Canada Alberta Northwest Territories

Northern River Basins Study















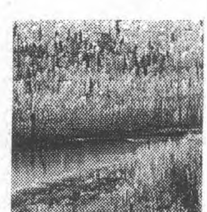

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Prepared for the
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NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 24

BIOPHYSICAL INVENTORY OF CRITICAL OVERWINTERING AREAS

PEACE RIVER, OCTOBER, 1992

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PREFACE:

The Northern River Basins Study was initiated through the "Canada-Alberta-Northwest Territories Agreement Respecting the Peace-Athabasca-Slave River Basin Study, Phase II - Technical Studies" which was signed September 27, 1991. The purpose of the Study is to understand and characterize the cumulative effects of development on the water and aquatic environment of the Study Area by coordinating with existing programs and undertaking appropriate new technical studies.

This publication reports the method and findings of particular work conducted as part of the Northern River Basins Study. As such, the work was governed by a specific terms of reference and is expected to contribute information about the Study Area within the context of the overall study as described by the Study Final Report. This report has been reviewed by the Study Science Advisory Committee in regards to scientific content and has been approved by the Study Board of Directors for public release.

It is explicit in the objectives of the Study to report the results of technical work regularly to the public. This objective is served by distributing project reports to an extensive network of libraries, agencies, organizations and interested individuals and by granting universal permission to reproduce the material.

NORTHERN RIVER BASINS STUDY
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Whereas the above publication is the result of word conducted under the Northern River Basins Study and the terms of reference for the work are deemed to be fulfilled,

IT IS THEREFORE REQUESTED BY THE STUDY OFFICE THAT;
this publication be subjected to proper and responsible review and be considered for release to the public.

F.J. Wrona ________________ 30 NOV 93
(Dr. F.J. Wrona, Ph.D., Science Director) (Date)

Whereas it is an explicit term of reference of the Science Advisory Committee "to review, for scientific content, material for publication by the Board",

IT IS HERE ADVISED BY THE SCIENCE ADVISORY COMMITTEE THAT;
this publication has been reviewed for scientific content and that the scientific practices represented in the report are acceptable given the specific purposes of the project and subject to the field conditions encountered.

SUPPLEMENTAL COMMENTARY HAS BEEN ADDED TO THIS PUBLICATION: [ ] Yes [ ] No

P.A. Larkin ________________ Dec 14/93
(Dr. P. A. Larkin, Ph.D., Chair) (Date)

Whereas the Study Board is satisfied that this publication has been reviewed for scientific content and for immediate health implications,

IT IS HERE APPROVED BY THE BOARD OF DIRECTORS THAT;
this publication be released to the public.

Bev Burns ________________ Dec. 16, 1993
(Bev Burns, Co-Chair) (Date)

Lucille Partington ________________ Dec. 16, 1993
(Lucille Partington, Co-Chair) (Date)

NRBS.005

BIOPHYSICAL INVENTORY OF CRITICAL OVERWINTERING AREAS, PEACE RIVER, OCTOBER, 1992

STUDY PERSPECTIVE

The occurrence, distribution, abundance and habitat utilization of fish species of the Peace, Athabasca and Slave rivers and their major tributaries are subjects of major interest to the Study. People living within the basins have identified fish as significant elements of the river's ecosystems. Aggregations of fish in overwintering sites exposed to altered water quality from upstream effluent sources are of concern to the Study. The location and intensity of fish species utilization of probable overwintering habitats can assist investigators in assessing the contaminant exposure and potential stress from low oxygen levels. Knowledge of critical overwintering habitats would also benefit the design of monitoring programs set up to study the affects of altered water quality/quantity on the aquatic environment.

Related Study Questions

1A) How has the aquatic ecosystem, including fish and /or other aquatic organisms been affected by exposure to organochlorines or other toxic compounds?

6) What is the distribution and movement of fish species in the watersheds of the Peace, Athabasca and Slave river? Where and when are they most likely to be exposed to changes in water quality and where are their important habitats?

10) How does and how could river flow regulation impact the aquatic environment?

14) What long term monitoring programs and predictive models are required to provide an ongoing assessment of the sate of the aquatic ecosystems. These programs must ensure that all stakeholders have the opportunity for input.

Earlier fisheries' work observed significant concentrations of fish in deep hole habitats (waters with depths greater than 7.0 metres). Characterization of these possible winter habitats, in addition to fish species composition, abundance and population structure, were the principal areas of investigation.

Intensive studies were directed at sites where upstream effluent discharges are completely mixed. Sampling methods were found to be ineffective in meeting the projects objectives and the project was terminated at the conclusion of the qualitative assessment for "deep hole" overwintering sites. This project served to point out that deep-water areas are not limited in the Peace River and that new techniques would have to be tried before any practical determination of fish population structure within these riverine habitats could be undertaken. Results of this project are being juxtaposed with other biophysical data before any decision is made to follow-up this project with alternative techniques to characterize the fish utilization in these unique riverine habitats.

ACKNOWLEDGEMENTS

Funding for this study was provided by the Northern River Basins Study.

The author would like to thank Dave Walty, of Alberta Fish and Wildlife Division, for his contribution to this project. The following staff members of R.L. & L. Environmental Services Ltd. participated in this project.

Larry Hildebrand	Project Manager
Richard Pattenden	Project Biologist
Curtiss McLeod	Project Advisor
Chantal Pattenden	Senior Biological Technician
Jim Campbell	Biological Technician
Scott Morrison	Biological Technician
Mike Braeuer	Biological Technician
Frances Baker	Word Processing

Our firm appreciates the assistance of local individuals -- Ken Wright of Peace River and Sherry Poole of Grouard.

REPORT SUMMARY

This report, entitled "Biophysical Inventory of Critical Overwintering Areas - Peace River," has been submitted as partial fulfilment of contractual obligations to the Northern River Basins Study. The primary objectives of this study were to locate deep-water areas in that portion of the Peace River upstream of Vermilion Chutes, to select deep-water areas that had potential as critical overwintering habitat for fish communities, and to conduct an intensive biophysical survey of selected areas. This information would then be used to assess the importance of deep-water sites as critical overwintering areas for fish communities in the Peace River. This report presents the findings of studies conducted during October 1992.

Deep-water sites ($\geq$7.0 m) are distributed throughout the study area (i.e., Peace River from Vermilion Chutes to the Alberta-B.C. border). The number of deep-water areas in the river ranged from 11 to 21 per 100 km section, with highest densities observed in the lowermost reach of the Peace River. Although abundant, there was a trend towards decreasing depths of deep-water areas from Vermilion Chutes to the Alberta-B.C. border. Mean depth decreased from 9.6 to 8.0 m. This information suggests that deep-water areas are not severely limited in the Peace River. As such, potential overwintering sites are accessible to fish communities in the system.

A reconnaissance survey in three sections of the Peace River (i.e., Many Islands, Notikewin, and Carcajou areas) assessed the suitability of potential deep-water sites for intensive sampling. Qualitative assessments, utilizing echo sounding as the principal method, established the presence of fish in deep-water areas in all three sections. Fish numbers were higher in the deep-water sites than in "normal habitat" in the immediate vicinity. Small to medium sized individuals dominated fish communities at most sites. Fish generally were located in 2.0 to 3.5 m depths along the margins of deep-water zones or were associated with some form of bottom irregularity. The bottom morphology was non uniform at most sites and consisted primarily of large cobble, boulder, or bedrock fractures.

Intensive sampling was conducted in one deep-water area; the Wolverine River Site, which is located near the settlement of Carcajou. The maximum water depth was 11.3 m, and the portion of the river that exceeded 7.0 m depth was 33 ha, or 20% of the intensive sampling site. This deep-water area extended for approximately 2.95 km. Bottom morphology in the deep-water zone of this site was irregular, indicating the presence of large boulders or bedrock outcroppings. Water velocities in the thalweg of the site were high, ranging from 0.5 to 1.9 m/s in the unobstructed water column. High water velocities such as these would limit the usefulness of open-water locations as holding areas for fish. It is more likely that individuals positioned themselves adjacent to bottom obstructions or along the edge of the thalweg; locations that characteristically exhibit low velocities. Dissolved oxygen and water temperature readings did not vary extensively. Temperatures remained at

approximately 2.5 °C, while dissolved oxygen ranged from 13.5 to 15.5 mg/L. This suggests that complete mixing occurred in the water column.

Several sampling techniques were employed in an attempt to capture fish from the intensive sampling site; they included deep-water electrofishing, drift netting, a combination of electrofishing and drift netting, and use of set lines. Prior to employing a particular method, fish concentrations were located with sonar to ensure that sampling effort was directed at a specific location containing fish. During four days of intensive deep-water electrofishing and drift netting, one goldeye was captured and two northern pike were observed. Deep-water sampling with set lines did produce some fish, which included three northern pike, and nine burbot. Captured fish were evenly distributed along the line at depths from 1.0 to 9.0 m. Surface electrofishing utilizing deep-water electrodes was conducted to collect fish samples for contaminant analyses. In total, six northern pike, four burbot, and three longnose suckers were collected.

Despite an intensive effort to sample the fish community in the Wolverine River Site, very few fish were captured utilizing techniques employed, even though fish concentrations (i.e., as determined by sonar) were present in the sampled area. As such, intensive field sampling of the three remaining deep-water sites was terminated. The study objective pertaining to collection of information on fish communities utilizing deep-water areas, was not achieved. As such, an assessment of the deep-water areas as critical overwintering habitats for fish communities in the Peace River could not be completed.

The results of the study suggest that deep-water areas are not limited in the Peace River, and that fish tend to concentrate at these sites during late fall. However, drift nets and deep-water electrofishing were ineffective as sampling methods used to capture these fish. If future sampling of these sites is to be considered, alternate capture techniques should be utilized. A potential method is combined trawl-electrofishing, which would employ electrical arrays attached directly to the mouth of a trawl net. This type of system would greatly improve the capture efficiency of fish that are immobilized by the electric field. Set lines also may be an alternate technique to intensively sample piscivorous fish species inhabiting deep-water areas; however, there are limitations associated with this method. These include sampling bias (i.e., selection for species such as burbot that rely heavily on olfactory senses to locate food) and high mortality rates of captured fish. If these limitations are acceptable, this method could be utilized to survey fish in deep-water habitats in the Peace River.

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1.0 INTRODUCTION

1.1 BACKGROUND

Current and proposed developments in the Peace River basin (i.e., industries such as pulp mills and municipal effluents) may have potential impacts on fish communities and their habitats. Although biophysical information has been collected from the Peace River system (Hildebrand 1990; Pattenden et al. 1990, 1991; Boag 1992), little is known about critical wintering habitats, or the fish species that utilize these areas. This information is required to monitor the sensitivities of fish populations to present development in the basin and to allow predictive modelling of potential impacts of planned developments.

The mainstem Peace River (from the Alberta-B.C. border to the Peace-Athabasca delta) covers a distance of over 1000 km. Within this section of river are deep-water areas ($\geq$7.0 m in depth) that have the potential to provide critical winter habitat for several fish species. A study conducted by R.L. & L. Environmental Services Ltd. during 1988 and 1989 established the presence of these unique habitats in the Peace River (Hildebrand 1990). This investigation indicated that some of these areas were utilized by fish species during the fall period; however, it was unclear whether or not deep-water areas were important habitats to fish communities in the Peace River during winter.

R.L. & L. Environmental Services Ltd. was contracted to document the distribution of deep-water areas in the Peace River, to quantify the physical characteristics of a representative sample of these areas, and to inventory fish communities that utilize these sites.

1.2 OBJECTIVES

The objectives of the program, as specified in the Terms of Reference, were as follows:

1. To locate and map the distribution of deep-hole habitats ($\geq$7.0 m) in two reaches of the Peace River:
   a) downstream of the B.C. border and upstream of the Smoky River confluence, and
   b) downstream of Daishowa and upstream of the Vermilion Chutes.

2. In consultation with the contract scientific authority, select two deep-holes within each reach for fish population assessment.

3. To determine the species composition, relative abundance, growth population characteristics, and distribution of fish species in these wintering areas.

4. To tag several of the key fish species for ongoing assessments of the movement of these fish species within the Peace River system.

5. To collect specified fish species for contaminant analysis, and

6. To assess the overall significance of deep-hole habitat for overwintering.

1.3 STUDY AREA AND SCHEDULE

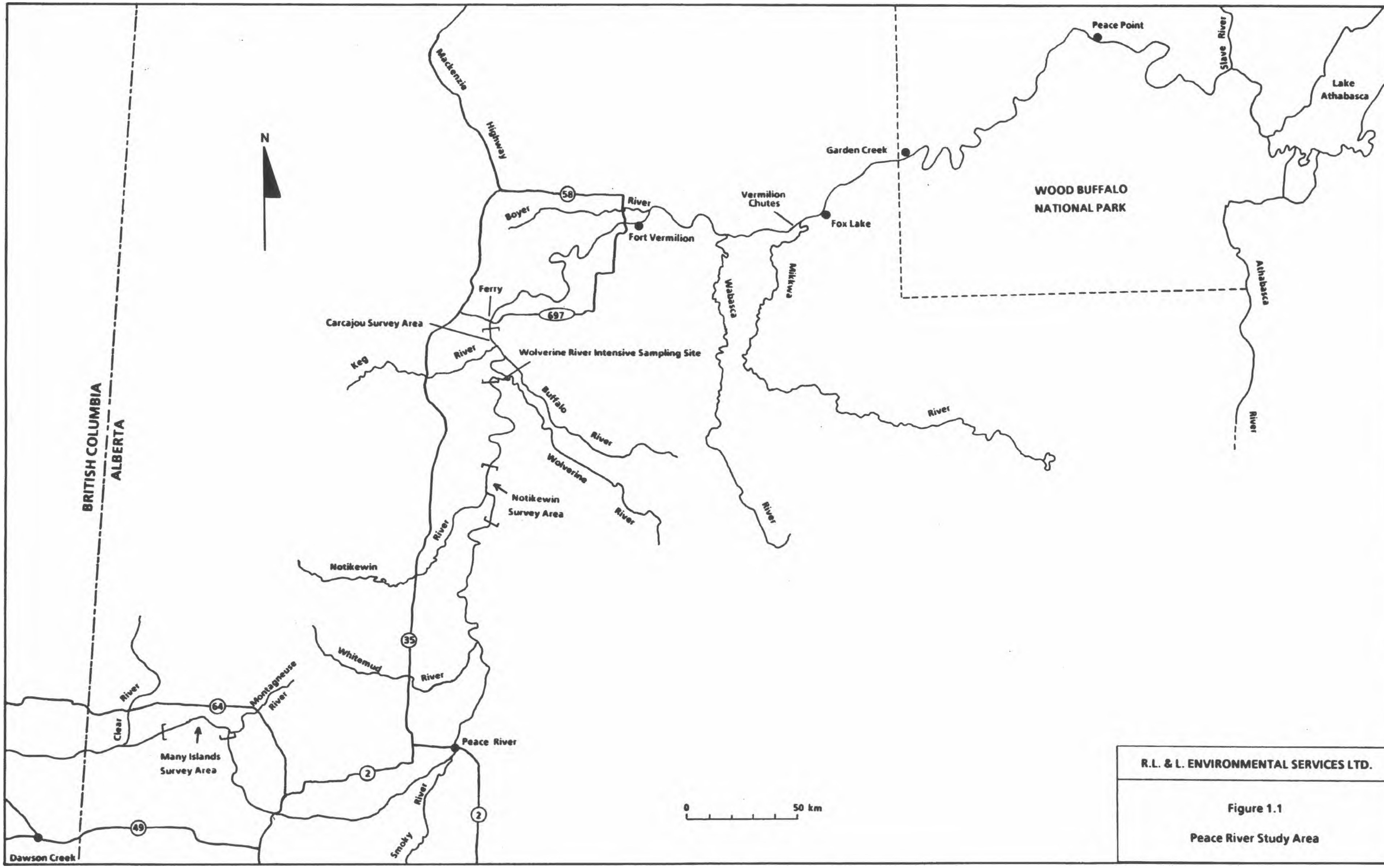
The study was conducted on the mainstem Peace River during late fall 1992 (Figure 1.1). The study area consisted of two reaches. The upper reach was located downstream of the B.C. border and upstream of the Smoky River confluence, while the lower reach was downstream of the Smoky River confluence and upstream of Vermilion Chutes.

The field reconnaissance survey of potential intensive sampling sites, completed between 8-12 October, concentrated on three sections of the Peace River. These were the Many Islands area, the Notikewin area and the Carcajou area (Figure 1.1). The intensive biophysical inventory was completed between 16-21 October at the confluence of the Wolverine River, which is located due east of the settlement of Carcajou (Figure 1.1).

2.0 METHODS

2.1 DISTRIBUTION OF DEEP-WATER AREAS

Information gathered during an intensive study conducted by R.L. & L. Environmental Services Ltd. during 1988 and 1989 (Hildebrand 1990) was used to map the location and distribution of deep-water habitats in the Peace River. These data were obtained during spring, summer, and fall surveys of the Peace River from the Alberta-B.C. border to just upstream of Vermilion Chutes. During each survey, the thalweg of the river was continually monitored utilizing a depth sounder, and any deep-water areas encountered were marked on 1:30 000 scale air photos and their maximum depth recorded. Complete surveys of the study area ensured that significant deep-water areas were located. Information on the location and distribution of deep-water areas ($\geq$7.0 m depth) were summarized from these data. Office pre-typing also allowed identification of potential intensive sampling sites, which were subsequently examined by a field crew.



R.L. & L. ENVIRONMENTAL SERVICES LTD.

Figure 1.1

Peace River Study Area

2.2 RECONNAISSANCE OF POTENTIAL SAMPLING SITES

Once distributions of deep-water areas were mapped, a two-person field crew conducted a reconnaissance of three river sections to identify potential intensive sampling sites (i.e., deep areas containing concentrations of fish, and good road accessibility). The crew utilized a 5.5 m river boat powered by a 115 hp jet-drive outboard motor to access river sites and were based from a mobile field camp. A Lowrance X-60 echo sounder with a 20° high resolution transducer was utilized to determine habitat characteristics and fish distributions at each site. The extent of each site was mapped and its physical characteristics identified (maximum depth, substrate composition, and bottom morphology). A qualitative estimate was made of fish abundance and size distribution by completing several sonar transects at each site. To ensure that fish observed at deep-water sites represented concentrations, comparisons of relative abundance were made with fish numbers in "normal stream" habitats in the immediate vicinity.

Information obtained during the reconnaissance was used to assess potential areas for their usefulness as intensive sampling sites. This information was verbally presented to Northern River Basins Study staff members to verify site selection.

2.3 DETAILED ASSESSMENT OF INTENSIVE SAMPLING SITE

2.3.1 Habitat

Detailed habitat assessments were conducted by a two-person crew utilizing a 5.5 m jet-drive river boat.

Assessments involved descriptions of depth contours, bottom morphology, substrate composition, and dissolved oxygen, temperature, and velocity profiles. The methods utilized are outlined below.

Site Location and Water Surface Elevation

Site location and water surface elevation were recorded to allow an evaluation of conditions at a future date, under differing flow regimes. A temporary benchmark (TBM) was established that consisted of a 25 cm-long spike driven into the base of a tree situated above the high water mark. The benchmark was marked with orange surveyors tape; an aluminum site marker affixed to the tree identified the site as an R.L. & L. benchmark. Water surface elevation was determined by differential levelling using an automatic level and surveyor's rod.

The sampling site was related to Universal Transverse Mercator Coordinates for Zone 11 by utilizing a Trimble GPS system.

Depth Contours, Bottom Morphology, and Substrate Composition

An X-60 Lowrance chart recording sonar, equipped with a 20° high-resolution transducer, was utilized to assess depth contours, substrate composition, and bottom morphology. To accomplish this, ten transects were placed perpendicular to the stream channel within the sampling site (Figure 2.1). These transects were connected by other transects run diagonally across the channel. Tracings were made along each transect to establish depth profiles, which were used to generate a depth contour map of the site. Bottom morphology and substrate composition also were assessed using these tracings.

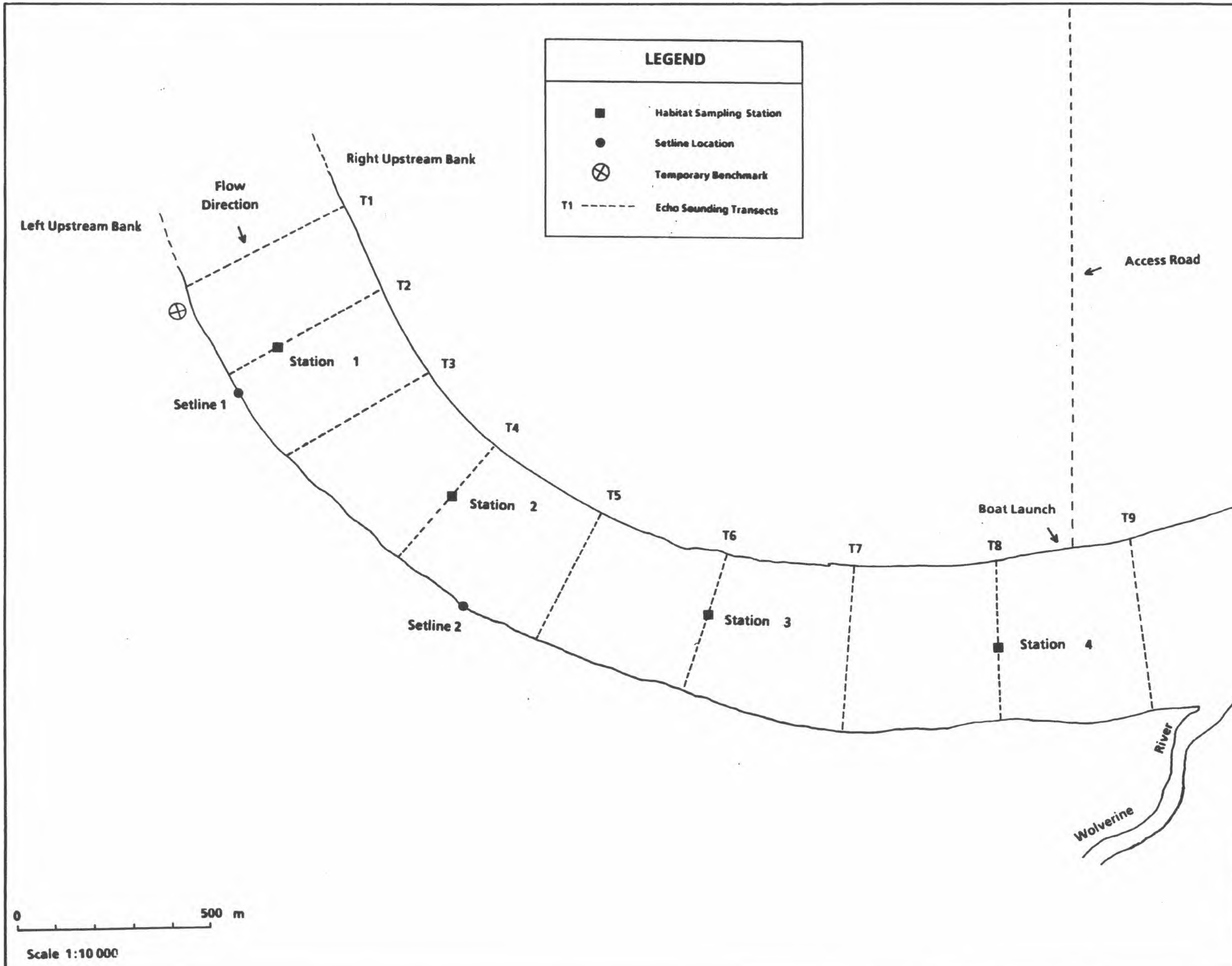
Water Velocity, Dissolved Oxygen, and Temperature Profiles

Water velocity, dissolved oxygen and temperature were measured at the intensive sampling site. Five locations along the centre of the river served as sampling stations (Figure 2.1). At each station, measurements were taken at 0.5 m intervals from the water surface to the bottom. Sampling instruments were fastened to a 30 kg torpedo weight to ensure measurements were obtained at appropriate depths. Sampling position was located by visual reference to shoreline markers and by use of the echo sounder to locate the thalweg. The boat's position was maintained with a dual anchor system.

