TROUT RIVER HYDROTECHNICAL STUDY

FINAL REPORT

BACKGROUND DATA & SURVEY AND MONITORING

PREPARED FOR

DEPARTMENT OF ENVIRONMENT AND LANDS

ST. JOHN'S NEWFOUNDLAND

JOINTLY PREPARED BY

ISLAND ENGINEERING CO. LTD

CORNER BROOK NEWFOUNDLAND

AND

CUMMING COCKBURN LIMITED

WILLOWDALE ONTARIO

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I N D E X

1.0 FIELD REPORT

1.1 Introduction

The objectives and scope of the hydrotechnical studies on the Feeder Brook and Trout River watersheds are as follows:

1. Obtain and analyze background information on local ice jams, historical flooding and hydraulic characteristics in the study area in order to document the flood problems.

2. Obtain and review background climatological, hydrometric and tidal information relevant to flood conditions in the study area.

3. Analyze the influence of ice jams on flooding in the study area.

4. Determine the influence of local physiographic and cultural factors of flooding conditions in the watershed.

The field program was undertaken by staff members of Island Engineering Co. Ltd. and Cumming-Cockburn and Associates Ltd.

Arrangements were made with a local resident, Mr. Fred Crocker, to take crest gauge readings. As well, Mr. Crocker was engaged to assist with the surveying activities.

Mr. Bill Mullins and Mr. Paul Noseworthy, of Environment Canada, Water Resources Branch, were engaged to monitor stream flow velocities. The following sections describe the field program which primarily comprised stream flow measurements, physical surveys related reconnaissance activities.

1.2 Field Program

Physical aspects of the field program included installation of crest gauges and subsequent collection of stream discharge data and water level measurements during runoff conditions.

In addition, all structures along both Trout River and Feeder Brook were identified by photographs and physical dimensions obtained.

Cross-sections of the channel and flood plain at various locations along both watercourses were surveyed as part of the initial field program.

To supplement the physical aspects of the field program, field investigators conducted interviews with long time residents of the area to obtain a better understanding of past floods, their causes, and their degree of severity. These interviews resulted in our obtaining relevant information and photographic documentation of these past floods.

1.3 Crest Gauge Stations

Upon reviewing the existing mapping for the area, it was decided that three crest gauges would be adequate to obtain the required water level measurements. This was also confirmed in the field and the gauges were placed where required.

The gauges were located in the main stream channel and where structural or natural constraints such as bridges or islands were could impede the flow and thus cause backwater buildup.

Three 2.2 m long crest gauges were constructed using 50 mm A.B.S. piped closed at both ends. Small holes were drilled approximately 300 mm from the bottom of the pipe to allow water to enter.

A square wooden measuring rod was then put in the tube. Ground cork was also put in the tube. The cork would stick to the wooden rod indicating the maximin and minimum water level. These crest gauges were installed on May 9, 1989.

Elevations for the crest gauges were established relative to Geodetic Datum and the level circuits for the cross sections. The gauges were tied into Geodetic Benchmark 77 F

031, set in concrete on the foundation wall of Jakeman Central High School in the Community of Trout River.

The locations of the crest gauges and Geodetic Benchmarks are listed in Section A of this summary report.

Photographs will accompany the location and description of the crest gauges.

1.4 Physical Surveys

Physical surveys carried out as part of the field program included defining structure types and sizes along both watercourses, obtaining cross-sections of both streams and also flood plains.

These aspects of the physical survey are referenced to Geodetic datum and large scale topographic mapping of the area.

These field measurements are described in greater detail in the following sub-sections.

1.4.1 Obstructions

The obstructions along Trout River and Feeder Brook causes the flow in both streams to be somewhat impeded. Therefore, physical dimensions and critical elevations, as noted below, were obtained.

Bridges

Clear span opening between piers.
Height of bridge deck above the channel bottom.
Intermediate pier dimensions.
Deck surface elevation.
Depth of flow at centre of span or channel.

Culverts

No. of culverts.
Size of culverts.
Invert elevation.
Elevation of road above culverts.

Islands

Size.
Elevation of highest point.

The pertinent data sheets and photographs for each of the aforementioned structures are included in Section B of this report.

The photographs were taken during the period of May 8 - 10, 1989.

1.5 Cross Sections

Prior to the start of the cross sectioning survey, both streams were traversed in order to select the locations of the cross section points. Using a Wild Nako Level, temporary bench marks and turning points were established to be used as vertical control.

Field personnel then proceeded to survey cross sections, starting at a cross section on the Government Wharf, which is located at the mouth of Trout River. Cross sections 1 and 2 were done on May 9, 1989 using a Nikon N.T.D. 4 E.D.M. Theodolite. Field location of the lines was determined by angle and distance measurements from existing landmarks. Subsequent measurements were performed in the same manner.

Since the two streams were too fast to get a profile during the time of the initial surveying of the bed streams by wading or by boat, it was decided that only land sections be taken at this time. Bottom profiles would have to be taken at a time when the water conditions were more appropriate. A total of thirteen cross sections were taken on land, eleven on Trout River and two on Feeder Brook. The land sections on Trout River started at the mouth of the river itself, where it runs into the harbour, and proceeded upstream to where the it runs out of Trout River Pond. These land cross sections varied in length from 70 m to 264 m.

Land sections on Feeder Brook began at ± 10 m downstream from the bridge over the brook to a point ± 430 m upstream from the bridge.

Two sections were taken varying in length from 14 m to 30 m.

Bottom cross sections of both Trout River and Feeder Brook were surveyed on June 16, 1989, and varied in width from 22 m to 42 m.

1.6 Discharge Measurements

Two stations, one on each of the watercourses, were established to facilitate stream discharge measurements as part of the field monitoring program.

The station on Trout River was located at the upstream rail on the bridge over Trout River at the outlet of Trout River Pond. This Bridge is designated as B1.

The station on Feeder Brook was located ± 10 m downstream from the bridge over Feeder Brook. This bridge is designated as B2.

On May 17 and May 30, 1989, flow measurements were taken by using a 50 lb leaded weight with an automatic current meter. Twenty (20) vertical sections were taken over the span of the river and a discharge rate of 36.7 m3/sec was calculated.

Flow measurements at B2 were taken by wading. Twenty-one (21) vertical sections were taken over the span of the brook and a discharge rate of 1.63 m3/sec was calculated.

On May 30, 1989, the same procedure was repeated to obtain the low flow measurements. Flow measurement at B1 was 20.7 m3/sec and at B2 was 0.769 m3/sec. The charge calculations are included in Section "C".

The monitoring program continued for 1 1/2 months, terminating on July 22, 1989. During this period river elevations were obtained during periods of rainfall and during normal periods.

Two significant problems were encountered during the monitoring program.

(1) There was no significant amount of rainfall in the Trout River area during the monitoring period. Although the snowfall received during the 1988 - 1989 winter months was normal for the area, gradual melting of the snow in the surrounding hills eliminated large spring floods. As a result, there were no flooding events by overbank flow.

(2) Although the crest gauges were not destroyed, they had been tampered with on numerous occasions.

However, the gauges could be adjusted to their original position and measurements taken by the normal procedure.

SECTION "A"

TABLE I

CREST GAUGE LOCATIONS
FOR
TROUT RIVER HYDROTECHNICAL STUDY

TEST GAUGE NO.	LOCATION
1	On wooden retaining wall adjacent to cross section line #2, roadside of Trout River.
2	On wooden retaining wall near Jakeman Central High School, roadside of Trout River.
3	Between large rocks underneath Bridge #1 at the mouth of Trout River Pond.

TABLE 2

LIST OF GEODETIC BENCHMARKS
USED FOR SURVEY CONTROL
TROUT RIVER HYDROTECHNICAL STUDY

Benchmark No.	Elevation	Description of Location
77F033	4.796	Anglican Church, tablet in North or front concrete foundation, 50 cm from northwest corner, 90 cm below wooden clapboard siding. Latitude: 49 - 28.8 Longitude: 58 - 07.8
77F031	2.227	Jakeman Central High School, tablet in east or front concrete foundation. 1.0 m from southeast corner, 65 cm below siding. Latitude: 49 - 28.4 Longitude: 58 - 07.8

TROUT RIVER WATER LEVELS

DATE	TIME	GAUGE #1 - SHED	GAUGE #2- SCHOOL	GAUGE #3 - Pond
May 8		20.5	30	43
May 9		92	30	43
May 10		37	29.5	42
May 12	5:00 p.m.	85	74.5	112.5 Before rain
May 14	1:15 p.m.	116.5	75.5	116.5 after rain
May 16	5:30 p.m.	117.5	72.0	106.5
May 18	6L00 p.m.	97.5	61.5	104
May 22	7:15 p.m.	117	61	89
May 25	12:00 a.m.	112	54	68 before rain
May 31	9:30 a.m.	151	48	55
June 6	9:00 a.m.	Tampered 160	44	57 tampered
June 13	10:15 a,m.	152	31	54
June 20	8:00 a.m.	gone	12	gone
June 27	11:00 a.m.		11	Before rain
June 30	4:00 p.m.		42	after rain
July 4	10:30 a.m.		25	
July 11	6:00 p.m.		12	
July 18	11:00 a.m.		8	
July 22			6	

TROUT RIVER WATER LEVELS

DATE	TIME	GAUGE #1 - SHED	GAUGE #2- SCHOOL	GAUGE #3 - Pond
MAY 8		52.07	76.20	109.22
May 9		92	76.20	109.22
May 10		93.98	74.93	106.68
May 12	5:00 p.m.	85	74.5	112.5 before rain
May 14	1:15 p.m.	116.5	75.5	116.5 after rain
May 16	5:30 p.m.	117.5	72	106.5
May 18	6:00 p.m.	97.5	61.5	104

SECTION 2

BACKGROUND

2.0 BACKGROUND

2.1 Interviews

On May 8, 9 and 10, 1989 interviews were held with residents of Trout River and other people knowledgable of the area. Further interviews were held in June and July, 1989.

Mr. David Hann of Trout River indicated there is frequent flooding on the road. Some years the ice in the Lower Trent River Pond melts in place, staying in the pond as it did this year. Other years the ice breaks up and flows down the river, jamming at downstream locations. Precise location of these ice jams was not indicated.

Mr. Isaac Crocker has lived in the first house upstream of the bridge, on the east side of the river, west of the road, for the past 40 years. Before that he lived on the other side of the river. He has seen ice pans two to three feet thick and twenty feet long going past his house. They do not jam up and cause flooding at the bridge. He has not been flooded from the river since a retaining wall (approximately 1 m high) was installed along the river with fill placed behind it.

Mr. Fred Crocker lives near Isaac Crocker but approximately 35 m east of the road, further from the river. He indicated that some ice occasionally backs up at the bridge, but never enough to cause flooding. The tide comes up as far as the bridge but does not seem to make the problem any worse.

Mr. Crocker said that flooding in town (he has had water in his yard) is caused upstream at the confluence of the "Feeder" and Trout River. Ice comes down the Feeder and backs up at the bridge and culverts. Water flows across the road, and down the road to town. Nineteen eighty-nine is the first year he has not seen it flood the road.

Ice flowing down the Trout River also accumulates in the shallows at the outlet of the Feeder and combines with ice from the Feeder causing water backup.

Mr. Walter Crocker lives in the first house downstream of the Feeder, on the east side of the road. Mr. Crocker says that the road has not flooded since the new bridge was built (about 1976) and the four culverts placed at the location of the old bridge. With the old bridge, sheet ice from the Feeder used to back up at the bridge and flood the road.

Mr. Barnes said that the largest flood ever was in 1938. That year, a barn at the fork in the road (with Hwy. 431) was washed away with the spring flood.

Mrs. Mary Crocker said there was another big flood about 30 years ago (1959). Photographs taken at that time by a local resident are shown on Figure 2.1.

Mr. Murdock Brake, an elderly resident of Trout River has lived most of his life in a house located on the east side of the river, west of the road, about 600 meters north of the Big Feeder Brook. Mr. Brake indicated that the last two large floods, that he could recall, occured in 1976 and 1983 respectively. He has seen ice jams at the Trout River bridge, but has not seen any flooding of the town as a result of this since the retaining wall was built. Mr. Brake said that the major cause of flooding in the last 15 years has been from the Big and Small Feeder Brooks.

Discussion with Mr. H. Smith, Public Works Canada, in Rocky Harbour indicated that Public Works has no information concerning the Trout River flooding problems.

A meeting was also held with Mr. P. Caines, Chief Park Warden for Gros Morne National Park. After discussion with other staff members, it was determined that Parks Canada had no photographs or records on the Trout River. When the new bridge was built at Lower Trout River Pond, some research was done into high water marks but all information was verbal.

When it is needed, Parks Canada gets tidal information from the Coast Guard.

2.2 Historical Floods

2.2.1 History of Flooding

Winter 1985/86: According to Mr. Howard Crocker, the Mayor of Trout River, ice which formed on the Feeder Brook broke up and was flushed downstream to jam at the confluence of the Feeder with Trout River. In this incident a local road was closed due to water and ice flowing across it. There were no reports of any property damage. Mr. Crocker stated that this type of flooding occurs every two or three years.

1980-82: Floods have also occurred as a result of ice jams near the island in Trout River. Sometime between 1980 and 1982 an ice jam near this island resulted in the grounds surrounding the local school being flooded. There were no reports of property damage from this flood. According to residents this type of flooding occurs less frequently than the type of event noted above.

Spring 1976: The Trout River bridge was damaged by ice and high water. Scouring was reported around the centre pier and settling resulted. Ice also damaged the planking on the nose of the piers. No other damage was reported.

2.2.2 Nature of Flooding

The known floods which have occurred in the Trout River area appear to have been as a result of ice jams, usually at the confluence of Feeder Brook with Trout River, and less frequently at the island in the river or near the bridge in the community. There have been no reports of floods from high fresh water flows or of floods related to high tides.

We have been informed by the residents of Trout River that the flooding in the last 15 years has not been caused by Trout River but by two small tributaries which flow into the river known as the Big and Small Feeder brooks. Before 1975 the runoff was handled by the two Feeder brooks and each brook contained its own bridge. In 1975 or 1976 the Dept. of Highways tried to rechannel all of the runoff into Big Feeder Brook by eliminating the bridge on the Small Feeder and placing four 1.2 meter culverts in its place. Eighty meters down from the pump house where the Big Feeder and Small Feeder intersect a gravel retaining wall was constructed to eliminate the flow of water into the Small Feeder. A new bridge was then constructed over the Big Feeder. This was an attempt by the Dept. of Highways to eliminate the problem of flooding caused by ice jamming at both of the old bridges. Ten to fifteen meters above the area where the gravel retaining wall was constructed a bend in the Big Feeder causes ice to block up during quick runoff. Water builds up behind the ice and flows over the gravel retaining wall into the Small Feeder down towards the four culverts. Snow buildup around the four culverts from natural snow fall and winter snow clearing causes the culverts to block up. The water that is flowing in the Small Feeder builds up behind the blocked culverts until it reaches a level where it flows onto the road and into surrounding fields. Ice building up at the Big Feeder bridge adds to the flooding problem. Another area of problem is where the Big Feeder and Trout River intersect. If this area is blocked with ice from Trout River then ice flowing down the Big Feeder has nowhere to go and adds to the ice jam. Water builds up behind the ice, thus resulting in the surrounding area being flooded. This flooding does not seem to be as serious as the first one mentioned.

2.3 Previous Studies

2.3.1. Regional Flood Frequency Analysis for the Island of Newfoundland

A study was carried out with the objective of providing a technique for estimating the 20 and 100 year recurrence interval instantaneous flood flows for the Island of Newfoundland. The results are described in the report "Regional Flood Frequency Analysis for the Island of Newfoundland". These are extensively used in the estimation of flood flows for a variety of projects including flood risk mapping, remedial measures studies, the design of spillways, bridges, and other hydraulic structures.

2.4 Existing Data

2.4.1 Hydrometric Data

Data from five hydrometric stations in the area would be used. These stations are:

1. 02YF001 Cat Arm River above Great Cat Arm
2. 02YJ001 Harry's River below Highway Bridge
3. 02YK002 Lewaseechjeech Brook at Little Grand Lake
4. 02YK003 Sheffield River near TCH
5. 02YK004 Hinds Brook near Grand Lake

Physiographic and hydrometric data for each of these stations is shown in Table 2.1. Location of these hydrometric stations is shown on Figure 2.2.

