Ontario

Manual of Instructions

Aquatic Habitat Inventory Surveys

FISHERIES BRANCH

Official Procedural Manual
Policy FI 2.03.01
Eighth Edition 1987

Ministry of Natural Resources

INTRODUCTION

The basic purpose of an inventory survey is to provide the 'First Good Look' at a body of water. Furthermore, Aquatic Habitat Inventory surveys are not intended to answer complex questions or solve problems for long-term management. The survey procedures which are outlined in this manual are designed to acquire basic knowledge of the chemical, physical and biological conditions of the lakes and streams of Ontario. The manual has been written to standardize the many methods and techniques which have been devised over the past several decades. The methods chosen for this manual have been field tested, evaluated and found to be most suited for our purposes. Revision will be necessary, of course, as new equipment and better methods are developed.

The most important principle to be followed in the collection of 'Inventory Data' is that it is essential that all observations be accurate. Inaccurate data are worthless. It is also important that the methods and instructions outlined in this manual are followed as closely as possible. There is no intention to discourage individual ingenuity; however, it is absolutely essential that standardization of data collection and documentation be maintained because people other than those familiar with the surveys use the data. All the data is stored in a comprehensive central computer storage and retrieval system which demands exacting standards (Ontario Fisheries Information System — O.F.I.S.).

The Arrangement of the Manual

The manual has been arranged to separate the Aquatic Habitat Inventory Surveys into three parts: 'Lake Surveys', 'Stream Surveys' and 'River Surveys'. Obviously, there are many identical procedures in all three types of surveys. Where duplication occurs, the procedure is first outlined in one part and is referenced in the other parts.

Within each part of the manual (Lake Surveys, Stream Surveys and River Surveys), the text is divided into three sections; 1) 'Pre-Field Activities, 2) 'Field Activities' and 3) 'Post Field Activities'. Therefore, methods and procedures are described in the logical way that they would normally be performed when carrying out the survey.

It is hoped that this manual becomes an integral part of each survey crew's basic gear and that it helps to alleviate many of the frustrations of all people associated with inventory.

Acknowledgements

We are indebted to a great many people who contributed to the evolution of this manual. To Frank Maher who initiated the Inventory Program in 1968 and guided it through its infancy, we extend our thanks.

The Large River Inventory Section was carefully guided through its completion by a steering committee composed of William Dentry, Bill Therriault and Chris Brousseau in addition to the authors.

We are also grateful to the many field personnel whose constructive criticism and comments were valuable in shaping the final product. Many of their suggestions have been incorporated into the text. As well, several hundred students field tested our ideas over the years and offered many beneficial suggestions.

Special thanks are extended to Ken Inamoto, Edit Zaj and John Ralls of Surveys and Mapping Branch who completed the artwork. Their skill turned many crude diagrams and pictures into useful illustrations. We also appreciate the editorial and technical assistance given by Dennis Stann, Bill Clark and Bill Martin in helping us bring this manual to publication.

Lastly, we are most grateful to Daryl Robinson, Hannah Ohashi, Lyne Beadmen, Joanne Marwick and Carol-Ann Gravel for their patience and skill in typing and editing and for their many helpful suggestions.

D. P. Dodge J. C. Tilt I. MacRitchie
G. A. Goodchild D. G. Waldriff

Manual of Instructions

Aquatic Habitat Inventory Surveys

FISHERIES BRANCH

Official Procedural Manual
Policy Fl. 2.03.01

Ontario

Ministry of Natural Resources

Hon. Vincent G. Kerrio
Minister

Mary Mogford
Deputy Minister

ISBN 0-7729-2430-9

First Edition published 1979, Eighth Edition 1987

Printed in Ontario, Canada

Information in this manual regarding commercial products or companies may not be used for advertising or promotional purposes and it is not to be construed as endorsement of any product or company by the Ontario Ministry of Natural Resources.

Current publications of the Ontario Ministry of Natural Resources, and price lists, are obtainable through the Ministry of Natural Resources Public Information Centre, Room 1640, Whitney Block, 99 Wellesley Street West, Toronto, Ontario M7A 1W3 (personal shopping and mail orders).

And:

Personal shopping: Ontario Government Bookstore, Main Floor, 880 Bay Street, Toronto.

Mail Orders: MGS Publications Services Section, 5th Floor, 880 Bay Street, Toronto, Ontario M7A 1N8. Telephone 965-6015. Toll free long distance 1-800-268-7540, in Area Code 807 dial 0-Zenith 67200.

Cheques or money orders should be made payable to the Treasurer of Ontario, and payment must accompany order.

CONTENTS

PART ONE
LAKE SURVEYS

PART TWO

STREAM SURVEYS

PART THREE

RIVER SURVEYS

APPENDIX

PART ONE
LAKE SURVEYS

LAKE INVENTORY

The inventory of waters, no matter whether lake, stream or river inventory, follows similar methods. In the collection of fishes, different methods can be used but the basic premise is to collect fish species from every habitat. Water chemistry uses the same methods for testing but the sampling manner is different. All in all, we have decided that rather than produce three manuals, the combination of lake, stream and river inventory into one manual would reduce duplication. People using the manual would become adept in data collection for all three waters.

SECTION ONE

PRE-FIELD ACTIVITIES

Before any field work is started there are a number of things that have to be completed. It is essential that each survey crew becomes familiar with the lake to be surveyed, and that the crew is prepared with all the necessary maps and information before they leave to start field work.

Listed below are the steps to be taken in preparing for the field.

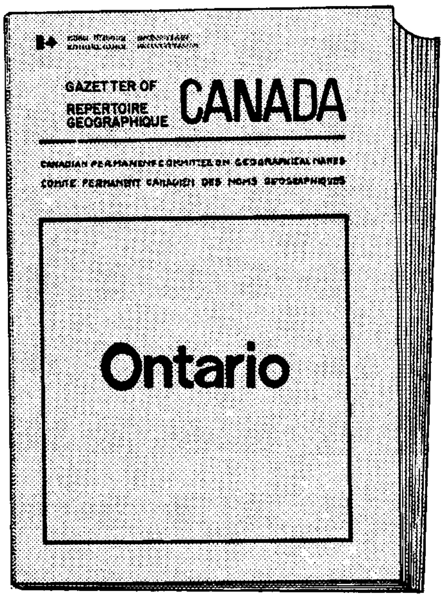
1) Obtain the necessary maps, aerial photographs, gazetteer and supplements.
2) Locate and identify the waterbody.
3) Obtain access information for the waterbody.
4) Prepare suitable copies of a work map.
5) Calculate surface area and shoreline length including island shoreline.
6) Search all available records for historical data.

CHAPTER 1

IDENTIFYING AND DEFINING WATERBODY LOCATION

Identifying by name and defining the location of a waterbody requires the use of the Gazetteer, Topographical Maps, National Watershed Code Maps and Ministry of Natural Resources District Numerical Code Lists. All are available at District Offices. This information is recorded on the Lake Survey Summary Sheet (form 1422).

1.1 The Gazetteer Name



The Gazetteer is the official source of information. Annual supplements are issued and include corrections, additions and deletions to the current edition. If the waterbody is not listed in the latest edition (1974) or subsequent supplements, (1977 being the latest) proceedings should be initiated to rectify the omission.

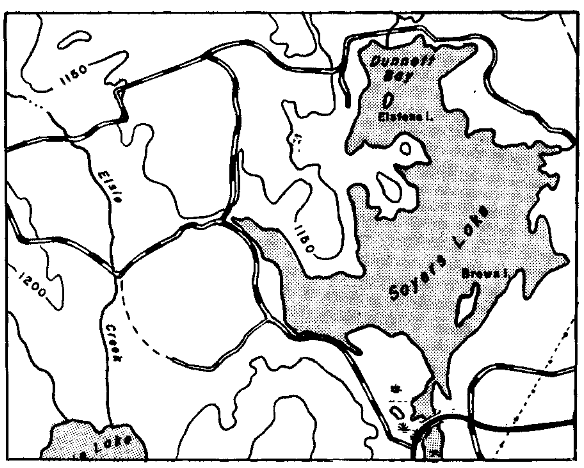
Record the name of the lake, exactly as it appears in the Gazetteer, into the box marked 'Gazetteer Name' on form 1422. If the lake is not listed, then record **NL** in this box. Nothing else is required.

Any erroneous or missing information should be reported to the Ontario Geographic Names Board, Ministry of Natural Resources, Queen's Park, Toronto.

1.2 Geographic Coordinates

The geographic coordinates of the lake, as listed in the Gazetteer, are entered in the identification key (Section A) of form 1422. If the lake is not listed **(NL)**, then locate the lake on a topographic map (1:50,000 usually) and determine its centroid (central point). Using the centroid as a starting point, rule a line at right angles to the nearest horizontal map border and another line perpendicular to the nearest vertical border. Take the degrees of latitude and longitude from the lower right hand map corner, and estimate the minute nearest to each intersection, of the above two perpendiculars, with the map border. Record these coordinates in the identification key.

1.3 The Topographic Map Name



The Topographic Map is the most common and available source of information for identifying and distinguishing waterbodies.

The 1:50,000 Topographic Maps, produced by the Canada Department of Energy, Mines and Resources, and available at most Ministry Offices, are recommended for inventory use. The name of the waterbody on the topographic map may or may not be shown and it may or may not agree with the Gazetteer name. The name of the waterbody as shown will be recorded in the appropriate box on the form 1422. If it is not named on the map, then **'Unnamed'** should be written.

1.4 Name of Topographic Map and Number

The name of the topographic map which appears at the bottom of the map and also the number and edition are recorded on the 1422 form in the appropriate box.

i.e. Vein Lake 42E/1, Edition 2

1.5 Ministry Administrative Code System

NUMERIC CODES - FIELD OFFICES
MINISTRY OF NATURAL RESOURCES

NORTHWESTERN REGION	10	ALGONQUIN REGION	50
Dryden	11	Algonquin Park (inside Park)	51
Fort Frances	12	Bancroft	52
Ignace	13	Bracebridge	53
Kenora	14	Minden	54
Red Lake	15	Parry Sound	55
Sioux Lookout	16	Pembroke	56
		Leslie M. Frost Centre	57
NORTH CENTRAL REGION	20	Algonquin Park (outside Park)	58
Atikokan	21		
Geraldton	22		
Nipigon	23	EASTERN REGION	60
Terrace Bay	24	Brockville	61
Thunder Bay	25	Cornwall	62
		Carleton - Place	63
NORTHERN REGION	30	Napanee	64
Chapleau	31	Tweed	66
Cochrane	32		
Gogama	33		
Hearst	34	CENTRAL REGION	70
Kapuskasing	35	Huronia	71
Kirkland Lake	36	Cambridge	72
Moosonee	37	Lindsay	73
Timmins	38	Maple	74
		Niagara	75
NORTHEASTERN REGION	40		
Blind River	41	SOUTHWESTERN REGION	80
Espanola	42	Aylmer	81
North Bay	43	Chatham	82
Sault Ste. Marie	44	Owen Sound	83
Sudbury	45	Simcoe	84
Temagami	46	Wingham	85
Wawa	47		

A numeric code is used exclusively in recording inventory data on the Lake Survey Summary Sheet (form 1422). Such designation provides convenience in the documentation, retention and extraction of survey data from the various filing systems.

Find the appropriate M.N.R. district number and enter it into the designated box on the 1422 form.

Maps are available in all offices indicating the M.N.R. regional and district boundaries. The approved code numbers are listed.

1.6 Local Name

Local name is self-explanatory. Often this name will differ from both the Gazetteer Name and/or the Topographic Map Name. There may also be more than one local name. In the case of a lake being in an unpopulated area or where no knowledge is available about the local name, the local name is assumed to be the same as the topographical name. If the lake has no name whatsoever, write in **"Unnamed"**. Where the lake has more than one local name, list the names with the most popular name first.

1.6.1 Naming Procedure

The following format is used when listing waterbody names on certain forms requiring a single entry.

1. If the gazetteer name and local name are identical, then only the gazetteer name is listed, i.e., Gazetteer Name.

2. If the gazetteer name is different from the local name, then the gazetteer name is listed followed by the local name in brackets, i.e., Gazetteer Name (Local Name).

   Note that the descriptive word for the waterbody type (lake, river, etc.) isn't repeated within the brackets if *its* redundant, e.g., Claribel Lake (Ahern). In cases where they differ, list both, e.g., Fairy Lake (Acton Pond), Ruisseau des Atocas (Azatika Brook), Fort Channel (French River).

3. If there is no gazetteer name listed and only a local name exists, then the local name is listed and is followed by **NL** in brackets, i.e., Local Name (**NL**).

4. If no names exist, then only **NL** is listed.

1.7 County or Judicial District and Geographic Township

Note these are listed in the Gazetteer and enter same into the appropriate boxes on the 1422 form. Be careful that the correct spelling is used. If the lake is not listed in the Gazetteer, this information will have to be taken from the appropriate Topographic Map. Be careful regarding new names and boundaries. Township refers to the Geographic township, *not* the municipal township. Unnamed territory is labelled "**Unorganized**".

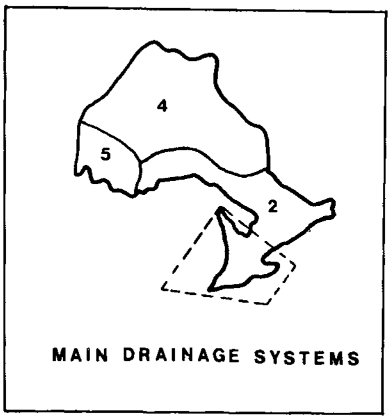
1.8 Lot and Concession

Lot and Concession may or may not be designated. These boxes need only be completed if the lake is unnamed on the Topographic Map and small enough that latitude and longitude do not accurately distinguish the lake. If lots and concessions are needed and they do not appear on the Topographic Maps, then township and county maps will have to be consulted. The Lot number is written in Arabic numerals (1,2,3). The Concession number is written in Roman numerals (I,II,III).

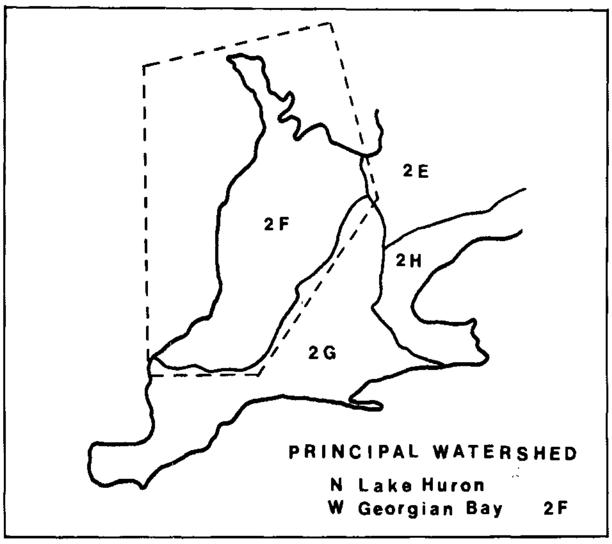
1.9 Elevation

Elevation is measured as the mean height above sea level of the waterbody. The elevation is often indicated on Topographic Maps. However, smaller lakes are not and the elevation of these will have to be estimated from the surrounding land contours and known elevations of connecting lakes. Where estimates are required use the elevation that is midway between known values, i.e. surrounding lakes and/or contour lines. Elevations in feet will have to be converted to metres.

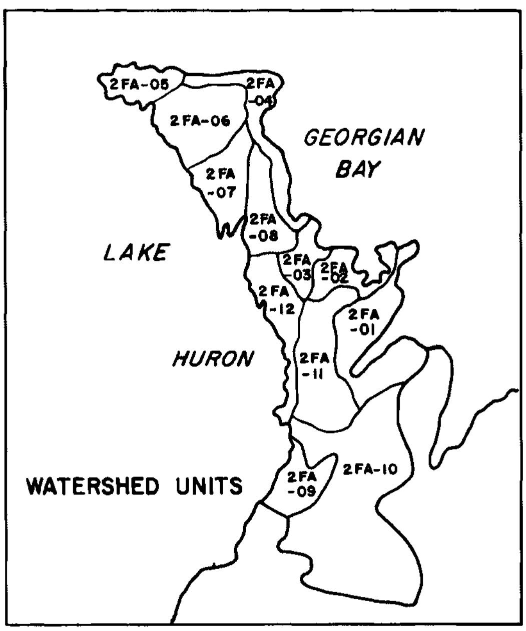
1.10 Watershed Code



The Watershed Code Maps number watersheds and drainage systems in Canada. In Ontario, there are three Main Drainage Systems: The St. Lawrence (2), The Hudson Bay (4), and Lake Winnipeg (5) (Can. Dept. Environment).



Each system has been divided into Principal Watersheds and Watershed Units. The Bruce Peninsula segment of the St. Lawrence System is illustrated. As shown in the illustrations, a combination alpha-numeric code has been developed to identify the watershed codings.



Inventory requirements are designating the waterbody to the Principal Watershed (2FA) and to the Watershed Unit Code (2FA-01). These data are entered on the 1422 form in the appropriate boxes.

1.11 Access

Access describes the manner and direction one takes in reaching a waterbody. The access description should be kept *short* but precise. More detailed information is kept in the field notes. The space provided on the 1422 form is divided into 2 parts divided by an oblique(/) stroke. The portion before the stroke refers to whether or not the public has access to the waters and is to be completed as either: **'Not Public'** when the general public is prohibited from entering; **'Legal'** when there is access through public property; **'Restricted'** when access is not available at all times or to all persons; **'Permitted'** when the public is permitted through private property. If there is a possibility of change or the access description is not clear, make a reference in the 'History and Comments' section on the reverse side of the 1422 form.

The portion of the line following the oblique(/) stroke refers to the method and direction of access. If the lake is large with many access points, a simple statement to this effect is enough. If there is one major access point, describe it in some such way as 'private road from Hwy. 11, 12 km north of Bracebridge'. A 'fly-in' lake should be described as '110 km by air N.N.E. of Ignace'. Keep the description short.

1.12 Crown and Patent Land

Using the appropriate maps in the district office, calculate the percentage of shoreline of the lake that is privately owned and the percentage owned by the crown. If the land is leased from the crown, e.g. (remote cottaging), make note of such in the 'History.' (Refer to Section 2.3 for measuring techniques.)

CHAPTER 2

PREPARATORY MAP WORK

Before starting the field work at least 4 – 5 lake outline maps are required for the following data maps:

1) Sounding transect map
2) Shoreline cruise map
3) Rough draft contour map
4) Final contour map
5) One or more extra copies to retain in files for future use

2.1 Tracing the Outline Map

The initial outline map used in the field should be traced from the appropriate 'Forest Resource Inventory' map (FRI). These four inch to one mile FRI maps have been produced by tracing directly from aerial photographs so are probably the most accurate maps that are readily available at all Ministry of Natural Resources offices. Up to date negatives and maps of reduced scales (1″ = 1 mile and 2″ = 1 mile) are readily available by requisition from Main Office. The 1:50,000 and/or 1:250,000 Topographical Maps adequately complement the base map and the aerial photographs for all the mapping and documentation requirements of these surveys. Some areas of the province are not covered by FRI maps. In these cases the best maps available should be sought.

The lake outline should be traced directly from the FRI Base Map and then enlarged, if necessary, in direct multiples of the original 4″ = 1 mile scale, i.e. 8″ = 1 mile, 12″ = 1 mile, 16″ = 1 mile.

> Although all measurements are to be in metric units, until metric scale base maps are available, the original lake outline tracing should remain 4″ = 1 mile. This scale and any enlargements can be readily converted to the equivalent metric scale as shown in Chapter 2.5.
>
> Ontario Base maps (OBM) should be used instead of FRI or 1:50,000 maps when available. Four OBM scales are available for some areas of the province.
>
> a) 1:20,000 (5.0 cm = 1 km)
> b) 1:10,000 (10.0 cm = 1 km)
> c) 1:5,000 (20.0 cm = 1 km)
> d) 1:2,000 (50.0 cm = 1 km)

The final scale of the working map will have to be decided according to the size, shape and estimated depth of the lake. As a rule of thumb, the smaller the lake the larger the scale of the map should be. The finished copy should be large enough to be of a workable size in the field but not too large that it is cumbersome. Some thought should be given to the plotting of contours after the survey is done.

2.2 Features on the Outline Map

The Outline Map will show all island outline(s); all inflowing and outflowing waters, any rock outcrops and shoal locations; the muskeg, bog and flooded areas as identified on maps and photographs. Man-made features such as settlements, railroads, highways, bridges, docks, dams and access points will also be shown. The north directional sign, and bar scale are also shown. All of these features are necessary. A complete list of features is contained in Appendix 5.

The map should be traced using an 'HB' or equivalent lead pencil or a fine pointed India ink pen (0 or 00). These materials provide for good reproduction of copies.

Lake Outline Map

Gazetteer name . . . . Trout Lake

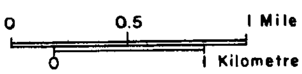
Local name. . . . . .Brown Trout Lake

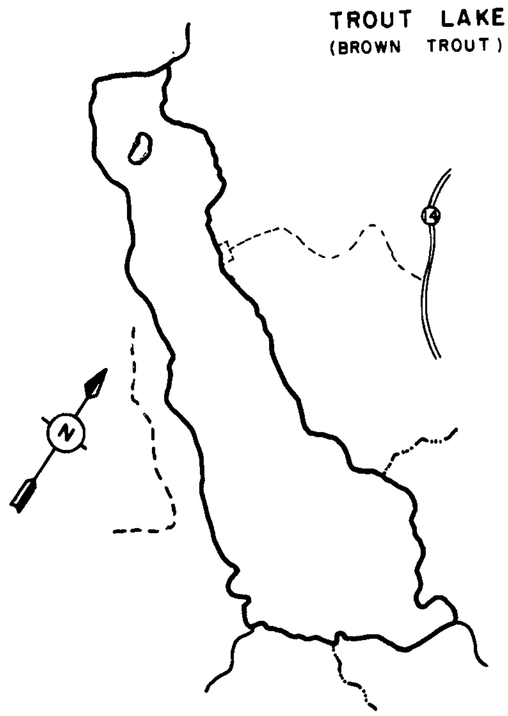
M.N.R. District. 58

Township . . . . .Dickens

Lat. and Long. . . . . .45°37'-77°57'

Area conversion factor. . . .1.03

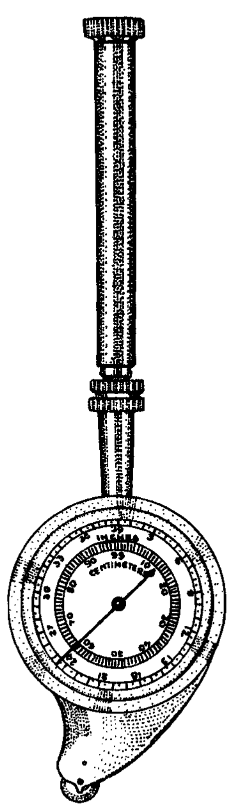




2.3 Lake Shoreline and Island Shoreline

Once the lake has been located on a FRI map the surface water area and perimeter of the lake and islands should be measured and recorded. These measurements are done first because tracings and enlargements introduce error. Enter these measurements into their appropriate boxes in Section D of the 1422 form.

2.3.1 The Map Measurer



This unit measures linear distance in centimetres or inches. The indicator needle is set at zero by rotating the tracing wheel. Measure the shoreline by tracing the outline of the figure, and then read the result from the scale. Care must be taken so that the indicator needle travels in a positive direction. Also, on a large lake the needle may travel more than once around the circumference of the dial. Therefore, the operator should keep close watch as to the number of revolutions.

Use a start/finish line on the map to eliminate most of these problems.

The shoreline in kilometres is calculated by dividing the total number of centimetres by the appropriate map scale.

e.g. map scale is 6.3 cm = 1 km (4 in = 1 mile)

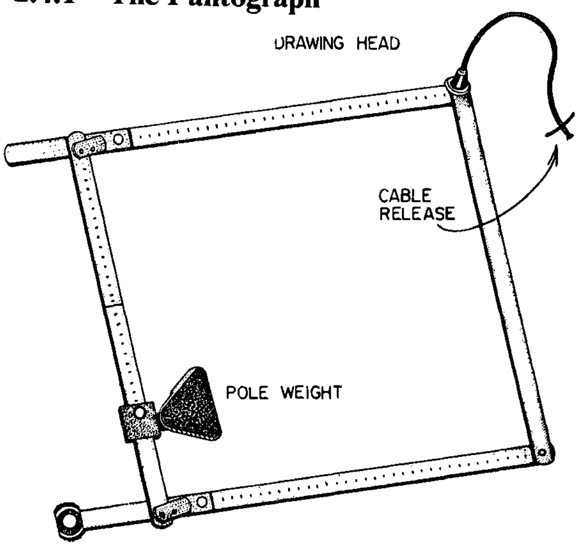
length of shoreline = 20.4 cm

$$\therefore \quad \text{perimeter} = \frac{20.4}{6.3} = 3.2 \text{ km}$$

2.4 Enlarging of Lake Outlines

The lake outline often requires enlargement to provide a suitable working size copy. Although Epidiascopic (overhead projector) and photographic techniques can be used, error and/or distortion is practically impossible to prevent. These methods should be avoided wherever possible. The most reliable method is to use the precision model pantograph.

2.4.1 The Pantograph



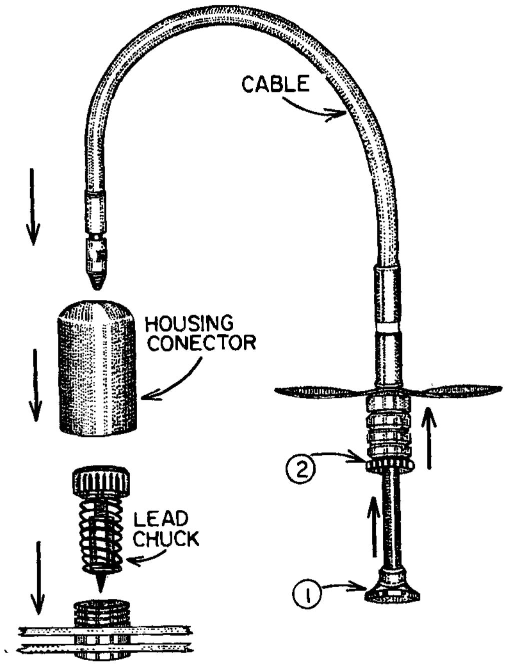
The pantograph is a simple mechanical apparatus for copying drawings, pictures, photographs and either enlarging or reducing them as required. Basically, the pantograph is a hinged parallelogram of four or five bars. The bars are of equal length and design, and graduated for setting to the desired scale ratio. Read and follow the operating instructions of the model at your disposal. Practice and use improves efficiency. The operation of the OTT Small Precision Pantograph 500 is briefly outlined below.

For enlarging, set up the pantograph as indicated in the diagram. The settings are listed below.

N.B. *All* 3 adjustable joints must be set to the same reading.

Popular Settings (Pole in middle)

Enlargement Ratio	**Setting**	
2:1	333	(doubles map size, scale)
3:1	375	(triples map size, scale)



It is important that the drawing head is assembled properly. Follow the example making sure that the knurled nut (2) is not tight. Once the parts have been connected, the graphite tip (lead) can be exposed to the tracing paper by pushing the plunger (1). Pushing the knurled nut (2) (cable release) will release the graphite tip enabling the user to quickly draw islands and other isolated features without lifting the drawing head from the table. If the graphite tip (lead) is dull or needs adjusting unscrew the knurled nut on the lead chuck and adjust accordingly.

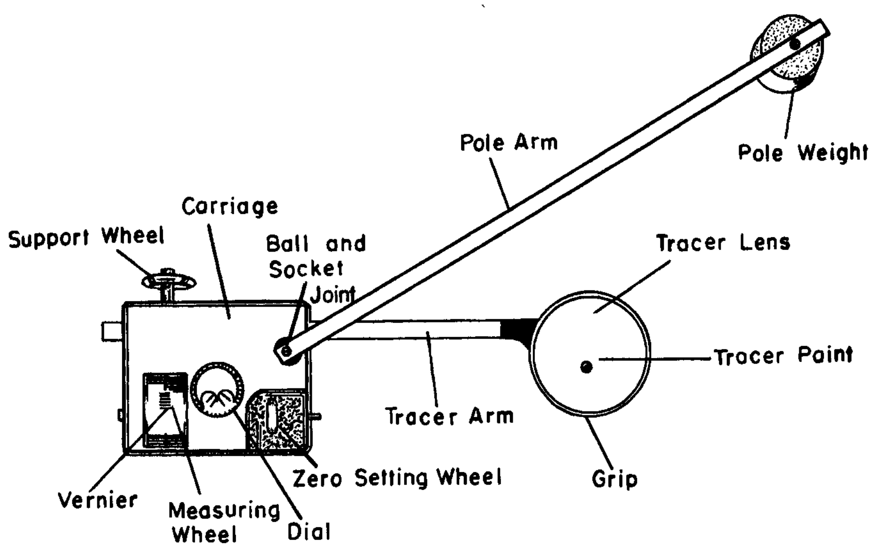
For reducing outlines simply reverse the tracer and drawing heads. If enlargements of 4x or more are required the enlargement will have to be done in 2 steps. i.e. for 4x enlargement first double the map size and then double the first enlargement. Obviously the more steps used, the more chance there is of introducing error.

2.5 Measuring the Waterbody Area

Surface area is calculated from measurements taken with an electronic or polar planimeter or by using a dot grid overlay. If available, use of the electronic planimeter, e.g. Numonics Series 1200, is recommended due to increased accuracy and efficiency. Contact Fisheries Branch for scaling factors and constants.
Lake area is defined as the surface *water* area, excluding islands. When measuring a lake with islands, be sure to subtract the area of the islands from that of the lake.

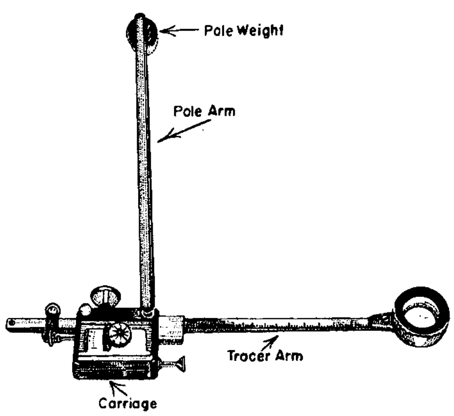
2.5.1. The Polar Planimeter

The compensating polar planimeter is a precision instrument for measuring plane areas of any form. The movement of the tracer point around the periphery of the figure causes the measuring wheel to revolve and record the distance in *Vernier units.* The Vernier units are then converted to area measurements in hectares according to the scale of the map.



To Use the Polar Planimeter

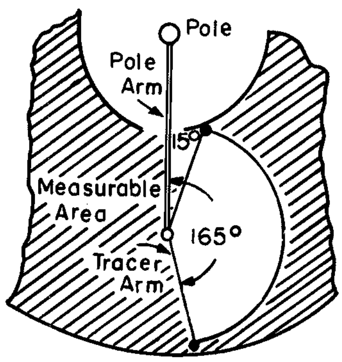
1) Place the drawing to be traced on a level and smooth surface.
2) If the planimeter has an adjustable tracer arm make sure the arm is set at the reading for "metric" given inside the carrying box.

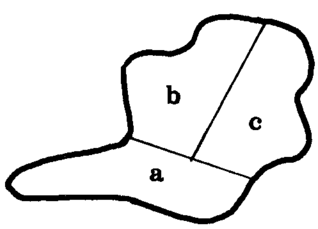


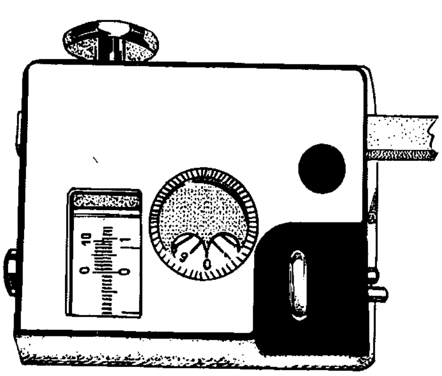
3) Position the carriage with the tracer arm parallel to the front edge of the drawing board, the tracer point to the right and in the approximate centre of the figure to be measured.

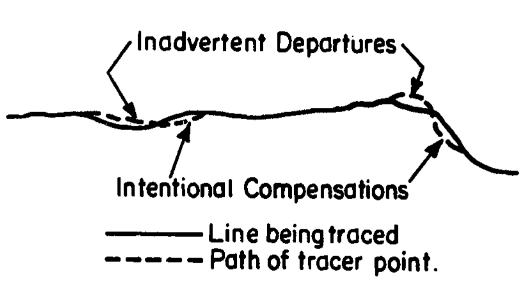
4) Insert the pole arm into its socket and move the pole weight to a position where the angle between pole arm and the tracer arm form an approximate right angle.

5) Secure pole arm.









6) Check to determine whether the tracer point will circumscribe the area within the operation limits of the instrument (15° – 165° Arc). If it does not, move the pole weight until this can be accomplished. If this is impossible, then divide the figure to be measured into as many parts as required. Measure the area of each part as a separate unit. The area of the lake will be the sum of the areas of the parts (as in example: a+b+c = area of lake).

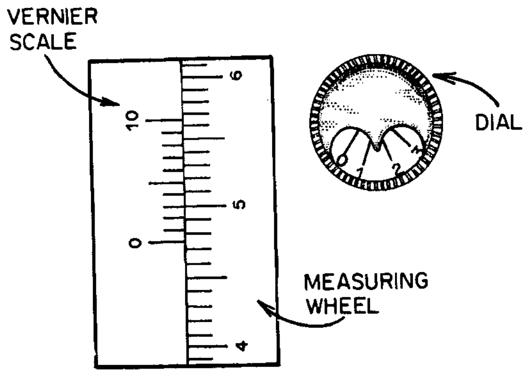
N.B. Make sure that the surface the measuring wheel runs on is not too shiny or smooth. This will cause the unit to slip and will give inaccurate readings.

7) Establish a starting/finishing point on the circumference of the figure to be measured.

8) Set the Vernier scale: — With the carriage free of the paper, rotate the zero setting wheel until the dial pointer rests on zero and the zero on both the measuring wheel and the Vernier are opposite. Set the tracer point directly over the starting/finishing mark and lower the carriage to the paper. Holding the tracing eye firmly make the final fine zero-zero measuring wheel-Vernier adjustment. See diagram. Some units have a zero setting button.

9) Circumscribe in one exercise the periphery of the figure to be measured by moving the tracer point from the designated starting/finishing point in a clockwise direction. Inadvertent departures from the drawn outline(s) can be compensated. If the tracer point accidentally departs from the line, it is not necessary to back-up and reset the Vernier scale. The tracer point may be intentionally moved the other way to compensate for the inadvertent error (see illustration).

10) Read the polar planimeter as follows:
   (a) The dial is numbered from 1 to 0 (10) and indicates the number of revolutions of the measuring wheel.
   (b) The measuring wheel is numbered from 1 to 0 (10) with each number representing 1/10 of a revolution.
   (c) Each of the 10 numbered parts of the measuring wheel has 10 graduations with each representing 1/100 of a revolution.
   (d) The Vernier scale represents 1/100 of a graduation on the measuring wheel or 1/1000 of a revolution on the measuring wheel.



The reading of the number of Vernier units from the diagram is as follows:

i) The pointer indicates *1* plus revolution of the measuring wheel (on dial).
ii) The smallest number showing on the measuring wheel is *4*.
iii) The zero line of the Vernier scale intercepts the measuring wheel between the *7th* and *8th* division of the *4th* unit. Always read the lower division, in this case it is 7.
iv) The *3rd division of the Vernier* scale *exactly* coincides with a division of the measuring wheel.

Note: Only *one* division of the Vernier scale ever coincides with a division of the measuring wheel at any one time.

Therefore, the reading in Vernier units is *1473*.

11) The area in square centimetres is calculated next by multiplying the reading in Vernier units by the appropriate factor. Each planimeter has the factor listed inside the box cover. Each planimeter has a different factor, i.e. 1473 x 0.1 = 147.3 cm^2. This represents the actual real area of the map.

12) Convert the reading to hectares, by multiplying the square centimetre reading by a map scale factor as listed in the following table:

When		Then	
British	**SI**	**British**	**SI**
1 in. = 1 mile	1.6 cm = 1 km	1 sq.in. = 640 Ac.	1 cm^2 = 40.14 ha
2 in. = 1 mile	3.2 cm = 1 km	1 sq.in. = 160 Ac.	1 cm^2 = 10.03 ha
4 in. = 1 mile	6.3 cm = 1 km	1 sq.in. = 40 Ac.	1 cm^2 = 2.51 ha
8 in. = 1 mile	12.6 cm = 1 km	1 sq.in. = 10 Ac.	1 cm^2 = 0.63 ha
12 in. = 1 mile	19.0 cm = 1 km	1 sq.in. = 4.44 Ac.	1 cm^2 = 0.28 ha
16 in. = 1 mile	25.3 cm = 1 km	1 sq.in. = 2.5 Ac.	1 cm^2 = 0.16 ha
24 in. = 1 mile	37.9 cm = 1 km	1 sq.in. = 1.11 Ac.	1 cm^2 = 0.070 ha
32 in. = 1 mile	50.5 cm = 1 km	1 sq.in. = 0.63 Ac.	1 cm^2 = 0.039 ha
x in. = 1 mile	1.58 x cm = 1 km	1 sq.in. = $\frac{640}{x^2}$ Ac.	1 cm^2 = $\frac{40.14}{x^2}$ ha

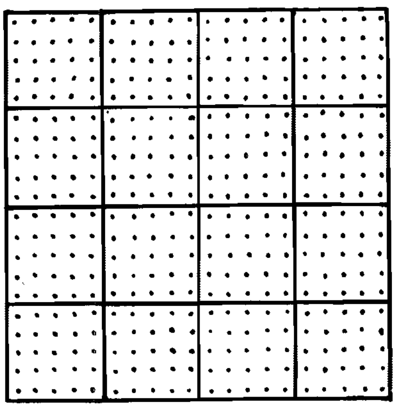
British	**SI**	**SI**
1:50,000	2.0 cm = 1 km	1 cm^2 = 25 ha
1:125,000	0.8 cm = 1 km	1 cm^2 = 156 ha
1:250,000	0.4 cm = 1 km	1 cm^2 = 625 ha
1:506,880	0.2 cm = 1 km	1 cm^2 = 2569 ha

Care and Maintenance

Planimeters are built for accuracy and long service, if properly used and maintained.

- Do not use on a sloping drawing board. If it slides to the floor, damage is almost certain.
- Clean the surface on which the instrument is being used. Grit and dirt cause unnecessary wear on the measuring wheel.
- Wipe and apply watch oil sparingly to the measuring wheel regularly and before storing. Wipe again before using.
- Check accuracy of instrument periodically by measuring a circular or rectangular figure of a known area.
- Always measure areas with the measuring wheel on paper, never on shiny wood or glass surfaces.

2.5.2 The Dot Grid



There is more than one dot grid design, but all are of the same principle. A one hundred dot per square inch transparent overlay can be used on any scale map.

Areas of plane figures are measured by counting the dots and relating them to actual area equivalents.

To Use the Grid

1) Place the grid over the feature outline or a defined section of the feature if it is larger than the overlay. Do not line up the boundaries.
2) Count the total number of dots which fall within the boundary line.
3) Count one-half of the number of dots which fall on the boundary line.
4) Total the number of dots counted and multiply by the Factor related to the Map Scale to calculate the area, as shown in the following table:

When		Then	
British	**SI**	**British**	**SI**
1 in. = 1 mi.	1.6 cm = 1 km	1 dot = 6.4 Ac.	1 dot = 2.59 ha
2 in. = 1 mi.	3.2 cm = 1 km	1 dot = 1.6 Ac.	1 dot = 0.65 ha
4 in. = 1 mi.	6.3 cm = 1 km	1 dot = 0.4 Ac.	1 dot = 0.16 ha
8 in. = 1 mi.	12.6 cm = 1 km	1 dot = 0.1 Ac.	1 dot = 0.04 ha
12 in. = 1 mi.	19.0 cm = 1 km	1 dot = 0.044 Ac.	1 dot = 0.018 ha
16 in. = 1 mi.	25.3 cm = 1 km	1 dot = 0.025 Ac.	1 dot = 0.010 ha
24 in. = 1 mi.	37.9 cm = 1 km	1 dot = 0.011 Ac.	1 dot = 0.0045 ha
32 in. = 1 mi.	50.6 cm = 1 km	1 dot = 0.006 Ac.	1 dot = 0.0024 ha
x in. = 1 mi.	1.58 x cm = 1 km	1 dot $= \frac{6.4}{x^2}$ Ac.	1 dot $= \frac{2.59}{x^2}$ ha
1:50,000	2.0 cm = 1 km	1 dot = 3.98 Ac.	1 dot = 1.61 ha
1:125,000	0.8 cm = 1 km	1 dot = 24.91 Ac.	1 dot = 10.08 ha
1:250,000	0.4 cm = 1 km	1 dot = 99.64 Ac.	1 dot = 40.32 ha
1:506,880	0.2 cm = 1 km	1 dot = 409.6 Ac.	1 dot = 165.76 ha

SECTION TWO

FIELD ACTIVITIES

There are a number of activities to be undertaken when the field work commences. They are listed below in 4 main categories.

1) Echo Sounding
2) Water Chemistry
3) Fish Sampling and Collecting
4) Shoreline Cruise

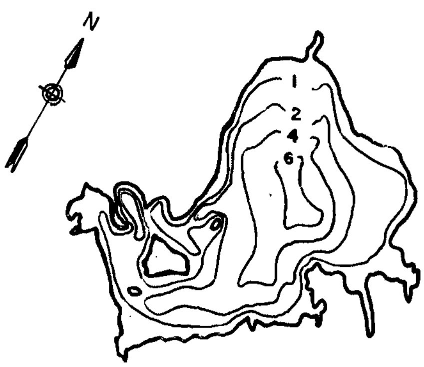
The order or manner in which they are performed will be determined by the size and shape of the lake, the weather and the time at hand.

CHAPTER 3

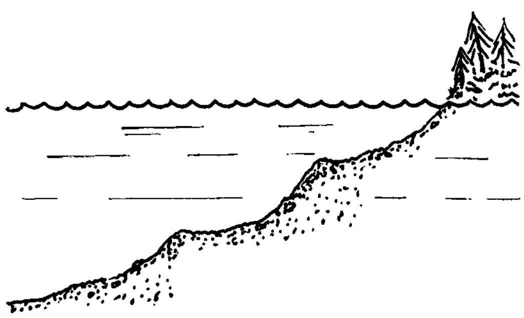
ECHO SOUNDING

The preparation of a Contour Map is essential to develop the profile characteristics of the lake basin and to calculate the volume of water.

The Contour Map



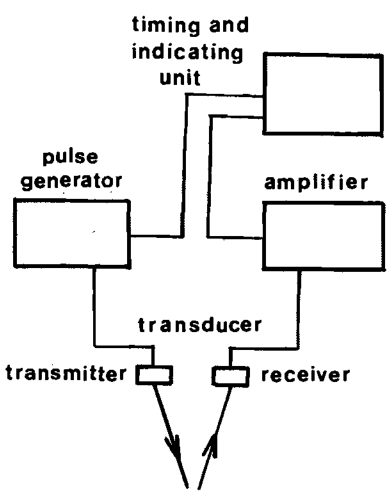
HEAD LAKE



PROFILE OF LAKE BOTTOM

The Contour Map, sometimes called a Bathymetric or Hydrographic chart is a graphic representation of the lake bottom or lake bed, as determined from depth soundings. The Contour Map reveals the extent of shallows, the degree of inclination of the lake bottom, the shoals and the deep holes. To prepare the Contour Map, the various depths of the water basin have to be measured by an echo sounder.

3.1 The Echo Sounder

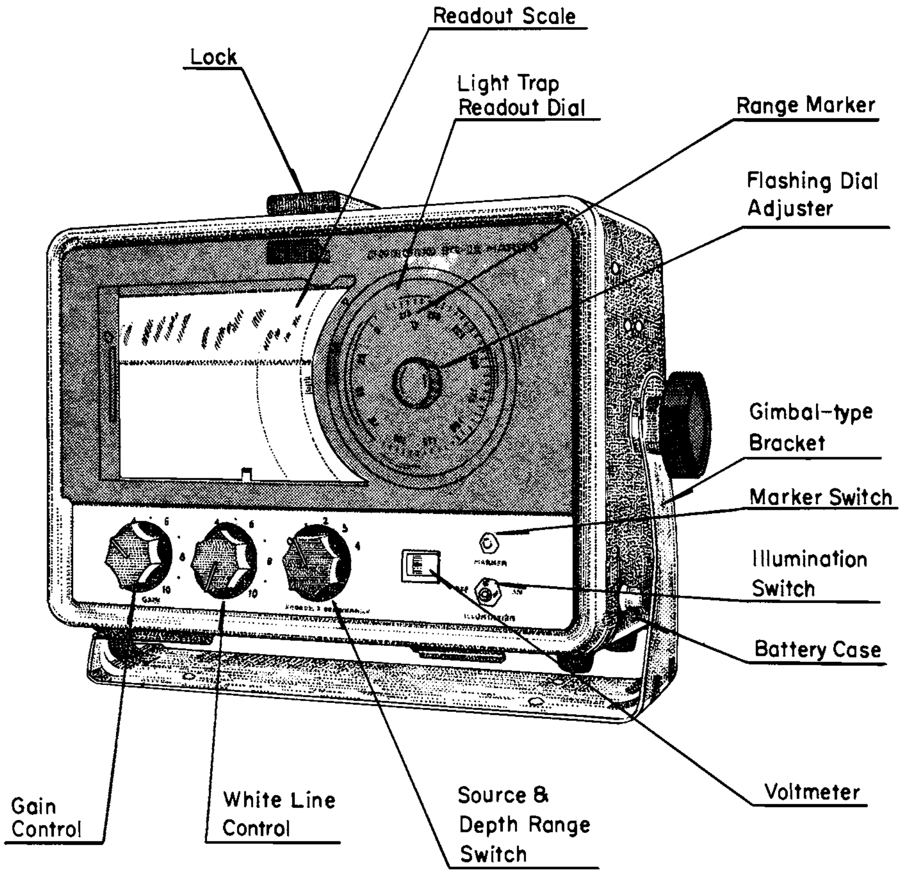


LAKE BED

There are a number of models and types of echo sounders, but all operate on the same principle — 'sonar'. This word is derived from *so*und, *na*vigation and *r*anging. Simply, sonar measures and records time between the transmission of sound through water and the reception of an echo. A schematic diagram of the principle is shown.

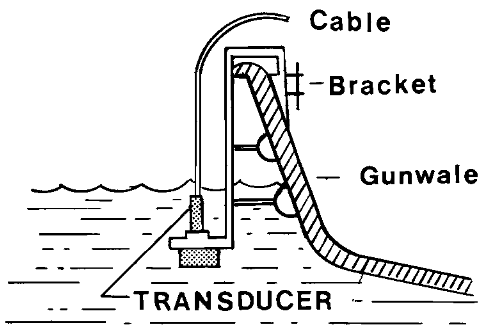
Furuno models are the more common instruments used in the program at this time although some Ferrograph models may be used.

Note: It is the responsibility of the operator to become familiar with the unit in use by reading the appropriate Instruction Manuals. Only some *common* features are expressed in this manual.

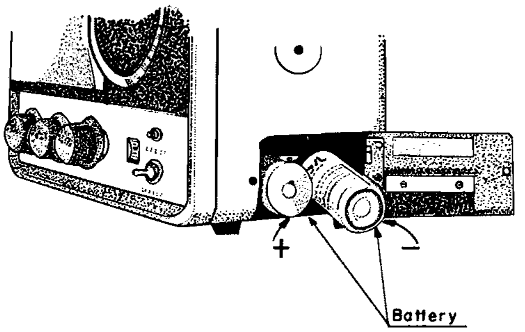


FRONT VIEW OF FG-11/200 MARK-3 FURUNO

The Transducers (transmitting and receiving unit) are tuned to a specific recording unit. Make certain that the number on the transducer corresponds with the number on the Echo Sounder. If these numbers are not legible, confirm numbers from District records and re-mark the Unit and/or Component.



The Transducer must be completely submerged in water to record properly. The face is normally secured to a bracket mounted on the gunwale of the boat. Signals will also penetrate unpainted aluminum and clear ice, as long as the face of the transducer is submerged in water, (alcohol mixture for winter operation). Polyethylene bags are used to hold the liquid in these cases.



The power supply for both the Furuno and Ferrograph units is a 12V battery (wet or dry cell). Each unit normally has a volt-meter dial to indicate the power supply strength. Furuno models should operate as efficiently with eight *transistor* dry cell batteries as with twelve volt wet cells. You can expect problems though if you use ordinary flashlight batteries.

The Ferrograph operates more efficiently on a 12 volt wet cell or for short periods on two 6 volt dry cells wired in series. The unscrewing of the scale illumination lamp bulb from its holder will maintain the necessary voltage for longer periods.

The signals received by the transducer are changed into electrical energy, magnified by the amplifier and recorded on the electro-sensitive recording paper by the rotating stylus.

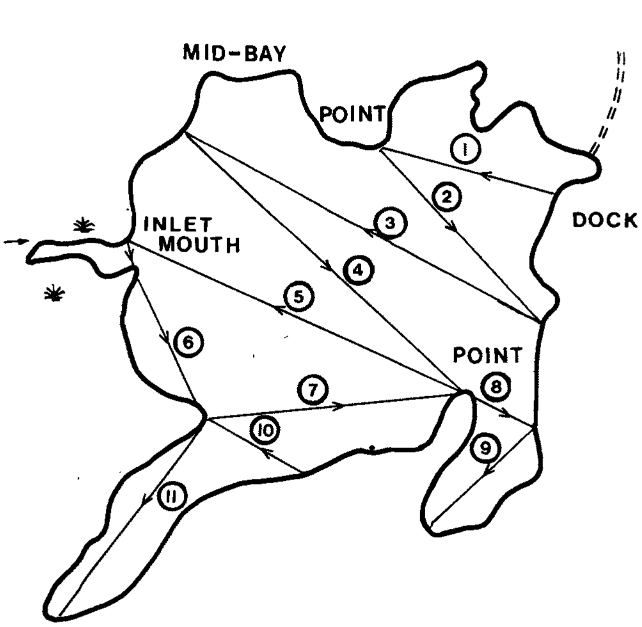
The strength of the pulse which makes the mark on the recording paper, depends on the echo that produces it. Obviously the strongest echo will be produced by the true lake bed, but it is not unusual for multiple echoes of the lake bed as well as echoes of other objects, including fish, to be recorded.

The resistance of the lake bottom to sound and consequently the number of multiple echoes, decreases with the degree of reflecting power in a rock, sand or mud bottom. The more solid the substance, the less the number of echoes.

The resistance to sound also decreases with the inclination of the lake bed. i.e. A flat lake bottom will give a better echo than a sloping one.

The degree of amplification influences both the information of multiple echo recordings and the extent of the marking on the recording paper. Adjust the gain control and refine the recording of the true lake bottom.

3.2 Echo Sounding Procedures

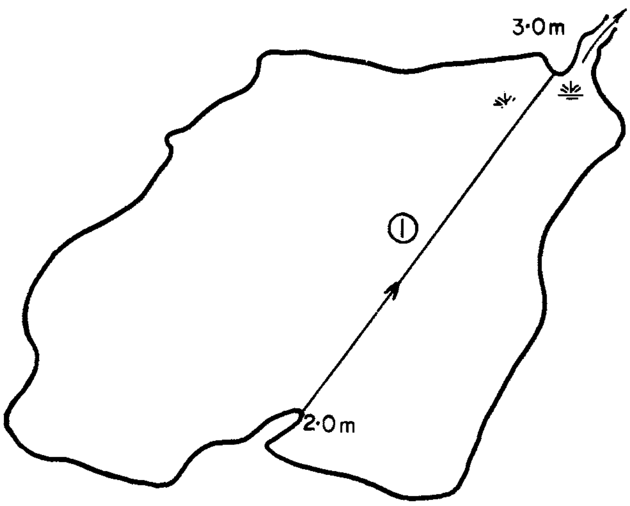


Echo sounding, i.e. running the sounding transect lines is a flexible and schematic procedure in collecting the required depth data for the production of a representative Contour Map.

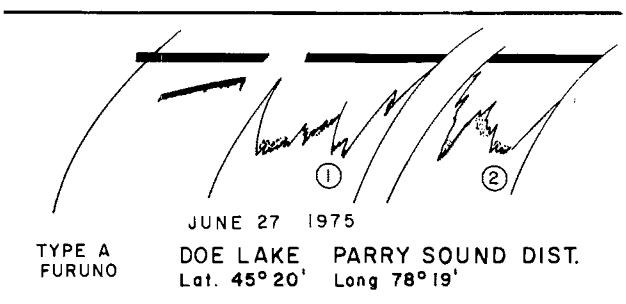
Transects must be *straight* runs from and to visible shoreline features which can be identified on the field map, (i.e. projections, centre of indentations, landmarks, etc.) Transects must be run at a *constant* outboard motor speed. Speeds may vary from line to line but *never* while running the *same* transect. If variation occurs, return to the starting point and recommence the sounding run. If the echo sounder has adjustable paper speed, it should *not* be changed during a sounding run.

Line number, direction of run and distance from shoreline(s) of the sounding recording terminals must be indicated on the transect map and on the tape. This eliminates any doubt in the interpretation of the sounding tape.

It is important to map the extent of all reefs and shoals as these are favourite feeding and/or spawning sites. This can be done by running extra sounding lines in deeper water or sounding with a weighted hand line in shallower water that is hazardous for echo sounding. A paddle with marked graduations is a handy tool for spot sounding in shallow water, i.e. behind small islands. Mark the depths directly on the 'transect map'.

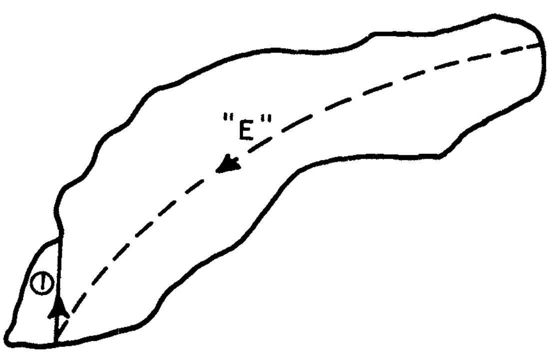


If the starting and finishing distance from shore is constant, then this can be marked on the map in some prominent position. This remedies needless duplication of effort. Otherwise, mark distance to shore at start and stop of each transect on the map.



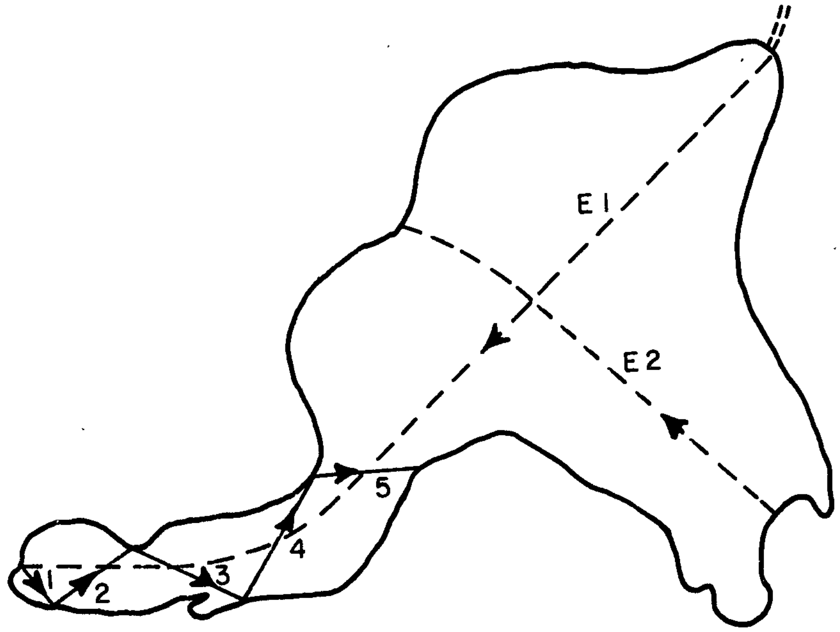
Transect line numbers on the transect map correspond with numbers marked on the tape. Date, Lake Name, District, Latitude and Longitude, and Sounder Tape Type (A or B) will be noted on each sounding tape if there is more than one.

3.2.1 The "E" Line



The "E" Line is an exploratory line and will always be the initial line run. If the basin shape is simple (reasonably oval or rectangular without indentations (bays)), then one "E" Line will normally suffice. If the basin shape is more complex, then more than one "E" Line is required. "E" Lines will be run the length of the basin or basin segment, midway between the shorelines. It may not, and it does not need to be a straight line. It will be shown as illustrated on the transect map.