An Oxyguard Handy Mk II meter was utilized to measure oxygen (±0.1 ppm) and temperature (±0.1 ° C), while a Price 622A current meter was employed for velocity measurements.

2.3.2 Fish Community

The fish community present in the deep-water area selected for intensive sampling was assessed during the same period as the physical habitat. A variety of sampling techniques were utilized in an attempt to measure relative abundance, distribution, and size-classes of fish species utilizing the site.



R.L. & L. ENVIRONMENTAL SERVICES LTD.

Figure 2.1

Sampling Locations Wolverine River Site

Sonar

Sonar was the major sampling tool used to identify fish distributions in the sampling site. This technique was utilized to locate fish, to establish their position in the water column, to assess their relative abundance, and to provide information on gross size differences (i.e., small juveniles versus large adults). A Lowrance X-60 digital echo sounder equipped with a 20° high resolution transducer was employed for this purpose. Paper tracings were obtained with a Lowrance X-16 echo sounder at selected locations.

Two procedures were employed. The first procedure involved random searches of the site to locate fish. The second included continuous use of sonar while utilizing capture methods to "see" fish that potentially could be captured.

Boat Electrofishing

Because of depths associated with deep-water areas (≥7.0 m), normal boat electrofishing methods (i.e., anode probes submerged to 1 m) were of little value for sampling purposes. Instead, a variable-depth electrofishing method was employed (Hesse and Newcomb 1982; Sheehan et al. 1990) in an attempt to capture fish. This system utilized two electrodes that were lowered to a predetermined depth for sampling. This system was mounted on a Smith-Root SR18E electrofishing boat.

Two procedures were utilized during boat electrofishing. The first entailed locating a concentration of fish by echo sounder, at which time the electrofishing boat was positioned upstream of the concentration and the electrodes lowered to a predetermined depth. The system was then activated, and the boat drifted downstream through the fish concentration. The second procedure involved random downstream passes through the study section at predetermined depths. Parameters recorded during each pass included location, time spent electrofishing, and distance of each pass.

Drift Netting

Drift netting provided an alternate method to electrofishing for sampling predetermined depths. The drift net consisted of a gill net panel (2 m deep x 15 m long) suspended from weighted cables and held in position by two boats, one on each side of the net. Mesh sizes utilized included 3.8, 8.9, and 14.0 cm. During the latter part of the study, the panel area was doubled (4 m deep x 15 m long). Sampling procedures followed those outlined for boat electrofishing.

Combination Electrofishing and Drift Netting

Deep-water electrofishing was combined with drift netting in an attempt to capture fish that were stunned by the electric field but did not come to the surface. This was accomplished by positioning the electrodes a short distance ahead of the drift net while sampling.

Set Line

Deep-water set lines (20 hooks/set) were employed for 12 h periods in the intensive sampling site (Figure 2.1). Lines were anchored towards the channel thalweg and anchored to shore. This ensured that a range of depths were sampled by each set line. Hooks were baited with coarsefish collected during electrofishing.

2.4 FISH PROCESSING PROCEDURES

Data collected from all captured fish included species, fork length (mm), and gross morphology. Owing to low numbers of fish collected and the need for contaminant analyses samples, no internal examinations were completed and no ageing structures collected.

2.5 FISH SAMPLING PROCEDURE FOR CONTAMINANT ANALYSIS

During fisheries investigations of the intensive sampling site, fish were collected for contaminant analyses. Fish were processed following the protocol outlined in Schedule B of the Terms of Reference (Appendix A). Intact whole specimens were placed immediately into contaminant-free plastic bags supplied by the Northern River Basins Study. After fish length was measured, each sample was individually labelled with the following information: species, length, date, location, collector's name, and sample number. This information was placed on the sample bag with indelible ink and on a waterproof tag securely fastened to the bag. The fish were then quick-frozen by packing the sample in dry ice.

All samples were kept frozen by placing them in insulated containers. Each container was clearly marked listing its contents, date, location of collection, and collector's name. The samples were promptly shipped to the Standards Development Office of Alberta Environment in Edmonton, Alberta.

3.0 RESULTS AND DISCUSSION

3.1 DISTRIBUTION OF DEEP-WATER AREAS

Deep-water areas (i.e., ≥7.0 m) are distributed throughout the Peace River from Vermilion Chutes to the Alberta-B.C. border (Table 3.1). Map locations of these deep-water areas are presented in Appendix B. The number of deep-water areas in 100 km sections of the river ranged from 11 to 21 (Figure 3.1). Highest densities of deep-water areas were recorded near Fort Vermilion (21 holes/100 km) and near the town of Peace River (20 holes/100 km). The lowest density, 11 holes/100 km, occurred in the Notikewin section of the Peace River. These numbers indicate that deep-water areas are not severely limited and they are evenly distributed throughout the mainstem. As such, potential overwintering sites are widely accessible to fish communities in the system.

Although relatively abundant, deep-water areas do not have uniform depths (Table 3.1). There is a distinct trend towards decreasing depths of deep-water sites from Vermilion Chutes upstream to the Alberta-B.C. border (Figure 3.1). Mean depth of deep areas decreased from 9.6 to 8.0 m. This trend was statistically significant (Linear Regression Analysis, $P<0.001$) with a correlation of $r=0.448$. Maximum depths exhibited the same pattern, averaging 13.0 m in the lowermost section and 10.9 m near the Alberta-B.C border.

3.2 RECONNAISSANCE SURVEY OF POTENTIAL SAMPLING SITES

Prior to conducting the reconnaissance survey, potential intensive sampling sites were identified from existing information gathered during 1988 and 1989 surveys completed by R.L. & L. Environmental Services Ltd. Three areas were selected for the reconnaissance survey (Figure 1.1); one area near Many Islands, a second area near Notikewin Provincial Park, and a third location near the settlement of Carcajou.

Many Islands Area

Five deep-water sites were investigated in the Many Islands area (Table 3.2, Figure 3.2). Deep-water sites in this section were generally limited both in size and depth. None of the sites exceeded 40 ha in surface area (range 12-40 ha), and only one exceeded 9.0 m in depth (range 6.2 - 14.0 m). Bottom morphology was non uniform and consisted primarily of cobble, boulder, or bedrock. Bottom irregularities were most apparent at Site 2, which was adjacent to a large bedrock outcropping. This site also contained the highest apparent number of fish of any of the locations surveyed in the Many Islands area.

Table 3.1 Distribution of deep-water sites in the Peace River from Vermilion Chutes to the Alberta - B.C. border.

Reach	Section	Sample Number	Maximum Depth (m)	Position in Mainstem	NTS Map Number	Latitude	Longitude	Kilometre Location
Lower	Fort Vermilion	1	9.4	Thalweg	84K	58° 23' 51"	116° 4' 45"	416
	(Km 400-499)	2	7.0	Thalweg	84K	58° 24' 3"	116° 6' 45"	417
		3	9.7	Thalweg	84K	58° 24' 19"	116° 8' 45"	419
		4	9.1	Thalweg	84K	58° 22' 50"	116° 13' 0"	424
		5	7.9	Thalweg	84K	58° 22' 14"	116° 13' 0"	425
		6	12.4	Thalweg	84K	58° 18' 51"	116° 22' 0"	435
		7	9.4	Thalweg	84K	58° 14' 56"	116° 27' 8"	446
		8	13.0	Thalweg	84K	58° 17' 18"	116° 29' 8"	453
		9	12.1	Thalweg	84K	58° 17' 50"	116° 31' 30"	458
		10	9.7	Thalweg	84K	58° 16' 13"	116° 37' 30"	466
		11	7.9	Thalweg	84K	58° 15' 41"	116° 40' 53"	468
		12	8.5	Thalweg	84K	58° 13' 39"	116° 40' 53"	476
		13	11.5	Thalweg	84K	58° 14' 44"	116° 35' 38"	478
		14	7.6	Thalweg	84K	58° 14' 11"	116° 35' 38"	480
		15	10.6	Thalweg	84K	58° 10' 8"	116° 36' 30"	490
		16	8.8	Thalweg	84K	58° 9' 44"	116° 35' 15"	491
		17	7.6	Thalweg	84K	58° 9' 11"	116° 33' 38"	493
		18	10.6	Thalweg	84K	58° 8' 39"	116° 33' 0"	494
		19	9.7	Thalweg	84K	58° 8' 14"	116° 32' 45"	495
		20	9.1	Thalweg	84K	58° 7' 42"	116° 32' 45"	496
	Carcajou	21	8.2	Thalweg	84K	58° 5' 41"	116° 44' 0"	512
	(Km 500-599)	22	7.3	Thalweg	84K	58° 5' 41"	116° 46' 0"	513
		23	9.7	Thalweg	84K	58° 5' 30"	116° 47' 30"	514
		24	9.4	Thalweg	84K	58° 4' 52"	116° 56' 45"	526
		25	9.1	Thalweg	84K	58° 3' 14"	117° 2' 45"	534
		26	7.6	Thalweg	84J	58° 0' 57"	117° 6' 53"	538
		27	12.1	Thalweg	84F	57° 51' 5"	117° 2' 8"	561
		28	13.3	Thalweg	84F	57° 50' 49"	117° 1' 30"	562
		29	11.8	Thalweg	84F	57° 50' 25"	117° 1' 30"	563
		30	9.1	Thalweg	84F	57° 50' 4"	117° 1' 38"	563
		31	9.7	Thalweg	84F	57° 47' 5"	117° 5' 30"	575
		32	10.0	Thalweg	84F	57° 45' 8"	117° 0' 23"	582
		33	9.0	Thalweg	84F	57° 41' 33"	117° 3' 0"	597
	Notikewin	34	7.9	Thalweg	84F	57° 33' 27"	117° 55' 45"	621
	(Km 600-699)	35	11.5	Thalweg	84F	57° 21' 53"	117° 7' 30"	656
		36	9.1	Thalweg	84F	57° 21' 33"	117° 7' 53"	657
		37	9.4	Thalweg	84F	57° 17' 2"	117° 6' 45"	666
		38	7.9	Thalweg	84F	57° 13' 47"	117° 5' 45"	674
		39	7.9	Thalweg	84F	57° 13' 2"	117° 6' 0"	675
		40	10.3	Thalweg	84F	57° 9' 44"	117° 5' 38"	681
		41	10.6	Thalweg	84F	57° 9' 16"	117° 5' 45"	682
		42	8.2	Thalweg	84F	57° 8' 51"	117° 6' 15"	683
		43	7.0	Thalweg	84F	57° 8' 7"	117° 10' 0"	686
		44	8.2	Thalweg	84F	57° 7' 26"	117° 15' 21"	691
	Peace River	45	9.1	Thalweg	84F	57° 5' 41"	117° 11' 0"	700
	(Km 700-799)	46	10.9	Thalweg	84F	57° 4' 11"	117° 11' 53"	704
		47	8.2	Thalweg	84C	57° 1' 25"	117° 13' 8"	711
		48	8.8	Thalweg	84C	56° 58' 2"	117° 14' 15"	716
		49	8.5	Thalweg	84C	56° 55' 49"	117° 15' 45"	719
		50	8.8	Thalweg	84C	56° 52' 38"	117° 17' 38"	726
		51	7.3	Thalweg	84C	56° 51' 1"	117° 17' 23"	733
		52	7.9	Thalweg	84C	56° 48' 14"	117° 17' 23"	740
		53	7.3	Thalweg	84C	56° 47' 38"	117° 17' 0"	741
		54	7.3	Thalweg	84C	56° 47' 22"	117° 15' 38"	743
		55	8.5	Thalweg	84C	56° 43' 47"	117° 10' 30"	753
		56	7.6	Thalweg	84C	56° 39' 40"	117° 10' 0"	765
		57	8.5	Thalweg	84C	56° 35' 8"	117° 8' 45"	774
		58	11.2	Thalweg	84C	56° 34' 44"	117° 8' 0"	777
		59	8.8	Thalweg	84C	56° 34' 44"	117° 7' 0"	778
		60	7.6	Thalweg	84C	56° 34' 28"	117° 5' 8"	779
		61	7.9	Thalweg	84C	56° 32' 18"	117° 5' 30"	783
		62	7.0	Thalweg	84C	56° 30' 25"	117° 5' 51"	786
		63	7.6	Thalweg	84C	56° 27' 42"	117° 6' 30"	791
		64	8.5	Thalweg	84C	56° 27' 18"	117° 6' 45"	792
		65	8.5	Thalweg	84C	56° 24' 23"	117° 9' 53"	795

Continued ...

Table 3.1 Concluded.

Reach	Section	Sample Number	Maximum Depth (m)	Position in Mainstem	NTS Map Number	Latitude	Longitude	Kilometre Location
Upper	Dunvegan	66	7.0	Thalweg	84C	56° 22' 34"	117° 10' 0"	802
	(Km 800-899)	67	7.3	Thalweg	84C	56° 21' 33"	117° 11' 30"	803
		68	7.4	Thalweg	84C	56° 21' 1"	117° 12' 8"	804
		69	9.1	Thalweg	84C	56° 14' 40"	117° 18' 38"	819
		70	7.3	Thalweg	83N	55° 59' 56"	117° 46' 23"	859
		71	7.3	Thalweg	83N	55° 57' 10"	117° 51' 38"	872
		72	7.3	Thalweg	83M	55° 55' 0"	118° 2' 38"	877
		73	7.0	Thalweg	83M	55° 55' 16"	118° 10' 38"	888
		74	10.0	Thalweg	83M	55° 55' 4"	118° 14' 30"	890
		75	9.1	Thalweg	83M	55° 54' 19"	118° 21' 30"	897
		76	7.3	Thalweg	83M	55° 54' 11"	118° 22' 0"	898
		77	7.9	Thalweg	83M	55° 54' 32"	118° 24' 15"	899
		78	7.0	Thalweg	83M	55° 54' 32"	118° 24' 45"	899
	Many Islands	79	7.6	Thalweg	83M	55° 54' 7"	118° 29' 15"	905
	(Km 900-999)	80	7.0	Thalweg	83M	55° 0' 20"	118° 33' 23"	910
		81	7.9	Thalweg	83M	55° 0' 28"	118° 38' 38"	915
		82	7.0	Thalweg	83M	55° 56' 33"	118° 45' 38"	919
		83	8.5	Thalweg	84D	56° 0' 44"	118° 49' 30"	930
		84	10.9	Thalweg	84D	56° 1' 49"	118° 52' 8"	934
		85	7.0	Thalweg	84D	56° 1' 46"	118° 53' 8"	935
		86	7.6	Thalweg	84D	56° 5' 37"	118° 53' 30"	943
		87	7.6	Thalweg	84D	56° 13' 55"	118° 57' 45"	959
		88	9.5	Backwater	84D	56° 16' 1"	119° 2' 38"	968
		89	7.3	Backwater	84D	56° 17' 10"	119° 6' 8"	972
		90	9.5	Backwater	84D	56° 18' 7"	119° 8' 23"	973
		91	8.2	Thalweg	84D	56° 17' 58"	119° 11' 53"	981
		92	7.3	Thalweg	84D	56° 17' 1"	119° 16' 23"	985
		93	7.9	Thalweg	84D	56° 16' 5"	119° 17' 53"	988
		94	7.6	Thalweg	84D	56° 14' 11"	119° 25' 0"	996
		95	7.6	Thalweg	84D	56° 13' 51"	119° 29' 0"	999

A qualitative assessment of fish concentrations in the Many Islands area suggests that fish densities were generally low at most sites investigated (Table 3.2). Despite these limited concentrations, fish densities within the deep-water sites were much higher relative to "normal" river habitat in the immediate vicinity. Sonar readings suggest that most fish were in the small to medium size-class, with few large individuals encountered. Fish distributions in the deep-water sites were restricted to the margins of the deep-water zone. Most individuals were recorded by sonar suspended at depths between 2.0 and 3.5 m. Also, fish were most often associated with locations exhibiting an irregular bottom (i.e., bedrock or boulder outcropping).

Notikewin Area

Four deep-water sites were surveyed in the Notikewin area (Table 3.2, Figure 3.3). Size and depth of surveyed sites were greater than those observed in the Many Islands area. Sites ranged between 40 and 98 ha in size and were between 8.7 and 11.5 m in depth. Similar to observations made at Many Islands, the bottom morphology was quite irregular, which indicated the presence of boulders or bedrock fractures.

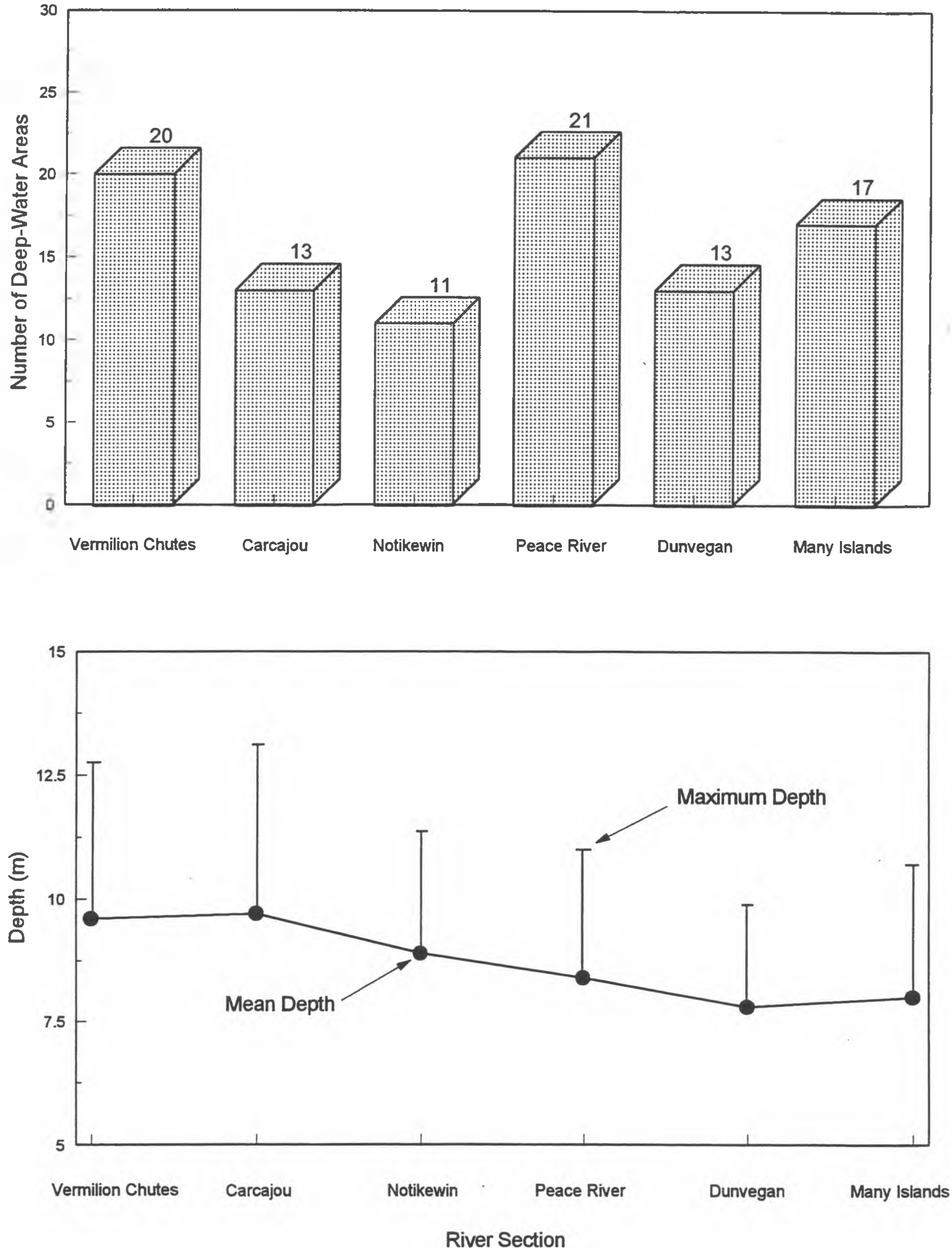


Figure 3.1. Number and depth of deep-water areas in 100 km sections of the Peace River from Vermilion Chutes to the Alberta - B.C. border.

Table 3.2 Biophysical characteristics of deep-water sites investigated during reconnaissance of the Peace River, October 1992.