TABLE 2.1 (Part 1)
PHYSIOGRAPHIC AND HYDROMETEOROLOGIC DATA BASE

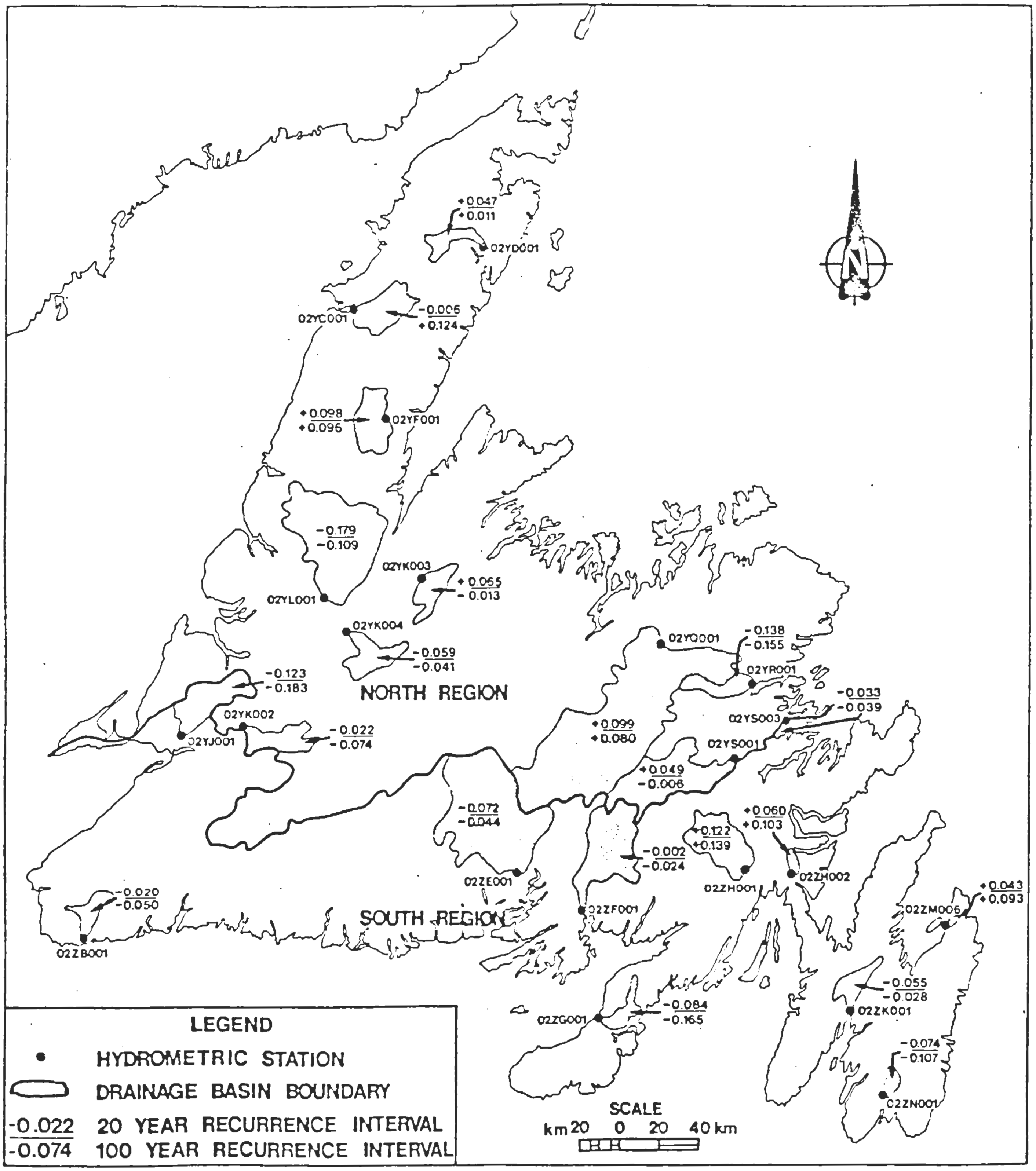
STATION NAME AND NUMBER	DRAINAGE AREA (km^2)	LAKE AREA (km^2)	SWAMP AREA (km^2)	FOREST AREA (km^2)	BARREN AREA (km^2)	LENGTH OF MAIN CHANNEL (km)	ELEVATION OF BASIN DIVIDE IN VICINITY OF MAIN CHANNEL (m)	SLOPE OF MAIN CHANNEL (%)	DRAINAGE DENSITY (km/km^2)	SHAPE FACTOR	OVERBURDEN THICKNESS (m)
Cat Arm River above Great Cat Arm (02YF001)	611	51.39	28.91	420.69	110.01	30.17	250	.829	.582	1.86	2.19
Harry's River below Highway Bridge (02YJ001)	640	35.43	55.24	505.48	43.85	60.00	509	.848	1.120	1.81	4.62
Lewaseechjeech Brook at Little Grand Lake (02YK002)	470	46.47	29.05	258.25	136.23	54.88	560.8	1.022	.627	2.32	.98
Sheffield River near Trans Canada Highway (02YK003)	391	37.36	29.70	264.59	59.34	38.09	378	.992	.191	1.98	19.80
Hinds Brook near Grand Lake (02YK004)	529	62.54	125.41	186.26	154.79	49.29	320.1	.649	.637	1.78	12.50

TABLE 2.1 (Part 2)
PHYSIOGRAPHIC AND HYDROMETEOROLOGIC DATA BASE

STATION NAME AND NUMBER	AREA CONTROLLED BY LAKE & SWAMP (%)	MEAN ANNUAL RUNOFF (mm)	MEAN SNOWPACK WATER EQUIVALENT AT BASIN CENTROID ON MARCH 20 (mm)	24 HOUR, 25 YEAR RETURN PERIOD STORM RAINFALL AT CENTROID (mm)	QP_2 (m^3/s)	QP_{10} (m^3/s)	QP_{20} (m^3/s)	QP_{100} (m^3/s)	LATITUDE (°)	LONGITUDE (°)
Cat Arm River above Great Cat Arm (02YF001)	100	1420	430	84	271	379	417	499	50.160	57.050
Harry's River below Highway Bridge (02YJ001)	75	1321	250	82	321	530	617	825	48.747	58.000
Lewaseechjeech Brook at Little Grand Lake (02YK002)	100	1162	270	84	86.3	131	147	183	48.569	57.653
Sheffield River near Trans Canada Highway (02YK003)	94	856	260	78	74.0	98	103	113	49.282	56.597
Hinds Brook near Grand Lake (02YK004)	95	984	250	80	91.3	126	138	164	48.963	57.018

)URCE: REGIONAL FLOOD FREQUENCY ANALYSIS FOR THE ISLAND OF NEWFOUNDLAND

REGRESSION ANALYSIS RESIDUALS [21 STATIONS]



SOURCE: REGIONAL FLOOD FREQUENCY ANALYSIS FOR THE ISLAND OF NEWFOUNDLAND

FIGURE 2.2

TABLE 2.2

PARAMETER RANGE USED IN ANALYSIS*

ENTIRE ISLAND

DA	3.9	to	4400 km^2
MAR	788	to	2124 mm
ACLS	55	to	100%
SHAPE	1.24	to	2.45

NORTH REGION

DA	237	to	4400 km^2
MAR	788	to	1420 mm
LATITUDE	48.379	to	50.943°

SOUTH REGION

DA	3.9	to	2640 km^2
MAR	929	to	2124 mm
ACLS	55	to	100%
SHAPE	1.24	to	2.45

* These parameter ranges are presented for general guidance only. If, when computing flood flows using the equations presented in this report, the value of the above parameters falls near the extremities of or outside these ranges, then the estimates of flood flows will be questionable.

SOURCE: REGIONAL FLOOD FREQUENCY ANALYSIS FOR THE ISLAND OF NEWFOUNDLAND

Regression equations and results for the entire Island and for the North Region for the 20 and 100 year storms are shown in Appendix A. The parameter range used for the analysis is given in Table 2.2.

2.4.2 Tidal Data

Hourly tidal data for the Lark Harbour station was obtained for the period 1963-1988. These data were provided by Environment Canada (Marine Environmental Data Service), Department of Fisheries and Oceans in hard copy tabular form (150 pages). (See Table 2.3 for an example page of the data format.)

In addition two recent investigations on tides and extreme water levels at Cox's Cove and Parson's Pond were obtained and reviewed.(1)(2) The results of these analyses are summarized in Tables 2.4 to 2.7.

No local tidal measurements were found. In the absence of local tidal measurement, tidal information will be derived from the regional reference point at Harrington Harbour. Comparisons will then be made to the above noted investigations in order to determine the modification in water level necessary to approximate storm surge effects. Interpolation of results from Table 2.4 to 2.7 will be utilized and/or referred to for comparison purposes.

2.4.3 Field Surveys

Field surveys of channel and floodplain characteristics were carried out along the Trout River in the spring of 1989 by staff from Island Engineering and Cumming Cockburn Limited. These studies are discussed in Section 3.0 of this report.

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(1)Martec Limited, "Historical Flooding Review and Flood Risk Mapping Study for Cox's Cove", Canada-Newfoundland Flood Damage Reduction Program, Newfoundland Department of Environment, Environment Canada, December 1988

(2)Martec Limited, "Historical Flooding Review and Flood Risk Mapping Study for Parson's Pond", Canada-Newfoundland Flood Damage Reduction Program, Newfoundland Department of Environment, Environment Canada, December 1988.

TABLE 2.3

EXAMPLE OF LARK HARBOUR TIDE DATA

0 164LARK HARBOUR NFLD - NST -

0	1	164	93	55	21	-8	-28	-13	0	51	90	139	177	205-
0	1	164	214	200	165	127	92	66	56	76	98	129	142	153-
0	2	164	142	112	71	40	13	-1	11	33	80	119	157	201-
0	2	164	219	232	219	196	165	140	121	109	128	144	161	169-
0	3	164	167	157	126	89	55	29	13	18	39	69	111	141-
0	3	164	174	189	191	175	150	120	95	87	90	105	130	151-
0	4	164	168	169	164	134	109	82	56	53	56	79	100	133-
0	4	164	154	177	176	163	151	118	102	77	77	82	100	119-
0	5	164	137	152	156	150	132	112	93	76	73	80	97	114-
0	5	164	139	151	164	166	155	142	122	100	86	84	90	106-
0	6	164	127	139	153	158	155	141	120	101	82	73	71	83-
0	6	164	99	116	129	143	139	132	119	100	83	70	72	75-
0	7	164	97	108	124	135	145	143	133	119	106	95	92	95-
0	7	164	108	119	130	137	150	141	133	114	99	81	71	69-
0	8	164	77	89	101	119	131	138	136	128	116	98	84	75-
0	8	164	74	83	92	103	117	121	120	108	97	78	63	52-
0	9	164	57	60	76	96	113	132	144	147	140	127	113	94-
0	9	164	83	82	84	96	103	113	117	116	107	79	71	47-
0	10	164	39	40	48	71	89	123	147	162	163	160	157	132-
0	10	164	140	127	135	144	169	192	203	218	214	198	167	143-
0	11	164	114	90	80	79	97	111	136	155	165	156	142	126-
0	11	164	108	91	84	94	110	129	150	171	177	172	162	140-
0	12	164	119	97	87	89	103	127	154	179	192	196	183	162-
0	12	164	127	103	86	80	86	97	114	129	141	138	126	101-
0	13	164	71	43	30	30	37	68	105	135	166	179	184	168-
0	13	164	144	116	94	80	80	91	109	129	141	150	139	121-
0	14	164	95	66	46	37	46	66	99	142	173	183	204	210-
0	14	164	133	165	132	102	99	95	119	133	156	168	166	153-
0	15	164	122	90	59	41	35	42	72	105	148	171	189	193-
0	15	164	183	164	135	112	94	89	101	118	143	164	176	174-
0	16	164	154	124	92	62	45	44	61	91	126	157	187	197-
0	16	164	197	177	148	119	94	82	83	99	124	149	166	172-
0	17	164	169	145	112	82	60	52	59	83	117	151	179	200-
0	17	164	205	199	174	143	108	87	75	80	100	117	137	147-
0	18	164	141	123	96	68	43	26	22	34	63	98	134	165-
0	18	164	181	185	166	135	109	82	70	66	86	107	129	149-
0	19	164	153	151	130	101	73	51	41	42	60	85	116	145-
0	19	164	163	173	160	136	103	79	59	56	67	90	116	130-
0	20	164	147	142	134	109	87	58	45	44	52	80	104	134-
0	20	164	148	159	160	144	131	111	80	65	56	65	83	104-
0	21	164	130	140	150	142	127	108	84	64	58	63	84	96-
0	21	164	131	151	163	165	155	147	109	100	77	85	92	102-
0	22	164	132	149	170	179	176	168	147	126	103	98	89	102-
0	22	164	119	136	152	160	162	152	130	105	83	66	61	66-
0	23	164	88	108	130	150	166	168	160	142	127	105	92	90-
0	23	164	96	112	126	142	153	156	144	126	102	80	62	55-
0	24	164	63	80	105	127	149	167	171	164	149	130	108	89-
0	24	164	84	90	98	117	131	144	148	138	125	96	77	56-
0	25	164	52	56	70	99	130	154	178	181	176	155	134	107-
0	25	164	88	79	77	94	101	123	123	141	126	112	93	68-
0	26	164	61	44	50	82	125	161	201	233	242	233	203	172-

TABLE 2.4

EXTREMAL ANALYSIS OF PARSON'S POND
WATER LEVEL DATA

Ordered Input Data (m above) Chart Datum	Geodetic Datum	Surge Year	Probability	Return Period
2.95	1.06	1985	.041	24.342
2.91	1.02	1970	.095	10.511
2.86	.97	1983	.149	6.703
2.81	.92	1966	.203	4.920
2.81	.92	1968	.257	3.887
2.80	.91	1971	.311	3.212
2.78	.89	1973	.365	2.737
2.76	.87	1977	.419	2.384
2.75	.86	1969	.474	2.112
2.74	.85	1982	.528	1.895
2.72	.83	1974	.582	1.719
2.71	.82	1981	.636	1.573
2.71	.82	1972	.690	1.450
2.70	.81	1965	.744	1.344
2.69	.80	1986	.798	1.253
2.69	.80	1979	.852	1.174
2.60	.71	1978	.906	1.104
2.57	.68	1967	.960	1.042

	Input Data	Three-Parameter Lognormal Transformation
mean	2.7512	0.2908
standard deviation	0.1000	0.0714
coefficient of skew	0.2170	-0.0016
coefficient of kurtosis	3.9594	3.9506

Source: Martec Limited, "Historical Flooding Review and Flood Risk Mapping Study for Parson's Pond", Canada-Newfoundland Flood Damage Reduction Program, Newfoundland Department of Environment, Environment Canada, December 1988.

TABLE 2-5

WATER LEVEL AT PARSON'S POND FOR SELECTED RETURN PERIODS

Three-Parameter Lognormal Distribution fitted by Maximum Likelihood

Return Period (year)	Estimate (m above)		90% Confidence Limits (m above)	
	Chart Datum	Geodetic Datum	Chart Datum	Geodetic Datum
5	2.83	0.94	2.79 - 2.88	.90 - .99
10	2.88	0.99	2.82 - 2.93	.93 - 1.04
20	2.92	1.03	2.84 - 2.99	.95 - 1.10
50	2.96	1.07	2.87 - 3.05	.98 - 1.16
100	2.99	1.1	2.88 - 3.10	.99 - 1.21
200	3.02	1.13	2.88 - 3.15	.99 - 1.26

Source: Martec Limited, "Historical Flooding Review and Flood Risk Mapping Study for Parson's Pond", Canada-Newfoundland Flood Damage Reduction Program, Newfoundland Department of Environment, Environment Canada, December 1988.

TABLE 2.6

EXTREMAL ANALYSIS OF LARK HARBOUR/COX'S COVE WATER LEVEL DATA

Ordered Input Data (m above) Chart Datum	Geodetic Datum	Surge Year	Probability	Return Period
2.79	1.75	1970	.041	24.342
2.58	1.54	1981	.095	10.511
2.57	1.53	1966	.149	6.703
2.56	1.52	1983	.203	4.920
2.56	1.52	1985	.257	3.887
2.51	1.47	1968	.311	3.212
2.49	1.45	1977	.365	2.737
2.49	1.45	1969	.419	2.384
2.47	1.43	1971	.474	2.112
2.44	1.40	1965	.528	1.895
2.42	1.38	1979	.582	1.719
2.39	1.35	1982	.636	1.573
2.37	1.33	1974	.690	1.450
2.35	1.31	1972	.744	1.344
2.33	1.29	1978	.798	1.253
2.30	1.26	1986	.852	1.174
2.30	1.26	1967	.906	1.104
2.28	1.24	1973	.960	1.042

	Input Data	Three-Parameter Lognormal Transformation
mean	2.4556	-1.1956
standard deviation	.100	.4041
coefficient of skew	.7935	-.1260
coefficient of Kurtosis	4.6276	2.9764

Source: Martec Limited, "Historical Flooding Review and Flood Risk Mapping Study for Cox's Cove", Canada-Newfoundland Flood Damage Reduction Program, Newfoundland Department of Environment, Environment Canada, December 1988

TABLE 2.7

WATER LEVEL AT LARK HARBOUR/COX'S COVE FOR SELECTED RETURN PERIODS

Three-Parameter Lognormal Distribution fitted by Maximum Likelihood

Return Period (year)	Estimate (m above)		90% Confidence Limits (m above)	
	Chart Datum	Geodetic Datum	Chart Datum	Geodetic Datum
5	2.55	1.52	2.47 - 2.63	1.45 - 1.59
10	2.63	1.60	2.52 - 2.74	1.49 - 1.71
20	2.71	1.68	2.56 - 2.87	1.52 - 1.83
50	2.82	1.78	2.59 - 3.05	1.56 - 2.01
100	2.90	1.86	2.61 - 3.19	1.57 - 2.16
200	2.98	1.95	2.61 - 3.35	1.58 - 2.31

Source: Martec Limited, "Historical Flooding Review and Flood Risk Mapping Study for Cox's Cove", Canada-Newfoundland Flood Damage Reduction Program, Newfoundland Department of Environment, Environment Canada, December 1988

SECTION 3

STUDY OF ICE CONDITIONS

3 - STUDY OF ICE CONDITIONS

During the months of December, 1989, and January, 1990, the entire northern peninsula was subject to prolonged periods of extreme cold temperatures. This resulted in the freezing of the majority of rivers and waterways in the vicinity of the Community of Trout River. Those waterways that did not freeze completely were filled with pans of ice. This type of weather condition is consistent with normal winter conditions in the region. These conditions usually continue until spring. However, on January 25, 1990, weather conditions changed drastically. From January 25 to the 28 temperatures rose to above freezing levels and there was constant rain. By January 27, 1990, the change is weather conditions had caused considerable flooding in the Community of Trout River. The main reason for the flooding was a build-up of ice at the mouth of Trout River. This ice build-up, combined with the rapidly melting ice and snow up-stream, caused the river to overflow its banks.