The running of the number (1) sounding line will commence at or near the finish terminal of the "E" Line, see Figure below. Sounding transects (1), (2), (3), (4), (5), would be done prior to the running of the "E" 2 Line — a time efficiency procedure.

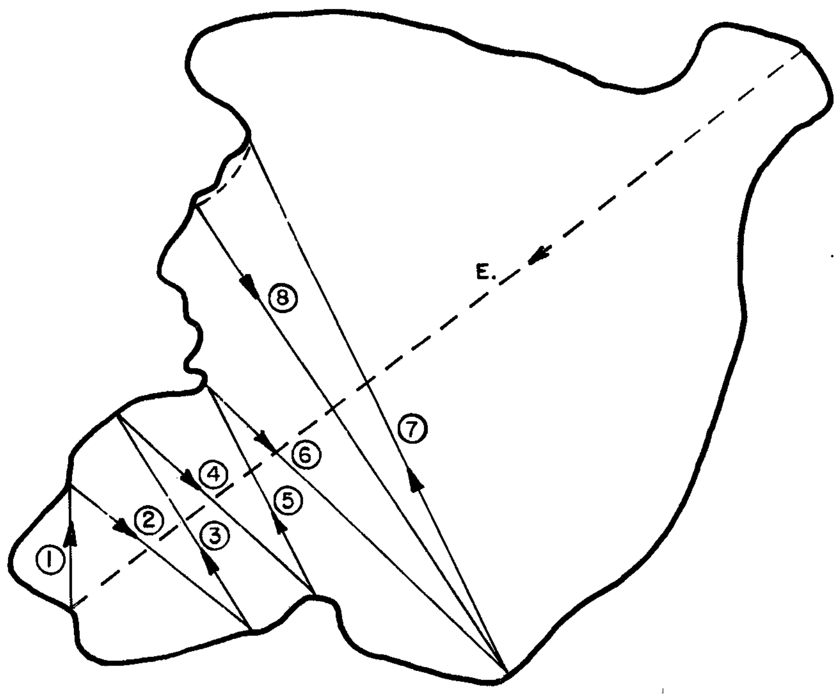


"E" Lines dictate sounding density: — The more irregular the bottom profile, the greater the number of transect lines required. It is mandatory that the lake be adequately covered by sounding lines but doing too many only wastes time and energy.

3.2.2 Transects

Transects are always run in a zig-zag fashion across the breadth of the basin(s). Eye-ball the "E" Line to determine the number and location of transects, so that underwater formations can be isolated.

Crossing transect lines should be avoided where possible as this often causes confusion when drawing the Contour Map. Also, transect lines should always be kept as *short* as possible and *perpendicular* to shore. In this way there is less chance of going off course and a constant speed can be maintained.



CHAPTER 4

WATER CHEMISTRY DATA

The water chemistry tests at a lake can only be carried out after the echo sounding has been at least partially completed. These tests combine both measurements of physical as well as chemical parameters. However, since they are all done at the same time, they are being treated as a unit in this manual. A complete chemistry test consists of all the following measurements, no less:

1) Secchi disc
2) Cloud cover
3) Water surface
4) Water colour
5) Air temperature
6) Water temperature profile
7) Dissolved oxygen
8) pH
9) Alkalinity
10) Conductivity
11) Cell temperature
12) Time

4.1 Choosing Chemistry Stations

The selection of water chemistry stations is very important. The station should reflect as much as possible the situation in the lake at the time of the survey and also if in the future more samples must be taken, this information can be used as time sequence data. Too few stations tell little about the lake while on the other hand, too many can provide little additional information and contribute to great time losses. Each station is given a number and this number is entered on the 1422 form. The station at the *deepest* part of the lake should be labelled *number one* regardless of whether it is done first.

4.2 Basin Differentiation

Surveyors should keep in mind that the inventory program must describe for the first time many characteristics of the waterbody. In order to undertake this, the following criteria are recommended as guidelines in establishing chemistry stations:

1) The number one chemistry station should be conducted in the deepest basin of the waterbody. If the echo sounding tapes indicates more than one basin of equal depth (with ± 5 metres), then sample each basin at the deepest part.
2) If there is a basin in proximity to an inlet(s) and/or an outlet(s), a sample station should be set up. However, do *not* sample where there is movement of water since these data will reflect the inlet characteristics and not those of the lake. Also, if the discharge is less than 0.5 m^3/s a station is not required.
3) If a basin is 75% of the maximum depth of the deepest basin of the waterbody, a sample station should be set up.
4) If there are bays that are isolated from the main body of water, it is advisable to set up a station.
5) As a rule of thumb, there should be at least one chemistry station for every 250 hectares of water surface area.

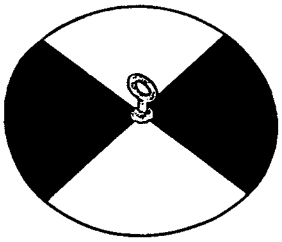
4.3 Time of Day

Water chemistry measurements in *lakes* are performed during the solar mid-day hours, i.e. between 1130 hours and 1400 hours.

4.4 Water Transparency

Transparency describes the extent of light penetration into water. As light plays an important part in many biological processes, this measurement must be performed accurately. Transparency is always measured at the time of each and every chemistry test. If the chemistry tests are done before noon the transparency tests are done on completion of the chemistry tests. If in the afternoon, transparency is done first so as to get the reading as close to high noon as possible.

4.5 Secchi Disc



Transparency in lakes is measured with a weighted metal disc, twenty centimetres in diameter with alternate white and black quadrants. This instrument is known as a *secchi disc*. A line, graduated in metres and centimetres is attached to the disc.

To obtain a Secchi disc reading

1) Lower the disc into the water on the shady side of the boat and note the depth at which the disc *disappears* from view in descent.
2) Raise the disc and note the depth at which the disc *reappears* in ascent.
3) Calculate and record the arithmetic mean of these two readings. *This* is the secchi disc reading.
4) **If the lake bottom is contacted during visual descent, record station depth for secchi depth.**
5) **Record water surface conditions, cloud cover and time as listed below.**

Note: Sunglasses are *never* worn when taking secchi disc readings.

4.6 Water Surface Conditions

Surface conditions will alter the secchi disc readings. Therefore, it is important that these conditions are recorded when the test is performed. The various categories are listed below:

Calm	— complete absence of wind glass like appearance of water
Rippled	— lightly ruffled — not more than a 2 cm rise in the undulations
Wavy	— ruffled — not more than a 5 cm rise in the undulations
Rough	— waves more than 5 cm in height

N.B. Chemistry tests should not normally be done in rough conditions.

4.7 Colour

The colour reading is a superficial determination. Due to the great variation in water colours and the variability between surveyors in discriminating colour, only 3 colour categories are given. These are yellow/-brown, blue/green and colourless.

The best method to use in determining water colour, is to fill a clear glass container with water and hold a piece of white paper behind it. Observing colour of the white quadrants of the secchi disc while it is under water is another good method.

4.8 Cloud

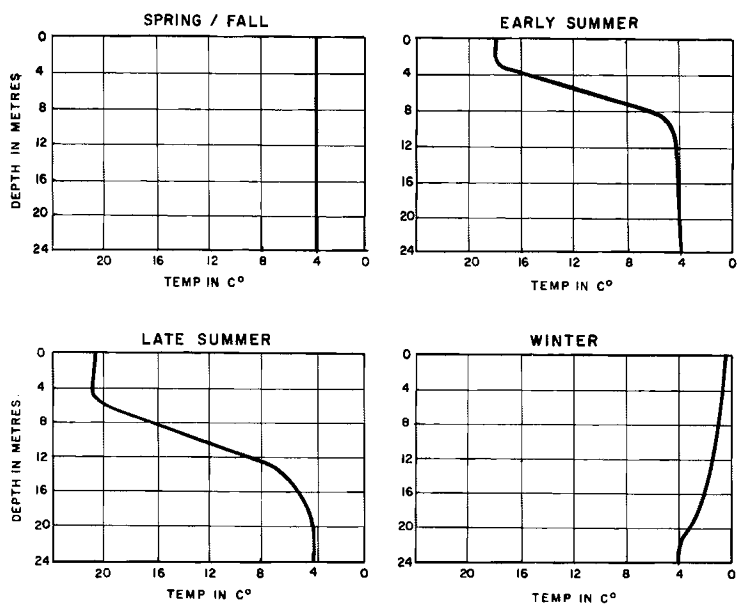
An estimation of the total cloud cover is given as a percentage of the total sky visible. A clear sky is indicated as 0%.

4.9 Time

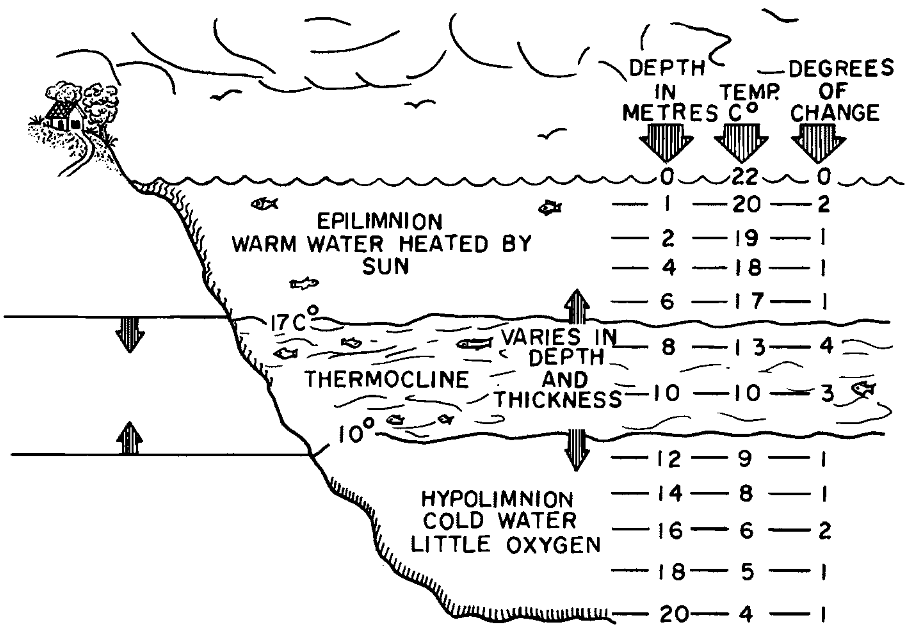
The time of the secchi disc reading is recorded in the appropriate box following cloud cover.

4.10 Thermal Properties of Lakes

Water temperature, as a single factor, is recognized as one of the more important factors in determining habitat and quality for fish survival and production. Water has the unique attribute of reaching maximum density at a temperature of four degrees celsius (4.0°C), at which time there is free mixing or circulation of water — regardless of depth. In winter, when there is an ice cover, the temperature of the water below the ice is relatively uniform, ranging between 1.5°C and 4.0°C, from surface to bottom. The temperature at the bottom of the lake will probably be 4°C. In spring and fall, as the air and water temperatures change, uniform temperatures of 4°C develop through the depths with the result that there is free vertical mixing. Wind action will complete the mixing action enabling all the water to become oxygenated at this time. As summer progresses, water temperatures increase and resistance to vertical mixing becomes more pronounced, at which time a condition known as thermal stratification may be evident in most of our deeper lakes.



4.11 Thermal Stratification



Stratification is the result of the vertical heating of water in a lake basin. A series of vertical temperature records, taken at two metre depth intervals from top to bottom, is illustrated in the diagram above.

Such vertical temperature series may show three distinct temperature layers of water known as:

4.11.1 EPILIMNION

The upper layer of water of the lake in which the water temperature remains essentially warm and rarely drops more than 2°C per 2 metre interval.

4.11.2 HYPOLIMNION

The lower layer of water of the lake, in which the temperature remains uniformly cold from its upper limit to the bottom, and rarely drops more than 2°C per 2 metre interval.

4.11.3 THERMOCLINE (Metalimnion)

The mid-layer of the lake in which there is the most rapid decrease in water temperature. The upper and lower limits of this layer are determined from the Epilimnion and Hypolimnion deductions.

The temperature in the thermocline usually drops more than 2°C per metre or more than 3-4°C per 2 m sampling interval (1°F per foot). The lake in the preceding illustration will continue to change through the summer months. The thermocline band will spread and sink deeper. The epilimnion increases in size and the hypolimnion shrinks. Energy from the sun causes the water in the epilimnion to continue warming.

N.B. There must be a distinct epilimnion and hypolimnion in order to have a thermocline.

4.12 Water Temperature Series

A vertical temperature series in lakes is recorded at all water chemistry stations, i.e. as outlined in Section 4.2. Proceed as follows:

1) Measure and record the air temperature by use of a *dry* bulb thermometer, in the shade over the side of the boat and near the water surface. Don't let the thermometer get wet.

2) Observe and record the water temperature at each of the surface and one and two metres below the surface. Continue at 2 metre intervals, i.e. 4 m, 6 m, 8 m until the lake bottom is reached or the water temperature reads 4°C.

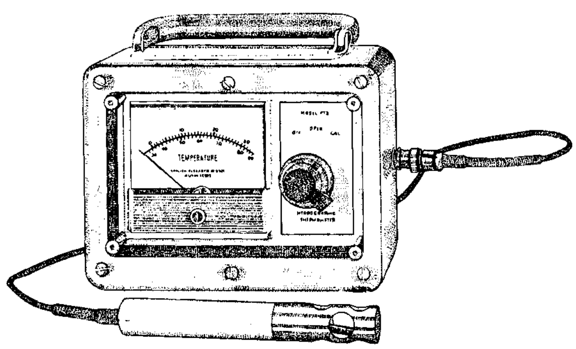
3) Water temperature recordings are waived in the 4°C temperature depths — *BUT* temperatures will be taken and recorded *one* metre above the bottom and *midway* between the bottom and upper 4°C temperature recording.

4) Stations less than 10 m deep should have the temperature recorded at one metre intervals.

5) In addition, water temperatures must be taken and recorded at *all* depths where water chemistry tests are made, e.g. mid-thermocline and the four mg/L dissolved oxygen level.

4.13 The Survey Gear for Taking Water Temperatures

Hydrographic Thermometers and Maximum/Minimum Thermometers are used to determine water temperatures.



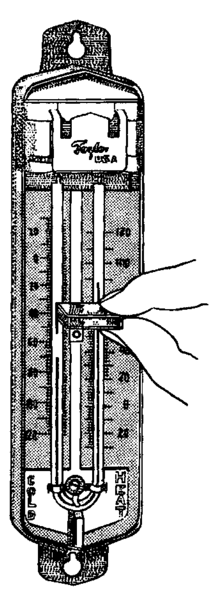
HYDROGRAPHIC THERMOMETER

The YSI Telethermometer and the Hydrolab Hydrographic Thermometer are the most common battery operated units in use at this time.

Both units consist of a sensitive direct current meter and a calibrated bridge network that contains a temperature sensitive resistor called a thermistor. All thermometers must be standardized.

To Take Temperatures:

Max/Min THERMOMETER



1) Lower the sensor probe of the thermistor unit or the maximum/minimum thermometer to the desired depth of water by means of a graduated (in metres) cable or line.
2) If using a thermistor, record the temperature reading on the dial face and the corresponding water depth, after the meter needle has stabilized (5-10 seconds).
3) If using a maximum/minimum thermometer, leave it suspended at desired depth for at least one minute, lift, and record the temperature from minimum side reading and the corresponding water depth.

N.B. Refer to Unit Operator Manuals for maintenance and calibration instructions.

4.14 Chemistry Measurement Series (Lakes)

A vertical chemistry measurement series is developed at each water chemistry station. That is to say, a water temperature, dissolved oxygen, total alkalinity, pH and specific conductance test must be completed according to the following criteria. A secchi disc reading and the accompanying data are recorded for each sample site.

1) A water sample shall be tested from at least 3 water depths, i.e.,
   (a) 2 metres below the water surface
   (b) 2 metres above the lake bed (to the nearest metre)
   (c) mid-depth to the nearest metre (or mid-thermocline if thermal stratification is evident)

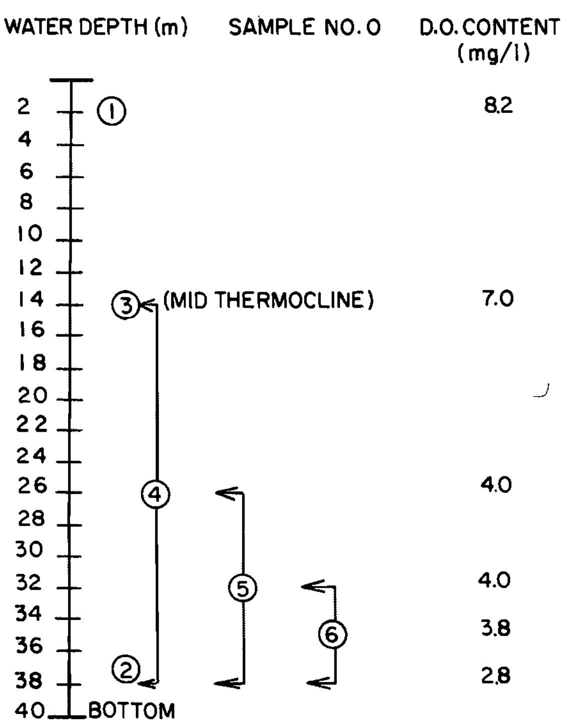
2) If the station depth is less than 6 metres then a water sample is tested from,
   (a) 1 metre below the surface
   (b) 1 metre above the lake bed
   (c) mid-depth

3) When the station depth is less than 4 metres omit the mid-depth sample.

4.15 Finding the 4.0 mg/L Dissolved Oxygen (D.O.) Cut-off

Additional samples are taken when the dissolved oxygen content drops below the 4.0 mg/L level. When this happens, it is necessary to locate the depth that the D.O. content drops *below* 4.0 mg/L. It is not adequate to only just locate the 4.0 mg/L depth as there is usually a layer of water several metres deep with this D.O. content. The cut-off point should be located within 2 metres of the deepest 4.0mg/L reading.

N.B. Whenever a *D.O.* reading is taken all the other required tests are performed, i.e., water temperature, pH, alkalinity, conductivity, cell temperature.



To locate the depth of the 4.0 mg/L dissolved oxygen cut-off proceed as illustrated in the diagram.

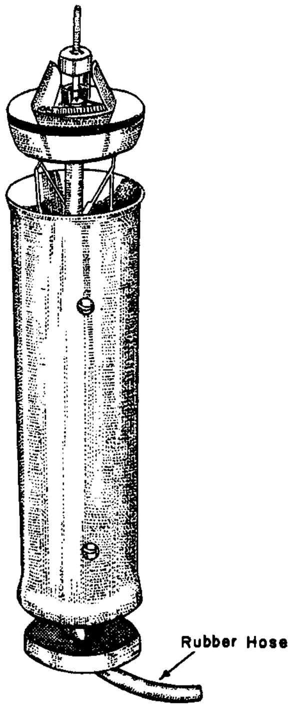
1) Collect the first additional (4) sample midway between the levels at which the dissolved oxygen content is above 4.0 mg/L and below 4.0 mg/L.
2) Measure the D.O. content.
3) If the D.O. reading is 4.0 mg/L or greater, sample between the preceding sample (4) and the bottom as illustrated by (5).
4) If the D.O. is still 4.0 mg/L or greater, sample between sample (5) and the bottom as illustrated by (6).
5) Continue to sample until the D.O. value is less than 4.0 mg/L.

As can be seen from the example chart above, the dissolved oxygen cut-off point is between 33 m and 35 m.

4.16 Collecting Methods (water sampling)

Two devices for collecting the water sample for chemistry measurements are recommended. These are the Kemmerer Bottle and the Van Dorn Bottle.

4.16.1 The Kemmerer Bottle



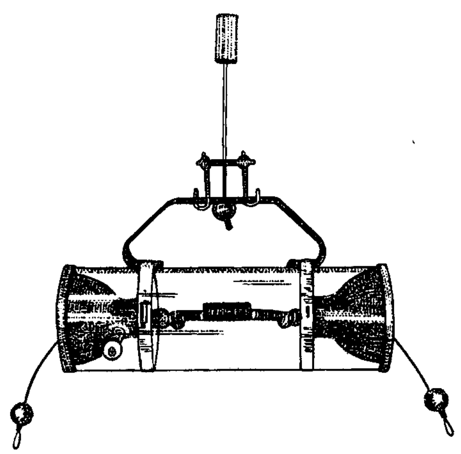
KEMMERER WATER SAMPLER
(1200ml)

The vertical type Kemmerer bottle, as illustrated, is brass or plastic in construction and is available in different sizes. The most common 1200 model is 6.5 cm in diameter, 64 cm in length and weighs approximately 3 kg.

The unit is secured by a graduated braided nylon line not exceeding 5.0 mm in diameter for lowering and/or suspension in water.

The mechanism to close the stoppers and isolate the water at desired depths is controlled by the striking impact of a 300 g split or solid brass component, called a messenger. It is released by the operator once the bottle is located at the desired depth.

4.16.2 The Van Dorn Bottle



HORIZONTAL VAN DORN BOTTLE

The Van Dorn bottle as illustrated is a sampler made of non-metallic components. The body and drain valves are constructed of P.C.V. plastic or clear acrylic. Closure of the bottle is by means of a messenger similar to the Kemmerer Bottle. The Van Dorn bottles are available in many sizes and come in two types. One is a vertical sampler, the other is a horizontal type. The model illustrated is a horizontal unit.

4.16.3 To Use the Kemmerer and Van Dorn Bottles

1) Remove from the case and check to ensure that the graduated line is not frayed and is securely fastened to the bottle. Fraying usually takes place where the messenger strikes the closing mechanism.

2) Ensure that the messenger is securely attached to the line.

3) Secure the free end of the line to the boat (a safety precaution).

4) Ensure that the end stoppers on the bottle are extended and locked in the open position (to permit water flow through the tube during descent).

5) Flush the interior of the tube with the surface water at the site of the chemistry station.

6) Lower the bottle to the desired sampling depth with one hand while holding on to the messenger with the other.

7) Release the messenger, *only* after the bottle has rested at the desired depth level for a period of at least thirty (30) seconds.

8) Check for water leakage when the bottle is raised to the surface before proceeding with any tests. Such leakage alters dissolved oxygen content. Repeat steps 4 to 7 if there are any signs of a leak.

N.B. All bottles *must* be equipped with 15 cm of rubber hose on the drain tap. This is mandatory for the dissolved oxygen sample.

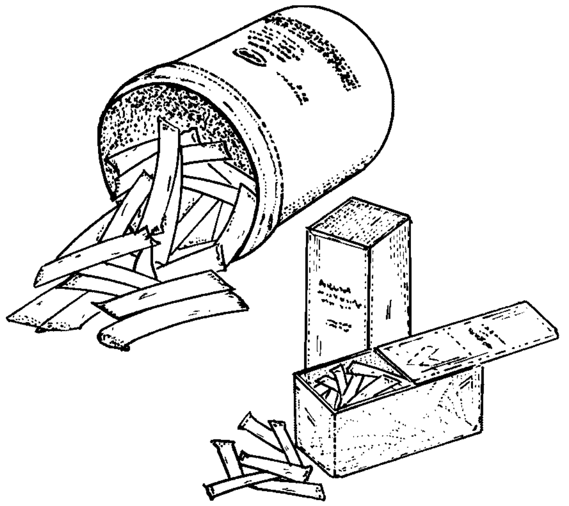
4.17 The Dissolved Oxygen (D.O.) Test

Dissolved oxygen is mainly derived from:
- (a) air mixed in water by turbulence and
- (b) photosynthetic processes by chlorophyll-bearing aquatic plants

Dissolved oxygen is mainly used or lost by:
- (a) respiration by the inhabiting animals and plants
- (b) decomposition of organic matter
- (c) reduction in volume by another gas (carbon dioxide, methane) dissolved in water
- (d) increasing temperatures

To Measure the Dissolved Oxygen Content

The dissolved oxygen test will always be done *first* in water chemistry testing (after temperature profile).



Whether the Hach DR-EL or AL36 kit is used, the dissolved oxygen test procedure is identical. Premeasured dry powdered Manganous Sulphate (D.O.I), Alkaline Iodide-Azide (D.O.II) and Sulfamic Acid (D.O.III) pillows are used. Each pillow contains sufficient reagent for one test. The polyethylene container is easily opened with clippers or a sharp knife. The dissolved oxygen content is determined by adding Phenyl Arsine Oxide (P.A.O.) solution.

To measure the dissolved oxygen content, proceed as follows:

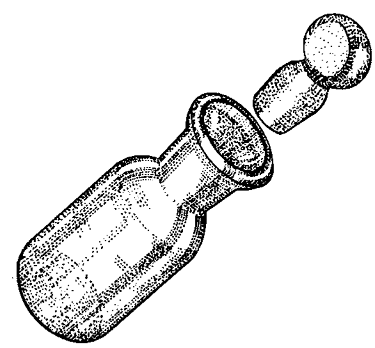
1) Fill the 60 mL glass stoppered D.O. bottle (1909-02) with water to be tested from the Kemmerer bottle or from the water pail (stream surveys). In both cases, the rubber or plastic tubing is inserted to the *bottom* of the D.O. bottle.

2) Release the water through the tube on the Kemmerer by depressing the spring loaded drain valve assembly. Siphoning is required to obtain flow through the tube from the pail, (avoid undue agitation of the Kemmerer sample and sample bottle during this transfer of water).

3) Allow the water to overflow the bottle for at least ten seconds before removal of the delivery tube.

4) Add the contents of a D.O.I. pillow (catalogue stock number 981) and then the contents of a D.O.II pillow (982)

Note: All the contents must go into the bottle. If there is any loss, start again.



5) Stopper the bottle in a manner to prevent trapping air bubbles in the bottle. Incline the bottle somewhat and insert the glass stopper with a quick thrust.

6) Pour any excess water off the rim and invert several times to mix, holding thumb or finger over the stopper. A flocculent precipitate of brownish-orange will form if dissolved oxygen is present.

7) Allow the sample to stand until the floc settles and leaves the top half of the solution clear.

8) Again mix by inverting, as above, and allow floc to settle. Allowing the floc to settle twice ensures the chemicals have reacted with all of the dissolved oxygen present.

9) Remove the stopper and add the contents of D.O.III pillow (987). Re-stopper and shake to mix. The floc will dissolve and a yellow colour will develop if oxygen is present. This is known as the prepared sample, i.e., the dissolved oxygen content is now fixed.

10) Pour off contents of the D.O. bottle until the level reaches the 29 mL mark on the bottle.

11) Add the P.A.O. solution (1079) dropwise by holding dropper in a vertical position and agitate after each drop to mix. Count each drop until the sample is colourless when viewed against a white background.

12) Calculate the dissolved oxygen content. Each drop of P.A.O. added to the sample is equal to 0.2 mg/L. dissolved oxygen. (See chart on next page.)

13) Record the test information on the 1422 form.

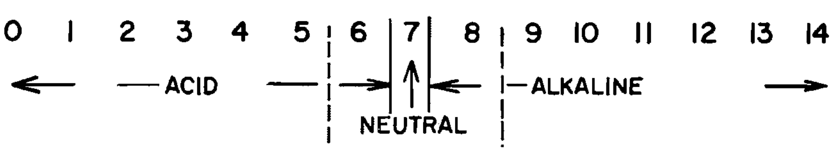
N.B. In most cases, the dissolved oxygen content does not exceed 14 mg/L. However, if readings are near or above this value, re-do the sample to verify the previous test. Dissolved oxygen readings for surface waters range from 6 to 10 mg/L while values of 0-4 mg/L are not rare in deep basins. If values exceed 14 mg/L on retesting the sample, the cause could be algae blooms or severe turbulence caused by wind previous to the sampling (rare). Be suspicious of abnormal readings.

Dissolved Oxygen

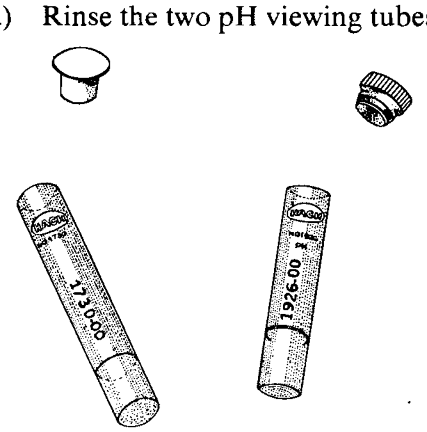
No. of Drops of P.A.O.	D.O. in mg/L	No. of Drops of P.A.O.	D.O. in mg/L
1	0.2	15	3.0
2	0.4	20	4.0
3	0.6	25	5.0
4	0.8	30	6.0
5	1.0	35	7.0
6	1.2	40	8.0
7	1.4	45	9.0
8	1.6	50	10.0
9	1.8	55	11.0
10	2.0	60	12.0

4.18 The pH Test

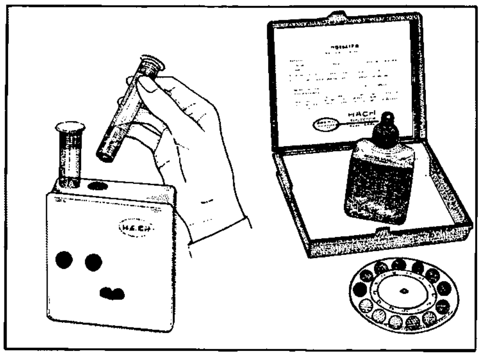
pH is an expression of the free hydrogen ion activity not bound by carbonate or other bases. It is expressed as the logarithm of the reciprocal of the hydrogen ion activity in moles per litre at a given temperature. pH is measured on a scale of 0 (very acidic) to 14 (very basic). Pure water at 25°C is neutral and has a pH of 7. The pH value represents the instantaneous hydrogen ion concentration rather than the buffering capacity or the strength of the acid or base. Most waters in Ontario range in pH value from 5.5 to 8.5.



1) In AL36 model Hach Kits
   (a) Rinse the two pH viewing tubes (1730-00 or 1926-00) 3 times with the water to be sampled.



   (b) Fill each tube to the 5 mL mark with the water to be sampled.
   (c) Insert one of the samples into the *outer recess* of the comparator box.
   (d) Add six (6) drops of the wide range pH reagent (216) to the other sample. When adding the drops, the dropper must be held in a vertical position.
   (e) Stopper this sample tube and swirl to mix the reagent solution and water sample.



(f) Insert the prepared sample in the *inner recess* of the comparator box.

(g) Hold the colour comparator box up to the light such as the sky or light coloured backdrop and view the water colours in the tubes through the openings in the front.

(h) Rotate the colour disc until the best colour match is made with the pH colour disc and the prepared sample.

(i) Read the pH value from the scale through the viewing window. Do *not* estimate a value midway between colours.

(j) pH values are only accurate to 0.5 pH units. If, however, the colour appears to lie between the colour discs, select the lower value.

A word of caution concerning the pH disc, catalogue number 1919. Since the small colour discs in the wheel fade on exposure to sunlight, try to minimize the exposure time when conducting pH tests. All M.N.R. pH discs were standardized as of January 1, 1978. If there are any questions regarding the pH readings obtained, please contact your immediate supervisor who will relay the problem to Main Office, Toronto.

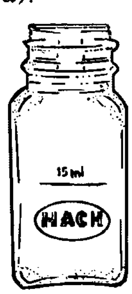
4.19 The Total Fixed Endpoint Alkalinity Test (T.F.E.)

Alkalinity refers to the capability of water to neutralize acids. Alkalinity is also referred to as "a measure of the buffering capacity of water". In neutral waters, alkalinity most commonly occurs, when carbonates, bicarbonates and hydroxides of calcium, magnesium and sodium metals are present. The level of alkalinity depends directly on the source of the water. Waters originating from granitic rock (Precambrian Shield) usually have total alkalinity values between 0 and 50 mg/L, while waters originating in limestone parent material usually have values ranging from 100 to 250 mg/L.

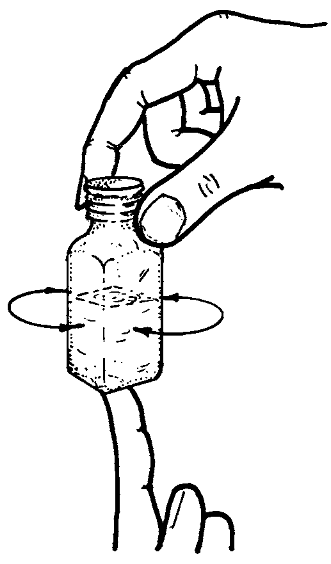
To Measure the Alkalinity Content

When using the AL36 field kit, proceed as follows:

1) (a) Clean the square glass mixing bottle (2327-00) with water from the Kemmerer bottle, *(the water to be tested).*



(b) Fill the mixing bottle to the 15 mL mark with that water.



2) (a) Add the contents of one Brom Cresol Green-Methyl Red Indicator Pillow (943) to the sample. The adding of the Brom Cresol Green-Methyl Red Indicator Pillow will turn the sample to a blue or greenish-blue colour.

(b) Add to the coloured sample Alkalinity Sulphuric Acid (413) dropwise, with constant swirling (see illustration) and count the drops, until the colour *changes* from green to a pinkish colour. There should be no blue or green colour after agitation.

(c) If colour changes after addition of 4 or less drops, go to step 3.

(d) Multiply the drops by 6.84 to determine the total alkalinity content in mg/L.

Note: Sometimes the water will turn a ruddy mauve colour before turning pink. This is the end point. Do *not* continue to titrate – doing so only dilutes the sample.

Total Fixed Endpoint Alkalinity in mg/L

No. of drops of Sulphuric Acid	Alk. in mg/L	No. of drops of Sulphuric Acid	Alk. in mg/L
1	6.8	11	75.1
2	13.7	12	82.1
3	20.5	13	88.9
4	27.4	14	95.8
5	34.2	15	102.6
6	41.0	16	109.4
7	47.9	17	116.3
8	54.7	18	123.1
9	61.6	19	130.0
10	68.4	20	136.8

3) (a) Clean the square mixing bottle (2327-00) with water to be tested.

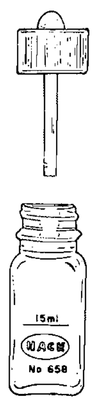
(b) Add 30 mL of the water to be tested to an erlenmeyer flask. Use only the mixing bottle to measure. Do not use the graduations on the erlenmeyer flask as a guide. These are not accurate enough!

(c) Add the contents of 2 Brom Cresol Green-Methyl Red Indicator Pillows (943) to the sample. The adding of the pillows will turn the sample to a blue-green colour.

(d) Add to the coloured sample Alkalinity Sulphuric Acid (413) dropwise, with *constant* swirling and count the drops until the colour changes from green to ruddy mauve or a pinkish colour. There should be no blue or green colour after agitation.

(e) Multiply the number of drops by 3.42 to determine the total alkalinity in mg/L or check the alkalinity from the following chart.

Total Fixed Endpoint Alkalinity in mg/L



No. of drops of Sulphuric Acid	Alk. in. mg/L
1	3.4
2	6.8
3	10.3
4	13.7
5	17.1
6	20.5
7	23.9
8	27.4
9	30.8
10	34.2

N.B. Proper Storage of Chemicals

All chemicals used in the tests described in this manual should be stored away from strong light or sunlight, and in a cool, dry (low humidity) area.

For bottles containing liquid reagents, close caps tightly to prevent evaporation and hence a change in concentration (PAO, H_2SO_4).

Also, mark reagents with the date they were received. Always use the oldest ones first; however, discard reagents that are older than one year. Avoid transporting more reagent than you'll need for on-site testing.

4.20 Testing For Total Dissolved Solids

The concentration of total dissolved solids is calculated by converting specific conductance measurements. Conductivity is a numerical expression of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions, their total concentration, mobility, valence, and on the temperature of measurement. Electrolytic conductivity increases with temperature.

Total dissolved solids are obtained by referring to Appendix 7 using the specific conductance reading and the temperature at which the measurement was made. Total dissolved solids are considered a very important parameter in estimating fish productivity capabilities. In general, total dissolved solid readings for the Precambrian Shield range from 10 to 100 mg/L while readings in southern Ontario range from 150 to 500 mg/L. In highly industrialized areas total dissolved solids may range up to 2000 mg/L.

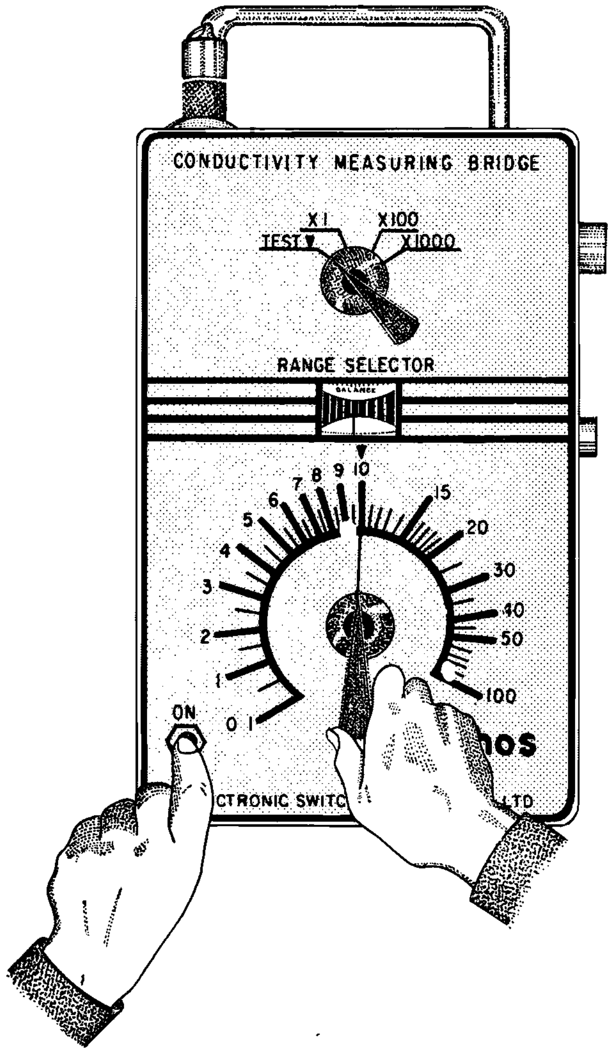
Measuring Specific Conductance

There are a number of conductivity measuring bridges available with a variety of cell types (illustrated is the MC3). The Lisle-Metrix MC3, C40 and C45 models are the recommended units. It is important that the user becomes familiar with the unit before proceeding to take measurements.

The battery operated transistorized resistance measuring bridge is housed in a case and can be balanced manually. Thermometers are either a separate part of the unit or built-in.

To determine specific conductance with the MC3 Conductivity Bridge, the following procedure should be followed.

To Test The Instrument



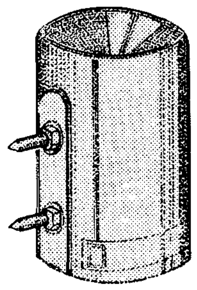
1) (a) Plug into the meter case the clean, dry conductivity cell.

   (b) Set the range selector switch to the marked 'test' position.

   (c) Hold down the 'ON' button and slowly rotate the bridge balance control knob until the balance indicator is in the central or zero position. The control knob terminal should be at the uppermost point of the scale — 10. If balance is not obtained at this position, then the balance control knob must be removed and reaffixed to its shaft. If the needle movement appears sluggish, the battery probably needs changing.

2) Remove the conductivity cell from the unit.

3) Rinse the conductivity cell with the water to be tested, at least three times. *Do not* wet the electrodes.



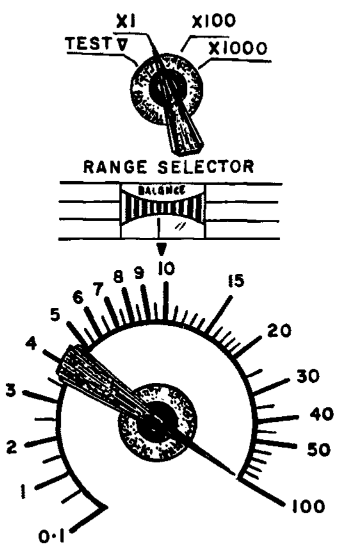
4) Fill the cell with the water to be tested until it is up to the top edge of the cell bore. Excess sample causes no difficulty, whereas insufficient sample prevents full contact of the solution with the top electrode and results in incorrect readings.

5) Plug the filled cell into the unit.

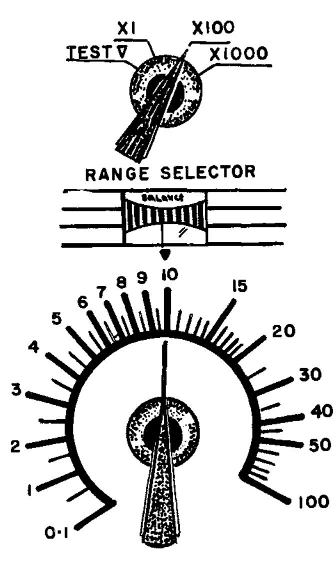
6) Determine and record the temperature of the water in the cell. If the sample temperature is taken with a hand controlled thermometer, move it gently 'up and down' in the *centre* of the cell to ensure uniform temperature and removal of any air bubbles present.

7) *Remove* the thermometer from the cell in order to obtain the correct specific conductance reading.

8) Set the selector switch to the 'XI' range and the balance pointer knob to 100. Depress the 'ON' switch briefly.



(a) *If* the balance indicator deflects to the *right*, the sample conductivity is *below* 100 micromhos/cm — hold down the 'ON' switch and turn the control knob slowly (anti-clockwise) until the balance indicator is central. The conductivity of the sample in μmhos/cm is shown on the scale at the point of the control knob.



(b) *If* the balance indicator deflects to the *left*, the sample conductivity is *above* 100 micromhos/cm. Set the selector switch to the 'X100' range and the balance pointer knob to the 100 position.

Hold down the 'ON' key and turn the balance control knob *slowly* (anti-clockwise) until the balance indicator is central. The scale reading must now be multiplied by 100 to obtain the conductivity of the sample in μmhos/cm.

9) Note and record specific reading and temperature.

Note: The scale of the meter is logarithmic, i.e. the scale is not in equal increments. Therefore, the most accuracy hoped to be obtained is ½ of each of the indicated points on the scale. The conductivity readings on the T.D.S. conversion table correspond to all the possible readings on the MC3 meter. Any other readings can only be obtained by guess-work. In other words, if the control knob falls somewhere between two increments on the scale, the halfway mark is used as per the table.

10) Clean the cell by washing thoroughly with the cleaning brush provided. Shake out any residual water. Never dry the cell bore with a cloth or other material.

11) Wipe dry the exterior of the cell and return it to the case with the conductivity bridge.

Using the Lisle-Metrix Minibridge (Model C40)

1) Ensure that the measuring cell is perfectly clean. Clean the cell with a bristle brush and warm water, if necessary.

2) Measure the temperature of the water sample.

3) Set the temperature knob to the actual water temperature.

4) Switch the range selector to "HI" and balance the meter needle by slowly rotating the large knob. If the meter will not balance at the centre, turn the range selector to "LO" and balance the meter.

5) Read the specific conductance on the appropriate scale as indicated by the hair line on the balancing knob.

6) Record the conductivity *and* 25°C on the summary sheet.

The instrument is functioning properly when the meter balances with the cell disconnected, the selector switch at the test position (at the arrow), the red light is on and the balancing knob pointer is at 1000.

N.B. When the dial is set to the actual water temperature, the meter gives the conductivity at 25°C (i.e. standard conductivity). For automatic temperature compensating units, e.g. Model C45, the conductivity is given automatically at 25°C. Record the conductivity and 25°C on the summary sheet.

Maintenance and Care

To Cleanse the Cell:

1) Place in partially filled water container.

2) Remove the bottom plastic stopper from the cell by pushing it out with a blunt object.

3) Use the cleansing brush to scrub the bore of the cell.

   IF DRY PATCHES APPEAR QUICKLY, THE CLEANING OPERATION MUST BE RE-PEATED.

4) Use Javex liquid cleaner to remove hard-to-remove coatings of carbonate salts.

Replace battery when the balance indicator does not have an extremely sharp and precise movement close to the balance point.

Dry the interior of the Conductivity Bridge case periodically and *always* subsequent to using in humid or damp weather and before putting in storager. Dampness breeds corrosion.

N.B. Remove batteries from unit before putting in storage.

Total Dissolved Solids

To determine total dissolved solids from initial specific conductance readings, refer to the Conductivity/-T.D.S. Conversion Chart (Appendix 7).

1) Locate the 'initial specific conductance' in the column on the 'Y' axis of the chart.

2) Locate the accompanying cell temperature from the series listed along the 'X' axis.

3) Record the T.D.S. reading found at the intersection of two imaginary lines drawn horizontally and vertically from the Y and X axes respectively.

e.g. An initial specific conductance of 60 μmhos/cm and cell temperature of 22°C would give a T.D.S. reading of 42.5 mg/L.

If the conductivity or cell temperature readings do not fall within the range of the chart, the T.D.S. can be calculated by using the following formula:

$$\text{T.D.S.} = \left[\frac{(\text{Initial Conductivity } \mu\text{mhos/cm})}{1 + (0.02\,(\text{cell temp. } ^\circ\text{C} - 25))}\right] \times 0.666$$

Note: In a number of cases, the total alkalinity reading will be greater than the total dissolved solids (T.D.S.) reading. Since T.D.S. is a measure of all the ions in the solution and total alkalinity is a measure of carbonates, bicarbonates and hydroxides, in theory T.D.S. will always be greater than total alkalinity. Then why is there a discrepancy? Simply, the sensitivities of the two methods are different.

This problem usually arises when the T.D.S. readings are less than 40 mg/L.

CHAPTER 5

SAMPLING THE INHABITING FISH SPECIES

5.1 Sampling Objective and Policy

The objective of the inventory survey is to determine 'which' fish species are inhabiting the water community under survey. This is not an easy task. Even the more selective and experienced fishermen are always attempting to improve their catches. The object is to catch as many *species* as possible not as many *specimens.*

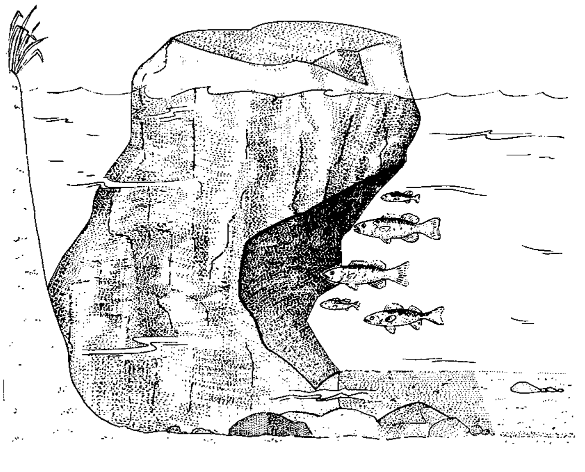
5.2 Some General Behaviour Patterns

Regardless of any tolerances and preferences of a specific species, it still remains true that there are some common behaviour patterns which, when known, will increase the chances of catching fish. Fish occupy only a small portion of the water basin, regardless of the numbers of fish in the system. In calm water with bright sunlight fish will move to deeper water. Conversely, when there is a light chop on the water surface and less light penetration (overcast sky) the fish will move nearer the surface.

The thermocline, if thermal stratification has developed, is a productive fishing zone, but *also search* for fish above and below this stratum.

To adequately sample all the different types of habitat several methods must be used. *Gill nets* cover the open water but should be used both in deep water and shallow. Shallow water can be sampled with *seine nets*, small *trap nets*, and *dip nets*. Piscicides such as rotenone are extremely effective in weedy bays and difficult sampling areas. Angling with small hooks and lures will attract many small species that are often missed using other methods.

Normally small fish are found in the shallows and/or near the surface, whereas larger fish prefer the deeper water when not feeding.

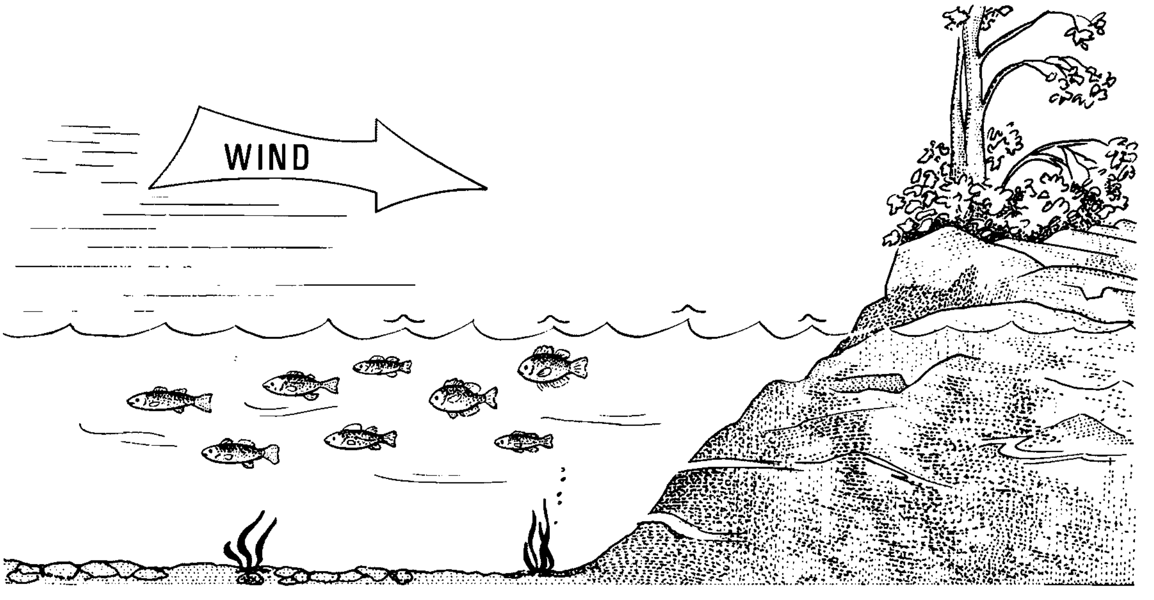


Underwater projections, ledges, reefs or shoals and sunken islands are 'home sites' or 'migration routes' between home feeding sites. All fish live and move within an umbrella of cover to find food and sustain life. By fishing within cover types the chance of catching fish increases.

Regardless of size, most fish species prefer sand, gravel or rocky bottoms rather than mud or silt bottoms, but some species (carp, bullheads) are frequently taken at these latter sites.

Feeding fish are more often found on the *'wind exposed'* shore. These fish are taking the easy route to meet their food requirements. The microscopic plant and animal life which drifts with the wind soon becomes a concentrated mass and attracts fish of all species and sizes.

Fish are normally more active and more readily available for collection during the twilight hours than during the daylight hours. At the same time, if it is necessary to make collections during the daylight hours, one should be aware and take advantage of certain conditions. During the hours of bright sun, fish are more apt to be found in the shady areas.

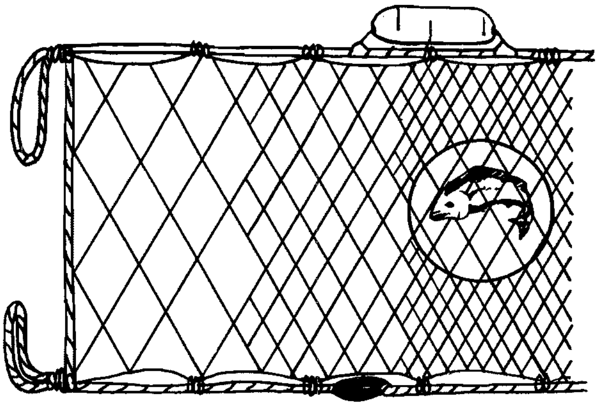


5.3 The Fish Sampling Gear

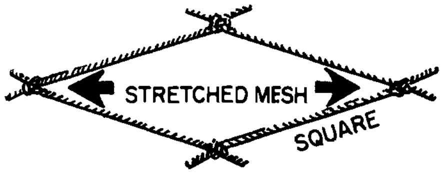
Acquiring information about the fish species composition in any body of water is time consuming and it must be accepted that a wide range of fishing gear will be used. Also, collections must be made at both the sites favoured by the angler and commercial fisherman and sites not considered to be productive by these consumers. Our purpose is quality (how many species), not quantity (how many trout, etc.).

The FISH SAMPLING GEAR used in the Inventory Program includes:

5.3.1. Gill Net



Experimental gangs of either multifilament (nylon) or monofilament nets, are used for sampling larger fish. The recommended minimal *gang of nets* consists of at least eight different stretched mesh size segments of 1.5 metres in depth and fifteen metres in length. The continuing use of the eight by fifty foot nets in one-half inch intervals is logical and practical, until replacement is required, or until the equivalent metric sized nets are available through suppliers.



The stretched measure of the mesh sizes will vary at regular 12.5 ± millimetres (0.5 inch) intervals between 25 mm (1.0 in.) and 140 mm (5.5 in.).

It is considered that at least *two* minimal gangs of nets are required per crew to efficiently and economically sample the fish population in most lakes.

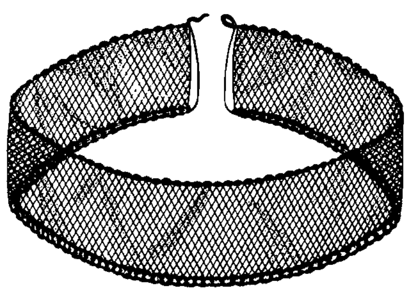
These gangs of nets are either assembled by tying them together (by the crew) or are sewn together by the manufacturer. The approved randomized mesh size distribution, depending on the number of segments of net, is:

mm	64 —	114 —	38 —	89 —	51 —	102 —	76 —	127		
in.	2.5 —	4.5 —	1.5 —	3.5 —	2.0 —	4.0 —	3.0 —	5.0		

mm	140 —	114 —	38 —	89 —	51 —	102 —	76 —	127 —	25	— 64
in.	5.5 —	4.5 —	1.5 —	3.5 —	2.0 —	4.0 —	3.0 —	5.0 —	1.0	— 2.5

Gill nets are always used in sampling fish in lakes and should be available for sampling larger streams and rivers.

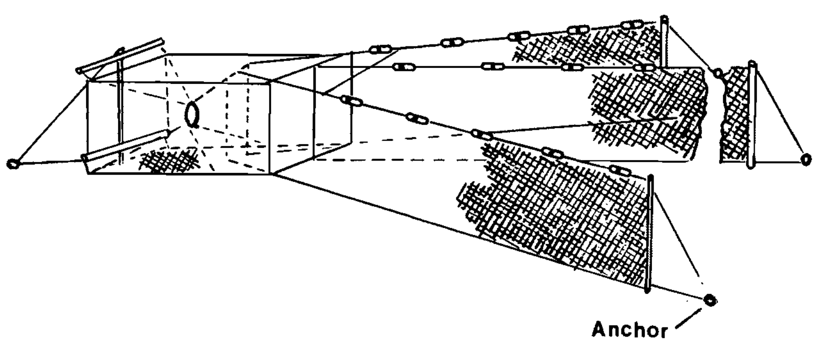
5.3.2 Seine Net



A 'drag-type' of either knotted filament or knotless nylon web is the most common type used for sampling the smaller fish. The small mesh net, not exceeding eight millimeters (5/16″ ±) stretched measure, is used to surround and capture fish in the shallow waters.

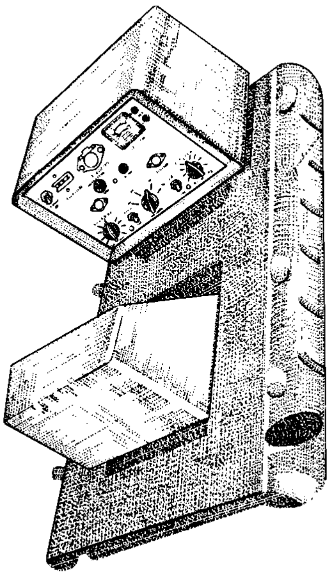
5.3.3. Nylon Web Minnow Trap

A typical two and one-half foot square 'trap type' net. Knotless nylon webbing of one-quarter (¼″) inch and three-eighth (⅜″) inch square measure is used in the net construction of this net.



This type of net permits fish sampling at all bottom site types for extended periods of time and without constant attending by personnel.

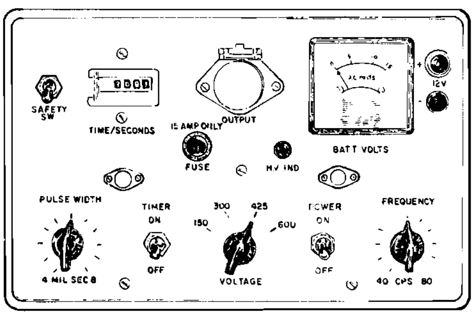
5.3.4 Electrofisher



All electrofishing equipment and procedures must adhere to MNR Official Procedure Manual, Policy FI.3.01.01.