Parameter	Many Island Sites					Notikewin Sites				Carcajou Sites	
	1	2	3	4	5	1	2	3	4	1	2
Maximum Depth (m)	14.0	9.0	7.5	6.2	7.1	11.5	9.3	8.7	10.3	13.0	11.3
Area (ha)	40	15	23	21	12	75	34	50	91	160	120
Dominant Substrate	Cobble/Boulder	Boulder	Gravel/Cobble	Gravel/Cobble	Gravel/Cobble	Cobble/Boulder	Gravel/Cobble	Cobble/Boulder	Gravel	Boulder	Boulder
Bottom Morphology	Rough	Rough	Non uniform	Non uniform	Non uniform	Rough	Non uniform	Rough	Non uniform	Rough	Rough
Fish Concentrations	Low	High	Low	Moderate	Low	High	Low	Moderate	Low	High	High
Fish Size[a]	Medium	Medium	Small	Small	Small	Large	Small	Small	Small	Medium	Medium

[a] Size designations: Small: $\leq$10 cm, Medium: $>$10 cm and $<$30 cm, Large: $\geq$30 cm

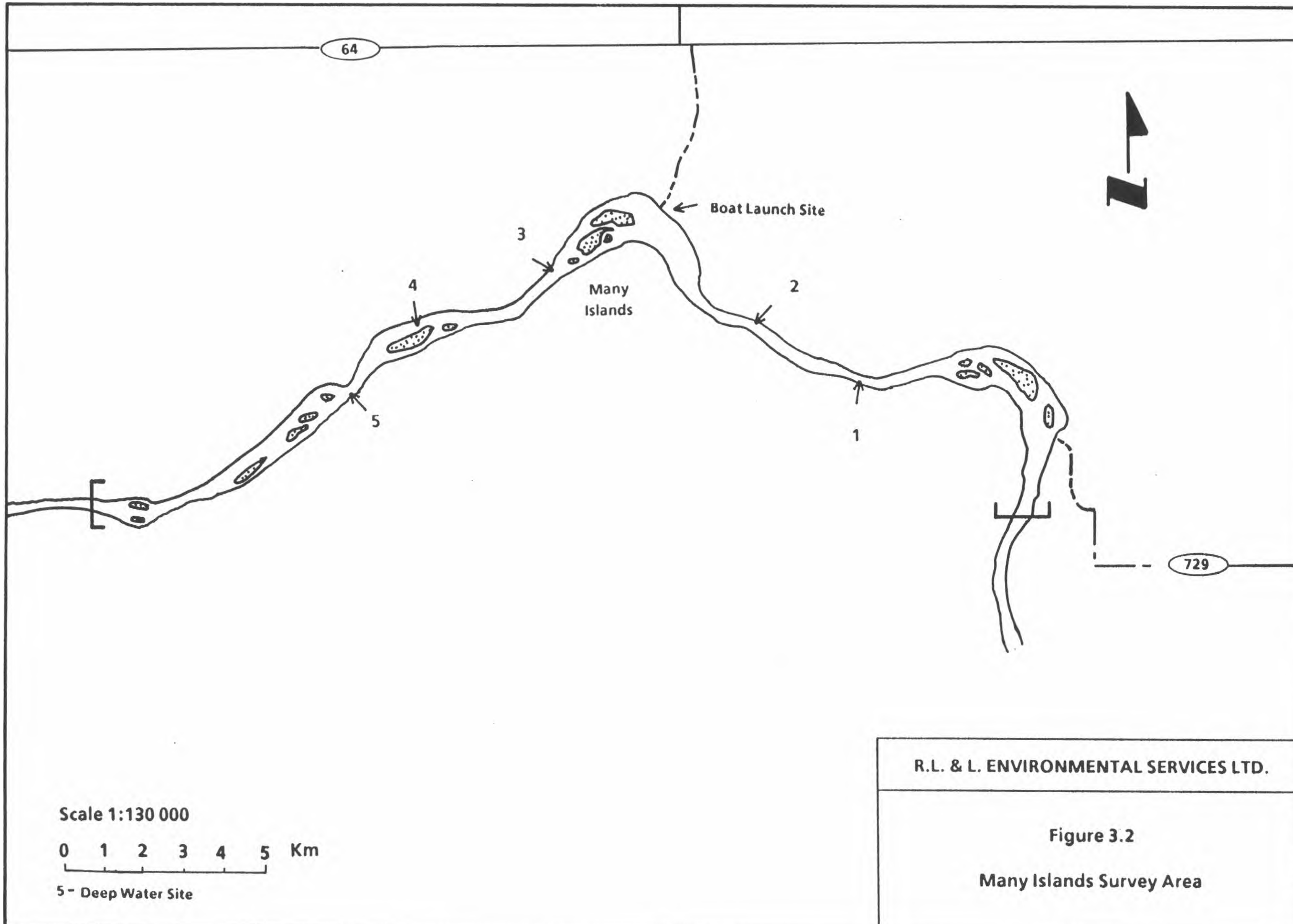


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Figure 3.2

Many Islands Survey Area

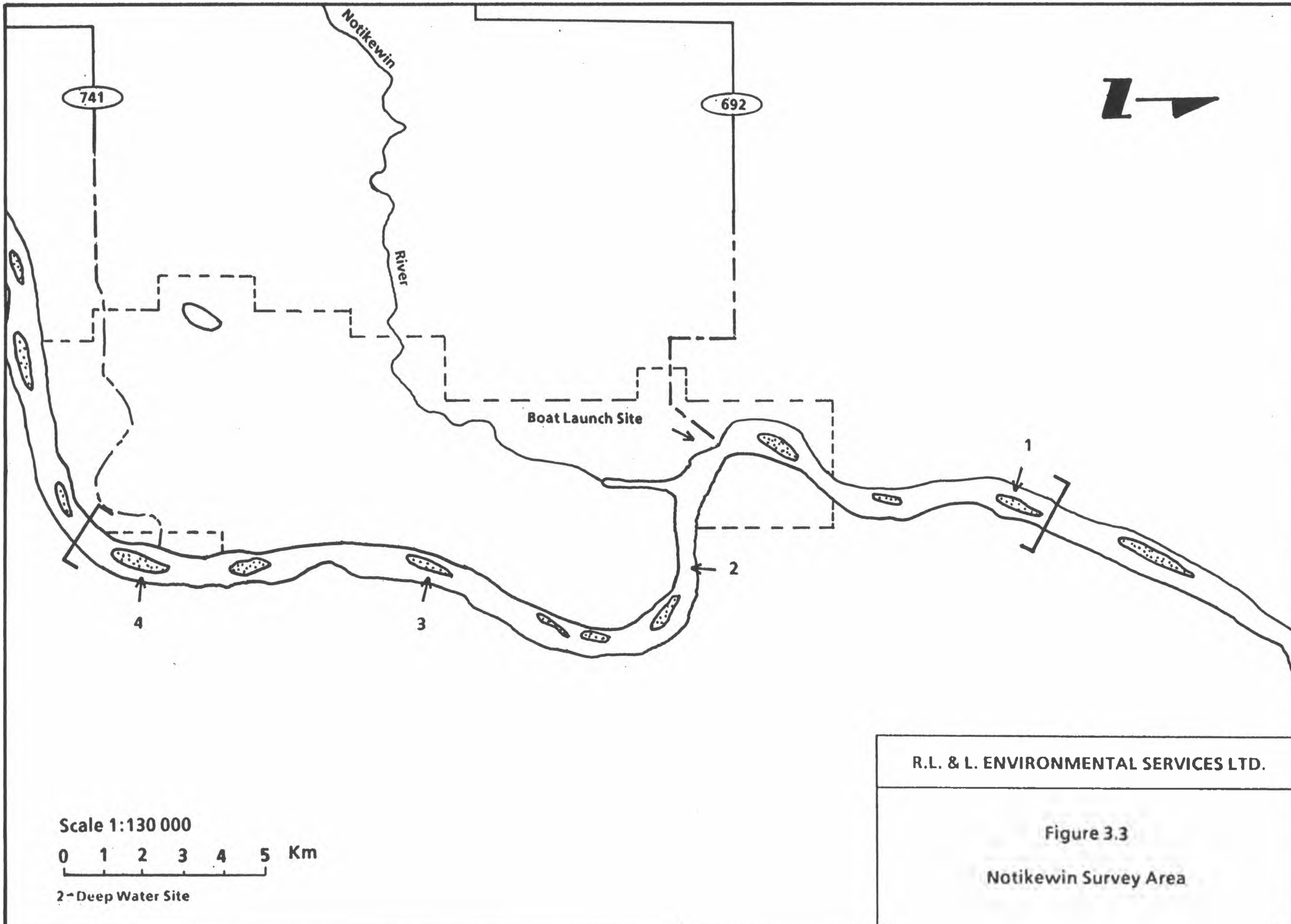

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Figure 3.3

Notikewin Survey Area

Sonar readings indicated that fish were concentrated in deep-water areas relative to "normal" habitat in the immediate vicinity. Fish densities were moderate to low at most sites, and most fish were small to medium in size. An exception occurred at Site 1, which is located downstream of the confluence of Notikewin River. Sonar indicated the presence of high densities of large fish at this site. Fish were suspended at water depths between 2.0 and 3.5 m and were distributed along the margins of deep-water zones. Many individuals also were associated with some form of bottom irregularity.

Carcajou Area

Two deep-water sites were investigated near the settlement of Carcajou (Table 3.2, Figure 3.4). They included large meanders at the confluences of Buffalo and Wolverine rivers. These sites were extensive (i.e.,230 and 160 ha in size, respectively) and relatively deep, with maximum depths of 13.0 m recorded at Site 1 and 11.2 m at Site 2. Bottom morphology was irregular in the thalweg of these sites, indicating the presence of large boulders or bedrock outcroppings.

Large concentrations of fish were recorded at both sites. Similar to the two previous river sections examined, fish were characteristically distributed along the margins of deep-water zones, suspended in 2.5 to 4.0 m depths and associated with some form of bottom irregularity.

3.3 INTENSIVE SAMPLING OF DEEP-WATER SITE

One deep-water site was intensively sampled during October 1992; the Wolverine River Intensive Sampling Site that is located near the settlement of Carcajou (Figure 1.1).

3.3.1 Habitat

Site Location and Water Surface Elevation

Site location and water surface elevation was recorded to allow evaluation of conditions at this site at a different date. The benchmark (TBM), which consisted of a 25 cm long spike driven into the base of a tree, situated on the left upstream bank at the upper end of the site, was located at UTM coordinates 11 499789; V 6399663 (Figure 2.1). Water surface elevation, relative to the TBM, was 8.49 m on 20 October, 1993.

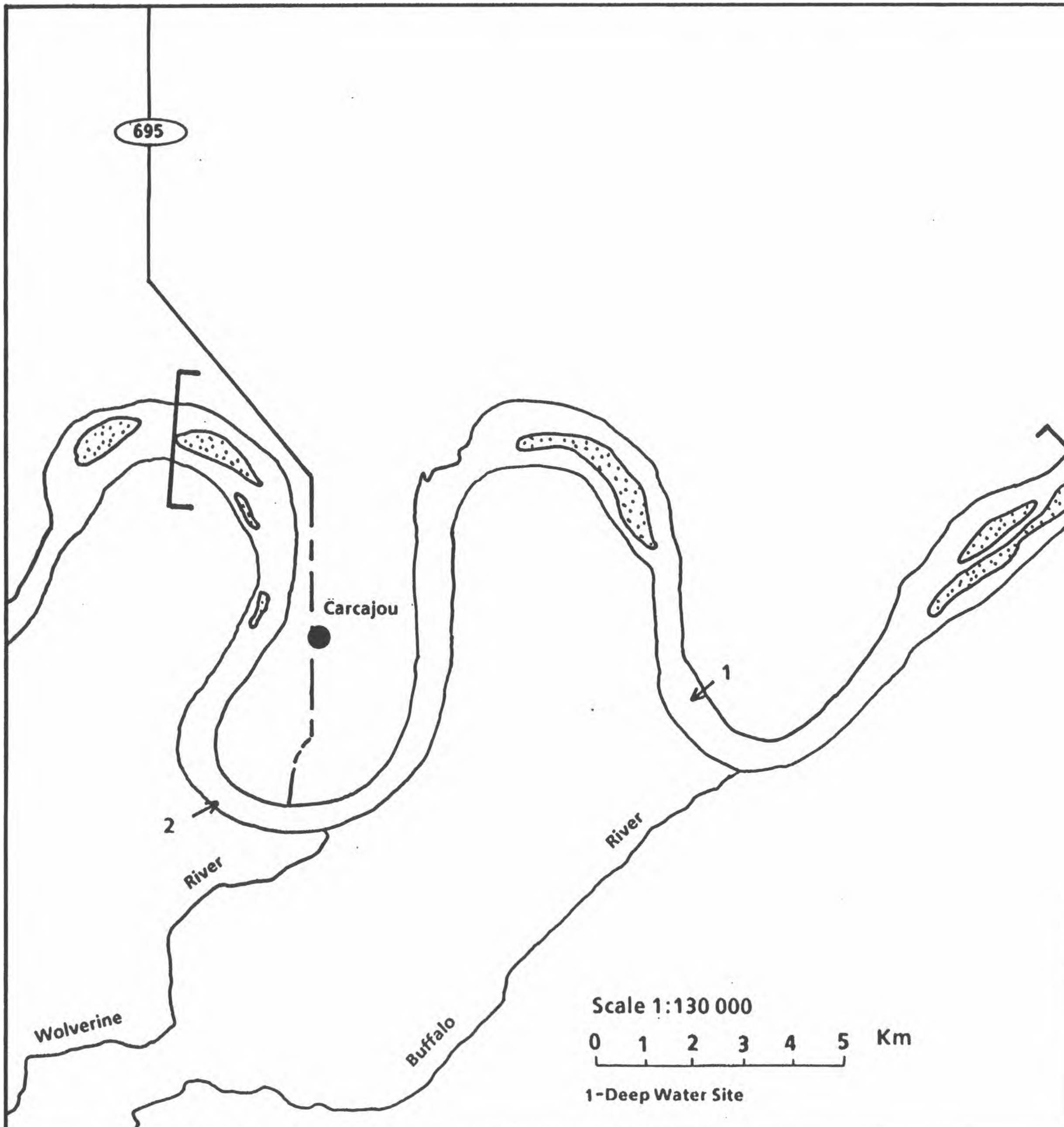

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Figure 3.4

Carcajou Survey Area

Depth Contours, Bottom Morphology, and Substrate Composition

The greatest water depth encountered at the Wolverine River site was 11.3 m, and was located near the centre of the site (Figure 3.5). The portion of river that exceeded 7.0 m in depth was approximately 33 ha, or 20% of the area of the intensive sampling site. This deep area extended for approximately 2.95 km.

Bottom morphology at this site was irregular, as illustrated by echo sounding depth profiles in Figure 3.6. Bedrock outcroppings and/or large boulders are most likely the reason for this non uniform bottom. The site was dominated by this substrate type, particularly at depths greater than 3.0 m. At shallower depths, echo tracings indicate a more uniform bottom morphology, with substrate likely dominated by cobble to gravel sized substrate. The absence of diffuse echo recordings suggest that fine substrates such as sand and silt were not abundant in the deep-water zone of this site.

Water Velocity, Dissolved Oxygen, and Temperature Profiles

Water velocities at all five sampling stations were high, ranging between 0.5 and 1.9 m/s (Figure 3.7). These high values were not unexpected because they were obtained from the unobstructed water column within the main channel. Information from the literature suggests that these velocities exceed the critical maintenance velocity for many freshwater fish species (Bainbridge 1960; Fry and Cox 1970; Jones et al. 1974). As a result, fish probably would not utilize these open-water locations as holding sites. It is more likely that individuals would position themselves adjacent to bottom obstructions or along the edge of the thalweg; locations that characteristically exhibit low velocities.

Dissolved oxygen and water temperature readings did not vary extensively (Figure 3.8). Temperatures remained at approximately 2.5 °C, while dissolved oxygen ranged from 13.5 to 15.5 mg/L. As expected for a riverine environment, complete mixing occurs within the water column.

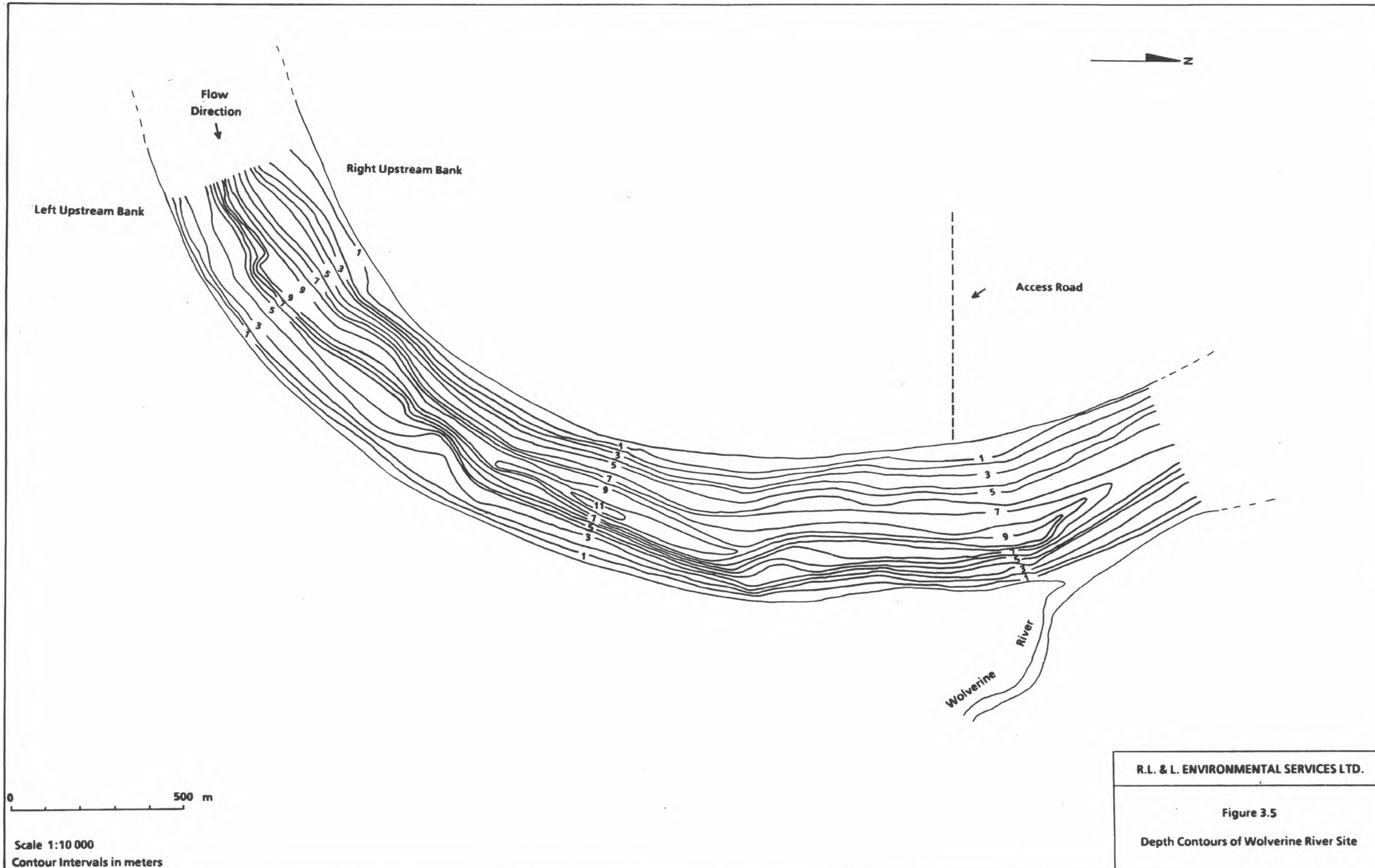

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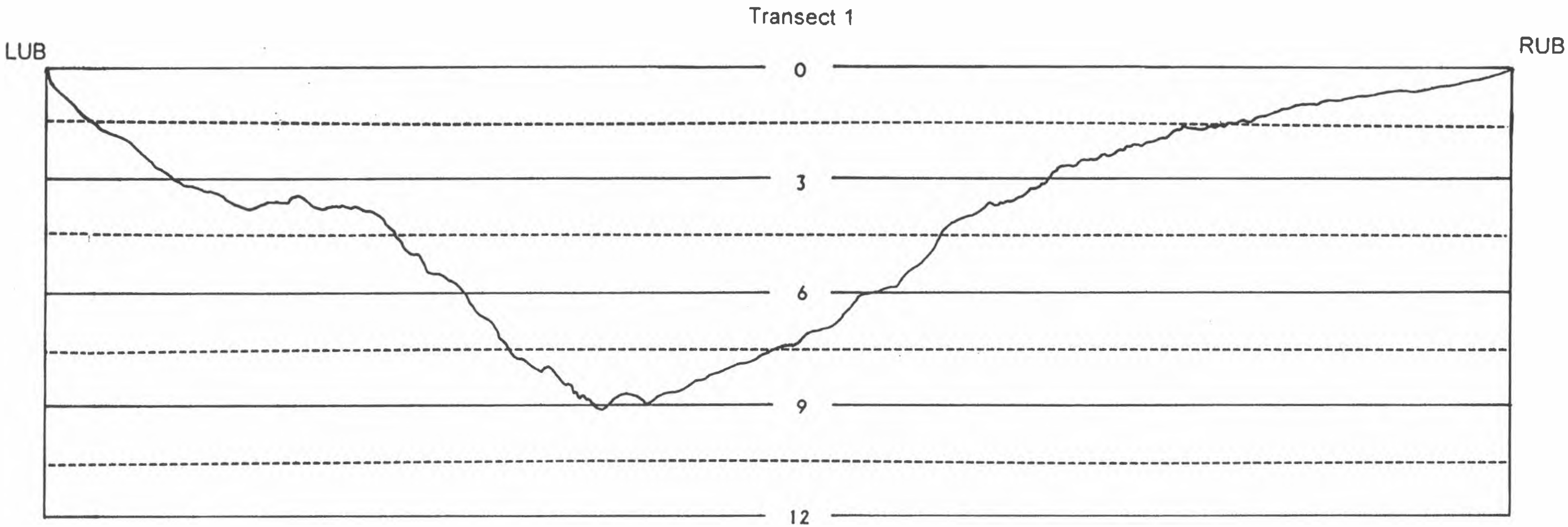
Figure 3.5

Depth Contours of Wolverine River Site



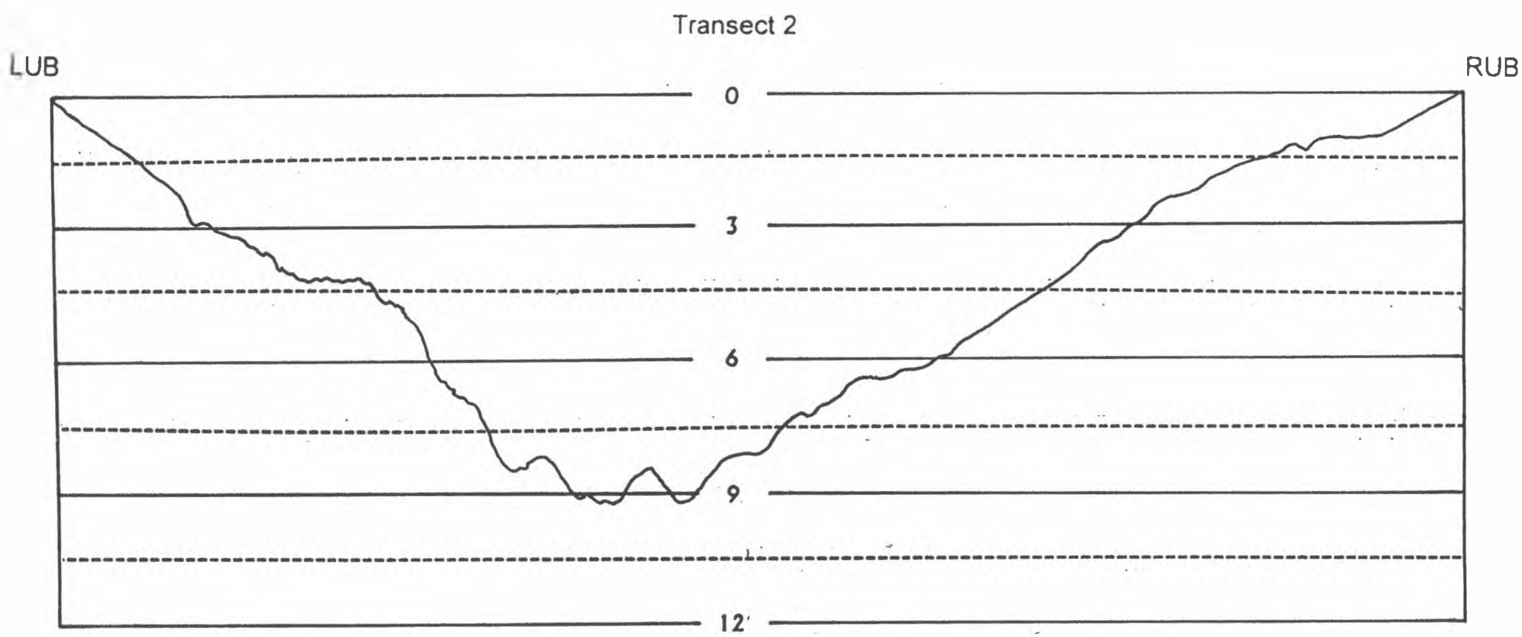
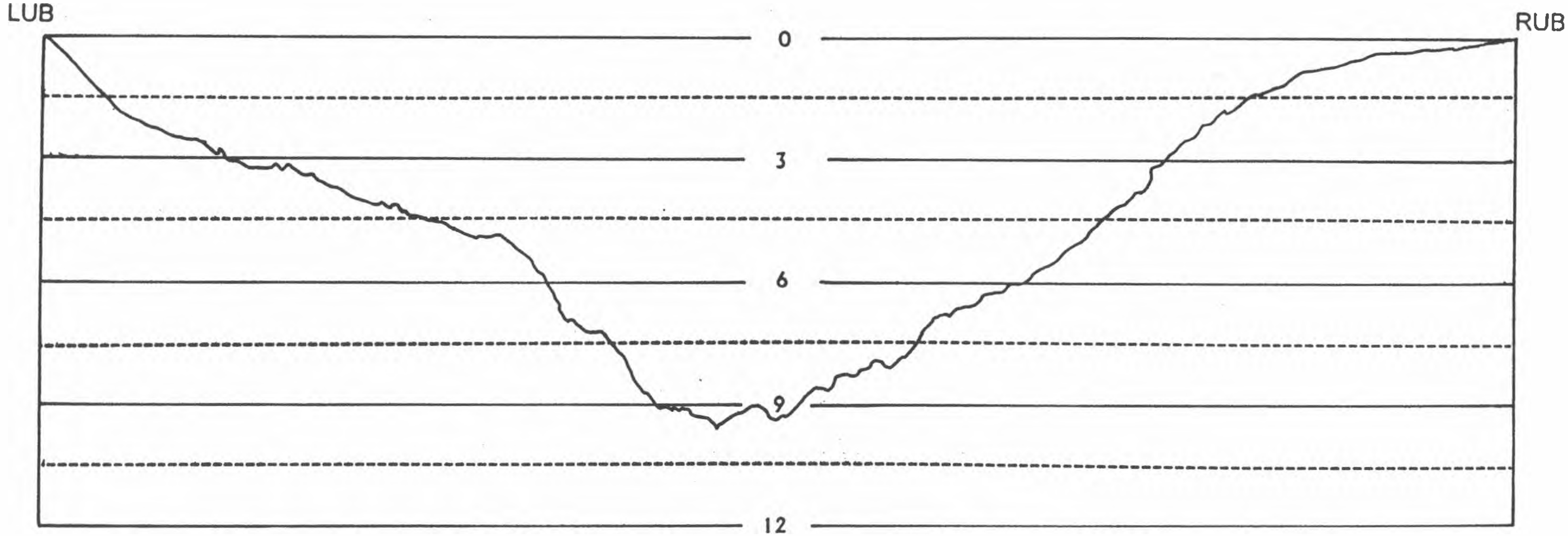


Figure 3.6 Depth profiles (m) for echo sounding transects 1-10 at the Wolverine River intensive sampling site, October 1992.