Due to the weather conditions investigators were unable to travel to the site until January 28, 1990. At that time the flood waters had subsided, the blocked ice had been freed from the mouth of the river and normal winter temperatures had return, thus there was no more run-off from melting snow. However, interviews were conducted with a number of residents. Also, still photographs and video tape were able to capture pictures of the damage caused in the area. (See appendix D). The still photographs are noted with captions that reflect what the investigating team was told by the residents regarding the severity of the flooding in various areas of the town.

Apparently, this type of flooding is consistent with the beginning of spring in the Trout River area. It should be noted however, that on the weekend of March 16 to the 18, 1990, the region was once again subject to a period of very mild weather and rains. A number of Newfoundland communities that have flooding problems similar to that of the Community of Trout River were once again flooded. However, a telephone call to a resident of the area confirmed that Trout River did not experience flooding.

Now that spring has begun, we will be closely monitoring the region to see if more flooding occurs.

APPENDIX A - REGRESSION RESULTS

STEPWISE REGRESSION RESULTS FOR $\log_{10}QP_2$ ENTIRE ISLAND

$$\log_{10}QP_2 = k + a \log_{10}DA + b \log_{10}MAR + c \log_{10}ACLS + d \log_{10}SHAPE$$

REGRESSION PARAMETER COEFFICIENT

Step Number	k	a	b	c	d	SE	Multiple R.
1	0.1424	0.7380	0.	0.	0.	0.26	0.90
2	-6.3102	0.8230	2.0363	0.	0.	0.14	0.97
3	-2.5295	0.7934	1.6307	-1.2654	0.	0.11	0.98
4*	-2.5824	0.8310	1.7260	-1.3269	-0.7894	0.10	0.99

Notes:

1. F = 4.5 (the regression constant and coefficients are all significant at the 5 percent level or better)
2. SE = Standard Error of Estimate in log units.
3. * = Accepted step.

SOURCE: REGIONAL FLOOD FREQUENCY ANALYSIS FOR THE ISLAND OF NEWFOUNDLAND

STEPWISE REGRESSION RESULTS FOR $\log_{10}QP_{10}$ ENTIRE ISLAND

$$\log_{10}QP_{10} = k + a \log_{10}DA + b \log_{10}MAR + c \log_{10}ACLS + d \log_{10}SHAPE$$

REGRESSION PARAMETER COEFFICIENT

Step Number	k	a	b	c	d	SE	Multiple R.
1	0.3886	0.7047	0.	0.	0.	0.28	0.87
2	-6.8567	0.8002	2.2865	0.	0.	0.14	0.97
3	-2.6934	0.7675	1.8398	-1.3934	0.	0.11	0.98
4*	-2.7419	0.8020	1.9273	-1.4499	-0.7243	0.09	0.99

Notes:

1. F = 4.5 (the regression constant and coefficients are all significant at the 5 percent level or better)
2. SE = Standard Error of Estimate in log units.
3. * = Accepted step.

SOURCE: REGIONAL FLOOD FREQUENCY ANALYSIS FOR THE ISLAND OF NEWFOUNDLAND

STEPWISE REGRESSION RESULTS FOR $\log_{10}QP_{20}$ ENTIRE ISLAND

$$\log_{10}QP_{20} = k + a \log_{10}DA + b \log_{10}MAR + c \log_{10}ACLS + d \log_{10}SHAPE$$

REGRESSION PARAMETER COEFFICIENT

Step Number	k	a	b	c	d	SE	Multiple R.
1	0.4679	0.6916	0.	0.	0.	0.29	0.86
2	-7.0661	0.7909	2.3776	0.	0.	0.14	0.97
3	-2.8270	0.7576	1.9228	-1.4188	0.	0.11	0.99
4*	-2.8741	0.7911	2.0077	-1.4736	-0.7031	0.09	0.99

Notes:

1. F = 4.5 (regression constant and coefficients are all significant at the 5% level.)
2. SE = Standard Error of Estimate in log units.
3. * + Accepted step.

SOURCE: REGIONAL FLOOD FREQUENCY ANALYSIS FOR THE ISLAND OF NEWFOUNDLAND

STEPWISE REGRESSION RESULTS FOR $\log_{10}QP_{100}$ ENTIRE ISLAND

$$\log_{10}QP_{100} = k + a \log_{10}DA + b \log_{10}MAR + c \log_{10}ACLS + d \log_{10}SHAPE$$

REGRESSION PARAMETER COEFFICIENT

Step Number	k	a	b	c	d	SE	Multiple R.
1	0.6300	0.6623	0.	0.	0.	0.31	0.84
2	-7.4743	0.7691	2.5576	0.	0.	0.15	0.97
3	-3.1059	0.7348	2.0889	-1.4621	0.	0.11	0.98
4*	-3.1500	0.7662	2.1684	-1.5134	-0.6581	0.10	0.99

Notes:

1. F = 4.5 (the regression constant and coefficients are all significant at the 5 percent level or better.)
2. SE = Standard Error of Estimate in log units.
3. * = Lowered F from 4.5 to 4.4 in order to retain SHAPE in equation, accepted step.

SOURCE: REGIONAL FLOOD FREQUENCY ANALYSIS FOR THE ISLAND OF NEWFOUNDLAND

STEPWISE REGRESSION RESULTS FOR $\log_{10}QP_2$ NORTH REGION

$$\log_{10}QP_2 = k + a\,\log_{10}DA + b\,\log_{10}MAR + c\,\log_{10}LAT + d\,\log_{10}SHAPE + e\,\log_{10}BAREA$$

REGRESSION PARAMETER COEFFICIENT

Step Number	k	a	b	c	d	e	SE	Multiple R.
1	-0.3926	0.8987	0	0	0	0	0.23	0.86
2	-6.8128	0.9319	2.0930	0	0	0	0.11	0.97
3*	-28.0689	1.0172	1.2782	13.8620	0	0	0.08	0.99

Notes:

1. F = 5.5 (the regression constant and coefficients are all significant at the 5% level or better.)
2. SE = Standard Error of Estimate in log units.
3. * = Accepted step.

SOURCE: REGIONAL FLOOD FREQUENCY ANALYSIS FOR THE ISLAND OF NEWFOUNDLAND

STEPWISE REGRESSION RESULTS FOR $\log_{10}QP_{10}$ NORTH REGION

$$\log_{10}QP_{10} = k + a \log_{10}DA + b \log_{10}MAR + c \log_{10}LAT + d \log_{10}SHAPE + e \log_{10}BAREA$$

REGRESSION PARAMETER COEFFICIENT

Step Number	k	a	b	c	d	e	SE	Multiple R.
1	-.0814	0.8406	0	0	0	0	0.24	0.83
2	-7.1541	0.8772	2.3058	0	0	0	0.10	0.97
3*	-28.7324	0.9638	1.4786	14.0721	0	0	0.07	0.99

Notes:

1. F = 5.5 (the regression constant and coefficients are all significant at the 5% level or better.)
2. SE = Standard Error of Estimate in log units.
3. * = Accepted step.

SOURCE: REGIONAL FLOOD FREQUENCY ANALYSIS FOR THE ISLAND OF NEWFOUNDLAND

STEPWISE REGRESSION RESULTS FOR $\log_{10}QP_{20}$ NORTH REGION

$$\log_{10}QP_{20} = k + a \log_{10}DA + b \log_{10}MAR + c \log_{10}LAT + d \log_{10}SHAPE + e \log_{10}BAREA$$

REGRESSION PARAMETER COEFFICIENT

Step Number	k	a	b	c	d	e	SE	Multiple R.
1	0.0169	0.8202	0	0	0	0	0.25	0.81
2	-7.3483	0.8583	2.4011	0	0	0	0.10	0.98
3*	-29.1468	0.9458	1.5655	14.2157	0	0	0.06	0.99
4	-34.2758	0.9802	1.6149	16.9861	0.6654	0	0.05	1.00

Notes:

1. F = 5.5 (the regression constant and coefficients are all significant at the 5 percent level or better.)
2. SE = Standard Error of Estimate in log units.
3. * = Accepted step.

SOURCE: REGIONAL FLOOD FREQUENCY ANALYSIS FOR THE ISLAND OF NEWFOUNDLAND

STEPWISE REGRESSION RESULTS FOR $\log_{10}QP_{100}$ NORTH REGION

$$\log_{10}QP_{100} = k + a \log_{10}DA + b \log_{10}MAR + c \log_{10}LAT + d \log_{10}SHAPE + e \log_{10}BAREA$$

REGRESSION PARAMETER COEFFICIENT

Step Number	k	a	b	c	d	e	SE	Multiple R.
1	0.2187	0.7759	0	0	0	0	0.27	0.77
2	-7.7740	0.8173	2.6057	0	0	0	0.10	0.98
3*	-30.2744	0.9076	1.7432	14.6735	0	0	0.06	0.99
4	-35.2997	0.9413	1.7915	17.3879	0.6520	0	0.04	1.00
5	-36.2564	0.9345	1.4831	18.4648	0.6556	0.0742	0.01	1.00

Notes:

1. F = 5.5 (the regression constant and coefficients are all significant at the 5 percent level or better.)
2. SE = Standard Error of Estimate in log units.
3. * = Accepted step.

SOURCE: REGIONAL FLOOD FREQUENCY ANALYSIS FOR THE ISLAND OF NEWFOUNDLAND

APPENDIX B - PHOTOGRAPHS

Looking upstream across the river from near the present location of the school.

Looking upstream along the road from the riverside downstream of existing bridge

Looking downstream along the road

FIGURE 2.1

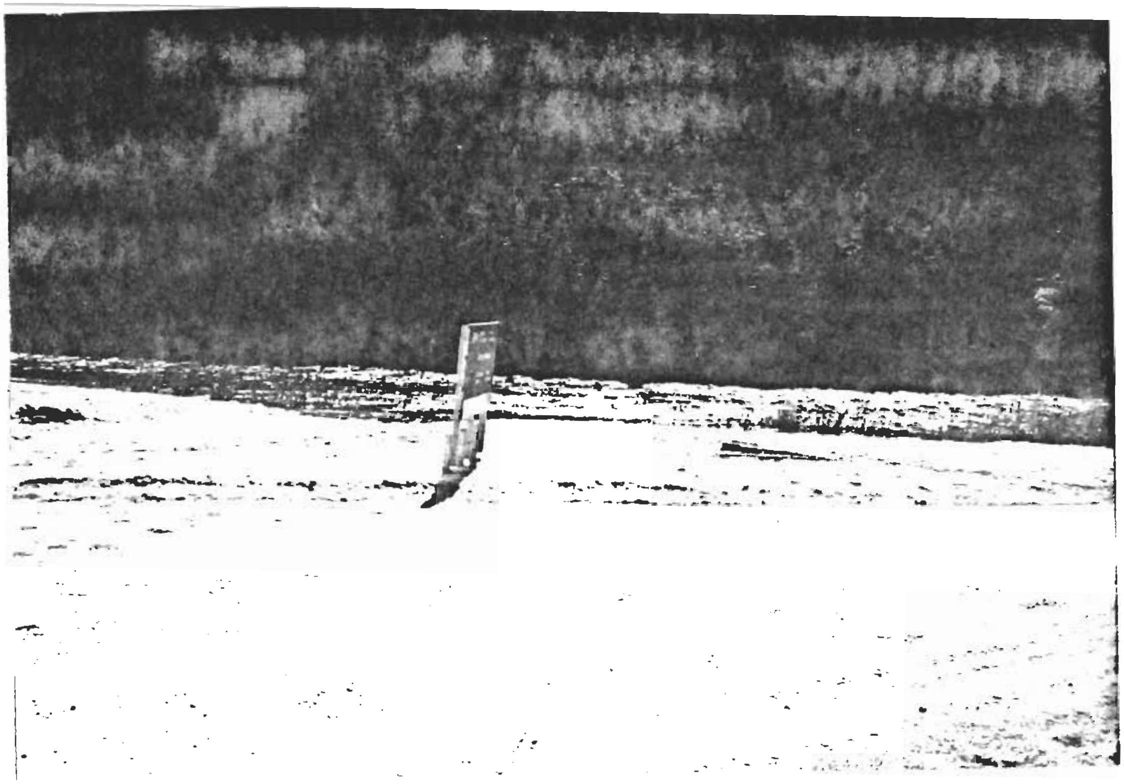


PHOTO 2-22
Looking south west toward Trout River along X-section #10,
May 9, 1989.

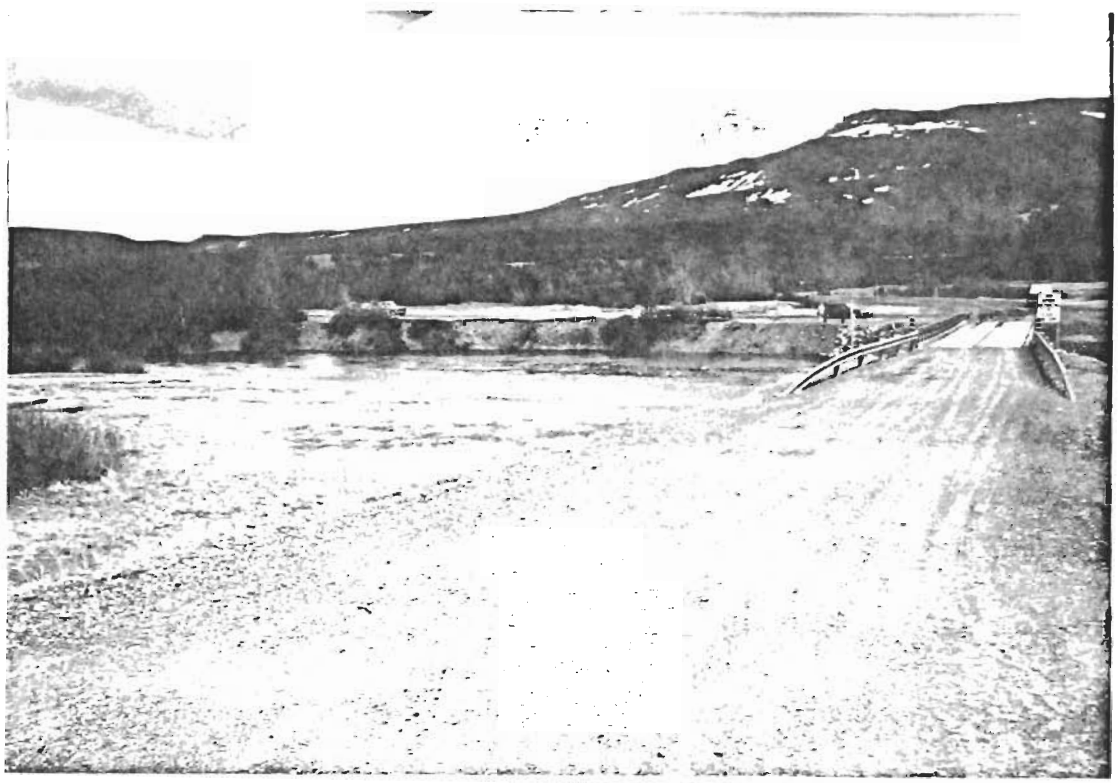


PHOTO 2-5
Looking north east along X-section #11 toward Bridge #1
over Trout River at mouth of Little Trout River Pond. May 9, 1989.

PHOTO 3-16
Looking north east upstream toward bridge over Feeder Brook. X-section Line #1 ± 10 m downstream from bridge. May 9, 1989.

PHOTO 3-24
Looking north east upstream along Feeder Brook X-section Line #2 runs left to right across barren section middle right of photo. May 9, 1989.

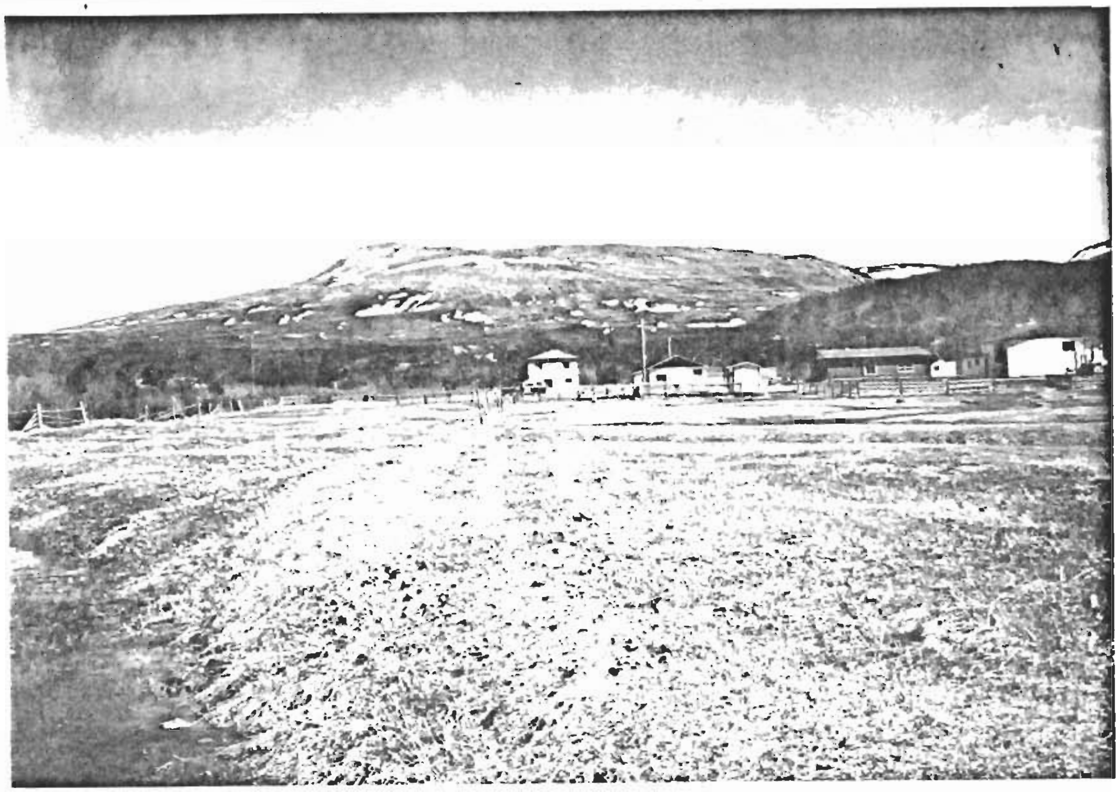


PHOTO 4-9
Looking north east from the west bank of Trout River along X-section Line #8.

