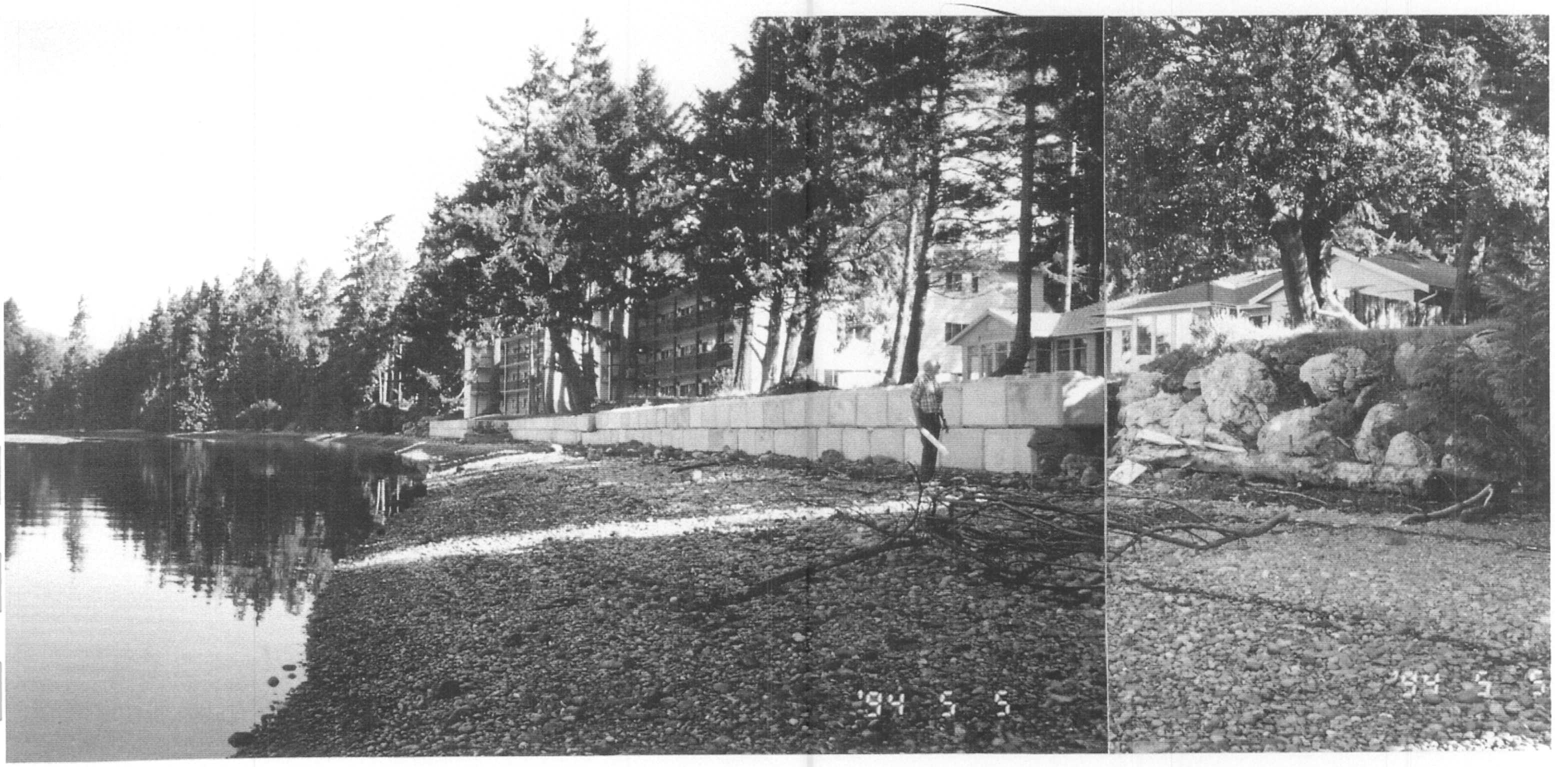


WHIFFIN SPIT - ENTRANCE TO SOOKE HARBOUR

Appendix 2
Photographs

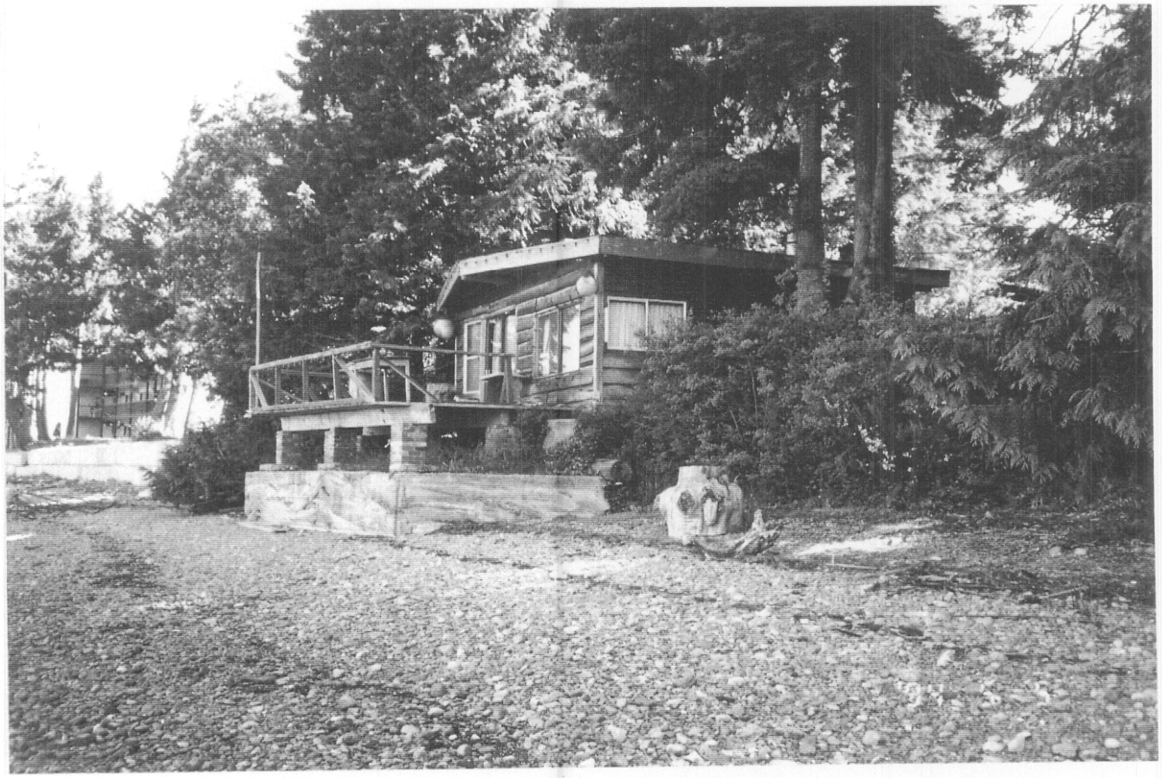


SOOKE RIVER - LOOKING UPSTREAM TOWARDS XS - 1 FROM BILLINGS SPIT, SOOKE HARBOUR



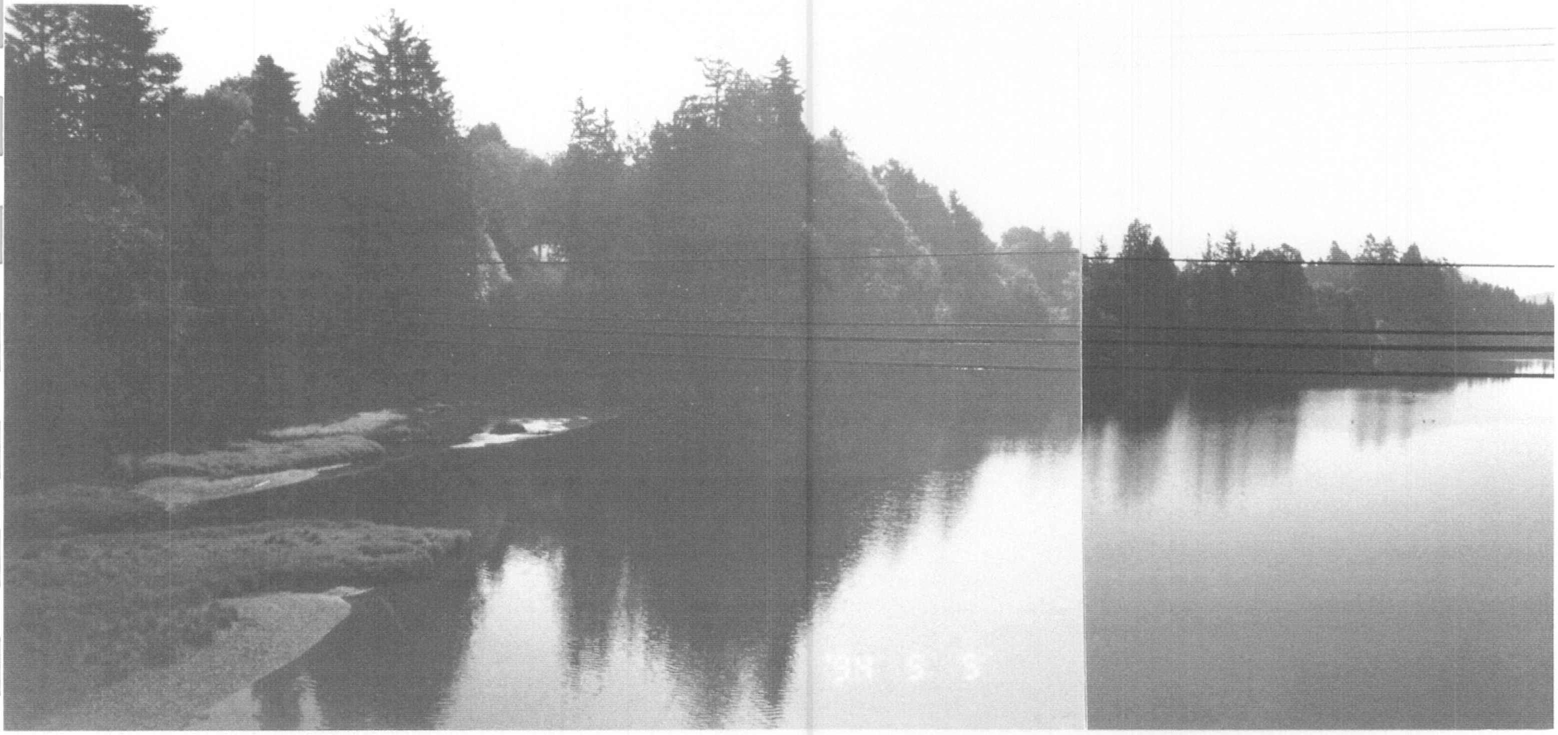
Appendix 2