Transect 3



Transect 4

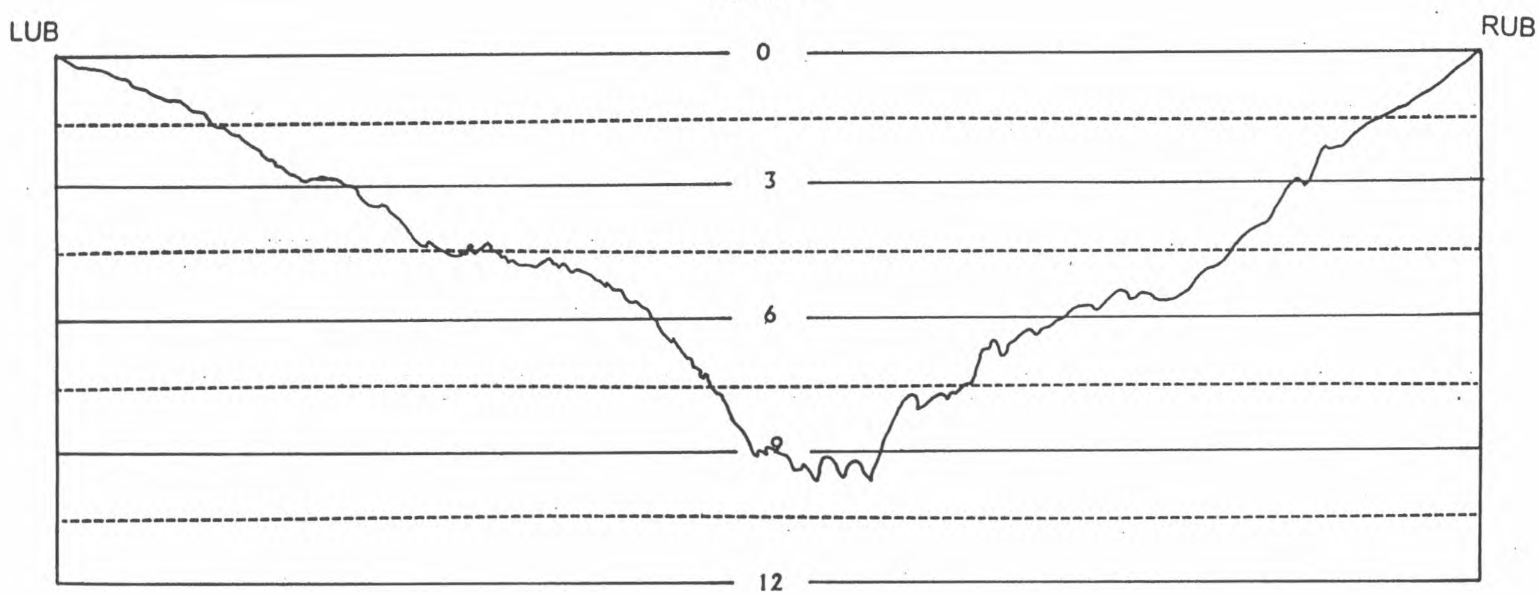
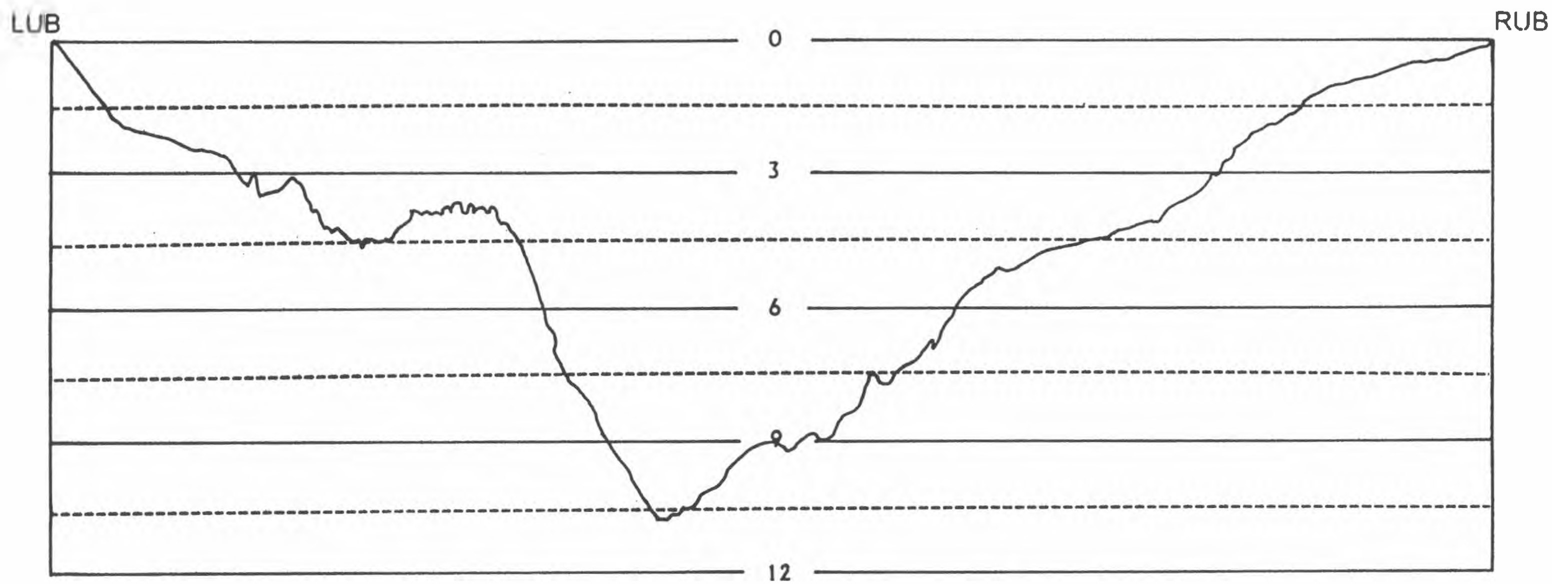
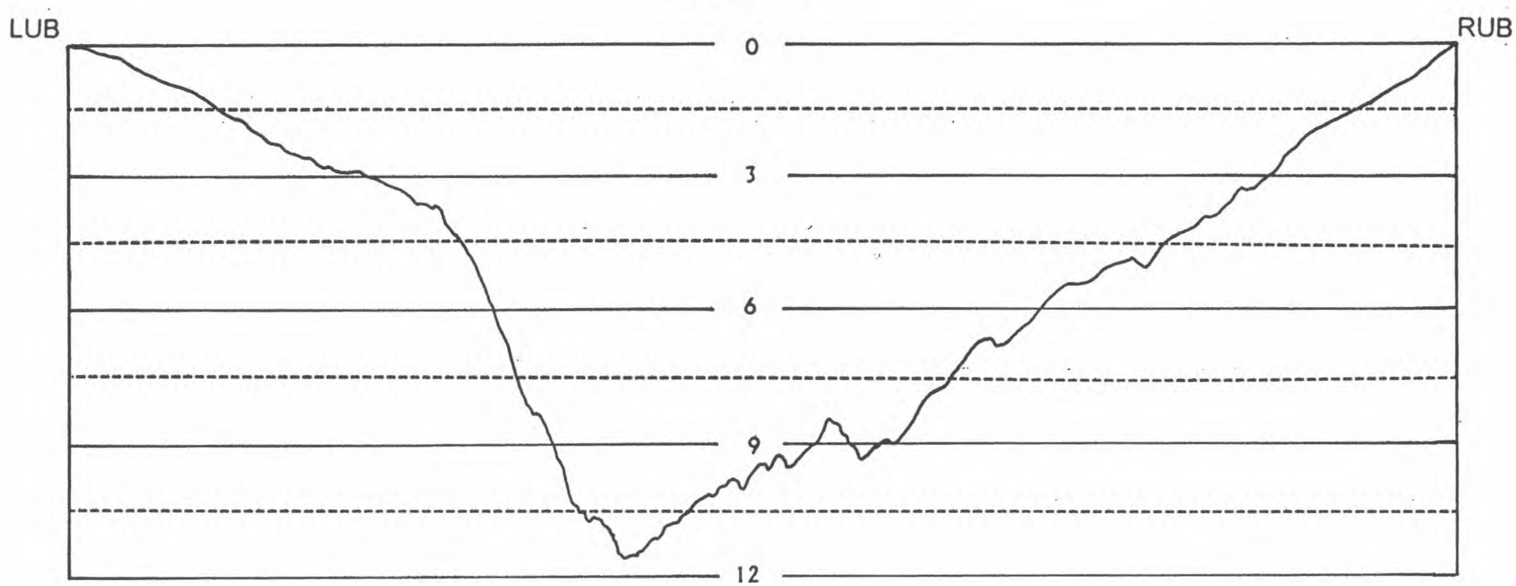


Figure 3.6 Continued.

Transect 5



Transect 6



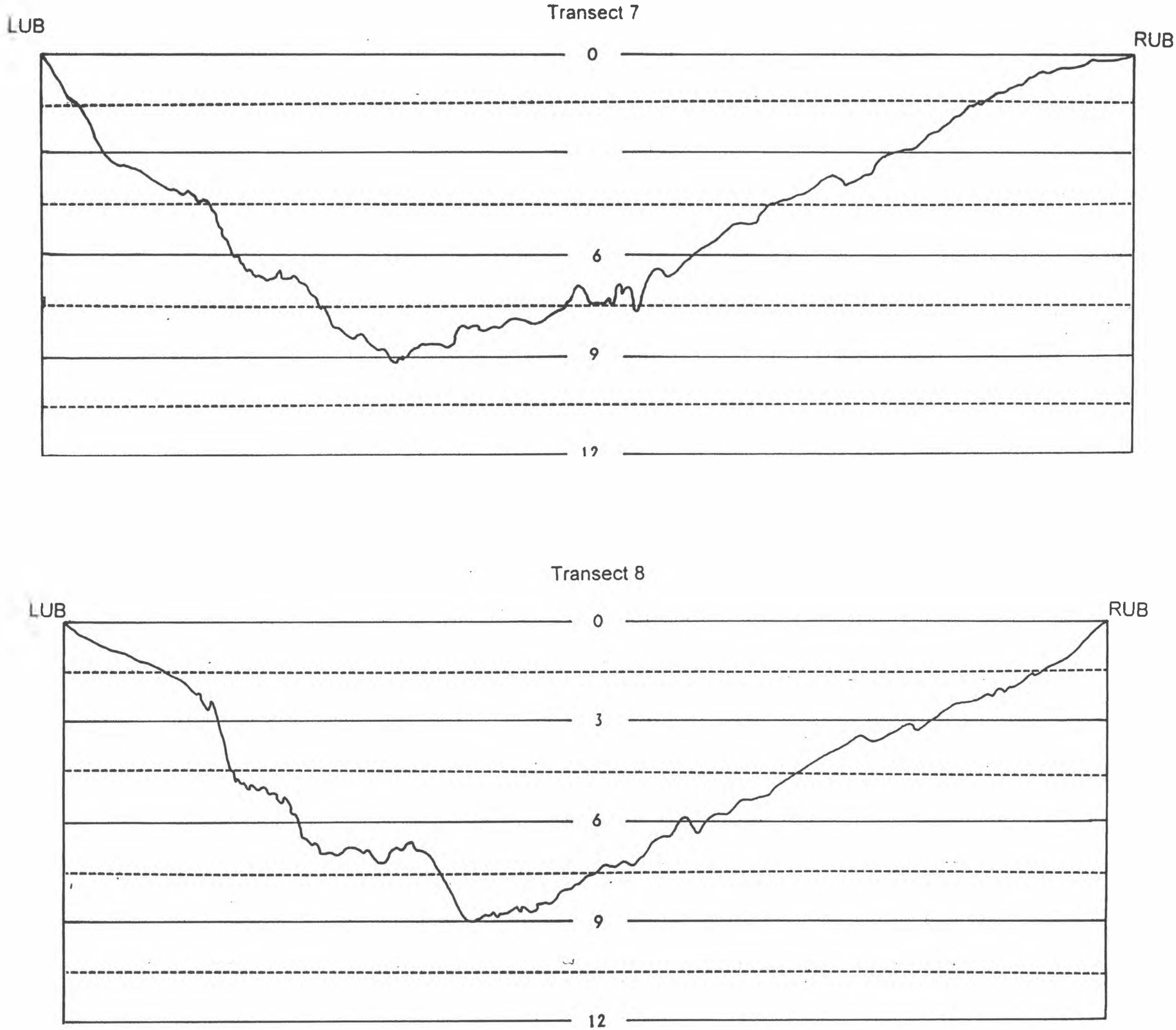


Figure 3.6 Continued.

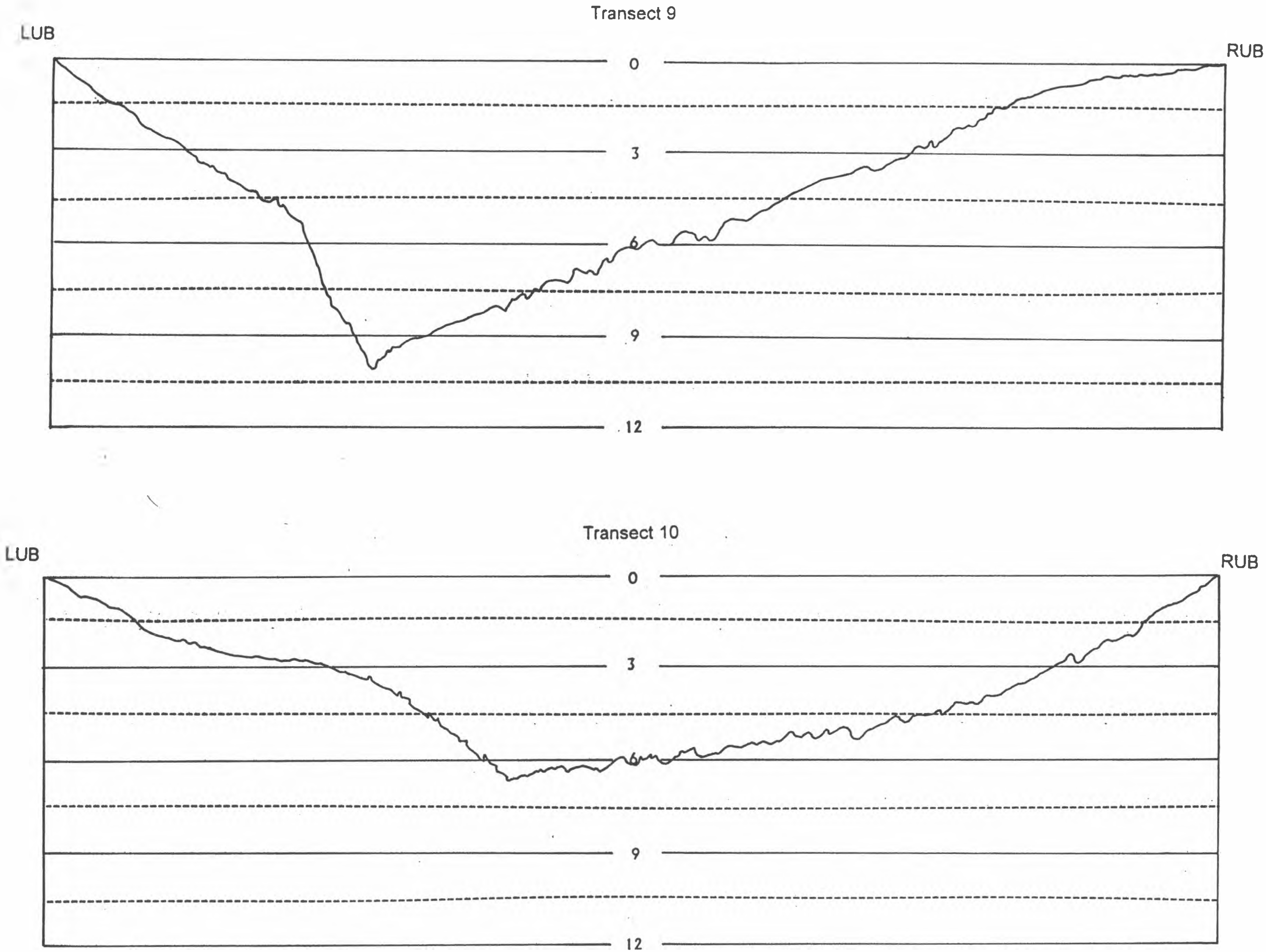


Figure 3.6 Concluded.

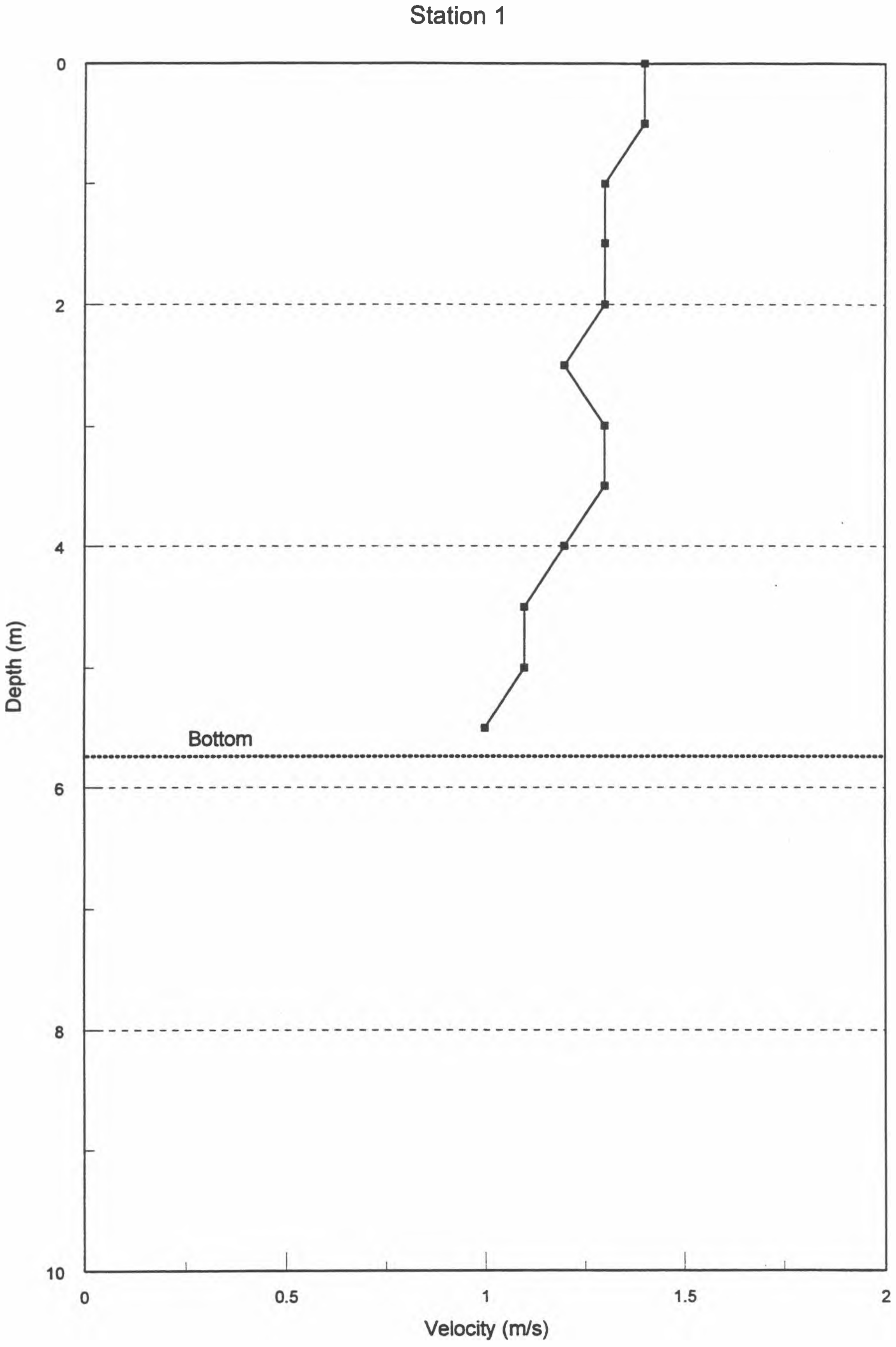


Figure 3.7 Velocity profiles at sampling stations at the Wolverine River Intensive Sampling Site, October 1992.

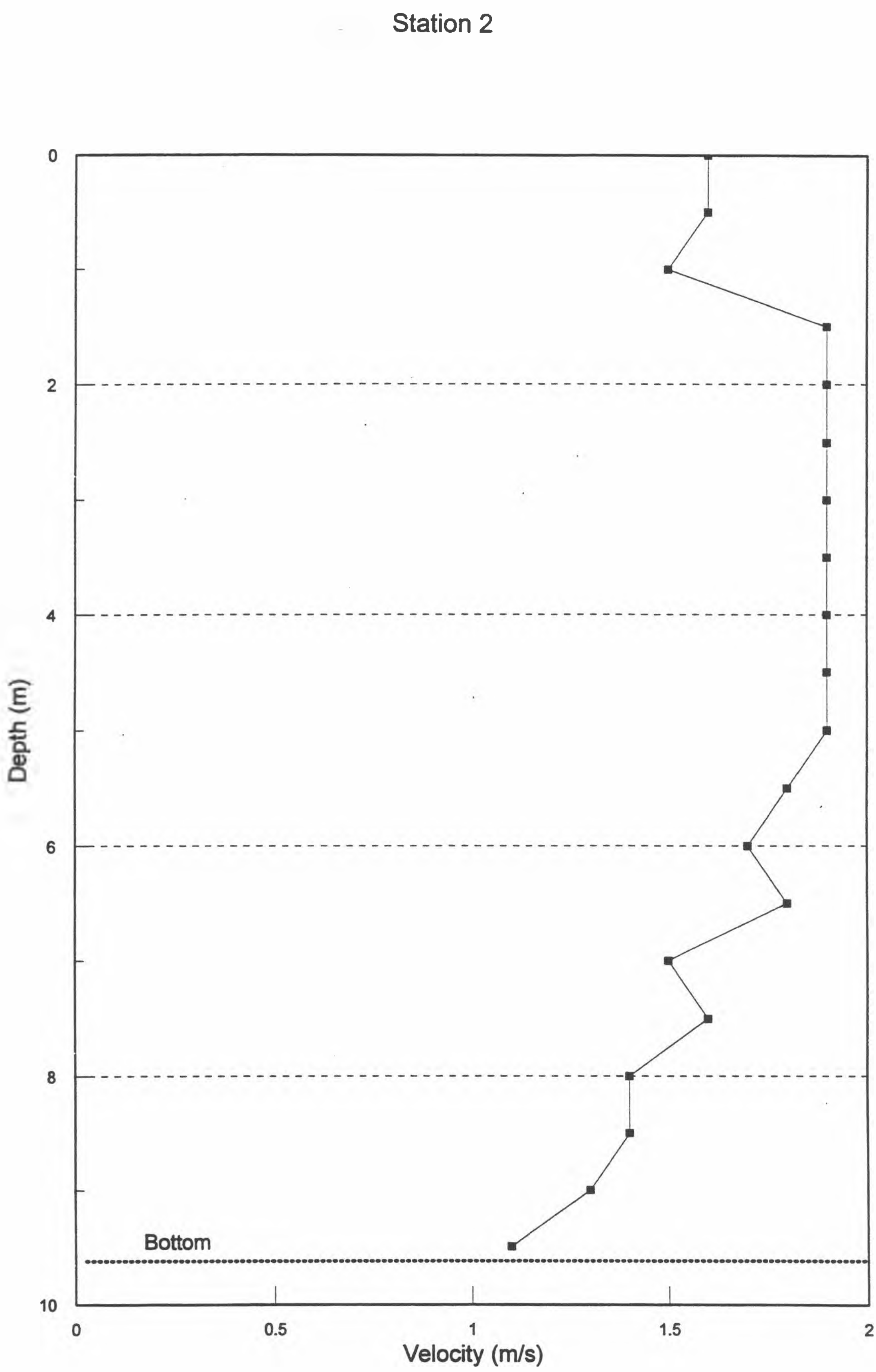


Figure 3.7 continued..