Portable gas powered or 12V battery operated units with a fibreglass anode pole and floating cathode plate are commonly used for the transmission of electric currents through water.

Electric currents can frighten, attract (lead), stun or kill fish.



Due to the decreased mortality rate and faster recovery rate of the shocked fish, *pulsed direct current* operation of the unit is recommended. In view of the catchability efficiency of other types of gear in lakes and the high unit price tags, the electrofishing method is presently confined for use in the stream survey.

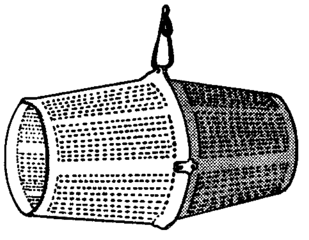
5.3.5 **Piscicide** (fish toxicant)

The use of piscicides in the Province of Ontario at this time is restricted to 'Rotenone base' products of powder form only. No other chemicals or formulations of rotenone are registered for use in Canada.

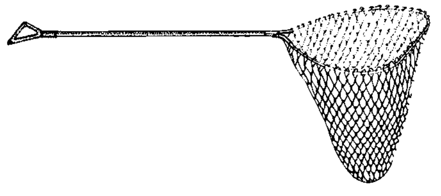
A 'Licence to Use' must also be procured (See District Supervisor) from the Ontario Ministry of the Environment (MOE).

Fish sampling, by controlled use of piscicide, in areas difficult to sample by use of the other gear is always a rewarding effort.

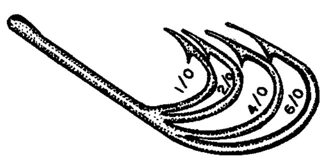
5.3.6 Supplementary Gear



a) The Anglers Minnow Trap Net: A two sectioned unit of wire or plastic mesh with small throat openings at either end and which lock together to form a trap.



b) Dip Net: A heavy duty hand dip net with knotless webbing mesh attached to a bow frame and long handle.



c) A Fish Hook as used under angling regulations.

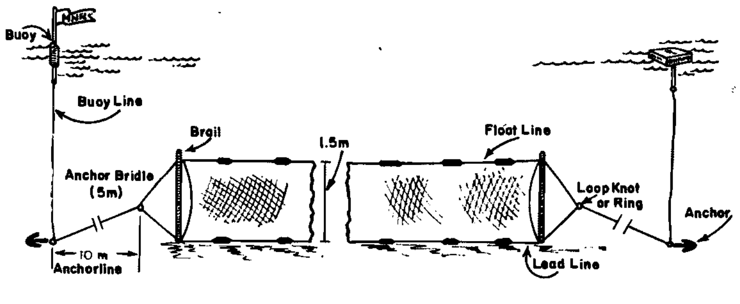
Although often considered not as productive as the more sophisticated gear at our disposal, fishing results with this gear can be rewarding, often surprising.

5.4 Using the Fishing Gear

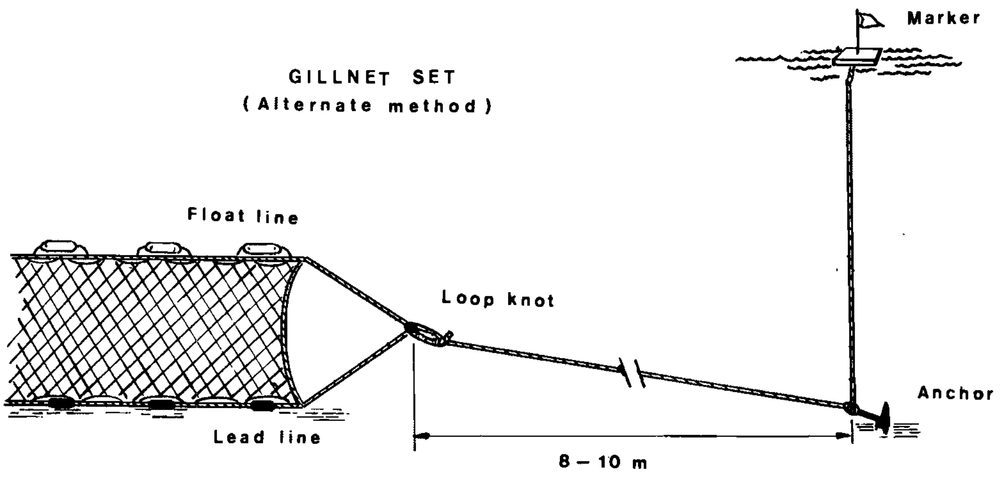
5.4.1 The Gill Net

Each gang of gill nets must be rigged with a buoy; a marker; an anchor; a bridle; or bridle and brail and a minimum of thirty metres (100 feet) of seven millimetre (¼ inch) diameter polypropylene rope for use as buoy and anchor lines.

As shown in the diagram below, the anchor line, at least nine metres (30 feet) in length is attached *to a ring or loop knot on the bridle* and the buoy line is attached to the anchor.



Long anchor lines equalize tensions with the result that there is a compensating effect on the narrowing in of meshes due to site irregularities.



The net should not be set on steep slopes nor across drop-offs. Sites of this nature result in narrowing or closing of meshes which prevent gilling.

Use the echo sounder and hand line in selecting net sites — choose as regular a bottom as possible.

Gills nets are usually set from shallow to deep water and in a manner that the float line rests at least one metre below the water surface.

To Set the Net

The net man (bowman), as the boat is propelled *backwards* by the outboard motor will: —

1) Drop the buoy and anchor (the anchor line may be secured to some object on shore) and play out the net.

2) Play out the float and weighted lead lines evenly with the float line handled at the higher level and toward the water. If the net is not tangled, it is often possible to handle the float line only, allowing the lead line to run while 'shaking-out' the netting. If tangled it will be necessary to stretch the float and lead lines further apart.

3) Lower the anchor line to the bottom when the net is fully played out and drawn taut.

4) Apply more tautness or tension by jerking the buoy line and bouncing the anchor along the bottom, outwardly from the net terminal.

   Before lowering the anchor line, make certain that the buoy line is of sufficient length to reach the surface and is attached to the anchor.

To Lift the Net

The net man, as the outboard motor operator controls the boat movement, will: —

1) Lift the downwind buoy and anchor into the boat.
2) Detach the buoy and anchor line rigging from the net *while retaining hold* of the float and lead lines.

3) Grasp the terminals of the float and lead line in one hand and pull the net into the boat as the other partially closed hand is slid down the net, the arm's length. This method is often referred to as the 'rope-type fashion'.
4) Continue to pull in the net by alternating position and function of the hands.
5) Coil the net with care, to prevent tangling, into the net tub or box.
6) Remove fish as the net is retrieved and place them in their sampling container(s).
7) Rinse slime and disengage tangles after removing fish and before coiling is continued.
8) Detach second rigging from net.
9) Tie float and lead line terminals to handle on net container.
10) Cover or place net container so that the nets are not exposed to the sun's rays.

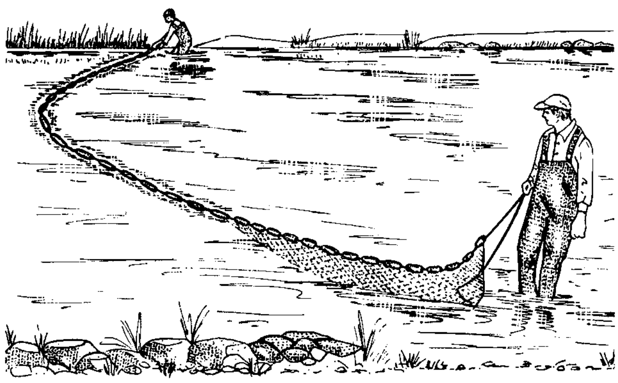
Remove rings and watches. Wearing buttonless outer garments and maintaining smooth edges on net box and boat gunwales will minimize mesh snagging.

5.4.2 The Seine Net

The seine net should be rigged with a brail or a three metre (9 feet) bridle at both ends (see gill net illustration chapter 5.4.1 for definition of terms). Although the shallow obstacle free, flat sand beaches are ideal seining sites, deeper waters can be fished by using a boat. Also many rocks and woody forms can be uprooted and dragged when extra tension on the lead weighted line is maintained. Other areas can be sampled using the seine net and piscicides together (see Chapter 5.4.4).

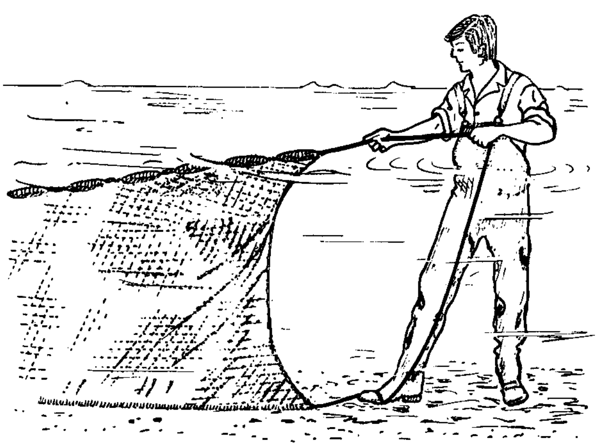
Active Seining

A) When seining along a shore, two people will hold opposite net ends and —



1) Hold and/or hold and pull the one end at the water edge.

2) Drag the other end of the net offshore in a manner that the selected area for seining will eventually be completely encircled (see diagram). The efficient use of a seine net is accomplished by:



(a) inserting the toe of the boot inside the brail or in the cross bridle/lead line loop, (see diagram),
(b) dragging the lead line along the bottom by pulling simultaneously on the float line by hand and the lead line by foot, and
(c) holding the float line taut, but yet in a manner that the webbing trails behind both lines, forming a 'pocket'.

3) Haul-in the net, once encirclement is completed and both lead line terminals meet at the onshore site. Efficient hauling-in is accomplished by —

(a) pulling the lead line terminals in such a way that the lead lines will continue to drag along the bottom and be slightly ahead of the float line, and

(b) pulling the float line terminals as this line becomes slack, but in such a way that the 'pocket' in the net is maintained.

4) Collect the fish sample, (refer to Chapter 6, Documentation and Preservation of Fish Collections).

5) Clean and store the net, avoiding exposure to the sun's rays.

B) Seining from a boat. This method is excellent for sampling fish in deep water.

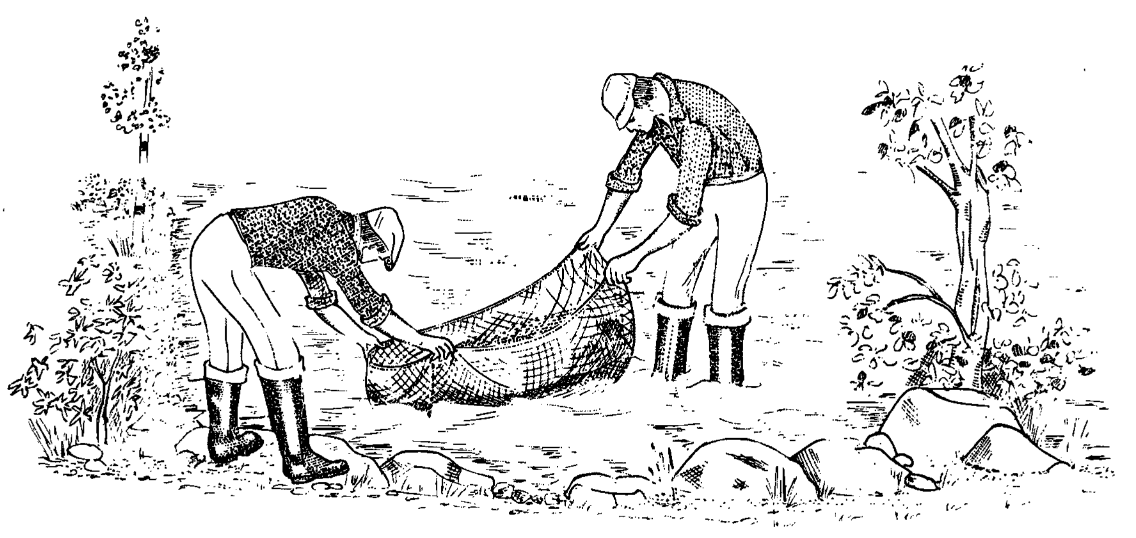
1) Tie one end of the seine to a stationary object onshore.

2) Tie the other end to a short pole (weight end of pole if possible).

3) From the bow of the boat, lower the stick with the attached seine to the desired depth.

4) Move in circular fashion through the sample area by using the outboard motor in reverse.

5) Close off the sample area and pull in the seine as in A3 above.



Passive Seining

A) Inaccessible sites

1) Set-out the seine net in a circular fashion with a wide mouth in a narrow bay or a stream clogged with stones or logs.
2) Tie the terminal ends of the seine to stationary objects.
3) Walk a short distance in front of net and then slowly walk towards the net moving the fish in

front of you. Thrash water with sticks, poke areas under rocks, banks, etc. to move fish toward net.

4) When the fish are trapped, pull in the seine net and sample the fish (and be quick about it!).

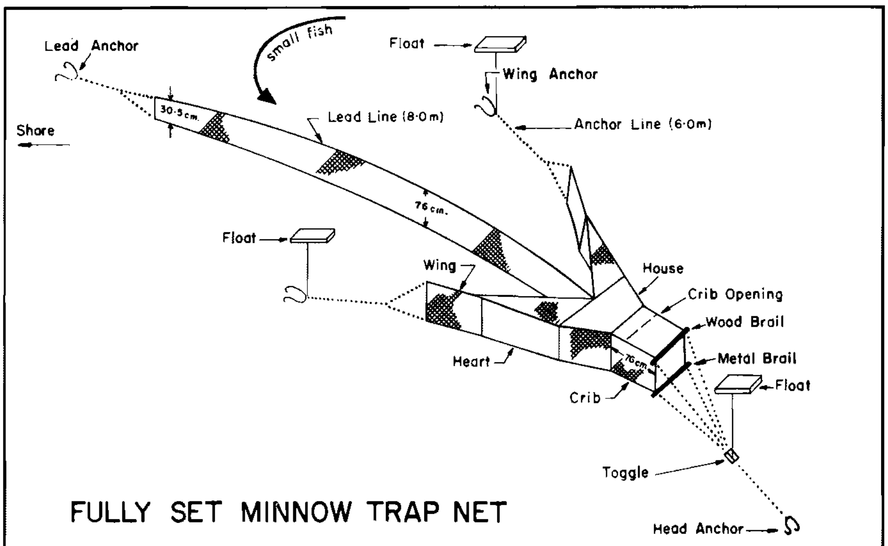
This is a good way of sampling at inlets and outlets.

B) Seining Rapids

1) Tie the terminal ends of the seine to stationary objects immediately below a rapids.
2) Walk upstream and move stones and debris, and thrash and poke the water with sticks, in order that the fish will panic.
3) When the fish panic the current is usually strong enough to carry the fish into the seine net.
4) Lift the seine and collect the sample.

5.4.3 The Nylon Web Minnow Trap

This trap consists of a crib, a house, twin hearts with wings, and a lead. The net is rigged with anchor lines, crib brails and four anchors as shown in the diagram below.



FULLY SET MINNOW TRAP NET

The net is usually set perpendicular to shore with the crib section completely submerged in the deeper water, but not in a water depth exceeding double the net height of five feet (1.5 m).

To Set the Net

The net man (bowman) will:

1) Drop the lead anchor near shore (the anchor line may be secured to some object on shore) and play out the lead line net section as the boat is propelled from shore by the partner until the wing lines are encountered.

2) Cast the wing anchor lines (without anchors attached) and wings to their appropriate 'left' and 'right' side of the lead line.

3) Continue to play out the remainder of the net (house and crib), drop the brails, grasp the brail ropes, cast float as it is reached but retain hold on head anchor line.

4) Stretch the net until straight and taut by holding the anchor line with attached anchor as the partner continues to propel the boat.

5) Drop the anchor on the net side of the boat.

6) Move in turn to wing anchor lines, attach floats and anchors, stretch wings until taut at an approximate forty five degree (45°) angle from the crib and drop anchor.

7) Move to head anchor float, lift toggle, and move boat under the anchor line so that this line is stretched across boat amidship.

8) Increase net tautness by pulling more float line through the toggle.

9) Move boat out from under the anchor line.

10) Check net for proper setting and adjust wing and lead lines, if necessary. Ropes on funnel must be tight. Opening must be secure.

To Check Net and/or Remove Fish

1) Proceed to head anchor float. Lift and move boat under line so that anchor line is stretched across the boat amidship.

2) Pull boat sideways toward net with netman and boatman pulling along opposite brail lines.

3) Lift brails across boat amidship and allow crib to rest in boat.

4) Unzip or untie the crib opening.

5) Collect the fish sample, (refer to Chapter 6 — Documentation and Preservation of Fish Collections). Use a dip net.

6) Close the crib opening and move boat out from under net.

7) Check net for proper setting and adjust head anchor, wing and lead lines, if necessary.

To Lift the Net

1) Repeat steps '1' to '6' as listed in the preceding section — 'To Check Net and/or Remove Fish'. In this case, it is advantageous to release tension of head anchor before proceeding to step '2'.

7) Proceed, in turn, to wing anchor floats, lift and remove anchors and floats.

8) Proceed to head anchor float, repeat step '1' and remove anchor and float.

9) Repeat step '2' and '3'.

10) Retrieve and fold net between the brails in the same manner — but in the reverse order — in which the net was set.

11) Wash and, if necessary, repair.

12) Stow the net so that it is not exposed to the sun's rays.

5.4.4 Toxification of Waters

The use of piscicides is an important method of collecting small fishes in lakes and streams. This method is especially effective in the collection of bottom dwelling, sedentary types of fish not usually caught using nets and traps. Caution should be taken however when using piscicides because devastating results can occur if the toxicant is not administered properly.

Rotenone-based solutions kill fish by means of suffocation. The toxicant constricts the capilliaries in the gill region thereby reducing oxygen uptake by the blood. Fish do not die instantly but become disorientated at first, often 'flipping' along the surface; making them easy to catch with a dip net.

Application of Toxicant

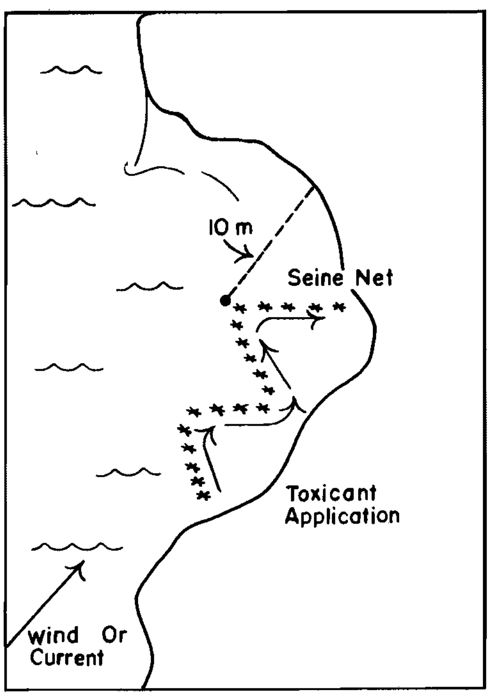
The best places to use piscicides are areas that can be closed off by seine or small mesh gill nets. Fish can and will avoid the poison as it is dispersed into the water. Therefore, cordon off an area with a seine net(s). The best depth of water is 1-2 m so that the fish can be scooped out easily and not lost on the bottom.

Rotenone powder must be mixed thoroughly with water. It is suggested that a pump or agitator be used in order to get the powder into suspension.

Trial and error will probably dictate the best concentration to use as rotenone seems to weaken with age.

To Sample Shoreline Sites

1) Select the sampling site (not greater than 200 square metres).



2) Set the seine net by angling in from shore and enclose part of the open side of the sampling site.

3) Mix the toxicant according to the instructions in an appropriate container, i.e., a water-pail, bottle, etc.

4) Distribute the solution in a uniform manner over the water surface, commencing at the shore and upwind from the net. Criss-cross the surface as shown in the diagram. Depending on water depth this may be done by wading or from the boat. Increased agitation of the water will aid in the distribution.

5) Retrieve the fish as they become immobilized and come into view by use of a dip net or any other available means (hands or open mouth containers) and place immediately in the collection bucket(s). This exercise will take up to one hour. Reaction is directly dependent upon species, size, amount of chemical applied and water temperature.

6) Drag the seine across the sampling site.

7) Increase the concentration and repeat the exercise, if less than ten fish are captured.

5.4.5 The Supplementary Gear

The Angler's Minnow Trap

The minnow trap is used primarily to sample habitats where other gear is unsuitable. These sites would include the mouth of small inlet with a detritus-covered bottom; beaver channels leading from beaver houses; rock outcroppings; dense aquatic growth areas and very deep water. To fish deep water, attach the trap to the anchor line of the gill net.

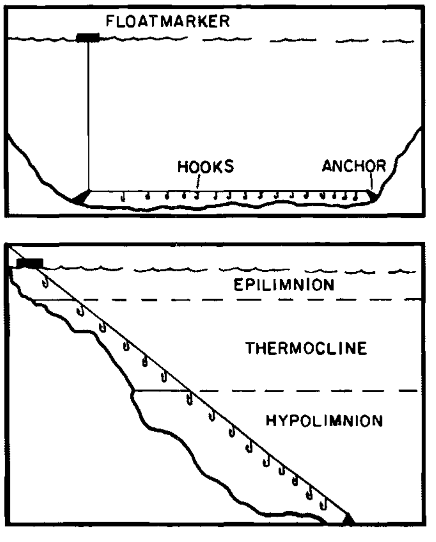
To Use the Minnow Trap, follow the instructions below:

1) Lock the sections together to form the trap.
2) Attach line with marked (MNR) float.
3) Bait with bread, meat or dry cereal.
4) Lower trap into the water at selected sites and leave set.
5) Check and retrieve fish periodically, at least once each day.
6) If nothing is caught after 24 hours, move the trap to another location.

The Dip Net

This gear often permits an attempt to sample unexpected schools of moving fish. The dip net is often very successful where other methods fail. Keep it handy at all times.

The Set Line or Night Line



SET LINES

A series of baited hooks (use minnows and small suckers caught by seining) is suspended at desired depth(s). The most common method is the bottom set. A series of hooks (single or treble) is suspended from a stretched line along the basin bottom.

The other method is a hanging set, with only one terminal anchored. It is preferable to set it in such a way that the float terminal is near and secured to the shore and the line suspended near the basin rim from bottom to surface.

Angling

Fishing using a rod and reel is an accepted method of collecting fish from a lake. Don't forget to abide by the angling regulations though. Also, don't overlook other anglers' creel.

Talk to people around the lake; they may know of fish species that you have not collected. Record under 'Remarks' on the 1422 form.

Stomach Samples

One method often overlooked is that of sampling the stomachs of the larger piscivorous fish species. Many fish can be obtained in this manner that normally would not be caught such as the small deepwater species, e.g. spoonhead and four-horned sculpins. These fish should be preserved and documented normally as if they had been caught in a trap or net. Even if they are partly digested they should still be preserved as often they can be identified by just the skeletons or heads.

Caring for the Netting Gear:

The most efficient results in the use of the fish sampling equipment can only be obtained *if* that gear is maintained in the best possible condition.

This can be done by adhering to the following instructions:

1) Rinse, wash and untangle the net section(s) as lifted. This exercise frees the algae and fish slime from the net webbing and facilitates 'settling' the net the next time.
2) Transport the nets in a manner that the netting is not exposed to the direct rays of the sun *at any time*, i.e. cover the nets while in the boat and dry or repair the nets in shaded areas. Sunlight accelerates deterioration of net filaments.
3) Keep the net in the best possible fishing shape, i.e. remove the fish in a manner that the breaking of the mesh is minimized; mend, patch and/or sew sections together in order to minimize escape holes along the length of the net.
4) Store nets in a clean and dry condition.
5) Treat cotton nets with an appropriate fungicide to prevent mold and mildew growth.

CHAPTER 6

DOCUMENTATION AND PRESERVATION OF FISH SAMPLES

Fish collections are of no value unless the collections are expertly identified, documented in detail and records properly filed.

A sample of *all* small fish collected ⩽10cm total length, regardless of species must be preserved in the field, documented and shipped to Main Office for identification. Small fish should *never* be identified in the field regardless of whether or not the collector feels confident in identifying the specimens. These specimens are not only sent to Main Office for identification, but they are also used by various other agencies. Many are deposited into the Royal Ontario Museum collection and many more in the collection of the National Museum of Natural Sciences.

The only fish that are identified in the field are those larger fish (10 cm +) that are easily identifiable; the exception is the minnow family (Cyprinidae), carp excluded. If there is any doubt as to the identification of *any* fishes they should be preserved and properly documented for further identification. If the specimen is too large to fit in a bag or bottle it can be cut up. Include the head, fins and tail in the preservative.

Remember "Any mistake in identification immediately sheds doubt on all the rest of the survey data."

6.1 Gill Net and Trap Net Catches

When the fish are removed from the nets notes should be made recording the species, number, size and weight of the fish. Survey crews should check with their immediate supervisor as to the extent of the data that they collect when the nets are lifted. It is handy to make up forms as below to record these data.

GILL NET CATCH RECORD

LAKE: TROUT LAKE (Brown Trout)												M.N.R. DISTRICT NO. 58			
LAT. 45° 37'			LONG. 77° 57'				DATE SET: Aug. 6/78						TIME: 18:00		
SET NO: 2 of 4			NETTING TIME: 12 hours									DEPTH OF SET: 2 - 10 m			
nets used			x	x	x	x	x	x	x	x	x				
SPECIES:	½"	3/4	1"	1½"	2"	2½"	3"	3½"	4"	4½"	5"	5½"	6"	6½"	TOTAL:
80	X	X		•	•••	•	•						X	X	6
163	X	X	••	•••	•••••	•••	••	••	•	••			X	X	20

CATCH DATA

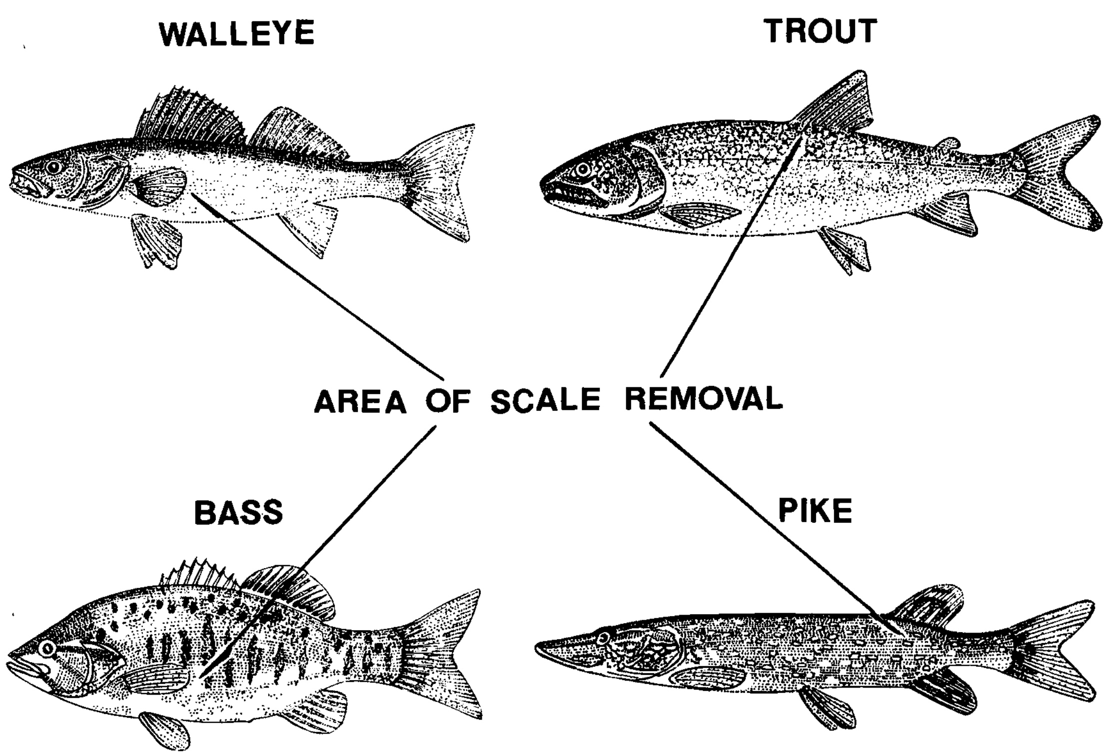
LAKE: TROUT LAKE (Brown Trout)			M.N.R. DISTRICT NO. 58
LAT. 45° 37'	LONG. 77° 57'	TWP. Dickens	
GILL NET SET NO: 2 of 4		NETTING TIME: 12 HRS.	DATE: Aug. 7/78

SPECIES:	T.L./CM	WT./KG	REMARKS
80	49.3	1.20	L. V. fin clip
80	29.5	0.21	
80	38.6	0.58	
80	43.9	0.85	fin clipped (adipose)

6.2 Scale Samples

Before taking scale samples crews should check whether their supervisor requires scales to be taken and what fish should be sampled. If samples are required, refer to the next section on sampling.

REMOVAL OF FISH SCALES FOR AGEING



Ministry of Natural Resources
Ontario

Field Collection Record

Use Pencil Only

No. of Bags:

District No.	Name of Waterbody	Collection No.	Station No.
58	TROUT LAKE (BROWN TROUT)	01	2

County or Judicial District	Township	Watershed Code
NIPISSING	DICKENS	2KD-09

Locality of Waterbody (if other than stream or river): 15 Km. NORTH OF EXETER ON HWY. 14, 1 Km. W ON BUSH RD.

Locality of station: EAST END OF LAKE BESIDE INLET

Latitude	Longitude	Date Day	Month	Year	Time Started
45°37'0	77°57'0	06	08	78	1330 Hrs.

Duration: 1.0 Hrs. Drainage System: UPPER MADAWASKA RIVER

Water Type
☐ Spring ☐ Canal ☐ Stream/River ☐ River/Lake Junction ☐ Flooded Area ☐ Pool
☐ Pond ☒ Lake ☐ Muskeg/Bog ☐ Reservoir ☐ Other

Water Temperature	Air Temperature	Distance Offshore Min.	Max.	Depth of Capture Min.	Max.
19 °C	24 °C	0 m	3.5 m	0 m	1.5 m

Plant Type
☒ Submergent ☐ Floating ☐ Emergent ☐ None

Bottom Type
☐ Rock ☐ Boulder ☐ Rubble ☐ Gravel ☒ Sand ☐ Silt
☐ Clay ☒ Muck ☐ Marl ☐ Detritus ☐ Other

Current
☒ Still ☐ Slow ☐ Medium ☐ Fast ☐ Quantitative ______ m/s

Water Colour
☐ Colorless ☒ Yellow/Brown ☐ Blue/Green ☐ Turbid ☐ Other

Cover (Shore)
☐ None ☒ Sparse ☐ Moderate ☐ Dense ☐ Other

Cover (In water)
☐ None ☒ Sparse ☐ Moderate ☐ Dense ☐ Other

Gear
☒ Seine ☐ Gill Net ☐ Dip Net ☐ Angled ☐ Trawl ☐ Minnow Trap
☐ Piscicide ☐ Trap Net ☐ Hoop Net ☐ Electrofish ☐ Surber ☐ Other

Size of Net (Gill or Seine Net) Length	Size of Net or Mouth (Trap, Hoop or Trawl)	Mesh Size Smallest	Largest
~15 m	N/A m	0.5 cm	0.5 cm

Selectivity of Sample
☐ All Kept ☐ None Kept* ☒ Some Kept* ☐ No Catch
*List Released Fish on Back

Preservative
☒ Formalin 10% ☐ Kahle's Solution ☐ Alcohol ☐ Frozen ☐ Other

Date Day	Month	Year	Collectors
06	08	78	A. SMITH, D. JONES

Additional Data: Pollution, Colour and Condition of Fish, Parasites, etc.

Small fish very plentiful
- no pollution evident - some campers garbage on shore.

2066 (12/79)

Shaded Areas For Main Office Use Only

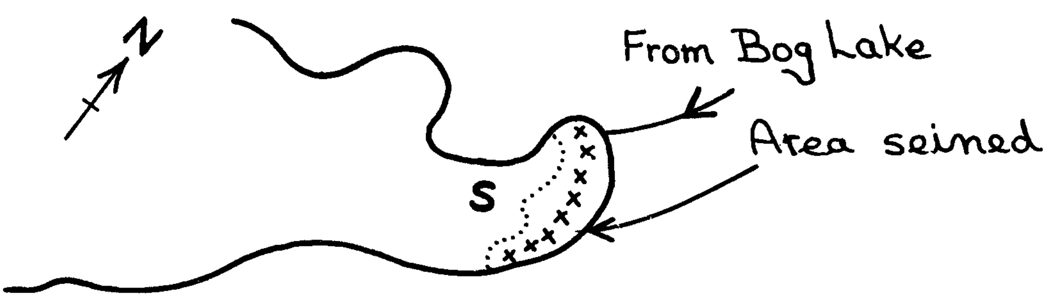
MNR District No.	Name of Waterbody	Collection No.	Station No

Date Received (Day / Month / Year)	Township	Latitude	Longitude	Acc.	Page	Of
		° ′	° ′			

No.	Scientific Name	Code	Size Range (T.L. in mm)	OMNR Cat No.	ROM Cat. No.
2	CATOSTOMUS COMMERSONI	163	200-245		
~400	$\underbrace{\text{ASSORTED SMALL FISH}}$		10 - 100		
	ABOVE RELEASED				
	N.B. 2 BAGS OF FISH				

Identified by	Date

Station Diagram



Taking the Scale Sample

Locate the proper area on the fish to remove the scale samples by referring to the diagram below. Using a sharp penknife or scalpel remove the slime in this vicinity by scraping with the knife towards the tail of the fish. Next, pick out a few scales using the knife. Place the knife blade into the envelope and then withdraw the blade leaving the scales inside. Tweezers can also be used for removing scales.

Documenting the Scale Sample

Scale Sample Envelope
Ontario Ministry of Natural Resources

Species BROOK TROUT
No. 1 OF 10 Party No. —
Date AUG. 6. 1978
Locality TROUT LAKE
45°37' × 77°57'
Total L. 30 cm Fork L. 29 cm
Weight 0.4 kg Sex ♂
State of Organs GREEN
Gear Gillnet - 2" mesh
Stomach Cont. small minnows
Remarks healthy specimen
Marks Adipose clip Age
Collector A. Smith D. Jones
Form SF.2 (6/73) 73-0000

Fill out the envelope data as indicated in the diagram. Remember, always fill out each envelope completely.

6.3 Documenting Preserved Samples on the Field Collection Record

This form records the locational and environmental data pertaining to the area sampled for fish. Use this form to document both successful and unsuccessful collection attempts (i.e. no catch).

The form must be completed as soon as the samples are preserved so that the required information is at hand. Use pencil when filling in the form and do not bother having the form typed. A carbon sheet is attached to each pad for copies. Send the *original form with* the fish samples to Main Office where identification of the samples will be completed. Be sure that information on this form corresponds exactly with that on all other forms, especially the collection label, i.e. latitude, longitude and station numbers. Keep the carbon copy with the survey results.

6.4 Completing the Field Collection Record Form (F.C.R.)

This form is designed so that there is little question as to what is required. However, listed below are some instructions regarding areas of the form which may be questionable.

Name of Waterbody

If the waterbody has more than one name, list the Gazetteer name first and any other names in brackets. If no name exists, use the ''NL'' format. Refer to Chapter 1.6.1 for further explanation.

Station No.

Each location that is sampled for fish is given a station number. Stations are numbered sequentially and maintain that number throughout the survey. Even if one location is sampled several times using different gear and on different days it still retains the same station number.

Collection No.

Each time fish are sampled at a station the sample is given a collection number. Therefore at each station there will be one or more collection numbers. (even if there is no catch.)

Locality of Station

Enter the *name* of the Tertiary watershed, i.e. ''English River''. See appendix 10 for a list of watersheds.

Drainage System

Enter the *name* of the Tertiary watershed, i.e. "English River". See appendix 9 for listing by watershed.

Selectivity of Sample

If fish are released or are discarded and not preserved, then the identifications are listed on the reverse side of the F.C.R. form, i.e. a seine haul produces several hundred small fish and two fairly large white suckers. A sub-sample of the small fish would be taken and the suckers released. Fill in the back of the form as in the sample.

These forms are used by many people who are not necessarily familiar with the inventory program so it is imperative that they are completed accurately and neatly.

Station Diagram

Draw a diagram that accurately locates the sample site. A section of the lake usually suffices.

6.5 The Field Collection Label

Accompanying the 'Field Collection Record' form is the 'Field Collection Label'. This Label is completed at the time the fish are preserved and is immersed right into the preservative solution with the fish sample. These labels are made of special *waterproof* paper and *cannot* be substituted by any other type of label or paper. *Fill out* the form in *pencil* as in the example below. The information on this label should be identical to the information on the accompanying F.C.R.

In a case where the fish sample is too large to fit into one container, a label must be filled out *completely* for each additional container. Mark the label indicating this. i.e. 'Bag 1 of 4'.

Ministry of Natural Resources
Ontario

Collection Label

Bag No. 1 of 2

Use Pencil - Immerse in solution with collection

M.N.R. District No. 58	Name of Waterbody TROUT LAKE (BROWN TROUT)	Collection No. 01	Station No. 04
Township DICKENS	County or Judicial District NIPISSING	Watershed Code 2KD09	
Latitude 45° 37′ .	Longitude 77° 57′ .	Method of Capture SEINE NET	
Preservative 10% FORMALIN	Collectors A. SMITH D. JONES	Day 06 Month 08 Year 78	

1414 (03/78)

The back of the label can also be used for recording additional information that might be of importance.

Ink, marker pens, etc., all fade and dissolve in preservatives.

Always Use Pencil

6.6. Preserving Fish Collections

1) Sort the collected fish sample.

2) Select *all* fish for preserving if there are less than ten specimens in the sample. If there are more than ten specimens in the sample, select the largest and the smallest and a randomly taken handful of the remainder.

3) Put the fish samples in a 10% formalin solution immediately following capture. The 40/60 formaldehyde/water mixture — 'Formalin' is further mixed *one* part formalin to *nine* parts water — 'formalin solution'.

4) Immerse sample specimens up to 10 centimetres in length directly into a plastic bag or glass jar containing the Formalin Solution. Be sure to have twice as much preservative as volume of fish sample in the container.

5) Slit the visceral cavity (lower right side) of sample specimens exceeding 10 cm in length before immersing. Do not pierce through both sides and take care not to damage internal organs or bone structure. This enables preservative to enter the body cavity.

6) Complete the 'Specimen Collection Label' *in pencil* and immerse it in the solution with the fish.

7) Hold fish collection samples completely immersed in solution for a minimum period of seven days. The fixation process will then be complete.

8) Jars (wide mouth, Mason jar type) and plastic bags may be used for immersion of specimens in the field. Perforated plastic bags, holding the individual collections immersed in a formalin bath (2 – 4 litres of formalin in a seal tight container) is also an efficient method.

6.7 Shipping Fish Collections

Once the fish have been 'fixed' in 10% formalin, they are ready to be shipped to Main Office for identification. Follow the procedure below.

1) Drain excess formalin from plastic bags leaving enough to keep specimens damp.

2) Seal bags making sure that most of the air is removed.

3) Pack bags in a box, making sure that they are protected from crushing and that the bags will not leak.

4) Enclose all of the 'Field Collection Records' with the fish samples.

5) Ship the boxes at regular intervals of 2 – 3 weeks regardless of the number of collections. Make the shipment at a time and in such a way that there will be a minimum delay in reaching its destination (i.e., pack and ship on Mondays and Tuesdays). Mark on the outside of the box 'Fish Collection'.

6) Ship to the following address:

   Fisheries Laboratory
   Fisheries Branch
   Ministry of Natural Resources
   Room 2610, Whitney Block
   99 Wellesley St. West
   Toronto, Ontario
   M7A 1W3

   Small shipments by parcel post are desirable as well as economical. Do not stockpile the collections.

CHAPTER 7

THE SHORELINE CRUISE

The shoreline cruise is intended to collect specific information about the physical attributes of a waterbody. Most of the data concerning these attributes is collected on the shoreline cruise and recorded on the 'Physical Features Map'. From this information, it will be necessary to summarize a number of the attributes before entry of the data on the 1422 form. These attributes are as follows and will be discussed individually.

1) Bench Mark
2) Fluctuation
3) Number of Resorts
4) Number of Cottages
5) Dams
6) Slope Angle of Terrain
7) Inlets and Outlets
8) Shoreline Soil Types
9) Bottom Soil Types
10) Pollution
11) Vegetation

    a) Terrestrial Vegetation (Timber types)

    b) Aquatic Vegetation (Hydrophytes)

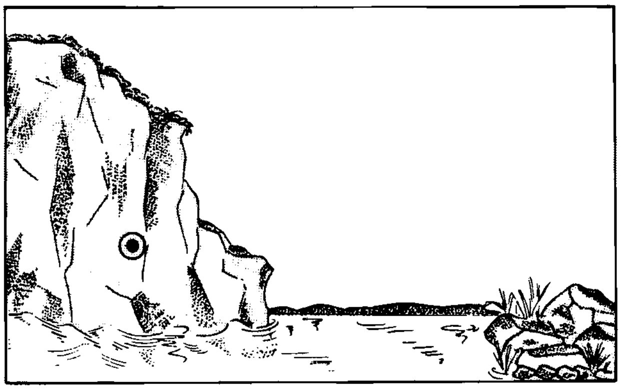
The collection of this information can be carried out at any time during the survey depending on weather conditions. However, it is suggested that the completion of these data be conducted when the crew is familiar with the lake.

The information regarding slopes, soil types and vegetation can be collected when the echo sounding of the lake is in progress. However, it should be stressed that this information should be collected when the shoreline cruise is in progress since the crew's familiarity with the lake will enable them to make better judgments. In addition, this is an opportune time to check for missing data.

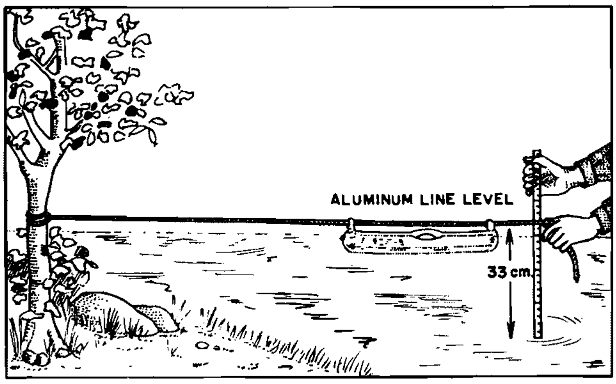
7.1 Bench Mark

At the time of the survey an attempt is made to *estimate* the amount that the water level fluctuates annually. Water levels in both lakes and streams are subject to natural seasonal variations as well as alterations by human activities. As well as estimating the annual fluctuation, the survey crew also establishes a bench mark so that future measurements can be made and *actual* fluctuations and changes can be measured.

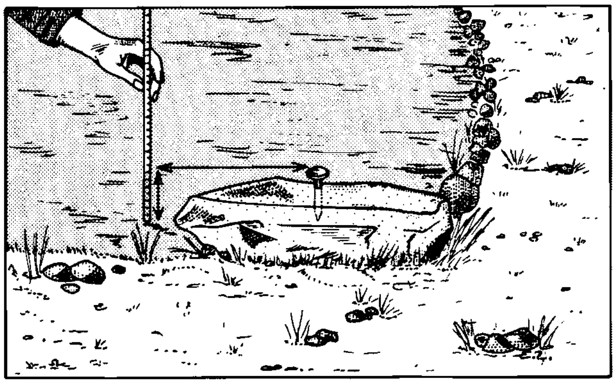
A bench mark, if it is not in existence or cannot be located, should be established. Many dams, bridges and docks have staff gauges which can be used. When establishing a bench mark, use an existing feature such as the bottom of a bridge or the top of a dam. Failing this, the following methods can be used.



a) Spray paint a circle (not more than 20 cm in diameter) on a flat faced rock, approximately 1 metre above the high water level. Use a star drill to make a hole 2 cm in depth near the centre of the circle.



b) If there is no rock face available, a blaze on a tree will suffice. Blaze an area 30 cm by 15cm, spray paint a circle on the blaze and hammer a 10 cm (4 in.) nail in the centre of the circle. A living tree is a more permanent bench mark than a dead tree.



c) Secure a cement mound (approximately 8 cm in height and 10 to 15 cm in diameter) to a rock surface. Set a nail in the centre of the cement.

Note: Do not deface the shoreline. Try to make the bench mark noticeable, yet discreet. Be sure the bench mark is above the high water mark.

The drilled hole (star drill) and nail in the blaze or concrete are the reference point (bench mark) for the future records of water levels. Using this reference point, a vertical measurement in metres is taken from the reference point to the *water surface.* This distance is placed in the box 'Below Bench Mark'. However, if the bench mark is not on a rock face, a carpenter's handline with handline level will be used as shown in the diagram. Measure down from the carpenter's handline to the water surface and record as in the previous method.

If a staff gauge is present, measure from the top of the gauge to get the correct measurement. Use a metre tape or metre stick to obtain the vertical measurements. Measurements are made to the nearest centimetre.

7.2 Fluctuation

Fluctuation refers to the change in water levels. The measurement is in metres and is recorded in the appropriate box. However, in a number of cases it will be difficult to detect water fluctuations if there is no exposed rock so it will be up to the discretion of the survey crew to obtain the measurement. The vertical distance in metres between the high water mark and the low water mark is the fluctuation. These marks are usually stains on the rock. The high water mark is indicated by the growth of lichens which give rocks a dark stain and a light exposed surface below. The low water level is recognized by a light area exposed to weathering and a dark stain below indicating permanent submergence by water. Of course, if there is a permanent monitoring station such as a power dam on the lake, the appropriate authorities can be contacted and the accurate measurements can be obtained.

7.3 Number of Resorts

The number of resorts is the total number of commercial establishments on the lake. Record in the appropriate box.

7.4 Number of Cottages

The number of cottages is the total number of private residences (year round living), cottages and cabins. If there are private residences and/or trapper's cabins, indicate the number of each in the history. Otherwise, the number indicated in the appropriate box will be taken as cottages. If there are abandoned mines or abandoned buildings (such as fish camps, Ministry of Natural Resources buildings, etc.) state this in the history.

7.5 Dams

Dams are any structures, natural or man made, that impede the flow of water into or out of a lake. These can be beaver dams, log jams, hydro dams, etc.

7.6 Slope of Terrain

Slope of terrain is the inclination at which the backshore is elevated from the water surface. The inclination is normally measured on-site at regular intervals using a clinometer and is expressed in degrees (0-31°). The four categories of slope: flat, rolling, hilly and mountainous describe ranges of slope expressed as degrees. The amount of these categories found around the lake are recorded on the lake survey summary form as a percentage (total 100%). Slope of terrain is indicated on the physical feature map using the symbols listed in appendix 1. Record the clinometer readings beside the symbols.

To accurately measure the slope angle with a clinometer, the boat must be at the shoreline. A reading is then taken from the front seat of the boat.

7.7 Inlets and Outlets

Inlets and outlets are the streams and rivers flowing in and out of a lake. These waters are divided into two groups: *perennial*, being a stream which has a continuous flow and *non-perennial*, being a stream which has a discontinuous flow. Record in the appropriate box the total number of streams and their total discharge in each division.

Since a quick approximation is needed to calculate flows into and out of lakes, the following formula can be used.

$$\text{Discharge} = \frac{W\ D\ L\ K}{\Delta t}$$

W = average width (m)
D = average depth (m)
L = length of station (m)
Δt = average time (s)

K = velocity correction factor
= 0.8 (rough bottom)
= 0.9 (smooth bottom)

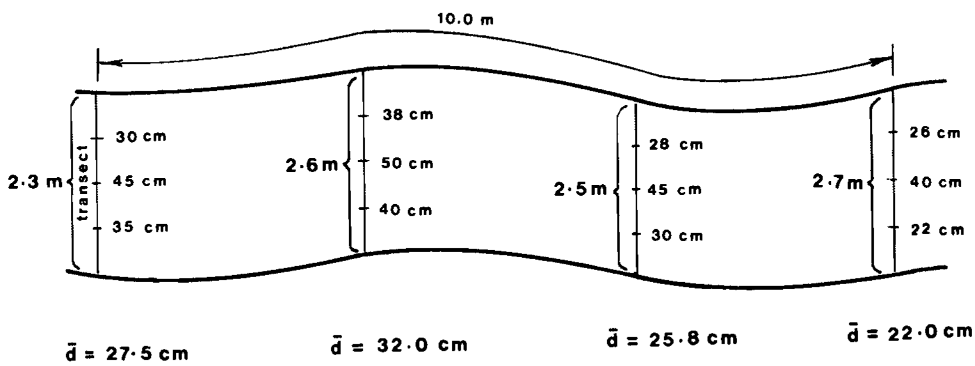
The section of stream selected should be as straight as possible, without obstructions, of approximately the same width and the same type of bottom throughout and far enough away from the lake that there is no effect of wind or wave action. Ten metres of stream is a convenient length.

A floating object is clocked to determine the time it takes to float the length of the station. A well punctured practice golf ball works well; however, chips of wood or other material that float just below the surface are suitable. The float should be timed over the distance at least three times then averaged.

To calculate the average depth, take three equally spaced depth measurements across the stream at each place where the width is taken (transect). Transects should be evenly spaced. Record the depth at the one quarter, midstream and three quarter points. Add these three depths together and divide the total by *four.* This takes into consideration the slope of the banks and gives the average depth (d) for that transect. Calculate the total average depth (D) by averaging all the transects (at least 4 transects should be measured).

The above values are substituted into the formula and the calculation will yield the discharge in cubic metres per second ($m^3 s^{-1}$).

EXAMPLE



D = $\Sigma d/4 = 0.27$ m
L = 10 m
Δt = 45 s
W = 2.5 m
K = 0.8 (rough bottom)

$$\text{Discharge} = \frac{W\,D\,L\,K}{\Delta t} = 0.12 m^3 s^{-1}$$

In the event that the discharge is too large to measure, insert 'D.G.M.' in the discharge box, meaning 'discharge is too great to measure'. On the other hand, if there is no discharge or the discharge is extremely minimal, ($< 0.01 m^3/s$) insert 'N.M.D.' in the discharge box meaning 'no measurable discharge'. The section for comments immediately below is used to record individual stream discharges, to estimate dimensions of D.G.M./N.M.D. streams, or any other pertinent observations.

7.8 Shoreline Soil Type

Shoreline soil type is the material on the foreshore. Using the description for soil types (Chapter 16.4), record as a percentage the amount for each soil type.

7.9 Bottom Soil Type

Bottom soil type is the material on the offshore. Using the description for soil types (Chapter 16.2) record as a percentage the amount for each type.

7.10 Pollution

Pollution should be checked for and noted. Any *visible* signs of contamination and possible sources should be noted. Examples could range from litter to algal blooms caused by sewage.

7.11 Vegetation

Vegetation is important to inventory but only in a generalized manner. Vegetation whether it be terrestrial or aquatic enhances the environment by impeding the erosion of soils, providing refuge from predatory animals, providing food whether direct or indirect, producing oxygen and increasing surface area for larger populations of animals. The type and quality of vegetation is limited by climate and soils. Soils derived from infertile hard rock have significantly less abundant vegetation than do soils derived from glacial till and sedimentary rocks.

The vegetation will be divided into two groups, the terrestrial plants and the hydrophytes or aquatic plants.

7.11.1 **Terrestrial Vegetation** (Timber types)

Terrestrial vegetation includes the herbaceous and woody plants which are found along the foreshore and backshore of lakes and streams. Foreshore and backshore will be defined in the hydrophyte section. It is not imperative that one knows all the species but just the generalized categories which are as follows:

1) D.A.L. developed agricultural land, i.e. cultivated land producing farm crops or devoted to market gardens or orchards.

2) PAS. grass or meadow areas, i.e. areas devoted to pasture for domesticated animals as well as wild grass or meadow areas exceeding one hectare (2.5 acres) in size.

3)  shoreline brush areas, i.e. the areas of growth near the water's edge covered by the grass and woody type plants which are unlikely to become commercial producing trees.

4)  open muskeg areas, i.e. wet areas of mosses, grasses, sedges and small herbaceous plants and interspersed with small areas of open water.

5)  treed muskeg areas, i.e. partially wet areas, with similar type growth as open muskeg areas but on which stunted commercial producing trees occur in small groups or as scattered individuals.

6) Co.-De. -upland tree areas, i.e., the areas of growth or Mix. on which commercial producing coniferous (Co.) or deciduous (De.) type trees are growing.

The density of the coniferous or deciduous type growth governs the growth site classification as follows:

1) Con. An area in which seventy-five per cent or more of the trees are coniferous.

2) Dec. An area in which seventy-five per cent or more of the trees are deciduous.

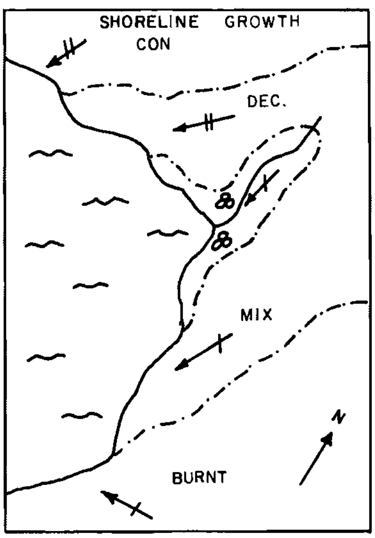
3) Mix. An area in which all other growth combinations are found.

4) Burnt An area that has recently been burnt and has no appreciable regrowth.

5) Cut An area that has recently been cut for wood products and has no appreciable regrowth.

These assessments will be made midway between the shorelines, i.e. the centre of the lake basin or midstream. Record the timber types found in each terrain category.

Shoreline vegetation will be mapped by:



1. Delineating the growth border(s) on the field physical feature map, as shown in the diagram. (Also see Physical Feature map in Chap. 9).

2. Identifying the type of growth within the border by using the appropriate symbol.

7.11.2 Aquatic Vegetation or Hydrophytes

Hydrophytes spend either all or part of their life cycle in an aquatic environment. Hydrophytes will colonize substrates to a depth where the light intensity is only 1 to 4 per cent of the intensity at the water surface. This area of colonization is commonly called the 'photic zone' and is usually limited to the upper 10 m of the water column. Since hydrophytes have flaccid stems they are unable to withstand the forces of waves so that the areas of plant growth are restricted to sheltered bays, the leeward sides of islands and areas protected from wave turbulence.

Hence in any given waterbody, whether an area is colonized or not will depend to a large extent on whether it is protected from or exposed to strong turbulence. Bare rock and gravel areas are usually associated with strong currents and have little or no vegetation. However, areas of silt and organic debris are associated with sedimentation and little or no turbulence which is conducive to plant growth.

The shore of a lake is divided into three areas; Offshore, Foreshore and Backshore.

Offshore

This is the area that is always inundated by water and is characterized by the hydrophytes that must utilize water as a support mechanism.

The offshore areas have three dominant types of hydrophytes:

Emergent hydrophytes are rooted in soils covered with up to 0.5 metres of water or on exposed soils just above the waterline. Plants are mainly perennial growing fròm creeping rhizomes or root stocks (i.e. cattail, wild rice).

Submerged hydrophytes occur on completely submerged soil at depths of 0.5 to 5.0 metres (elodea, coontail, pondweeds).

Floating hydrophytes are of two types, attached to substrate in water less than 3.5 m (12 ft.), (bladder wort, pondweed), or free floating (duckweed).

Foreshore

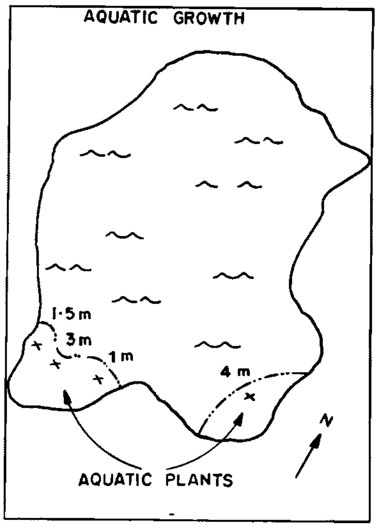
This is the area between the water's edge and the backshore. This area is usually covered by water for a period during the year. The vegetation is characterized by tag alders, Labrador tea, sweet gale, grasses and sedges with a height of less than 6 m (20 ft.). The hydrophytes must be able to withstand periods of dessication when water doesn't cover their root system.

