PROVINCE OF BRITISH COLUMBIA
MINISTRY OF ENVIRONMENT AND PARKS
WATER MANAGEMENT BRANCH

CRAWFORD CREEK ALLUVIAL FAN

An Overview of the Study Undertaken
to Provide a Preliminary Assessment
of the Flooding Hazard for Crawford Creek

by

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34-6300-S.1

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Appendices

CRAWFORD CREEK ALLUVIAL FAN

CRAWFORD BAY - KOOTENAY LAKE

Preface

The purpose of this report is to provide a preliminary assessment of the flooding hazard on the Crawford Creek alluvial fan. The report includes a review of available historic flooding information, an assessment of the morphology of the area and the results of hydrologic and hydraulic analyses.

1. STUDY AREA

The study area, located approximately 40 km northeast of Nelson as shown on Appendix 1, covers 2.3 kilometres of Crawford Creek upstream of Crawford Bay which is on the east shore of Kootenay Lake in the Central Kootenay Regional District.

The area is within the Cassiar-Columbia Mountains, one of the six main physiographic regions in the Province. Mean annual precipitation averages between 50 to 100 centimetres in the Crawford Creek drainage area. Mean daily temperatures range from a low of -5° C in January to a high of +20° C in July. (Appendix 2.1)

The drainage area of Crawford Creek is 190 square kilometres and the watercourse extends some 25 kilometres upstream of Crawford Bay. The maximum elevation of the mountain peaks in the area is 2,100 metres above Kootenay Lake, reaching elevations of 2,650 metres GSC.

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2. HISTORIC FLOODING INFORMATION

Information provided by Regional staff of the Ministry of Environment located in Nelson indicates there have been problems related to flooding in the study area as far back as 1910 when an avulsion resulted in the creek channel moving to the west side of the fan area for a period of time. The creek eventually moved back into its present channel (Appendix 2.3). Damages related to erosion of stream banks, rock and debris deposition on property and bedload removal to maintain the existing channel are annual problems in the area.

Floodwaters conveyed along existing active side channels in the fan area frequently pond behind Highway 3A, which crosses the floodplain just upstream of Crawford Bay. The Highway has been overtopped by floodwaters in past years and photos taken during a flood which occurred in June of 1968 are available (Appendix 2.3) which document such an event.

3. SURVEY AND MAPPING DATA

A total of twelve cross sections of Crawford Creek were surveyed by the Surveys Section of the Ministry of Environment and Parks in August of 1983. Additional survey information included bridge data, channel photos and the cross section locations as shown on an air photo mosaic of the study area. (Project No. 83-FDC-9, Appendix 2.4).

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Planimetric topographic base mapping of the study area was produced by the Mapping Section, Surveys and Resource Mapping Branch, Ministry of Environment and Parks in 1984. The mapping scale is 1:5000 with one metre contour intervals and spot heights. Air photography used in the mapping projects was obtained on August 25, 1981. (Appendix 2.5)

4. FAN MORPHOLOGY

The topographic information indicates the fan surface has convex cross profiles typical of alluvial fans (Appendix 2.2). A review of the survey data indicates the longitudinal profile of the watercourse averages 1.5 percent (maximum slope 2 percent) in the study area. Historic flooding information (Appendix 2.3) indicates the fan is active and sediment deposition requires channel maintenance on an annual basis. Active bank erosion was noted in the golf course area near XS-6 to 8 during a site visit by staff of the Special Projects Section on June 4, 1986.

The channel is not sufficiently incised downstream of the fan apex to prevent overflow of flood water onto the fan surface. Upstream of the fan apex, the creek slope is relatively steep and the watercourse is encased in a steep sided valley.

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5. FLOOD MAGNITUDES

The Surface Water Section, Water Management Branch of the Ministry of Environment and Parks completed a study in January of 1986 (Appendix 2.6) to estimate flood magnitudes for the study area.

The procedure used in the analysis consisted of a regional peak flow approach which included up-to-date frequency analyses of the gauged watersheds, St. Mary River (08NG046 and 08NG077), Kaslo River (08NH005), Harrop Creek (08NJ027), Redfish Creek (08NJ061) and Burden Creek (08NH052). Other regional hydrometric stations were also used in the analyses.