PHOTO 4-12
Looking north east from west bank of Trout River along X-section Line #9, May 10, 1989.

PHOTO 4-21
Looking east toward X-section Line #6 which runs across island at middle right of photo, May 10, 1989.

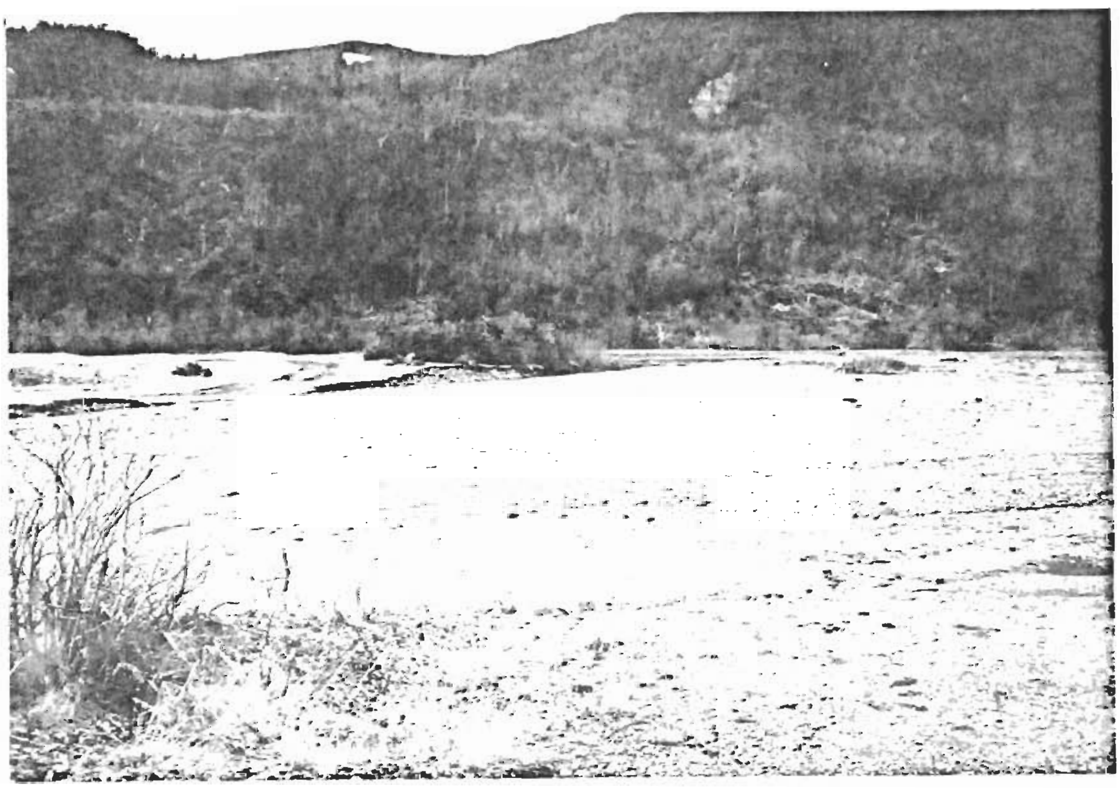


PHOTO 1-16
Looking south west along X-section line #7 toward Intersection of Feeder Brook and Trout River, May 8, 1989.

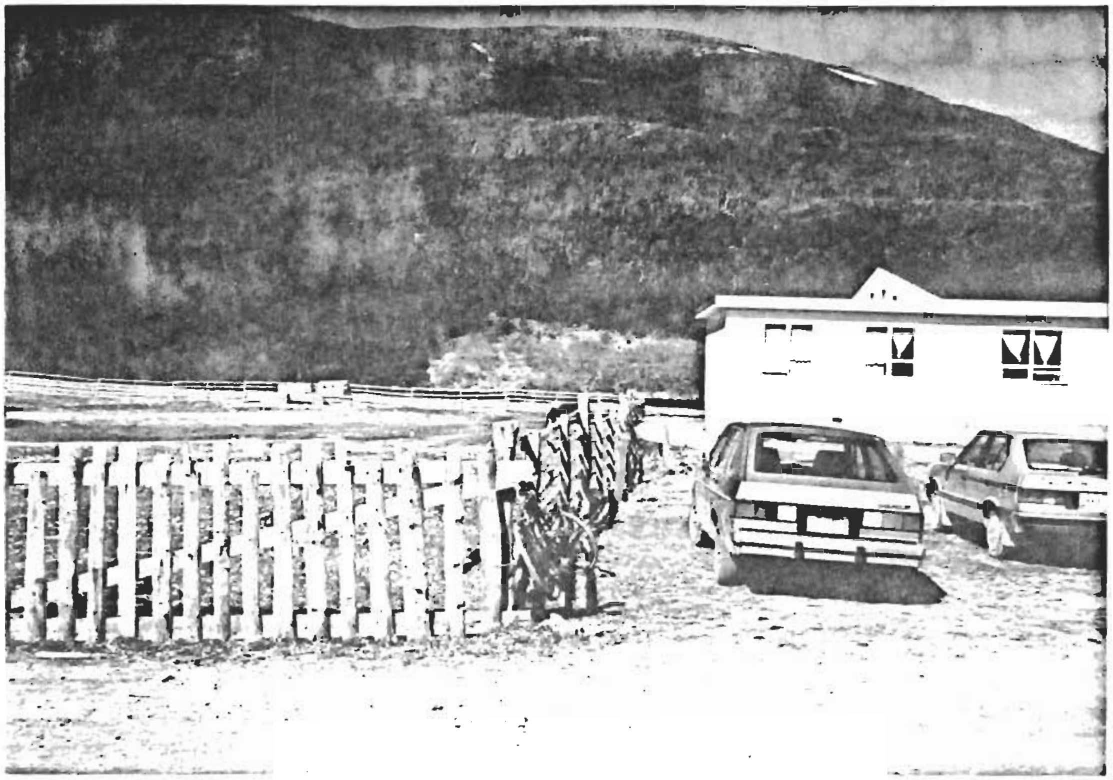


PHOTO 3-12
Looking west toward Trout River along X-section Line #4, May 8, 1989.

PHOTO 3-14
Looking west toward Trout River along X-section Line #5, May 8, 1989.

PHOTO 3-4
Looking west along X-section Line #2, May 9, 1989.

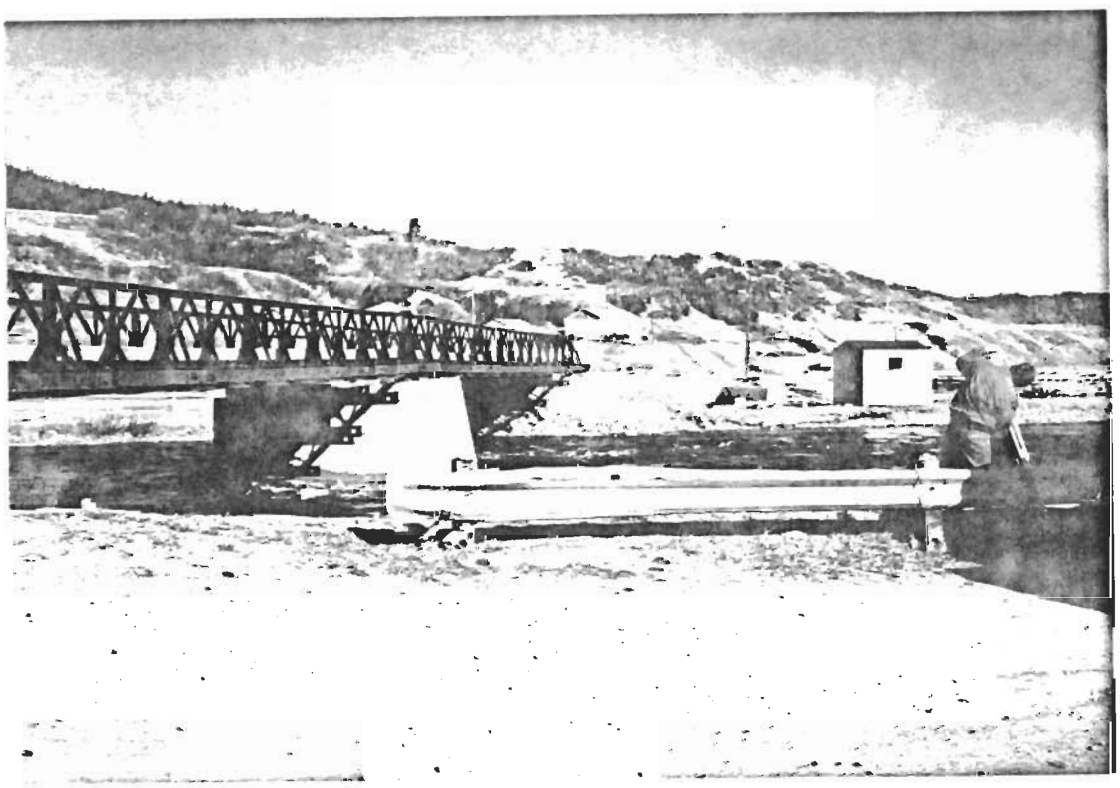


PHOTO 3-7
Looking west across Trout River to houses on west side of harbour at X-section line #3, May 8, 1989.

PHOTO 1-7
Looking seaward at the harbour, May 8, 1989.

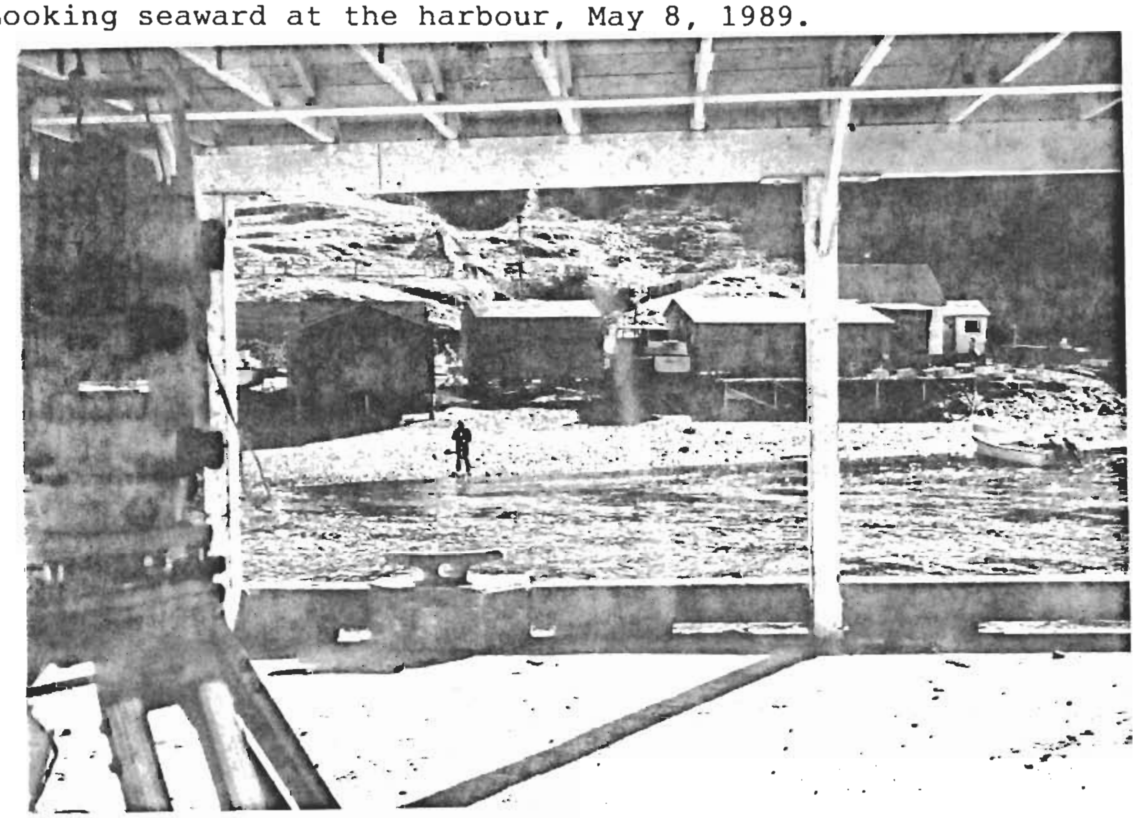


PHOTO 3-3
Looking south west along X-section Line #1 at convergance of Trout River and the harbour, May 8, 1989.

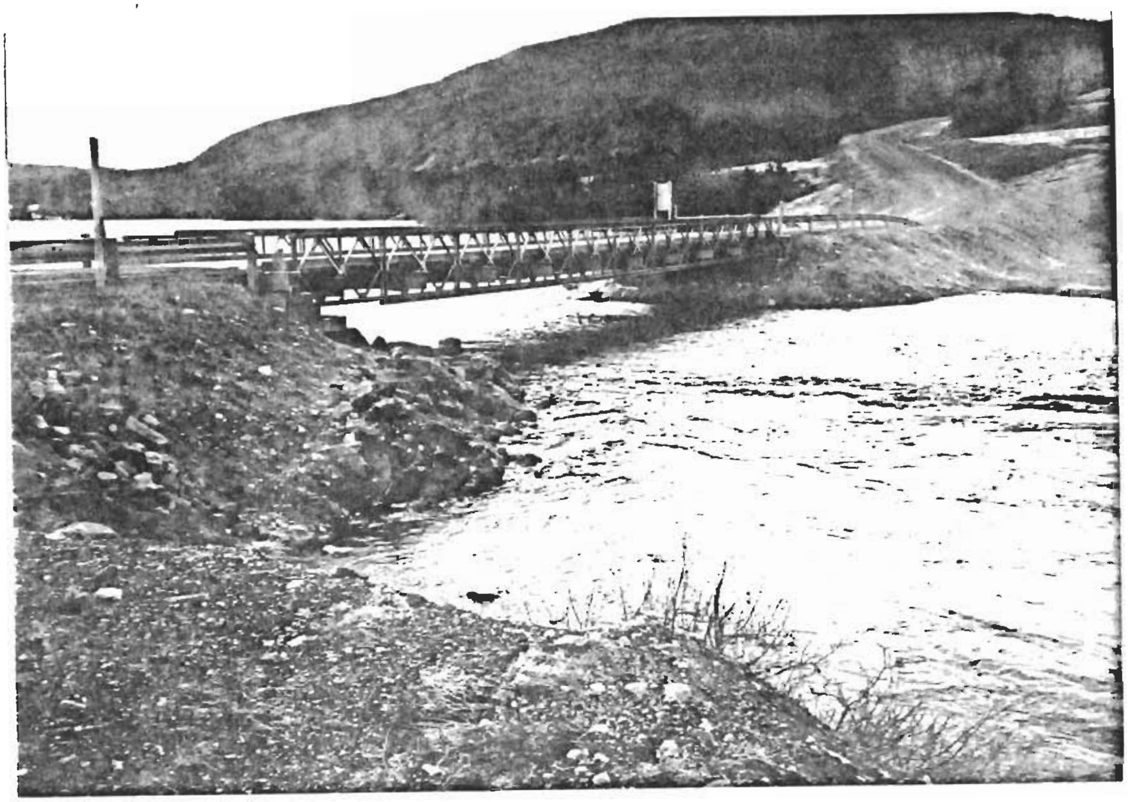


PHOTO 1-25
Looking upstream along Trout River toward the bridge over Trout River at the mouth of Lower Trout River Pond, May 8, 1989.

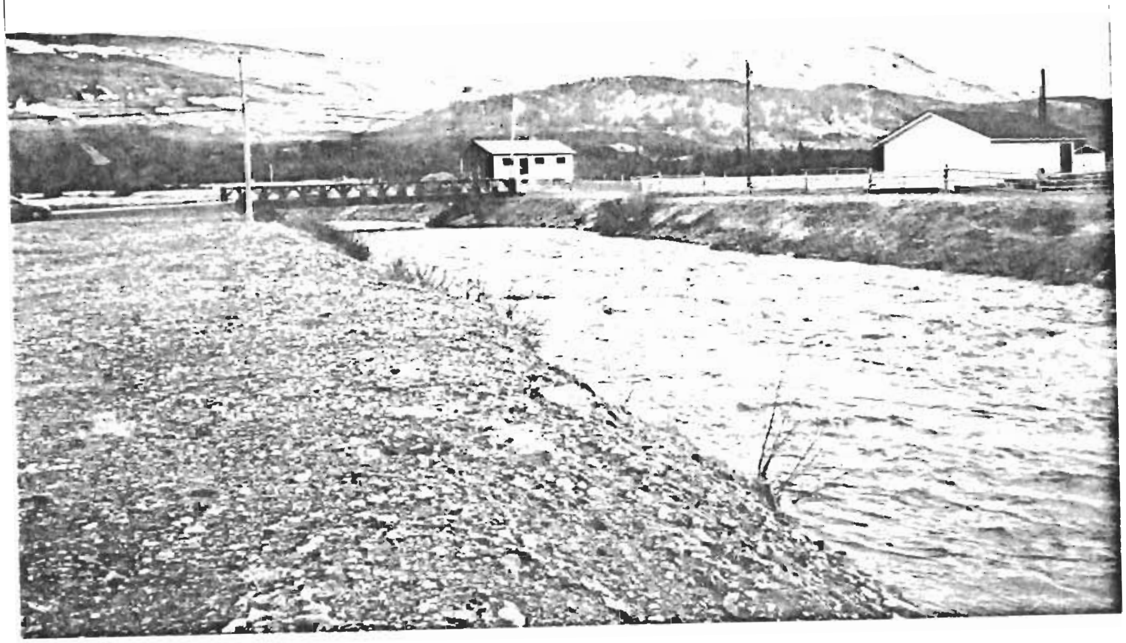


PHOTO 1-18
Looking upstream along Feeder Brook toward the bridge over Feeder Brook, May 8, 1989.