Photographs

SOOKE HARBOUR - NOTE DEVELOPMENT ENCROACHMENT WITHIN FORESHORE

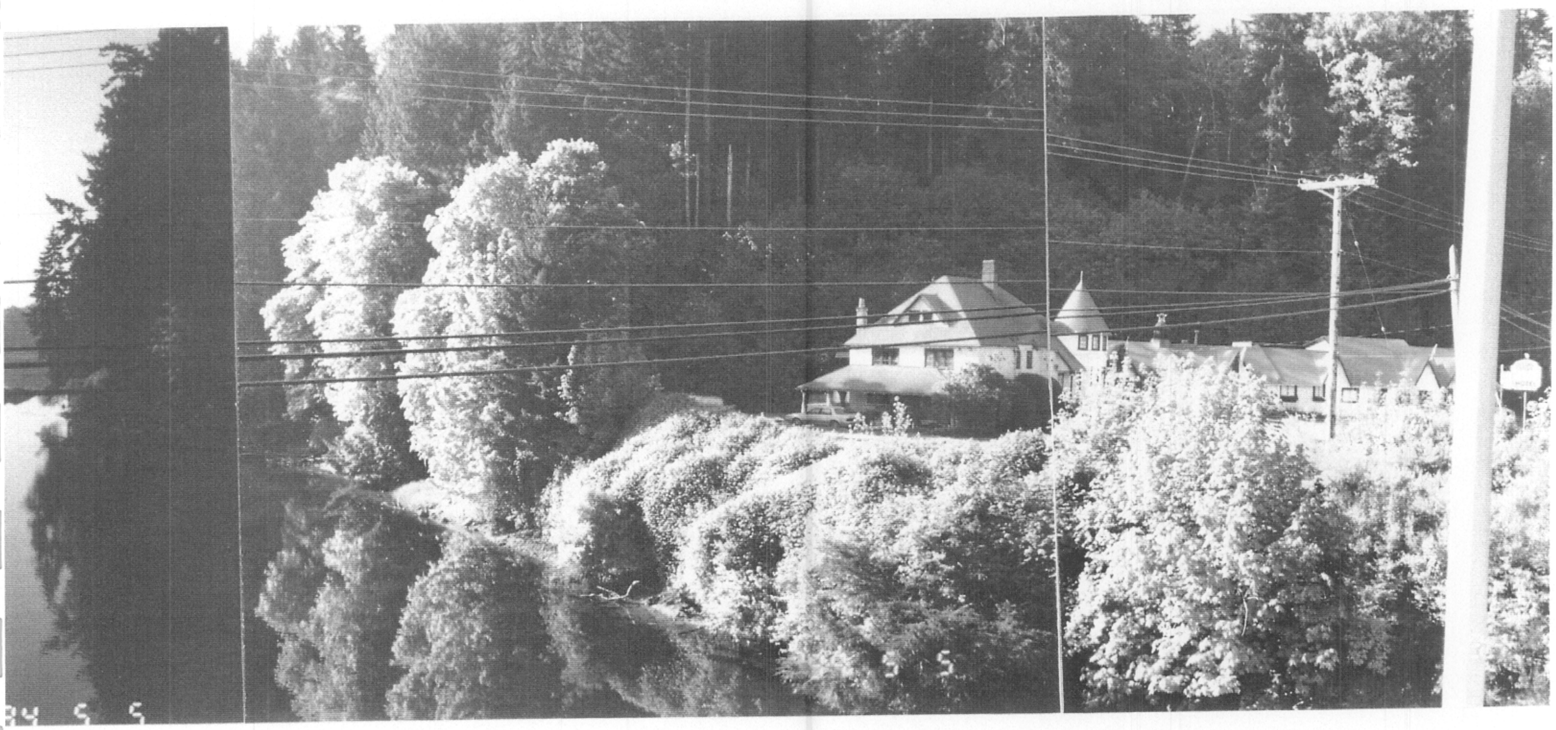


CLOSEUP OF ABOVE

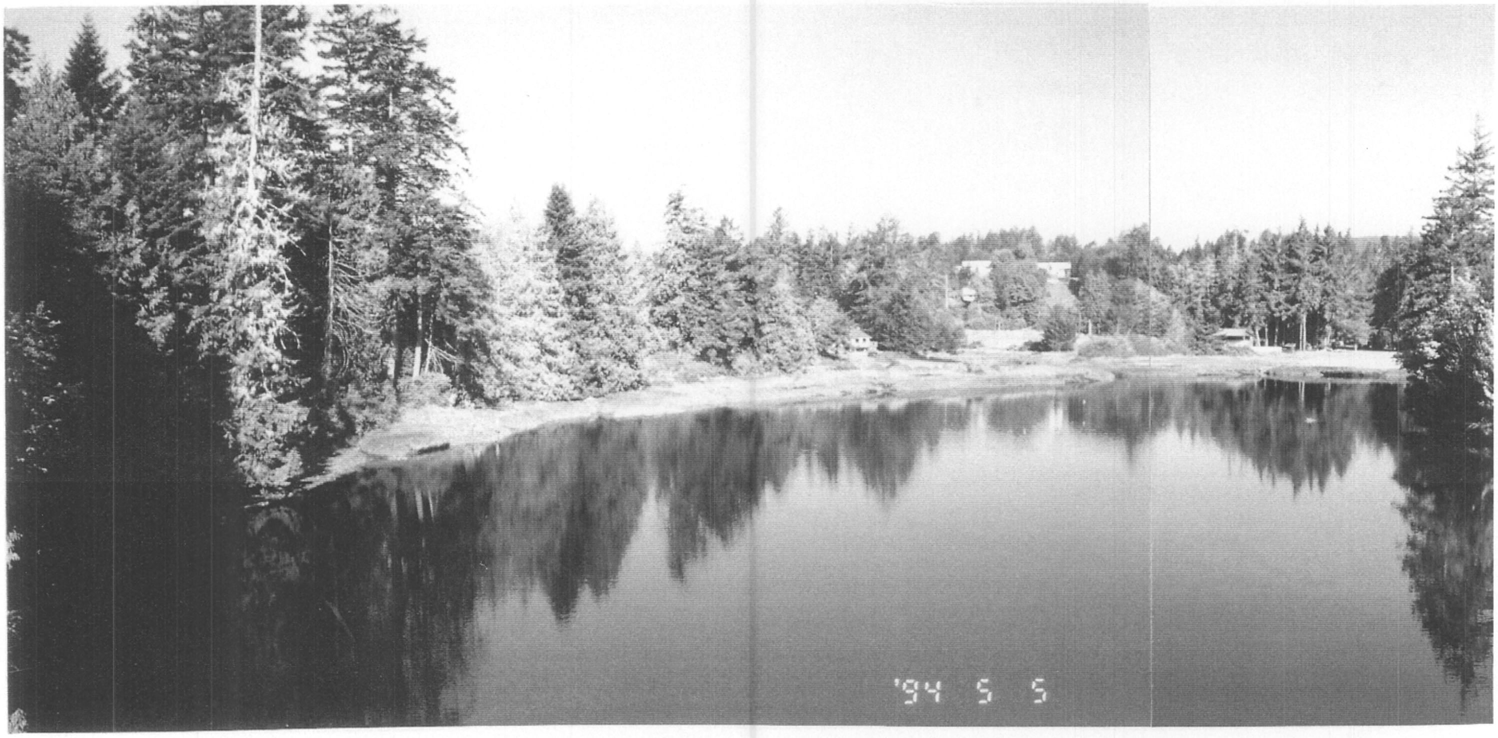
Appendix 2
Photographs



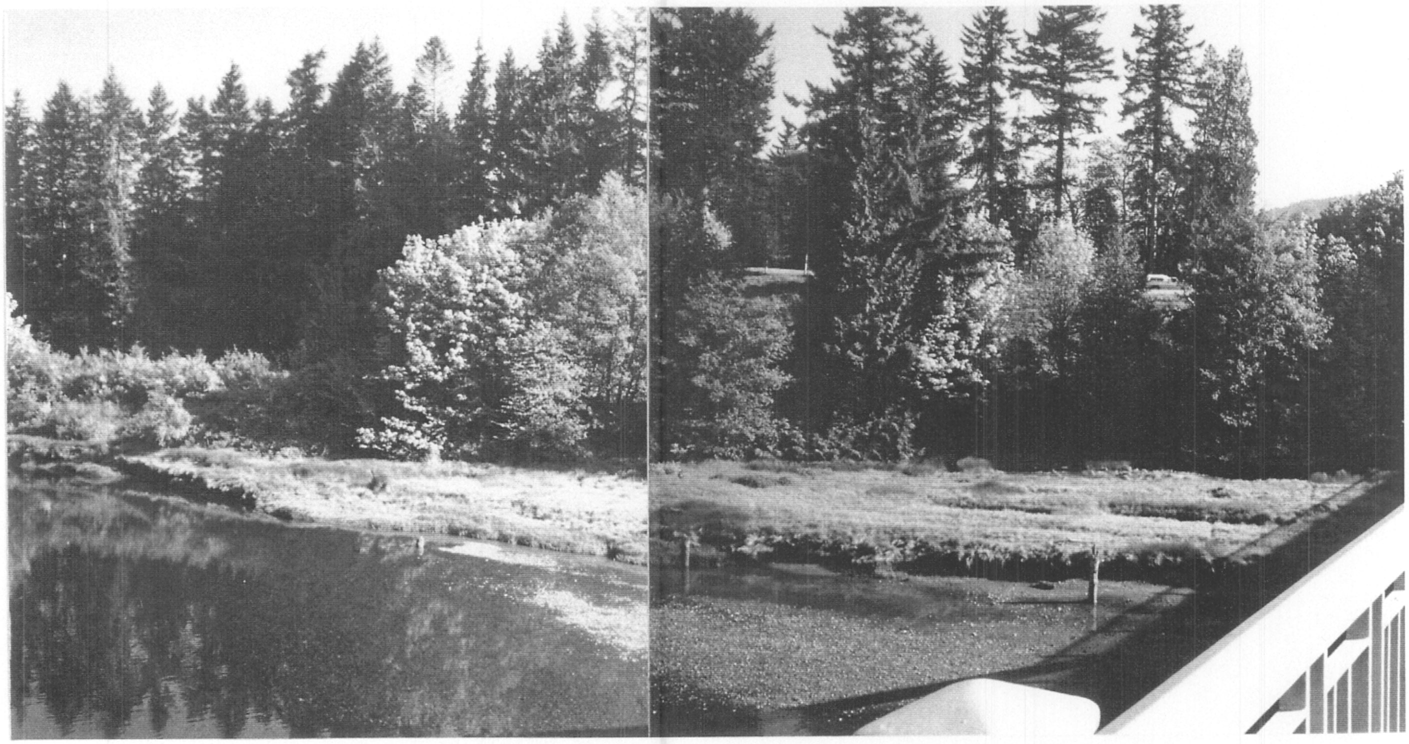
SOOKE RIVER FROM XS - 2 AT HIGHWAY BRIDGE