Flood envelope curves were drawn on plots of the frequency data and used to estimate the Crawford Creek flood peaks. The four year record (1949-52) of Crawford Creek (08NH104) was examined in the study. The recorded 1948 peak flow of 104 m^3/s was not considered to be reliable based on a careful examination of records of neighbouring hydrometric stations.

A regional instantaneous-to-daily discharge plot was used to determine instantaneous peaks for Crawford Creek. Since there is limited information available, the instantaneous estimates are considered to be approximate. The 1:20 and 1:200 year recurrence interval flows are estimated to be 71 and 89 m^3/s (daily) and 93 and 115 m^3/s (instantaneous) respectively.

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6. HYDRAULIC ANALYSIS

6.1 General

The information sources listed in Appendix 2 were utilized in the HEC-2 water surface computer program developed by the Hydrologic Engineering Center, U.S. Army Corps of Engineers.

The profile calculations, undertaken to assess the channel capacity, assumed open water flow conditions. The effect that sedimentation and/or a major debris jam on the main channel of the creek may have on flood levels in the immediate jam area is indeterminate. Consideration was given to the effect on flood levels of the confinement of flood waters by training works. The effect of ponding behind Highway 3A was also considered in the analysis.

6.2 Cross Section Plot Run

Computer plots of the cross sections were obtained to assess the field survey data of the Crawford Creek channel and the extensions of the channel sections which were obtained from the existing topographic mapping in the study area. Output from the plot run was also used to review the flow regime, loss coefficients, bridge information, reach lengths, overbank information and relative Mannings "n" values.

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6.3 Model Calibration

Highwater data corresponding to measured flows from a specific flood occurrence was not available in order to calibrate "n" values in the study area. The roughness characteristics at each cross section were estimated using the color photographs provided by the Surveys Section (Appendix 1.4) combined with experience gained in other studies and a review of the information available in a book published by the U.S. Department of the Interior entitled "Roughness Characteristics of Natural Channels". (Appendix 2.7)

6.4 Sensitivity to Manning's "n"

Mannings "n" values estimated for the channel varied between 0.040 and 0.047 in the model area. It was determined that the model is relatively insensitive to increased "n" values under high flow conditions due to the steepness of the watercourse (1.5% slope) in the study area.

For example, increasing "n" values by a factor of 1.6 for a 1:200 year daily flow of 89 m^3/s resulted in an average flood level increase of only 0.2 metres.

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6.5 Sensitivity to Confined Flows

Flood levels were calculated to determine the effect of containing the flow to within 30 metres of the right bank of Crawford Creek. The containment was assumed to commence at the Highway bridge upstream to cross section 10. Upstream of this section, the flow is contained by the existing channel configuration.

Under the above assumption, flood levels for a 1:200 year daily flow of 89 m^3/s will rise to a maximum of 0.50 metres higher than for the unconfined case, which is within the freeboard allowance of 0.60 metres. It should be noted that the confinement assumed was for the right bank only, the left bank flow being confined by the existing topography.

Results of the above analysis will assist in estimating training berm quantities, if such works are considered for future protection of the fan area.

6.6 Inundation of Highway 3A

Highway 3A has a crest elevation varying from 541.8 metres to 542.9 metres in the study area and constitutes a barrier to flood flows. The bridge crossing Crawford Creek is 30 metres wide with a road surface elevation of 542.1 metres and a low chord elevation of 541.0 metres. The surveyed channel capacity in the immediate vicinity of the bridge is adequate to pass a 1:200 year flow without the highway being overtopped.

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In practice, the flood waters are conveyed along existing active side channels in the fan area and are ponded at Highway 3A. Bedload material removed from the creek channel has been deposited on the right bank of Crawford Creek immediately upstream of the bridge preventing the ponded water along the Highway from returning to the creek channel. Consequently, flood waters overtop the Highway and in June of 1968 flood levels at the Highway reached elevation 542.9 metres (approximately) as existing culverts were not adequate. Figure 3 indicates a 1:200 year water surface profile for Crawford Creek. A flood level of 543.5 metres (0.6 metres freeboard) has been assumed for the ponded area immediately upstream of Highway 3A.