PHOTO 4-8
Looking upstream along Trout River toward big island at X-section #8, May 10, 1989.

PHOTO 3-25
Looking downstream at Feeder Brook toward the small islands at the intersection of Trout River and Feeder Brook. May 9, 1989.

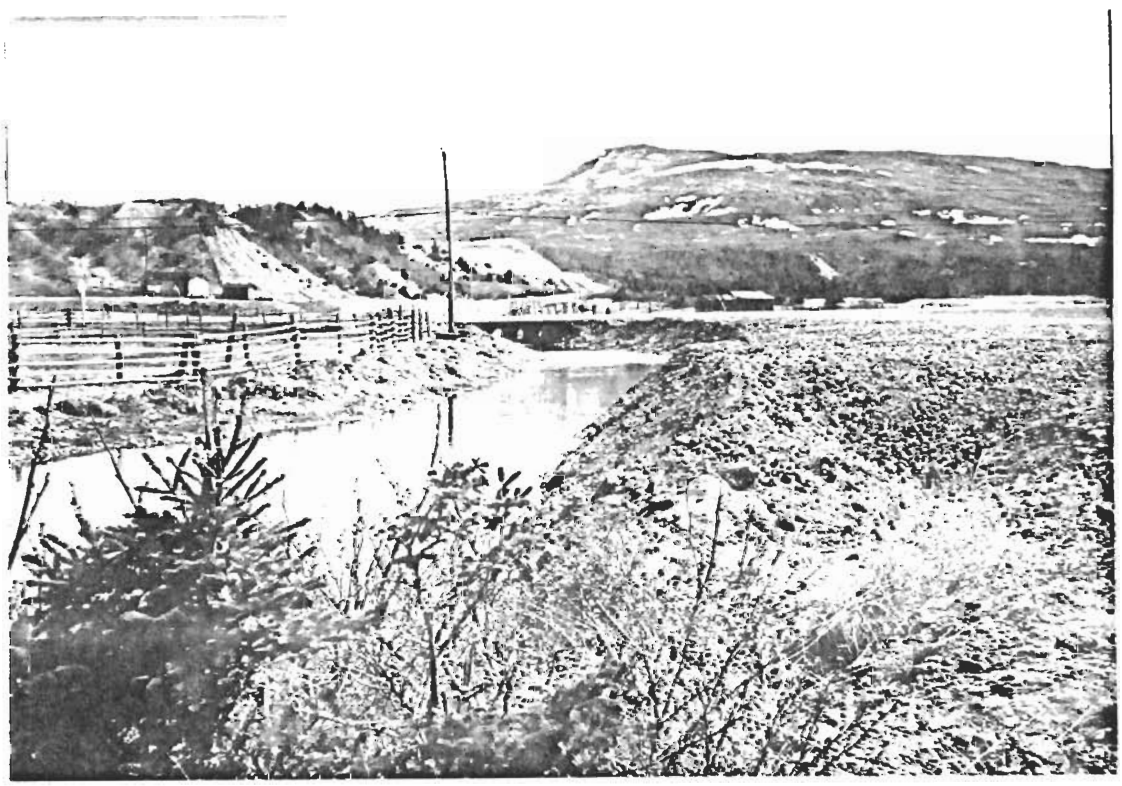


PHOTO 3-15
Looking north east toward the culverts under the road through Trout River 50 north of the bridge over Feeder Brook, May 9, 1989.

SECTION "B"

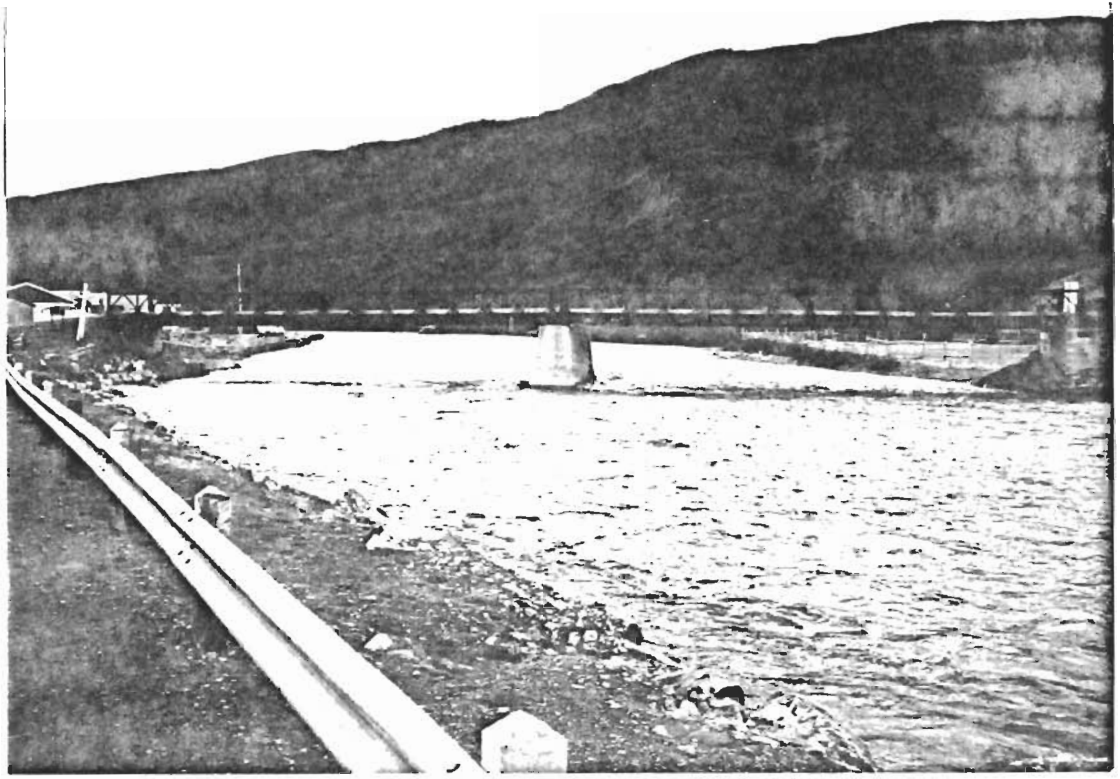


PHOTO 1-1
Looking upstream at bridge over Trout River along X-section Line #3. Note the angle of the bridge to the river. May 8, 1989.

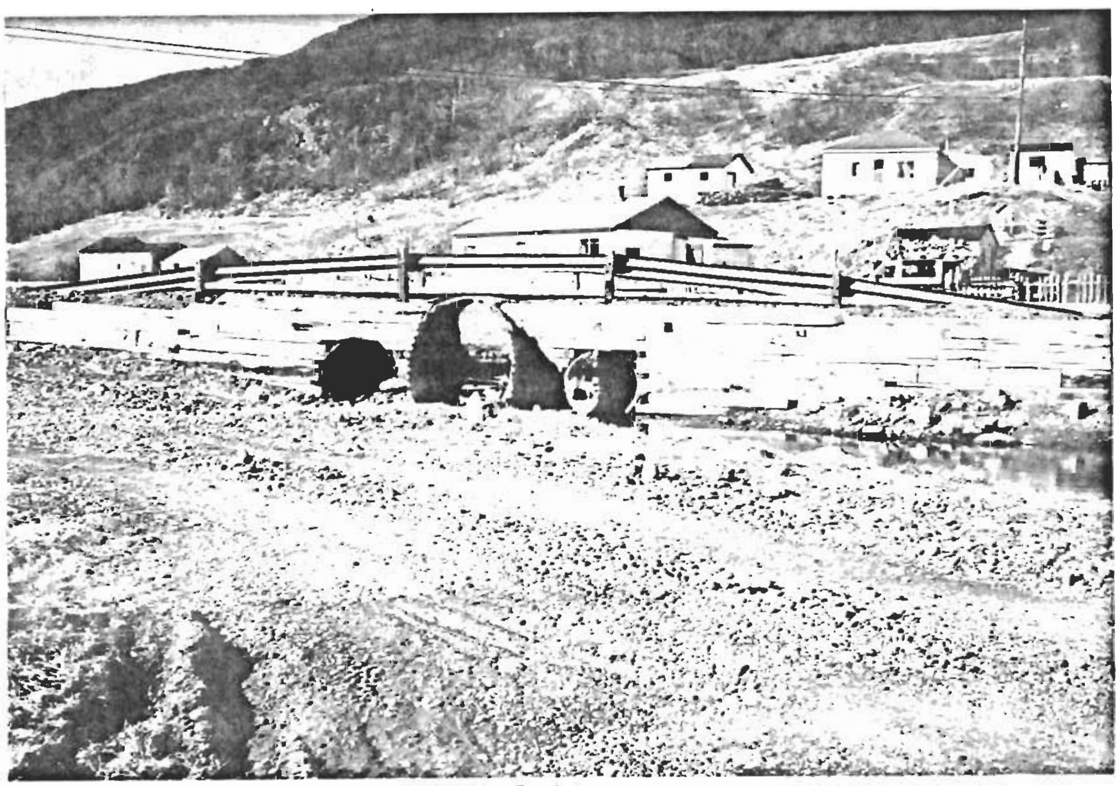


PHOTO 3-10
Looking northwest at culverts under the road which connects the banks of Trout River along X-section line #3. May 8, 1989.

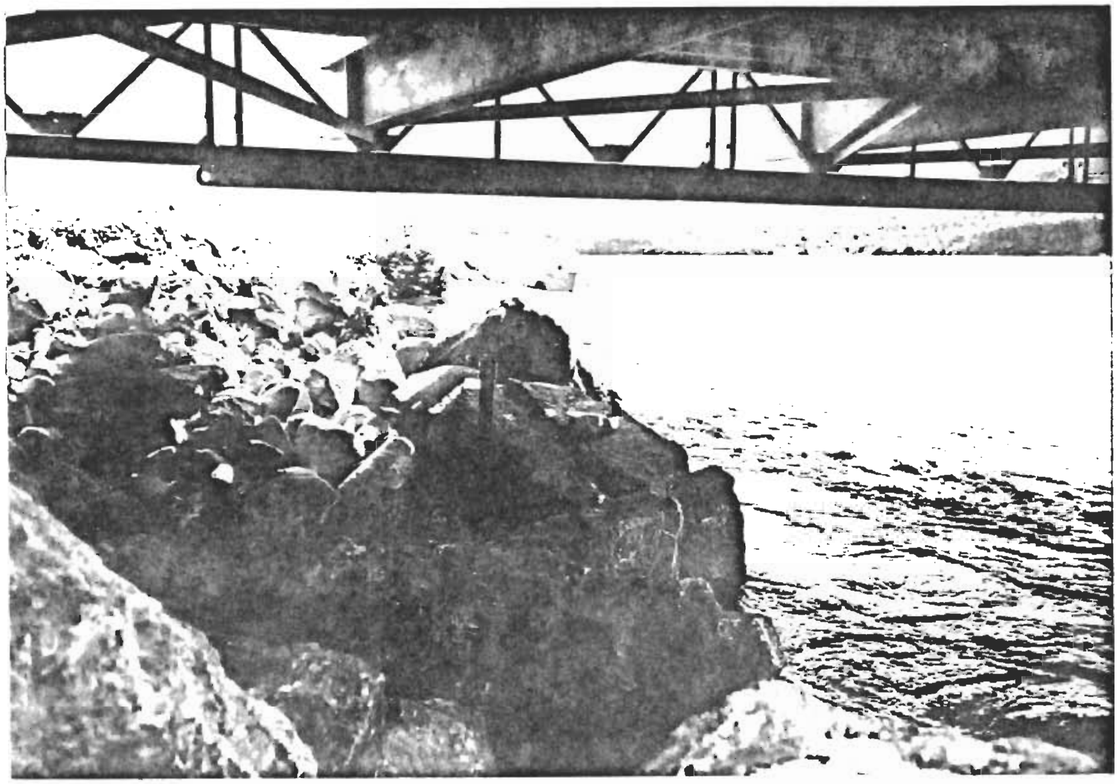


PHOTO 2-19
Crest gauge #3 set between rocks underneath the bridge over Trout River at the mouth of Trout River Pond, May 9, 1989.

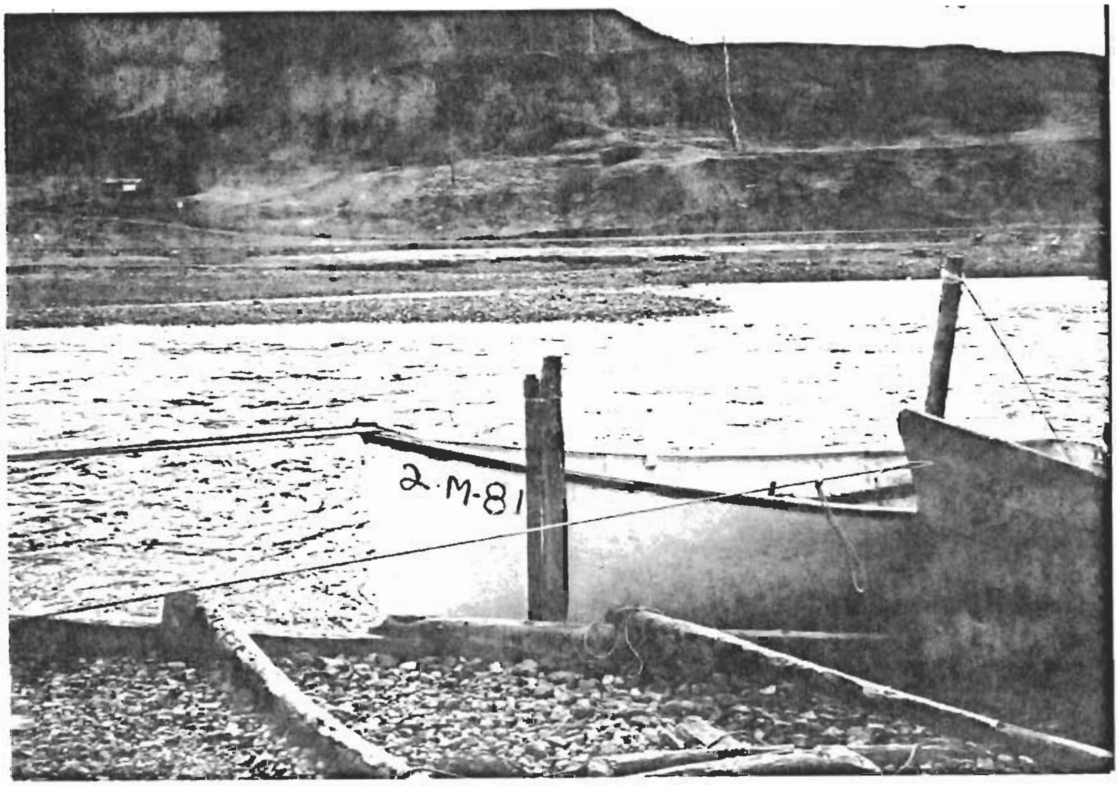


PHOTO 2-13
Crest gauge #1 attached to wooden retaining wall near X-Section Line #2, May 9, 1989.