LOOKING DOWNSTREAM - NOTE HOTEL IS ABOVE FLOODPLAIN LIMITS



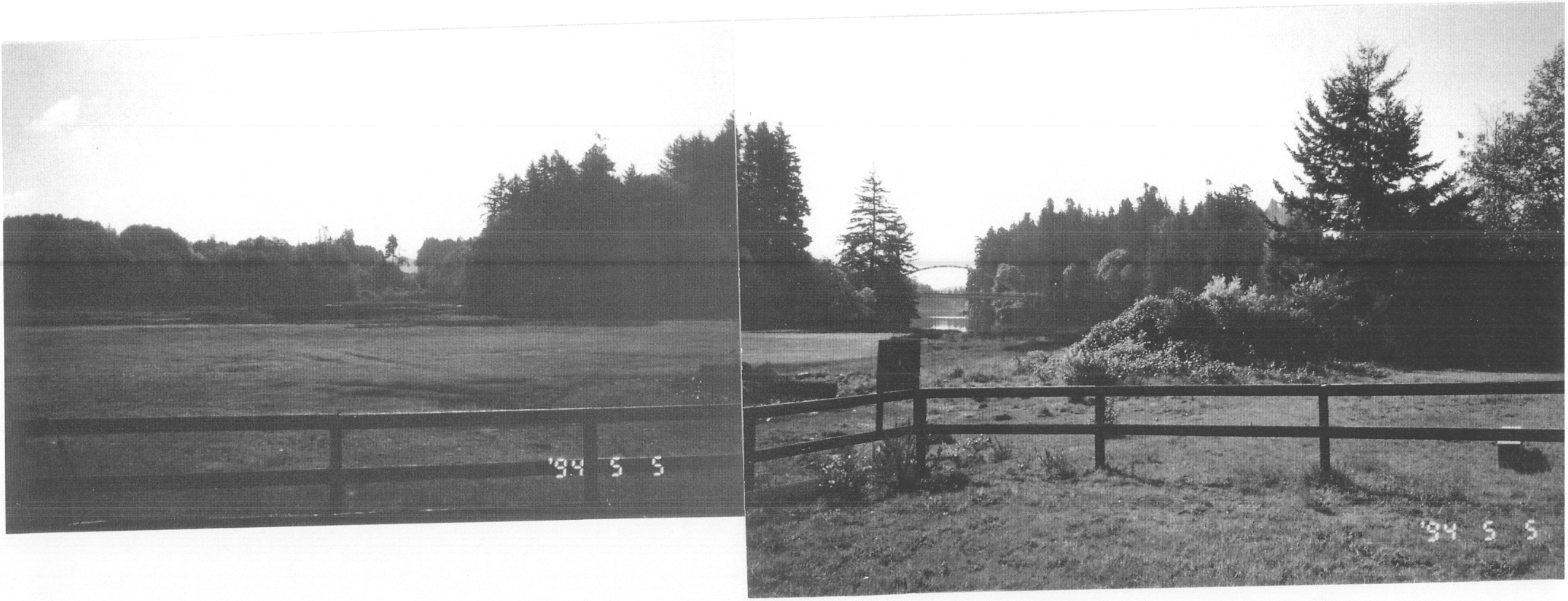
Appendix 2
Photographs



SOOKE RIVER - LOOKING UPSTREAM FROM HIGHWAY BRIDGE AT XS-3
NOTE FLUVO-GLACIAL DEPOSIT ON LEFT BANK



Appendix 2
Photographs



SOOKE RIVER - FROM XS-5 LOOKING DOWNSTREAM TOWARDS XS-4

Appendix 2
Photographs

SOOKE RIVER AT CHARTERS RIVER - LOOKING UPSTREAM

SOOKE RIVER AT CHARTERS RIVER - LOOKING DOWNSTREAM

Appendix 2
Photographs

VAN BEER'S RESIDENCE AT CONFLUENCE OF SOOKE RIVER AND CHARTERS RIVER (UNDERSIDE OF FLOOR APPROX. 200 YR. FLOOD LEVEL)