7. DRAWING 86-4-3

The 1:200 year flood level (freeboard included) of Kootenay Lake of 536.5 metres was established by the Ministry of Environment and Parks in June of 1975 (Appendix 2.8) and used in this study. The Kootenay Lake flood level does not affect Crawford Creek beyond the area in the immediate vicinity of the creek mouth.

Drawing 86-4-3 (Appendix 4) indicates the location of river cross sections, the deliniation of the geomorphic limits of the Beaver Creek - Crawford Creek fan complex, and the location of survey monuments in the study area.

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8. CONCLUSIONS

1. The study has indicated that the Crawford Creek alluvial fan is active and subject to flood hazard as a result of main channel dislocation, high velocities, rapid bank erosion and sediment or debris deposition.

2. Development should be kept clear of the fan area except where it can be shown that the potential threat to property and human life is low and adequate flood protection works can be provided.

3. The flood profile studies undertaken for this report provides a basis for assessment of possible future flood protection works for the fan area.

4. The alignment and freeboard for such works should account for bed accretion processes over time. Sediment sources in the drainage basin such as landsliding, logging or other disturbances should also be assessed in view of possible bedload deposition and/or debris jamming problems during flood periods.

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Attachment

STUDY AREA LOCATION

100 0 100 200 300 KILOMETRES

Province of British Columbia
Ministry of Environment and Parks
WATER MANAGEMENT BRANCH