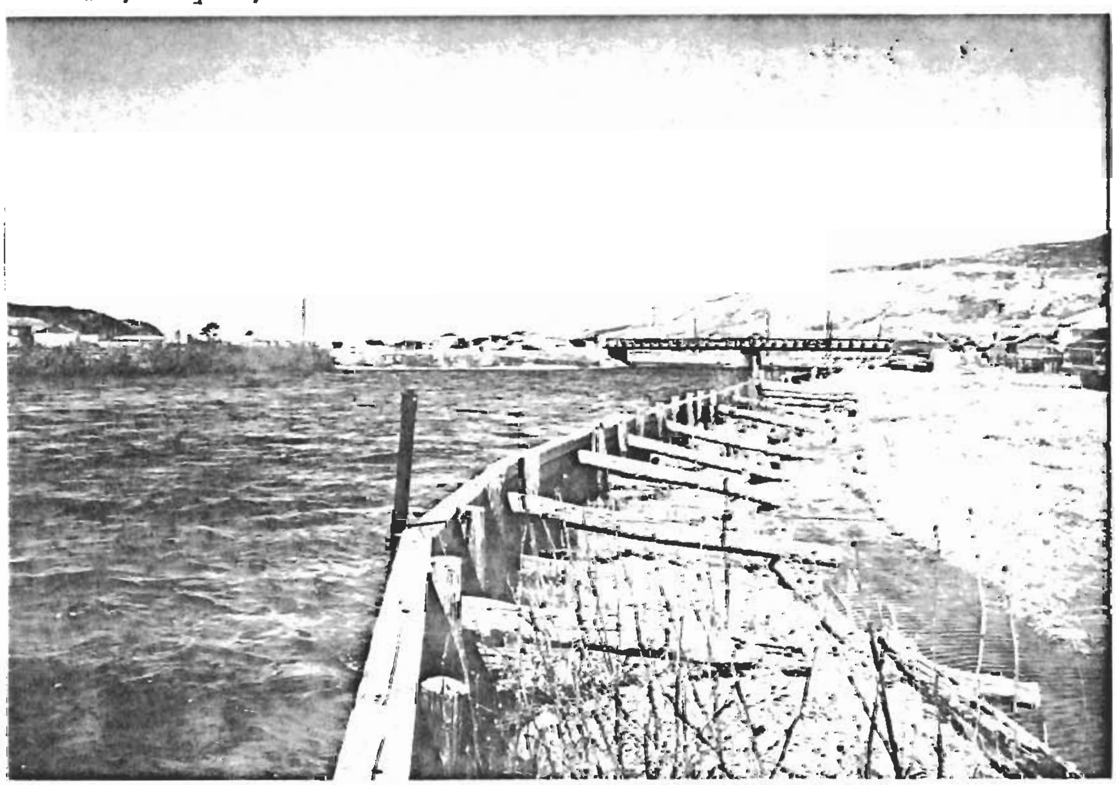
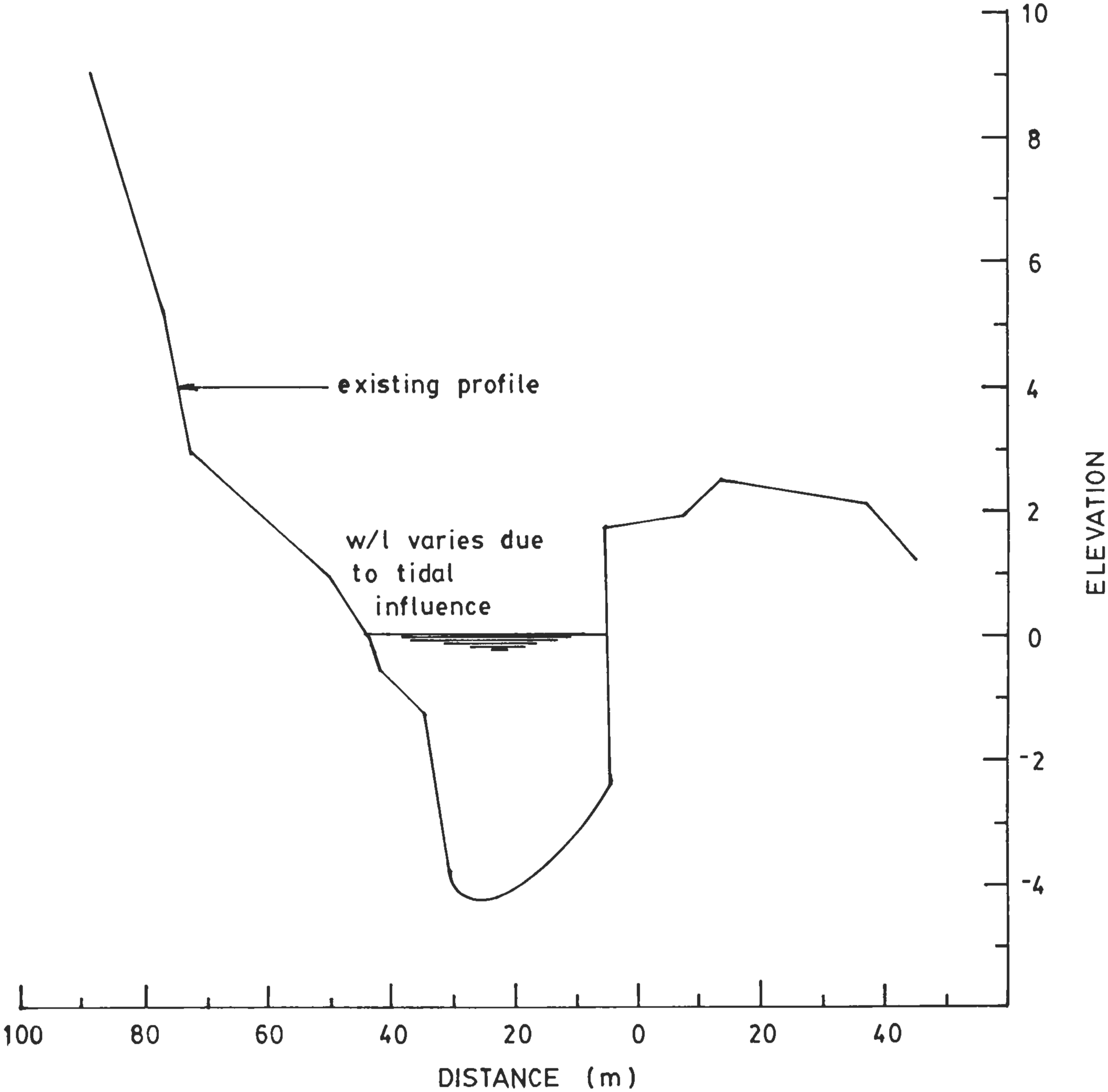


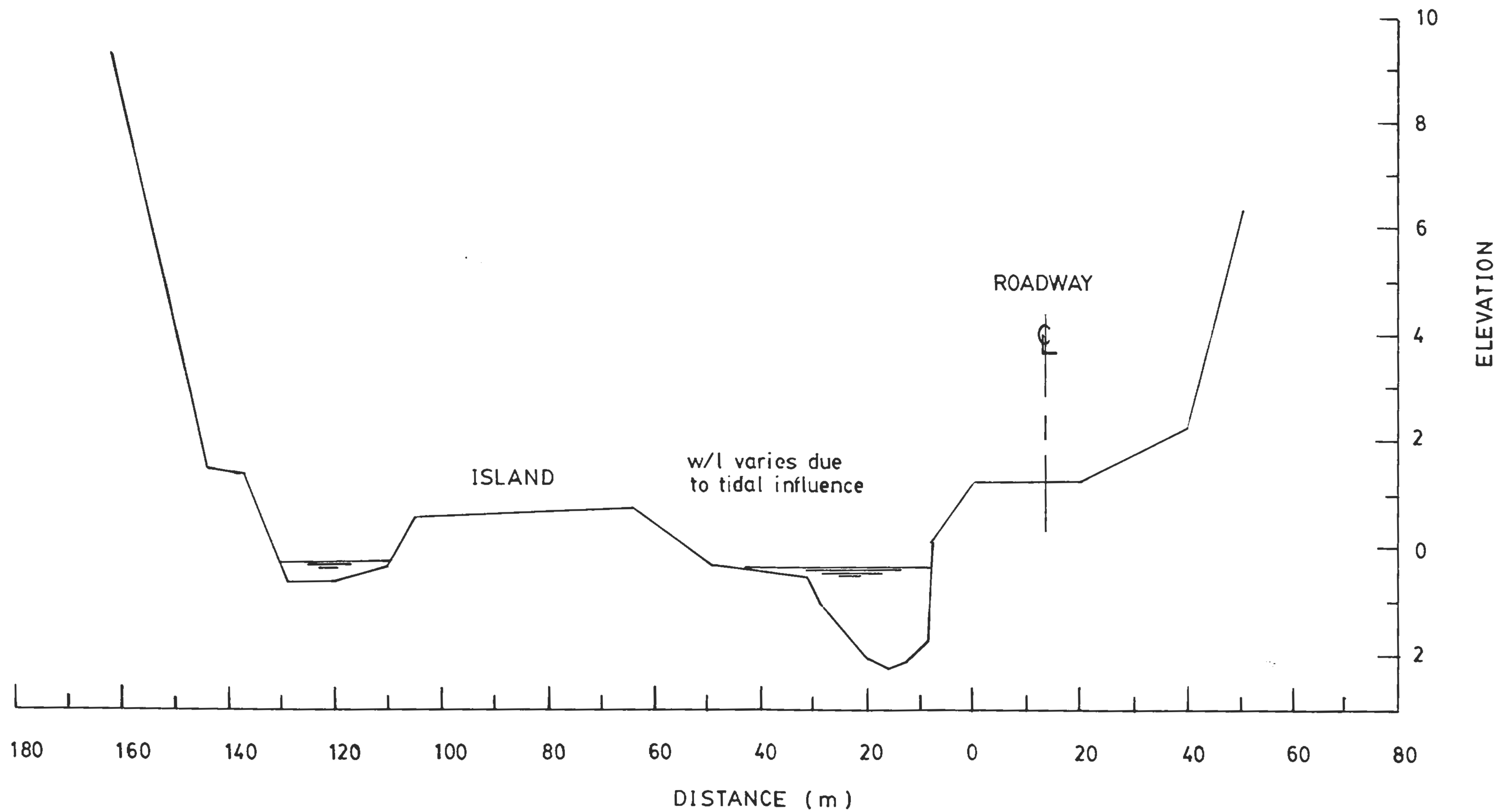
PHOTO NO. 2-18
Crest gauge #2 attached to wooden retaining wall 30 m north of Jakeman Central High School.

APPENDIX C - CROSS SECTIONS



CROSS SECTION 0+045

scale - horiz 1 : 1000
vert 1 : 100



CROSS SECTION 0+300

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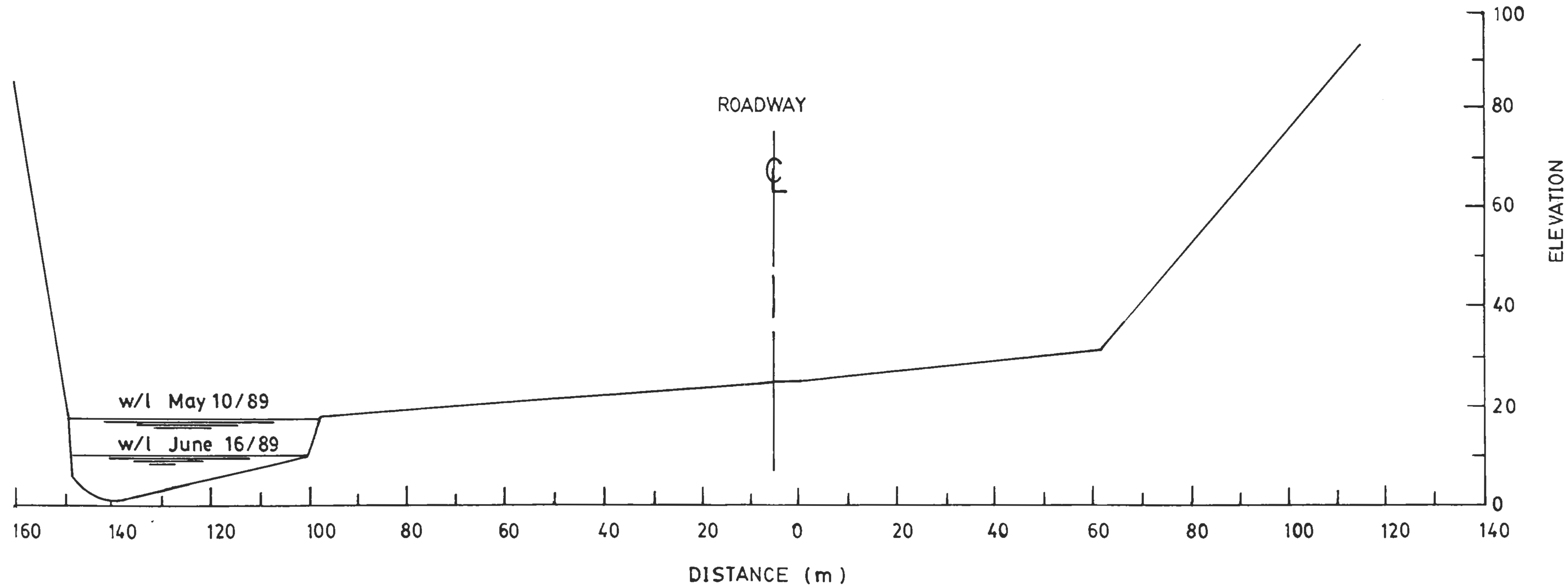
vert 1 : 100



CROSS SECTION 0+810

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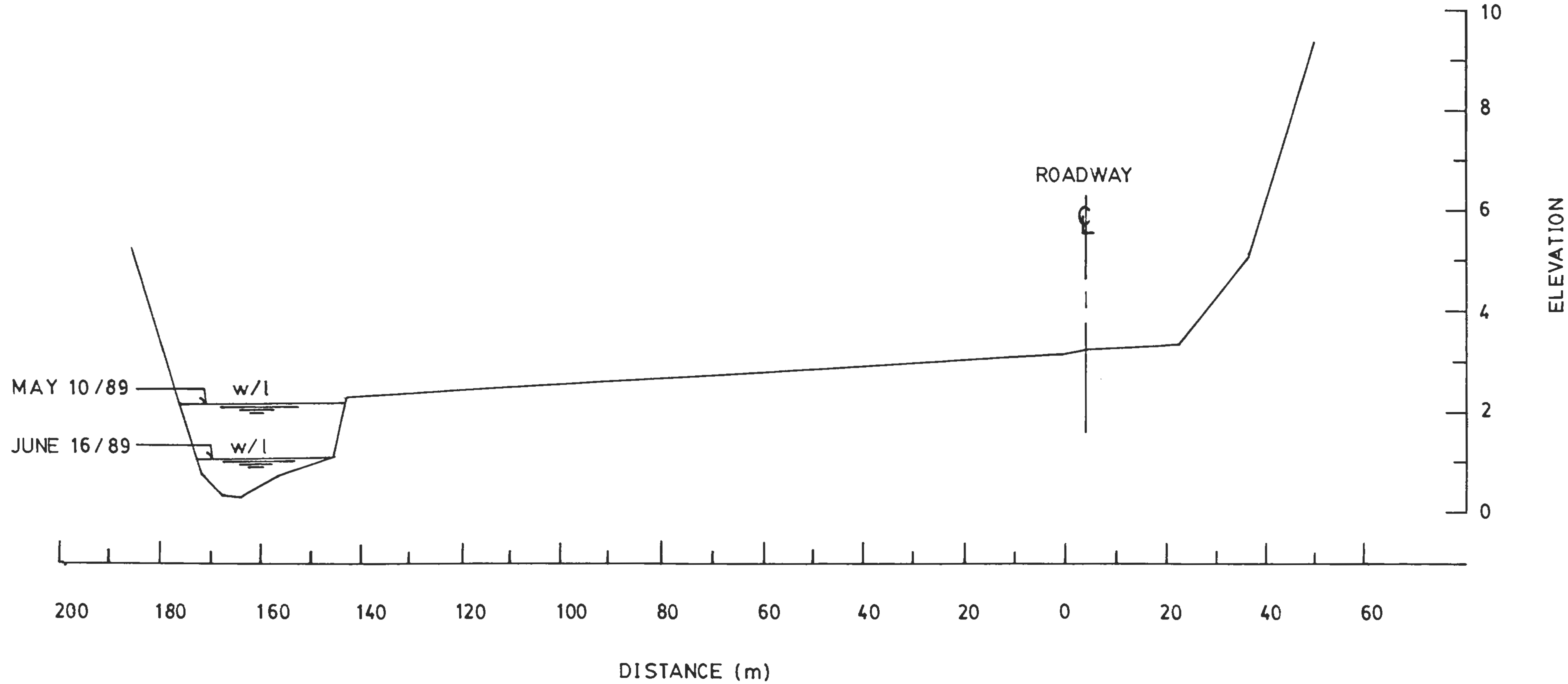
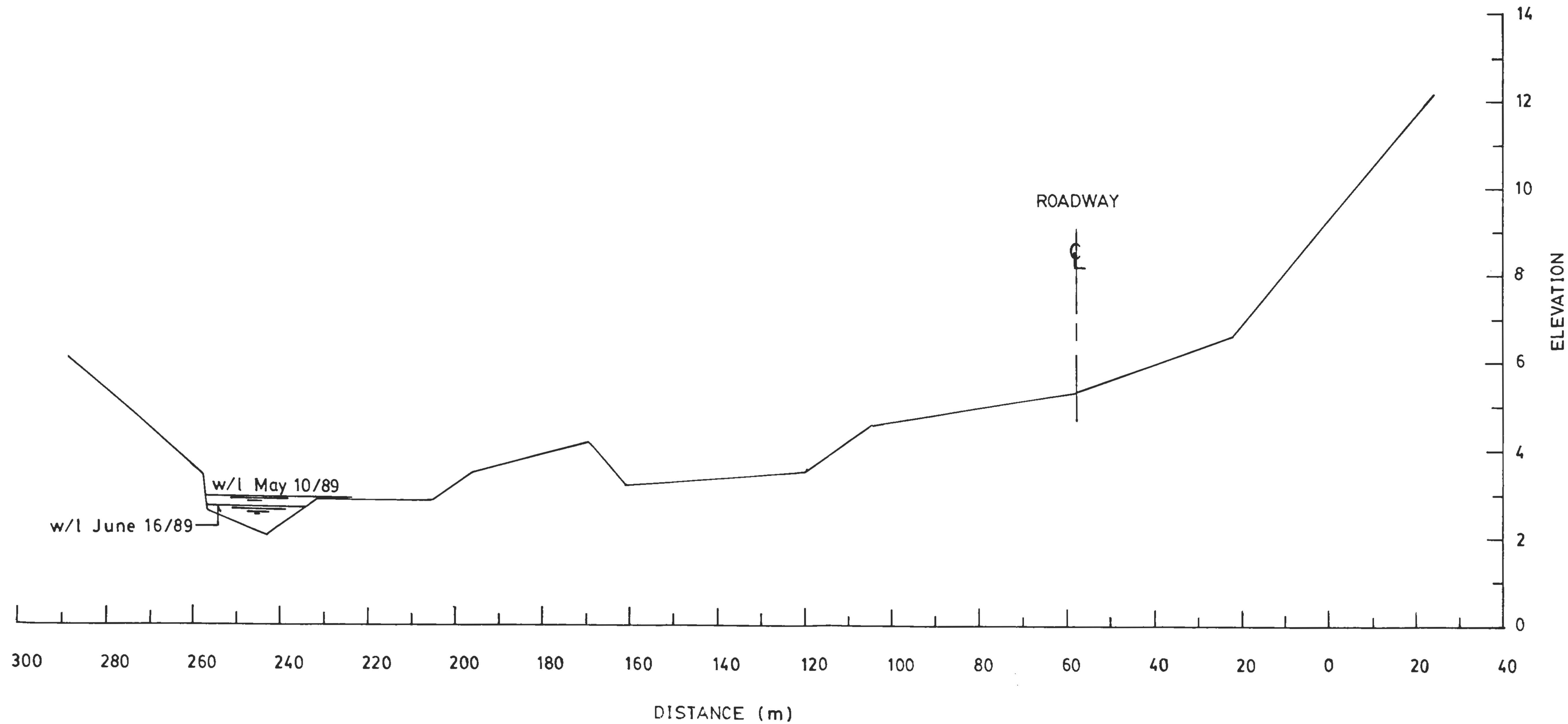
vert 1 : 100