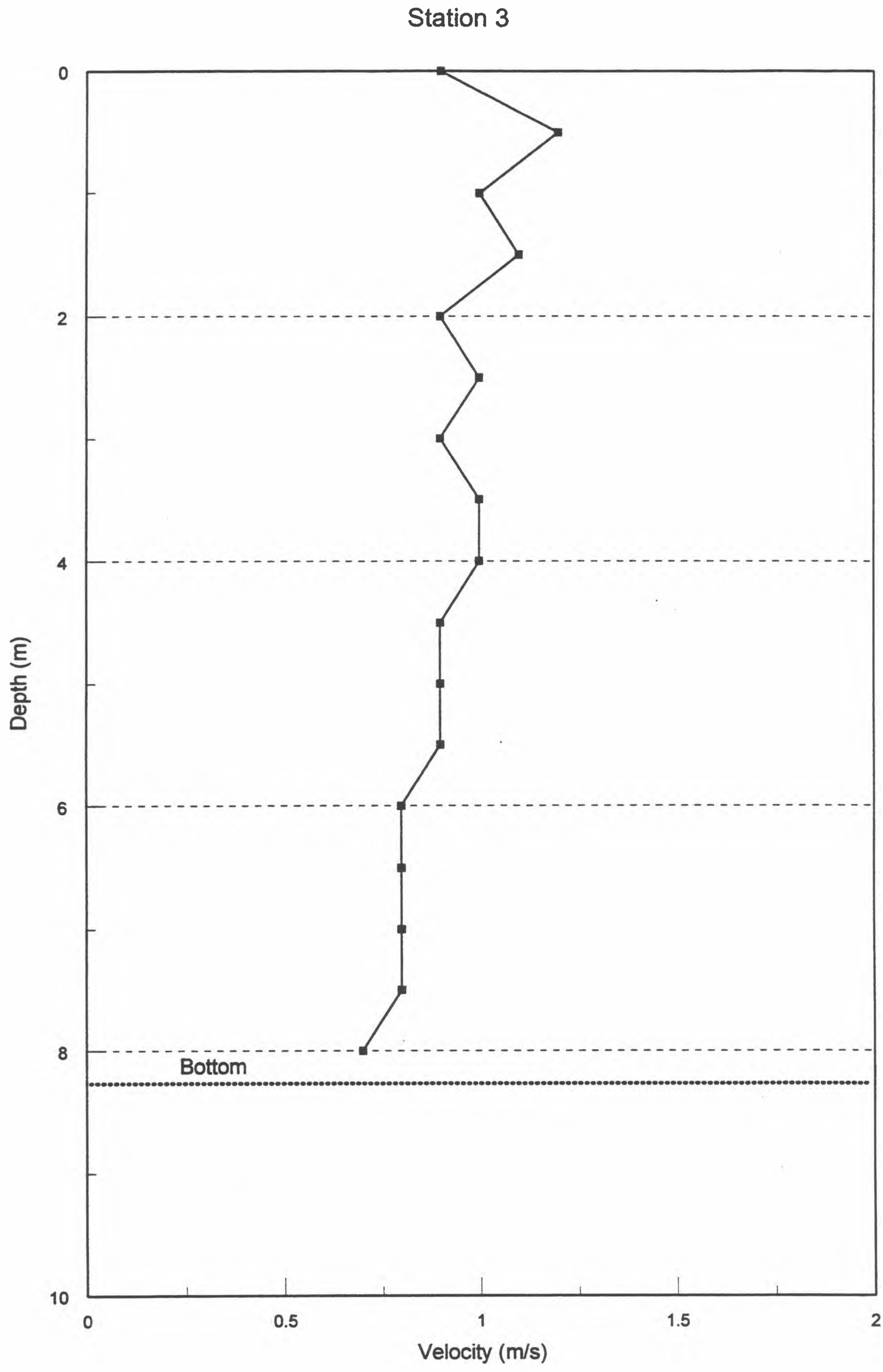


Figure 3.7 continued..

Station 4

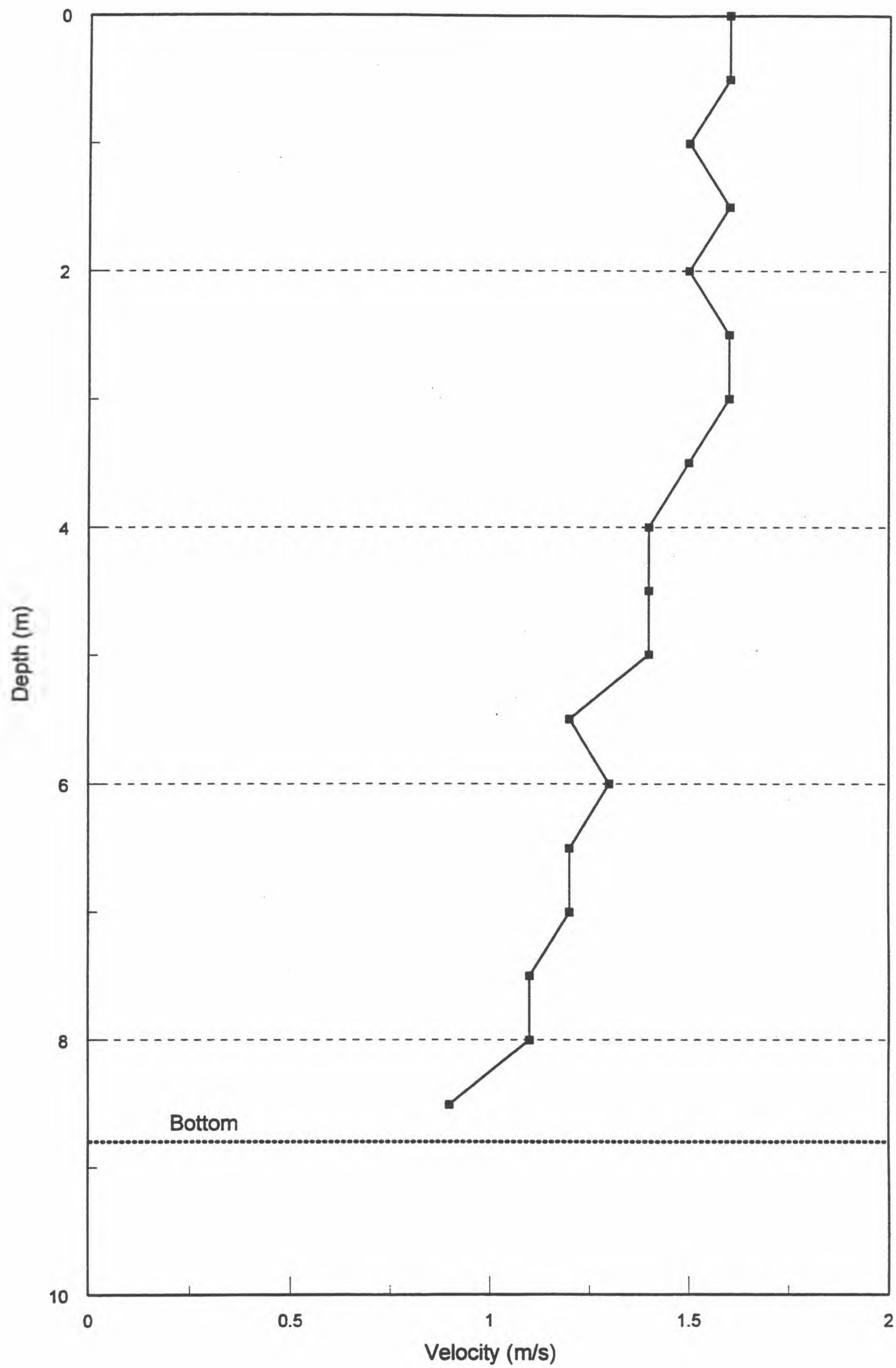


Figure 3.7 continued..

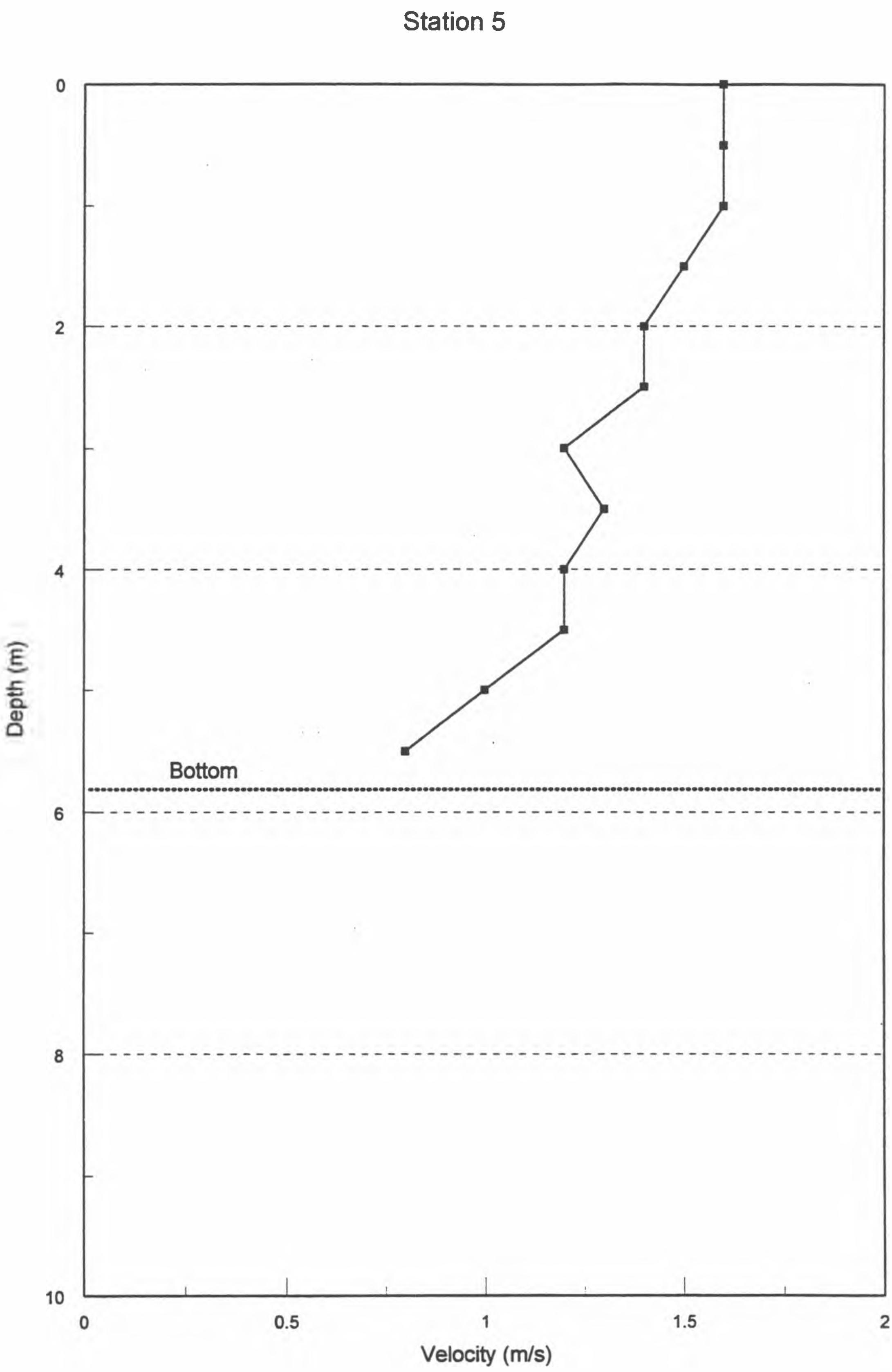


Figure 3.7 concluded.

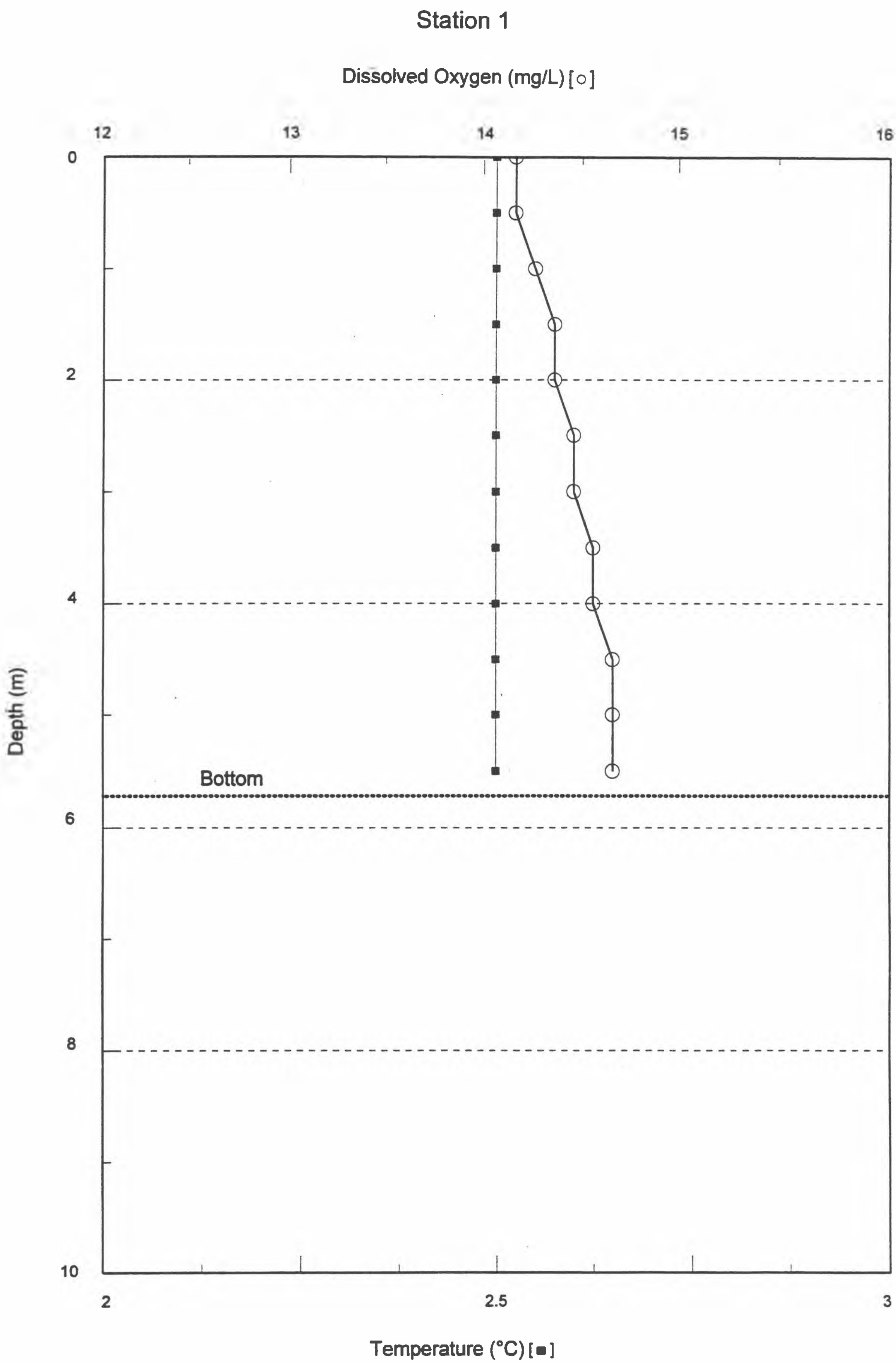


Figure 3.8 Dissolved oxygen and temperature profile at sampling stations at the Wolverine River Intensive Sampling Site, October 1992.

Station 2

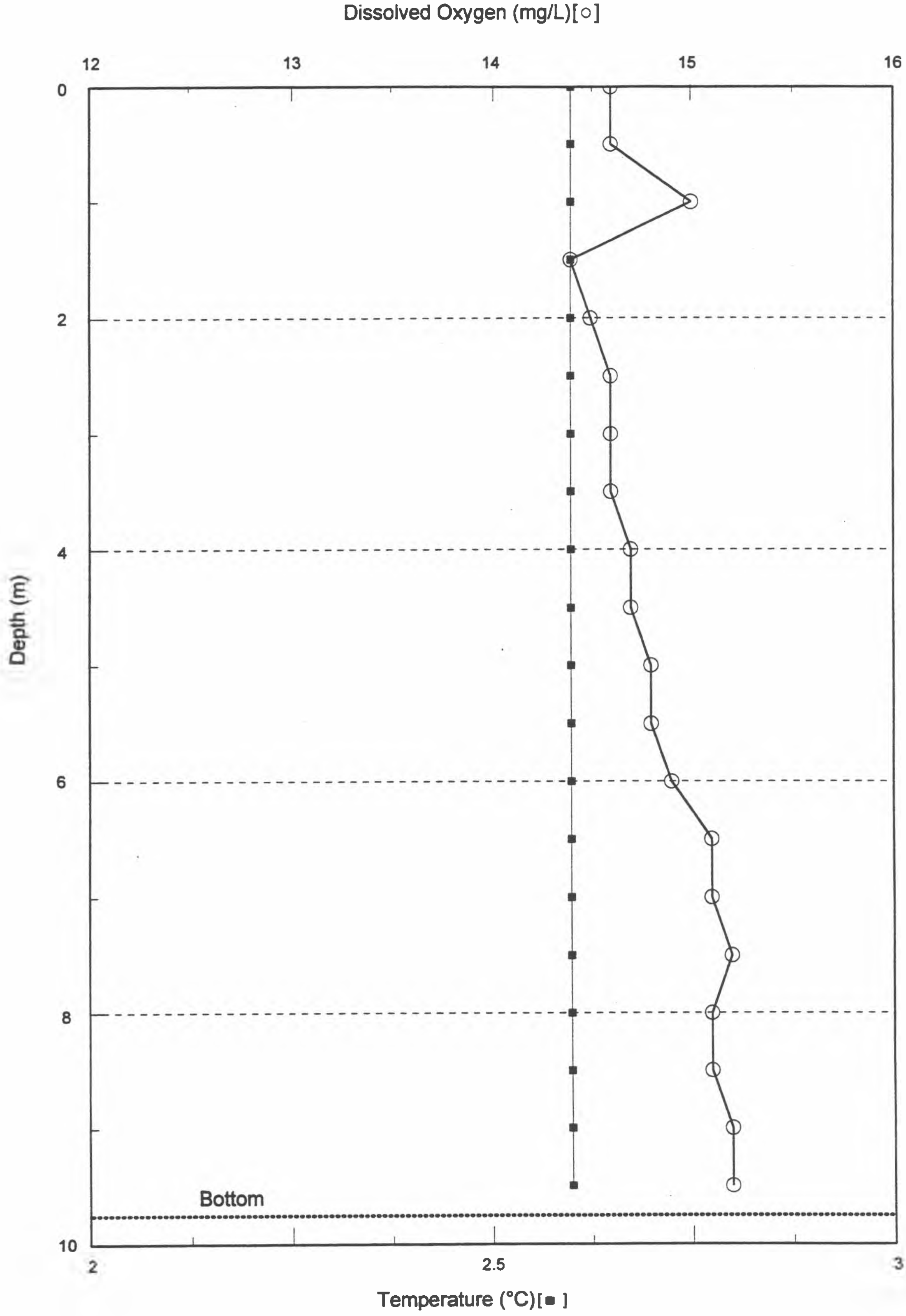


Figure 3.8 continued..

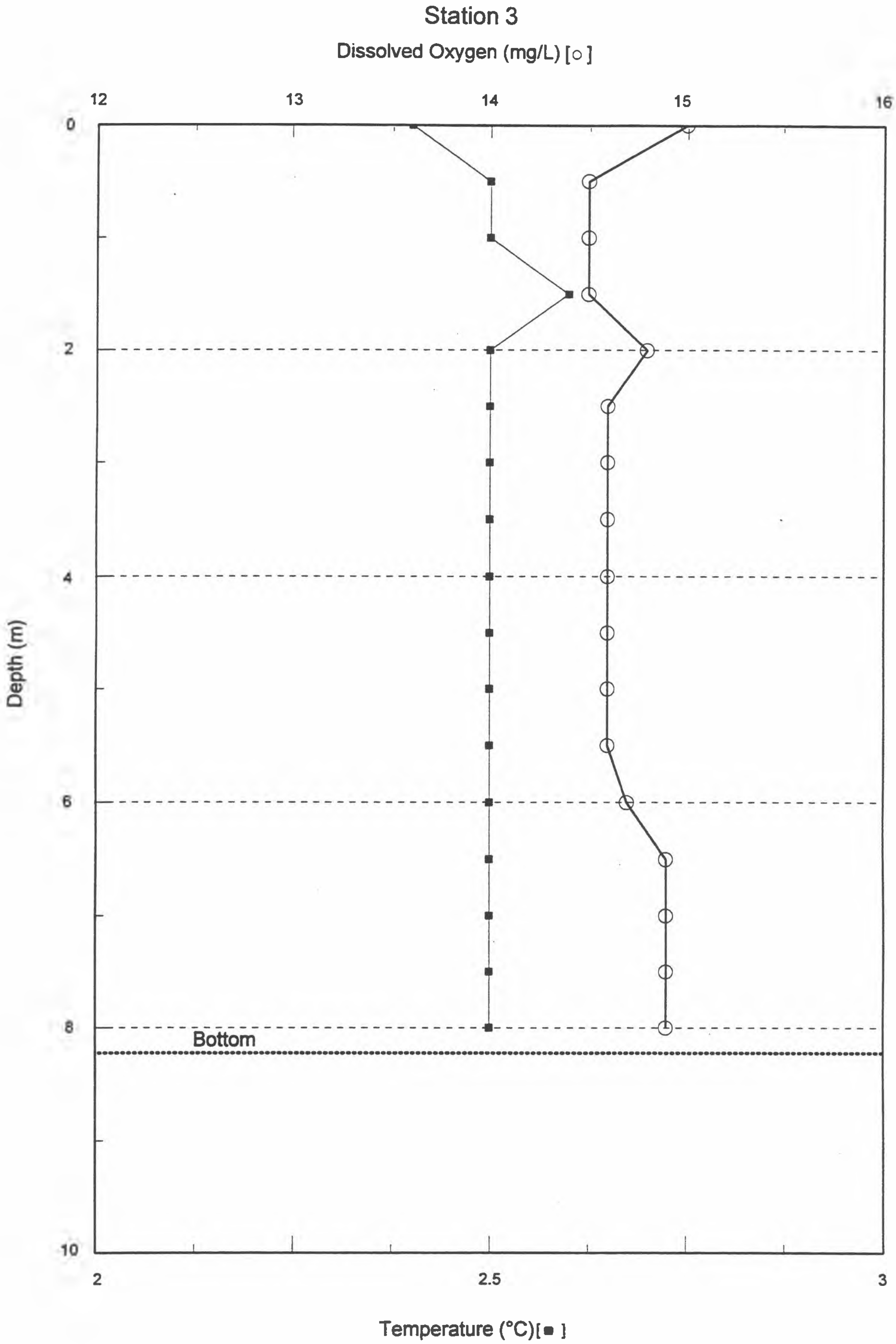


Figure 3.8 continued..