TO ACCOMPANY REPORT ON

CRAWFORD CREEK ALLUVIAL FAN

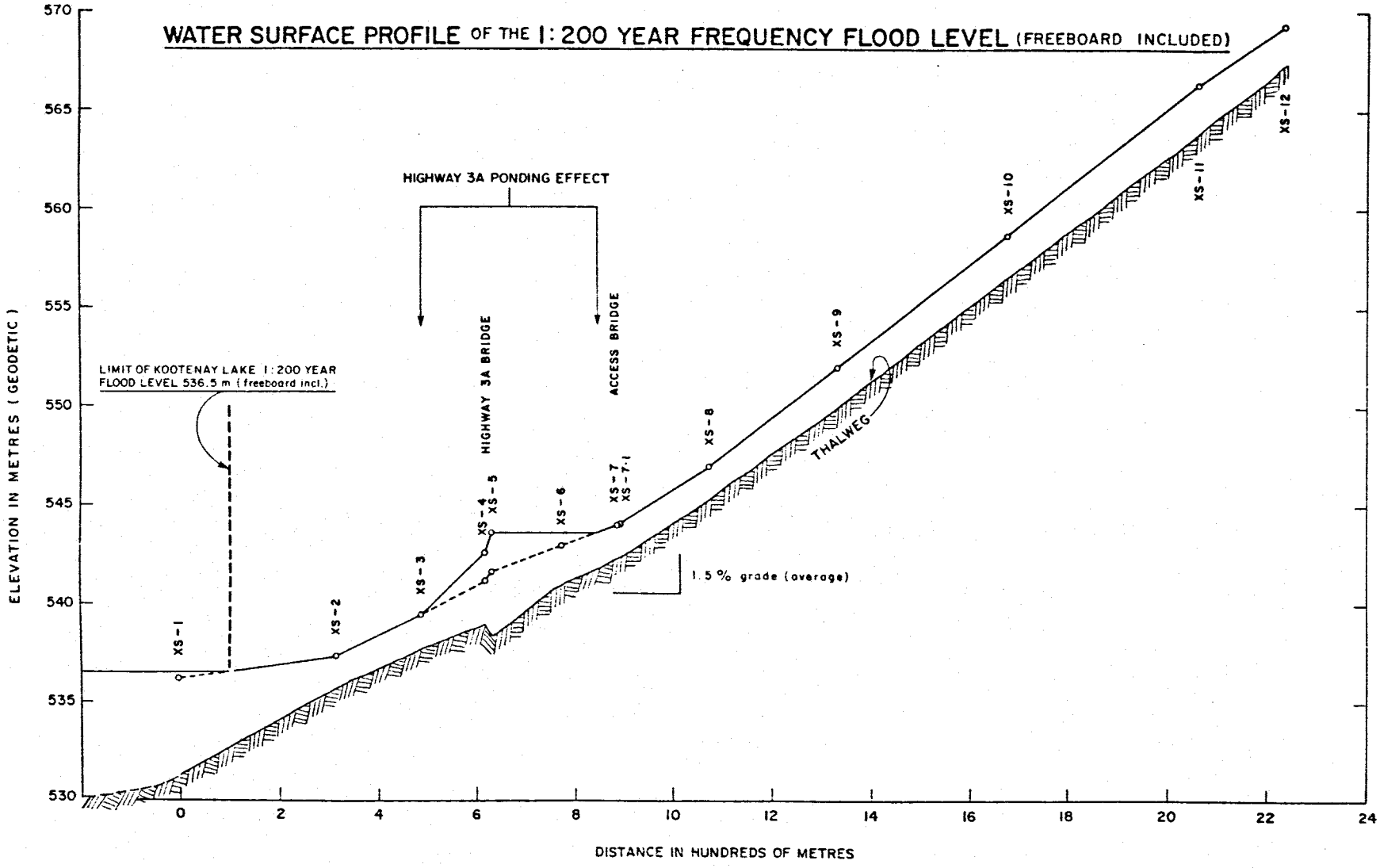
SCALE: VERT. ..... HOR. AS SHOWN

DATE MAR, 1986

R. W. NICHOLS ..... ENGINEER

FILE No. 34-6300-S.1 APPENDIX No. 1

BCIL 76/3 M E



Province of British Columbia
Ministry of Environment and Parks
WATER MANAGEMENT BRANCH

TO ACCOMPANY REPORT ON

CRAWFORD CREEK ALLUVIAL FAN

SCALE VERT. AS SHOWN	DATE
HOR AS SHOWN	MAR, 1986
R.W. NICHOLS	ENGINEER
FILE No. 34-6300-S.1	APPENDIX No. 3

DWG. NO. 86-4-2

APPENDIX 2

Detailed Information Sources
Crawford Creek Alluvial Fan

No.	Source	Contents
1.	Atlas of British Columbia, U.B.C. Press W.R. 912.711 F231 C.4	General information on the people, environment and resource use.
2.	"Floodplain Management on Alluvial Fans", report to Ministry of Environment, Water Management Branch, by Thurber Consultants Ltd., Victoria, B.C., August 15, 1983	Purpose is to provide a basis for assessing the hazard of flooding on alluvial fans.
3.	Ministry of Environment, Region 4, Kootenay, Water Management Branch, "Flooding History, Crawford Creek", memo dated Dec. 13, 1985, File: 55.500802	A summary of Crawford Creek flooding information obtained from Water Management Branch files and from local residents.
4.	Ministry of Environment, Surveys Section, Water Management Branch, Project 83-FDC-9, August 1983	Computer printouts of 12 cross sections, bridge details and photographs of the Crawford Creek channel.
5.	Ministry of Environment, Surveys and Resource Mapping Branch, Project No. 84-072T	Planimetric topographic mapping, 1:5000 scale, 1 metre contours, date of photography, August 1981.
6.	Ministry of Environment, Surface Water Section, Water Management Branch, "Crawford Creek Peak Flow Estimates", memo dated January 3, 1986, File: S2104-4	Estimates of peak flows in the study area based on a regional analysis.
7.	U.S. Department of the Interior, Geological Survey Water Supply Paper 1845, "Roughness Characteristics of Natural Channels", by H.H. Barnes, Jr., 1967	Color photographs and descriptive data for 50 stream channels for which roughness coefficients have been determined.
8.	Ministry of Environment, "Flood Profile West Arm of Kootenay Lake", memo from B.E. Marr to Regional District of Central Kootenay, June 16, 1975, File: 0305030-6	1:200 Year Flood Profile for Kootenay Lake - Main and West Arm.