CROSS SECTION 1+035

scale - horiz 1 : 1000
vert 1 : 100



CROSS SECTION 1+290

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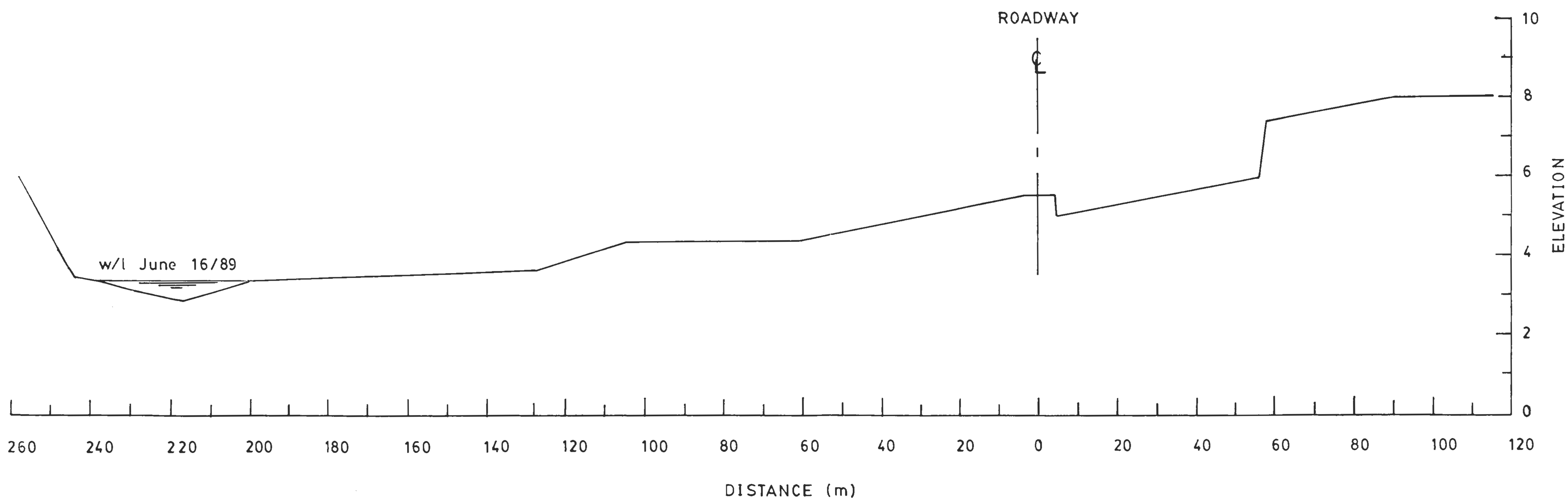
vert 1 : 100



CROSS SECTION 1+400

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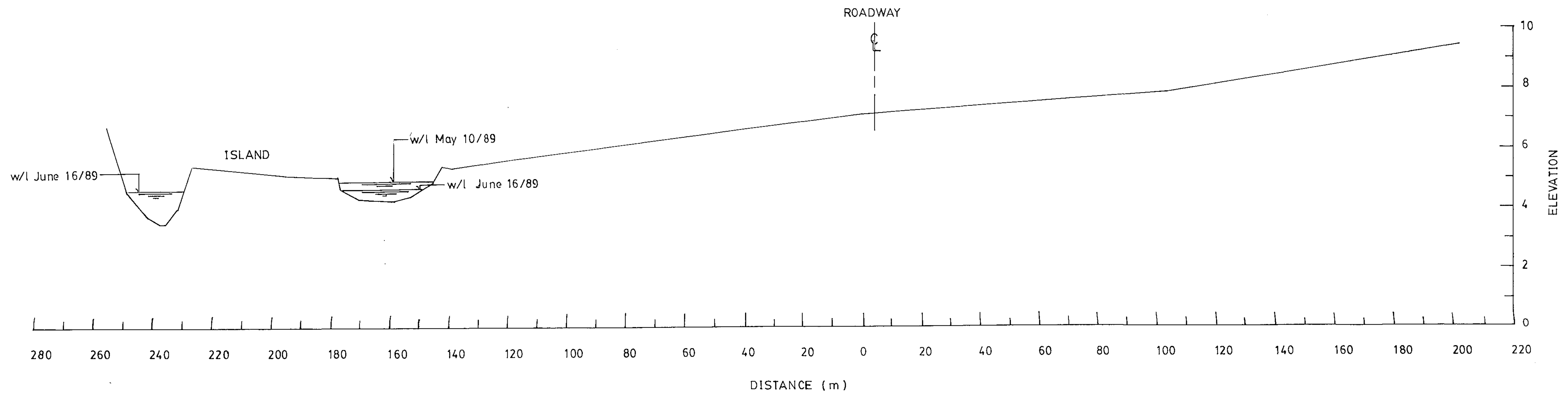
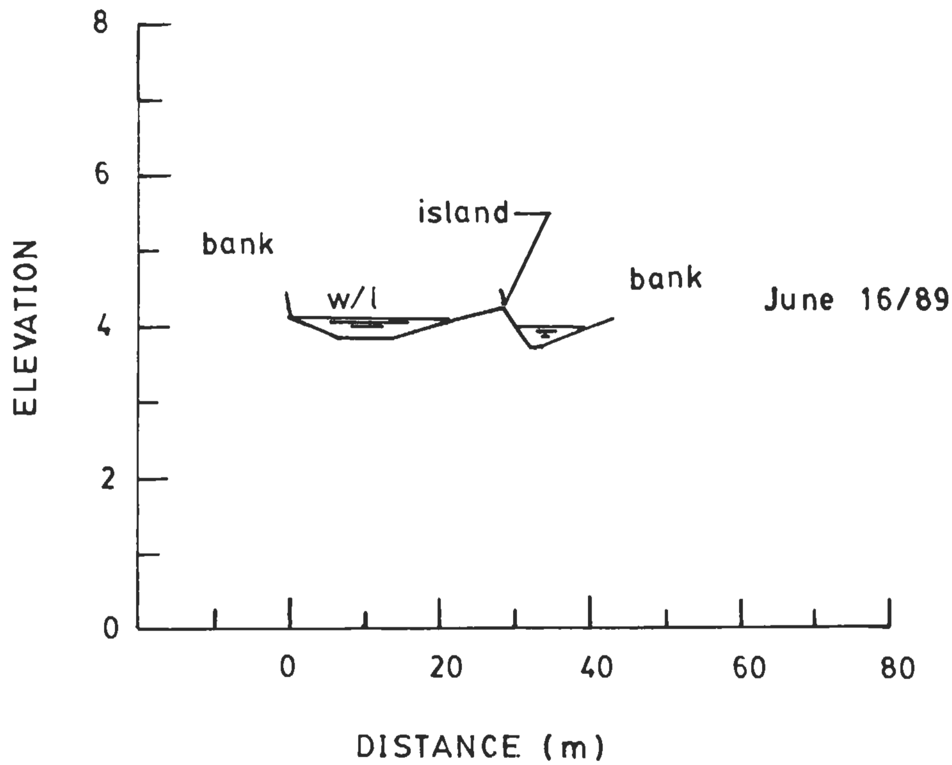
vert 1 : 100



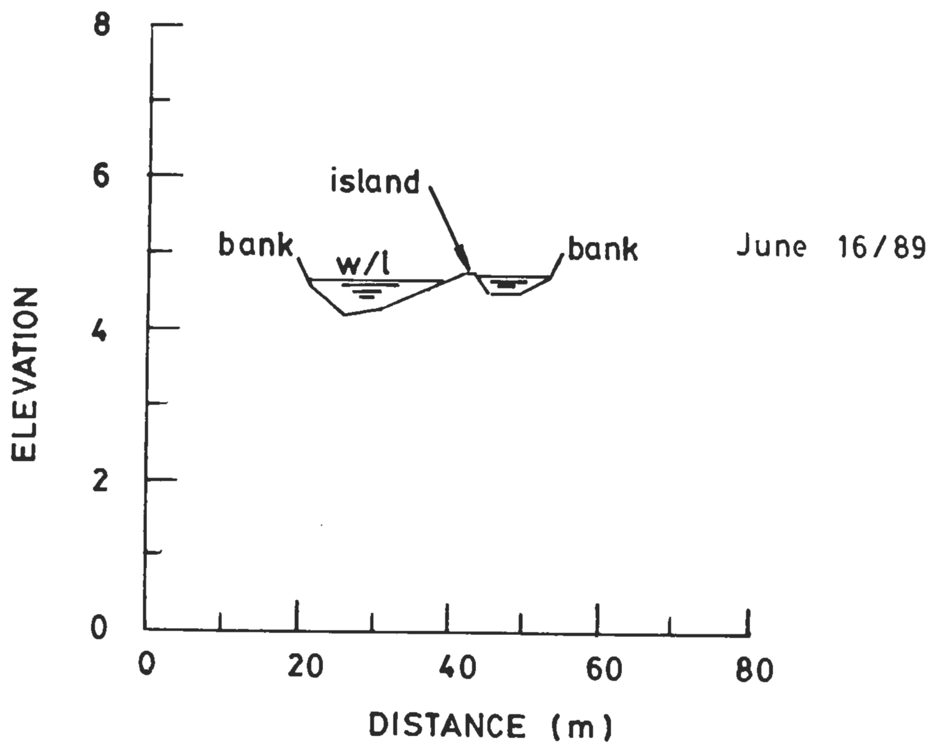
CROSS SECTION 1+700

scale - horiz 1 : 1000
vert 1 : 100



CROSS SECTION 1+805

scale - horiz 1 : 1000
vert 1 : 100



CROSS SECTION 1+635

scale - horiz 1: 1000
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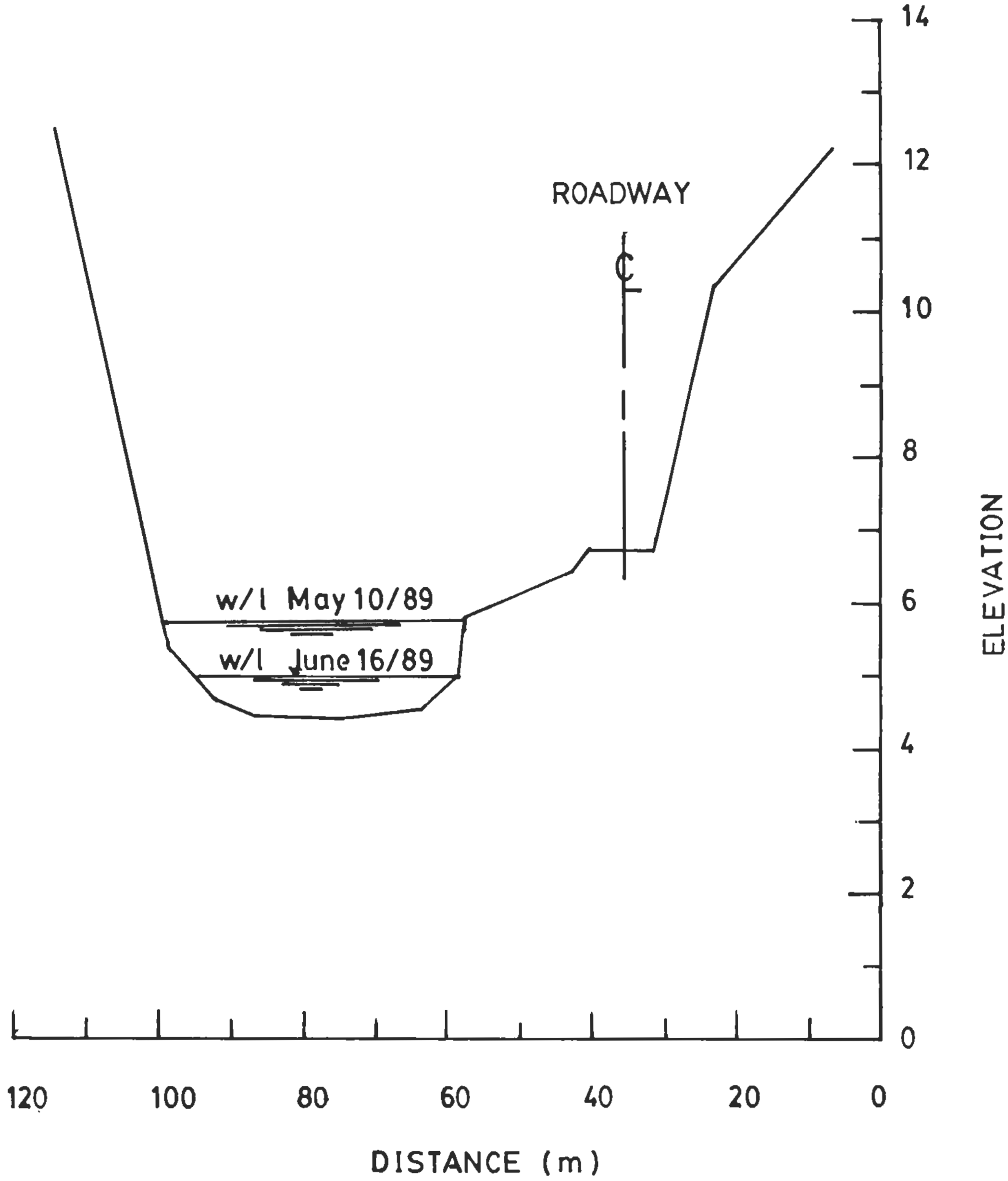

CROSS SECTION 2+085

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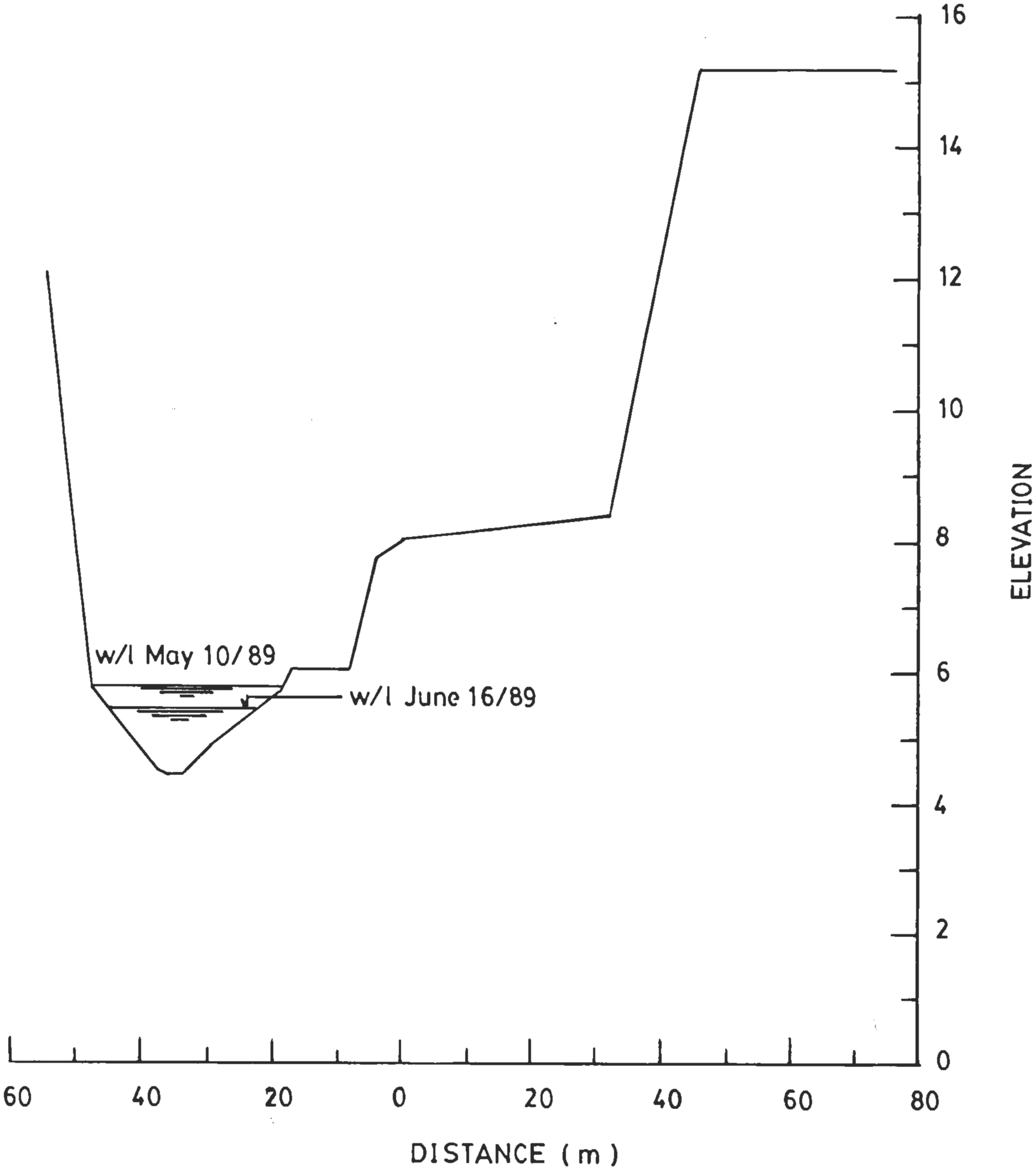