Backshore

This is the area above the foreshore and is never covered by or inundated by water. The vegetation is characterized by woody species over 6 m (20 ft.) in height.

Delineation of Vegetation

The identification of hydrophytes is not needed but the delineation of areas of hydrophytes is needed and is recorded as follows:



1) Delineating the growth border(s) on the field physical feature map, as shown in the opposite diagram.

2) Measuring and recording on the same map the water depths along the outer edge of the plant growth. Maximum depth of water associated with this growth is the primary concern.

3) Measuring the surface area(s) of the plant growth site(s), either by the polar planimeter or dot grid method.

4) **Recording the total area of the plant growth site(s) in the designated spaces of the appropriate 'Lake or Stream Survey Form'.**

SECTION THREE

POST FIELD ACTIVITIES

After all the field activities are completed, the writing of the finished report starts. There are a number of tasks which must be finished entirely before the survey can be filed as 'complete'. These are listed below.

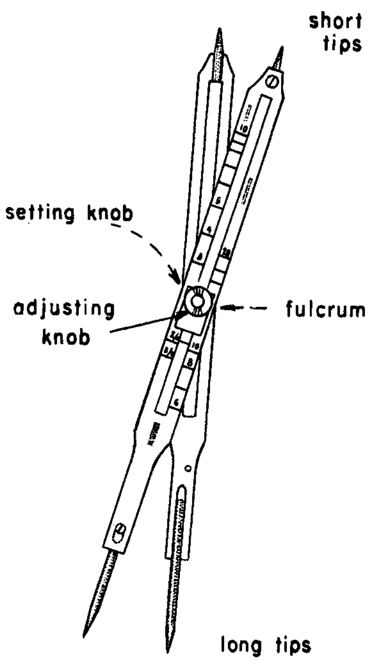
1) Prepare the 'Contour Map'.
2) Measure the contour areas and submit the calculation sheets to Main Office for computation.
3) Prepare the 'Physical Feature Map'.
4) Complete and type the 'Lake Survey Summary' 1422 form.

CHAPTER 8

PRODUCING THE CONTOUR MAP

The contour map is prepared by transcribing the depths from the echo sounding tapes to the corresponding transect map. This can be done using one of two methods. The preferred method is using proportional dividers. The second method which is much more time consuming and far less accurate is the 'geometric method' involving the use of triangles.

8.1 The Proportional Dividers



Proportional dividers are instruments made of crossed double pointed metal arms. They are made in such a way (as the name suggests) that they can be adjusted to measure ratios or proportions.

The tips on each end of the arms are of different lengths. One end has long tips and the other end has short tips. (See diagram.) The fulcrum also can be adjusted and moved towards either end by loosening the adjusting knob and turning the setting knob. The arms *must* be closed together when moving the fulcrum.

When transcribing depths from the tape to the map, one transect is covered at a time.

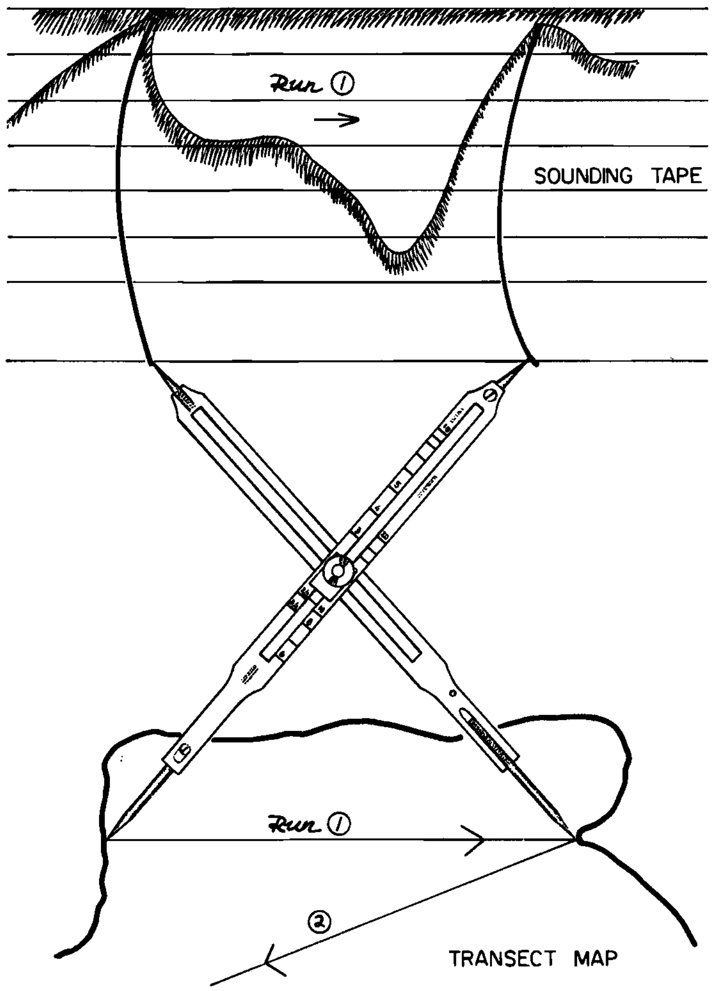
The dividers must then be adjusted so that the ends with the longer tips extend the length of the longer line and at the same time the ends with the shorter tips extend to the length of the shorter line. (See diagram)

N.B. Adjusting the dividers to the correct position can be tricky. See instructions following.

Adjusting the Dividers

To find the right position for the fulcrum of the dividers, there are two methods.

1) One method is to measure accurately the length of the lines and calculate the ratio. The dividers can then be set using the scale on the instrument and by following the formula supplied. (Each model type has a different formula.) This method involves time consuming measurements and calculations and is not recommended.
2) The other method is to set the dividers by 'trial and error'. This way is very quick and involves no measurements or calculations.



Trial and Error Method

a) Decide which line is longest, i.e. either the transect line on the map or the length of the sounding run on the tape.

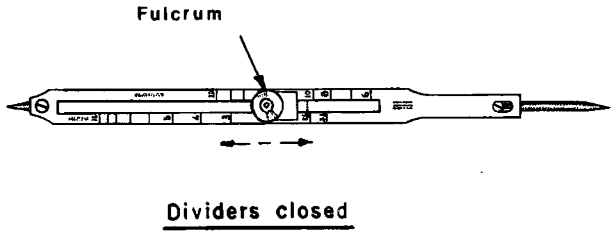
b) Place the dividers with the longer tips on the ends of the longer line, (usually the transect line on the map) as in the previous diagram.

c) With the dividers in the same position, place the dividers with the shorter tips onto the ends of the shorter line (usually the sounding tape).

d) *If* the distance between the shorter tips is *less* than the length of the line then proceed with step e. *If* the distance between the shorter tips is *greater* than the length of the line then proceed with step f.

e) Close the dividers and adjust the fulcrum by moving it towards the long points. (See diagram following.) Then repeat steps b, c, d, and e until correct setting is obtained.

f) Close the dividers and adjust the fulcrum by moving it towards the shorter points. (See diagram following.) Then repeat steps b, c, d, e and f until the correct setting is obtained.



Adjusting the fulcrum.

1) Loosen the adjusting knob.

2) Turn the setting knob.

Note: Usually the correct setting can be obtained in 2 – 3 tries. Speed will increase with experience.

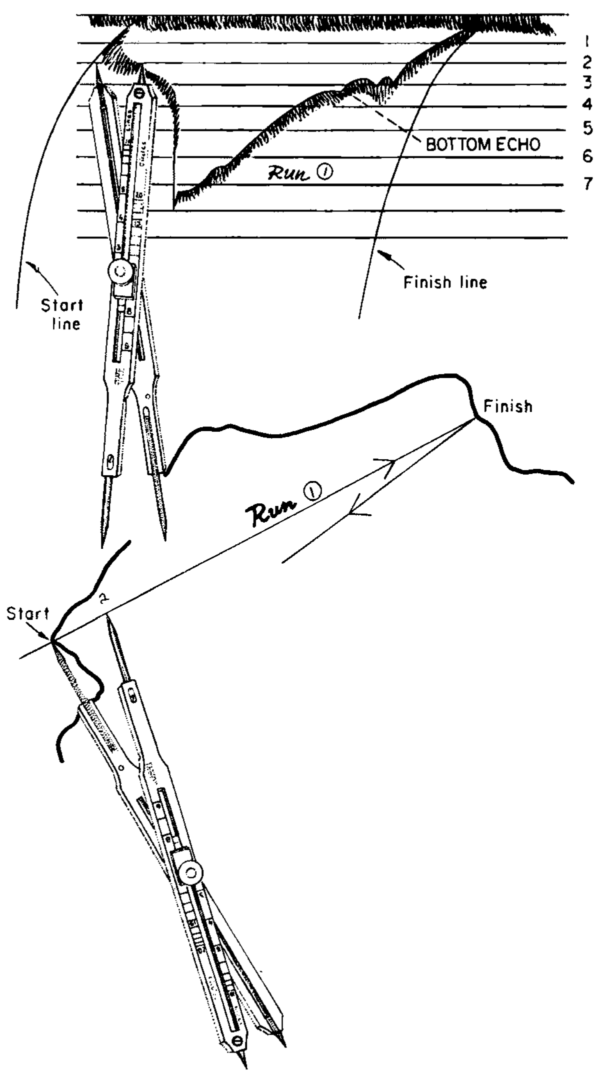
Also, if the same general boat speed has been maintained for each sounding transect very little adjustment of the proportional dividers will be necessary for each transect as the ratio will be fairly constant.

If some lines are too long for the dividers, divide the lines into equal sections and do separately.

Transcribing Depths

Once the proportional dividers have been adjusted the depths can be transcribed from the sounding tape to the 'transect map'.

Note. The dividers must be adjusted for *each* transect (run).



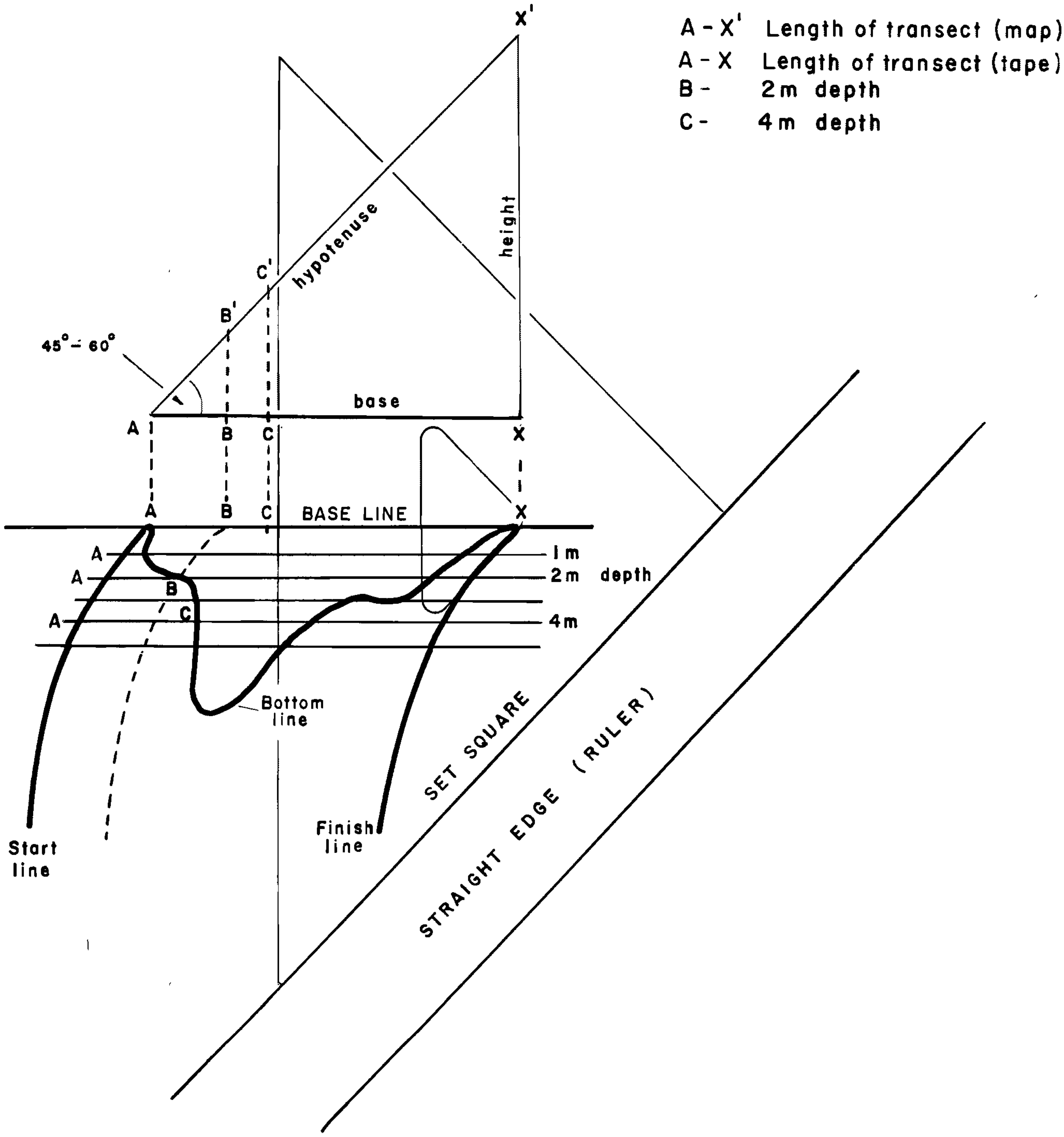
1) If the length of the sounding run on the tape is shorter than the map transect, then place the *shorter* ends of the dividers on the tape, i.e. for the 2 m depth place one tip on the start line of the run at the 2 m level. The other tip is placed on the 2 m line at the point that the bottom echo reaches 2 m in depth. See diagram opposite.
2) Remove the dividers making sure that the setting is not disturbed.
3) Place the divider's long points on the corresponding transect line. One long point should be at the *beginning* of the run while the other will cut the line as in the diagram. This point is then marked and the appropriate depth is marked, i.e. 2 m.
4) This technique is repeated for all the depths on the transect.
5) Each transect is transposed as described above.

Note: Be sure that the depths are plotted from the *start* of the run on the transect map.

6) Be sure to allow for distance from shore for start and finish of transects.

8.2 The Geometric Method

This method uses the principle of parallel lines in order to proportionally intersect the transect lines. As mentioned previously, it is less accurate than the method using proportional dividers and should only be used when proportional dividers are not available.



There are many variations of this method but all use the same general principle, that of parallel lines.

1) Draw a triangle with the base being the length of the transect on the tape and the hypotenuse being the length of the transect on the map. The angle should be between 45° – 60°.

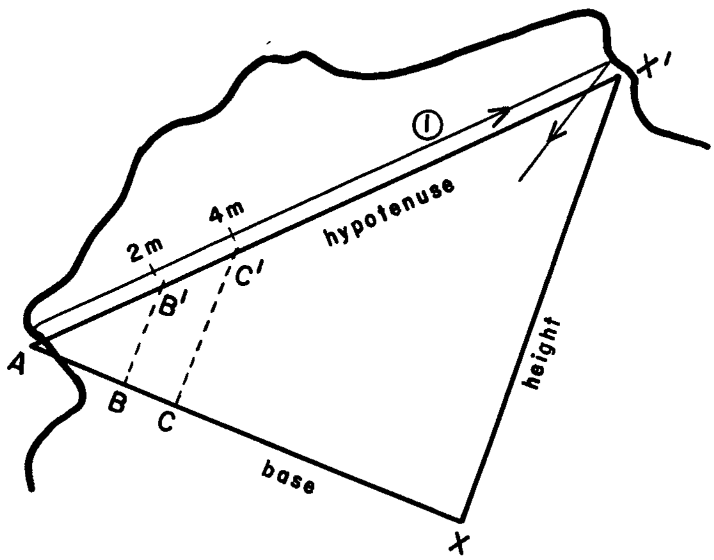
2) Plot the depths on the base line of the triangle by measuring on the tape along depth lines from the start line to where the bottom line cuts the depth, i.e. measure A – B at 2 m depth.

3) Transfer these lengths to the base of the triangle, i.e. A – B, A – C, etc.

4) Using a straight edge and set square draw lines parallel to the height of the triangle and through each of the depths marked on the base. Mark the hypotenuse where these lines intersect, i.e. B′, C′, etc.

5) Transfer these lengths (A – B′, A – C′, etc.) to the transect on the map (as in diagram).

Note: Be very careful to keep the lines parallel.



8.3 Required Contour Depths

The more depth contours which appear on a map, the more accurate are the calculations for volume and mean depth. However, discretion must be used when plotting depths or the contours become too closely spaced, blurred and meaningless. On the other hand, don't plot too few lines.

As a rule of thumb, the prescribed contours to be drawn (in metres) are 1, 2, 4, 6, 8 and thereafter by multiples of 2. If the lake is very deep and has a steeply sloping lake bed, multiples of 4 m can be used, i.e. 2, 4, 8, 12, etc.

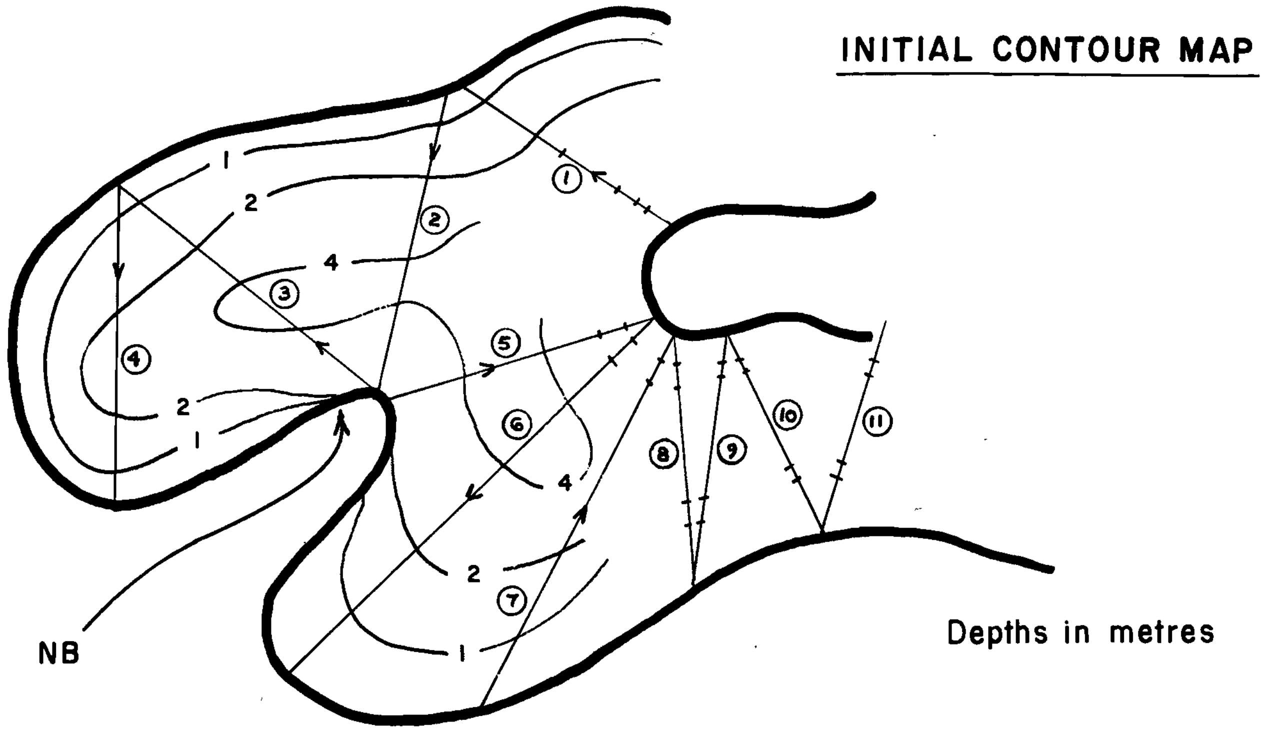
Do *not* use odd numbers, i.e. 1, 3, 5, 7, 9, etc.

In shallow lakes of less than 10 m in depth, contour intervals of 1m *may* be more appropriate, i.e. 1, 2, 3, 4, etc.

8.4 Drawing the Contours

Once all the depths have been transcribed from the sounding tapes to the transect map, then join the points of equal depth on the map.

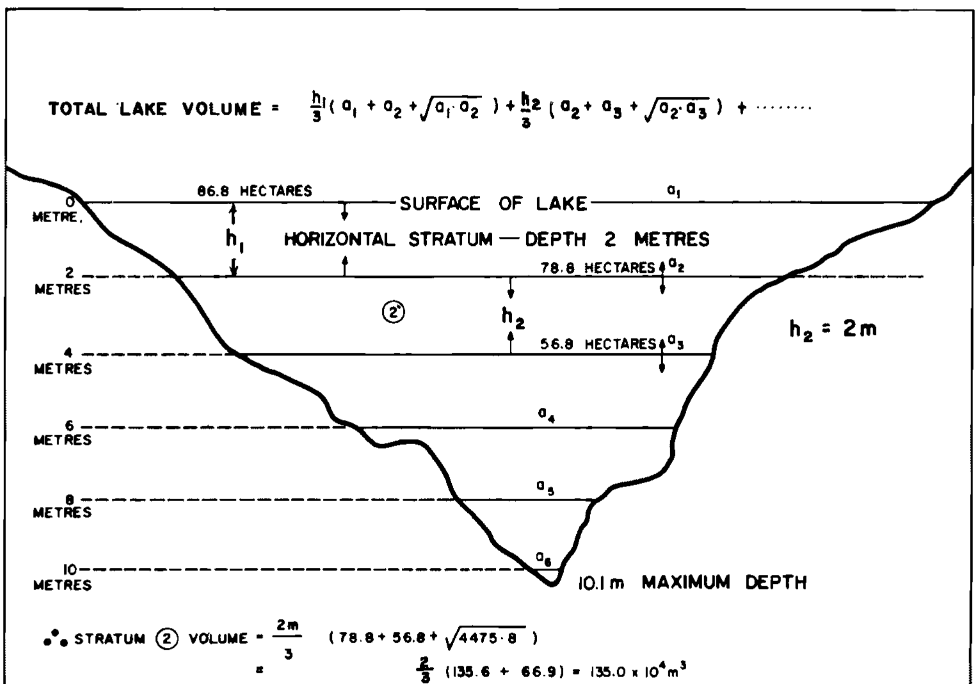
Join up the depths as accurately as possible. Sometimes when 'rapid dropoffs' occur it may be necessary to run contours into each other or into the shoreline. This is quite common when drawing on the 1 m contour. See example contour map illustrated.



8.5 The Final Contour Map

Once the initial contour map is completed, this map is then traced to produce the final map which will not show the transect lines. A complete list of features that appear on this map is shown in Appendix 5. A sample map appears in Chapter 9.

8.6 Volume Calculation



CROSS SECTION OF LAKE BASIN

To calculate the volume of a lake, measure the surface area of each contour. Then, by applying the formula above, the volume is calculated. These calculations are done by computer at Main Office or can be done at field offices using a programmable calculator.

8.7 Measuring Contour Areas

Measure the surface area from the contour map and calculate the 'Area Conversion Factor' (A.C.F.).

$$\text{A.C.F.} = \frac{\text{FRI area}}{\text{Contour Map Area}}$$

Record the FRI Area and the A.C.F. on the 'Lake Survey Data Calculation Sheet' (Form 0075). Next, measure each of the contour areas and multiply each by the A.C.F. This compensates for any error introduced by enlargement or reduction. N.B. The FRI area is *not* multiplied by the A.C.F.

The A.C.F. should be between 0.93 – 1.07. i.e. Strive to have the enlargement or reduction distortion less than 7%.

Note: When measuring the contour areas, measure all of the water area within the appropriate contour. i.e. The 2m contour area includes all the water *within* the 2 m including the 4, 6, 8, etc. The total land area of islands is subtracted from the surface area of the lake to give the surface water area. Any contours surrounding islands are measured and *subtracted* from the corresponding contour area for the entire lake.

8.8 The Lake Survey Data Calculation Sheet (Form 0075)

Complete this form completely and accurately as in the example. Submit forms to Fisheries Branch at Main Office and the volumes will be computed and returned immediately. A copy should be retained at the District Office. (See instructions at the bottom of the form.)

8.9 Mean Depth

Mean depth ($\bar{z}$) in metres is calculated by dividing the volume (V) of the lake by the area (A).

$$\bar{z} = \frac{V\ (10^4\ m^3)}{A\ (ha)}$$

8.10 S.D.F.

Shoreline Development Factor describes the irregularity of the shoreline by relating shoreline length (perimeter) to the length of the circumference of a circle with the same area as the lake. (Island shoreline is *not* part of this calculation.)

i.e. The S.D.F. of a lake that is a perfect circle is 1.0. Therefore, S.D.F. is never less than 1.0.

$$\text{S.D.F.} = \frac{P}{2\sqrt{A\pi}}$$

P = shoreline in km (perimeter)

A = area in square km (km^2)

π = 3.14

8.11 Maximum Depth

Maximum depth in metres is the greatest depth recorded for the whole lake.

Ministry of Natural Resources
Ontario

Lake Survey Data Calculation Aquatic Habitat Inventory

M.N.R. District No. 58

Lat. 45° 37' Long. 77° 57' Survey Year 19 78

Gazetteer Name	Local Name	Township
TROUT LAKE	BROWN TROUT LAKE	DICKENS

FRI AREA (84.0 ha) / CONTOUR MAP AREA (81.6 ha) = 1.03 = AREA CONVERSION FACTOR

Perimeter 5.5 km Is. Shoreline 0.2 km

WATER AREAS (converted)

Surface (FRI) Area	84.0 ha	
Inside 01m Contour	77.9 ha	
Inside 02m Contour	66.3 ha	
Inside 4m Contour	64.0 ha	
Inside 6m Contour	48.5 ha	
Inside 10m Contour	42.9 ha	
Inside 14m Contour	34.3 ha	
Inside 18m Contour	28.5 ha	
Inside 22m Contour	18.9 ha	
Inside 26m Contour	3.6 ha	

Maximum Depth 28.0 m

Submitted by D. Jones & A. Smith — Date: day 10 month 08 19 78

Volume 992.7 X 10^4 m^3 Mean Depth 11.8 m S.D.F. 1.7

Calculated by G. A. G. 77 — Date: day 12 month 08 19 78

Before submitting for calculations, it is suggested that a copy (photo or carbon) be retained and filed in the respective Lake Folder. A copy of the completed form will be retained at Main Office.

0075 (12/79)

CHAPTER 9

THE COMPLETED LAKE SURVEY REPORT

9.1 Completing the Lake Survey Summary Form *(1422)*

Section A: **Identification Key**

This section is completed during pre-field activities as outlined in Chapter 1.1 to 1.10.

Section B: **Location Data**

This section is completed during pre-field activities as outlined in Chapter 1.1 to 1.12.

Section C: **Water Chemistry Data**

This section is completed during field activities. However, it should be completed in such a manner that the depths and accompanying data are listed sequentially, from the surface to the bottom. Do not record the depths out of order. i.e. Do *not* list the mid-thermocline measurements at the bottom of the section.

Section D: **Basin and Terrain Characteristics**

Parts of this section will be completed during the three phases of the survey.

Below B.M. — Refer to Chapter 7.1

Fluctuation — Refer to Chapter 7.2

Max. Depth — Refer to Chapter 8.6

Mean Depth — Refer to Chapter 8.9

Perimeter — Refer to Chapter 2.3

Island Shoreline — Refer to Chapter 2.3

Surface Area — Refer to Chapter 2.5

Volume — Refer to Chapter 8.6

S.D.F. — Refer to Chapter 8.9

No. Resorts — Refer to Chapter 7.3

No. Cottages — Refer to Chapter 7.4

Crown, Patent — Refer to Chapter 1.12

Terrain — Refer to Chapter 7.6

Timber — Refer to Chapter 7.11

Section E:	**Physical Data**
Inlets	— Refer to Chapter 7.7
Outlets	— Refer to Chapter 7.7
Soil Types	— Refer to Chapter 7.8
Aquatic Vegetation	— Refer to Chapter 7.11
Bench Mark Description and Site Location	— Refer to Chapter 7.1
Section F:	**Fish**

Inhabiting Species

All species present in the lake are recorded in this section. The species are all coded (see Appendix 2) and the codes are listed in the appropriate boxes. List the codes from top to bottom using one column at a time. The codes should be listed in descending order of *importance* not abundance or any other such criteria. Game fish are first, minnows should be listed last. Remember to add the codes of the small fish which are identified at Main Office.

Plantings

Check the district records of all fish plantings for the lake and give a brief stocking history. Ensure that the initial plantings of all species are recorded and record recent plantings (last 2 – 3 years). Keep species separate. Statements such as "lake trout plantings discontinued in 1961" and "annual plantings of brook trout" or whatever the case, should be noted in the history section.

Section G: **History and Comments**

This section is intended to summarize important information about the lake relevant to fish habitat, utilization by anglers, commercial fishermen, etc. Any qualitative and anecdotal information should be included here. e.g. "Local residents report a lake trout population was present in the thirties." or "Lake fished heavily during winter months."

Dams

Type and year of construction should be noted. Beaver dams can be mentioned.

Pollution

Any visible signs of contamination, and source, if obvious should be noted.

Food

The identified specimens or material matter, removed from the pharynx, oesophagus or stomach of the fish are noted. Available food if game fish are absent should be included also.

Disease

List the diseases known to have been important in the lake or which are readily apparent. i.e. "Die off of brook trout due to furunculosis in 1961." or "Heavy infestation of black spot on yellow perch."

Recommendations

Recommendations are made *only* by the 'Fish and Wildlife Supervisor' or 'Fisheries Biologist' after the lake survey results have been noted.

Management Classification

The district officer responsible for the district fisheries management program classifies the lake.

General Information

Listed below are some general notes regarding the completing of the 'Lake Survey Summary Form (1422)'.

1) All information should be entered in the appropriate boxes. Do not write between boxes or lines.

2) Use additional sheets if more space is necessary. i.e. Additional chemistry or history information. If additional sheets are used, each sheet should have section A and B completely filled out. This ensures that misplaced sheets can be properly identified.

3) Do *not* fill up empty boxes with zeros. Use zeros only where appropriate i.e. 0 cottages, 0.40 m fluctuation.

4) Do not leave sections empty. i.e. If no dams are present at a lake state "no dams". Do not leave the section blank.

5) Some Districts ask for observations on birds and wildlife. Please check with your Supervisor for the District policy on this point.

9.2 Filing of the Completed Report

When the final lake survey report is completed the multitude of notes, forms, maps and papers must be correctly amalgamated and filed. Some information is sent to Main Office (Fisheries Branch) to be filed in the master 'Provincial Lake Survey files' and subsequently entered into the computerized data base (Lake Inventory Data Base). The bulk of the original data, however, is filed at the appropriate District Office in one complete package. Listed below is an outline of which data are required and where they are filed.

	District Office	**Main Office**
Lake Survey Summary (1422)	original copy	*carbon copy not xerox*
Contour Map	original copy	blueray copy/(not xerox)
Data Calculation Sheet (0075)	xerox copy	*original copy
Transect Map	original copy	not required
Physical Feature Map	original copy	not required
Field Record Form (2066)	carbon copy	**original copy
Field Collection Label	not retained	***original copy
Field notes	all retained	not required
All rough notes, maps calculations, sounding tapes	all retained	not required

Note: *original is returned to District Office after computations are completed
**original copies required to enter fish identifications and making subsequent copies — included with fish samples
***included with fish samples and Field Record Forms

9.3 Forms

Order all forms from Central Supply Warehouse at 51 Esandar Drive, Toronto. Use warehouse requisition forms.

9.4 Update and Replacement Surveys

Before an attempt is made to update or replace any lake survey, there must be a complete original survey on file. An update provides new information for selected sections of a lake survey. A replacement survey provides an entirely new lake survey.

9.4.1 Chemistry/Fish Species Updates

In most cases previously documented physical data are satisfactory; only chemical and/or biological data require revision.

Techniques for field work and documentation procedures are the same as for original surveys described in previous chapters. Attempt to place the chemistry stations in the same locations as in the previous survey(s). As well, additional chemistry stations may be established as described in Chapter 4.2.

On the Lake Survey Summary Form 1422 Sections A, B, C, and/or F must be completed. Note previous survey date(s) in section G. Record the appropriate title at the top of each sheet.

Chemistry Update
Chemistry & Fish Sp. Update
Fish Sp. Update.

9.4.2 Replacement Surveys

Original surveys rarely need to be replaced except in the following instances:

1) original survey information may be obsolete, e.g. as a result of altered land use.

2) the majority of original survey information is suspect.

Follow the same procedures as outlined for original surveys. All data summary forms (0075, 1422, 2066) must have **Replacement Survey** recorded at the top of each sheet. In the History and Comments Section G, record all previous survey dates. Indicate what data, if any, has been obtained from previous surveys.

All new data collected will replace previous data with the exception of chemistry and fish species which will supplement former surveys.

Ministry of Natural Resources
Ontario

Lake Survey Summary
Aquatic Habitat Inventory

A. Identification Key

M.N.R. District No. 58 Watershed 2KD

Lat. 45°37′ Long. 77°57′ Survey Year 19 78

B. Location Data

Gazetteer Name	Topographic Map Name	Local Name	
Trout Lake	Little Trout Lake	Brown Trout Lake	
County or Judicial District	**Township**	**Lot**	**Concession**
Nipissing	Dickens	N/A	N/A
Name and No. of Topo. Map		**Watershed Code**	**Elevation**
Round Lake 31F/12 Edition 3		2KD 09	389 m

Access: Legal / 15 km north of Exeter on Hwy. 14, 1km west on bush road

C. Water Chemistry Data

Sta. No. 1 of 2 Secchi 3.6 m Cloud 80 % 1210 hrs. Date — Day 06 Mo. 08 Year 19 78

Surface — Calm [x] Rippled [ ] Wavy [ ] Rough [ ] Thermocline From 6.0 m To 10.0 m

Colour — Colourless [ ] Yellow/Brown [x] Blue/Green [ ] Air Temp. 24.9 °C No Thermocline [ ]

Depth m	Temp. °C	D.O. mg L^{-1}	pH	Alk. mg L^{-1}	T.D.S. mg L^{-1}	Cell T. °C	Conductivity µmhos/cm
00	19.5						
01	19.5						
02	19.0	7.2	7.0	13.7	14.2	22.0	20.0
04	18.0						
06	17.0						
08	13.5	6.8	6.5	13.7	15.5	18.0	20.
10	8.0						
12	6.5						
14	5.0						
16	4.0						
17	4.0	4.0	6.5	6.8	16.6	12.0	18.5
19	4.0	3.8	6.5	6.8	16.6	12.0	18.5
22	4.0	3.6	6.5	6.8	16.6	12.0	18.5
26	4.0	3.2	6.5	6.8	16.6	12.0	18.5
27	4.0						

Numbers Only [ ]

Checking Only [X]

Chemistry Test Time From 1210 hrs. to 1230 hrs. Station Depth 28.0 m

D. Basin and Terrain Characteristics

				Timber Types
Below B.M.— 1.52 m	Fluctuation 1.40 m	No. Resorts 1	Flat 26 %	mixed
Max. Depth 28.0 m	Mean Depth 11.8 m	No. Cottages 12	Rolling 30 %	mixed, Con
Perimeter 5.5 km	Is. Shoreline 0.4 km	Crown 55 %	Hilly 44 %	mixed, Con
Surface Area 84.0 ha		Patent 45 %	Mntnous %	

Volume — 992.7 $\times 10^4 m^3$

S.D.F. — 1.7

Survey Date: day 05 month 08 19 78 To day 07 month 08 19 78

Investigator(s) A. Smith, D. Jones

Sheet 1 of 2

1422 (12/79)

E. Physical Data

Inlets:

	No.	m^3/s
Perennial	2	0.05
Non-Perennial	2	NMD

Outlets:

	No.	m^3/s
Perennial	1	0.08
Non-Perennial		

Comments (re: Inlets and outlets)

Southern perennial inlet = 0.01 m^3/s

Eastern perennial inlet = 0.04 m^3/s

2 Non — perennial inlets dry at time of survey

Soil Types

	Sh. line	Btm.
Rock	05 %	10 %
Bldr.	10 %	10 %
Rubble	10 %	10 %
Gravel	20 %	30 %
Sand	55 %	40 %
Silt	%	%
Clay	%	%
Marl	%	%
Muck	%	%
Detr.	%	%

Aquatic Vegetation

[X] Present [ ] Absent Total Area 4.7 ha

Comments (re: Aquatic Vegetation)
Heavy growth in N.W. end of Lake.
Mostly water lilies. Some cattails and
sedges around outlet.

Bench mark description and site location
Triangle with dot in centre painted on
a rock face opposite island on N.W. shore.
Measurement taken from dot.

F. Fish

Inhabiting Species

Code No.	Code No.	Code No.	Code No.
080			
163			
182			
183			

Plantings

19	Sp. No.	Amount and Class
45	80	1000 Fg
75	80	1000 Fg
76	80	1000 Fg
77	80	1500 Fg

G. History and Comments

This lake is fished quite often by locals. Mostly winter fishing. The tourist resort has several boats which were on the lake during the survey. Anglers were having good luck. Lake trout have been stocked in the past but did not seem to catch on. Access road is fairly good for most vehicles. A launching ramp has been dug out by locals.

Dams: Beaver dam on south inlet.

Food: Brook trout feeding on minnows.

Pollution: Some garbage on island at north end.

Disease: None noted.

H. Recommendations

Manage as self supporting brook trout fishery.
Discontinue planting.

Management classification: Self supporting brook trout fishery. by A. Johnson position F.& W. Supervisor

Fish: age class — EE — eyed eggs, Fy — fry, Fg — fingerlings, Yg — yearlings, II — age 2, IV — age 4, etc., Ax — adult age unknown, FC — fin clip.

Ministry of Natural Resources
Ontario

Lake Survey Summary
Aquatic Habitat Inventory

A. Identification Key

M.N.R. District No. 58 | Watershed 2KD

Lat. 45°37' | Long. 77°57' | Survey Year 19 78

B. Location Data — Gazetteer Name: Trout Lake | Topographic Map Name: Little Trout Lake | Local Name: Brown Trout Lake

County or Judicial District: Nipissing | Township: Dickens | Lot: N/A | Concession: N/A

Name and No. of Topo. Map: Round Lake 31F/12 Edition 3 | Watershed Code: 2KD 09 | Elevation: 389 m

Access: Legal / 15 km north of Exeter on Hwy. 14, 1 km west on bush road

C. Water Chemistry Data

Sta. No. 2 of 2 | Secchi 1.8 m | Cloud 80 % | 1200 hrs. | Date — Day 06 Mo. 08 Year 19 78

Surface — Calm [x] Rippled [ ] Wavy [ ] Rough [ ] | Thermocline From . m To . m

Colour — Colourless [ ] Yellow/Brown [x] Blue/Green [ ] | Air Temp. 24.0 °C | No Thermocline [x]

Depth m	Temp. °C	D.O. mg L^{-1}	pH	Alk. mg L^{-1}	T.D.S. mg L^{-1}	Cell T. °C	Conductivity µmhos/cm
00	19.5						
01	19.5	6.0	7.0	13.7	14.2	22.0	20.0
02							

Numbers Only [ ]

Checking Only [X]

Chemistry Test Time From 1130 hrs. to 1200 hrs. | Station Depth 2.0 m

D. Basin and Terrain Characteristics

Below B.M.— . m | Fluctuation . m | No. Resorts | Flat .%

Max. Depth . m | Mean Depth . m | No. Cottages | Rolling .%

Perimeter . km | Is. Shoreline . km | Crown .% | Hilly .%

Surface Area . ha | Patent % | Mntnous .%

Timber Types

Volume — . x$10^4 m^3$ 85

S.D.F. — .

Survey Date: day 05 month 08 19 78 To day 07 month 08 19 78 | Investigator(s) A. Smith, D. Jones | Sheet 2 of 2

1422 (12/79)

E. Physical Data

Inlets:

	No.	m^3/s
Perennial		
Non-Perennial		

Outlets:

	No.	m^3/s
Perennial		
Non-Perennial		

Comments (re: Inlets and outlets)

Soil Types

	Sh. line	Btm.
Rock	•%	•%
Bldr.	•%	•%
Rubble	•%	•%
Gravel	•%	•%
Sand	•%	•%
Silt	•%	•%
Clay	•%	•%
Marl	•%	•%
Muck	•%	•%
Detr.	•%	•%

Aquatic Vegetation

☐ Present ☐ Absent Total Area • ha

Comments (re: Aquatic Vegetation)

Bench mark description and site location

F. Fish

Inhabiting Species

Code No.	Code No.	Code No.	Code No.

Plantings

19	Sp. No.	Amount and Class

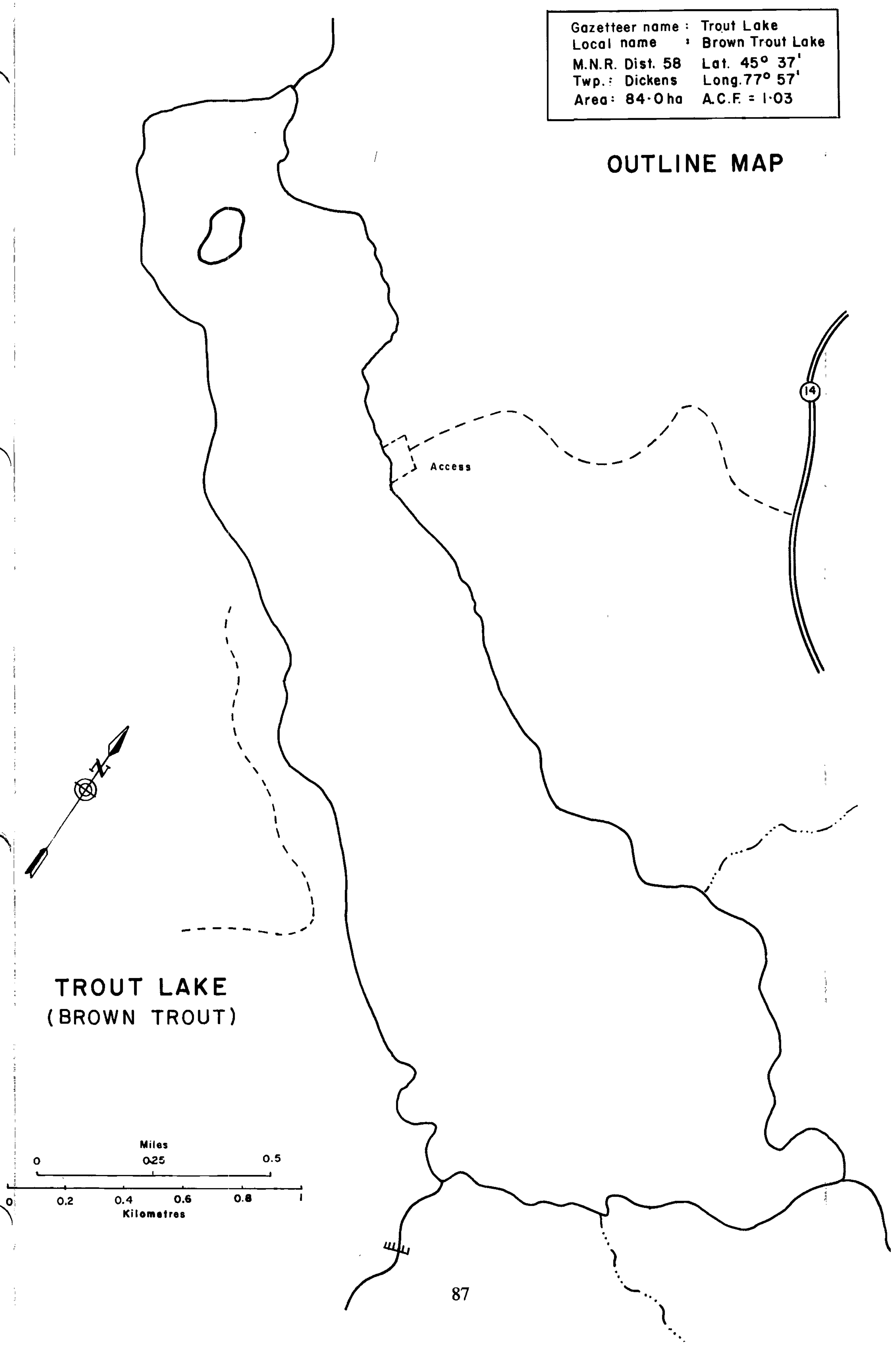
G. History and Comments

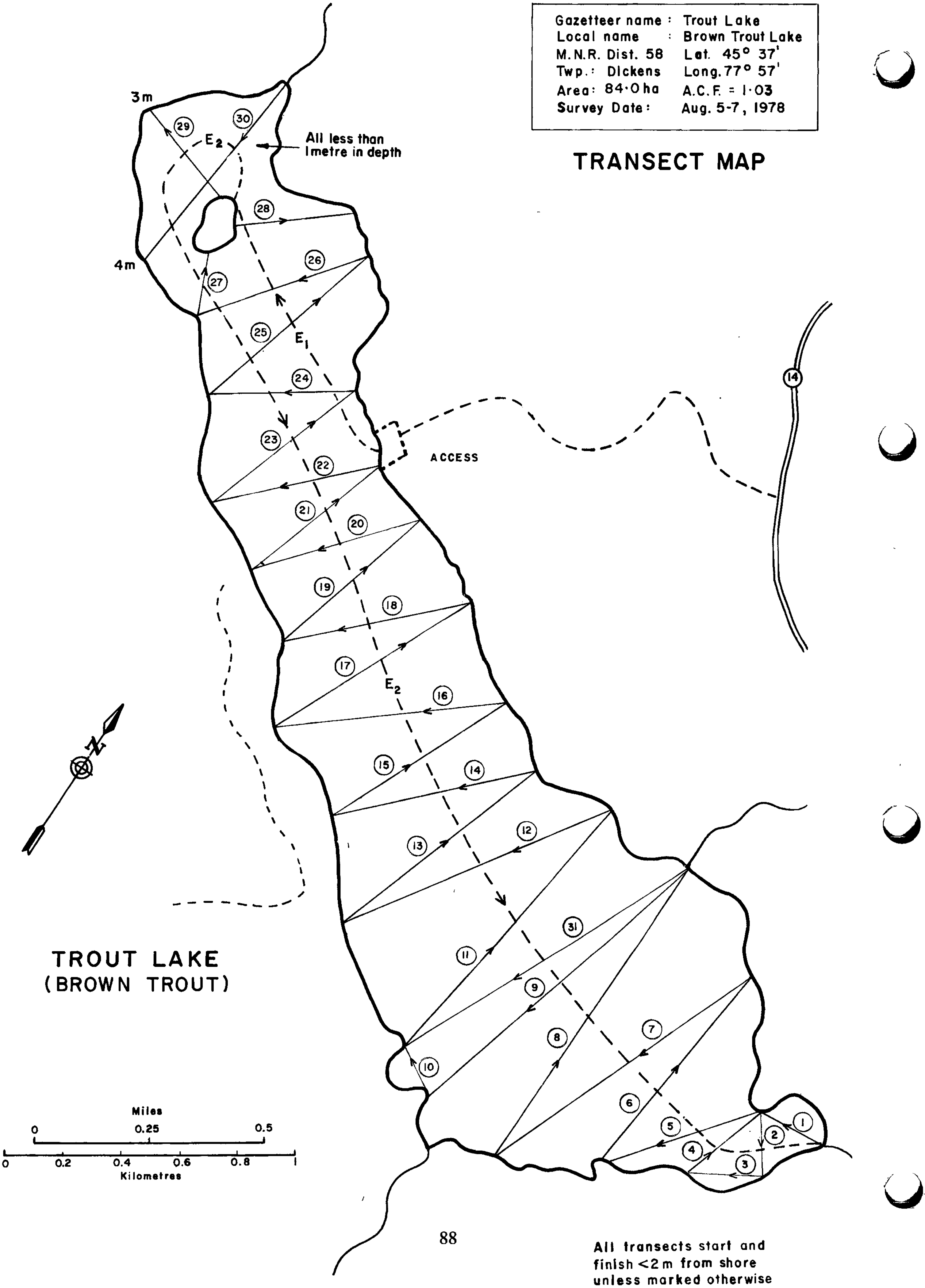
Dams	Food
Pollution	Disease

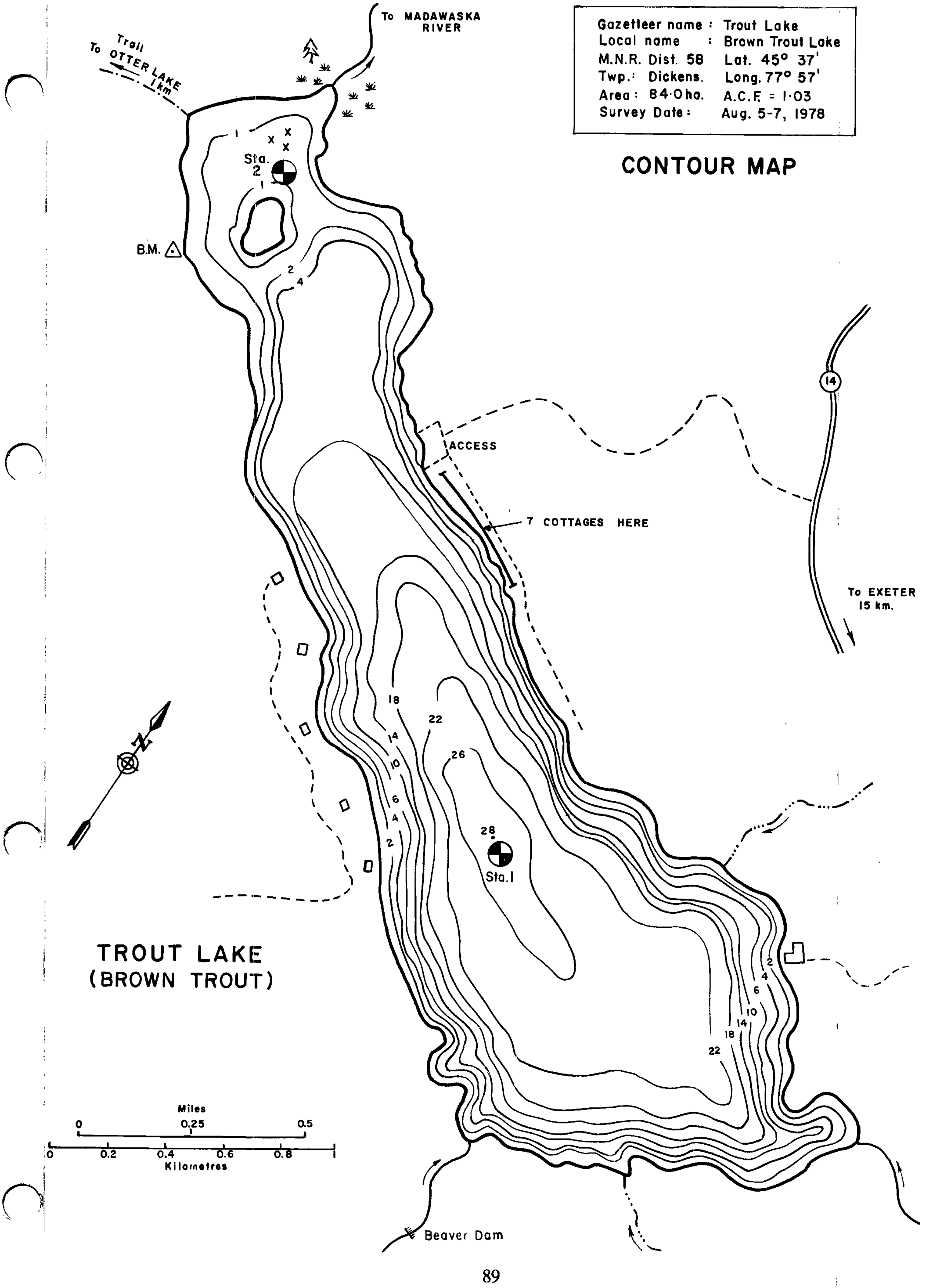
H. Recommendations

Management classification by position

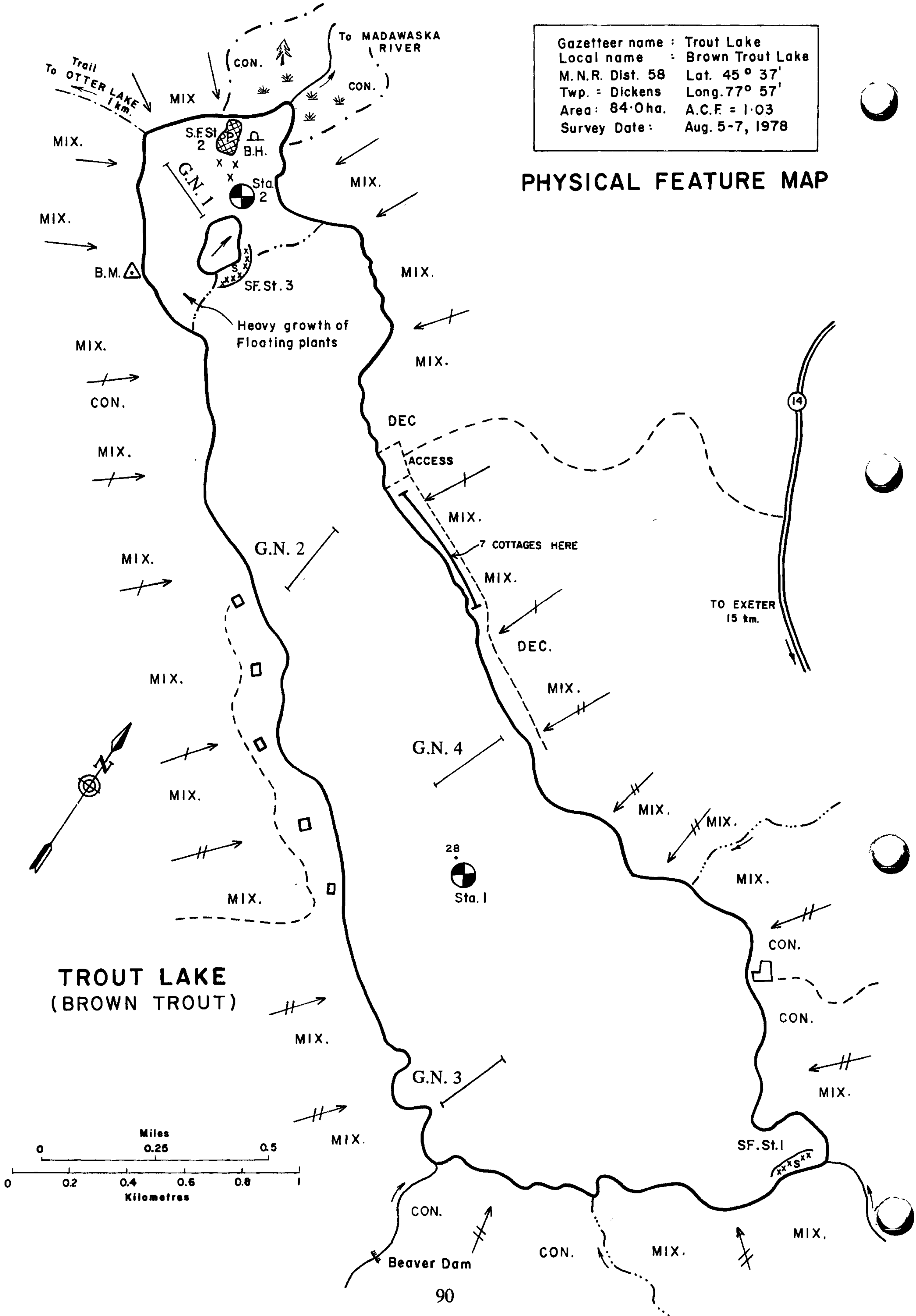
Fish: age class ÷ EE — eyed eggs, Fy — fry, Fg — fingerlings, Yg — yearlings, II — age 2, IV — age 4, etc., Ax — adult age unknown, FC — fin clip.