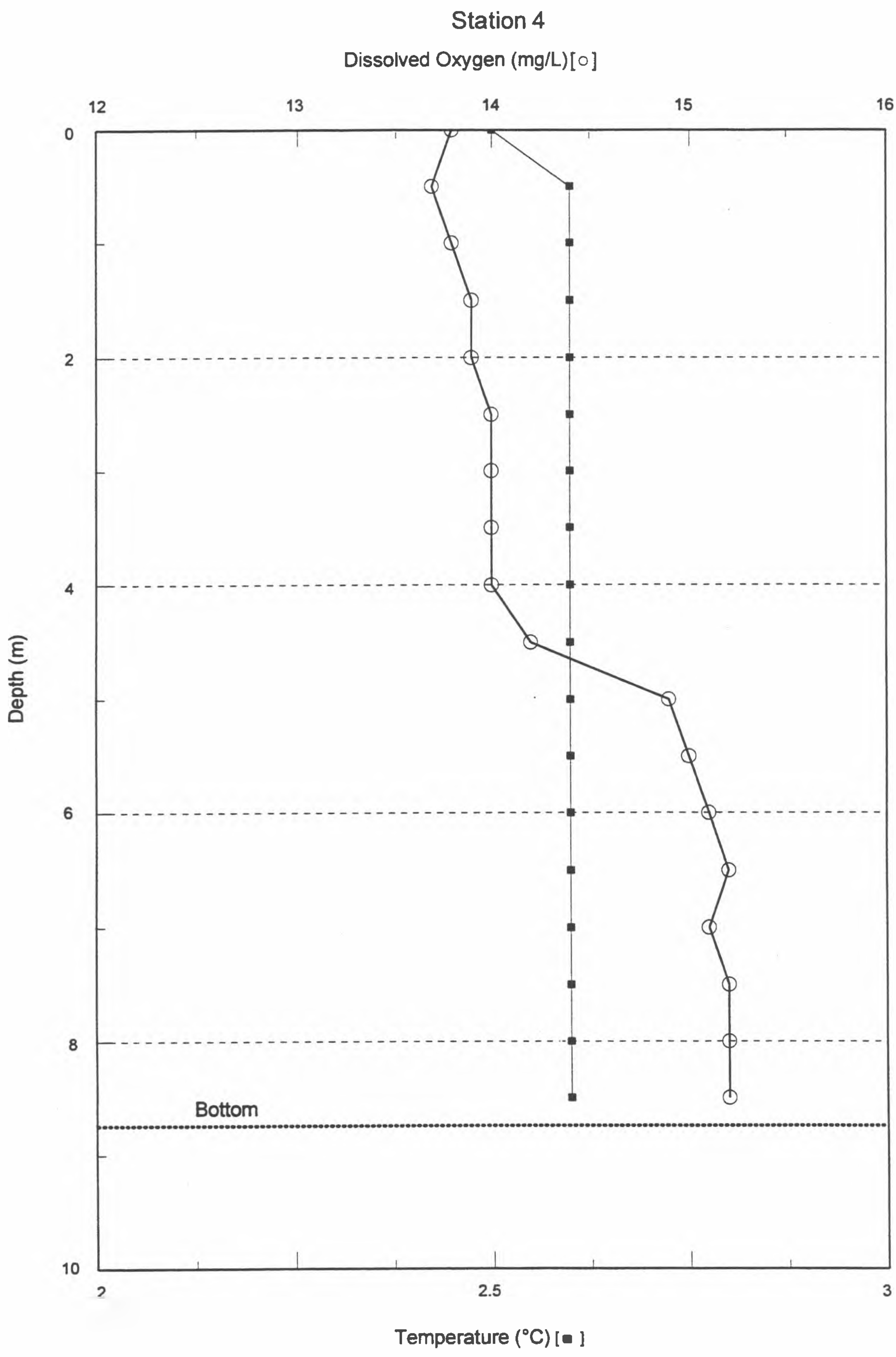


Figure 3.8 continued..

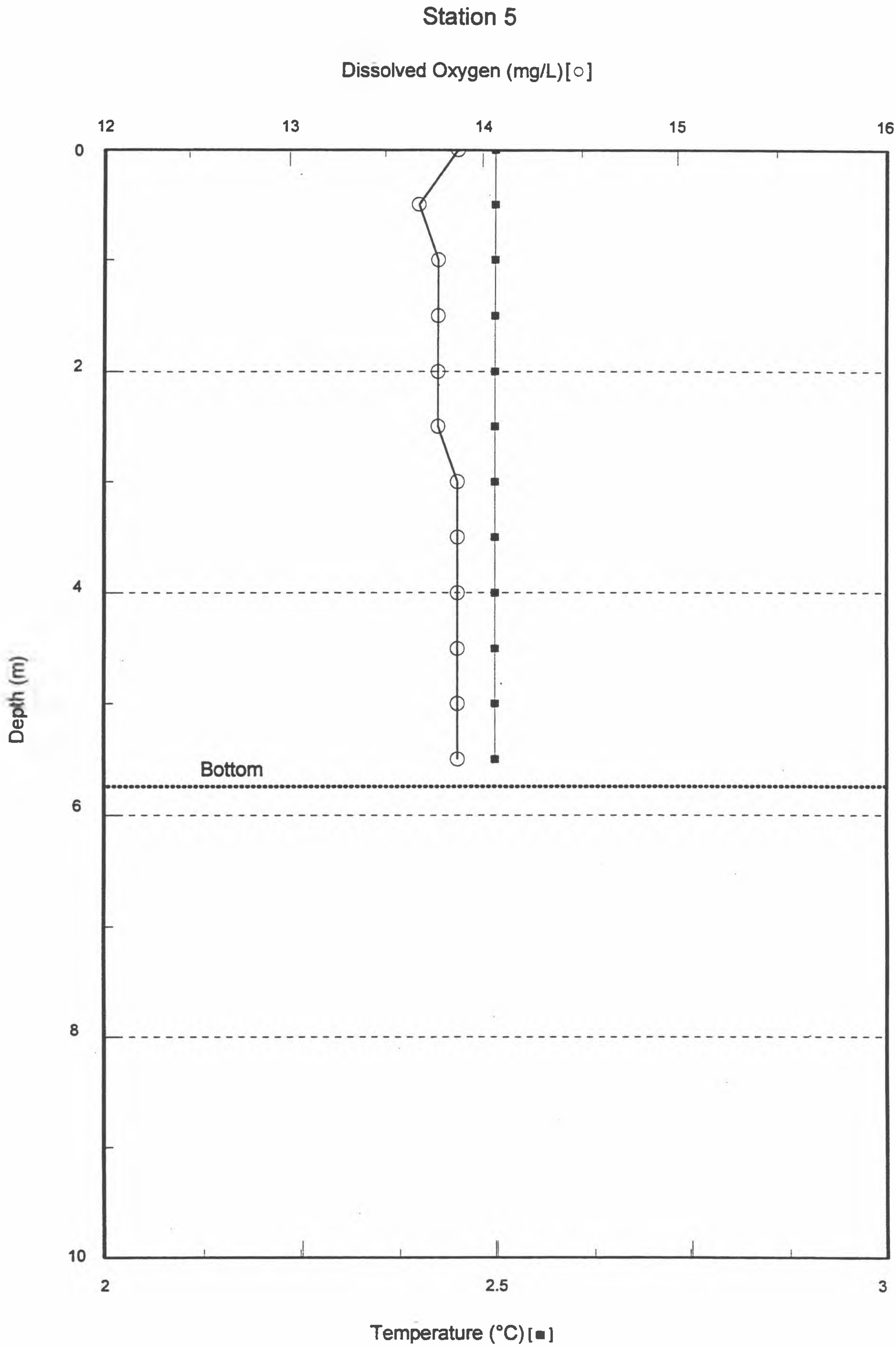


Figure 3.8 concluded.

3.3.2 Fish Community

Several sampling techniques were employed in an attempt to capture fish from the Wolverine River Intensive Sampling Site; they included deep-water electrofishing, drift netting, a combination of electrofishing and drift netting, and use of set lines. Prior to employing a particular method, fish concentrations were located with sonar to ensure that sampling effort was directed at specific locations containing fish.

Electrofishing

A variety of deep-water electrofishing techniques were utilized in an attempt to capture fish (Table 3.3). During four days of intensive sampling; however, only one goldeye was captured and two northern pike were observed. The captured goldeye exhibited extensive hemorrhaging on the fins and head area, which is an indication of electroshocking induced trauma (Schneider 1992). This suggests that fish were being shocked by the system; however, stunned individuals were not coming to the surface (i.e., either recovering before surfacing or being carried downstream by the current out of the study area).

Table 3.3 Boat electrofishing summary information for sampling of the Wolverine River Intensive Sampling Site, October 1992.

Site	Sample No.	Sampling Method		Current	Amperage	Pulse Frequency (pps)	Sampled Depth (m)	Sampling Time (s)
		Anode	Cathode					
Wolverine R.	1	2 Cable Array	Boat	DC	7.0	60	3.0	983
	2	2 Cable Array	Boat	DC	7.0	60	3.0	1503
	3	2 Pipe Array	Boat	DC	7.0	60	3.0	1608
	4	2 Pipe Array	Boat	DC	7.0	60	4.0	1245
	5	2 Cable Array	Boat	DC	8.0	60	5.0	1175
	6	1 Pipe Array	1 Pipe Array	AC	8.0	120	7.0	675
	7	1 Pipe Array	1 Pipe Array	DC	8.0	60	3.0	1937
	8	1 Cable Array	1 Cable Array	DC	8.0	60	3.0	1468
	9	2 Cable Array	Boat	AC	8.0	120	4.0	1450
	10[a]	2 Cable Array	Boat	DC	9.0	60	5.5	1008
	11[a]	2 Cable Array	Boat	DC	9.0	60	3.5	1432

[a] Electrofishing employed in conjunction with drift netting.

To test the effectiveness of the arrays utilized during deep-water electrofishing, both the cable array and steel pipes were employed while shallow water sampling to collect fish for contaminant analyses. Both deep-water arrays operated as efficiently as the standard shallow water arrays. The deep-water cable array stunned fish in a similar fashion as the standard array. The deep-water pipe array appeared to stun fish more severely than the standard array.

Drift Netting

Drift netting was employed as an alternative collection technique to deep-water electrofishing. An extensive amount of sampling effort failed to capture fish (Table 3.4). Problems identified with this collection method included the inability of the net to retain captured fish and avoidance of the net by fish. The drift nets frequently became snagged on the bottom, causing extensive damage to the nets.

Table 3.4 Drift netting summary information for sampling of the Wolverine River Intensive Sampling Site, October 1992.

Site	Sample No.	Sampling Method		Depth	Sampled Area (m^2)	Sampled Distance (km)
		Mesh Size (cm)	No. Panels			
Wolverine R.	1	3.8	1	3.0	30	0.5
	2	8.9	1	3.0	30	0.6
	3	8.9	1	4.0	30	0.5
	4	14.0	1	4.0	30	0.4
	5[a]	3.8,8.9	2	3.0	60	1.9
	6[a]	3.8,8.9	2	2.0	60	1.4

[a] Drift netting employed in conjunction with electrofishing.

Combination Electrofishing and Drift Netting

Deep-water electrofishing was combined with drift netting in an attempt to capture fish that were stunned by the electric field but did not come to the surface (Tables 3.3 and 3.4). This was accomplished by positioning the anodes a short distance ahead of the drift net while sampling. Using this method, one goldeye was captured during two sampling runs. This fish exhibited hemorrhaging of the fins and head area.

Set Lines

To sample for the presence and distribution of piscivorous species (i.e., northern pike, walleye, and burbot), set lines were employed. Each set line consisted of 20 baited hooks distributed at depths of 1.0 m to 9.0 m. Each set line was secured to the river bank and was fished for 22 hours. Catch results from the two sets included 12 fish on set line No. 1, and zero fish on set line No. 2. Fish captured on set line No. 1 were evenly distributed along the line and included three northern pike and nine burbot.

3.4 FISH COLLECTIONS FOR CONTAMINANT ANALYSES

Fish were collected from the Wolverine River site for contaminant analyses. Fish were captured using a variety of techniques that included boat electrofishing at the water surface using standard electrofishing methods,deep-water electrofishing, and set lines. The number of adult fish collected has been summarized in Table 3.5. All fish were processed following the protocol outlined in Schedule B of the Terms of Reference and were promptly shipped to the Standards Development Office of Alberta Environment in Edmonton.

Table 3.5 Fish collected for contaminant analyses at the Wolverine River Intensive Sampling Site, October 1992.

Capture Method	Species	Fork Length (mm)
Electroshocking	Northern pike	513
	Northern pike	445
	Northern pike	507
	Northern pike	468
	Northern pike	560
	Northern pike	502
	Goldeye	327
	Burbot	845
	Burbot	595
	Burbot	616
	Burbot	867
	Longnose sucker	455
	Longnose sucker	420
	Longnose sucker	510
Setline	Northern pike	796
	Northern pike	594
	Northern pike	778
	Burbot	607
	Burbot	653
	Burbot	872
	Burbot	470
	Burbot	533

All captured fish were examined for gross pathology following the instructions outlined in Schedule A of the Terms of Reference (Appendix A). An external examination of each fish indicated no gross pathology, aside from sub cutaneous hemorrhaging caused by electrofishing (see Section 3.3.2).

4.0 RECOMMENDATIONS FOR FUTURE SAMPLING

Deep-water sites ($\geq$7.0 m) are relatively numerous in the Peace River and are distributed throughout the system, which suggests that deep-water locations are not severely limited. As such, potential overwintering sites are accessible to fish communities in the system. This investigation established the presence of fish in the deep-water areas surveyed, and fish concentrations were generally higher in these areas than in adjacent sections of river. This information suggests that deep-water sites may be preferred overwintering habitat and this habitat is not limited. Owing to the paucity of captured fish, the significance of these areas to particular fish species, or size-classes of fish, still remains undetermined. Deficiencies in the sampling methodologies employed during this study should be addressed and alternate capture techniques developed if the significance of deep-water areas to fish communities in the Peace River is to be determined.

Despite intensive efforts to sample the fish community of a deep-water habitat in the Peace River, very few fish were captured utilizing the techniques employed, even though fish concentrations (i.e., as determined by sonar) were present. There was indirect evidence to suggest that deep-water electrofishing did influence fish distribution in the area. Prior to initial deep-water electrofishing, sonar readings indicated fish were concentrated in discrete areas along the river's edge, suspended between 2.5 and 3.5 m, in areas with a maximum depth of 5.0 m. Following the first sampling run, sonar readings indicated fish were more widely dispersed and had relocated to deeper water (i.e., 4.0 to 5.0 m depth). This was interpreted as an avoidance reaction to the electrical field (i.e., fish generally seek deeper water for refuge when disturbed). The low incidence of fish that were sufficiently immobilized and subsequently floated to the surface, however, prevented an assessment of species composition, one of the primary objectives of the study. Possible reasons for this included the following:

1) an active avoidance by fish of the sampling gear
2) the inability of immobilized (stunned) fish to rise to the surface due to current patterns at sampled depths, or
3) stunned fish recovered quickly when they floated out of the electrical field.

The recovery of some fish that exhibited symptoms of electrofishing trauma (i.e., sub cutaneous hemorrhaging)indicated that at least a portion of the fish sampled at depth were immobilized by the gear; however, these fish may have drifted a considerable distance downstream before surfacing, or they may have recovered prior to surfacing.

Combination Trawl-Electrofishing

The results of the present study suggest that, in deep-water areas of the Peace River, the use of drift nets or deep-water electrofishing alone are ineffective sampling methods. A possible method that was not tried was the use of a combined trawl-electrofishing system. This method would employ electrical arrays attached directly to the mouth of a trawl net. The net should have a large enough mouth area (e.g., 4 m x 10 m) to capture stunned fish and a long enough cod-end to prevent fish from escaping out of the net. Such a system would require the use of a large, powerful, boat. The trawl also would have to be expendable and be equipped with a quick-release system in the event it became snagged on the bottom. This type of system would greatly improve the capture efficiency of fish that are immobilized by the electrical field. Stunned individuals would enter the net immediately, before they have an opportunity to recover.

Set Lines

Set lines are an efficient sampling technique for piscivorous fish species inhabiting deep-water areas; however, there are limitations associated with this method. These include sampling bias (i.e., a greater selection for species such as burbot that rely heavily on olfactory senses to locate food) and high mortality rates of captured fish. If these limitations are acceptable, this method could be utilized to survey fish in deep-water habitats in the Peace River. To provide a more unbiased representation of the fish community, two modifications could be implemented. Different bait types could be utilized and baited hooks can be suspended off the river bottom (D. Walty, Alberta Fish and Wildlife Division, pers. comm.). If these modifications were employed, several of the major sportfish species residing in the Peace River could possibly be sampled (i.e., burbot, walleye, northern pike, and goldeye).

5.0 LITERATURE CITED

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APPENDIX A

TERMS OF REFERENCE

Canada Alberta Northwest Territories

Northern River Basins Study

September 21, 1992

Mr. Curtiss McLeod
R.L. & L. Environmental Services Ltd.
17312 - 106 Avenue
Edmonton, Alberta
T5S 1H9

Dear Mr. McLeod:

Re: Project 3117-B8 Overwintering Critical Area Fisheries Inventory - Peace River

From our September 21, 1992 discussion regarding the selection of your proposal to complete the project involving fish inventory in overwintering habitats of the Peace River, I would like to confirm some understandings that will be part of the contract between your company and the Northern River Basins Study Office.

The following points are considered to be understood and agreed to by R.L. & L Environmental Services Ltd. and this Study Office.

1. If weather conditions are such that the work cannot be completed, the project products could be reduced and the payment for the products would be reduced accordingly.

2. If initial sonar assessments indicate the absence of fish, no detailed habitat assessments will be required and an early termination of the contract may result. The accompanying contract payment will be reduced accordingly. The Study Office (R. Makowecki or K. Crutchfield) should be advised of these initial assessments.

3. The fish sampling techniques or the assessment of effective fish sampling gear will be carried out in the first week of the field work, should techniques prove ineffective the project could be terminated or reduced and the payment reduced accordingly. The contractor will be in communication with the Study Office (R. Makowecki or K. Crutchfield) following this initial assessment of fish sampling techniques.

4. The contractor will inform the Study Office and Mr. Dave Walty of times when fish sampling will be occurring. It is expected that some of these people may wish to observe the actual application of the various techniques.

#690, Standard Life Centre, 10405 - Jasper Avenue, Edmonton, Alberta, T5J 3N4
(403) 427-1742 Fax (403) 422-3055

5. An assessment of the relative abundance of fish in mid-winter will be part of the overall contract and will be completed at no extra cost. The assessment should be completed in January, depending upon the fall sampling program. This assessment will be carried out at one of the "deep hole habitats" and will be done to determine if fish remain abundant in these habitats in mid-winter.

Congratulations on your successful proposal and we look forward to working with you on this project.

Yours sincerely,

NORTHERN RIVER BASINS STUDY

R. Makowecki

Ray Makowecki

cc: D. Ferrier
D. Marko
N. Jankovic
K. Crutchfield - file
D. Donald
D. Walty

/mcr; 7415-3117-B8/065

NORTHERN RIVER BASINS STUDY

SCHEDULE A - TERMS OF REFERENCE

PROJECT 3117 — **OVERWINTERING CRITICAL AREA FISHERIES**
SUB-PROJECT 3117-B8 — **INVENTORY - PEACE RIVER**

DESCRIPTION

A consultant will be retained to determine the distribution and significance of "deep hole" habitats in the mainstream of the Peace River. Earlier preliminary fisheries' work observed significant concentrations of fish in deep hole habitats (waters with depths greater than 7.0 metres). Characterization of this possible winter habitat, fish species composition and abundance and fish population structure, is required to determine the status of the fish stocks. At the same time a continuation of fish tagging and fish collections will be part of this project.

The need for repeatable and reliable assessments is a significant element of this project. The locations of the intensive studies should be in areas where upstream effluent discharges are completely mixed. The specific studies may have application to future monitoring and predictive aspects of the overall study which is intended to assess the effects of various effluents on the ecosystem. The proposal will require some description as to the methods/techniques to be utilized in sampling fish in deep hole habitats.

OBJECTIVES

1. To identify, characterize and define one critical overwintering habitat (deep hole area) in two reaches (RSS) of the Peace River:

   (a) downstream of the B.C. border and upstream of the Smoky River confluence and;
   (b) downstream of Daishowa and upstream of the Vermilion Chutes.

2. To select one of the most significant, critical overwintering areas in each reach for fish population assessments.

3. To determine the species composition, relative abundance (C.U.E.), growth population characteristics and fish distribution (by depth) of the fish species in these wintering areas.

4. To tag several of the key fish species for ongoing assessments of the movement of these fish species within the Peace River system.

5. To collect specified fish species for contaminant analysis.

6. To assess the overall significance of deep hole habitat for overwintering.

SCHEDULE A

STUDY LOCATION

These reach specific studies will be focused on two areas of the Peace River mainstream:

(a) B.C. border downstream to the Smoky River confluence;
(b) downstream of Daishowa from the complete effluent mixing zone to the Vermilion Chutes.

The fisheries' sampling will be targeted on intensive and critical overwintering habitat in each of these reaches.

STUDY REQUIREMENTS

The contractor will:

1. Locate the deep hole habitats (defined as waters exceeding 7.0 metres in depth in October) in the two major reaches as identified in the study location section of these Terms of Reference. The locating of these deep hole habitats could be aided initially with the use of Transport Canada river maps. The proposal should include an assessment of the availability of existing maps.

2. Select one representative significant deep hole habitat in each reach for more extensive habitat description and intensive fish sampling. The selected site must be verified with the Northern River Basins Study office.

3. Characterize the significant "deep hole" habitats by describing the depths, water velocities, substrate, winter dissolved oxygen levels and overall assessment of these areas as suitable overwintering habitats.

4. Determine the age-length distribution, age-frequency distribution and length-frequency distribution of the major fish populations utilizing these overwintering habitats.

5. Determine the relative abundance and distribution (by depth) of all fish species in these deep hole habitats. This will be achieved by utilizing fishing techniques that will provide the smallest variance in catch by species and by number. C.U.E. results will be reported. Standardized methodology must be employed. A variety of techniques such as drift nets, baited hooks, sonar and others could be deployed with a minimum of 30 individual samples of each fishing method contributing to a determination of the method that provides the lowest variance for C.U.E. by species and number. The proposal should specify the details associated with providing meaningful estimates.

SCHEDULE A

6. Mark in an opportunistic manner the major fish species within this site using conventional tagging techniques that will support the long term assessments on fish migration. Information to be recorded includes species, unique tag number, date of capture, length, sex (if fish are ripe), age (utilizing aging structures as per McKay et al), location (UTM coordinates), gross morphology (as per Appendix A). All spaghetti tags to be supplied by the Northern River Basins Study.

   The key species include:

   a) B.C. border to Smoky River Confluence - Selected Deep Hole Habitat.
      - Rocky Mountain Whitefish
      - Burbot
      - Walleye

   b) Daishowa downstream to Vermilion Chutes (Selected Deep Hole Habitat)
      - Northern Pike
      - Goldeye
      - Burbot
      - Walleye

7. Collect 20 individuals of older age classes or larger sizes of the following species:

   a) B.C. border to Smoky River Confluence - Selected Deep Hole Habitat.
      - Rocky Mountain Whitefish
      - Burbot
      - Walleye
      - Flathead Chub
      - Longnose Suckers

   b) Daishowa downstream to Vermilion Chutes (Selected Deep Hole Habitat)
      - Goldeye
      - Burbot
      - Walleye
      - Northern Pike
      - Flathead Chub
      - Longnose Suckers

   Schedule A1 describes the fish sampling protocol that should be followed. Any fish exhibiting external abnormalities should also be collected.