CROSS SECTION 2+300

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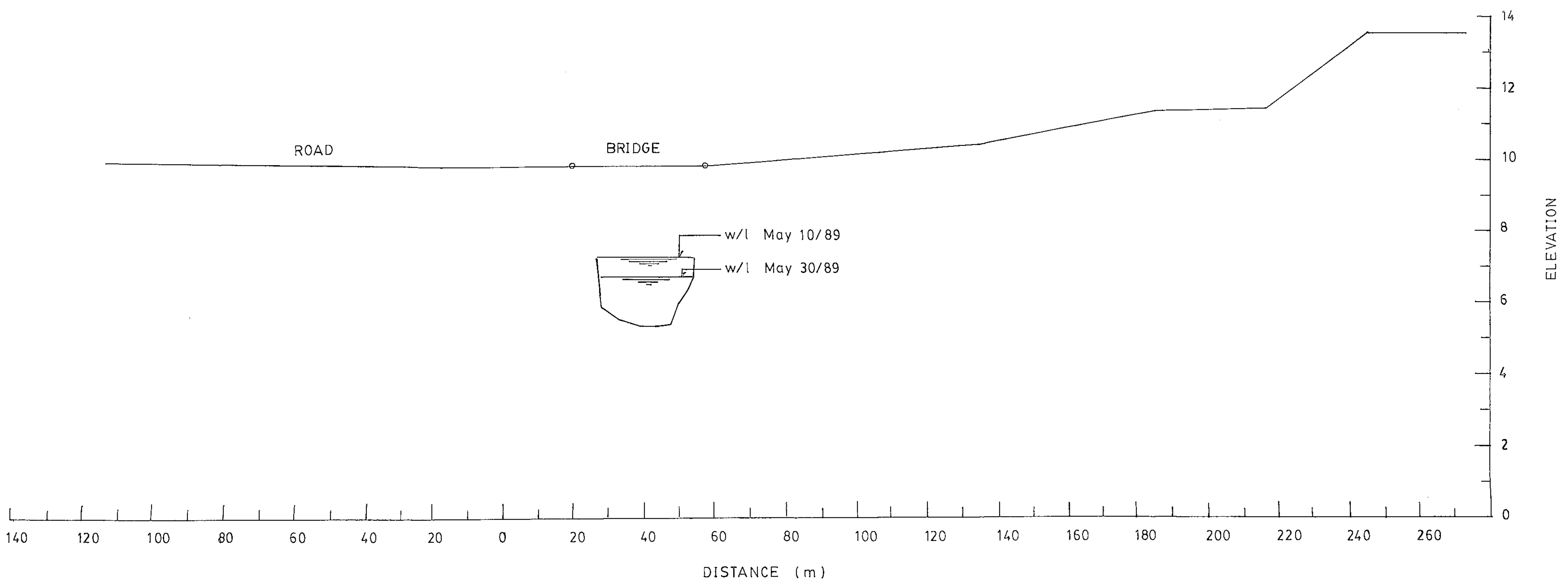
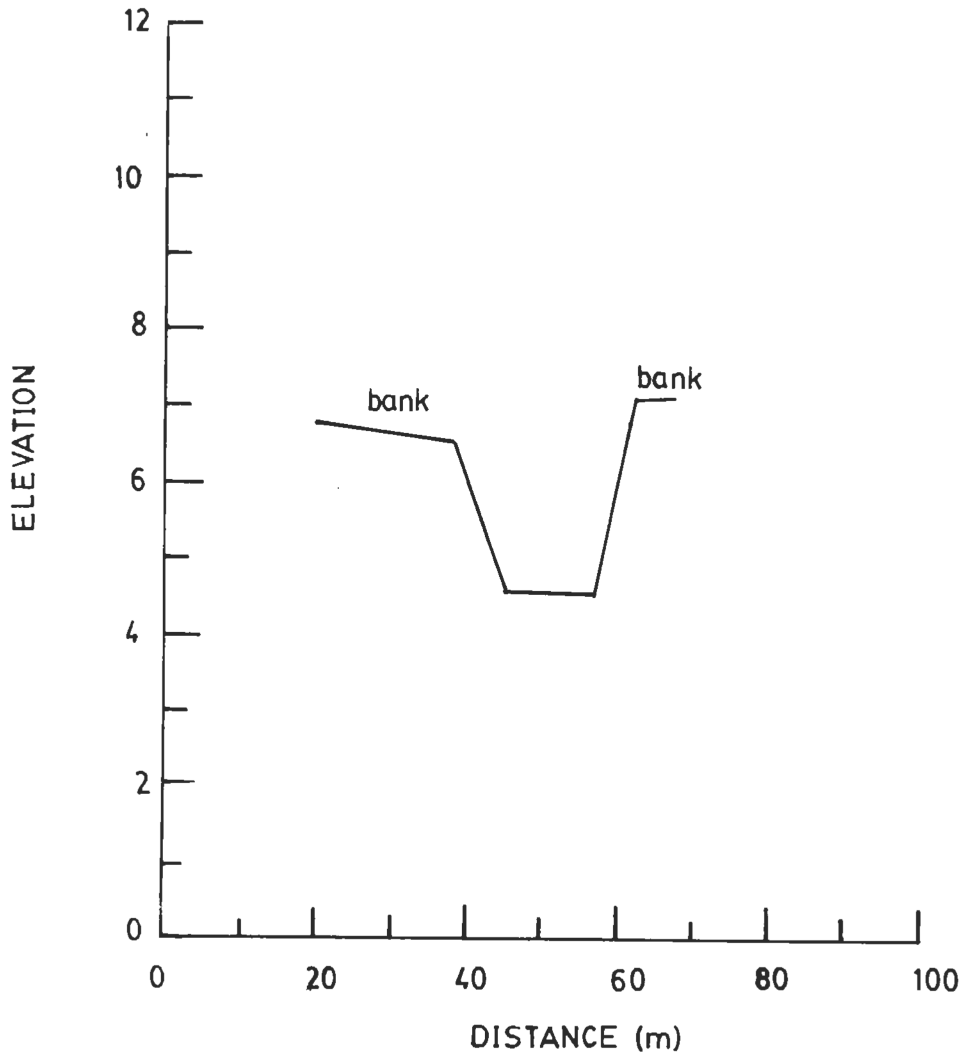


CROSS SECTION 2+620

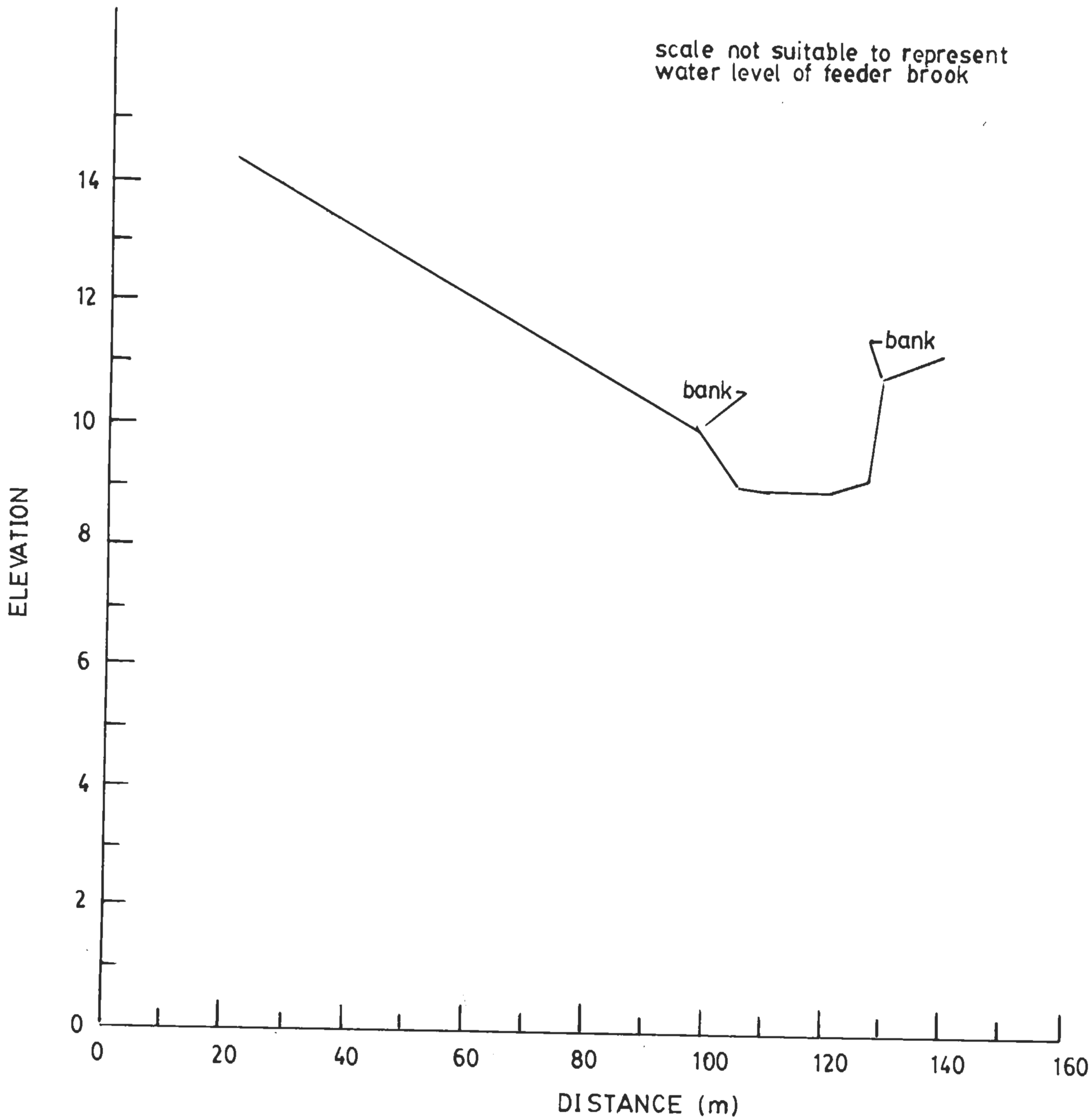
scale - horiz 1 : 1000
vert 1 : 100

scale not suitable to represent
water level of feeder brook



CROSS SECTION 7+230

scale - horiz 1 : 1000
vert 1 : 100



CROSS SECTION 7+530

scale - horiz 1 : 1000
vert 1 : 100

APPENDIX D

ICE STUDY PHOTOGRAPHS

NOTE: PHOTOGRAPHS IN THIS SECTION START AT NUMBER 11. NUMBERS 1 - 10 HAVE BEEN INCLUDED BY CUMMINGS AND COCKBURN LTD. IN THEIR PORTION OF THE REPORT.

PHOTO NO. 11

Showing the main area of town. A resident told us there was 450 mm of water flowing on this section the night of Jan. 27, 1990.

PHOTO NO. 12

Showing an outlet off the main road where the flood water eventually broke free into the river.

PHOTO NO. 13

Showing another outlet off the main road where the flood waters escaped into Trout River.

PHOTO NO. 14

Showing Trout River as it flows through the main community. Note the high water mark.

PHOTO NO. 15

Showing the lower section of Trout River just above the fish plant, on January 29, 1990.

PHOTO NO. 16

Showing the opposite site of Trout River just below the bridge. Note this area was totally underwater the night of January 27, 1990.

PHOTO NO. 17

Showing the bridge across Trout River.

PHOTO NO. 18

Showing a house just above the school. The owner told us that water ran into his basement windows.

PHOTO NO. 19

Showing a barn just below the Feeder Brook. A local told us that the water was 450 mm up the wall of the building.

PHOTO NO. 20

Showing the main road that had to be breached by heavy equipment to release the flood waters.

PHOTO NO. 21

Showing the four emergency overflow culverts that plugged with ice. The was a great cause of the flood water backing up.

PHOTO NO. 22

Showing the ice pile up at the junction of the Feeder Brook and Trout River.

PHOTO NO. 23

Showing the bridge at the Trout River Pond outlet. Since there are no scour marks on the snow, it appears that there may not have been any flooding in this area.

PHOTO NO. 24

Showing the area of Trout River just below the bridge at the pond. Again, note there are no scour marks in the snow. (Jan. 29. 1990)

PHOTO NO. 25

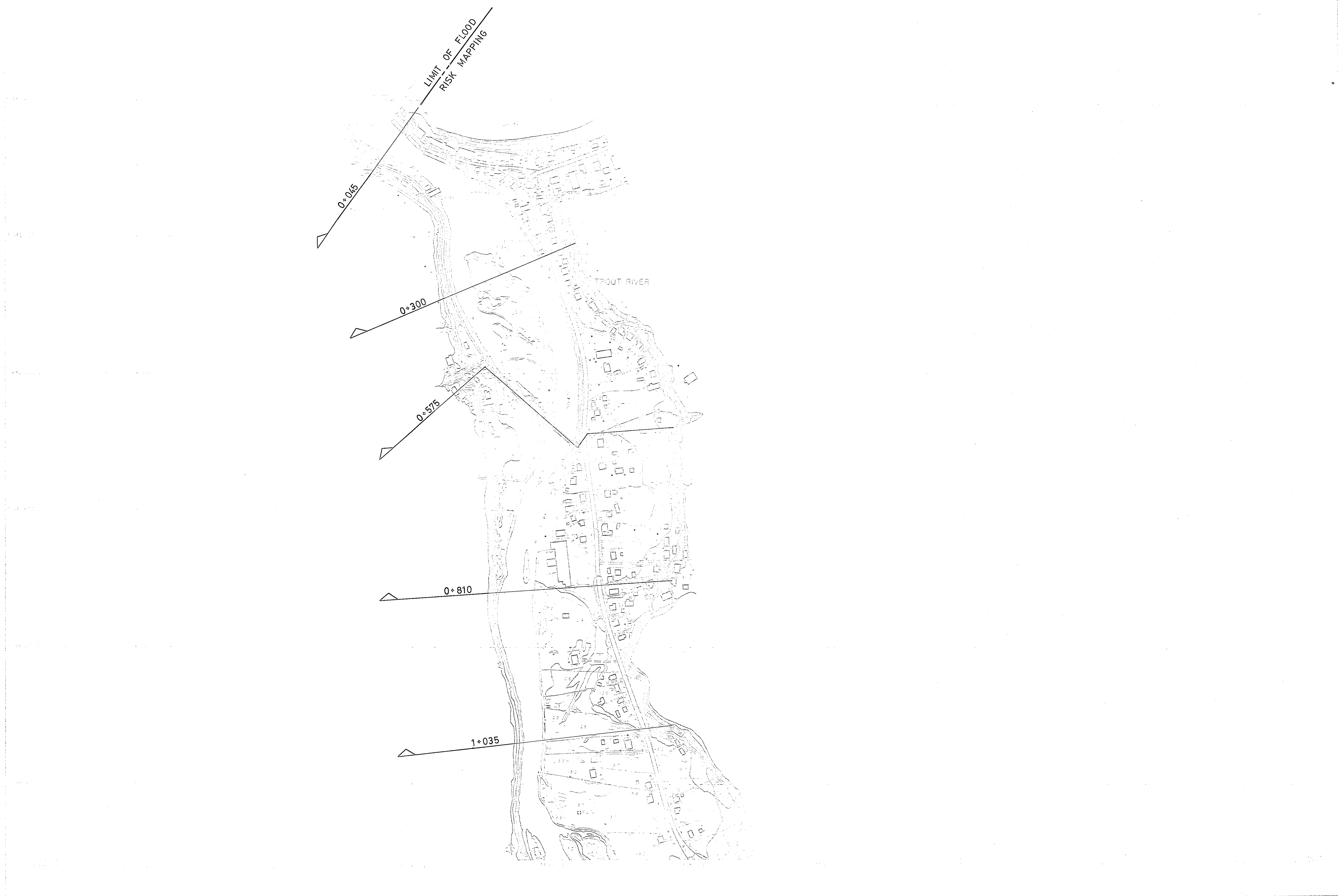
Showing the Bailey Bridge at Feeder Brook on January 29, 1990.

PHOTO NO. 26

showing upstream of Feeder Brook on Jan. 29, 1990. Residents claim that this was all underwater the night of Jan. 27, 1990.

PHOTO NO. 27

Showing downstream of Feeder Brook on January 29, 1990. The shed on the left was in abut 300 mm of water the night of January 27, 1990.



ISLAND ENGINEERING CO. LTD.
CORNER BROOK NEWFOUNDLAND

FLOOD RISK MAP
TROUT RIVER, NEWFOUNDLAND
CARTE DU RISQUE D'INONDATION
TROUT RIVER, TERRE-NEUVE

SCALE 1:2 500 ÉCHELLE

ISLAND ENGINEERING CO. LTD.
CORNER BROOK NEWFOUNDLAND

LEGEND-LEGENDE

GENERAL INFORMATION

This map has been produced for the Inland Waters Directorate, Environment Canada and the Water Resources Division, Newfoundland Department of the Environment and Lands in association with Energy, Mines and Resources Canada. The mapping complies with the specifications of "Surveying and Mapping Procedures for Flood Plain Delineation" and "Hydrologic and Hydraulic Procedures for Flood Plain Delineation", Environment Canada, May 1976.

TOPOGRAPHIC MAP

This map was produced by Kenting Earth Sciences International Ltd. in 1983 from aerial photography flown in May, 1983.

FLOOD LINES

LEGEND-LEGENDE

FLOOD RISK MAP
TROUT RIVER, NEWFOUNDLAND
CARTE DU RISQUE D'INONDATION
TROUT RIVER, TERRE-NEUVE

SCALE 1:2 500 ÉCHELLE

LEGEND-LEGENDE

RENSEIGNEMENTS GÉNÉRAUX