Gazetteer name : Trout Lake
Local name : Brown Trout Lake
M.N.R. Dist. 58 Lat. 45° 37'
Twp. : Dickens Long. 77° 57'
Area : 84·0 ha A.C.F. = 1·03
OUTLINE MAP
14
Access
TROUT LAKE
(BROWN TROUT)
N
Miles
0
0.25
0.5
0
0.2
0.4
0.6
0.8
1
Kilometres


Gazetteer name : Trout Lake
Local name : Brown Trout Lake
M.N.R. Dist. 58
Lat. 45° 37'
Twp.: Dickens
Long. 77° 57'
Area: 84·0 ha
A.C.F. = 1·03
Survey Date: Aug. 5-7, 1978
TRANSECT MAP
All less than 1metre in depth
3m
4m
E_1
E_2
ACCESS
14
N
TROUT LAKE
(BROWN TROUT)
Miles
0 0.25 0.5
0 0.2 0.4 0.6 0.8 1
Kilometres
All transects start and finish <2m from shore unless marked otherwise



Gazetteer name : Trout Lake
Local name : Brown Trout Lake
M.N.R. Dist. 58
Lat. 45° 37'
Twp.: Dickens.
Long. 77° 57'
Area : 84·0 ha.
A.C.F. = 1·03
Survey Date : Aug. 5-7, 1978
CONTOUR MAP
To MADAWASKA RIVER
Trail
To OTTER LAKE 1 km
Sta. 2
B.M.
ACCESS
7 COTTAGES HERE
14
To EXETER 15 km.
18
22
26
28
Sta. 1
14
10
6
4
2
TROUT LAKE
(BROWN TROUT)
Miles
0
0.25
0.5
0
0.2
0.4
0.6
0.8
1
Kilometres
Beaver Dam


Gazetteer name : Trout Lake
Local name : Brown Trout Lake
M.N.R. Dist. 58
Twp. = Dickens
Area : 84·0 ha.
Survey Date :
Lat. 45° 37'
Long. 77° 57'
A.C.F. = 1·03
Aug. 5-7, 1978
PHYSICAL FEATURE MAP
TROUT LAKE
(BROWN TROUT)
Trail To OTTER LAKE 1 km.
To MADAWASKA RIVER
TO EXETER 15 km.
14
CON.
MIX.
DEC
DEC.
ACCESS
7 COTTAGES HERE
S.F.St. 2
B.H.
P
Sta. 2
G.N. 1
G.N. 2
G.N. 3
G.N. 4
B.M.
SF. St. 3
Heavy growth of Floating plants
28
Sta. 1
SF. St. 1
Beaver Dam
N
Miles
0
0.25
0.5
0
0.2
0.4
0.6
0.8
1
Kilometres

PART TWO
STREAM SURVEYS

STREAM INVENTORY

In the following chapters many explanations will refer to previous chapters in the lake survey portion. This should not be an inconvenience to the reader since there are minimal differences in the survey techniques of lentic and lotic waters.

SECTION ONE

PRE-FIELD ACTIVITIES

Before any field work is undertaken, there are a number of activities that should be completed. It is essential that each survey crew becomes familiar with the stream to be surveyed by the use of maps and discussions with Conservation Officers and that all necessary information is assembled before commencing field activities.

Listed below are the steps in preparation for the field activities.

1) Obtain the necessary maps, aerial photographs, if needed, gazetteer and supplements.
2) Locate and identify the waterbody.
3) Obtain information on accessibility of the waterbody.
4) Calculate drainage areas.
5) Graphically illustrate the gradient profile.
6) Search all available historical records.

CHAPTER 10

IDENTIFYING AND DEFINING WATERBODY LOCATION

10.1 Gazetteer Name

Refer to Chapter 1.1.

10.2 Geographic Co-ordinates

The geographic co-ordinates of a stream locate the mouth of the stream and must correspond to the gazetteer geographic co-ordinates. If the stream is not listed (NL) in the gazetteer, then the co-ordinates are determined to the nearest tenth of a minute from a topographic map. Refer to Chapter 1.2.

10.3 Topographic Map name

Refer to Chapter 1.3

10.4 Name of Topographic Map and Number

Refer to Chapter 1.4. List the name, number and edition of all the maps covering the drainage basin.

10.5 Ministry Administrative Codes

Refer to Chapter 1.5

10.6 County or Judicial District and Township

Refer to Chapter 1.7. If the stream passes through more than one County or Judicial District, record them all. Similarly, record all townships in the drainage basin (watershed).

10.7 Local Name

Refer to Chapter 1.6

10.8 Lot and Concession

Refer to Chapter 1.8

10.9 Elevation

Refer to Chapter 1.9, 19.8. Record elevation of the mouth of the stream to the nearest metre.

10.10 Watershed Code

Refer to Chapter 1.10

CHAPTER 11

PREPARATORY MAP WORK

11.1 Topographic Map

In stream map work, always use 1:50,000 or 1:25,000 series of topographic maps for recording stream stations.

11.2 Stream Length

Regardless of whether the entire stream is surveyed, the stream length is the distance from the mouth to the farthest source excluding tributaries. To measure the distance use a map measurer and run it equidistant between the stream banks. When lakes/ponds are encountered, measure the shortest distance from the inlet to outlet. Upon completion, the length of the desired line will be indicated by the indicator needle in centimetre intervals. To convert centimetres to kilometres, divide the number of centimetres on the wheel by the map scale.

As an example

$$\frac{\text{reading on map measurer}}{\text{map scale}} = \text{distance}$$

$$\frac{36.5 \text{ cm}}{2 \text{ cm } (1\text{:}50{,}000)} = 18.3 \text{ km}$$

For scale conversions refer to Chapter 2.5.

11.2.1 Map Measurer

Refer to Chapter 2.3.1

11.3 Stream Drainage Area

Drainage area is the land surface area from which a stream receives its water. The boundary of the water drainage area is determined by defining on the 1:50,000 topographic maps the height of the land between stream drainages. Outline the drainage area on the map and calculate the area using a polar planimeter or a dot grid.

11.3.1 Polar Planimeter

Refer to Chapter 2.5.1

11.3.2 Dot Grid

Refer to Chapter 2.5.2

11.4 Average Gradient

The average gradient is a description of the rate of descent of a stream. The 'Gradient Profile' is a graphic illustration of the descent from source to mouth. A profile shows the location of both natural and artificial features which can influence the fish producing capabilities of the system. The profile is drawn to scale on graph paper as illustrated (following), from the data on the gradient profile summary.

11.4.1 The Gradient Profile

The mouth of the stream or river under survey will *always* be located at the extreme left of the illustration. The references for contours, natural and artificial features will be identified numerically on the gradient profile, in successive numbers from mouth to headwater (left to right) and correspond with the accompanying gradient profile summary. Elevations for some of the features are located on topographic maps. Estimate only the mouth and source elevations if not indicated. Use the elevation that is midway between known contour values. The following information is required on the gradient profile and the summary.

1) The mouth of the waterway under survey
2) The mouth of all tributary waters
3) The point of confluence of the waterway under survey through another water feature (lake or pond)
4) All contour lines that transect the course of the principal waterway
5) The site of any abrupt elevation change such as waterfalls or dams, even though the elevations are not indicated on the map
6) Stream station locations (added after field activities)

Tributaries of the stream under survey are classified and shown on the gradient profile diagram as follows.

1) Tertiary: 'waters of the *same* watershed code'
These waters will be shown by a broken line, 2 centimetres in length.

2) Secondary: 'waters of a *different* watershed code'
These waters will be shown by a solid line 1 centimetre in length.

Note: Be prepared to correct the gradient profile and summary from field observation, as new dams, etc., may have been built, and do not appear on the most recent topographic map.

11.4.2 Average Stream Gradient

The average stream gradient is the difference in elevation between the water source and the mouth, divided by the length of the stream.

$$\text{Average gradient} = \frac{\text{elevation at source} - \text{elevation at mouth}}{\text{length of stream}}$$

As an example: $\text{Average Gradient} = \frac{362\text{ m} - 286\text{ m}}{22.5\text{ km}} = 3.4\text{ m/km}$

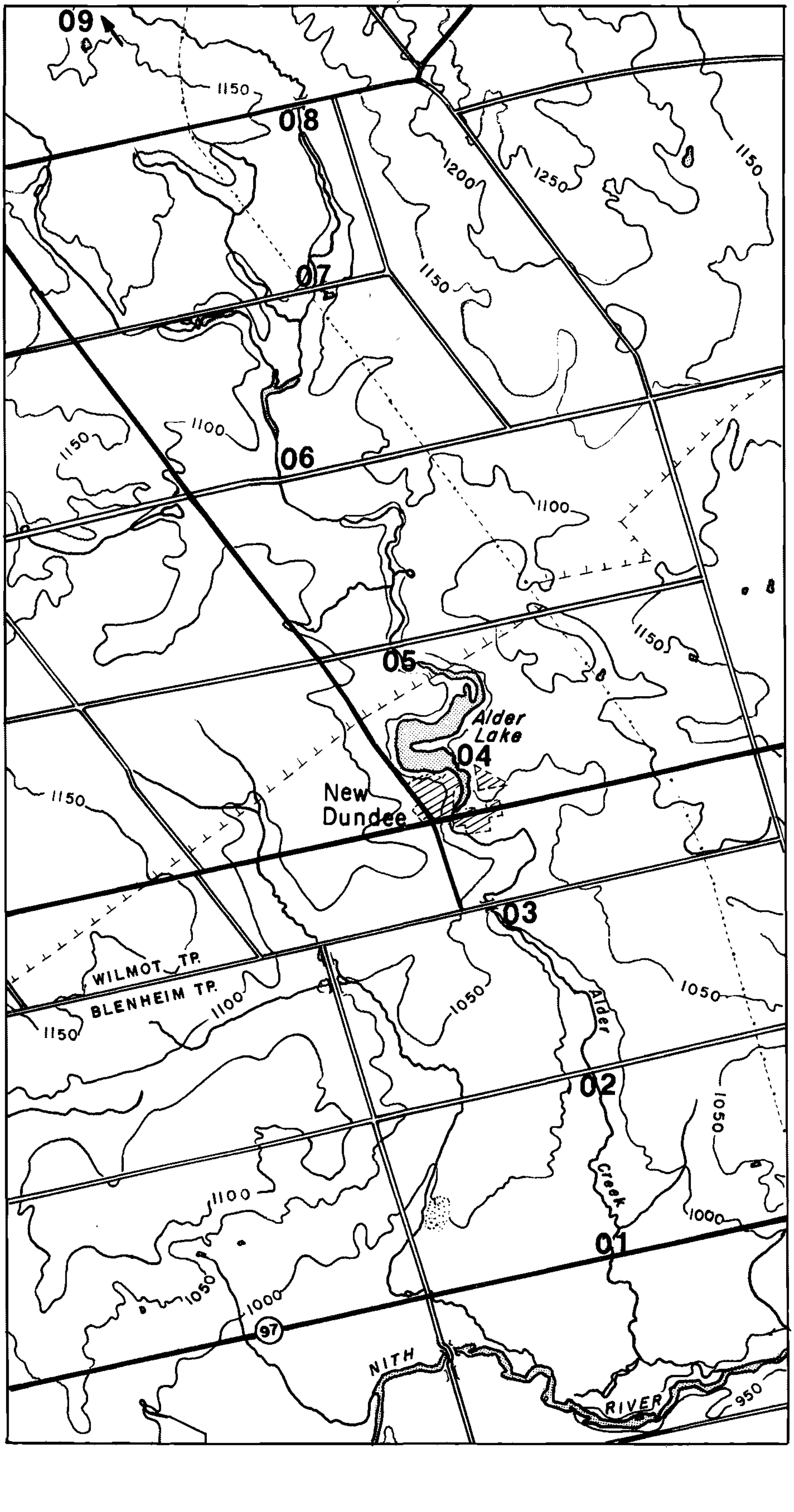
11.5 Stream Type

Perennial streams discharge year round and never become dry. Non-Perennial streams discharge only periodically after heavy rains or spring break-up and do become dry some times.

ALDER CREEK STREAM SURVEY

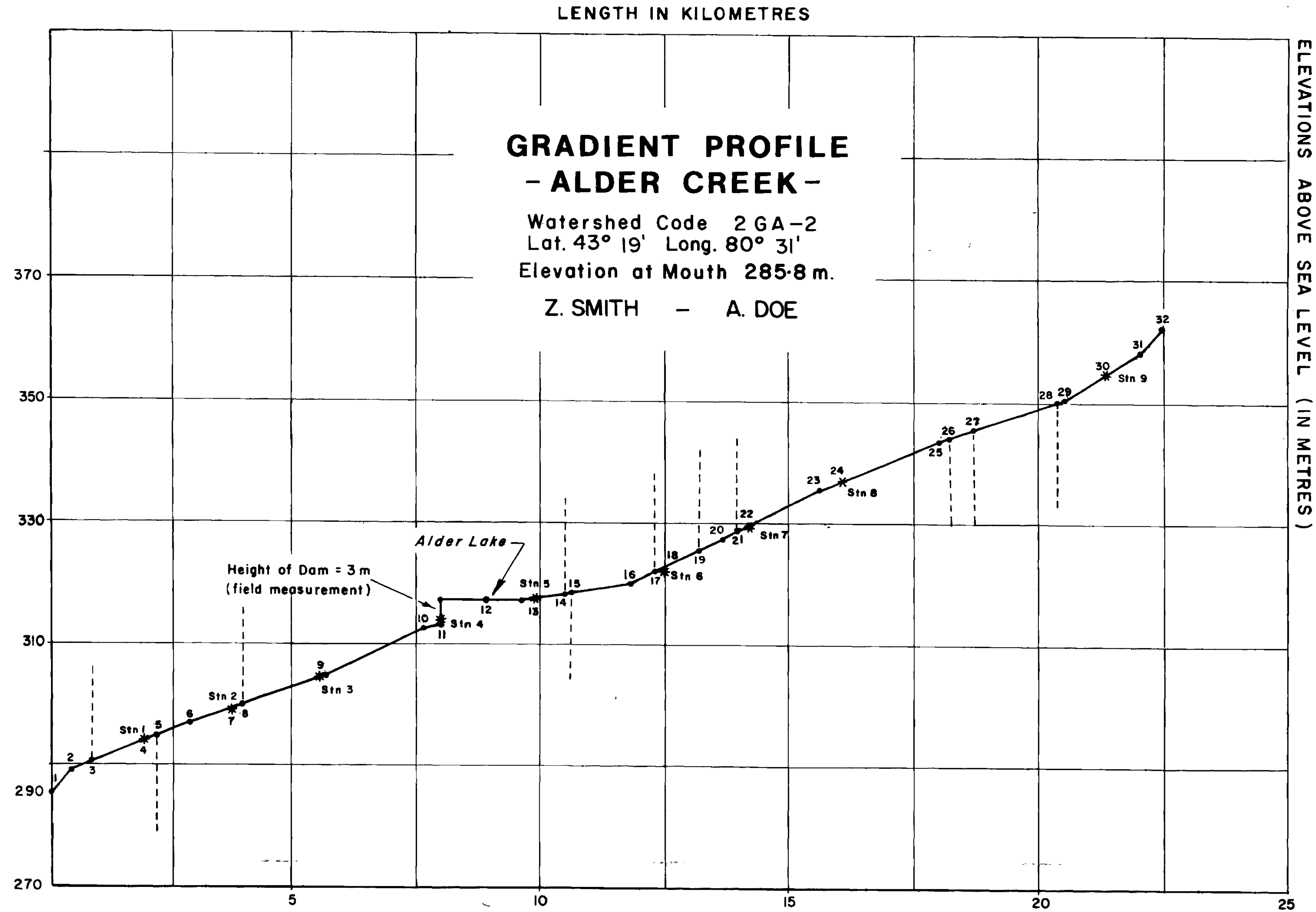
STATION LOCATIONS

01 – 08



Gradient Profile Summary of Alder Creek
Lat: 43° 19′ Long. 80° 31′

	Site Description	Elevation A.S.L. (m)	Distance Between (km)	Total Reference (km)	Topo. Map Name and No.
1.	Mouth (Nith R.)	286	0	0	Stratford
2.	Contour	290	0.4	0.4	40P/7
3.	Stream		0.4	0.8	Edit. 5
4.	Station 1		1.1	1.9	
5.	Stream		0.2	2.1	
6.	Contour	297	0.7	2.8	
7.	Station 2		1.1	3.9	
8.	Stream		0.1	4.0	
9.	Station 3, Contour	305	1.6	5.6	
10.	Contour	313	2.0	7.6	
11.	Station 4, Dam	314	0.3	7.9	
12.	Alder Lake	317	0.6	8.5	
13.	Station 5		1.5	10.0	
14.	Stream		0.5	10.5	
15.	Stream		0.1	10.6	
16.	Contour	320	1.2	11.8	
17.	Stream		0.5	12.3	
18.	Station 6		0.2	12.5	
19.	Stream		0.7	13.2	
20.	Contour	328	0.4	13.6	
21.	Stream		0.8	14.4	
22.	Station 7		0.3	14.7	
23.	Contour	335	0.9	15.6	
24.	Station 8		0.2	15.8	
25.	Contour	343	2.2	18.0	
26.	Stream		0.2	18.2	
27.	Stream		0.5	18.7	
28.	Stream		1.6	20.3	
29.	Contour	351	0.2	20.5	
30.	Station 9		0.9	21.4	
31.	Contour	358	0.9	22.3	
32.	Head Water (source)	362	0.2	22.5	


LENGTH IN KILOMETRES
GRADIENT PROFILE
- ALDER CREEK -
Watershed Code 2 GA-2
Lat. 43° 19' Long. 80° 31'
Elevation at Mouth 285·8 m.
Z. SMITH - A. DOE
ELEVATIONS ABOVE SEA LEVEL (IN METRES)
Height of Dam = 3 m
(field measurement)
Alder Lake
Stn 1
Stn 2
Stn 3
Stn 4
Stn 5
Stn 6
Stn 7
Stn 8
Stn 9
370
350
330
310
290
270
5
10
15
20
25

SECTION TWO

FIELD ACTIVITIES

Upon completion of the pre-field activities and the checking of equipment and vehicle, the field portion of the survey can be undertaken. The following list is in the order of performance so that one item causes no disturbance on the item following.

1) Water chemistry
2) Invertebrate collections
3) Fish collections
4) Discharge
5) Physical data

However, weather or time constraints can alter this arrangement.

CHAPTER 12

CHEMICAL AND PHYSICAL ATTRIBUTES OF WATER

12.1 Stream Stations

In streams, stations are located at the headwaters, mid-reaches and mouth. The mouth station is to be located where there is no influence from the receiving waterbody. The foregoing is the minimum number of stations for any stream. However, in many instances other natural and man-made features alter the water quality so that 3 stations are insufficient. Stations should be 40 m in length according to conditions and as uniform as possible in size and habitat.
The following is a list of criteria for placement of additional stations:

1) Upstream of and downstream from impoundments of water such as dams, lakes or a series of beaver dams

2) Above and below major waterfalls

3) Upstream and downstream from significant human population and industrial plants

4) Tributaries over 5 km in length or that have significant discharge (over one-quarter of the discharge of the main stream) should be sampled above their entry in the main stream and stations should be placed on tributaries using criteria as above. Sample away from the influence of the main stream. Tributaries with more than one station should be documented fully as a separate survey.

5) Stations must be numbered sequentially from the mouth to the source starting with station one.

12.2 Collection Methods

Refer to Chapter 4.16

12.2.1 The Kemmerer Bottle

Refer to Chapter 4.16.1

12.2.2 The Van Dorn Bottle

Refer to Chapter 4.16.2

12.2.3 How to Use the Kemmerer and Van Dorn Bottles

Refer to Chapter 4.16.3

12.2.4 The Water Pail

Approach the selected sampling site from downstream (to prevent any non-natural water disturbance) and,

1) Flush pail with stream water at least 3 metres (10 feet) downstream from the station site.
2) Slowly but completely submerse the pail in the water at the selected chemistry sampling site with minimal water disturbance.
3) Hold or rest the pail in a stationary position, the mouth of the pail facing upstream, for sixty (60)

seconds — (to permit water mixing at the site).

4) Raise the pail in a manner to minimize water disturbance.
5) Flush the plastic tubing with stream water (after raising water pail) at the chcmistry sampling Site by siphoning water through the tube.
6) Siphon water from pail as necessary for chemical tests.

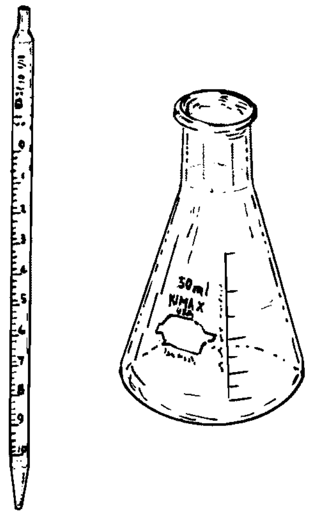
Note: In taking a water sample, always take the water sample from a pool since there are fewer air bubbles in the water and most of the oxygen dissolved in the riffle area has escaped, i.e. the water has reached a state of equilibrium.

12.3 The Dissolved Oxygen (D.O.) Test

Refer to Chapter 4.17

12.4 The Total Fixed Endpoint Alkalinity Test (T.F.E.)

When using the DR-EL Laboratory Models, proceed as follows:

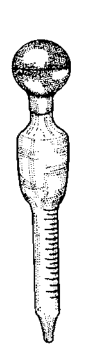


1) (a) Clean the 50 mL Erlenmeyer flask with water to be tested a minimum of three times.

(b) Rinse the 10 mL polyethylene/glass pipet with the water to be tested at least three times.

(c) Fill the pipet with 10 mL of water from the sample and transfer to the Erlenmeyer flask.

2) (a) Add the contents of one Brom Cresol Green-Methyl Red indicator pillow (943) to the sample. The adding of the Brom Cresol Green-Methyl Red indicator pillow will turn the sample to a blue or greenish-blue colour.



(b) Fill the buret (graduated in mL) with the liquid in the standard Sulphuric Acid (203) bottle by squeezing and releasing the rubber apex ball, then return fluid in the buret to the bottle by squeezing the rubber ball until the liquid level reaches zero. When viewed level with the eye, the bottom of the meniscus should be exactly even with the zero mark on the buret. If a drop of the acid solution is hanging on the tip of the buret, remove it by touching the tip against the outside of the bottle or flask.

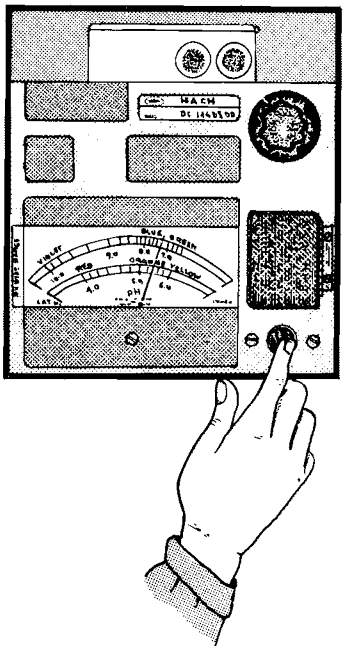
(c) Titrate slowly by holding the buret perpendicular with the tip inside the mouth of the titration flask. Depress the rubber ball until the water sample becomes pinkish (usually a ruddy mauve) or changes so that any green or blue colour vanishes.

(d) Multiply the total number of millilitres of acid used by 100 to determine the total alkalinity content in mg/L.

12.5 The pH Test

In DR-EL models —

(a) Fill a rinsed graduated plastic cylinder to the 25 mL mark with the water to be sampled and pour into the sample cell. Do not collect sample with the cell.



(b) Rinse two colorimeter square 1 oz. glass sample cells 13537-00 with water to be tested.

(c) Transfer a 25 mL sample from the cylinder into each of the colorimeter sample cells.

(d) Add 1 mL wide range indicator (2592) to one of the sample bottles and swirl to mix.

(e) Insert the wide range pH meter scale (13163-00) into the slot of the meter.

(f) Insert the color filter (4084) into the designated recess of the light cell.

(g) Place the other sample cell into the light cell and close the cover to standardize the meter.

(h) Depress the activator switch and adjust the light control so that the meter scale is reading at the far right end of the scale on zero. Depress the activator switch a minimum of three times to verify a 'zero' reading.

(i) Exchange the original water sample cell bottle with the cell containing the prepared sample.

(j) Depress the activator switch and read the pH value. Take three readings of the prepared sample.

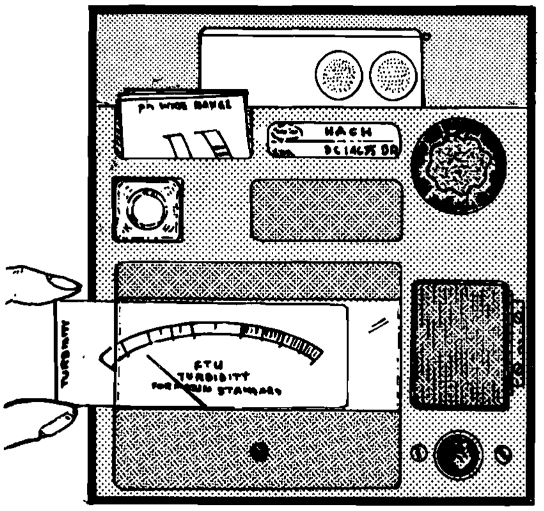
Note: When reading the DR-EL pH meter value, do not hold down the activator switch longer than necessary and *never more* than five seconds on any one depression. Failure to comply will burn out the bulb. Always dry the sample cells and colour filter before inserting into the meter.

12.6 Water Turbidity

Turbidity describes the water condition resulting from the presence of suspended particles such as clay, silt, finely divided organic and inorganic matter, plankton and other microscopic organisms. The concentration of these substances influences the transparency of the water.

12.6.1 The Turbidity Test

Turbidity is measured by estimating light absorption by the suspended material. When the Hach DR-EL kit is used, at range 0-500 FTU (Formazin Turbidity Units), to determine turbidity, proceed as follows:



1) Place the turbidity meter scale and the appropriate colour filter (4445) in respective compartments in the meter.

2) Fill a colorimeter bottle (13537-00) with demineralized water, sample blank.

3) Lift hinged light shield of light cell, insert sample blank and close shield.

4) Depress light switch and adjust light control until meter needle reads zero FTU.

5) Fill a second colorimeter bottle with water to be tested (prepared sample).

6) Remove sample blank, insert prepared sample, close shield, depress light switch, read the formazin turbidity units (FTU) directly from the scale.

7) Record the FTU reading.

Note: If the water sample is highly colored, a portion of it should be filtered and used in place of the demineralized water in Step 2. This is necessary because large amounts of color will cause interference resulting in high readings.

12.7 Total Dissolved Solids and Conductivity

Refer to Chapter 4.20

In turbid waters it is advisable to filter the water sample or allow it to settle to remove soil particles before doing the specific conductance test.

12.8 Thermal Properties of Streams

Although the basic thermal characteristics in stream waters are similar to lake waters, the stream presents a different set of temperature conditions.

The major factor in the warming of streams is direct solar radiation, but temperatures are also influenced from variations in velocity, volume, depth, substrate cover and water source. Temperature in stream waters then becomes a measure of actions and interactions of a wide variety of factors. In the upper reaches the water may be cooled by spring-fed tributaries and dense shading whereas the lower reaches are warmed because of greater width and exposure to direct sunlight. At the same time, nocturnal cooling is regulated by atmospheric temperatures and daytime warming is governed by the amount of cloud cover.

12.8.1 Water Temperatures

Water temperatures are always recorded in a pool and preferably in the shade. Leave the thermometer in the water for a minimum of one minute.

12.8.2 Air Temperatures

Air temperatures are recorded from a dry thermometer suspended in the shade for five minutes.

12.9 Time

Water chemistry is to be measured between 1300 and 1600 hours when near maximum conditions are likely to occur.

CHAPTER 13

INVERTEBRATES

Traditionally, physical and chemical data have been collected during Aquatic Habitat inventories and assessments. These parameters, such as dissolved oxygen, pH, temperature, current velocity, etc., are relatively easy to measure and lend themselves well to numerical analysis. The major drawback, however, is that they are instantaneous measures. Rapid, short-term, changes that may occur between sampling periods, go unnoticed. To overcome this problem many researchers have chosen to also collect benthic macroinvertebrates.[1]

Macroinverteberates are a particularly good choice because:

1) They are usually found in all aquatic habitats.

2) They may often be available in large quantities.

3) Their size makes them relatively easy to collect unlike larger organisms, such as fish, which may require cumbersome sampling gear (i.e. electrofisher) and bulky holding facilities (i.e. tubs). Also the combined effort of two or more people is usually required. Invertebrates however can be collected with equipment as simple as a kitchen flour sieve, can be stored and transported in a container as small as a pill bottle and require the attention of no more than one person.

4) Certain aspects make them good indicators of environmental conditions.

   i) They are less mobile than other groups of organisms (i.e. fish, birds, reptiles) and usually cannot escape adverse change in their habitat. They must either adjust or perish.

   ii) There are a very large number of different chemical and physical parameters of the aquatic environment. It would not be possible, at one time, to sample and measure them all. So many investigations into aquatic ecosystems usually concentrate on only a few parameters (i.e. D.O., pH, current velocity). Thus others, which may not at first seem important, will go unnoticed. Aquatic invertebrates, on the other hand, integrate all the parameters of their environment into one easily assessable unit which researchers are able to sample.

   iii) A large number of different species have a narrow range of environmental requirements within which they can survive (e.g. *Parapsyche apicalis,* a caddisfly, and *Leuctra truncata* a stonefly, are found only in streams width of 2 meters or less, having fast flowing, well oxygenated, water, and a temperature of 10°C or less). Any change outside this narrow range is intolerable to these species.

   iv) Many (e.g. *Ptaronarcys proteus*, a stonefly) have complex life cycles lasting one or more years and require conditions to remain within their tolerance limits throughout this period (i.e. a permanent flow of water).

Researchers therefore are able to monitor adverse short and long term changes in the aquatic environment by studying changes in benthic community composition and relative species abundance. Besides the environmental information gained from the study of invertebrates, knowledge also increases about their biology, distribution, community structure, diversity and taxonomy.

[1] Any invertebrate which is retained by a U.S. No. 30 standard seive (opening of 0.0232 in. or 0.059 cm).

13.1 Objectives

The aim of collecting aquatic invertebrates is much the same as that required for the collection of fish (see Chapter 5.1) The collector should endeavour to obtain as complete a list of invertebrate species for each station as possible.

13.2 What to Collect?

Although most collectors will recognize an invertebrate, many will not have been exposed to many of the aquatic invertebrate forms. Figure 13.2.1 illustrates some of the major aquatic invertebrate taxa which may be encountered. There are many other groups which will be encountered less frequently (e.g. the classes Ostracoda, Copepoda, Nematoda, Coelenterata) but when encountered may occur in large numbers. A knowledge of the different groups will enable the collector to discern whether or not any groups have been overlooked and whether additional effort should be made in collecting.

13.3 Where to Collect?

The aquatic stream environment can be subdivided into macrohabitats groups which can occur repeatedly within a stretch of stream. Figure 13.3.1 depicts a stream illustrating some of these. Within each habitat group there is an endless number of microhabitats as well. Each forms a unique environment affording individual organisms a chance to occupy their own niche (e.g. a single rock in a riffle). Collecting from the numerous microhabitats will produce many different species. Together, these species form an invertebrate community which is distinctive of each macrohabitat. Only by collecting from a maximum number of these will it be possible to collect the majority of the species present.

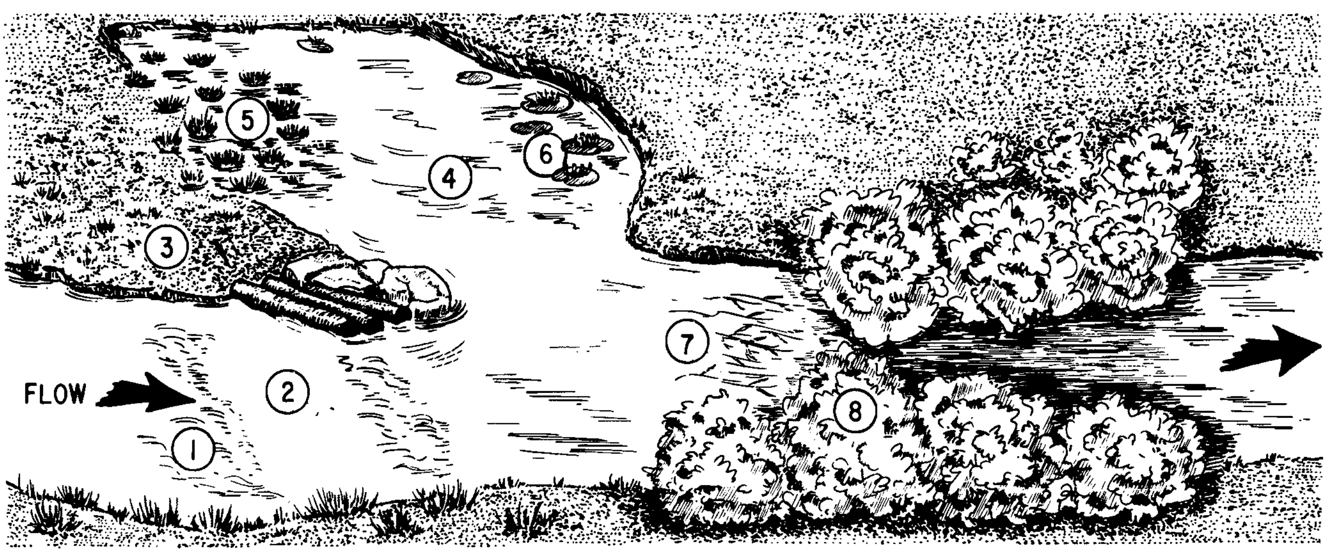


Fig.13.3.1 MACROHABITATS OF INVERTEBRATES. 1-RIFFLE, 2-POOL, 3-SHORE-LINE, 4-BACKWATER POOL, 5-MARSH, 6-WEEDED POOL, 7-WEEDED RUN, 8-CANOPY COVER (SHADE).

13.4 Collecting

Cummins (1962), noted that 'the number of different "mechanical" samplers used for collecting benthic macroinvertebrates is nearly proportional to the number of benthic investigations'. All these different sampling devices will fall into one, or both, of two categories, quantitative and/or qualitative samplers.

1) Quantitative Sampling is used to provide the number and density of individuals of each species present, at a station, by the sampling of known areas and volumes. Repetitive sampling allows the observation of changes within the community.

2) Qualitative Sampling is used to indicate the species of invertebrates present, at a sampling site, at one point in time.

In an inventory qualitative sampling is employed.

While not all sampling equipment is quantitative in nature all are qualitative. Still, all gear used qualitatively will have some aspect of its design that may make it more selective to one type of organism or habitat than another (e.g. a round dip-net used on a hard bottom may allow certain highly mobile invertebrates to escape under it's edge while a square dip-net, flush to the bottom, may capture these species). Therefore to produce the most complete species list, collecting should be done in as many different habitats as possible and with a variety of different sampling gear.

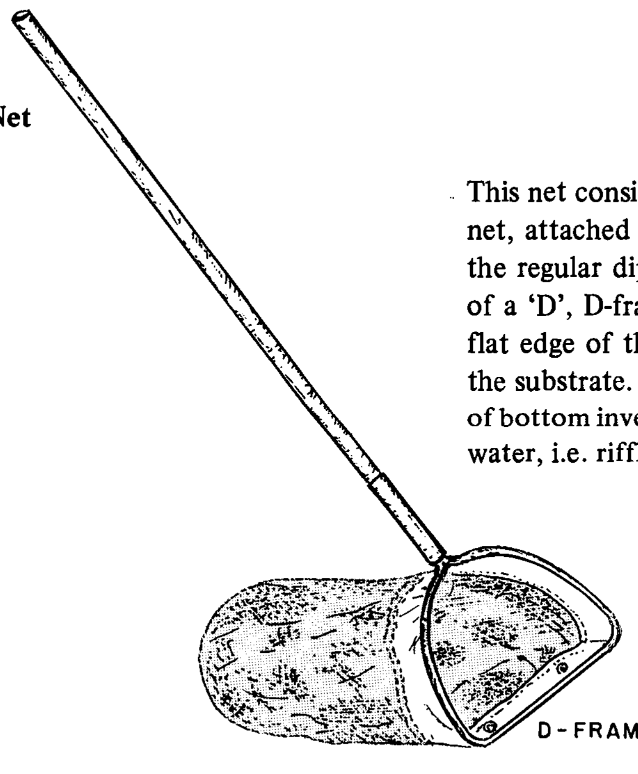
At each station, a minimum 2 hours of sampling effort is required. The sampling of all the different habitats may take only 15-20 minutes but the sorting of the large volume of material will take the majority of the time. This is especially so if patience and proper attention is given to catching the smaller (0.5-2.0 mm) and more obscure invertebrates which take longer to find and sort out. Experienced and efficient collectors may be able to finish in two hours but it is more likely that most collectors will have gathered such a volume of material that it will take them longer.

13.5 Sampling Gear

While much invertebrate sampling gear is specialized, to the habitat or taxa it samples, it need not be so. Some are more versatile (able to sample various habitats), have been widely used by other researchers, and are usually available from various suppliers. The collector should be familiar with these 'general' samplers as described. This does not mean that you are restricted to using only this equipment. The onus is left with the collector to be inventive and resourceful in the use of sampling equipment other than what is described in this manual.

13.5.1 The Dip Net

This net consists of a metal ring, containing a nylon net, attached to a long wooden pole. Variations of the regular dip net have the metal ring in the shape of a 'D', D-frame net, a square or a rectangle. The flat edge of these nets allow them to lie flush with the substrate. This allows for more efficient capture of bottom invertebrates especially in the fast flowing water, i.e. riffle areas.



The dip net is probably the most versatile qualitative sampler and can be used in almost any habitat. It is extremely useful in areas of little or no flow where the net is swept back and forth across the substrate and through the water column.

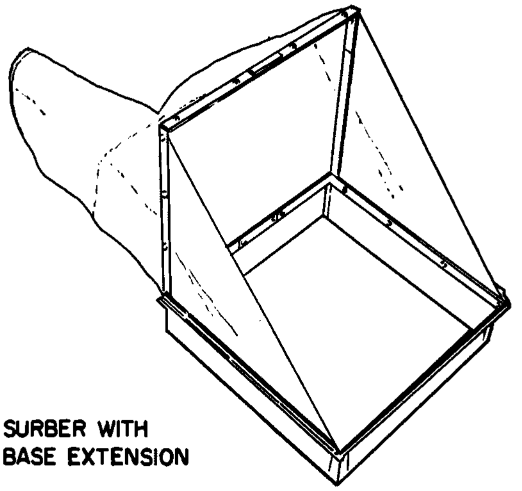
In flowing water, up to chest deep, the kick method must be used to sample the bottom substrate.

The Kick Method

1) The operator faces the stream bank and holds the net vertically between the legs, positioning the net so current flows through it.

2) With the lower rim resting on the bottom and the metal frame braced by one leg, use the other leg to kick up the substrate immediately in front of the net.

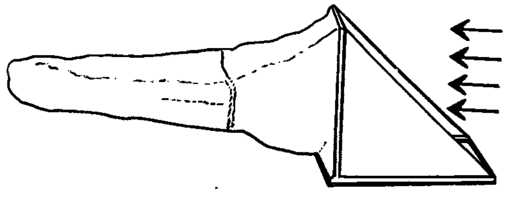
13.5.2 The Surber Sampler



SURBER WITH BASE EXTENSION

This sampler consists of two twelve inch folding metal (brass) frames. The open horizontal frame marks out the limits of the sampling area and a nylon net is attached to the vertical for capturing the sample. The base height extensions are used to penetrate the substrate and prevent lateral migration in the sampling zone. It is designed to sample aquatic life in shallow streams, 30 to 40 cm deep, but is more efficient when not totally submerged.

Use of the Surber



1) Open the sampler arms fully so that the horizontal and vertical arms form a right angle.

2) Approach the area to be sampled from downstream. Place the sampler with the horizontal frame resting on the stream bed, such that the vertical frame is facing upstream, as shown. To reduce movement place feet on the downstream corners of the sampling frame.

3) Place the sampler with the horizontal frame resting on the stream bed, such that the vertical frame is facing upstream, as shown. To reduce movement place feet on the downstream corners of the sampling frame.

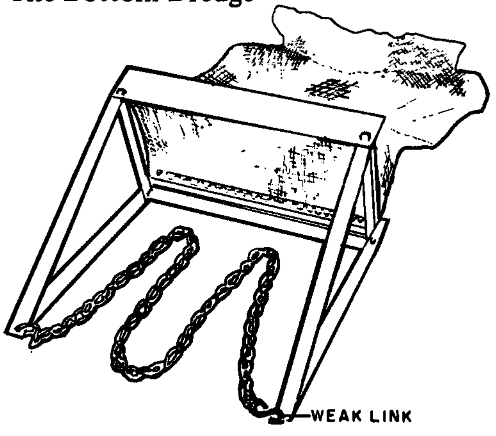
4) Agitate the substrate directly in front of the vertical frame, to a depth of 10 cm or more, by hand or with a small garden trowel, in such a manner that the disturbed material will be carried into the net.

5) All large objects, 5 cm and up, should be scrubbed with a brush. The object is held in the water in front of the net and the brush will dislodge clinging invertebrates which will then be carried into the net by the current. Invertebrates can be picked from these objects with forceps but this is more time consuming.

6) The sampler can then be removed from the water.

Note: Some surber samplers are equipped for the attachment of a handle to the vertical frame. The surber can then be used in deeper water, more than 45 cm, where the kick method must be used.

13.5.3 The Bottom Dredge



BOTTOM TYPE DREDGE

This sampler, or modifications thereof, consists of a heavy metal frame 45 cm x 25 cm to which a 75 cm long nylon net and pull chain (bridle) are attached. A weak link is attached to one terminal of the pull chain to reduce damage to the dredge if it becomes snagged. It is designed to gather aquatic life in deeper sections of the stream (i.e. up to a chest depth).

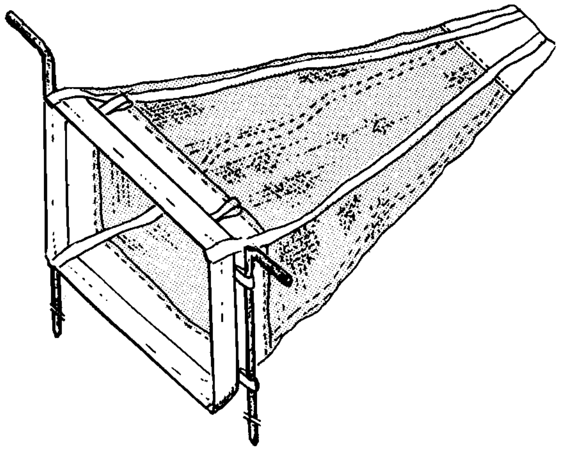
Use of the Dredge

1) Lower the dredge into the water and place it in an upright position facing upstream. Retain hold of the pull chain.

2) Drag it over the substrate in an upstream direction and in such a fashion that your feet are agitating the stream bed forcing quantities of material into the net.

13.5.4 Supplementary Gear

The Drift Net



The drift net consists of a rectangular metal or wooden frame on which a nylon net is attached. Two stakes attached to the frame hold the net into the substrate. The net passively collects invertebrates that are carried along in the current (drifting).

Use of the Drift Net

A drift net is set up at the downstream end of the sampling station before any other activity commences. Invertebrates normally drifting or disturbed during other activities may be trapped. The net is then removed and its contents checked for invertebrates which are preserved with the others already collected.

Long Handled Shovel

Any type of shovel can be used. It is very useful in obtaining substrate samples from hard bottoms, i.e. clay and rubble, from under over-hanging banks and obstructions such as fallen trees.

Flour Sieve

This is a simple baker's flour sieve that can be obtained in most grocery stores. It is best used to sample shallow areas, especially the shoreline, by dragging it across the substrate or through the water column. A long handle may also be attached to the sieve. It can then be used similarly to a dip net to reach under over-hanging banks and other obstructions that the larger net may not be able to sample.

The Sieve Box

This is a simple square or rectangular box made of wood or brass with a screen in the bottom. This device can save a lot of time when picking invertebrates by allowing the removal of fine particles from the collected material and leaving less material to sort through. Effeciency can also be increased by having one person collecting samples while the other is sieving them.

White Bottom Tray

A tray is used to sort invertebrates from the collected stones and detritus. Samples are placed into the tray. The white bottom facilitates the detection of the invertebrates.

Garden Trowel

This small shovel is very useful for digging into sand and gravel substrates, while using a dip net or surber. It is also useful for collecting samples along the shoreline and in weed beds.

Scrub Brush

A brush of any size that is easily held in the hands is usable. A large object, with clinging invertebrates, is held in the water, in front of an open net, and scrubbed with the brush. The current will then carry the invertebrates into the net.

Forceps

Fine pointed forceps are needed to pick up invertebrates from the collected sample.

Eye Dropper

An eye dropper is most useful for sucking up invertebrates from the sorting tray which may be too small for the forceps. The invertebrates plus a small amount of water is drawn into the dropper and then ejected into the sample jar. This small amount of water should not dilute the preservative too much.

13.6 Sorting Sample

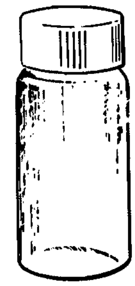
1) Collected material may be placed in the sieve box. The sieve box is then held in the water, so the top is not submerged. It is then agitated allowing the water to wash away finer particles. Alternatively, the sample may be kept in the sampling gear's net and the sample is then agitated as above, being careful not to tear the net.

2) The remainder of the sample is then placed into a white bottomed tray for sorting.

3) The addition of 1 to 2 cm of water to the tray will allow the invertebrates to move a little which aids in their detection.

4) Forceps and an eye dropper are used to pick the invertebrates out of the sample.

13.7 Preserving the Invertebrate Collection



1) All samples are preserved in the field.

2) The invertebrates are placed in 2 oz. glass sample bottles. Larger sized bottles may be used if specimens are too large.

3) Fill each bottle no more than half full of invertebrates to allow proper preservation.

4) Crayfish, snails, and clams are to be sorted into a separate bottle and preserved in 10% Buffered Formalin. Formalin is slightly acidic and will leach the calcium from the exoskeleton of hard shelled invertebrates making them difficult to identify, if not impossible. Formalin may be obtained already buffered but if it is not the addition of magnesium carbonate or Borax will neutralize the solution. Mix Borax with the Formalin until a small amount of powder remains on the bottom of the container (from Pennak, 1978, pg. 779).

5) All other invertebrates are preserved in Kahle's solution. Kahle's solution keeps the tissues of specimens soft, prevents shrinkage, and allows specimens to keep their natural colours longer. Kahle's will, however, dissolve the calcium of hard shelled invertebrates.

Formula of Kahle's Solution (from Pennak, 1978)

59 ml	Distilled Water
2 ml	Glacial Acetic Acid
28 ml	95% Ethanol
11 ml	100% Formalin
100 ml	Total

N.B. a) Specimens which are kept at the District Office for more than one week should have all the preservative in the sample replaced, with the same preservative, to ensure proper preservation.

b) Use only glass or plastic sample bottles. DO NOT USE PLASTIC BAGS. Plastic bags leak and specimens are more easily damaged in them.

13.8 Documenting the Invertebrate Collection

For invertebrate collections to be of value they must be documented in detail and the records should be properly filed before and after identification.

Two forms are required for proper field documentation; a copy of the 'Field Collection Record', Form 2066, at each station, and a 'Collection Label', Form 1414, for each sample bottle. These forms are totally completed, in pencil, while in the field.

13.8.1 The Field Collection Record (FCR) (Form 2066)

At the top of the form mark 'Invertebrates' to separate it from FCR forms used for fish samples. Make 1 copy, carbon paper is provided, sending the original in with the samples, (the carbon copy is kept with the field notes). Fill out the form as completely as possible (not all sections will apply).

Sections to Complete

No. of Bags

Refers to the number of sample bottles. Enter the number of sample bottles for the station.

MNR District No.

Enter the code number for the district in which the station occurs. Refer to Chapter 1.5.

Name of Waterbody

Refer to Chapter 1.6.1.

Collection No.

All samples collected at the same time will have the same collection number. Different collection numbers are used to separate repetitive samples that might be obtained at different times of the year, from the same station. However, if there is a reason to keep sample bottles separate from each other (i.e. quantitative samples) that have been collected, at the same time and station, then each of these would have a separate collection number.

Station No.

Enter the station number (refer to Chapter 12.1).

County or Judicial District

Refer to Chapter 1.7.

Township

Refer to Chapter 1.7.

Watershed Code

Refer to Chapter 1.10.

Locality of Station

Enough information should be included here so that the station can be accurately and exactly relocated in the future (i.e. lot and concession numbers, distance from roads, bridges, dams, etc., if available).

Ministry of Natural Resources

Ontario

Field Collection Record

INVERTEBRATES

Use Pencil Only

No. of Bags	2

District	Name of Waterbody	Collection No.	Station No.
72	Alder Creek	1	4

County or Judicial District	Township	Watershed Code
Waterloo	Wilmot	2GA-02

Locality of Waterbody (if other than stream or river)

Locality of station: Immediately downstream from pool below dam in New Dundee

Latitude	Longitude	Date Day	Month	Year	Time Started
43° 21.1'	80° 32.1'	27	05	77	1300 Hrs.

Duration	Drainage System
2.1 Hrs.	Upper Grand River

Water Type

- [ ] Spring - [ ] Canal - [x] Stream/River - [ ] River/Lake Junction - [ ] Flooded Area - [ ] Pool
- [ ] Pond - [ ] Lake - [ ] Muskeg/Bog - [ ] Reservoir - [ ] Other

Water Temperature	Air Temperature	Distance Offshore Min.	Max.	Depth of Capture Min.	Max.
23 °C	22 °C	m	m	0·0 m	0·69 m

Plant Type

- [x] Submergent - [ ] Floating - [ ] Emergent - [ ] None

Bottom Type

- [ ] Rock - [ ] Boulder - [x] Rubble - [x] Gravel - [x] Sand - [ ] Silt
- [ ] Clay - [ ] Muck - [ ] Marl - [ ] Detritus - [ ] Other

Current

- [ ] Still - [ ] Slow - [ ] Medium - [ ] Fast - [x] Quantitative 0·7 m/s

Water Colour

- [ ] Colorless - [ ] Yellow/Brown - [ ] Blue/Green - [x] Turbid - [ ] Other

Cover (Shore)

- [ ] None - [ ] Sparse - [ ] Moderate - [x] Dense - [ ] Other

Cover (In water)

- [ ] None - [ ] Sparse - [x] Moderate - [ ] Dense - [ ] Other

Gear

- [ ] Seine - [ ] Gill Net - [x] Dip Net - [ ] Angled - [ ] Trawl - [ ] Minnow Trap
- [ ] Piscicide - [ ] Trap Net - [ ] Hoop Net - [x] Electrofish - [ ] Surber - [x] Other Baker's Sieve

Size of Net (Gill or Seine Net) Length	Size of Net or Mouth (Trap, Hoop or Trawl)	Mesh Size Smallest	Largest
m	m	cm	cm

Selectivity of Sample

- [x] All Kept - [ ] None Kept* - [ ] Some Kept* - [ ] No Catch

*List Released Fish on Back

Preservative

- [x] Formalin - [x] Kahle's Solution - [ ] Alcohol - [ ] Frozen - [ ] Other

Date Day	Month	Year	Collectors
27	05	77	D. Price , M. Bankert

Additional Data: Pollution, Colour and Condition of Fish, Parasites, etc.

- Bottom Rocks, Gravel covered with Silt and/or Algae
- Refuse on banks and in River
- Yellow - Brown foam accumulating in pools

2066 (12/79)

Shaded Areas For Main Office Use Only

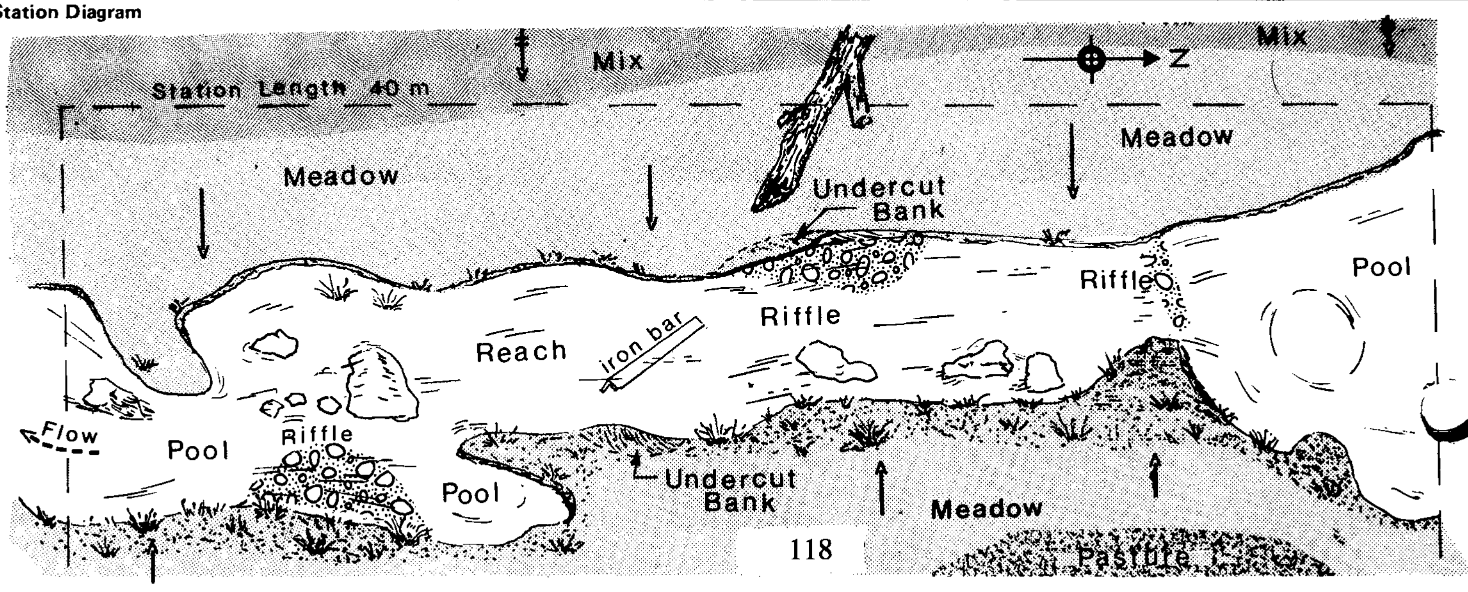
MNR District No.	Name of Waterbody	Collection No.	Station No.

Date Received (Day / Month / Year)	Township	Latitude ° ′	Longitude ° ′	Acc.	Page	Of

No.	Scientific Name	Code	Size Range (T.L. in mm)	OMNR Cat No.	ROM Cat. No.

Identified by	Date

Station Diagram



Latitude and Longitude

Enter the lat. and long. *for the station* to the nearest tenth of a minute (i.e. 45° 36.8' which equals 45° 36' 48").

Date

Enter the date that the sampling is started on.

Time Started

Enter the time at which sampling commenced using the 24 hour clock.

Duration

Enter the length of time required to collect your invertebrate samples (usually at least 2 hours). Do not include preserving and documenting time.

Drainage System

Refer to Chapter 6.4.

Water Type

Usually 'stream/river' but may also include marsh and pools connected to the stream.

Water Temperature

Enter the water temperature (refer to Chapter 12.8.1).

Air Temperature

Enter the air temperature (refer to Chapter 12.8.2.).

Distance Offshore

Does not apply.

Depth of Capture

Enter the maximum depth which a sample was taken. The minimum depth will usually be zero (shore/water interface).

Plant Type

Check the appropriate boxes.

Bottom Type

Mark all the bottom types that are present in the station. Refer to chapter 16.4 for definition of terms.

Current

Include the velocity of current once measurements are made. Check this appropriate box which best describes this flow.

Water Color

Mark the appropriate box.

Cover (instream)

Mark the relative amount of instream cover that occurs along the entire station (refer to Chapter 16.1).

Cover (shore)

Mark the relative amount of shore cover along the stations length. Shore cover refers to tree canopy, overhanging shrubs, tall grasses, etc.

Gear

Enter the different gear used while sampling. Make sure to include all types of gear that have not already been included on the FCR form.

Size of Net

Does not apply.

Mesh Size

Does not apply.

Selectivity

All invertebrate specimens are to be kept. The only occasion when 'some kept' will be marked will be when a large number of crayfish or large clams (>20) are caught. In which case a subsample may be retained (at least 10 individuals).

Preservation

Mark formalin and strength, or Kahle's solution or both if need be. Remember that formalin is used for clams, snails, and crayfish and Kahle's solution for all others.

Date

Enter the date when sampling was completed. Usually the same date as the start.

Collectors

Enter the name of all the collectors. Do not leave this blank.

Additional Data

Any information that the collectors feel is pertinent to the station or collected samples may be included here. (e.g. noticeable pollution and pollution sources, type of land uses above and below the station, accessibility of stream to livestock, etc.).