CHARTERS RIVER FROM BRIDGE LOOKING DOWNSTREAM TOWARDS SOOKE RIVER

Appendix 2
Photographs

CHARTERS RIVER LOOKING UPSTREAM TOWARDS NEW BRIDGE

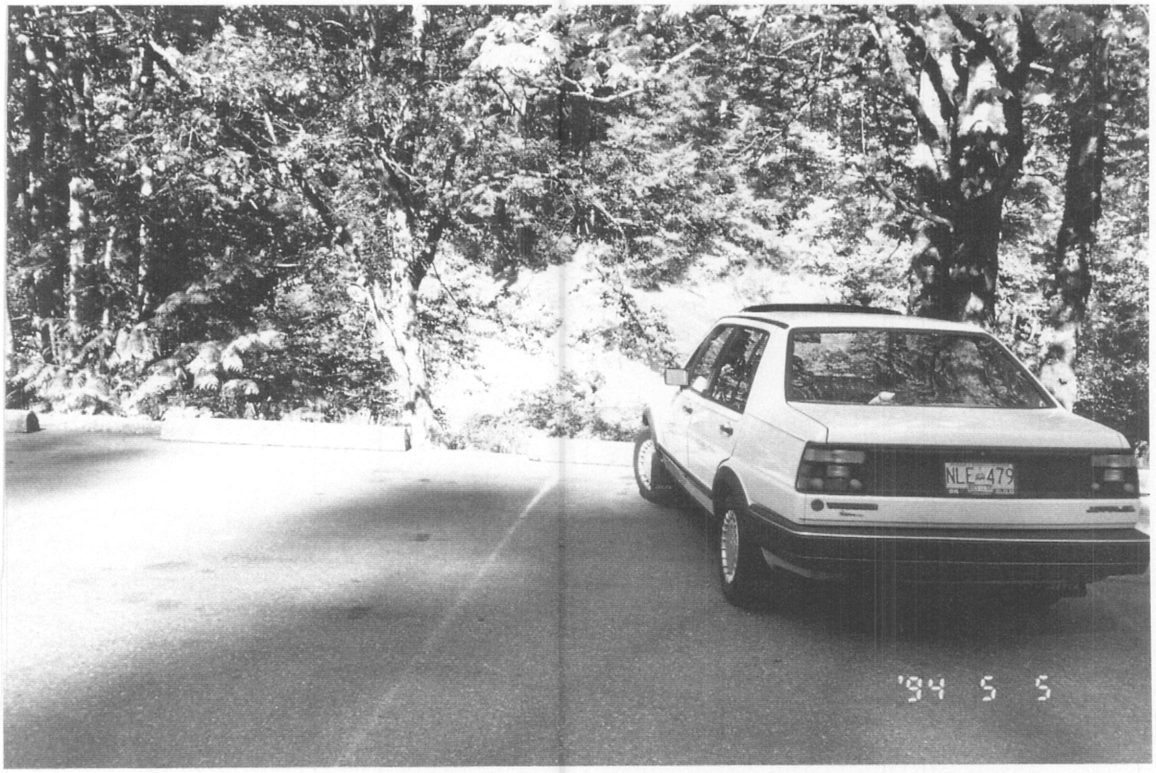
CHARTERS RIVER LOOKING UPSTREAM FROM NEW BRIDGE

Appendix 2
Photographs

SOOKE RIVER AT XS-24 WSC GAUGE HOUSE - 08HA059

SOOKE RIVER AT XS-24 WSC STAFF GAUGE - 08HA059

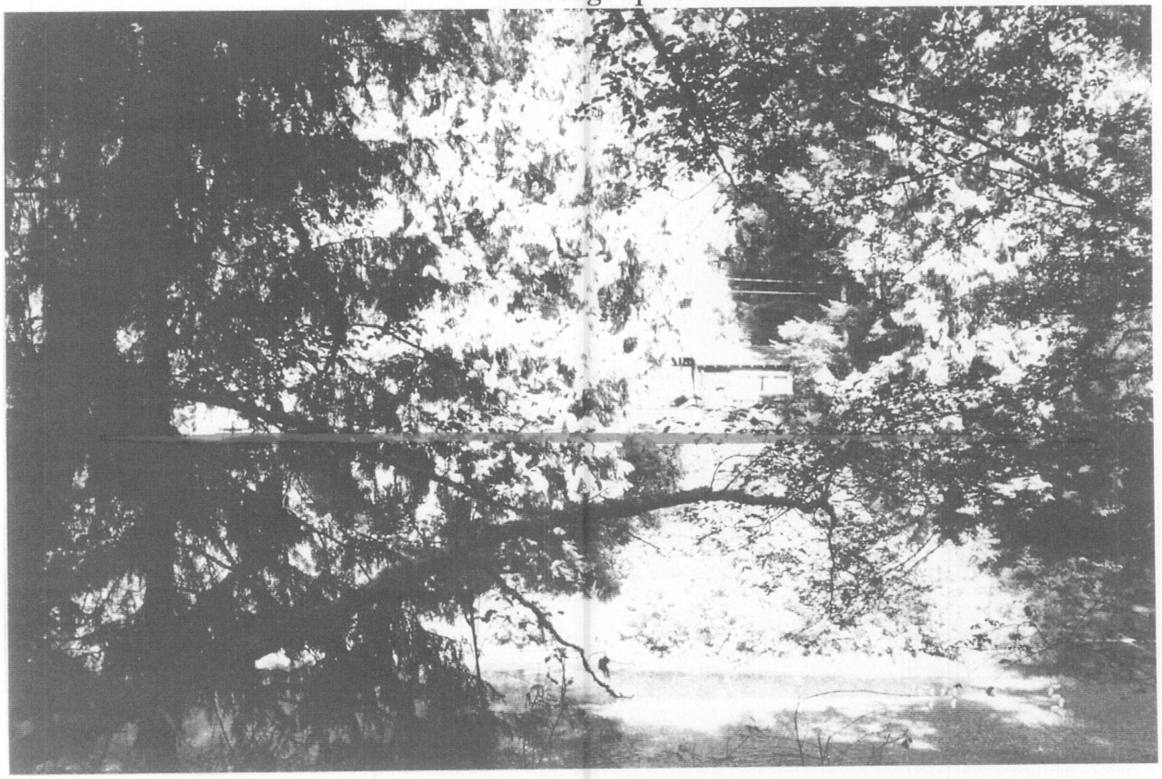
Appendix 2
Photographs



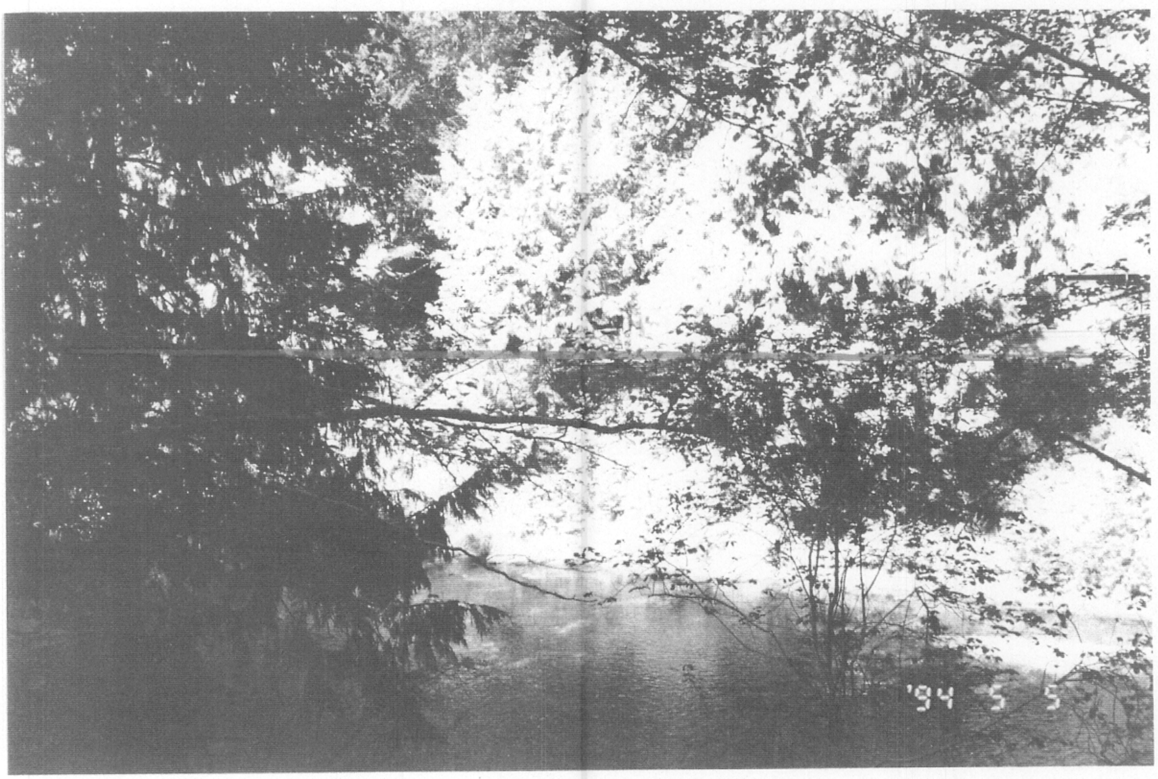
SOOKE RIVER AT "POTHOLES PARK" PARKING LOT - NOTE THIS VEHICLE WOULD HAVE BEEN UNDER WATER DURING 1990 FLOOD

AS ABOVE - NOTE MR. NICHOLS INDICATING HIGH WATER MARK

Appendix 2
Photographs



SOOKE RIVER FROM LEFT BANK (ABOVE STUDY AREA)
LINE INDICATES APPROX. HIGH WATER MARK NOV. 11, 1990 EVENT



AS ABOVE

APPENDIX 3

File No. 42500-40/R1
Study No. 402
December 14, 1993

HYDROLOGY SECTION REPORT

SOOKE RIVER

INTRODUCTION

In response to a request (memorandum of June 7, 1993) from P.J. Woods, Flood Hazard Identification (FHI) Section, peak flow estimates were made as input to a floodplain mapping project for Sooke River at its mouth. Sooke River and its major tributary, Leech River, drain moderate southern slopes of Vancouver Island from an elevation of 941 m (Survey Mountain) to sea level in Sooke Harbour. Sooke Lake forms the headwaters of Sooke River but contributes to only 20% of its drainage area. The Lake attenuates high peak runoff but high peak outflows do occur during heavy storm events, coincident with peak flows of neighbouring watersheds. Also, the Lake serves as the major water supply for the greater Victoria area and Saanich Peninsula but diversions during major peak flow events are not significant.

Peak flow events on southeastern Vancouver Island are generally caused by late fall and winter westerly frontal rainstorms of low intensity but long duration. Compared with directly exposed watersheds such as of the San Juan River, eastern and southern watersheds, such as of the Sooke River, which is located southwest of the San Juan River, experience smaller unit peak flows. The Sooke River watershed is also sheltered by the Olympic Mountains which further reduce the amount of rainfall on Sooke River. Occasionally frontal storms become unstable and remain stationary over a watershed for several days, producing thunderstorms and heavy showers which could cause severe flooding and damage.

Peak flow estimates for Sooke River were based on two regional peak flow studies, previously done for the eastern and southeastern parts of Vancouver Island. Selected records were updated for this study and local hydrometric data were included. The reports referenced are *Millstone River Peak Flow Estimates* (June 24, 1986; Study No. 218) and *Chemainus River Floodplain* (June 23, 1987; Study No. 243). Regional peak flow envelope curves derived in the hydrology report for the coastal mainland region in the *Fraser Delta Strategic Plan* (June 15, 1983) that were used in the above two studies were also used as reference in this study. General text book reference for the study procedure can be found in Chapter 7 of the Hydrology Section *Manual of Operational Hydrology in British Columbia*.