8. Endeavour to utilize local contractors and services for the field studies and maintain a list of suppliers and services utilized along with dollars spent.

9. Make every effort to minimize fish mortality. All sacrificed fish are to be disposed of in a manner acceptable to the Alberta Fish & Wildlife Division. Appropriate non-lethal capture methods will be used in a manner that will enable comparisons of abundance, size and occurrence during the sampling period.

10. Progress reports, final manuscripts, electronic data files, samples and photographic materials are to be delivered to the Study Office as per Schedule B. The format for the final report will follow the editorial style of the Canadian Journal of Fisheries and Aquatic Sciences.

11. Utilize statistical methods that achieve the highest level of confidence and power based on possible limited sample sizes.

12. Assess the overall significance of those deep hole habitats considering the frequency of such habitats and the relative abundance of the fish species in the normal mainstream portions of the Peace River. A winter check on these areas would likely be desirable for such an assessment.

NORTHERN RIVER BASINS STUDY

PROJECT 3117 — **GENERAL FISH INVENTORIES**
SUB-PROJECT 3117-B8 — **OVERWINTERING CRITICAL AREA FISHERIES INVENTORY - PEACE RIVER**

SCHEDULE A1

A. FISH SAMPLING PROTOCOL - CONTAMINANT ANALYSIS

1. Fish may be collected using a variety of techniques including:

   - Electro-shocking
   - Gill nets
   - Seines
   - Drift nets
   - Set lines
   - Angling

2. All samples must be submitted as intact whole fish.

3. All fish samples are to be frozen as soon as possible after collection.

4. Details of species, length, date, location and the collector's name must be recorded with the sample number for each sample and this information must be supplied directly with the fish and on the outside packaging.

5. All fish must either be:

   (a) immediately processed (length) and directly placed into contaminant free plastic bags supplied by the Northern River Basins Study and the bags specifically labelled, or

   (b) placed into stainless steel buckets or basins (rinsed for each site with a solvent series as described in the "Instrument and Equipment Cleaning Procedure" provided below) and kept cool until processed, and then placed into approved contaminant free plastic bags and the bags specifically labelled.

   INSTRUMENT AND EQUIPMENT CLEANING PROCEDURES:

   i) washed with tap water and laboratory detergent,

   ii) rinsed with tap water and deionized water (18 meg-ohm),

   iii) rinsed with pesticide grade acetone, hexane, dichloromethane and hexane, respectively, and

iv) air dried and heated to 325°C for six hours. All cleaned instruments and equipment to be wrapped in heat treated (325°C) aluminum foil until required.

N.B. Placing fish in ordinary plastic bags will contaminate the samples.

6. The use of dry ice for initial freezing and shipping is the approved method. Alternatives are ice packs and then ice, and may be used only as a secondary means on occasion where there may exist a shortfall in available dry ice. Fish processed by this latter means are to be frozen within 12 hours.

7. The use of sturdy styrofoam coolers is most practical and is recommended. Styrofoam coolers of weak construction may not assure constant freezing and may break down during shipping. Coleman type coolers may be used but not necessarily be returned immediately for repetitive use. The Contractor is responsible for picking up coolers when notified by Alberta Environment.

8. Place dry ice both on top and bottom of coolers to assure that no freeze-thaw cycles will occur during transport.

N.B.: Any freeze-thaw, however moderate it may be, will cause contaminant migration within a sample and this may affect contaminant concentration levels in tissues.

9. Ship samples as soon as possible or, if not possible, samples must be kept frozen in a freezer at -20° until shipping. Samples of liver tissue for MFO analysis must be stored at -60°C or colder.

Any contractor/consultant or government personnel that is transporting fish to Edmonton must contact one of the following people before leaving place of origin:

Earle Baddaloo	Work:	(403) 427-6102
	Home:	(403) 434-8967
Sub Ramamoorthy	Work:	(403) 427-6102
	Home:	(403) 435-8137

If the above personnel are not in, a message indicating fish is on its way and approximate time of arrival in Edmonton must be left with the secretary (in office) between 8:15 a.m. and 4:30 p.m., or on an answering machine (home) after 4:30 p.m., before leaving place of origin.

Upon arrival in Edmonton with specimens from Northern River Basins Study projects, contractor(s) or consultant(s) should contact one of the above personnel again.

If the above personnel cannot be contacted on a weekday (Monday to Friday), contractor(s)/consultant(s) should proceed directly to **VERSACOLD only between 8:00 a.m. and 4:00 p.m. Drop cargo (fish) off at VERSACOLD under the name of Earle Baddaloo, Alberta Environment. DO NOT LEAVE FISH OUTSIDE OF VERSACOLD!!**

VERSACOLD IS OPEN BETWEEN 0800 AND 1600 HOURS. MONDAY THROUGH FRIDAY.

ADDRESS: 9002 - 20 Street
Edmonton, Alberta
TELEPHONE: (403) 464-1770
CONTACT: Mr. Merve Permann

If fish tissue arrive after 4:00, contractor(s)/consultant(s) must make every effort to contact Mr. Baddaloo or Dr. Ramamoorthy so that alternate storage for the night or weekend may be found.

It is, therefore, imperative to call contacts before leaving place of origin so that they (contacts) will be aware of the transport activity and can make arrangements for the arrival of the specimens.

WEEKEND TRANSPORT

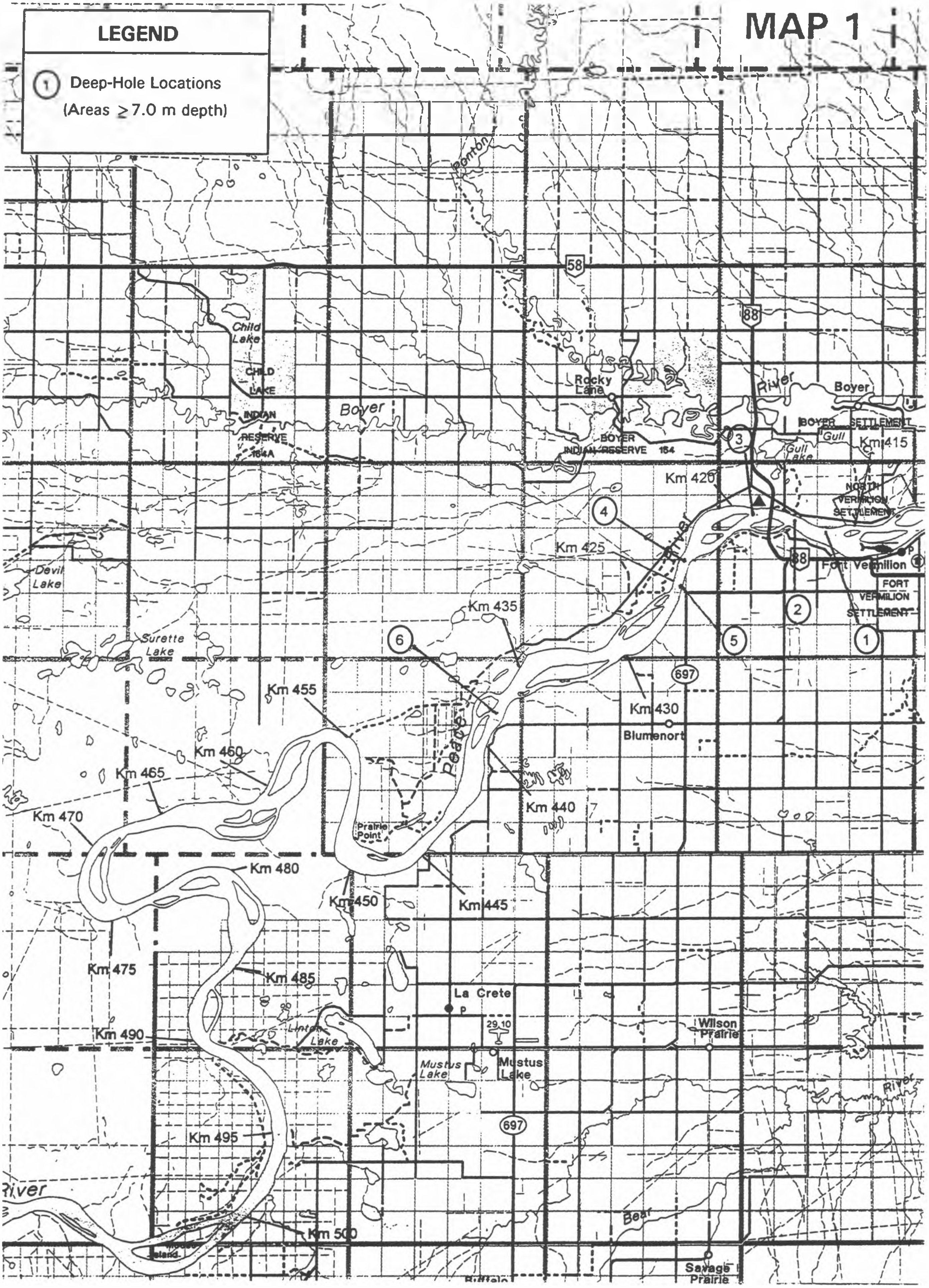
If fish has to be transported to Edmonton on the weekend (Saturday, Sunday or public holiday), the contractor(s)/consultant(s) or government personnel should contact Mr. Baddaloo or Dr. Ramamoorthy on the last working day before the weekend or public holiday. (If contacts are not available, messages must be left with the secretary.) Again, before leaving place of origin, please call contacts at home and leave a message if they are not there; and upon arrival in Edmonton, please call contact again.

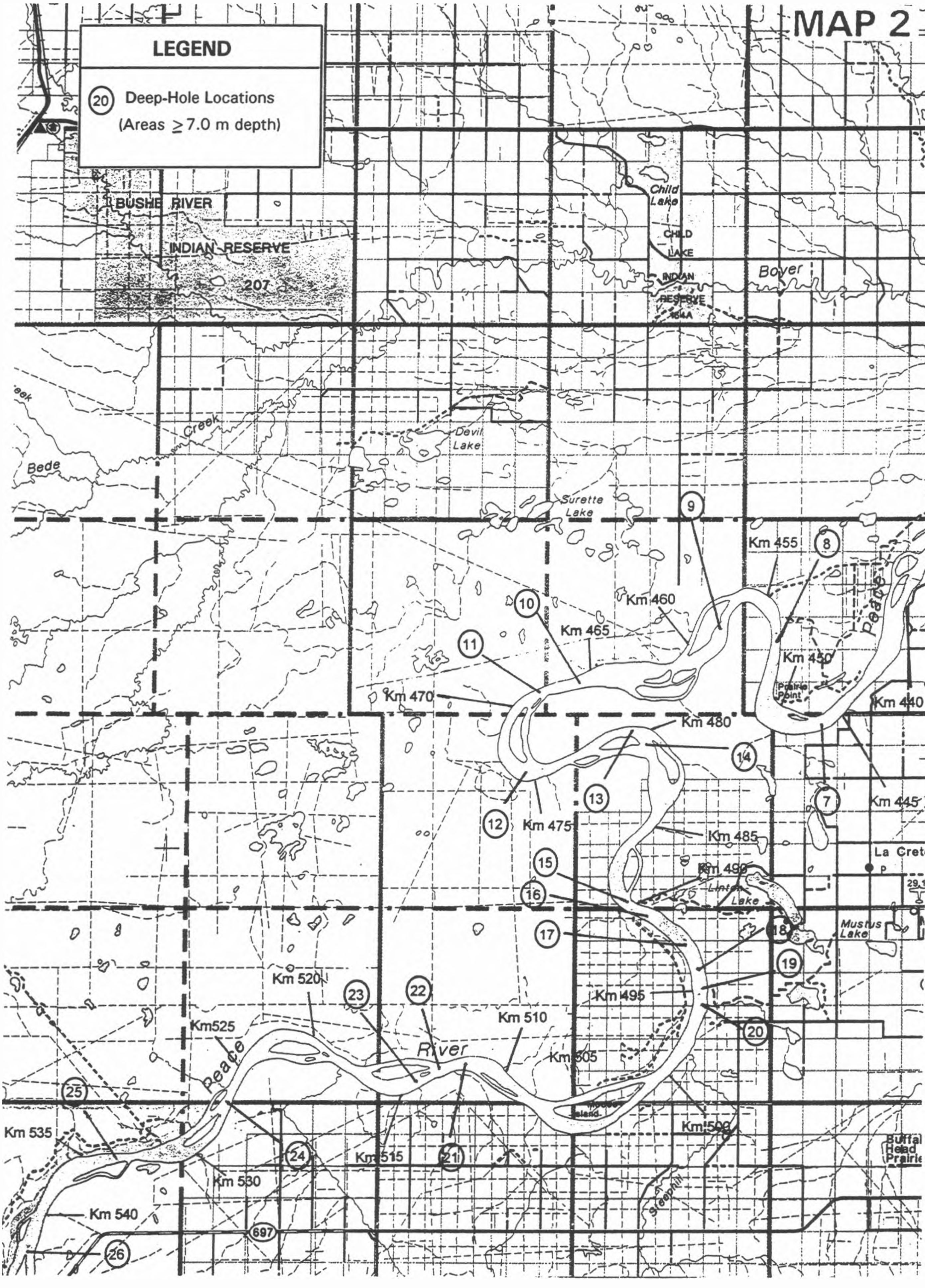
10. Any deviation from the above established protocol/procedure should be justified and accounted for in writing and a detailed description of what was done is to be submitted with the fish sample; this is to assure credibility and validity of results.

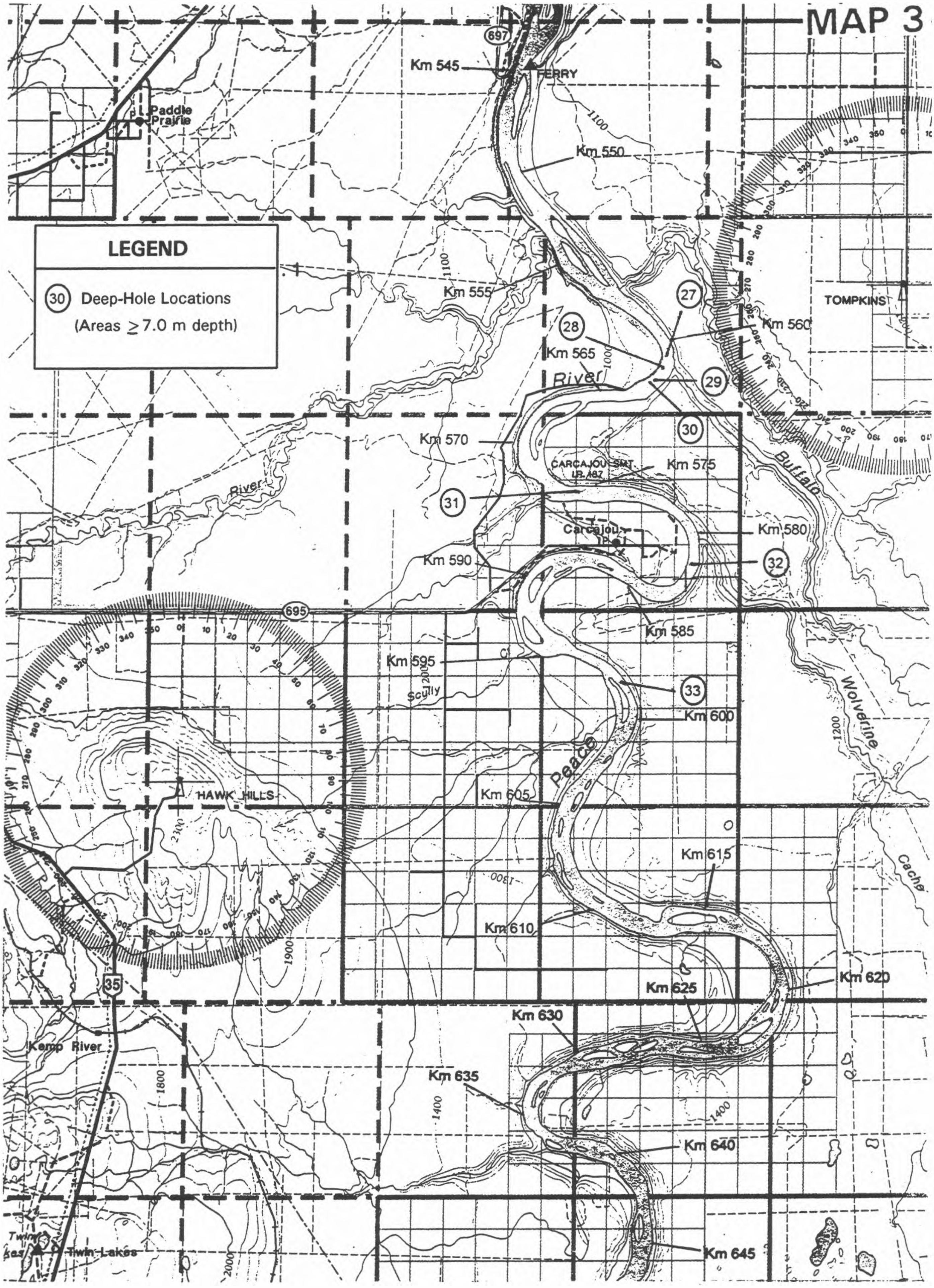
11. Develop a photographic record of equipment and techniques to capture and process fish samples. As appropriate, take close-up photographs of fish exhibiting internal and/or external abnormalities. Use 35 mm 200 ASA Fuji slide film in a camera having a 50-55 mm lens. Maintain records to associate photographs with sample material.

APPENDIX B

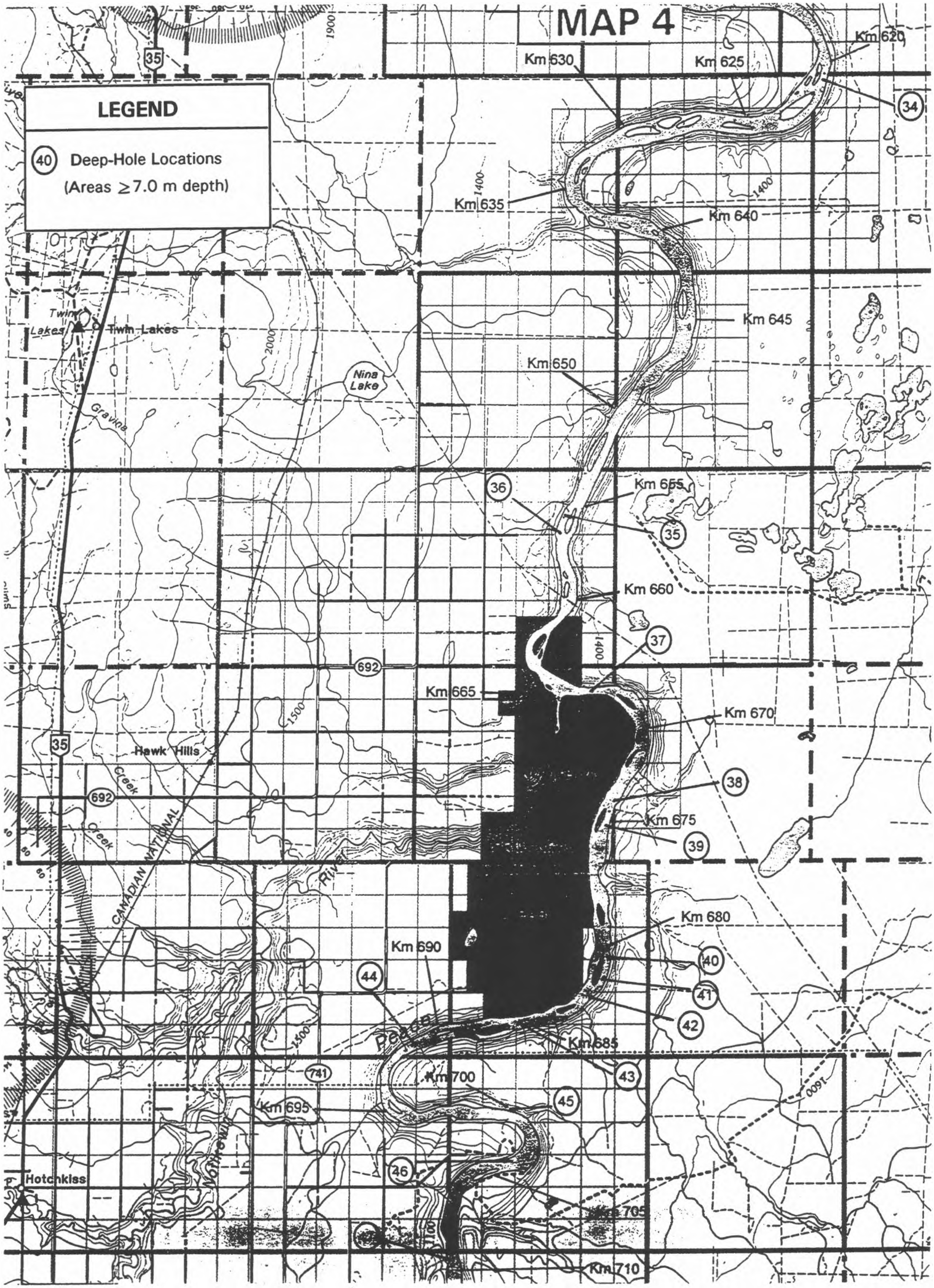
LOCATIONS OF DEEP-WATER AREAS IN THE PEACE RIVER

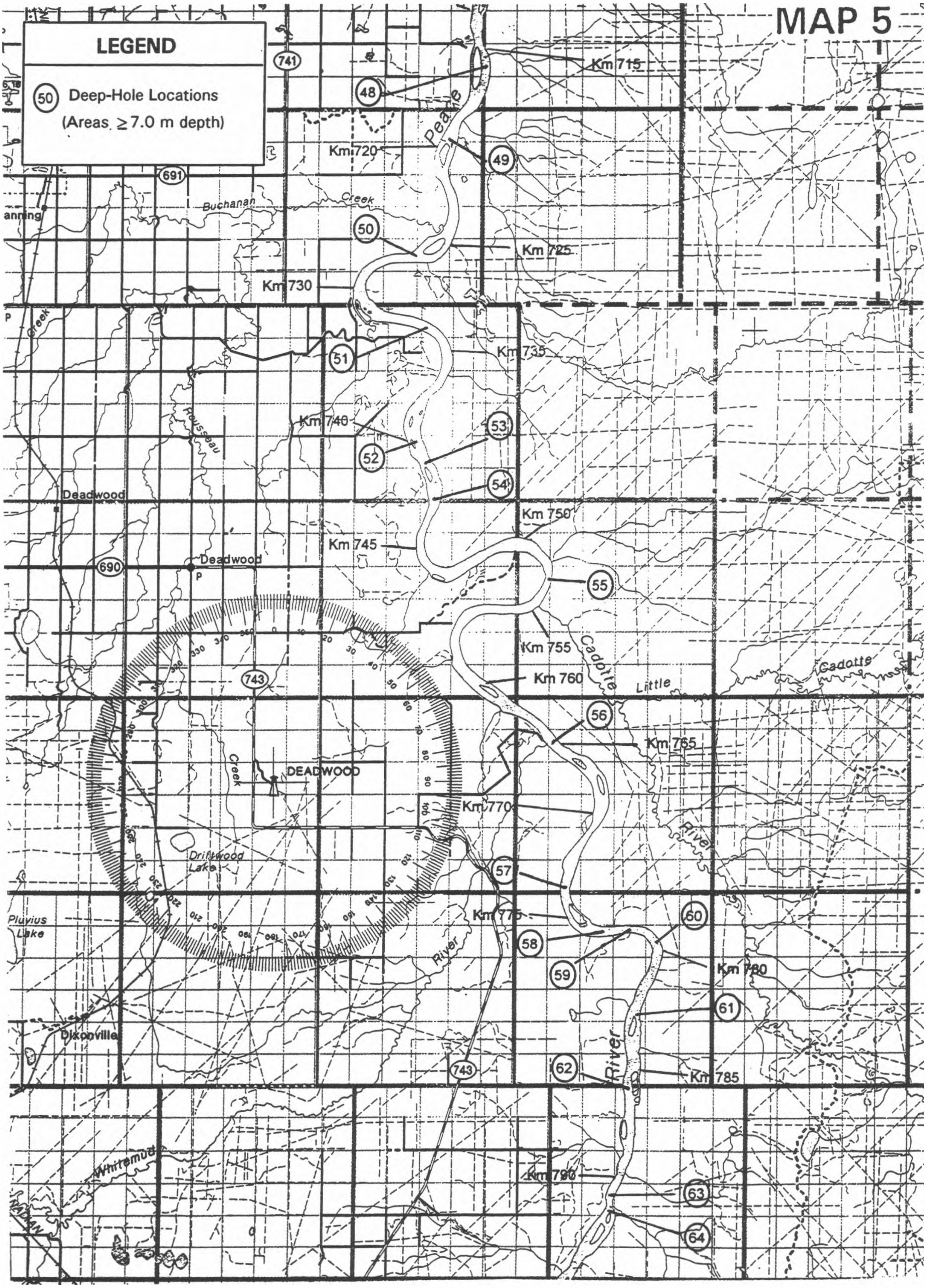

MAP 1
LEGEND
1 Deep-Hole Locations
(Areas ≥ 7.0 m depth)
Child Lake
CHILD LAKE INDIAN RESERVE 164A
Boyer
Rocky Lane
BOYER INDIAN RESERVE 164
River
Boyer
BOYER SETTLEMENT
Gull Lake
Km 415
Km 420
NORTH VERMILION SETTLEMENT
Km 425
Fort Vermilion
FORT VERMILION SETTLEMENT
Devil Lake
Surette Lake
Km 435
Peace River
Km 430
Blumenort
Km 455
Km 460
Km 465
Km 470
Km 440
Prairie Point
Km 480
Km 450
Km 445
Km 475
Km 485
La Crete
Km 490
Linton Lake
Wilson Prairie
Mustus Lake
Km 495
River
Bear
Km 500
Savage Prairie
58
88
697
1
2
3
4
5
6