Station Diagram

Sketch a diagram of the station. Include the location of instream cover, riffles, pools, the shore cover (up to 50 meters from the stream edge), slope of the banks, direction of flow, and station length. Try to include a permanent reference point i.e. large rocks, trees, culverts or roads. Also include a north/south vector. Some of the symbols in Appendix 1 may be useful.

13.8.2 Collection Label

One must be completed, using pencil only, for every sample bottle. All the information must be taken from the 'FCR' form. In the upper right corner, 'Bag No.', include the number of the sample bottles and total number of bottles for the sample as follows: – '1 of 3' or '2 of 5' as necessary.

Roll up the collection label and put it into the sample bottle along with the sample. Try to have the stream name visible. Refer to Chapter 6.5.

13.9 Shipping

Top up all the sample bottles, with the correct preservative, before shipping. This will help decrease the amount of physical damage to the specimens while in transit. Group the samples together by station, or stream. Package securely, to prevent breakage, and ship to:

Fisheries Laboratory
Fisheries Branch
Ministry of Natural Resources
Whitney Block
99 Wellesley Street West
Toronto, Ontario
M7A 1W3

Mark "INVERTEBRATE SAMPLES" on the outside of the package.

CHAPTER 14

SAMPLING THE INHABITING FISH SPECIES

14.1 Sampling Objective and Policy

Refer to Chapter 5.1

14.2 Some General Behaviour Patterns

Refer to Chapter 5.2

14.3 The Fish Sampling Gear

Refer to Chapter 5.3

14.3.1 Gill Net

Refer to Chapter 5.3.1

14.3.2 Seine Net

Refer to Chapter 5.3.2

14.3.3 Nylon Web Minnow Trap

Refer to Chapter 5.3.3

14.3.4 Electrofisher

Refer to Chapter 5.3.4

14.3.5 Piscicide

Refer to Chapter 5.3.5

14.3.6 Supplementary Gear

Refer to Chapter 5.3.6

14.4 Using the Fishing Gear

Refer to Chapter 5

14.4.1 Gill Net

Refer to Chapter 5.4.1

14.4.2 Seine Net

Refer to Chapter 5.4.2

14.4.3 Nylon Web Minnow Trap

Refer to Chapter 5.4.3

14.4.4 Toxification of Waters

Refer to Chapter 5.4.4

14.4.5 Supplementary Gear

Refer to Chapter 5.4.5

14.4.6 Electrofishing

All electrofishing equipment and procedures must adhere to "Electrofishing Guidelines and Procedures" as outlined in the MNR Official Procedure Manual, Policy FI.3.01.01.

Electrofishing is the use of electric currents in water to induce immobility of fish. When electric current is passed through the water and a fish is in the vicinity, the current causes 'excitation' of the nerves and muscles. That is, a threshold is reached and induces a determined reaction — a directed movement.

With direct current the first visible reaction is a fluttering of the fish's body and orientation toward the anode. The second reaction is galvanotaxis, when the fish swims towards the anode. Finally galvanonarcosis takes place when the fish rolls on its side and is incapable of movement. This is a simple explanation of electrofishing.

In electrofishing, wading upstream eliminates the effects of turbidity caused by bottom sediment on the vision of the person using the net.

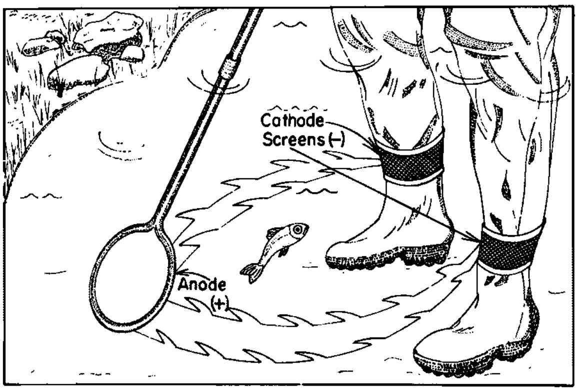
Fish normally orient upstream so that when shocked they bolt into high voltage densities and are held immobile. Fish such as Salmonids will exhibit 'forced swimming' where they will swim more rapidly and for a longer time than will Cyprinids. Salmonids are good swimmers, while Cyprinids are poor swimmers and become exhausted very quickly. Fishes that live on the bottom tend to flatten to the substrate rather than react to forced swimming.

The specific conductance of water effects the efficiency of electrofishing. On the Precambrian Shield, the specific conductance is low. Therefore, much more power is used to obtain the desired results. The converse is true for southern Ontario with high specific conductances.

An increase in the voltage produces more desirous effects but as a rule of thumb, the unit should be set at 225 volts in southern Ontario and 425 volts north of the Trent-Severn Waterway.

TO FISH WITH THE ELECTROFISHER

1) The shocker member of the crew should step into the water with *the anode ring held forward.*



2) The retriever member of the crew follows, stepping into the water on the downstream side of his partner.

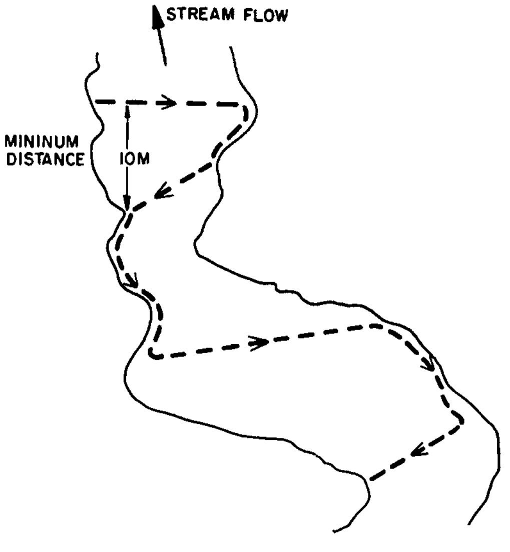
3) The shocker member will intermittently depress and release the strip switch on the anode pole as sampling is performed. The time lapse between the depress-release-depress-release action should vary and depend upon the numbers of fish coming to the surface. The main concern at this time is to permit the retriever to capture all the fish that do come to the surface.

4) The retriever member attempts to capture, by use of the dip net, all fish that come to the surface. After retrieval, all captured fish are transferred to the fish collecting water bucket.

5) Always keep the dip net in the water since many fish drift into the net without anyone noticing.

6) The electrofishing site should not be less than thirty metres in length.

The Swathe Method, i.e. — Moving the positive anode ring from side to side, and across the stream flow (perpendicular or angular) will always be used in the initial sampling by:



1) Traverse the stream breadth in the manner as shown in the diagram opposite – in the upstream direction. Most of the fish species orient in the upstream direction. This technique in conjunction with the 'attractive feature' of electric currents in water will improve the catch per unit effort (C.U.E.).

2) Probe with the anode ring in all likely fish niches, i.e. under logs and overhanging banks, holes and riffles.

MAINTENANCE AND CARE

1) Check battery cells regularly and maintain proper electrolyte level.
2) Keep battery fully charged at all times in order that the unit is functioning at maximum efficiency. A portable battery charger should be part of the electrofisher package.
3) Avoid acid spills by ensuring that battery cell caps are completely set and the battery is carried and/or transported in a manner that dropping or over-turning is prevented. A skin or clothing acid burn is a telltale sign of carelessness.
4) Do not depress the switch when the anode pole is out of the water. It shorts out the transistors in the unit.
5) Remove cell caps when recharging batteries to avoid explosions.

SAFETY IN ELECTROFISHING

1) Be thoroughly familiar with the equipment.
2) Connect only one wire at a time. (The battery is 24 amperes and touching wires will act like a welder.)
3) Wear rubber chest waders with no holes.
4) There *must* be two people at all times when the unit is in use.
5) Do not plug wet connectors into the unit.
6) Do *not* use the unit if you have a heart ailment.
7) Know how to apply CPR.

CHAPTER 15

DOCUMENTATION AND PRESERVATION OF FISH SAMPLES

15.1 Gill Net and Trap Net Catches

Refer to Chapter 6.1

15.2 Scale Samples

Refer to Chapter 6.2

15.3 Documenting Preserved Samples on the Field Collection Record Form (F.C.R.)

Refer to Chapter 6.3 and Chapter 13.8.1

15.4 Completing the Field Collection Record Form (F.C.R.)

Refer to Chapter 6.4 and Chapter 13.8.1

15.5 Field Collection Label

Refer to Chapter 6.5 and Chapter 13.8.2

15.6 Preserving Fish Collections

Refer to Chapter 6.6

15.7 Shipping Fish Collections

Refer to Chapter 6.7

CHAPTER 16

PHYSICAL ATTRIBUTES OF A STREAM

16.1 Instream Cover

Materials in the water that provide protection to inhabiting fish are termed instream cover. Logs, trees, boulders and aquatic vegetation are typical examples. Instream cover is very important because it increases the amount of living space and can dissipate the energy of moving water, thus reducing the effort of the inhabiting species to maintain their position in the stream. This increase in surface area (living space) also promotes an increase in fish populations, as well as invertebrates, which are important food sources for stream fishes. Instream cover is recorded as a percentage and is divided into the following categories.

16.1.1 Undercut Banks

These are areas where the water has eroded away the material under a stream bank, but the upper portion has not slipped into the water. Root systems of trees and other vegetation usually consolidate and restrict the erosive forces. In some cases, the material erodes back underneath the bank as much as 50 cm. In other situations, the soil is washed away, but the dense root systems of the trees or shrubs still remain. This can provide prime habitat in salmonid streams for all size ranges of fish (even in only 5 to 10 cm of water).

16.1.2 Boulder

These are rock materials over 25 cm in diameter which form part of the bottom substrate. The size of the boulder, its shape and location influence the size and species of fish using the cover. Fish species, especially trout, are often found behind or under these obstacles. Boulders deflect the current and create a dead space behind them as the deflected water flows up and around. Irregular shaped and slab-sided boulders appear to provide the best cover.

16.1.3 Log and Tree

Individually, sunken or floating logs and large tree branches can provide significant cover for fish. Logs can accumulate to form jams and impede fish movement, but for the most part they provide excellent cover. In deep water larger fish utilize the material, while in very shallow water yearlings and fry are most commonly found.

16.1.4 Organic Debris

This material is composed of drifted accumulations or scattered fragments of leaves, twigs and algae which provide nursery habitat for fish in the fry stage. It also provides useful habitat for many types of invertebrates.

16.1.5 Macrophytes (Vascular)

Aquatic macrophytes provide superb habitat in both cold water and warm water streams. In many ways weed masses behave like 'soft, flexible' boulders (e.g. *Ceratophyllum* sp., *Utricularia* sp., *Potamogeton* sp., etc.).

16.1.6 Combination

This category is used as a catch all for instream features that by themselves may not constitute cover, but taken together or in combination provide instream shelter. An example of this would be a large boulder in very shallow water with overhanging vegetation. A boulder in very shallow water would not provide a safe cover for trout and neither would vegetation trailing over shallow water on their own; however, together they could provide excellent cover for several 2 + year old fish.

Another secondary cover form is water depth. Fish will often utilize areas of sparse instream cover if the water is deep enough to conceal them from above. Also, small rocks in a shallow run will often harbour fish if the water surface is rippled because the rippling effect itself conceals the presence of fish.

16.1.7 No Cover

The percentage of no cover is equal to the sum of the percentages for the previous six categories subtracted from 100%. Only in rare cases will there ever be 100% instream cover. A stream that has 50% or more cover has excellent instream habitat for fish.

16.2 Bank Stability

Erosion is a natural and dynamic process balanced by water velocity, volume, depth, gradient and channel roughness. Man's activities can alter the equation and a stream often responds with increased bank erosion.

Observing the stability of stream banks provides an indication of the degree of erosion. Excessive erosion causes silting and encourages the stream to widen and become shallow, eventually causing a decrease in the production of aquatic invertebrates and fish.

16.2.1 Highly Unstable Banks

These banks usually have a 1:1 (45° or steeper) angle of incline. Loose material constantly erodes into the stream. Upper banks often slump causing trees to topple into the water and water depths increase rapidly from the bank to mid water.

16.2.2 Moderately Unstable Banks

These banks have approximately a 2:1 (30°) angle of incline. They are partially covered by vegetation and interspersed with pockets of exposed substrate. Active slumping of the upper bank is rare and the toe is stable for the most part with only a small degree of erosion.

16.2.3 Stable Banks

In this case, there is no obvious erosion, no slumping and an abundant growth of grasses, shrubs and trees. The banks may have been stabilized previously by artificial means.

N.B. Both banks of the stream are taken into consideration. The sum of the three categories equal 100%.

16.3 Access

'Access' describes whether or not permission must be granted before entering a property. 'Posted' and 'unposted' are self-explanatory, and indicate in a general way the amount of land that is inaccessible without permission. Check the appropriate box.

16.4 Streambed Data

The type of substrate covering the bed of a stream is of critical importance to the productivity, abundance and diversity of aquatic invertebrates and fish. Porous substrates (boulder, rubble and gravel) support larger populations of invertebrates than do non-porous substrates (sand). Some fish species require a gravel substrate for spawning. The following is a description of the different substrate types.

16.4.1 Bedrock or Rock

All exposed rock with no overburden.

16.4.2 Boulder

All rock over 25 cm (10 inches) in diameter (approx.)

16.4.3 Rubble/Cobble

Rock material between 8 cm (3 in.) and 25 cm (10 in.) in diameter.

16.4.4 Gravel/Pebble

Rock material between 0.2 cm (1/8 in.) and 8 cm (3 in.) in diameter (approx.).

16.4.5 Sand

Material of crystalline rock origin less than 0.3 cm (1/9 in.) in diameter but still large enough to be palpable as grit.

16.4.6 Silt

As inorganic material of various origins but finer than sand.

16.4.7 Clay

A material of inorganic origin (aluminum silicates) with a greasy feel between the fingers and no apparent structure.

16.4.8 Muck

A soft material largely of organic origin without sand or gravel intermingled but composed of silt and clay with considerable amounts of organic material.

16.4.9 Marl

A calcareous material composed principally of carbonates derived from the photosynthetic activity of algae and mollusk shells. It is primarily light gray in colour.

16.4.10 Detritus

An organic material in which large pieces such as sticks, leaves, remnants of decayed aquatic plants, etc. form at least eighty-five per cent of the total mass of the soil.

Note: The measurement of soil types as percentages must equal 100 (total).

16.5 Stream Dimensions and Discharge

The dimensions of the stream provide information on the species and the production in the stream. A slow sluggish stream generally harbours slow-swimming warmwater fish species. Whereas, the fast shallow stream is attractive to the salmonid species (other conditions being suitable).

16.5.1 Length

In measuring discharge, the length of the station should be 40 metres. In the event that heavy vegetation and logs clog the stream channel, the station can be shortened to 20 metres or 10 metres.

16.5.2 Width

The mean width is calculated by adding the widths taken every 4 metres and dividing by the number of measurements.

$$\text{Mean Width} = \frac{\Sigma W\eta}{\eta}$$

where W = width (total)
and η = number of measurements

See Appendix 9 for an example of calculation for mean width of a stream.

16.5.3 Depth

To calculate mean depth at least 5 depth measurements must be taken at each transect width.

Note: The depth measurements must be evenly spaced.

$$\text{Mean Depth} = \frac{\frac{Y_1 + Y_2}{2} + \frac{Y_2 + Y_3}{2} + \ldots + \frac{Y_{\eta-1} + Y_\eta}{2}}{\eta - 1}$$

where Y = depth
and η = number of measurements (including zeros)

When all the mean depths are calculated for each transect, an average must be derived for the station.

See Appendix 9 for an example of a calculation for mean depth of a stream.

16.5.4 Velocity

16.5.4.1 Golf Ball Method

This is comparable to the floating chips method but the perforated plastic golf ball is not affected by wind currents since it floats just below the water surface. Allow the golf balls to travel the distance of the discharge station and record the time of 10 measurements.

$$V = \frac{d}{\Delta t}$$

where V = velocity
d = distance
Δt = average time for measurements

Note: Several balls can be used simultaneously.

16.5.4.2 Current Meters

Current meter measurements are made by counting revolutions of the meter propeller in a unit time. A signal for a revolution is initiated by closure of an electrical circuit in the contact chamber. Velocity is measured by the number of revolutions (ticks) in a unit time. This method requires a minimum of 10 measurements, equally spaced, across the width of the stream.

16.5.5 Velocity Correction Factor (K)

This factor compensates for the friction over the stream substrate.

0.9 — smooth bottom (sand, silt, clay, muck, smooth bedrock)
0.8 — rough (gravel, rubble, boulder)

16.5.6 Discharge

In calculating discharge using the golf balls, the formula is as follows:

$$\text{Discharge} = W \times D \times V \times K$$

where W = average width
D = average depth
V = average velocity
K = velocity correction factor

See Appendix 9 for an example of a completed discharge measurement.

If a current meter is used, the discharge is calculated by another formula (see Chapter 25.12.2, 25.12.3). When using this method, no velocity correction factor (K) is used, since it is incorporated into the velocity measurements.

16.6 Barriers

A barrier is any obstruction that impedes the movement of fish. The stopping of a spawning run or the impedence of individuals from nursery areas to areas for maturation constitute serious threats to fish populations. Natural barriers are defined as non man-made structures. Barriers should be recorded only in the vicinity of the station.

16.7 Stream Morphology

This term refers to the physical characteristics of a stream and is broken down into four types: riffle, run, pool and flat. The dimensions of these four types of areas are variable and proportional to the size of the stream. For example, a pool on a 1 m wide stream will be much shallower and smaller than a pool on a 20 m wide stream.

16.7.1 Riffle

Riffles are shallow, swift flowing sections of streams where the water surface is broken and in many cases gravel, rubble or boulders break the surface. Water depths range from less than 1 cm—20 cm deep. Because of the swift water, healthy, non-degraded riffles have no silt deposition on them.

16.7.2 Pool

A pool is a deep, slow moving body of water. Because of the appreciable decrease in current speed through the pool, the bottom is often composed of silt, debris and sand.

16.7.3 Run

Runs are deep, swift flowing sections of streams. The bottom is usually composed of rubble and boulders. The depth and materials found in runs make them excellent cover locations for salmonids.

16.7.4 Flat

Flats are shallow, slow moving sections of stream. The bottom is usually relatively featureless and composed of rock, silt or fine sand.

16.8 Terrain Characteristics

Terrain characteristics are a description of the vegetation types and the land use within 50 metres of the station. Stream cover is the vegetation on the stream bank (less than 5 metres from water's edge). Both terrain characteristics and stream cover are very important in stream production.

Heavy vegetation promotes reduced water temperatures, reduction of erosion, increases in food and in fish populations.

Terrain characteristics are divided into the following:

16.8.1. Cultivated

This refers to agricultural land whether it be a sod crop or a tilled crop.

16.8.2. Firm pasture

This refers to well drained upland areas being used for grazing.

16.8.3. Meadow

This refers to wet pasture which becomes hummocky with extended use.

16.8.4. Upland hardwood

These are well drained soils of deciduous trees, i.e. hard maples, basswood, oak, birch.

16.8.5. Upland conifer

These are well drained soils of coniferous trees, i.e. red and white pine, hemlock.

16.8.6. Swamp hardwood

These are deciduous trees able to withstand wet soils with standing water for periods of the year, i.e., soft maple, elm.

16.8.7. Swamp conifer

These are coniferous trees on wet soils, i.e. cedar, tamarack.

16.8.8. Shrub marsh

These are areas covered for extended periods of time and with woody plants of less than 6 metres in height.

16.8.9 Open marsh

These are areas that are dry only periodically and contain mainly herbaceous plants with some woody plants less than a metre in height.

16.8.10 Lawn

An area of closely cut grass.

16.8.11 Impervious

A surface which prevents water percolation into the subsoil. Examples are precambrian shield granite outcrops, asphalt or cement roadways and parking lots, brick and cement buildings and bridges.

16.9 Stream Cover

Stream cover is divided into three categories. The measurements must total 100 per cent.

16.9.1 Dense

75% to 100% shaded by canopy.

16.9.2 Partly Open

25% to 75% shaded by canopy.

16.9.3 Open

0% to 25% shaded by canopy.

16.10 Stream Gradient (Calculated % slope)

Stream gradient is the actual visual angle of descent of the stream at the station. % slope is calculated for each station. It is a measurement of the average slope for the section of stream that the station is located on. Measure the length of stream between the two contours immediately upstream and downstream from the station and divide this distance into the vertical drop (difference in contour height).

$$\% \text{ slope} = \frac{\Delta h}{1} \times 100$$

where: Δh = difference in contour elevation (m)
1 = length of stream between contours (m)

i.e. $\frac{7.6\text{m (25 feet)}}{1950\text{m}} \times 100 = 0.38\%$

16.11 Aquatic Vegetation

See discussion Chapter 7.11. In the space provided, briefly describe the vegetation present at each station.

16.12 General Comments

Section P is intended to summarize important information about the stream relevant to fish habitat, pollution, industrial waste, utilization by anglers, accessibility, etc. Any qualitative and anecdotal information should be included here, e.g. "Local owner of farm property bordering the stream reports a brook trout population although none were captured at the time of survey." or "Cattle were observed between stations 2 and 3 drinking at the streams edge. Bank vegetation was eroded away and large patches of exposed soil and manure falling into the stream were evident."

SECTION THREE

POST FIELD ACTIVITIES

After all the field activities are completed, the writing of the finished report starts. There are a number of tasks which must be finished entirely before the survey can be filed as 'complete'. These are listed below.

1) Complete Station Map
2) Complete Gradient Profile
3) Complete and type the Stream Survey Summary 1427 Form.

CHAPTER 17

THE COMPLETED STREAM SURVEY REPORT

17.1 Completing the Stream Survey Summary 1427 Form

The information collected from maps and field work must be entered correctly in the appropriate spaces. Failure to do this renders the survey meaningless. At every station, all the required data should be collected. However, if this is not possible due to equipment problems, etc., then provide a written explanation of the problems encountered and note the data still to be obtained. The following explains how the form is to be completed.

Section A — Identification Key

Refer to Chapter 1.2, 1.5, 10.2. List the M.N.R. code number of the district conducting the survey, regardless of the number of districts the stream flows through.

Section B — Location Data

To complete this section, refer to the following chapters.

Gazetteer Name	— Chapter 10.1
Topographic Map Name	— Chapter 10.3
Local Name	— Chapter 10.7
Country or Judicial District and Townships	— Chapter 10.6
Lot and Concession	— Chapter 10.8
(If available, provide this information for only the stream mouth)	
Name and No. of Topo. Map	— Chapter 10.4
Watershed Code	— Chapter 10.10
Elevation	— Chapter 10.9
Stream Length	— Chapter 11.2
Average Gradient	— Chapter 11.4, 11.4.2
Drainage Area	— Chapter 11.3
Stream Type	— Chapter 11.5
(Place a check in the appropriate box)	

Investigators: List the names of all personnel involved in the data collection.

Station Name: List the name of the watercourse at each station. For instance, some stations may be placed on tributaries of the main stream. The name of the tributary would be listed here to distinguish it from the main stream stations. Use the format described in Chapter 1.6.1.

Station Coordinates: List the latitude and longitude, as determined from a topographic map, to the nearest tenth of a minute.

Station Time and Date: This refers to the time the water chemistry analysis is begun and the date is the day all components of the survey are accomplished. All aspects of the survey should normally be completed within one day. Refer to Chapter 12.9.

Section C — Water Chemistry

To complete this section, refer to the following chapters.

Air Temperature	— Chapter 12.8.2
Water Temperature	— Chapter 12.8.1
Dissolved Oxygen	— Chapter 12.3
pH	— Chapter 12.5
Turbidity	— Chapter 12.6.1
Alkalinity	— Chapter 12.4
T.D.S. & Conductivity	— Chapter 12.7

Section D — Instream Cover

To complete this section, refer to Chapter 16.1.

Section E — Bank Stability

To complete this section, refer to Chapter 16.2.

Section F — Access

To complete this section, refer to Chapter 16.3.

Section G — Streambed Data

To complete this section, refer to Chapter 16.4.

Section H — Dimensions

To complete this section, refer to Chapter 16.5.

Section I — Barriers

Refer to Chapter 16.6 and record the number of each.

Section J — Stream Morphology

Refer to Chapter 16.7 and record the number of each.

Section K — Terrain Characteristics

Refer to Chapter 16.8 and check the appropriate boxes.

Section L — Stream Cover/Canopy

Refer to Chapter 16.9

Section M — Stream Gradient

Refer to Chapter 16.10 and check the appropriate box.

Section N — Fish Species

Refer to Chapter 6. For those fish identified in the field, insert the fish code and the number of specimens into the appropriate boxes for each station. Small fish sent to main office will not have their codes entered until positive identification is received from main office.

Section O — Aquatic Vegetation

Refer to Chapter 16.11.

Section P — General Comments

Refer to Chapter 16.12.

17.2 Documentation

1) Do not place 'zeros' in front of numbers but zeros *must* be placed in front of decimal points.
2) If there is no information in a box, *do not* fill it with zeros.
3) If there is no information after the decimal point, record a zero following the decimal point.
4) Time must be by the 24 hour clock.
5) If information is not available, record on the 1427 form or with attachment stating why it is not available.

17.3 The Gradient Profile

The gradient profile is to be completed on graph paper, accompanied by the summary.

17.4 The Topographic Map

All stream stations are to be marked on the topographic maps and the original is to be sent to Main Office. Photocopies do not reproduce well.

17.5 Forms

Order all forms from Central Supply Warehouse at 51 Esandar Drive, Toronto. Use warehouse requisition form, (form 1406).

17.6 Filing the Completed Report

When the final stream survey report is completed, the multitude of notes, forms, maps and papers must be correctly amalgamated and filed. Some information is sent to Main Office (Fisheries Branch) to be filed in the master 'Provincial Stream Survey files' and subsequently entered into the computerized data base (Stream Inventory Data Base). The stream survey summary (1427) must be typed or legibly hand printed in ink. The bulk of the original data is filed at the appropriate District Office in one complete package. Listed below is an outline of data requirements and filing locations.

	District Office	Main Office
Stream Survey Summary (1427)	original copy	carbon copy (not photo)
Topographical Map (showing stations and drainage basin outline) (N.B. Do not photo copy)	1 copy	second copy
Gradient Profile	original	photo copy
Gradient profile Summary	original	photo copy
Field Record Form (2066)	carbon copy	* original
Field Collection Label (1414)	not retained	** original
Field Notes	all retained	not required
All rough notes	all retained	not required

Note: * original copies required to enter fish identifications and making subsequent copies – included with fish samples

** included with fish samples and Field Record Forms

Ontario

Ministry of Natural Resources

Aquatic Habitat Inventory
Stream Survey Summary

Instructions

▽ Numbers only

▽ Checking only X

A. Identification Key

M.N.R. District No.: 72

Survey year: 19 77

Lat.: 43° 19.'

Long.: 80° 31.'

B. Location Data

Gazetteer Name: Alder Creek

Topographic Map Name: Alder Creek

Local Name: Alder Creek

County or Judicial District: Oxford, Waterloo

Name and No. of Topo. Map: Stratford 40 P/7

Edition No.: 6

Watershed Code: 2GA 02

Elevation at mouth: 286 m

Township(s): Blenheim, Wilmot

Stream Length: 22.5 km

Average Gradient: 3.4 mkm^{-1}

Lot: 3

Concession: 12

Drainage Area: 5699. ha

Investigator(s): Z. Smith, A. Doe

Stream Type: ☐ Perennial ☐ Non-Perennial

Station No.	Station Name	Latitude	Longitude	Time - hrs.	Survey Date Year 19	Month	Day
1	Alder Creek	43°19.2'	80°31.3'	1000	77	05	26
2	Alder Creek	43°19.9'	80°31.4'	1540	77	05	30
3	Alder Creek	43°20.5'	80°31.9'	1500	77	05	31
4	Alder Lake	43°21.1'	80°32.1'	1555	77	05	27
5	Alder Creek	43°21.6'	80°32.5'	1500	77	05	27
6	Alder Creek	43°22.3'	80°33.2'	1600	77	05	31
7	Alder Creek	43°23.1'	80°33.0'	1445	77	06	01
8	Alder Creek	43°23.8'	80°33.0'	1530	77	06	01
9	Alder Creek	43°24.3'	80°35.9'	1450	77	06	02

C. Water Chemistry

Station No.	Temp. Air °C	Temp. Water °C	D.O. $mg L^{-1}$	pH	Turbidity	Alkalinity $mg L^{-1}$	T.D.S. $mg L^{-1}$	Sp. Cond. $umhos cm^{-1}$	Cell Temp. °C
1	20.0	20.5	11.2	9.0	12.0	205.2	382.7	500.0	18.5
2	19.0	16.5	7.8	8.5	8.0	225.7	529.8	700.0	19.0
3	22.0	19.5	8.2	8.0	59.0	212.0	571.8	850.0	24.5
4	25.5	24.5	9.2	9.0	19.0	143.6	249.7	375.0	25.0
5	23.0	23.0	13.2	9.0	32.0	266.8	407.8	600.0	24.0
6	21.5	22.0	10.8	9.0	19.0	266.8	446.2	650.0	23.5
7	14.0	16.0	9.2	9.0	22.0	287.3	555.0	700.0	17.0
8	14.0	17.0	10.2	9.0	29.0	287.3	548.4	700.0	17.5
9	7.0	12.0	5.4	8.0	102.0	328.3	740.0	800.0	11.0

D. Instream Cover (% Total surface area)

Station No.	Undercut Banks	Boulder	Log & Tree	Organic Debris	Macrophytes (Vascular)	Combination	No Cover
1	10		10		20		60
2	10	10	40		10		30
3			5		15		80
4	30	5	25			5	35
5	5	5		5	20		65
6	30	20	10		10		30
7			10		20	10	60
8		20			10		70
9		5		5		10	80

E. Bank Stability (%)

Station No.	Highly Unstable	Moderately Unstable	Stable
1	30	30	40
2	20		80
3	40	40	20
4			100
5			100
6	5	5	90
7	10	10	80
8			100
9			100

F. Access

Station No.	Unposted	Posted
1		X
2		X
3		X
4		X
5		X
6	X	
7		X
8	X	
9	X	

G. Streambed Data (%) Substrate Rock Types

Station No.	Bedrock/Rock	Boulder	Rubble/Cobble	Gravel/Pebble	Sand	Silt	Clay	Muck	Marl	Detritus
1				75	5	15				5
2		5	5	30		60				
3		5	10	60		25				
4			30	60	10					
5		5	5	35		50		5		
6		5	40	20	5	30				
7						100				
8			10	40	40	10				
9				10	10	30		50		

H. Dimensions / **I. Barriers** (Nos. of)

Station No.	Length m	Mean Width m	Mean Depth m	Velocity $m\,s^{-1}$	Constant K	Discharge — $m^3\,s^{-1}$	Natural	Artificial
1	40	7.15	0.19	0.65	0.8	0.71	0	0
2	40	9.80	0.44	0.10	0.9	0.39	0	1
3	20	7.30	0.15	0.37	0.8	0.32	0	0
4	40	4.50	0.17	0.75	0.8	0.46	0	1
5	20	10.00	0.36	0.08	0.9	0.26	0	0
6	40	4.50	0.15	0.28	0.8	0.15	0	1
7	40	3.80	0.37	0.05	0.9	0.06	0	0
8	10	3.30	0.11	0.41	0.8	0.12	0	0

H. Dimensions (continued)

Station No.	Length m	Mean Width m	Mean Depth m	Velocity $m\,s^{-1}$	Constant K	Discharge — $m^3\,s^{-1}$
9	40	·60	0·18	0·31	0·9	0·08

I. Barriers (Nos. of)

Natural	Arti-ficial
0	0

J. Stream Morphology (Nos. of)

Station No.	Riffles	Pools	Runs	Flats
1	2	4	0	0
2	4	3	0	0
3	3	2	0	0
4	1	2	1	0
5	0	0	0	1
6	3	2	0	0
7	0	0	0	1
8	5	2	0	2
9	0	0	0	1

K. Terrain Characteristics (Check appropriate box.)

Cult.	Firm Past.	Mea-dow	Upld. Hdwd.	Upld. Con.	Swamp Hdwd.	Swamp Conif.	Shrub Marsh	Open Marsh	Lawn	Imper-vious
		X	X		X					
		X			X	X				
	X	X	X							
			X						X	
		X						X		
		X			X					
X		X				X				
X		X								
		X	X							

L. Stream Cover/Canopy (% Stream shaded)

Station No.	Dense	Partly Open	Open
1	10	10	80
2	75	25	
3		5	95
4	95	5	
5			100
6	20	10	70
7		20	80
8			100
9		5	95

M. Stream Gradient

Low <10°	Med. 10°-60°	Steep >60°	Calculated % Slope
X			0·29
X			0·28
X			0·28
X			0·17
X			0·17
X			0·44
X			0·35
X			0·33
X			0·39

N. Fish Species

Station No.	Code	No.	Code	No.	Code	No.	Code	No.	Code	No.	Code	No.	Code	No.
1	080	11	163	24	165	4	192	2	202	1	217	1	198	20
1	211	70	212	9	281	5	338	1	337	9	381	1		
2	080	15	163	4	186	3	165	3	198	1	209	2	211	5
2	212	1	235	4	341	4								
3	186	10	192	2	198	9	208	3	209	18	211	2	281	2
3	338	1	341	4										
4	186	15	163	11	198	18	224	2	208	2	209	3	211	18
4	233	3	311	1	313	1	337	1	338	10				
5	198	1	208	15	209	75	212	7	281	9	338	7	341	12
6	163	10	189	7	198	8	208	6	209	25	210	24	211	3
6	212	29	281	2	341	18								
7	163	36	189	10	198	3	209	16	212	9	341	2		
8	210	15												
9	NO	CATCH												

O. Aquatic Vegetation (occurrence)

Stations 1 - Pondweed (<u>Potamogeton</u> sp.), Watercress, Cattail
2 - Arrowhead, Pondweed, Duckweed, Algae
3 - Arrowhead, Pondweed, Duckweed, Algae, Coontail
4 - Pondweed, Algae (<u>Cladophora</u> sp.)
5 - Arrowhead, Pondweed, Algae
6 - Arrowhead, Pondweed, Algae, Cattail
7 - Arrowhead, Pondweed, Algae
8 - Arrowhead, Duckweed, <u>Cladophora</u> sp.

P. General Comments (History, Pollution, etc.)

Alder Creek appears to suffer from two major problems; siltation and a heavy influx of organic wastes. Several residents of Mannheim complained of fouled water wells and the pollution of Alder Creek. The water at station 9 (downstream from Petersburg) was turbid, green and had an unpleasant odour. At Mannheim (station 8) a large algal bloom was observed. Refuse (tin cans, bottles, car tires, wire, etc.) was found on the banks and in the stream at most stations. The occurence of a number of small cold springs entering Alder Creek at station 4 and possibly downstream may partially account for the presence of brook trout. The presence of carp in Alder Creek apparently provides a great deal of recreation for fishermen, both young and old alike, especially just below the dam at New Dundee.

PART THREE
RIVER SURVEYS

RIVER INVENTORY

In the following chapters many explanations will refer to previous chapters in the lake and stream survey portions. This should not be an inconvenience to the reader since there are minimal differences in the survey techniques of lentic and lotic waters.

SECTION ONE

PRE-FIELD ACTIVITIES

Before any field work is undertaken, there are a number of activities that should be completed several months in advance. It is essential that personnel become familiar with the river to be surveyed by obtaining all the relevant data and maps that may be available from several agencies.

Listed below are the steps in preparation for the field activities.

1) Obtain the necessary maps, aerial photographs, if needed, gazetteer and supplements.
2) Locate and identify the water body.
3) Search all available historical records.
4) Obtain information on accessibility of the waterbody.
5) Obtain a videotape that provides an aerial view of the river in late summer, prior to the commencement of the field season. Refer to Chapter 20.7, 20.8, 20.9.
6) Analyse the videotape to:
    i) select representative reaches
    ii) select stations
    iii) prepare for field crew support
7) Determine drainage areas
8) Graphically illustrate the gradient profile

CHAPTER 18

COMPLEMENTARY DATA

18.1 Data Types

Historically, rivers in Ontario have been used for a variety of purposes and as a result, several agencies have undertaken to monitor river conditions. These agencies include the Ontario Ministry of Natural Resources, the Ontario Ministry of the Environment, Ontario Hydro and Environment Canada. The complementary data from these agencies can be used to describe the prevailing riverine conditions with respect to water quality, river discharge, sedimentation and biology. Since the complementary data are normally collected on a continuous basis, they can be used to supplement the point in time data collected during a river survey. In addition, all types of complementary data can be examined for specific management needs. The sources of these data should be listed along with the other characteristics of a river.

Generally there are two types of publications as follows:

1) Data Publications. These are normally a number of ongoing data publications which are brought up-to-date periodically. Some are published annually while others are published once every two to five years. These publications usually cover data collected at sampling stations situated throughout Ontario. The data may be requested by the titles listed in the chapters to follow.

2) Report Publications. These are nonperiodical narrative reports which address specific questions on individual rivers. More commonly, these include studies on biological oxygen demand, water dispersion rates, invertebrate communities and industrial effluent to name just a few. These types of reports must be requested on a per river basis.

18.1.1 Regional Libraries

OMNR Regional Offices usually maintain a library current in all publications pertinent to the rivers of that MNR region. Many publications can be obtained by being placed on the mailing list of each of the appropriate agencies. District staff should check first with their regional library prior to requesting a specific report. The table below summarizes the types of information available from each agency.

	ONTARIO MINISTRY OF NATURAL RESOURCES			ONTARIO MINISTRY OF THE ENVIRONMENT	ONTARIO HYDRO	ENVIRONMENT CANADA
	MAIN OFFICE	REGIONAL OFFICE	DISTRICT OFFICE			
Sport Fish	1,2	1	1	1	-	-
Commercial Fish	1	1	1	-	-	-
Creel Census	-	-	1	-	-	-
Invertebrates	1	-	1	1	-	-
Water Quality	-	1	1	1,2	-	1,2
Water Temperature	-	-	-	1,2	-	1
Sediment	-	-	-	1	-	1
Water Levels	-	-	1	1,2	1	1
River Discharge	-	-	-	1,2	1	1
Active Hydrometric Stations	-	-	-	1,2	1,2	1,2
Dams/Levees/Diversions	-	-	-	1,2	1,2	-

1 - data publication
2 - map indicating data recording station
General summary data are provided on some maps.

18.2 Ontario Ministry of Natural Resources

At present, the O.M.N.R. does not publish data series for rivers. Requests for other publications and data, however, should be made to the District and Regional offices involved and to Fisheries Branch, Whitney Block, Queen's Park, Ontario M7A 1W3.

18.3 Ontario Ministry of the Environment

The following is a list of specific data series publications:

1) Selected streamflow data for Ontario (date) Water Resources Bulletin;
2) Streamflow data for I.H.D (International Hydrological Decade) representative basins. 1965–1978. Water Resources Bulletin 3–100;
3) Water quality summary (by Region; see Appendix 11);
4) Water quality data, Ontario lakes and streams (date). Water quality data series;
5) Low flow characteristics of streams in (M.O.E. Regions) Map series 3005;
6) General characteristics of streamflows (by M.O.E. Regions) Map series 2006.

These reports are available from the Regional Offices of the Ministry of the Environment listed in Appendix 11.

Non-periodical publications should be requested through the M.O.E. regional Office that is responsible for the area where the river is located.

18.4 Ontario Hydro

Ontario Hydro produces 1 in. = 16 mi. scale maps which indicate all of the active and non-active water impounding and regulating devices in Ontario. *(Ontario Hydro; Principal Power Facilities and Municipal Systems Served, January 1, 1974).* Ontario Hydro will also supply data for specific sites, for example, day-to-day river discharge rates. The Ontario Hydro Library (700 University Ave., Mezzanine, Toronto, Ontario, M5G 1X6) is open to the public and some historical and background information may be available there.

Requests for recent site specific data should be directed to the Regional Offices of Ontario Hydro listed in Appendix 11.

18.5 Environment Canada

Environment Canada publishes both maps and data. The maps indicate the location of sampling sites and in some cases a summary of the types of data that are collected. The data are mainly physical characteristics such as water level, river discharge and sediment. Each publication is periodically updated on a one, two or five year cycle depending on the nature of the data:

1) Ontario, Active Hydrometric Stations, 1978. Water Resources Branch, Inland Water Directorate Ottawa Map.

2) Surface Water Data Reference Index. Published once every two years. This publication lists gauging station locations and the types of data collected there.

3) Surface Water Data, Ontario. Published annually. The data include streamflow and water levels of selected stations. The streamflow data are listed on a day-to-day schedule. Data listings prior to 1964 are out of print. The Historical Streamflow Summary should be used for pre 1964 data.

4) Historical Streamflow Summary, Ontario. Published once every five years. This publication contains a summary of monthly and mean annual discharges as well as annual extremes and total discharge for the period of record.

5) Historical Water Levels Summary, Ontario. Published once every five years.

6) Sediment data reference index. Published once every two years. It contains descriptive information on selected sediment stations.

7) Sediment Data for Canadian Rivers. Published annually. It contains descriptive information on selected sediment stations.

8) Historical Sediment Data Summary. Published once every five years. It contains data listings of monthly and mean annual suspended sediment load and annual total suspended loads from 1947 to present.

9) NAQUADAT. Published annually. It is a computerized national water quality report which contains chemical, physical, bacteriological, biological and hydrometric data relevant to water quality for surface water, groundwater, estuaries, waste water, precipitation and sediments.

These reports are available from the Environment Canada offices listed in Appendix 11.

18.6 Fisheries and Oceans Canada

The federal Department of Fisheries and Oceans in Ontario is responsible for the Great Lakes Basin and its tributaries. They collect water quality data, benthic invertebrates, and perform environmental impact studies. Requests for publications regarding tributaries of the Great Lakes Basin should be made on a per river basis to both the offices listed in Appendix 11.

CHAPTER 19

IDENTIFICATION AND DEFINING WATERBODY LOCATION

19.1 Gazetteer Name

Refer to Chapter 1.1

19.2 Geographical Co-ordinates

Refer to Chapter 10.2

19.3 Topographic Map Name

Refer to Chapter 1.3

19.4 Name of Topographic Map and Number

List in sequence beginning at the mouth, the name, number and edition of all the maps that show the main channel of the river.
Refer to Chapter 1.4

19.5 Ministry Administrative Codes

Most large rivers cross the boundaries of one or more M.N.R. administrative districts. On Form 1, enter the code numbers of the M.N.R. districts that the river's main channel (not tributaries) flows through.
Refer to Chapter 1.5

19.6 County or Judicial District and Township

If the river is not listed in the Gazetteer, this information can be found on the appropriate topographic map. Enter only the county or judicial district and township for the river mouth.
Refer to Chapter 1.7

19.7 Local Name

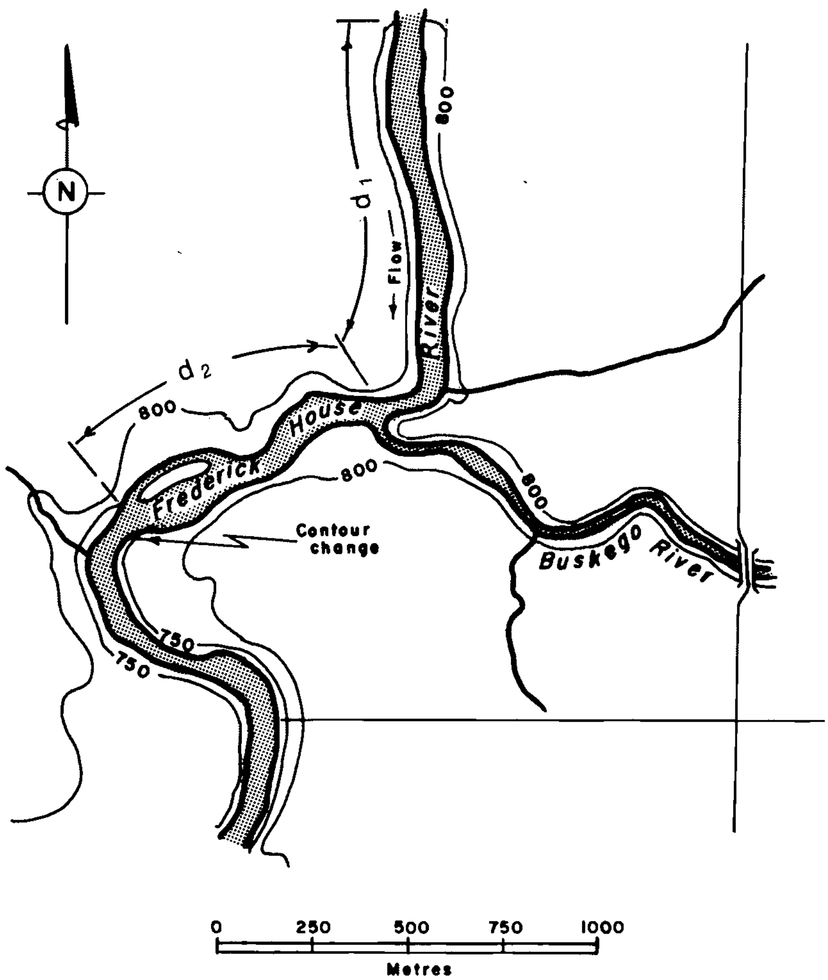
Refer to Chapter 1.6

19.8 Elevation

The elevation at the mouth of the river is the same as the receiving water. The receiving water is usually a large lake that has its elevation printed on a topographic map. If the receiving water is seawater, then the elevation can be assumed to be 0.0m. If the receiving water is another river with no contour line at the point of confluence, then elevation is determined as a proportion of the distance and placement of the river mouth between contour intersections along the receiving river as follows:

$$E = H - L\frac{(d_1)}{(d_1 \times d_2)} = 800\text{ ft} - 50\text{ ft}\frac{1\text{ km}}{1\text{ km} + 0.7\text{ km}} = 244\text{ m} - 15\text{ m}\,(0.59) = 235\text{ m}$$

Where
- E = river mouth elevation (m)
- H = elevation (m) of the receiving river contour line upstream from the river mouth
- L = difference in elevation (m) between the contour lines along the receiving river upstream and downstream of the river mouth
- d_1 = distance from the upstream contour line to the mouth of the river (km)
- d_2 = distance from the mouth of the river to the downstream contour line (km)



19.9 Watershed Code

Refer to Chapter 1.10 and Appendix 10

CHAPTER 20

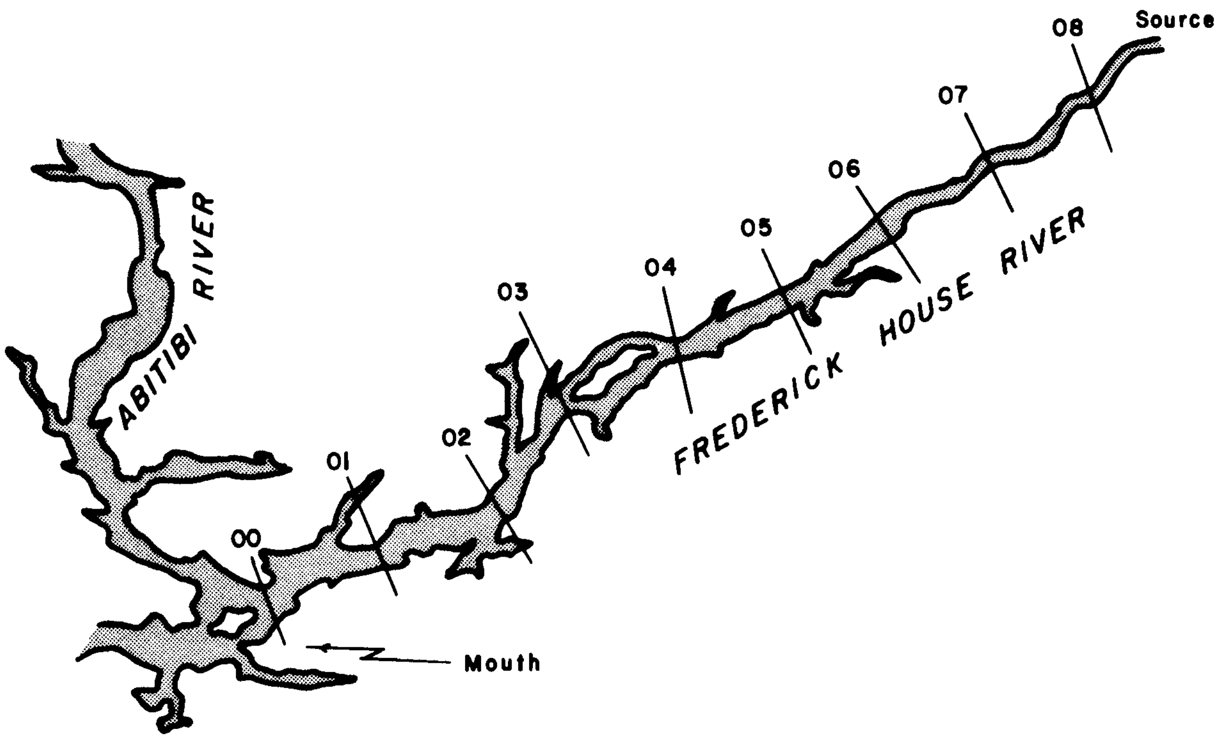
PREPARATORY MAP WORK

20.1 Topographic Map

Refer to Chapter 11.1. If it is impossible to cover the entire drainage area of a river with a complete series of the 1:50,000 scale maps, select the next largest scale, 1:250,000 series, which is available for all of Ontario. Do not mix scales to complete a series of maps. Other map scales that are available for some parts of Ontario, but do not have contour lines or elevations, are the provincial series of 1:100 000, 1:125 000 and 1:126 720. These may provide supplementary information such as access routes to the river.

20.2 Template Map

Template maps are those topographic maps on which all preliminary river mapping is done. Km markings are to be placed on these maps from mouth to source, so that site location can be stated as *distance from the mouth of the river.*



20.3 River Length

Use the template maps to measure main channel length and source length of the river. Refer to Chapter 11.2.

20.3.1 Main Channel Length

This measurement refers to the distance in km from the mouth of the river to the furthest point upstream which still bears the name of the river. This measurement could be identical to the source length in situations where there are no tributaries upstream of the furthest point along the main channel.

20.3.2 Source Length

This measurement refers to the distance in km from the mouth of the river to the furthest point upstream of the main channel and continues to the source of the longest tributary of the river.

20.3.3 Measuring River Length

Either a map measurer (Chapter 2.3.1) or a graphics calculator (Chapter 20.4.3) may be used to measure river lengths. The 1 km intervals that are required on the template maps can be marked with the aid of these instruments; however, neither can be used easily to mark a river at 1 km intervals since unusual multiples of a scale are required to mark the km markings with a map wheel, while the eyepiece of the graphics calculator must be positioned directly over the river on the template map making the placement of the mark difficult.

To avoid these difficulties, use a 40 cm length of string that has been calibrated to the equivalent of 1 km intervals for the map scale used. Ensure that the string is of a tightly wound fine fibre which will not stretch and tape the extreme ends of the string to a flat surface. Using the appropriate scale for the template map and an indelible ink pen, mark the zero km point first and next mark each km point between the zero and 20 km markers.

Melt a small amount of -5° to 0°C cross-country ski wax into a shallow metal dish, then pass the calibrated portion of the string through the melted wax. Wipe off the excess wax and check the length of string against the appropriate scale to ensure that it has not stretched during the waxing process. Start over if the string has stretched.

To measure the river length and mark the 1 km intervals with the waxed string, lay the string down the centre of the river channel starting with the zero mark at the river mouth. The wax will stick to the map and thus conform to the bends in the river. Use a blunt probe from a dissecting kit to massage the waxed string around the river bend. Mark the one km intervals onto the template map with lines that are drawn perpendicular to the river channel. Once the first 20 km stretch has been marked, lift the string and repeat the procedure for all subsequent 20 km stretches to the source. Check the string periodically to ensure that it has not stretched during the marking exercise.

20.4 River Drainage Area

If the river drains an entire tertiary or quarternary watershed, the drainage area is listed in Counts & Measurements of Ontario Lakes by E.T. Cox, 1978. If not, refer to Chapter 11.3 and the remainder of this chapter.

Place a check in the appropriate box (form 1) to indicate whether the watershed is main or tributary to the river system. Main watersheds are those containing the main channel of the river from its mouth to the furthest point upstream which still bears the name of the river. Tributary watersheds are those containing the tributaries entering the main channel anywhere along its entire length. Record the drainage area to the nearest hectare.

20.4.1 Polar Planimeter

Refer to Chapter 2.5.1.

20.4.2 Dot Grid

Refer to Chapter 2.5.2

20.4.3 Electronic Planimeter

Area measurements made with an electronic planimeter are preferred because of their capacity to provide a higher degree of accuracy. These instruments can be programmed to add and substract measured areas, and to measure several scales. The Timber Branch of many district offices has a Numonics Graphic Calculator (model 1250) or similar instruments.

To use the Model 1250 Graphics Calculator:

1) Both the instrument and the drawing to be traced must be on a smooth surface;

2) Determine whether the tracer point will circumscribe the area within the operational limits of the instrument. If the drawing cannot be moved to enable the area to be measured in one tracing, then subdivide the drawing and measure each area separately using the accumulator function;

3) Establish a start/finish point on the circumference of the area to be measured;

4) Proceed through the programming of the Model 1250 as directed in the owner's manual being sure to select the appropriate drawing scale and hectare as the unit of the area;

5) Ensure that the drawing is secured to the work surface;

6) Circumscribe the periphery of the figure to be measured by moving the tracing point from the designated start/finish point in a clockwise direction. If the tracer point accidentally departs from the line, it is not necessary to backup and reset the instrument. The tracer point may be intentionally moved in the opposite direction to compensate for the error;

7) Read the digital display.

Note: To test the accuracy of the machine, a 2 cm × 2 cm square on a 1:50,000 scale map should equal 1 km^2 (100 ha).

20.5 Average Gradient

Refer to Chapter 11.4

20.5.1 The Gradient Profile

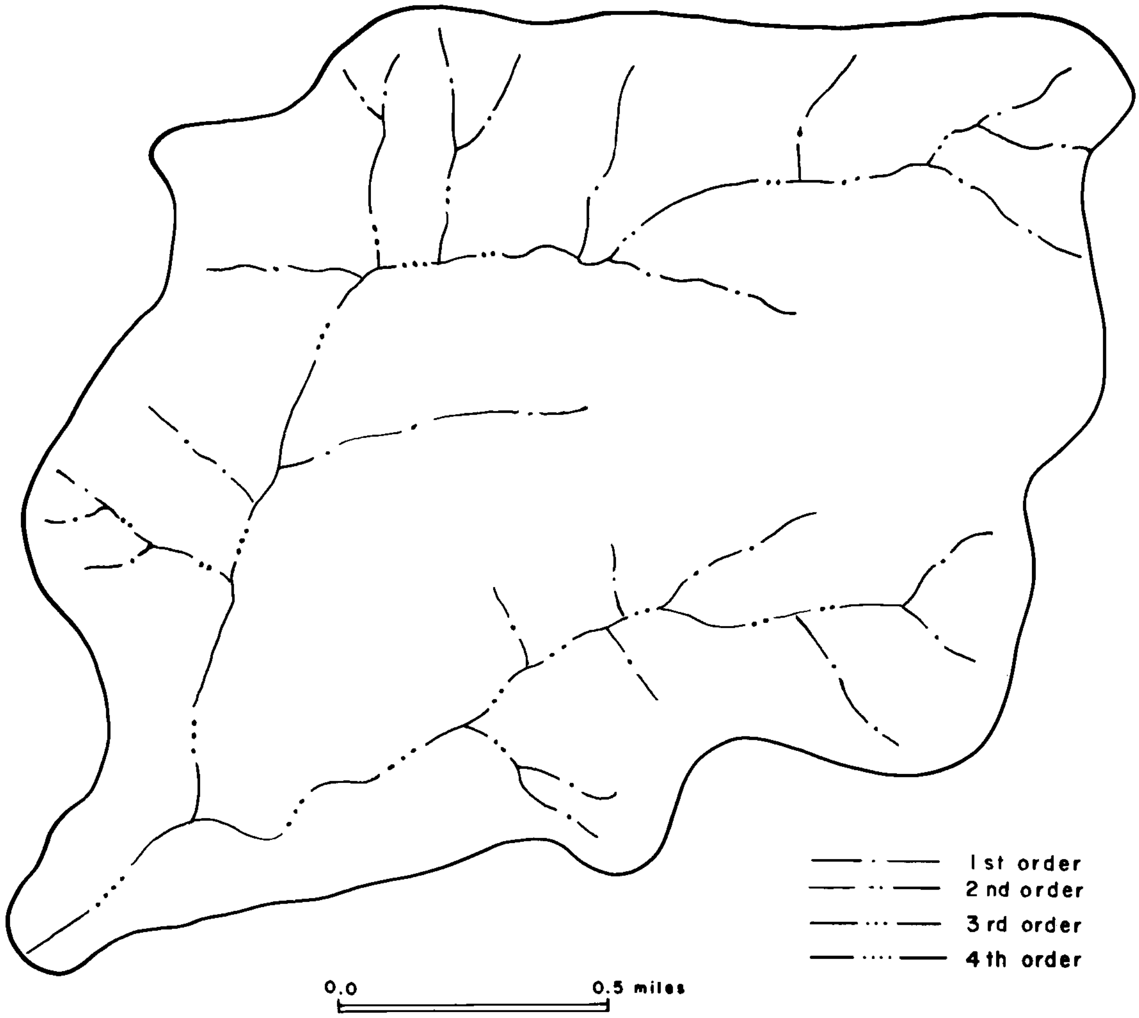
Refer to Chapter 11.4.1

20.5.2 Average River Gradient

The average river gradient is determined as the difference in elevation between the source of the main channel (not the source of the longest tributary) and the mouth, divided by the main channel length. This is calculated to the nearest 0.1 m Km^{-1}. Refer to Chapter 11.4.2.