6 931214

DATA

Data used in this study consisted of annual maximum discharges from three Water Survey of Canada (WSC) hydrometric stations used in the regional analyses of the above referenced studies. These stations are listed in the first group in the table below. Local WSC data for stations within the Sooke River watershed were also considered and are listed. Only the Cowichan River stations have published instantaneous discharge data. Sooke River above Charters River (08HA059) is also equipped with a recorder to measure instantaneous discharges but, thus far, instantaneous data have not been published. However, the FHI Section has surveyed high water marks near this station for a recent flood (November 23, 1990) and has modelled the storm discharge (using HEC2 and WSC recorder chart and stage-discharge data). The resulting peak discharge estimates have been incorporated in this study as 1990 observed data. All current records were updated with the latest available data (1992).

HYDROMETRIC STATION Name	Number	DRAINAGE AREA (km^2)	PERIOD OF RECORD
(Regional Stations)			
Cowichan River near Duncan	08HA011	826	1960-63,65-92
Cowichan R. at Lake Cowichan	08HA002	596	1914-18,40-92
Koksilah R. at Cowichan Station	08HA003	209	1915-16,60-92
(Local Stations)			
Leech River at the Mouth	08HA017	104	1963-65
Sooke River near Sooke Lake	08HA005	77.7	1916-63
Sooke River above Charters R.	08HA059	275	1990-92

REGIONAL PEAK FLOW ANALYSIS

The regional peak flow method consisted first of an examination of hydrometric data for Sooke River and nearby watersheds. Frequency analyses were conducted on the four long-term records of annual maximum daily discharges. Estimates for 20- and 200-year recurrence intervals were based on the log-normal frequency distribution which was the best-fit distribution (lowest K-S statistic) for three of the four data sets. Frequency runs were not made for the two short-term stations (08HA017 and 08HA059) but their long-term average-year peak flows were estimated by prorating their short-term averages to long-term by comparing the concurrent peak observations of the short to long-term averages.

The frequency analyses results were plotted as unit peak flow ($L/s/km^2$) against drainage area (km^2) on log-log graph paper, as shown in Figure 1. A mean annual peak flow envelope curve (straight line on a log-log scale) from the Fraser Delta study (Transition and Coast Mountain Zone) was copied on this graph and was used for defining the common slope of the 20- and 200-year estimating curves. This particular curve provided a very good fit for both slope and vertical position for the Sooke River basin for mean annual peak flows. The two lake outflow points (08HA005 and 08HA002) plot below the curve to reflect peak flow attenuation. Leech River (08HA017) plots above the curve reflecting land runoff only and higher unit peak flow of the windward side of the mountain divide separating these basins. Plots of both Sooke River (08HA059) and Cowichan River (08HA011) at their mouths reflect the relative contribution of upstream lake basins and the downstream land tributaries. Since the Koksilah River (08HA003) and the 08HA059 points plotted on the same curve, the Koksilah points were then used as anchor points for parallel curve projections for the required estimates for Sooke River. The 95% confidence limits for the Koksilah point 200-year estimate are -14% and +15%.

The instantaneous peak flow estimates were based on the regional curves of the Chemainus River study. The peak ratio envelope curve, shown in Figure 2, was derived from a regional plot of ratios of maximum instantaneous to daily discharges. Also shown on this graph are the two points estimated in this study, Cowichan River 08HA002 and 08HA011, and the Sooke River 08HA059 point derived from the FHI survey data. A symmetrical curve was drawn through the 08HA059 point and the estimate of 2.5 was located for Sooke River at mouth.

RESULTS AND RECOMMENDATIONS

The recommended peak flow estimates, as requested for 20- and 200-year recurrence intervals, for Sooke River at the mouth, based on the described procedure and data, are given as follows.

Drainage Area, 340 km^2;

Recurrence Interval (years):	20	200
Daily Peak Discharge ($L/s/km^2$),	890	1100
(m^3/s),	300	370
Instantaneous to Daily Discharge Ratio,	2.5	2.5
Instantaneous Discharge (m^3/s),	750	930

The above daily peak flow estimates are as accurate as the available data, but the instantaneous estimates are only approximate. However, in time, this inaccuracy should be decreased with revision as instantaneous discharge data are collected at the lower Sooke River gauge, especially during high peak flow events.