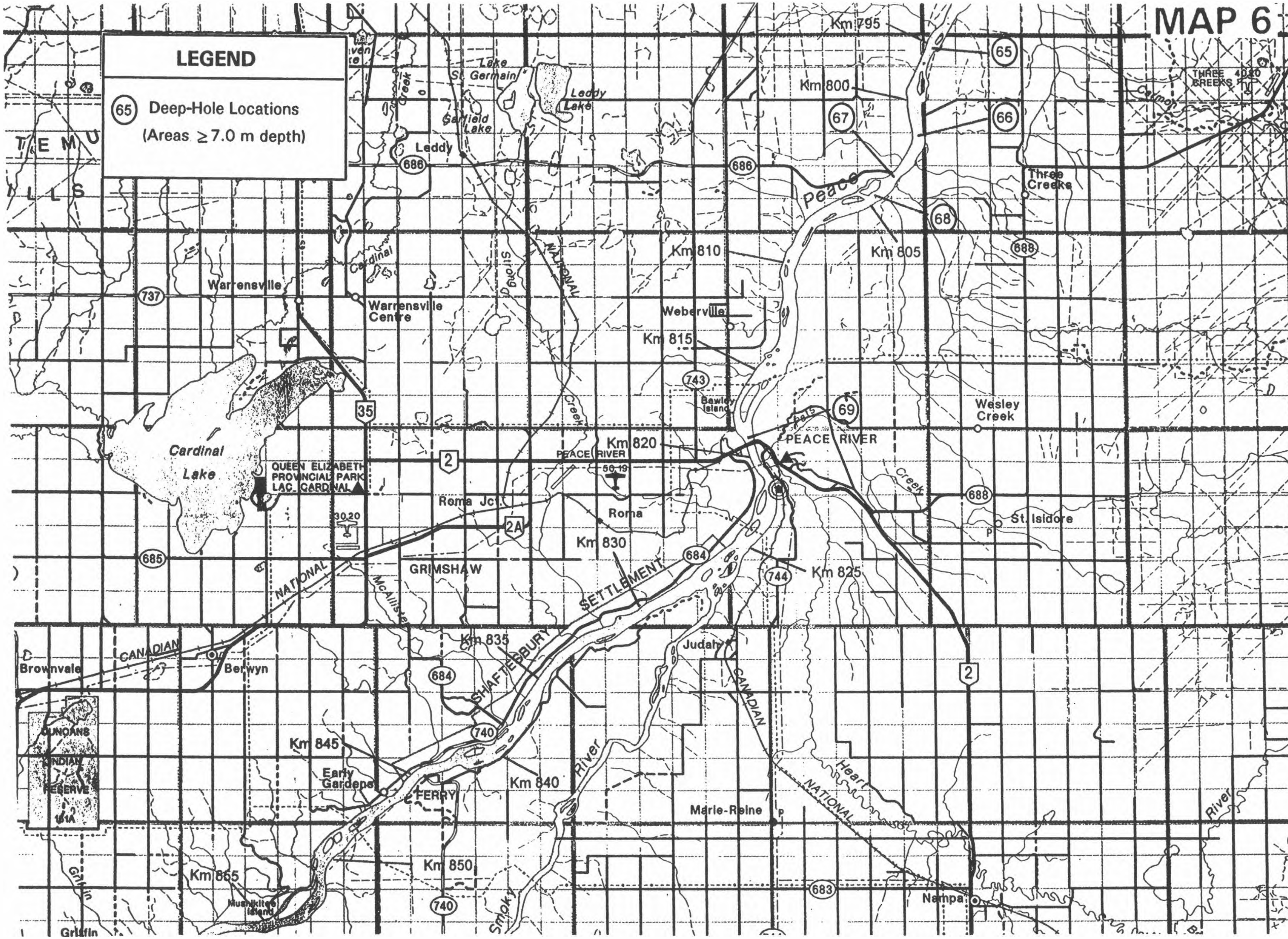

MAP 2
LEGEND
20 Deep-Hole Locations
(Areas ≥ 7.0 m depth)
BUSHE RIVER
INDIAN RESERVE
207
Child Lake
CHILD LAKE INDIAN RESERVE
Boyer
Creek
Bede
Devil Lake
Surette Lake
Km 455
Km 460
Km 465
Km 450
Prairie Point
Km 470
Km 440
Km 480
Km 445
Km 475
Km 485
La Crete
Km 490
Linton Lake
Mustus Lake
Km 495
Km 520
Km 510
Km525
Peace
River
Km 505
Km 500
Km 535
Km 515
Km 530
Km 540
697
Steephill
Buffalo Head Prairie
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

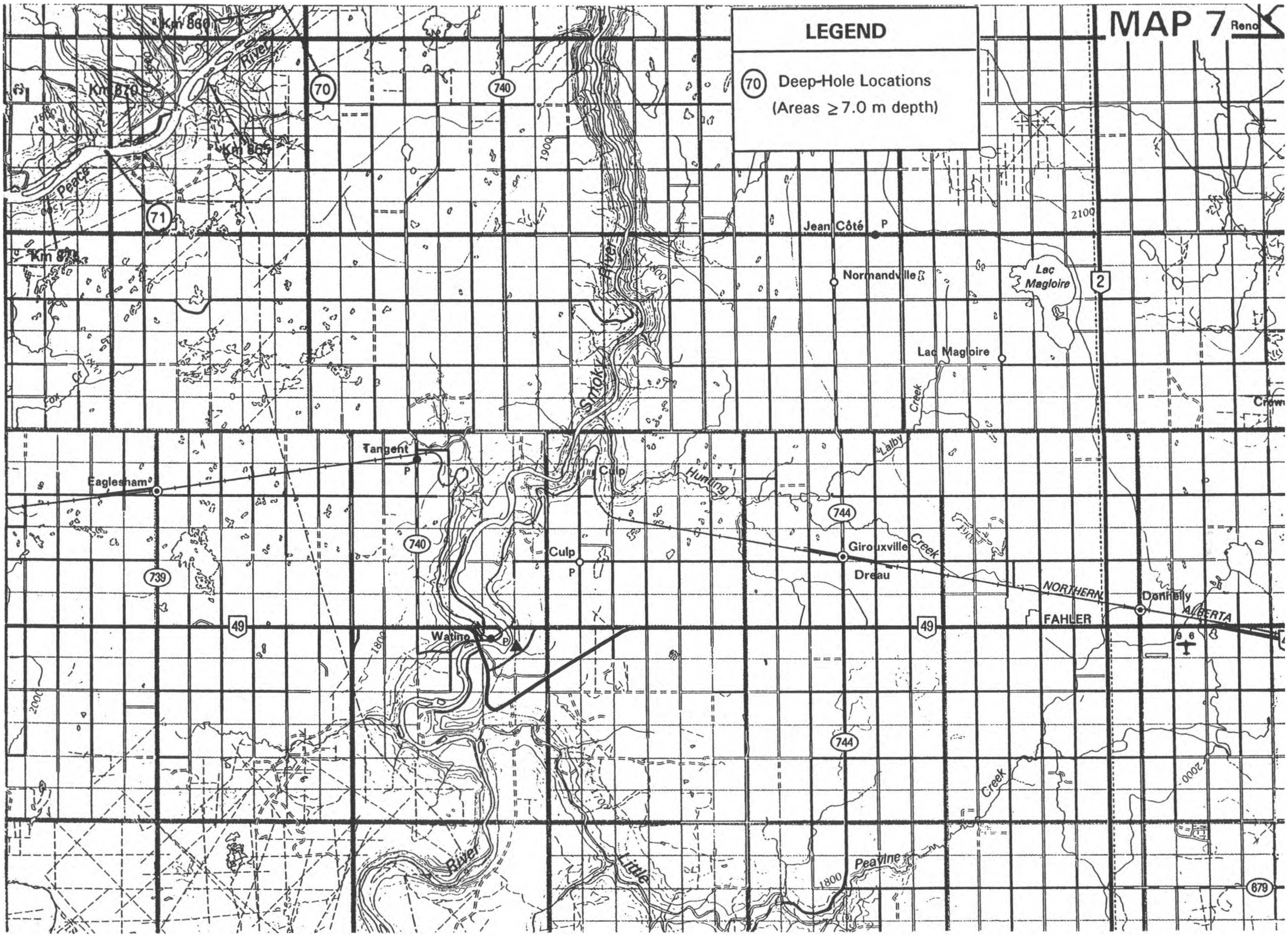


MAP 3
LEGEND
30 Deep-Hole Locations
(Areas ≥ 7.0 m depth)
Paddle Prairie
FERRY
TOMPKINS
Km 545
Km 550
Km 555
Km 560
Km 565
Km 570
Km 575
Km 580
Km 585
Km 590
Km 595
Km 600
Km 605
Km 610
Km 615
Km 620
Km 625
Km 630
Km 635
Km 640
Km 645
27
28
29
30
31
32
33
CARCAJOU SMT
Carcajou
Peace
River
River
Buffalo
Wolverine
Cache
Scully
HAWK HILLS
Kemp River
Twin Lakes
697
695
35

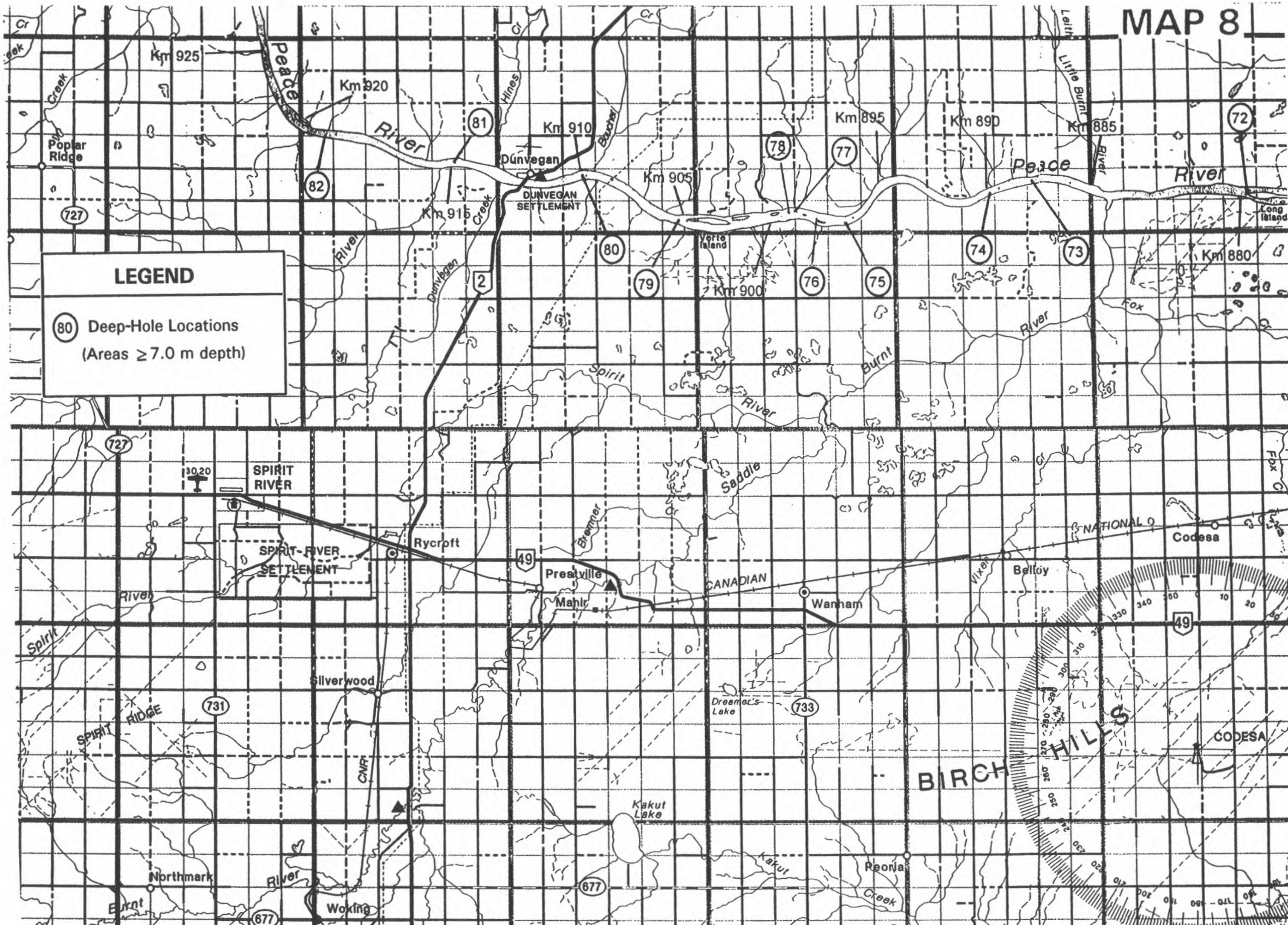

MAP 4
LEGEND
40 Deep-Hole Locations
(Areas ≥7.0 m depth)
Km 620
Km 625
Km 630
Km 635
Km 640
Km 645
Km 650
Km 655
Km 660
Km 665
Km 670
Km 675
Km 680
Km 685
Km 690
Km 695
Km 700
Km 705
Km 710
34
35
36
37
38
39
40
41
42
43
44
45
46
Twin Lakes
Twin Lakes
Nina Lake
Hawk Hills
Hotchkiss
Peace
River
Creek
CANADIAN NATIONAL
35
692
741
1400
1500
2000


MAP 5
LEGEND
50 Deep-Hole Locations
(Areas ≥ 7.0 m depth)
Peace
River
Km 715
Km 720
Km 725
Km 730
Km 735
Km 740
Km 745
Km 750
Km 755
Km 760
Km 765
Km 770
Km 775
Km 780
Km 785
Km 790
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
741
691
690
743
Buchanan
Creek
Deadwood
DEADWOOD
Rousseau
Cadotte
Little
Cadotte
River
Driftwood
Lake
Pluvius
Lake
Dixonville
Whitemud

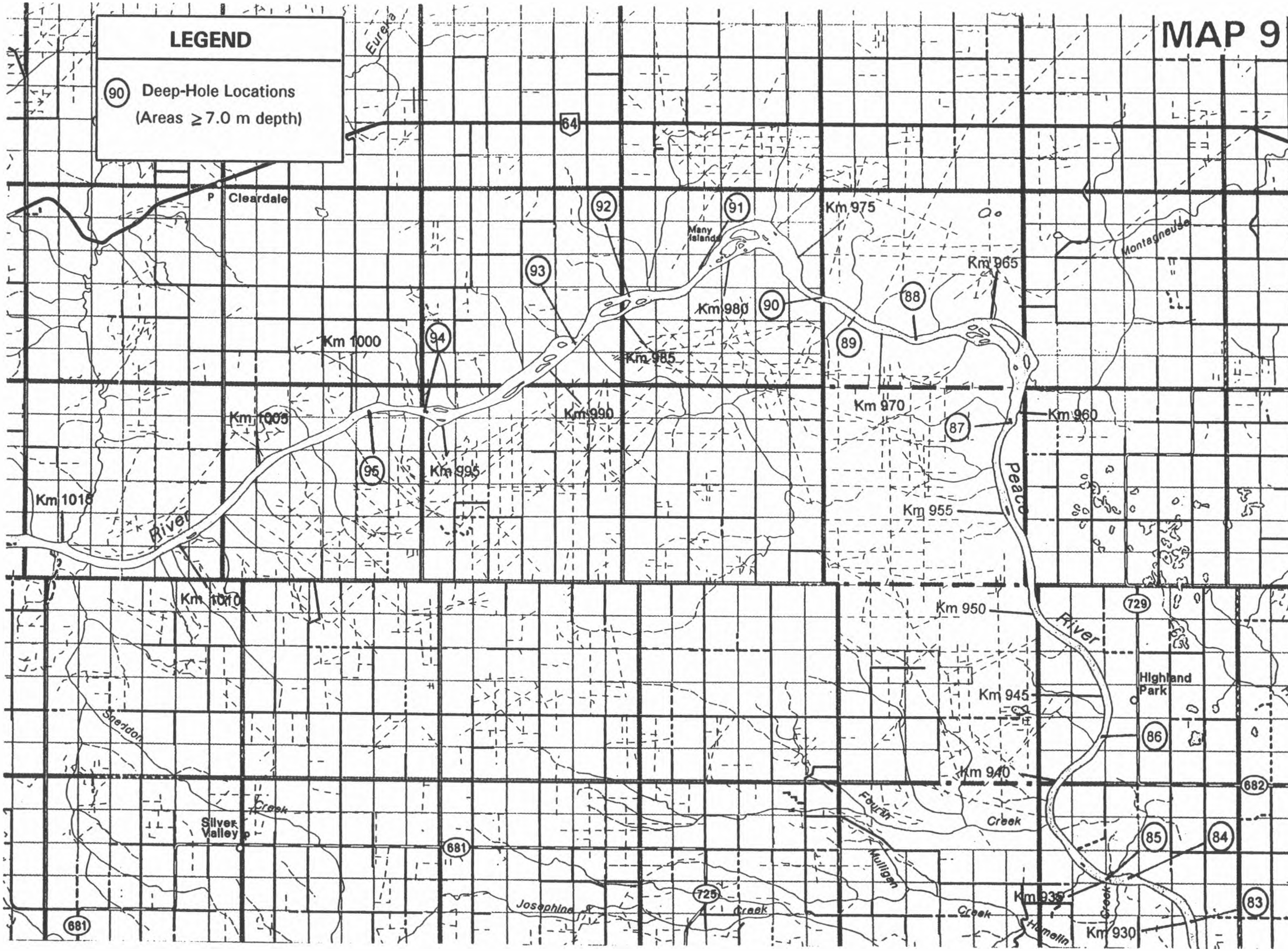

MAP 6
LEGEND
65 Deep-Hole Locations
(Areas ≥ 7.0 m depth)
Km 795
Km 800
Km 805
Km 810
Km 815
Km 820
Km 825
Km 830
Km 835
Km 840
Km 845
Km 850
Km 855
65
66
67
68
69
Peace
PEACE RIVER
Three Creeks
Wesley Creek
St. Isidore
Weberville
Bawley Island
Leddy
Lake St. Germain
Leddy Lake
Garfield Lake
Warrensville
Warrensville Centre
Cardinal Lake
QUEEN ELIZABETH PROVINCIAL PARK LAC CARDINAL
Roma Jc.
Roma
GRIMSHAW
SHAFTESBURY SETTLEMENT
Judah
Marie-Reine
Nampa
Brownvale
Berwyn
DUNCANS INDIAN RESERVE 151A
Early Gardens
FERRY
Mushkitee Island
Smoky River
Heart River
McAllister
Strong Creek
Cardinal
CANADIAN NATIONAL
686
737
35
2
2A
685
684
740
743
744
688
683


MAP 7
LEGEND
70 Deep-Hole Locations
(Areas ≥ 7.0 m depth)
Km 860
Km 870
Km 865
Km 875
Peace
River
70
71
740
739
49
744
2
679
Smoky
River
Jean Côté
Normandville
Lac Magloire
Lac Magloire
Creek
Lalby
Crow
Reno
Tangent
Eaglesham
Culp
Culp
Hunting
Creek
Girouxville
Dreau
NORTHERN ALBERTA
Donnelly
FAHLER
Watino
Little
River
Peavine
Creek
1900
1800
2100
2000
1500

MAP 8



LEGEND
80 Deep-Hole Locations
(Areas ≥ 7.0 m depth)
Peace River
Km 925
Km 920
Km 915
Km 910
Km 905
Km 900
Km 895
Km 890
Km 885
Km 880
72
73
74
75
76
77
78
79
80
81
82
Dunvegan
DUNVEGAN SETTLEMENT
Verte Island
Long Island
Poplar Ridge
Little Burnt River
Leith
Hines Creek
Buchel
Dunvegan Creek
Spirit River
Burnt River
Fox Cr
Saddle Cr
Bremner
SPIRIT RIVER
SPIRIT-RIVER SETTLEMENT
Rycroft
Prestville
Mahir
Wanham
Belloy
Codesa
CODESA
Vixen
CANADIAN NATIONAL
Silverwood
SPIRIT RIDGE
Dreamer's Lake
Kakut Lake
Kakut Creek
Peoria
BIRCH HILLS
CNR
Northmark
Woking
727
731
733
677
49
2


MAP 9
LEGEND
90 Deep-Hole Locations
(Areas ≥ 7.0 m depth)
64
Eureka
Cleardale
Many Islands
Montagneuse
Peace
River
River
Km 930
Km 935
Km 940
Km 945
Km 950
Km 955
Km 960
Km 965
Km 970
Km 975
Km 980
Km 985
Km 990
Km 995
Km 1000
Km 1005
Km 1010
Km 1015
83
84
85
86
87
88
89
90
91
92
93
94
95
729
682
681
725
Highland Park
Silver Valley
Sneddon
Creek
Fourth
Creek
Mulligan
Josephine
Creek
Hamelin
Creek
Creek


MAP 10
726
64
Eureka
River
Clear
Cleardale
Boundary Lake
717
Bear Canyon
Cherry Point
Many Islands
Km 965
Km 970
Km 975
Km 980
Km 985
Km 990
Km 995
Km 1000
Km 1005
Km 1010
Km 1015
Km 1020
Km 1025
Km 1030
Peace
River
Sneddon
Creek
Pouce Coupe R
Silver Valley
681
Fourth
Mulligan