20.6 Stream Order

Stream order is a measure of the position of a stream or river in the hierarchy of the tributaries which are part of the drainage system. First order streams are those which do not have tributaries, second order streams are those which have only first order streams as tributaries. Third order streams receive only first and second order channels and so on. In the illustration below, a stream becomes second order downstream from the confluence of two first order streams and a third order stream starts downstream from the confluence of two second order streams. The highest stream order found in the section of river at the mouth is entered into the appropriate space provided in Form 1. It is not necessary to order the entire watershed to determine this.



20.6.1 Major Tributaries to the Main Channel

Major tributaries are those tributaries which are rated as one stream order less than the order assigned to the main channel. For example, if the main channel is stream order five, then all the fourth order tributaries entering the river will be listed. Record the stream order and geographic coordinates (Chapter 10.2) of the mouth of each tributary. If the tributary has been previously surveyed, record the most recent year of survey. If it has not been surveyed, place a check in the 'No Survey' box.

20.7 Video Reconnaissance

The aerial video tape recording of a river is a permanent record which provides:

a) a river review without the cost of additional aircraft flights;

b) a preview of river hazards and conditions;

c) evidence for environmental cases where construction or some other perturbance has changed the nature of the river; and

d) a method for separating river reaches for the river inventory.

There are two ways of obtaining a video recording of the river. The first and recommended method is to hire an independent group that is experienced in video cassette recording. The second is to have district or regional personnel experienced in video cassette recording undertake the operation. In either case, the video recording crews must be familiar with the video taping equipment and the aircraft to be used.

20.8 Aerial Video Recording Guidelines

The following is a set of guidelines which will ensure consistent quality in video reconnaissance.

a) Timing. Flights should be made at least one year in advance of the intended year of the survey.

b) Time of the Year. Late summer during low flow is the optimal time to see potential navigational hazards, because plans for portages and field support should be made with the worst possible conditions in mind.

c) Aircraft. Only aircraft which allow an unobstructed view of both banks of the river should be used. Aircraft used to date which meet these criteria are:

   i) Helicopter Bell 206 Jet Ranger: Remove the right rear door of the helicopter. Video tape the river while the cameraman is facing forward and directing the camera angle 45° down from the horizontal plane. Helicopters possess a limited range and are expensive to lease compared to a fixed wing aircraft. Flights in remote settings may not be physically or economically possible. The Robinson 22 is a small relatively inexpensive helicopter to rent and may be a possible alternative to the more expensive turbine helicopters.

   ii) Fixed wing De Havilland Turbo Beaver and Otter. The video camera is suspended from a camera mount and positioned in the photo hatch. The camera is directed 45° down from the horizontal plane and facing aft (opposite to the direction of flight). Since the camera is directed to a spot behind the aircraft, the pilot must be provided with a video monitor which will help him to position the aircraft along the best flight line for the river video tape.

d) Speed and Altitude. The aircraft should be flown between 80 and 90 knots ground speed. The optimal altitude is dependent upon the width of the river and the field of the view of the camera. The video picture must contain the full width of the river including both banks. Seventy to 80 percent of the picture should be river while the remaining 20 to 30 percent should contain a view of both banks and some surrounding terrain.

e) Light Conditions and Flight Path. Flights can be made on sunny or overcast days since most video cameras can adjust to all daytime light levels. To avoid glare on sunny days, avoid video taping between 10:00 and 14:00 hours. Flight plans must be made which keep the sun behind the taping direction of the camera. A polarizing filter is recommended to further reduce glare.

f) Crew. The recommended crew size is three consisting of the pilot, navigator and a cameraman. Their duties are as follows:

   i) Pilot. The sole duty of the pilot is to fly the aircraft at the optimal altitude for video taping the candidate river.

   ii) Cameraman. The cameraman must monitor the video picture on the camera to ensure that the focus is correct and that the picture composition follows the guideline in section d) above. He will instruct the pilot to climb or descend in order to obtain the correct picture composition. The cameraman will also be required to pan the camera 15° to the left or right since it will not always be possible for the pilot to keep the aircraft positioned directly over the centre of the river channel. This is especially true around meandering sections of river where the pilot must bank to turn.

   iii) Navigator. The navigator must ensure that the correct flight path is followed. In addition, he must be a trained river observer who can comment upon substrate types and general terrain characteristics. The commentary can be done with a unidirectional microphone hooked directly into the video recorder. The navigator must also mark the corresponding video cassette recorder counter numbers onto a copy of the template map. These counter numbers are used for referencing locations during the video tape review.

g) Additional Equipment. Additional equipment that may be necessary includes:

i) Black and white or colour T.V. monitor. This is especially useful in aircraft where the direction of flight is opposite to the direction that the video tape camera is pointed, ie. Turbo Beaver. The pilot should be able to manoeuver the aircraft into preferred camera positions through occasional checks with the monitor.

ii) Auxiliary power. If an auxiliary power outlet is available on the aircraft of choice then a power connection from the outlet to the video tape machine through a transformer can be used. Most video equipment requires 12vdc.

20.9 Video Tape Review

View the entire tape to obtain an overall perspective of the river. The selection of representative reaches should be made after subsequent viewings and intensive study. The video tape must be reviewed well in advance of the field season by persons experienced in river survey so that the necessary documentation for the field season can be made. The success of the initial selection of stations will directly influence the quality of the river survey since the character of the whole river is judged by the stations.

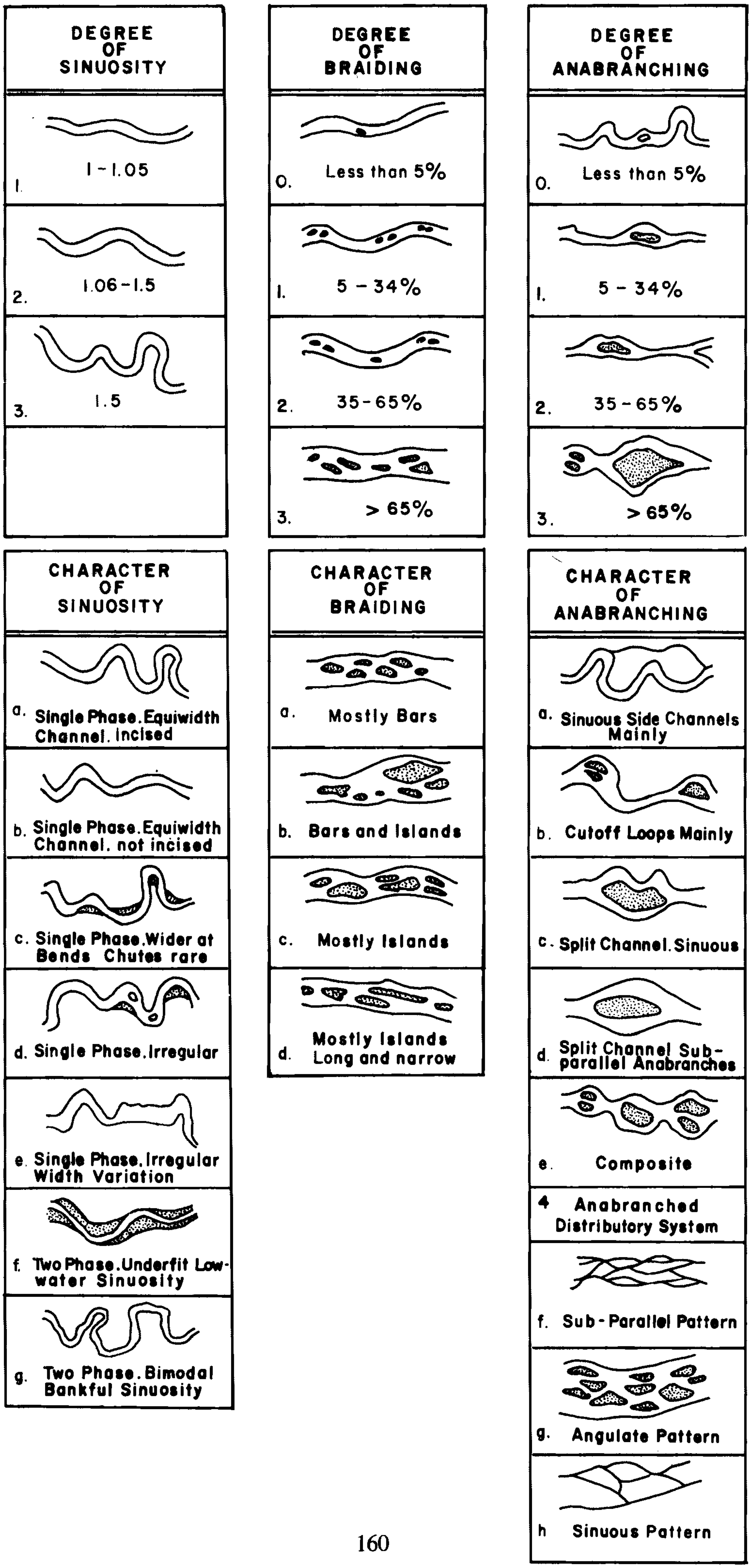
20.9.1 The Representative Reach

A representative reach is a section of river that is clearly physically different from other sections. Factors that differentiate one reach from another include: physical characteristics, degree and character of substrate type, flow, bank type and stability, aquatic vegetation, river width etc. In theory, habitat type is used to differentiate one representative reach from another; however, in practice, visual clues from the video tape are used to compare physical characteristics from one section of river to the next. The reviewer should then be able to determine where one representative reach ends and another begins. After this has been accomplished, stations are chosen.

Ideally, the variety of physical characteristics in a station within a representative reach should be identical to another station in the same representative reach. The assumption is that physical characteristics are homogeneous along the length of the representative reach. For example, a 20 km reach in a river consists of alternating sections of riffles and pools. It is a representative reach if the riffles and pools alternate in a consistent manner. The representative reach may be labelled a 50/50 or a 75/25 riffle-pool reach where 50/50 or 75/25 refers to the percentage of riffle to pool within the representative reach.

In many cases the selection of representative reaches from a video tape is not as simple as the riffle-pool example. Shoreline type, vegetative cover, meandering, braiding, falls, chutes and many other morphological features must also be considered during the selection process. The variety of reaches illustrated on the next page are presented as examples of the features that a video tape reviewer could encounter. A VHS video tape has been prepared to illustrate representative reach selection. (Available from Environmental Dynamics Section, Fisheries Branch.)

Man's influence on rivers must be considered in addition to the natural morphological variation. Dams, sewage disposal and causeways will alter the character of a river while a suspension bridge or a hydro electric wire crossing may not affect the character of the river channel much at all. The reviewer must decide to what extent a structure has affected the homogeneity of a reach.


DEGREE OF SINUOSITY
1. 1 - 1.05
2. 1.06 - 1.5
3. 1.5
DEGREE OF BRAIDING
0. Less than 5%
1. 5 - 34%
2. 35 - 65%
3. > 65%
DEGREE OF ANABRANCHING
0. Less than 5%
1. 5 - 34%
2. 35 - 65%
3. > 65%
CHARACTER OF SINUOSITY
a. Single Phase. Equiwidth Channel. Incised
b. Single Phase. Equiwidth Channel. not incised
c. Single Phase. Wider at Bends Chutes rare
d. Single Phase. Irregular
e. Single Phase. Irregular Width Variation
f. Two Phase. Underfit Low-water Sinuosity
g. Two Phase. Bimodal Bankful Sinuosity
CHARACTER OF BRAIDING
a. Mostly Bars
b. Bars and Islands
c. Mostly Islands
d. Mostly Islands Long and narrow
CHARACTER OF ANABRANCHING
a. Sinuous Side Channels Mainly
b. Cutoff Loops Mainly
c. Split Channel. Sinuous
d. Split Channel Sub-parallel Anabranches
e. Composite
4 Anabranched Distributory System
f. Sub-Parallel Pattern
g. Angulate Pattern
h Sinuous Pattern

20.9.2 Representative Reach Selection

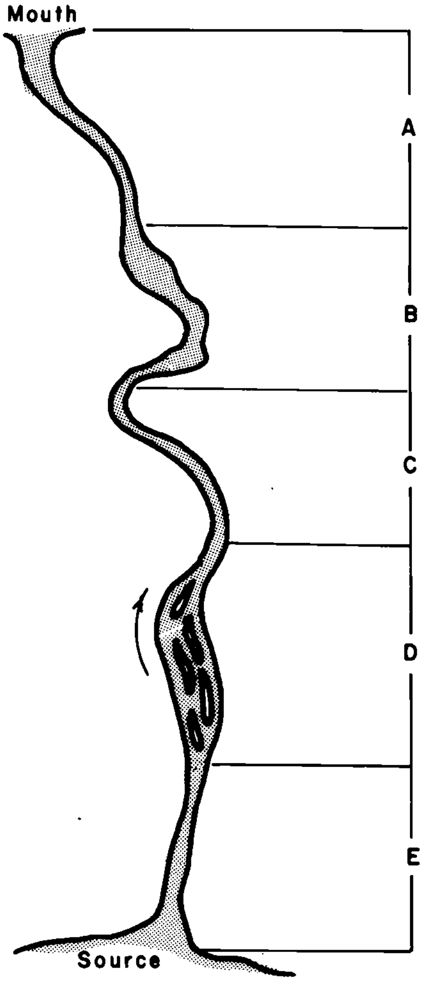
The selection of a representative reach is made by comparing a series of adjacent reaches with each other. When differences in habitat homogeneity occur, the video tape reviewer must check the sections on either end of the apparently different section to ensure that the river section is indeed the start of a new representative reach. The comparison and review of reaches is facilitated by the available functions of the video playback machine. These functions include play, rewind, forward and reverse search, slow motion and freeze frame and can be used to assist you in selecting representative reaches.

20.9.3 Transition Zones

The transition zone between two representative reaches will be abrupt in the case of a dam, chute or other such physical structure. However, sometimes there is no clear division between representative reaches and the transition from one reach to the next will be gradual and almost imperceptable. If the transition zone between reaches is 3 km or less, then the zone should be halved and shared between the two adjacent representative reaches. Transition zones that are longer than 3 km should be considered representative reaches in themselves.

20.9.4 Mapping Reaches

Mark out the representative reaches on a copy of the template map. Use a coloured pencil to mark the reaches so that they can be easily distinguished from the river km marks already on the map. Label the reaches from mouth to source as reach A, B and so on. Transfer the reach mapping accurately to the original template map.



20.9.5 Reach Description

A description of the reach is required on Form 1 (refer to Chapter 26). Record your observations for the following physical characteristics:

i) Relative Position of the Reach. Document the starting and end point of the reach in km from the mouth of the river. For example, reach C may start at km 56 and end at km 83.

ii) Shoreline. A description of the shoreline will include a reference to bank stability and vegetative cover.

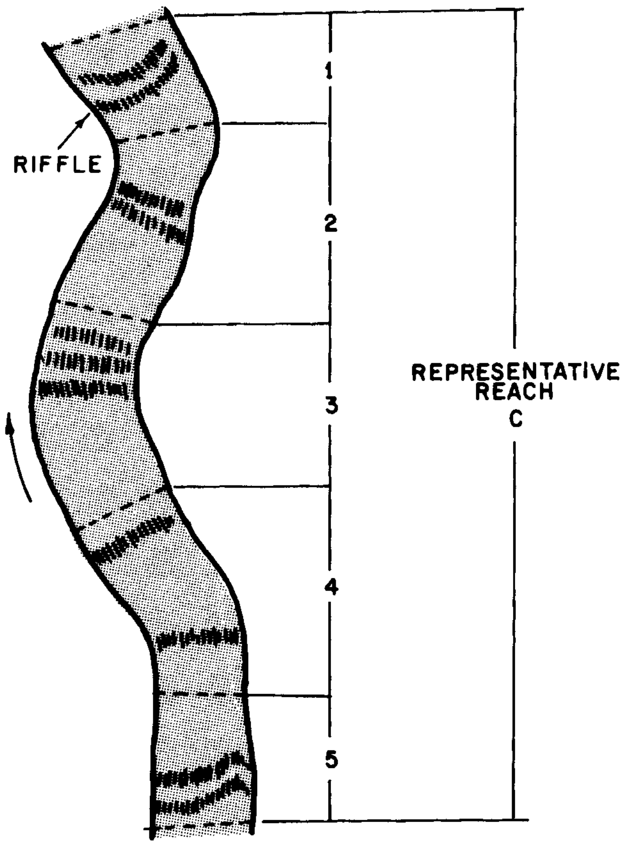
iii) Apparent Flow. The flow is described in terms of speed (slow, medium and fast) and turbulence (nil, moderate and high).

iv) Habitat Description. The habitat description refers to riffles, rapids, chutes, falls, pools, channels and so on. The proportion in which they occur in a reach is described as, for example, 50/50 riffle-pool reach.

v) Miscellaneous. Document the occurrence of visible aquatic vegetation, tributaries, bridges and other physical features.

20.9.6 Station

The station is a subsection of a representative reach which will be investigated intensively by the field crew. Ideally the station will bear the same proportions of physical characteristics that occur throughout the representative reach. The representative reach is subdivided into candidate stations that must be 10 to 15 times as long as the river is wide. For example, in the case of a meandering representative reach 20 km long and with an average river width of 80 m, the river could be subdivided into 20 equilength (one km) or 25 (0.8 km) candidate stations. More complex reaches such as a riffle-pool reach may not be divided into equilength stations but still maintain the same proportion of riffles to pool as is present in the whole representative reach. The candidate stations can be sectioned into various lengths in such cases, but still must remain 10 to 15 times as long as wide. The illustration shows a possible solution to the problem of selecting candidate stations in a riffle-pool representative reach. In some instances short sections (less than one km) of river within a representative reach will not fit into the homogeneity of the whole reach. Exclude any abnormally short sections from the sample rather than create two or more individual representative reaches or risk the possibility of selecting the abnormal section.



20.9.7 Station Selection

From each representative reach, a station is selected randomly from amongst all of the candidate stations. Assign each candidate station a number from one to 20 beginning with the candidate station furthest downstream. There are several methods one can use to randomly select a station. One valid method is described below.

a) Random Number Table. Select any column and row (a different column and row for each operation) from a random number table. Take the last two numbers from the number of the column-row co-ordinate. Designate 00 equal to 20.

Make all even numbers including zero in the tens column equal to zero and all odd numbers equal to one. For example from the random number 99571, take 71; seven is an odd number and thus designated as one. The selected field station becomes number 11. Other examples include:

Random Number	Number	Selected Station
77478	78	18
98143	43	03
64983	83	03
64040	40	00 (20)
75927	27	07
35611	11	11

The selected field stations must be marked onto the copy of the template map and shaded in with a coloured pencil. All selections must also be accurately transferred onto the original template map.

Obtain Forest Resource Inventory maps (F.R.I., 4 in. = 1 mi.) corresponding to the areas of the randomly selected stations. The F.R.I. maps should be available from each M.N.R. District office whose district covers the candidate river channel. With a pantograph, prepare fully labelled copies of each of the field stations enlarged three times to a scale of 19.0 cm = 1 km (12 in. = 1 mi.) (refer to Chapter 2.4.1). Ensure that the station maps are labelled with the scale, north sign and the identifying km limits. Make five photocopies of each station map for field use.

20.10 Critical Reach

Although a critical reach is not selected in the same way that the representative reaches are chosen, it is presented here to complete the reach selection process for a river.
Some examples of critical reaches are:

a) spawning areas

b) nursery areas

c) shallow sections (areas experiencing extremely small flows in late summer, thus barring fish migration)

d) planned construction sites (roads, bridges, dams, etc.)

e) any locally important feature (pulp and paper mill.)

The selection of the critical reach must be done by someone familiar with the candidate river. The district biologist, conservation officers and their supervisor should confer to select the critical reach(es). The reach selection group is cautioned to limit the number of designated critical reaches to only those reaches which are pertinent to the district fisheries management program. Too many critical reaches selected on a "catch all" basis will make the inventory process unwieldy. The dimensions of the stations on a critical reach follow the guidelines set out for representative reach stations in Chapter 20.9.6. These stations are then surveyed in the same way.

SECTION TWO

FIELD ACTIVITIES

The field portion of the survey is undertaken only after the completion of all of the preparatory documentation, and preparation of the necessary equipment and supplies.

Following are the outlines of the extensive (A) and intensive (B) field duties to be performed. The data collected for list A should be marked directly onto a copy of the FRI Base Map, or enlargements if necessary (Chapter 2.1 to 2.4.1.) The data collected for list B will be entered into the spaces provided in form 2.

A) River description between stations (Extensive):

1) River cruise map.

2) Hydraulic control measurements.

B) Data collection at the stations (Intensive):

1) Morphological data; hydraulics and habitat type identification.

2) Water chemistry.

3) Fish collections.

4) Invertebrate collections.

5) Aquatic vegetation assessment.

6) General notes.

The importance of complete field notes regarding all aspects of both the river description and the station data collection must be emphasized. In most cases it is difficult and time consuming to return to a station to obtain missed or misidentified data.

CHAPTER 21

CHEMICAL AND PHYSICAL ATTRIBUTES OF WATER

21.1 River Stations

A minimum of one chemistry site per station is required. The placement of the chemistry site will be mid-channel or at the deepest part of the station.

The following is a list of criteria for placement of additional chemistry sites.

1) upstream and downstream from impoundments, dams, and lakes
2) above and below waterfalls
3) upstream and downstream from human settlement and industrial activity (eg. forest clear cutting)
4) upstream and downstream from major tributaries

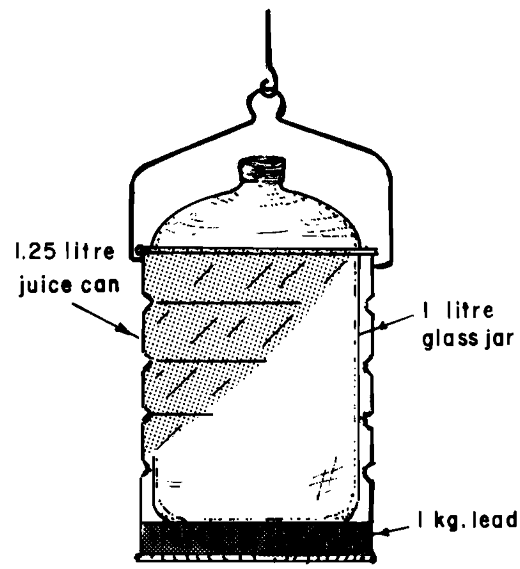
21.2 Collection Methods

In deep slow moving rivers, water conditions can resemble a quasi-lentic state with temperature stratification. In these situations obtain water samples as outlined for lakes in Chapter 4.14–4.16 and record the water chemistry analyses on a lake survey summary (form 1422).

The usual water condition that will be encountered is a shallow, fully mixed state (lotic). In these situations, obtain water samples as outlined in Chapter 12.2.4 for shallow wadeable stations and as outlined in Chapter 12.2.3 for deeper non-wadeable stations.

21.2.1 The Drop Bottle

The drop bottle is a one litre glass bottle seated in a lead weighted can. Before lowering this apparatus, ensure that the bottom is firmly seated in the weighted can. To rinse the bottle, lower the apparatus into the deepest part of the river until it reaches mid-depth. Once the bottle is filled retrieve the sample. Pour out the contents and repeat the procedure to obtain your working sample. Do not sample in the lee of the outboard motor because gas and oil may contaminate the sample. This water sampling method is used strictly to obtain samples for nutrient analyses when *fully mixed* water conditions are encountered.



21.2.2. The Tube Sample

This sampling method is used strictly to obtain water samples for nutrient analyses when temperature stratified water conditions are encountered. The procedure is outlined in:

Goodchild, G.A., G.E. Gale, D.M. Stann. 1981. Instruction Manual for Sampling and Field Titration. Determination of Total Inflection Point Alkalinity, Ontario Ministry of Natural Resources.

21.3 Time of Day

In lentic waters chemistry measurements are performed during the solar mid-day hours, i.e. between 1130 hours and 1400 hours.

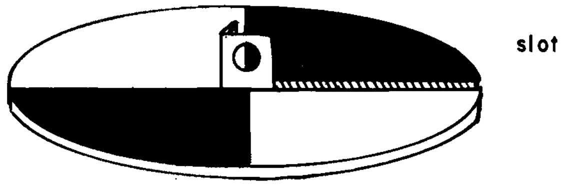
In lotic waters chemistry measurements are performed between 1300 and 1600 hours.

21.4 Water Transparency

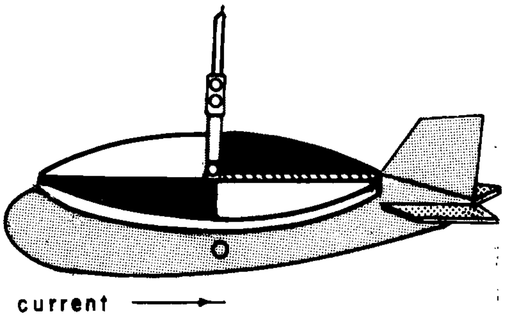
Refer to Chapter 4.4

Transparency measurements using the secchi disc in flowing water are difficult with the conventional handline method since the disc (diagram a) will flutter in even mild current. Instead, affix the disc to the "bomb weight" of the depth measuring equipment (diagram b) and zero the counter with the disc awash (refer to Appendix 14). Determine the transparency depth as it is outlined in Chapter 4.5 and read the measurement directly from the counter. Enter the result in the spaces provided in Form C. Remove the disc for the water velocity measurement since the disc will alter the flow characteristics about the current meter.

a)



b)



21.5 Secchi Disc

Refer to Chapter 4.5

21.6 Water Surface Conditions

Refer to Chapter 4.6

21.7 Colour

Refer to Chapter 4.7

21.8 Cloud

Refer to Chapter 4.8

21.9 Time

Refer to Chapter 4.9

21.10 Thermal Properties of Rivers

River water temperatures are not usually affected to the same degree as small streams by solar radiation and ambient air temperatures since larger volumes of water moderate the heating process. Many of the major rivers are monitored year-round for temperature at one or more locations along their length. However, many systems do not have monitoring stations and temperature series taken from unmonitored systems may be used to compare yearly temperature regimes between similar systems.

21.10.1 Maximum-Minimum Thermometer

To record diurnal water temperature, establish a calibrated maximum-minimum thermometer at one chemistry site within each station. Check the thermometer daily in the morning and record the maximum and minimum temperatures in the appropriate space provided in Form 2. Be sure to reset the thermometer after each reading. Refer to Chapter 4.13 for the calibration procedure for maximum-minimum thermometers.

21.10.2 Thermograph

The Ryan Thermograph is a fully submersible self contained temperature recording device that is available in a 90 or 180 day model. Both thermographs will continuously record water temperatures onto a calibrated scroll however, the 90 day model is recommended since it is capable of greater daily detail.

The thermograph should be established on rivers that do not have the time series temperature data normally published by Environment Canada. Locate the thermograph at an easily accessible point such as a bridge or boat launch since the field crew must return at the end of the field season to retrieve the unit. While the thermograph should be placed at an accessible spot, it must also be protected from exposure due to lowered water levels, and be safeguarded against damage, theft and tampering. Conditions and situations will vary for each river and it will be the crew's responsibility to place the thermograph safely. Fully document the instrument location so it can be easily recovered at the end of the 90 day period.

To operate the Ryan thermograph, feed the supply roll over the scribing plane and onto the take-up roll. Take up the slack paper with the manual advance. Test the strength of the battery with the battery test gauge and replace the battery with a new alkaline "C" cell battery before placing in situ. Calibrate the instrument against a mercury thermometer prior to field placement.

Immediately before setting the thermograph, rotate the take-up roll until the scribing stylus is positioned at the same point on the paper as the indicated time of day. For example, if it is 2:00 p.m. set the graph at 1400 hours, write the starting time and date directly onto the tape and move the toggle switch to the "on" position. Grease the "O" ring with a silicone gel, clamp the unit shut with the retainer clip and place the thermograph into the selected sampling location. Finally, recover the unit prior to the expiry date (90 or 180 days according to the model) or at the termination of the desired sample period. Refer to the Ryan manual for further instructions regarding the thermograph. It is advisable to check it once a month.

21.10.3 Air Temperature

Refer to Chapter 4.12. Record the temperature on Form 2.

21.10.4 Water Temperature

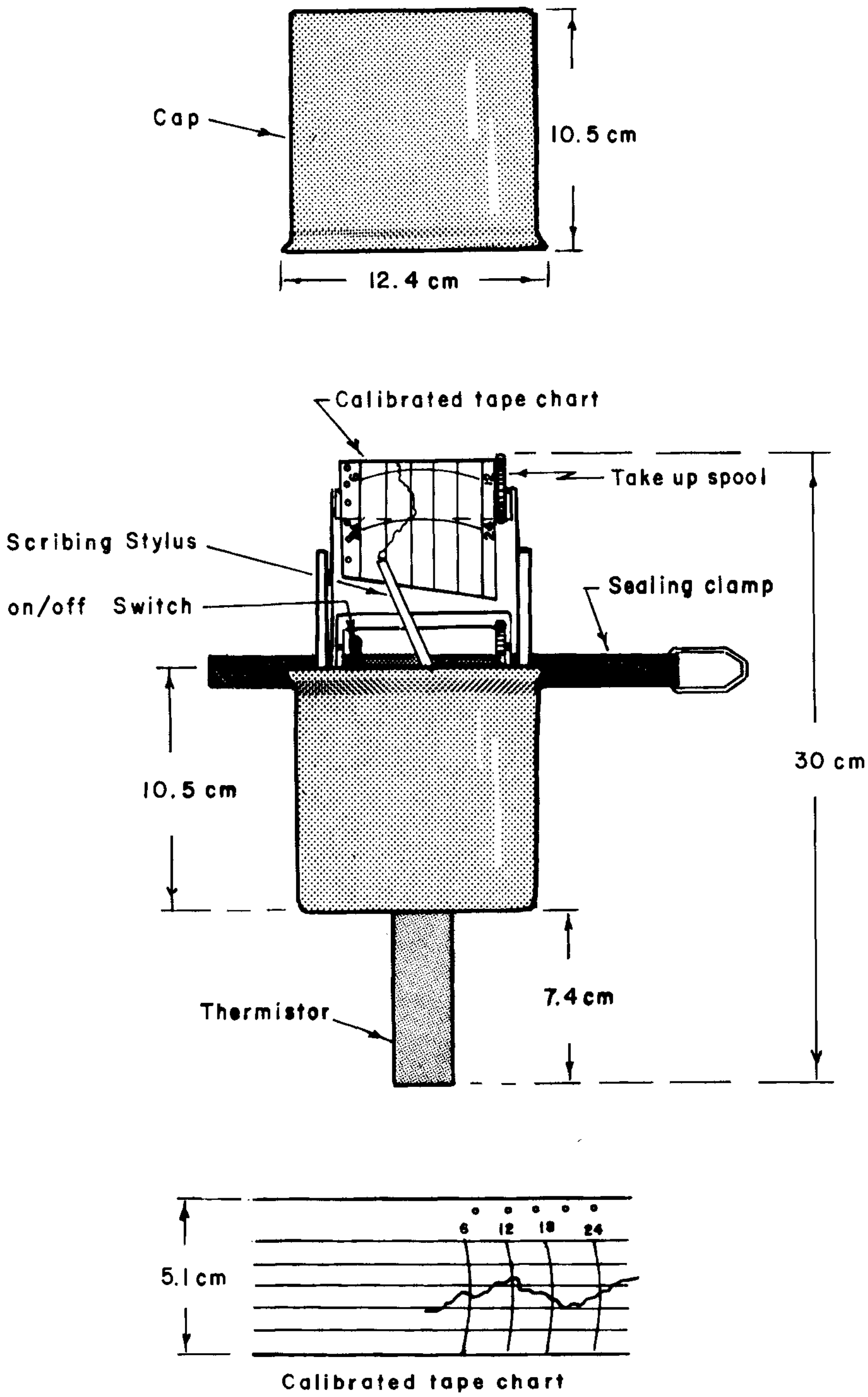
Using a maximum-minimum thermometer, measure the temperature of the water at the same location as the water sample for chemistry analysis is taken.

21.11 The Dissolved Oxygen (D.O.) Test

Refer to Chapter 4.17

21.12 The pH Test

Refer to Chapter 4.18



RYAN THERMOGRAPH

21.13 The Total Fixed Endpoint Alkalinity Test (T.F.E.)

Refer to Chapter 4.19

21.14 Water Turbidity

Refer to Chapter 12.6

21.14.1 The Turbidity Test

Refer to Chapter 12.6.1

It is not necessary to perform the turbidity test in the field if water samples are being sent to MOE for nutrient and turbidity analysis.

21.15 Total Dissolved Solids and Conductivity

Refer to Chapter 12.7 and 4.20.

21.16 Collecting Water Samples for Nutrient Analysis

For thoroughly mixed waters use the method outlined in Chapter 21.2.1.

For thermally stratified waters use the method outlined in Chapter 21.2.2.

In either case, a total of 1000 ml of water is collected and stored in two 500 ml glass or polystyrene plastic bottles. These are shipped to the Ontario Ministry of the Environment, 125 Resources Road, Rexdale, Ontario. Arrangements with MOE should be made *before* the field season commences.

The sample bottles from Pack 13 (available from MOE Central Stores, Resources Road, Rexdale, Ontario) must be thoroughly rinsed four times with the sample water. Do not contaminate the bottle by holding it beneath the water surface to fill the bottle. Syphon or pour the sample into the sample bottle and over fill. Cap the sample and ensure that air is not trapped inside. The sample should be taken on the last day just before leaving the station. Samples must be refrigerated at 4 °C immediately after collection and shipped on ice to the laboratory as soon as possible. The MOE Submission form must be filled out completely and accurately and sent together with the sample. Contact the MOE regional office in your area to obtain numbered Submission forms and Request for Analysis forms. See the example on the adjacent page. A copy must be kept with the river notes.

The analyses that should be requested are listed below with their test codes. Use the codes alone when completing the MOE Submission form.

Test	MOE Code
Alkalinity (TIP)	ALKTI
Colour (True)	COLTR
Conductivity at 25 °C	COND25
Nitrogen — Total Kjeldahl	NNTKUR
Nitrogen — Nitrate + Nitrite	NNOTFR
Nitrogen — Nitrite	NN02FR
pH	PH
Phosphorus — Filtered Reactive	PP04FR
Phosphorus — Total	PPUT
Turbidity	TURB

Ministry of the Environment
Ontario

Submission

Lab. use Only — Submission No.:

From Field Sample No.: 1

To Field Sample No.: 2

Page 1 of 1

Sample Program Code (Prog. / Study / Pro. Act. / Sub Prog. Act.)	Lab	Pri	FD Type	Sampling Agency (Min. / Dn. / Br. Reg. / Sec. / Unit)	Vote	Item	Date Submitted (DD MM YY)
01 / 003 / 5 / 0	TR	N		01 / 01 / 05 / 01 / 03			30/07/83

Mun. Code	Municipal Name	Name of Sampler	Phone
	COCHRANE M.N.R.	I. MAC RITCHIE	705-272-4365

Client Code 1	Report to (Name)	Phone	Establishment
NE 482	MACRITCHIE, I.	705-272-4365	MIN. OF NAT. RES.

Address	City	Province (Country)	Postal Code
2 THIRD AVENUE, P.O. BOX 730	COCHRANE	ONT.	P0L-1C0

------ Copies To ------

Client Code 2	Name	Phone
NE 002	R. BESNER	

Establishment:

Address:

City: Province (Country): Postal Code:

Client Code 3	Name	Phone

Establishment:

Address:

City: Province (Country): Postal Code:

Client Code 4	Name	Phone

Establishment:

Address:

City: Province (Country): Postal Code:

Client Code 5	Name	Phone

Establishment:

Address:

City: Province (Country): Postal Code:

171

Ministry of the Environment
Ontario

Request For Analysis LIS

Shaded Area For Lab Use Only

Submission No.

Page 1 of 1

1

Field Sample No.	Sample Type	Lab Sample Numbers
1		

Con. Sent	Con. Miss.	Sample Date	Time	Zone	Remarks
1		28·07·83	14·00	5	

Sample Location/Station	Sample Description
KM 24	MATTAGAMI R

Test Group	Deletions From Group	Individual Tests
NEIAN		NNO2FR

2

Field Sample No.	Sample Type	Lab Sample Numbers
2		

Con. Sent	Con. Miss.	Sample Date	Time	Zone	Remarks
1		30·07·83	14·30	5	

Sample Location/Station	Sample Description
KM 48	MATTAGAMI R

Test Group	Deletions From Group	Individual Tests
DITTO		DITTO

3

Field Sample No.	Sample Type	Lab Sample Numbers

Con. Sent	Con. Miss.	Sample Date	Time	Zone	Remarks
				5	

Sample Location/Station	Sample Description

Test Group	Deletions From Group	Individual Tests

4

Field Sample No.	Sample Type	Lab Sample Numbers

Con. Sent	Con. Miss.	Sample Date	Time	Zone	Remarks
				5	

Sample Location/Station	Sample Description

Test Group	Deletions From Group	Individual Tests

5

Field Sample No.	Sample Type	Lab Sample Numbers

Con. Sent	Con. Miss.	Sample Date	Time	Zone	Remarks
				5	

Sample Location/Station	Sample Description

Test Group	Deletions From Group	Individual Tests

6

Field Sample No.	Sample Type	Lab Sample Numbers

Con. Sent	Con. Miss.	Sample Date	Time	Zone	Remarks
				5	

Sample Location/Station	Sample Description

Test Group	Deletions From Group	Individual Tests

1448A 4/82

CHAPTER 22

INVERTEBRATES

The objective of sampling invertebrates is to collect a qualitative sample that is representative of the organisms inhabiting the river reach. It is often difficult to sample all habitats when depth, velocity and substrate conditions make invertebrate collection with conventional methods extremely difficult. It is impractical to carry all the gear types necessary to deal with each sampling possibility. Instead, invertebrates should be sampled at convenient sites with the gear supplied. (Refer to Chapter 13).

22.1 Sampling the Invertebrate Population

Sampling should follow the guidelines in Chapter 13.2 to 13.4.

The samples should be taken where river conditions permit without unnecessary risks to the field crew.

22.2 Invertebrate Sampling Gear

Three types of bottom sampling gear are recommended for river survey work. These include the dip net for shallow water, the bottom dredge for deep water and the drift net for habitats which cannot be sampled adequately with either the dredge or surber samplers. Refer to Chapter 13.5.

22.2.1 The Dip Net

Refer to Chapter 13.5.1. It is useful in wadeable waters such as riffles, bars and small rapids.

22.2.2 The Bottom Dredge (Scrape Type)

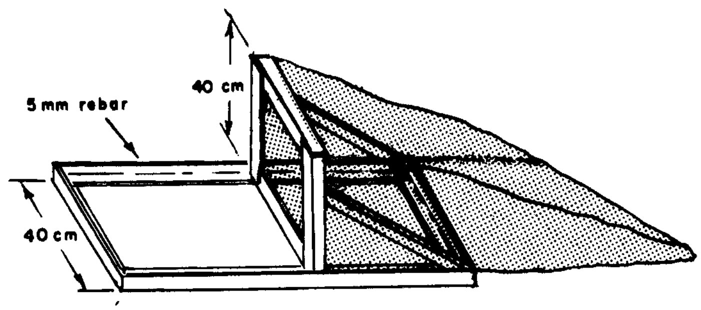
Refer to Chapter 13.2.2 and 13.3.2 for the guidelines to the bottom dredge and its use. The substrate size may be too large to drag the dredge effectively over the river bed in some instances. It is possible to increase the effectiveness by placing the dredge on the bottom and systematically disturbing the substrate in front of the dredge with a paddle or stick. The current will carry the dislodged invertebrates into the dredge. The crew should fully document the method used since the effectiveness of any method will vary under different conditions.

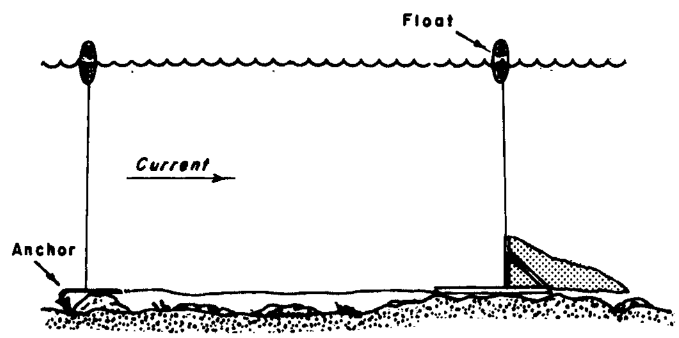
22.2.3 The Drift Net

Refer to Chapter 13.5.4.

A drift net can be of almost any dimension, however, the size of the drift net should be kept to a minimum standard size. The mouth of the drift net should be 40 cm x 40 cm and the net (20 meshes per cm) should be conical and 1 m long with a detachable cod-end. The net should be collapsible for convenience during transport.

The drift net should be used in habitat types which cannot be adequately sampled with the bottom dredge, D-frame dip net or surber sampler such as deep water or areas of very large substrate. Anchor the frame of the net to the bottom and attach a float for easy retrieval. Check and empty the net every four hours since entrapped invertebrates may crawl out. Note, the anchor line must be longer than the water is deep otherwise the net frame may be bent during recovery.





22.3 Sorting The Invertebrate Sample

Refer to Chapter 13.6

22.4 Preserving the Invertebrate Collection

Refer to Chapter 13.7

22.5 Documenting the Invertebrate Collection

Refer to Chapter 13.8

22.6 Shipping

Arrangements for shipment of the sample bottles must be made in advance with the Fisheries Branch Laboratory Supervisor. When authorization is received, follow the guidelines for shipping in Chapter 13.9.

CHAPTER 23

SAMPLING THE FISHES

23.1 Sampling Objective and Policy

Refer to Chapter 5.1. When sampling fish in rivers, at least 18 hours over a span of two days should be expended in a variety of habitats and at different times of the day to increase the probability of capture of each fish species present.

23.2 Some General Behaviour Patterns

Refer to Chapter 5.2 for background information on general behaviour patterns of fishes. Fishes may be rheophilic, limnophilic or possess traits of both, therefore the surveyor must be prepared to sample fast water as well as slow or standing water. In many cases back eddies and bays will yield most species but this does not negate the need to sample the flowing water habitat up to the limitations of the sampling gear.

Riverine fishes will congregate near underwater structures and food sources such as large rocks, overhanging banks, deep holes, the base of rapids and falls and the mouths of tributaries. The occurrence of fishes is not limited to these high probability areas and attempts should be made to capture fishes throughout the station. Night fishing with nets and angling may yield diverse catches as well.

Differences in water temperature, either higher or lower than the main channel temperature, may attract certain species of fishes at various times of the year. For example, cold water species such as trout will often seek out cooler spots in the summer months, such as deep holes, overhanging banks, springs and the mouths of cool water tributaries.

To summarize, fishes will occur more frequently in certain selected locations than in others, but effort must be representative of all sections of a reach.

23.3 The Fish Sampling Gear

Refer to Chapter 5.3. The most useful and versatile gear include the gill, dip and seine nets, baited minnow traps and the hook and line. Excessive gear adds to weight and restricts portability, an inconvenience on many river surveys.

River surveyors must be aware of the power of flowing water whenever they are positioning any type of netting gear in a river. The effects of water current will be more pronounced with small mesh size because of the greater surface area of the net. Debris or large catches of fish add substantially to the current drag on the net.

When handling nets, remove watches, rings and wear buttonless outer garments. A snagged net in standing water is annoying; in flowing water it can be dangerous! It is good practice to have a sharp knife available to cut the net in case of emergency. Nets must be free of debris prior to setting since there will be little time for removal while setting the nets.

The safest PFD's for this work are those without buckles or fasteners that could become entangled in the nets.

23.3.1 Gill Net

Refer to Chapter 5.3.1 for mesh sizes and the gang composition. The nets should be set to sample all water and habitat types. In each case the surveyor must take current velocity into consideration and in some instances it may be used to your advantage. One end must be attached firmly to shore or some permanent instream structure. The intended site should be clear of obstructions in the vicinity since the completed line of set is often different from the intended line of set. Three ways to set a net are described below.

Cross Current Set (slow or still water):

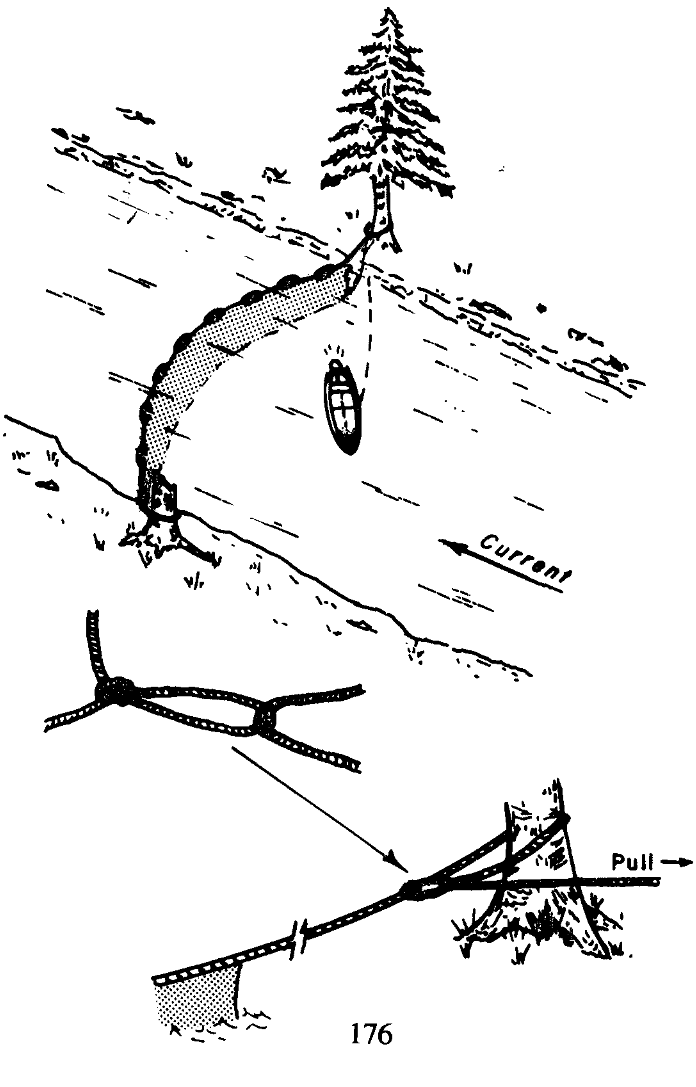
The person setting the net from the bow of the boat as the boat is propelled forward and at a slight upstream angle (depending on the current velocity) will:

1) attach the net to a permanent shoreline or instream structure;

2) set the net over the forward quarter of the boat. This must be done quickly since even slow current will begin to pull the net immediately. If any entanglements should result, immediately stop the attempt and try again;

3) attach the distal end to the far shore or secure it with a clawed anchor upstream from the set. The net set with a shore tie-off should be tightened with a rope cinch which consists of a loop attached to a tree or some other permanent object.

4) if the net bows too much and the float line vibrates violently, the net must be reset at an oblique angle to the current.



Running the Net

Since the net must be tended regularly in flowing water, it is advantageous to run the net rather than lift it and reset it each time. To run the net, the crew should:

1) approach the net from downstream;

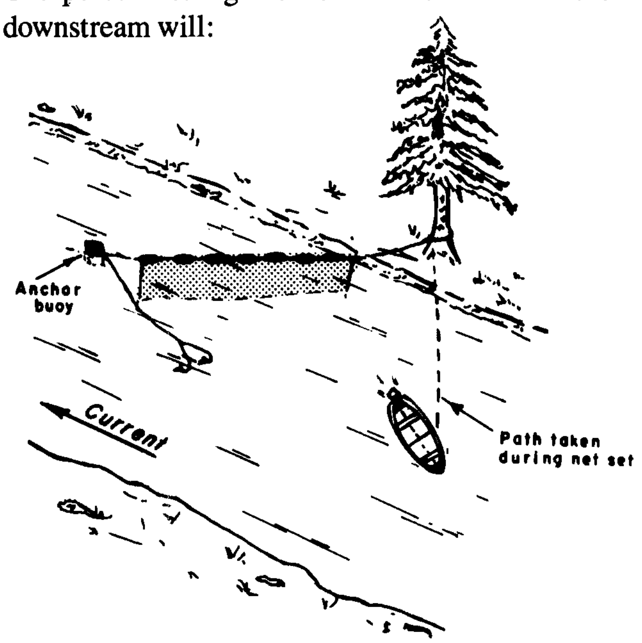
2) slide the bow of the boat under the net and drape it over both gunwales. Always drape the net forward of the geographic centre of the boat so that it will ride nose into the current.

3) proceed across the river by passing the net hand to hand (rope fashion). Remove debris as it is encountered and remove and sample all fishes that are caught. Minor repairs to the net may be made at this point while major repairs should be performed on shore after the net has been pulled;

4) slide the boat out from under the net after the sampling has been completed.

Oblique Set (moderate current velocity):

The person setting the net from the bow of the boat as the boat is propelled cross-current and slightly downstream will:



1) attach the net to a permanent shoreline object;

2) set the net from forward of mid ship and on the upstream side. The speed of the set will depend on the strength of the current. There will be little time to deal with snags and tangles since the current velocity quickly affects the set and renders it unmanageable. When this occurs, stop the attempt and retrieve the net for another try;

3) set the anchor at a 30° angle into the current. The net may be tightened by walking the anchor across the river. If this is done in fast water the person tightening the net may need to tighten the net from the stern of the boat since the motor may not be able to develop enough power in reverse to move the net. If the anchor will not hold, then the net must be set parallel to the current.

Running the Net

1) approach the distal end of the net from downstream;

2) loosen the anchor line slightly by lifting the anchor buoy;

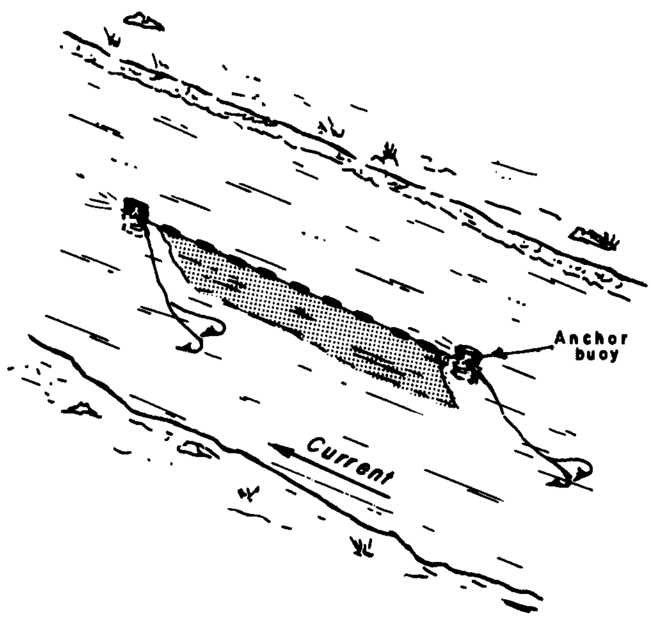
3) approach the bridle from downstream and grasp both the float and the lead line. The bowman then passes the compressed net back along the upstream side of the boat to the sternman. This process will reduce snags on either the bow or the stern of the boat;

4) remove debris as it is encountered and sample the captured fish. Make minor repairs to the net wherever it is necessary;

5) reset the net from the distal end as described in the "Setting" section.

Parallel Current Set (fast and deep current flows):

The person setting the net will:



1) attach the net to a permanent instream object or firmly set the anchor. To set the anchor, lower the buoy and anchor into the water ensuring that the tines of the claws are down. Play out 8 to 10 m of 3/8 in. (1.0 cm) braided polypropylene line (avoid twisted ropes to prevent twisting of the nets) and let the boat drift downstream until the anchor catches. Set the anchor firmly and ensure that it will not release by pulling on the line;

2) set the net over the upstream side of the forward quarter. The boat may be kept under minimal power in order to present the best side for setting the net. The current will keep the net straight;

3) anchor the distal end of the net downstream ensuring that the anchor buoy is visible on the surface. If the buoy line is too short or too long, the current will drag the line and the buoy under making net recovery difficult.

NB: A net set in fast water should not be left unattended for more than one hour. Accumulated debris or entangled fish will increase the current pressure on the net and result in possible loss or damage.

Never attempt to save time and effort by readjusting a net after it has been set. This practice is false economy and usually develops into a headlong run downstream resulting in a lost or destroyed net or worse.

Running the Net

The parallel net is run in the same fashion as the oblique set. However, the net may need to be pulled each time for deep river sets.

Lifting the Net

Retrieving the net is done in a similar fashion for all three sets.

1) approach the distal end of the net from downstream and pick up the float and anchor;

2) detach the anchor from the net and pull the net into the boat rope fashion and coil the net into a tub or packsack;

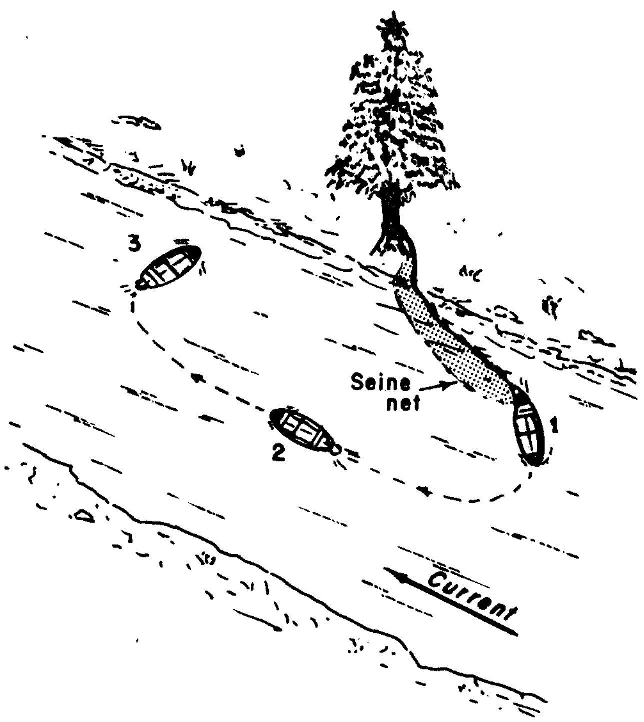
3) keep the boat under power and deflected into the current to present the forward quarter of the boat approximately 60° to the net to make the net easier to handle. Do not position the boat upstream of the net.

NB: The survey crew may find it easier to run the net and remove all fishes before lifting it.

23.3.2 The Seine Net

Refer to Chapters 5.3.2 and 5.4.2 for background information regarding seining. Most seining operations will be carried out in slow or slack water, however, small fish collections with the seine net *should* be attempted in deep slow flowing water.

As with the gill net, the river surveyor must be aware of the power of flowing water. Seine nets consist of small meshes and these will be vulnerable to the pressure of water current. The seine net methods outlined in Chapter 5.4.2 are useful for rivers where the current is slow, however, an additional method of fishing with a seine is recommended for deep slow flowing water. This method is useful for capturing fish only on relatively unobstructed seining sites. It requires quick reflexes and close attention to complete the set successfully. The steps are as follows:



1) tie one end of the seine to a stationary object on shore;

2) attach a rigid bridle (pole) onto the floating and lead lines of the distal end of the seine. Leave extra bridle for gripping purposes;

3) extend the full length of the seine upstream and along the shore;

4) pull net net out quickly into the current to form the top of a loop. The net will begin to collapse almost immediately, so power must be applied in a downstream direction and then into shore to close the loop that the seine has formed.

5) the crew member in the bow will then bring in the closed loop ensuring that the lead line is brought in slightly ahead of the float line;

6) Collect and document the sample.

NB: Excessive current velocity limits the usefulness of this technique. Release the net if it snags and retrieve it from the most advantageous position.