W. Obedkoff, P.Eng.
Senior Hydrologic Engineer
Hydrology Section
Hydrology Branch
387-9474

FIGURE 1

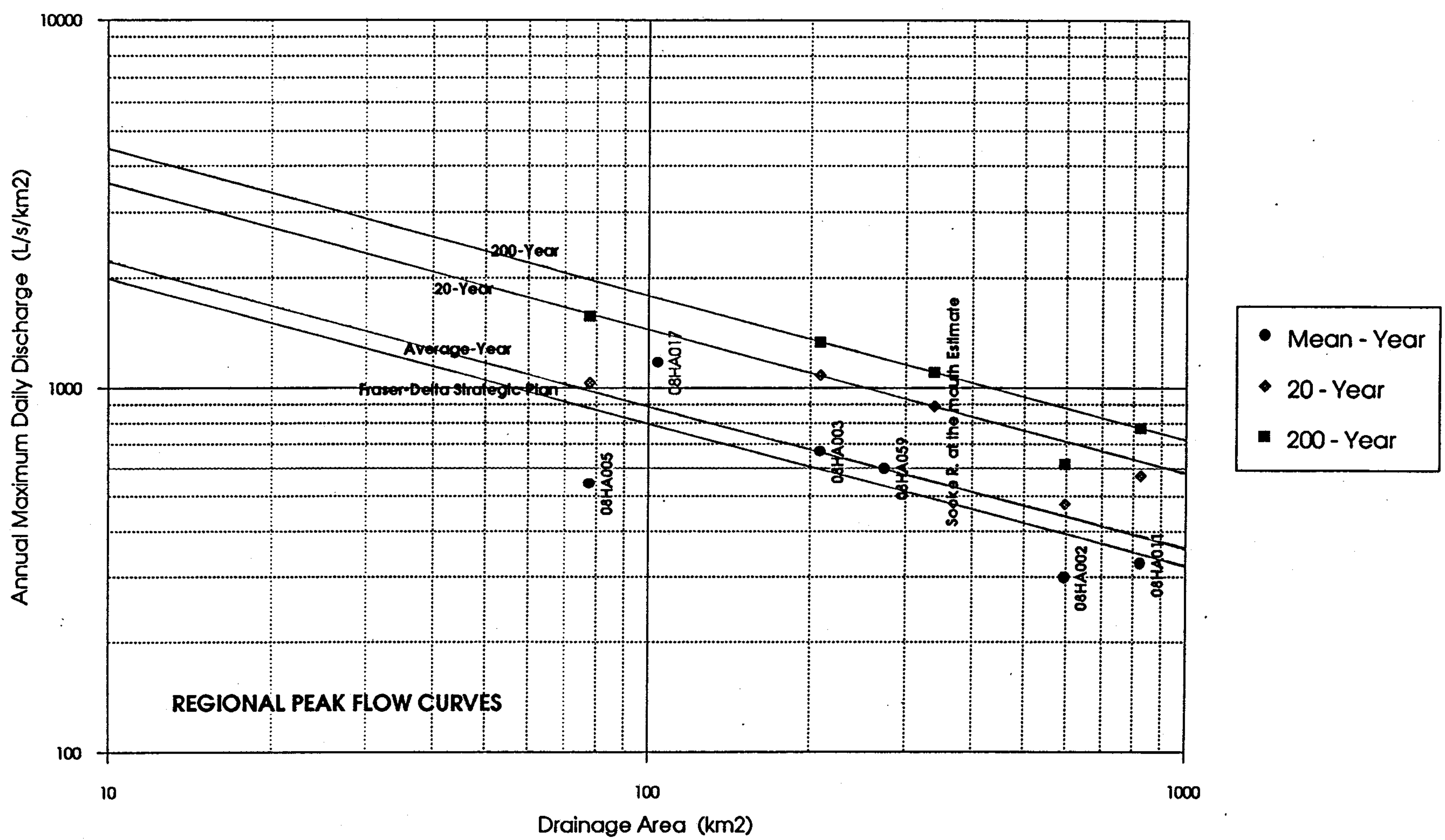
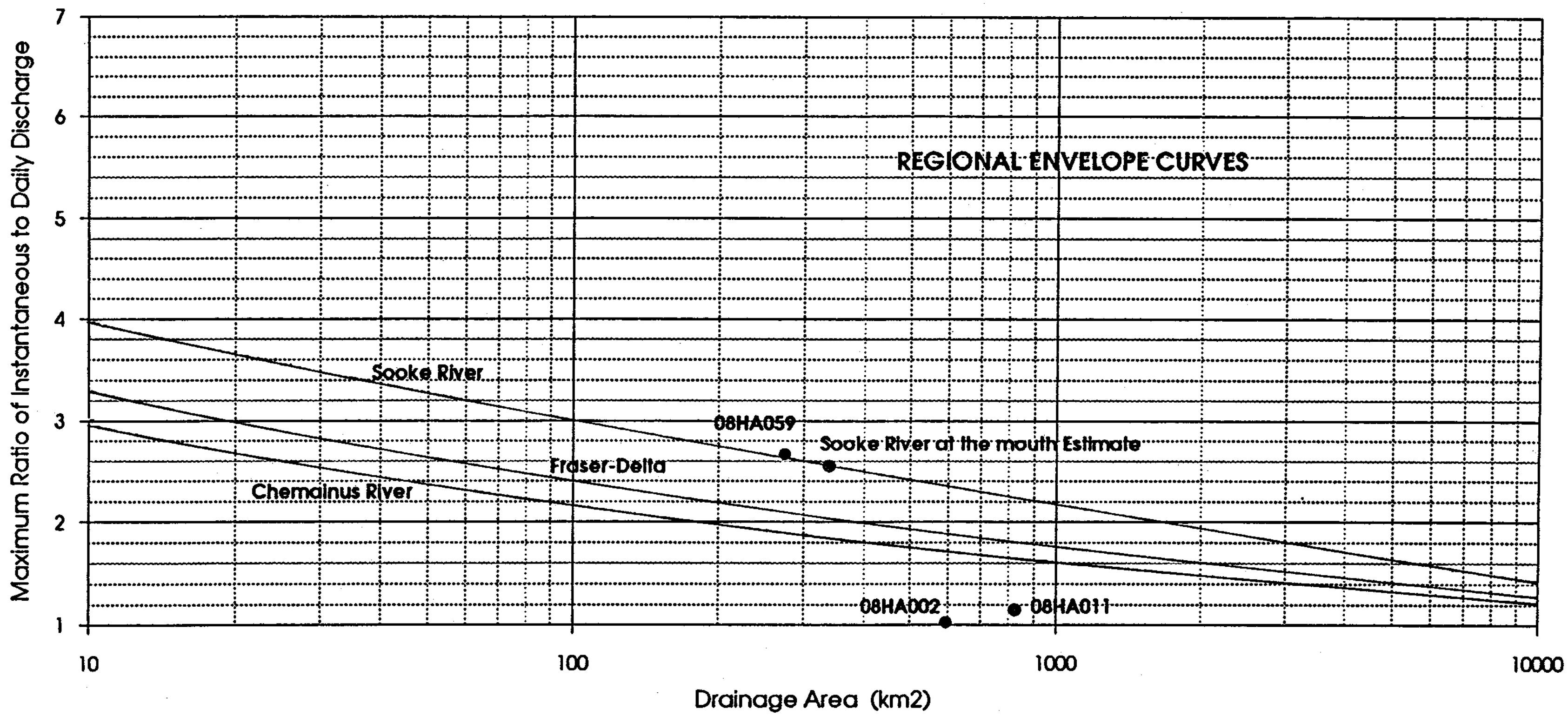

10000
1000
100
10
100
1000
Annual Maximum Daily Discharge (L/s/km2)
Drainage Area (km2)
200-Year
20-Year
Average-Year
Fraser-Delta Strategic Plan
08HA005
08HA017
08HA003
08HA059
Sooke R. at the mouth Estimate
08HA002
08HA011
REGIONAL PEAK FLOW CURVES
Mean - Year
20 - Year
200 - Year

FIGURE 2


REGIONAL ENVELOPE CURVES
Sooke River
08HA059
Sooke River at the mouth Estimate
Fraser-Delta
Chemainus River
08HA002
08HA011
Maximum Ratio of Instantaneous to Daily Discharge
1
2
3
4
5
6
7
10
100
1000
10000
Drainage Area (km2)