23.3.3 Supplementary Gear

Refer to Chapter 5.4.5.

CHAPTER 24

DOCUMENTATION AND PRESERVATION OF FISH SAMPLES

24.1 Gill Net Catches

Refer to Chapter 6.1.

24.2 Scale Samples

Refer to Chapter 6.2.

24.3 Documenting Samples to be Preserved

Refer to Chapter 6.3 and Chapter 13.8.1

24.4 Field Collection Record Form (F.C.R.)

Refer to Chapter 6.4 and Chapter 13.8.1. For locality of station, note the distance (km) from the river mouth.

24.5 Field Collection Label

Refer to Chapter 6.5 and Chapter 13.8.2. Where the label requires a station number this refers to the site of sampling within the river station and not the river station number itself.

24.6 Preserving Fish Collections

Refer to Chapter 6.6.

24.7 Shipping Fish Collections

Refer to Chapter 6.7.

CHAPTER 25

PHYSICAL ATTRIBUTES OF A RIVER

25.1 River Description

The River Cruise

The survey crew will make general notes regarding the physical conditions of the river while moving camp and survey equipment between stations by boat. For this purpose, use photocopies of the sections of the FRI Base Maps (or enlargements) that show the river. The cruise begins at the upstream limit of the river and proceeds downstream from the source or initial point of the river survey and it will be necessary for two crew members to backtrack upstream to complete the cruise while the third crew member ferries the survey equipment to the station. This will also be the case where portages have placed the crew well downstream from a set of rapids or falls. In areas where it is very difficult to gain access to the river, you will have to resort to the videotape or air photos for the information required.

The river cruise and station cruise are similar to the lake survey shoreline cruise (refer to Chapter 7). The conventional signs and reference symbols presented in Appendix 1 should be used to mark the physical features directly onto these maps. The chapters to follow outline particular items that should be observed and noted on the river cruise maps and the station maps.

The Station Cruise

The station cruise is a more detailed and intensified study of the biota and river morphology compared to the river cruise.

25.2 Access Points, Portages and Campsites

Previously unmapped access points, portages and campsites are entered onto the river cruise map and the nature of the site is reported fully in the field notes. These may include forest trails and/or graded roads.

25.3 Man-made Structures (Dams, Bridges, Locks etc.)

Man-made Structures may be operating or abandoned. Their presence may or may not alter the flow pattern through erosion, armouring, sedimentation and deposition. The surveyor should note the occurrences and the probable cause of these phenomena in the field notes.

25.4 Potential Sources of Pollution

Although we cannot say without intensive investigation whether or not a waterbody is polluted, suspicious areas can be labelled as potential sources of pollution. These concerns can then be addressed to the appropriate authority, usually the Ontario Ministry of the Environment. Potential point sources of pollution include outflows from townsites, logging operations, and other areas of population or industrial concentration. Discolouration of water, odour, prolific algal growth and foaming are some of the signs of pollution. The nature and source of the effluent should be reported in the field notes with the location marked on the river cruise map.

Agriculture, cottages, logging areas, townsites and industrial areas can all be diffuse sources of pollution. For example, algal abundance may increase downstream as an accumulative nutrient input from inadequate septic systems on a river lined with cottages. The effects of some of these pollutants may be as follows:

1) Nutrient runoff — prolific algal and aquatic macrophyte growth; dead or dying fish present.

2) Industrial effluent — discoloured water, dead or dying fish and floating and/or submerged debris; may be accompanied by an odour and foaming.

3) Logging/pulp — wood chips and bark accumulation on the shore accompanied by sulphur and methane odour. Methane gas produced on the bottom from decaying debris will bubble to the surface releasing methane gas with its distinctive odour.

4) Thermal input — may be accompanied by prolific algal and aquatic macrophyte growth, and an abundance of fish in the area. The water near the effluent will be several degrees warmer than the ambient water temperature.

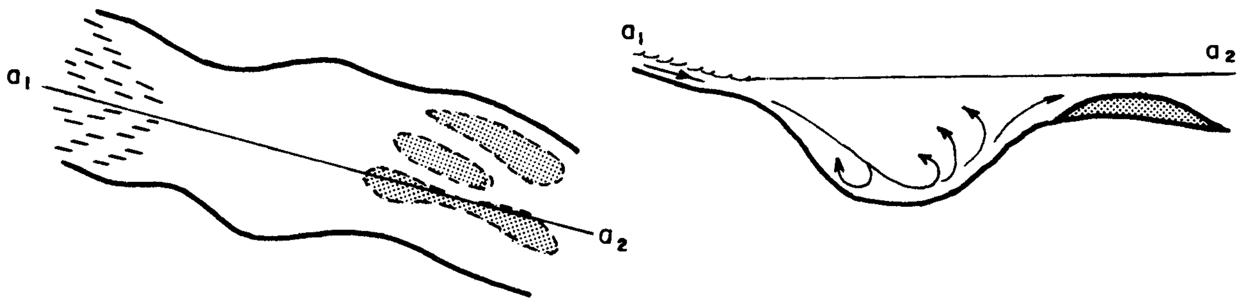
25.5 Instream Habitat

Rivers contain a variety of physical features or habitats such as those listed below. These must be identified and marked onto the river cruise maps as they are encountered.

After a full preliminary inspection of the station, all habitats are described according to the criteria outlined below. The position and extent of the physical features will be graphically represented on a station map as illustrated on the next page. These habitats include:

Riffle: Riffles are shallow, swift flowing sections of rivers where the water surface is broken and in many cases gravel, rubble, or boulders break the surface. Water depths range from less than 1 cm to 20 cm deep. Because of the swift water, healthy, non-degraded riffles have no silt deposition on them.

Pool: A pool is a deep, slow moving body of water. Because of the appreciable decrease in current speed through the pool, the bottom is often composed of silt, debris and sand. Look for pools at the base of rapids, chutes, falls and on the outside portion of a river bend. Illustration a_1 — a_2 shows a rapid-pool-rock bar sequence from a surface area view followed by a cross section view.



Run: Runs are deep, swift flowing sections of rivers. The bottom is usually composed of rubble and boulders. The depth and materials found in runs make them excellent cover locations for salmonids.

Flats: Flats are shallow, slow moving sections of rivers. The bottom is usually relatively featureless and composed of rock, silt or fine sand.

Rapids: a more robust form of a riffle in which the river cascades quickly over rock and boulders causing the water to be turbulent (white water). Rapids are longer and deeper than riffles and are generally not easily waded.

Chutes: a short narrow section of river through which the flowing water drops quickly from one elevation to a lower one. They are usually characterized by swift deep water which forms a smooth "V" at the top of the chute and then creates turbulent receiving water. Deep water is normally found at the base of a chute.

Falls: an abrupt vertical or near vertical drop of river water over a precipice. The tailwater is usually turbulent and deep.

Channels: the cross-sectional area of the river through which the greatest volume of water flows. It is normally the deepest section.

Bars: areas where the deposition of water borne substrate such as sand, gravel and rock has created a shallow section in the river. They may be submergent or emergent depending on the stage of the river water elevations. They are often found downstream from a pool, in slack water or on the inside of river bends. Many bars across and along the length of a river may create a braiding effect.

Major Inflows (tributaries and springs): these are relatively large additions of water to the river. Tributaries are easily recognized while springs may often go unnoticed. A slight difference in the colouration of the water or deviations from ambient river temperatures may indicate the presence of a spring.

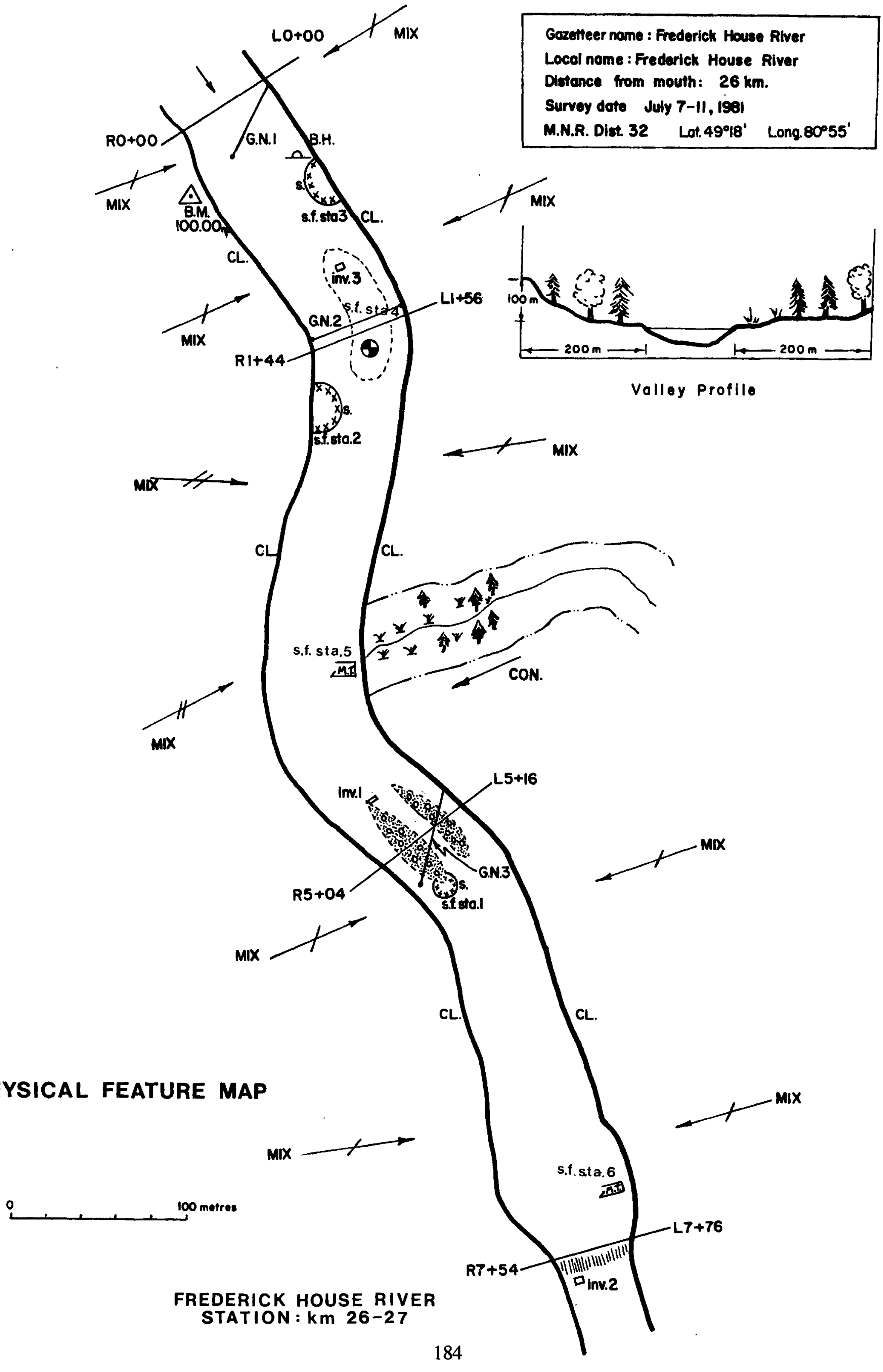
Backwaters: areas of water next to the river which may be connected but do not fall within the main mass of flowing water. These are often characterized by abundant aquatic plant growth both within and surrounding the water. These may include small bays, lakes and ox-bow lakes.

Pollution Sources: any one of the many possible sources may be described here. Some of the more common types of pollution are chemical, organic and thermal arising from, for example, farming, thermal and nuclear electric production respectively.

Extent and Type of Aquatic Vegetation: this includes the area of river where aquatic macrophytes are present. The macrophytes may be described as floating, submergent, emergent or any combination thereof.

Describe each of these possible habitat types in detail according to the physical characteristics outlined in Chapter 16.2. The substrate types used to describe habitat types are:

(16.4.1)	Bedrock or rock	(16.4.6)	Silt
(16.4.2)	Boulder	(16.4.7)	Clay
(16.4.3)	Rubble, Cobble	(16.4.8)	Muck
(16.4.4)	Gravel, Pebble	(16.4.9)	Marl
(16.4.5)	Sand	(16.4.10)	Detritus



PHYSICAL FEATURE MAP

FREDERICK HOUSE RIVER
STATION: km 26-27

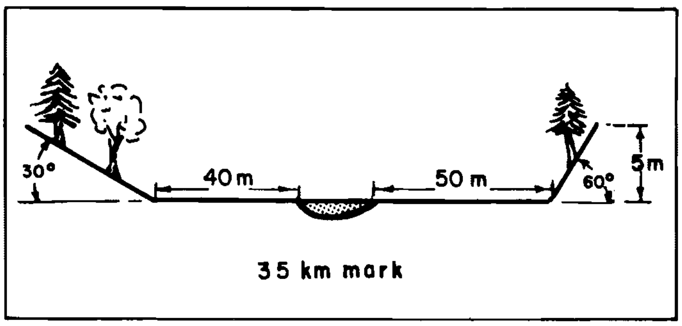
25.6 Foreshore and Bank Stability

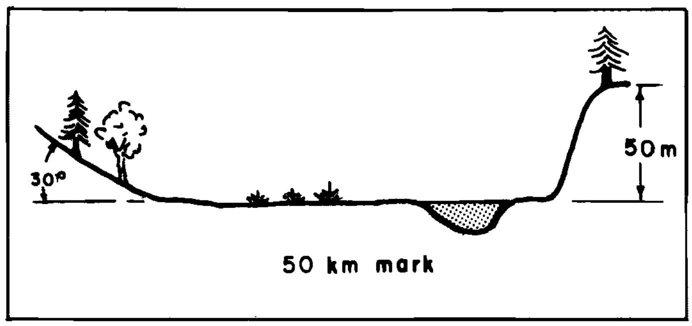
The foreshore (an area that can be covered by water at certain times of the year) is the area between the backshore (an area above the foreshore that is never covered by water) and the water's edge, and is commonly termed river bank.

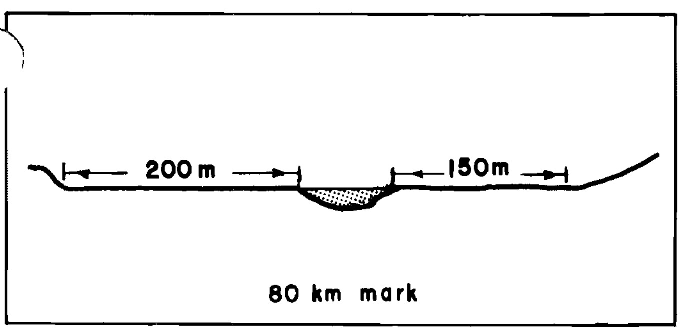
The stability of the river bank is dependent upon the covering vegetation and the hydraulic forces acting on it. Note the substrate composition, vegetation cover and relative stability of the bank directly onto the river cruise map. An unstable foreshore is normally characterized by little vegetation and signs of recent erosion. In these cases, banks may be undercut or caved in. Stable foreshores are more likely to be covered with shrubs, grass or some other stabilizing vegetation. Naturally, rock shores tend to be very stable.

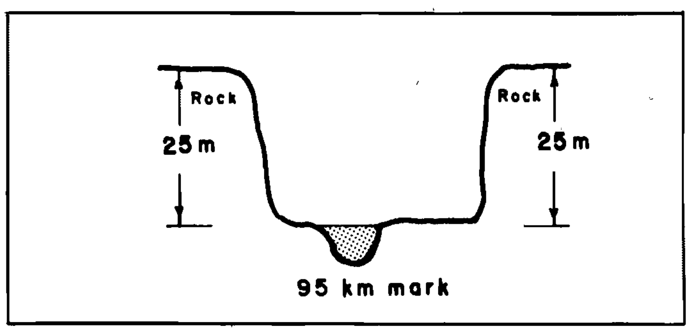
25.7 Backshore and Valley Profile

The backshore and valley profile should be sketched directly onto the station map and the river cruise maps. The profile on the station map should reflect the predominant profile type at the station while the profiles on the river cruise map should reflect both the predominant profile type as well as any unusual profiles having features such as high eroding banks, rocky chutes with steep cliffs and so on. Over the expanse of the entire river, the nature of the river valley will change. Each new valley profile type that is sketched onto the river cruise map should be labelled according to its distance from the mouth of the river. The profile sketches should contain the approximate slope and dimensions of the valley as well as the predominant vegetation types.









Make field notes about the vegetation and terrain type of the backshore directly onto the river cruise map. The vegetation and terrain type can be described simply as they are presented in Chapter 16.8. Briefly these are:

16.8.1	cultivated	16.8.5	upland conifer	16.8.9	open marsh
16.8.2	farm pasture	16.8.6	swamp hardwood	16.8.10	lawn
16.8.3	meadow	16.8.7	swamp conifer	16.8.11	impervious
16.8.4	upland hardwood	16.8.8	shrub marsh		

Indicate the slope of the backshore with the slope arrows that are presented in Appendix 1. The slope arrows marked directly on the maps should end approximately at the base of the valley slope.

25.8 Aquatic Vegetation

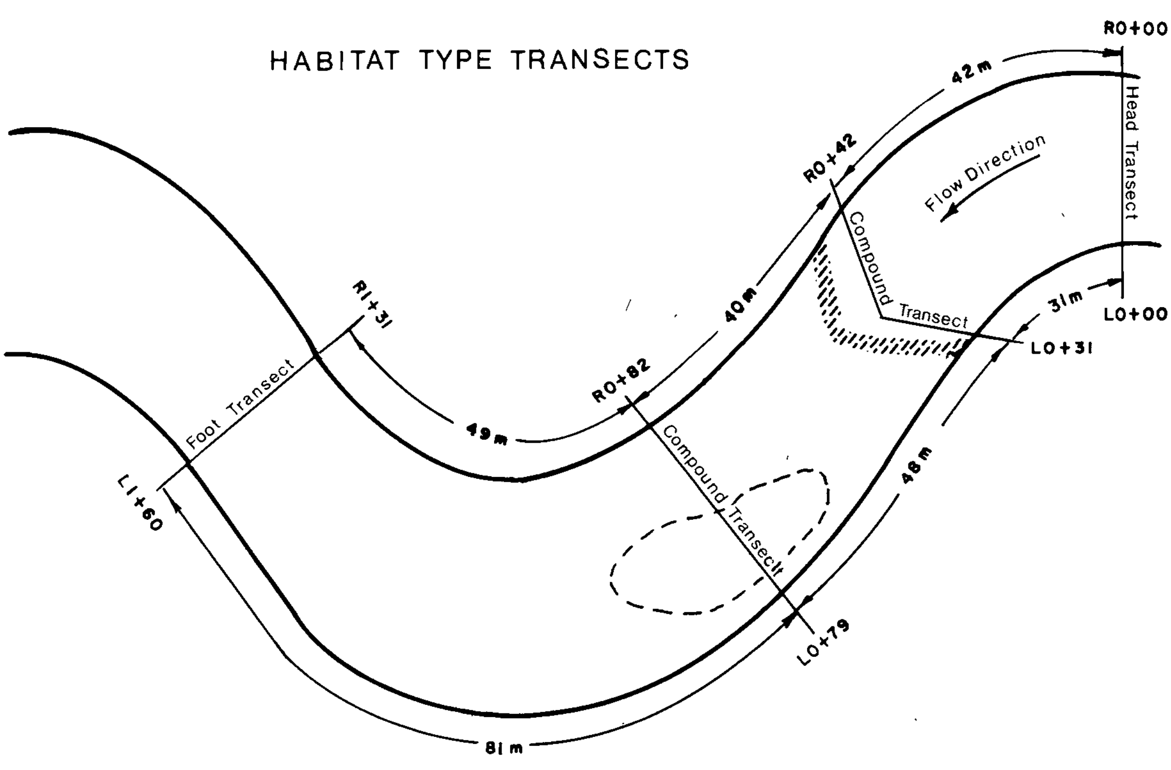
Refer to Chapter 7.11.2. Aquatic vegetation is an important component of habitat providing both food and refuge for numerous aquatic animals. Note that the stage of the river will influence the amount and extent of the aquatic vegetation present. For example, during early summer, the presence of aquatic vegetation will be less apparent than it would be in late summer when the plants have had time to grow to maturity. During the early part of the field season, speculation on the potential aquatic plant growth should be made by searching for roots and newly emerging plants. When this procedure is followed it must be noted in Section F of Form 2 as a speculative description of aquatic plants. Once the station has been closely inspected and described, then the percent of the station influenced by aquatic plants is estimated to the nearest five percent.

Delineate areas of aquatic vegetation directly on the river cruise map. The vegetation types will be simply described as submergent, emergent or floating. Note the relative abundance of the aquatic vegetation; for example, it may be present across the width of the river or restricted to sparse growth along the river's edge.

25.9 Hydraulic Control

A hydraulic control is simply a physical feature in the river which causes a noticeable change in the water level. A hydraulic control can be anything from a falls or a chute down to a small riffle over which the water level drops as little as 1.0 cm. Hydraulic controls may restrict fish movement. Measure the hydraulic head (the difference in water levels between a control and receiving water) if the shear drop exceeds 1 m. Note the measurement directly onto the river cruise map and into the field notes. Use the standard levelling techniques outlined in this chapter and Appendix 13 to determine the hydraulic head. Do not perform this operation on every riffle or rapid since this can be a time consuming operation. The hydraulic head measurements will be used after the field activities to add more detail to the gradient profile.

In some cases, topographic maps may have exact elevations listed where water levels drop significantly. These elevations can be used instead, therefore field measurements will not be necessary.



25.10 Station Transects

For the purpose of the river survey, transects are two-dimensional planes cutting through a river profile at 90° to the direction of flow. In most cases where the current flow is in one downstream direction, the line of a transect can be positioned straight across the river channel; however, where the current flow branches in two or more directions due to instream obstructions or an irregular hydraulic control, a compound transect will be needed. The middle transect is an example of a compound transect (at R0 + 42 and L0 + 31) which crosses each of the two current flows at a 90° angle.

25.10.1 Habitat Type Transects

Each habitat type identified within the station will be crossed with a transect. Place the transect at the mid-point of the habitat type and at 90° to the current flow. For example, a station which contains a pool, riffle and gravel bars will require one transect across each of the three habitat types.

25.10.2 Head and Foot Transects

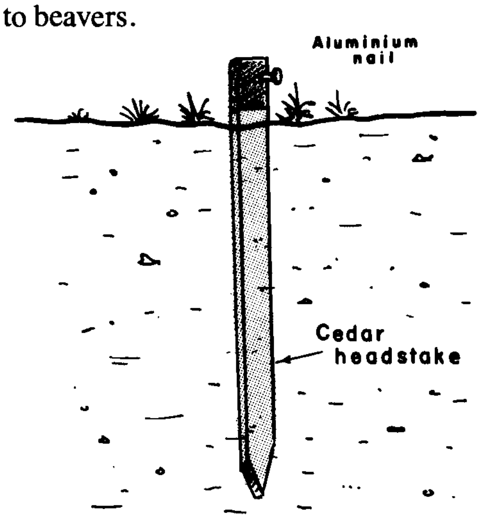
The "head" and "foot" transects are used for hydraulic simulation models which require that the "foot" transect be positioned as the transect furthest downstream, preferably at a hydraulic control. A hydraulic control is a structure or impediment until water overflows it. The head transect is positioned at the upstream limit of the station. It is logistically convenient if the head transect can double as the river discharge measuring site. In rare cases the discharge transect may be outside of the station. The criteria for the discharge measuring site are outlined in Chapter 25.12.1.

25.10.3 Marking the Transect

The location of each transect must be fully described so that it can be found easily at a later date. The most upstream transect will be labelled transect one (1), the next downstream, transect two (2) and so on to the last or foot transect.

Headstake: A headstake is generally a wooden stake that is driven into the ground permanently to mark a survey position. For river surveys, headstakes are used to mark the ends of each transect. Headstakes may be made from cedar or tamarack 5 cm in diameter, 0.5 to 1 m long and sharpened at one end. They are ideal due to their weather resistant properties, however, do not waste excessive time looking for the ideal headstake material. A small straight tree will do. Cut the tree down leaving approximately 1 m of stump standing. Make a point or an angled cross section at the extreme end to allow water to run off and thus slow the rotting process. Blaze a spot near the base of the stump and drive a nail horizontally into it leaving approximately 2 cm of nail exposed. If poplar is the only available tree, as is often the case in northern rivers, then it is necessary to peel the bark from the stump in order to make it less appetizing to beavers.

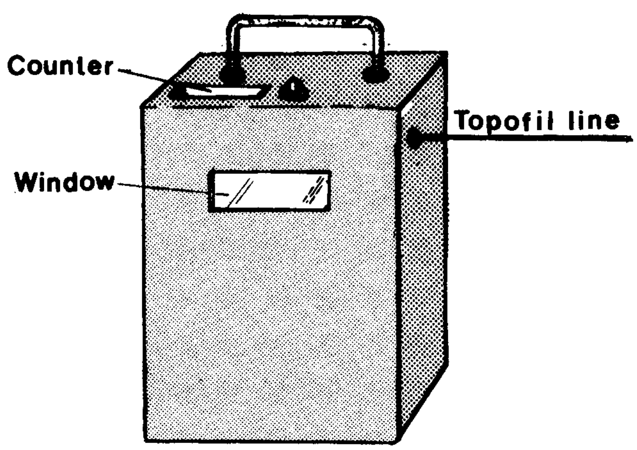
Clear an area approximately 5 m in from the levee of the river bank and drive the sharpened end of the headstake into the ground until 15 to 20 cm is left exposed. Saw off the portion of the headstake that was damaged as the headstake was driven into the ground. Approximately 10 cm of the headstake should remain above ground. Spray the headstake liberally with fluorescent paint, then drive a 5 cm aluminum nail 4 cm into the side of the headstake. The nail is used as a rest for the butt of the level rod, so it can be positioned precisely on the nail each time it is used for differential levelling.



This is necessary since if the top of a headstake is used and it is not cut level, one side will be higher than the other. In some locations where a headstake must be positioned in bedrock and a stake cannot be used, a 1.0 cm diameter star drill may be used to mark a spot in the rock. Mark the hole with a small fluorescent circle. Do not paint large areas with the spray paint since this will leave an unsightly mark. For each headstake, either established in bedrock or with stake, blaze a large relatively permanent tree nearby and highlight the blaze with fluorescent paint. Reference the position of the headstake to the tree and record the directions in the field notes. For example: "Headstake L1 + 75 positioned 2.0 m NNE from blazed cedar tree."

25.10.4 Positioning Transects

Positioning is a process through which the station headstakes are labelled with respect to their distance in metres from the upstream limit of the station. The left (L) and right (R) bank of a river are designated by left hand and right hand respectively when the surveyor is facing downstream. The headstakes at transect one, the upstream limit of the station, are always designated L0 + 00 and R0 + 00 respectively. The next pairs of headstakes at transects 2, 3 and so on to the foot transect, are further defined by their distance in metres from the first headstake along the same river bank. For example, if the left headstake at transect 2 is 75 m from L0 + 00 then it will be labelled L0 + 75; the left headstake at transect 3 if it is 163 m from L0 + 00 will be L1 + 63 and so on to the foot transect. The same rule applies to positioning the headstakes along the right bank. Finally, the length of the station is calculated as the mean of the distances along the left and right shores from the head transect to the foot or last transect. In the rare event that a station is straight, the length may be determined directly by measuring down the middle of the channel with the topofil. Headstakes between the head and foot transects are labelled by reading the distance measurement as the boat passes directly between the two headstakes on either bank.



A topofil is used to measure the distance between headstakes. It is an instrument that measures the length of string being passed between a pair of rollers. The string originates from a large internally mounted spool. The readout or counter is positioned at the top of the topofil and operates on a numbered roller system similar to the counter on a tape recorder. Most counters are calibrated to read in tenths of a metre and it can be zeroed for each new measurement by depressing the button which is positioned immediately next to the counter.

To measure the distance between headstakes, attach one end of the string to the first headstake, set the topofil to zero and walk along the shore to the next headstake. Record the distance and continue to the downstream headstakes recording their distance from transect one. The topofil line is reasonably strong and should last the entire length of the station. However, should the line break during the measurement, the surveyor must return to the last headstake measured and start measuring from that point. Add the new distances to the distance to the last headstake from transect one. The positioning measurements must be done on both banks of the station. If the surveyor cannot walk along the shore, then the topofil must be paid out from a boat while it is drifted downstream along each shore.

25.11 The Bench Mark

Refer to Chapter 7.1 for background information regarding the bench mark. Wherever possible, use an established bench mark such as those which exist on dams, bridges and other such sites. However, in river survey work, an established bench mark will not usually be available and one must be established by the survey crew. Since the survey crew will not have the sophisticated equipment required to determine height or altitude above sea level, they will assign an arbitrary datum of 100.00 m to the bench mark. This sets a datum from which all subsequent elevations such as water level and headstakes will be compared. For example a headstake with the elevation of 98.55 m is on a horizontal plane 1.45 m lower than the datum 100.00 m or bench mark. If the proper material for a bench mark exists in the same area that the first headstake will be positioned, then it is practical to establish the benchmark and headstake as one, otherwise, the bench mark should be established within an easy line of sight from the instrument (level) to the headstakes L0 + 00 and R0 + 00. This will make the initial instrument shots to transect 1 simple and less time consuming than if the bench mark were positioned well away from the first transects.

25.11.1 Determining Elevations

For the purpose of the sections to follow, it is assumed that the surveyor has some basic knowledge of the techniques used in differential and profile levelling. If this is not the case, the reader is encouraged to review Appendices 12 to 14 for the basics of surveying and Brinker and Taylor (1936) for a more detailed study.

25.11.2 Headstake Elevation

The height or elevation of the headstakes are determined with the butt of the level rod positioned on the headstake nail (refer to Chapter 25.10.3). The rod reading is always taken as a foresight (FS) and thus the surveyor must know the height of the instrument (HI). The headstake elevation is entered as its elevation on a horizontal plane with respect to the bench mark. For example, if a headstake at R1 + 75 is on a horizontal plane which is 3.64 m lower than the bench mark then the headstake elevation is 96.36 m with respect to the bench mark. Elevations are measured to the nearest 0.005 m. Refer to the elevation chart on the following page for an example of elevations entered into a field log book.

25.11.3 Bank Elevation

The elevation of the upper edge of the bank must be determined at each transect on both banks in order to define the level of the river channel. The "bank full" stage is the point immediately before which the river overflows and floods the backshore. Determine the bank elevation by positioning the butt of the level rod at the lip of the bank. The lip is defined by a marked change in the substrate slope from a horizontal profile to a more vertical profile. In some cases, the marked change in slope may not be present and there will be a gentle slope without a definable lip to the water's edge. In these cases, the approximate edge of the bank may be determined through a high water mark on rock slopes or a visible change in floral abundance and character on vegetated slopes.

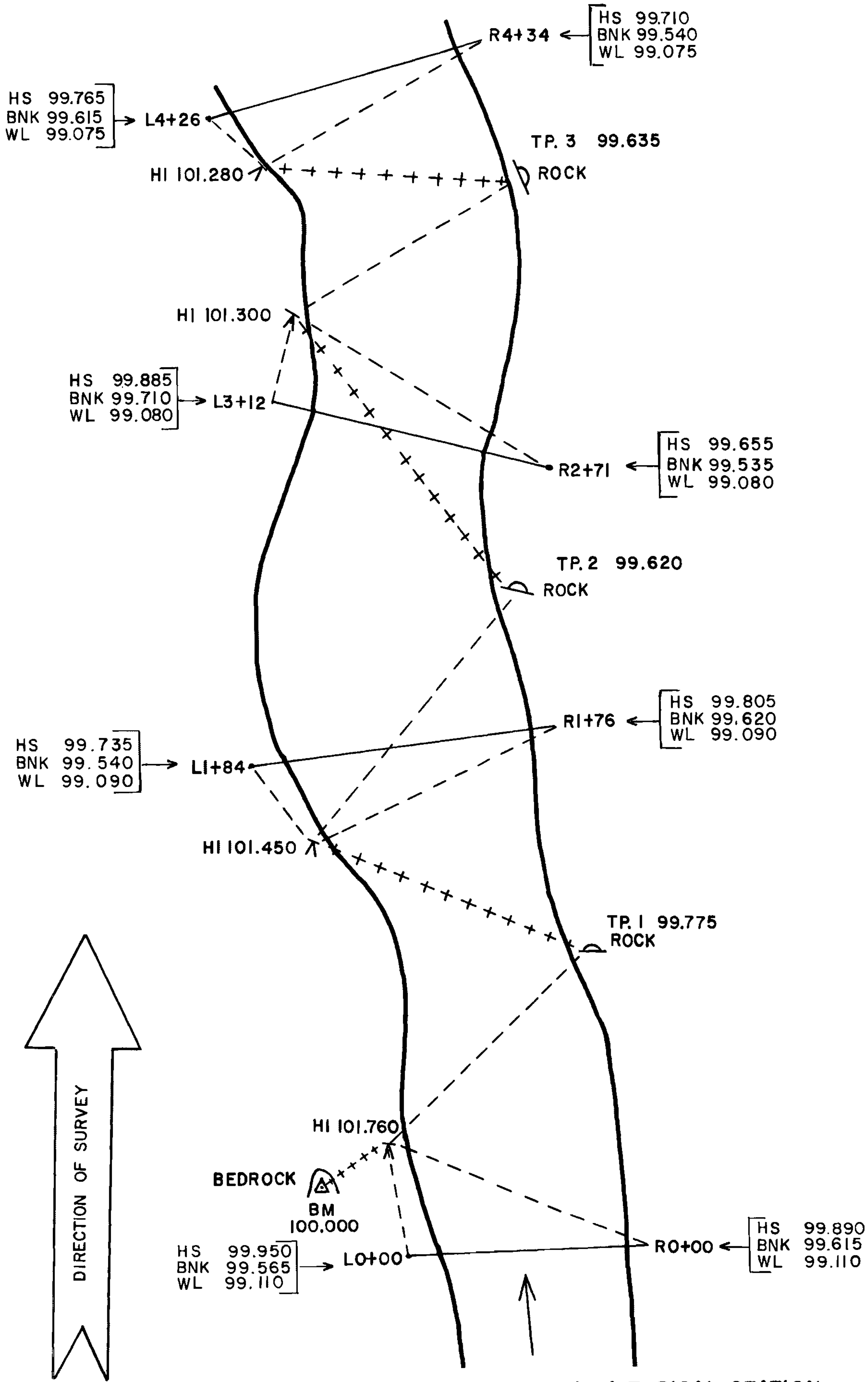
25.11.4 Water Surface Elevation

Water surface elevations will be determined at each transect and on both sides of the river. Ideally the water surface elevations on each bank of one transect will be equal. However, this may not always be the case across a set of turbulent rapids or around a bend in the river where the water can surge on the outside corner and thus raise the water level. These situations may show water elevation differences of a few cm. If water levels across a straight and deep transect are not equal then the level (instrument) must be checked and repaired by trained personnel and in a proper facility such as the Ministry of Transportation and Communications, Instrument Laboratory and Technical Services Unit, 1201 Wilson Avenue, Downsview, Ontario. M3M 1J8.

Once the water level at a transect has been determined, an aluminum metre stick or temporary staff gauge can be firmly implanted vertically into the river bed and thus any subsequent water level elevation changes during the survey, with respect to the bench mark, can be determined directly through simple readings from the staff gauge. For example, assume that on day one, the water level elevation is 94.43 m and the staff gauge reading at that time is 55 cm; then, if on day four the staff gauge reading is 50 cm, the water level elevation with respect to the bench mark will be 94.38 m. Do not set the staff gauge too close to the water's edge since a drop in water level may leave it high and dry. If the water level has changed by more than 2.0 cm at transect 1 during the traverse closure, then only the water levels need to be resurveyed. If the traverse closure indicates a high level of accuracy (refer to Chapter 25.11.6) then, it is not necessary to resurvey the whole station, rather the known elevation at each headstake can be used as a temporary bench mark from which the new water levels can be determined.

Elevation Chart

STATION	BS	HI	FS	ELEVATION
BM	1.760			100.000
		101.760		
L0+00 HS			1.810	99.950
BNK			2.195	99.565
WL			2.650	99.110
R0+00 HS			1.870	99.890
BNK			2.145	99.615
WL			2.650	99.110
TP.1			1.985	99.775
	1.675	101.450		
L1+84 HS			1.715	99.735
BNK			1.910	99.540
WL			2.360	99.090
R1+76 HS			1.645	99.805
BNK			1.830	99.620
WL			2.360	99.090
TP.2			1.830	99.620
	1.680	101.300		
L3+12 HS			1.415	99.885
BNK			1.590	99.710
WL			2.220	99.080
R2+71 HS			1.645	99.655
BNK			1.765	99.535
WL			2.220	99.080
TP.3			1.665	99.635
	1.645	101.280		
L4+26 HS			1.515	99.765
BNK			1.665	99.615
WL			2.205	99.075
R4+34 HS			1.570	99.710
BNK			1.740	99.540
WL			2.205	99.075
REPOSITION LEVEL				
R4+34 HS				99.710
	1.915	101.625		
TP.4			1.965	99.660
	2.120	101.780		
TP.5			2.060	99.720
	2.195	101.915		
CLOSURE HEIGHT (BM)			1.900	100.015



PATH AND DIRECTION OF SURVEY SHOTS AT A TYPICAL STATION

(Example of a differential levelling survey downstream)

– – – –	Foresight (FS)	HS	- Headstake
+ + + +	Backsight (BS)	BNK	- Bank
⊼	Instrument (level)(HI)	WL	- Water level
BM -	Bench Mark	TP	- Turning Point

25.11.5 Differential Levelling

Normally water elevations are determined in a downstream direction through a continuous series of measurements originating from the benchmark. Refer to the example of a differential levelling survey downstream. Notice that turning points are made on solid objects such as rocks in this example. All of the differential levels tie back to the benchmark. This is necessary where there is a noticeable drop in water level along the course of the station. Stations which are wide, shallow and contain hydraulic controls such as rocks, boulders and riffles or rapids are the usual candidates for the full treatment of differential levelling traverse closure. However, many stations may be established in deep channel portions of river where the water is flat or non-turbulent and there is no visible evidence of water level difference between the first and the last headstake.

Indeed, very small differences which may exist in this type of station will not be detectable within the limits of allowable error inherent in the technique recommended here. For the example in Chapter 25.11.6 the allowable error in a 1.5 km section of the river is 4.3 cm while the actual differential in flat relatively calm water would probably be less than 1.0 cm. In the cases of very flat non-turbulent water, it is expeditious to abandon the traverse loop procedure in favor of assuming equal water elevations at each transect. Each headstake and bank elevation at downstream transects may then be determined by using the water level at each transect as a temporary benchmark. For example, in a flat calm reach of river, if the water elevation at transect one is 98.75 m with respect to the benchmark, then assume that the water level at the downstream transects is also 98.75 m. The staff gauges should be monitored regularly to check for rising or falling water levels while this method is used.

25.11.6 Traverse Closure

After the water, bank and headstake elevations have been determined for all transects, the accuracy or allowable error of the survey must be checked by a method termed traverse closure. This procedure requires that after the last elevation has been recorded, the instrument is repositioned 1 or 2 m away from the last position and the station is re-surveyed back to the bench mark (as seen on the example on the next page.). It is not necessary in this instance to determine water level and bank elevations, however, it is recommended that the headstakes along the opposite bank are used as turning points (TP) (refer to appendix 13). Once the level loop is closed (returned to bench mark) then the allowable survey error is calculated as:

$$\text{Maximum Error of Closure} = 0.025\sqrt{K}$$
$$\text{where } K = \text{length of the level loop in km}$$

For example, a station 1.5 km long would have an allowable error as follows:

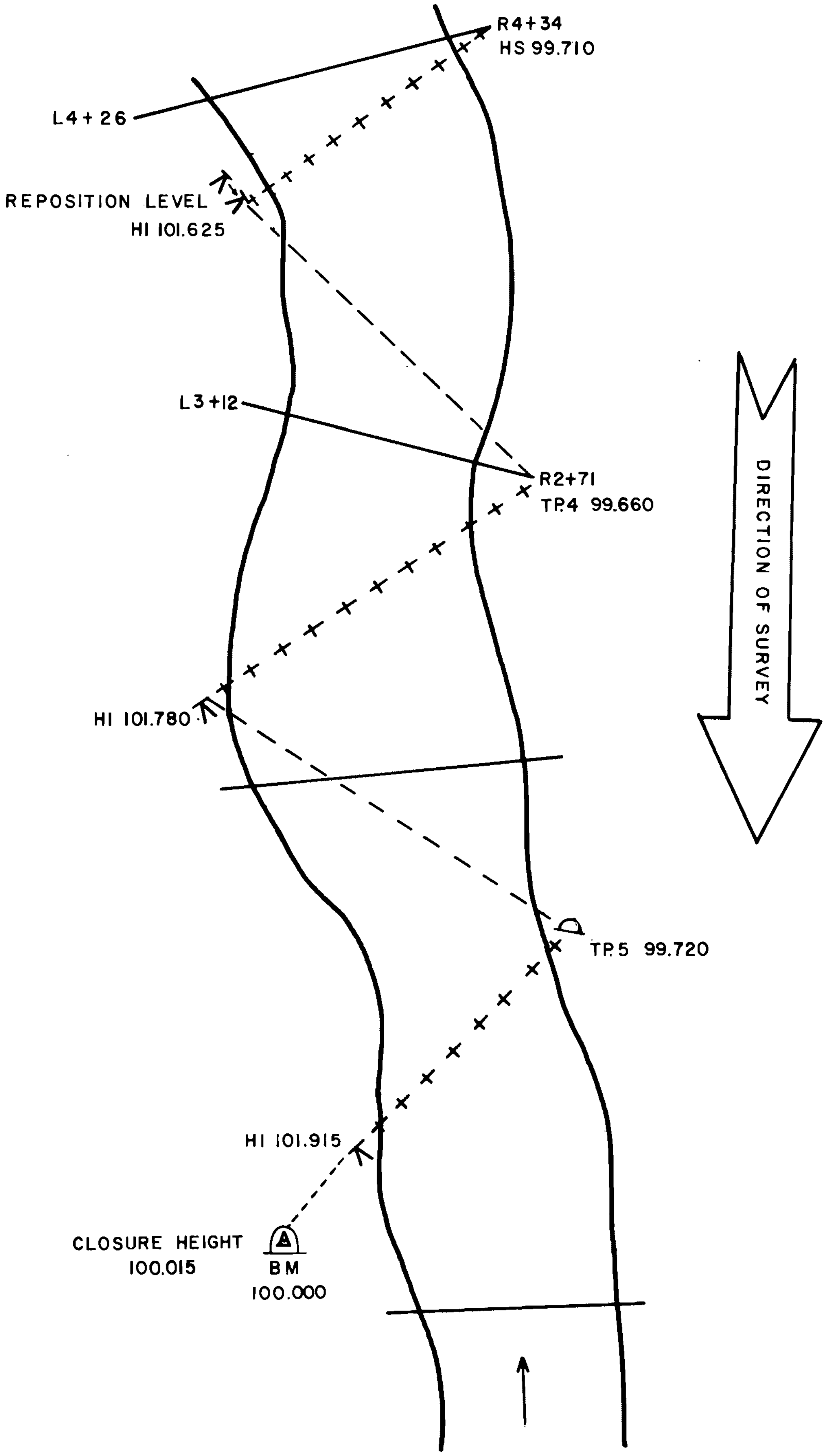
$$\begin{aligned}\text{Maximum Error of Closure} &= 0.025\sqrt{1.5+1.5}\\ &= 0.043\text{ m}\end{aligned}$$

From this we can see that the re-survey to the bench mark must be within 4.3 cm of the originally assigned datum 100.00, eg. 100.04 m or 99.96 m. A level loop closure error greater than the calculated allowable error requires a recheck of the differential levelling data and possibly a re-survey of the station.

25.11.7 Bed Elevations

A profile of each transect must be measured from headstake to headstake. The bed elevations are measured as a series of 10 elevations across the channel and the measuring sites are spaced equidistantly from each other. If the water is shallow, the rodman can wade to each of the 10 measuring sites and the bed elevation can be determined directly with an instrument shot to the rod when the butt of the rod is positioned on the river bed. Deeper water requires that the suspended system depth sounding gear outlined in Appendix 14 is used to determine the depth of water at a given water elevation. From this, the bed elevation equals the water level elevation minus the water depth reading taken from the suspended system.

To avoid confusion later, a habitat type transect requires only 10 bed elevations to be determined, while 20 measuring sites are used to measure river discharge. Refer to Chapter 25.12.1 for further clarification.



25.11.8 Particle Size

Estimate the composition, range and average particle size of the substrate material across the transect and according to the guidelines set out in Chapter 16.2. This may be done in shallow clear waters by direct and visual examination of the substrate while in deep and turbid waters, the surveyor must determine the substrate size and composition by the "feel" of the sounding gear or level rod as it touches bottom. For example a rock bottom will have a more resistant bottom than muck when the sounding weight is lowered to the bottom. Should the determination of the bottom type still prove to be elusive, then attempts must be made to bring some of the substrate to the surface. An invertebrate dredge or an anchor can be used to pick up river bed material.

25.12 Discharge Measurements

Discharge or river flow volume is measured in the units, cubic metres per second ($m^3 s^{-1}$). The discharge at the time of the field measurement may be obtained directly from a monitored flow station such as an operational hydro-electric dam, however, if there is any significant inflow between the dam and the station then the crew must measure the discharge with the water current meter as it is outlined in Appendix 14.

25.12.1 Discharge Measuring Site

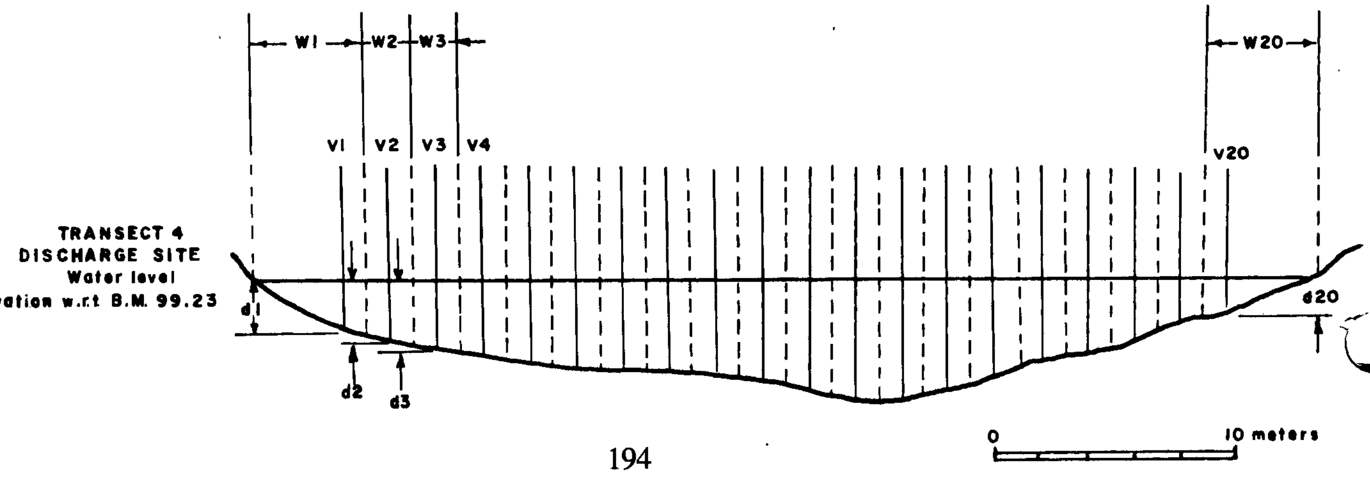
When a monitored station is neither nearby nor available, the surveyor must select the most uniform cross-section from which to take the discharge measurement. Ideally the bottom should be regular, without obstructions and have a reasonably symmetrical profile which is deepest at or near mid-channel. If such an area does not exist within the station the crew may select a more suitable site outside of its boundaries. There must not be any significant inflow or outflow between the measuring site and the station since either would influence the actual flow volume present at the station.

Once the discharge measuring site has been established, the crew must measure the distance across the river channel from the right headstake to the left headstake. Note distance of the right levee, right bank water's edge, left bank water's edge, left levee and finally the left headstake from the right headstake. Determine the width of the river channel by subtracting the distance from the right headstake to the right bank's water's edge from the distance from the right headstake to the left bank water's edge.

To calculate the placement of the verticals, simply divide the river width (shore to shore) by 21 and round to the nearest whole number. The result will indicate the required distance between verticals. Depending on the river width and whether the number is rounded up or down, 19 to 21 verticals will be required to complete the measurement.

25.12.2 Measuring Discharge

A more detailed explanation of the current meter and the operations required to measure flow velocity are provided in Appendix 14. This section will address what to measure and where.



In the preceding diagram of a discharge measuring site, note that the solid vertical lines denote the measuring points for velocity (v) and depth (d). The broken vertical lines denote the limits of the panel width (w). The panels W1 and W20 are both wider than the others to compensate for the edge effect of laminar flow.

Water flows through a panel at a velocity (v), however, due to the properties of flowing liquids the velocity of water near the surface is normally greater than the velocity of the water near the bottom and mid-water velocities are greater yet. There are some general velocity measurement rules which compensate for these differences and they are as follows:

1) for water less than or equal to 1.0 m deep, take one water velocity reading at 0.6 of the total depth (v.6d). The velocity value obtained will be entered directly onto Form C as the mean velocity ($\bar{v}$).

2) for water depths greater than 1.0 m, and flowing at a steady rate, measure the water velocity at 0.2 and 0.8 of the total depth. The water velocities are entered as v.2d and v.8d, respectively and mean water velocity ($\bar{v}$) is calculated as follows:

$$\bar{v} = \frac{v.2d + v.8d}{2}$$

3) For turbulent water that is greater than 1 m deep, water velocity measurements should be taken at 0.2, 0.6 and 0.8 of the total depth at each panel. Mean water velocity $\bar{v}$, is calculated as follows:

$$\bar{v} = \frac{v.2d + (2 \times v.6d) + v.8d}{4}$$

Normally the crew should avoid taking discharge measurements and transects where the water is turbulent and the v.2d, and v.6d, and v.8d velocity measurements are required. Wherever possible look for a site which is suitable for the v.2d and v.8d type measurements.

To ensure that the water level has not changed during the velocity measurements, the crew will check the staff gauge directly before and after the full discharge measurement. As a general rule, if the water level has increased or decreased greater than one percent of the mean profile depth during the time span of the discharge measurement, then the whole discharge measurement should be repeated.

25.12.3 Calculating Discharge

Discharge is a figure consisting of a width, depth and velocity. In Chapter 25.12.2, the width, depth and velocity were determined for each panel or subsection of a river profile and their product gave an estimate of flow volume in m^3s^{-1} for each panel. The sum of all the individual panel flow volumes is equal to the total river discharge at that point of measurement. The equation is as follows:

$$Q = \Sigma q = \Sigma(\bar{v} \times w \times d)$$

where Q = total discharge (m^3s^{-1})
q = discharge of each panel (m^3s^{-1})
$\bar{v}$ = average velocity per panel ($m\ s^{-1}$)
w = width of the panel (m)
d = depth of the panel (m)

The flow volume of the first and the last panel, the panels adjacent to each bank, must be estimated on the basis of a right angle triangle rather than a rectangle as it is for the other 18 panels. For example, panel one may have a depth of 0.5 m, width of 5 m and average water velocity of 0.05 m s^{-1}. The flow volume will be calculated as follows:

$$q = \tfrac{1}{2}(0.50\ \mathrm{m} \times 5.00\ \mathrm{m} \times 0.05\ \mathrm{m\,s^{-1}})$$
$$= 0.06\ \mathrm{m^3 s^{-1}}$$

In many cases the flow at the river's edge is not measurable, therefore the flow volume is entered as nil.

25.12.4 Checking the Discharge Measurement

Since a great deal of effort has been expended to obtain a discharge measurement, it is necessary to check the relative accuracy of the measurement. This can be done very easily in the field using the following formula and a scientific calculator:

$$n = \frac{R^{2/3}\, Se^{1/2}\, A}{Q} \text{ or } \frac{R^{0.677}\, Se^{0.5}\, A}{Q}$$

where n = roughness co-efficient

R = hydraulic radius

Se = energy slope

A = cross-sectional area of the profile

Q = flow volume (m^3s^{-1})

The flow volume Q is given from the discharge measurement.

The hydraulic radius (R) is approximated as the mean depth.

The energy slope Se is approximated from the differential levelling process as:

$$Se = \frac{H_2 - H_1}{X}$$

where H_2 = water elevation at the first transect

H_1 = water elevation at the last transect

X = the mean of the distances along both shores from the first transect to the last. For example, if H_2 is at L0+00, R0+00 and H_1 is at L5+50, R5+68 then $X = \frac{550+568}{2}$

$= 559$ m

The cross-sectional area (A) is simply the sum of the products of each d_i and w_i of all the panels across the profile. Note that the area correction for the two outside panels must be made in the same manner as the flow volume correction in the previous Chapter 25.12.3.

Since the substrate type and the shape of the river channel is known through the profile exercise and if the discharge measurement was done correctly, the estimation of n should fall within the following guidelines:

Man-Made Channels	**n**
Concrete	0.012 - 0.014
Rubble set in concrete	0.017
Soil bottom without weeds	0.020
Soil bottom with some stones and weeds	0.025

Natural River Channels	**n**
Clean and straight	0.025 - 0.030
Winding with pools and shoals	0.033 - 0.040
Winding and overgrown	0.075 - 0.150

Estimations of n which fall outside of the guidelines indicate an error in the estimation of river water discharge. The source of the error must be found and corrected. For example, common causes of error include, an incorrect calculation of a partial discharge, hydraulic radius, energy slope and so on. The river discharge measurement must be repeated if the error cannot be detected in the original calculations and data entries.

SECTION THREE

POST FIELD ACTIVITIES

After all the field activities are completed, the writing of the finished report starts. There are a number of tasks which must be finished entirely before the survey can be filed as 'complete'. These are listed below.

1) Complete and type the Pre-Field Summary, Form 1 and the Station Summary, Form 2.
2) Complete the Gradient Profile.
3) Complete the Template Map.

CHAPTER 26

THE COMPLETED RIVER SURVEY REPORT

26.1 Completing the River Survey Summary Form 1 (Prefield Summary)

This form summarizes information collected from the gazetteer, topographic maps, watershed maps, historical sources and the video tape of the entire river. In addition, it will provide an index to the complementary data sources that are available. A completed Form 1 is provided as an example in this chapter. The following explains how the form is completed.

Section A — Identification Key

Refer to Chapter 19.2. The M.N.R. District code number refers to the district conducting the survey regardless of how many districts the river may flow through. The codes are listed in Chapter 1.5. Since it may take more than one year to survey the entire river, list all the years in which the survey occurred.

Section B: Location Data

To complete this section, refer to the following chapters.

Gazetteer name	— Chapter 19.1
Topographic Map name	— Chapter 19.3
Local name	— Chapter 19.7
County or Judicial District and Township	— Chapter 19.6
Name and No. of Topo. Map	— Chapter 19.4
Elevation at Mouth	— Chapter 19.8
Stream Order	— Chapter 20.6
Main Channel Length	— Chapter 20.3.1
Source Length	— Chapter 20.3.2
Average Gradient to Source	— Chapter 20.5.2
MNR District Nos. (Mouth to Source)	— Chapter 19.5
Watershed Codes and Drainage Access	— Chapter 19.9, 20.4

Section C: Major Tributaries to Main Channel

This section is explained in Chapter 20.6.1

Section D: Lakes in Main Channel

Refer to the naming procedure in Chapter 1.6.1. List all lakes occurring in the main channel of the river. List the coordinates according to Chapter 1.2. If the lake has been previously surveyed, record the most recent year of survey. If it has not been surveyed, place a check in the 'No Survey' box.

Section E: Station Selections

Refer to Chapter 20.9.1 to 20.10.

Section F: Complementary Data Sources

Refer to Chapter 18

Section G: History

Briefly summarize the uses that the river and surrounding land have been put to over the years (e.g., log drives, navigation (trade), industry and recent socio-economic uses). Enter in either narrative or point form.

Section H: Pollution

Provide information on any potentially harmful water use and land use practices or any harmful substances flowing into the river (e.g., road construction, logging, dredging, agricultural runoff, damage from livestock, sewage, mine tailings, industrial discharge, etc.).

Section I: Video Tape Review (River Features Summary)

This is a permanent written analysis of the video tape recording of the river. The location and description of the physical features are basic requirements for selecting representative reaches and in some cases the critical reaches that occur in the river. Refer to the example in the completed form at the end of this chapter.

Structures such as dams, bridges and outpost camps may be identified by recording the distance of the structure from the mouth of the river. Using the template map, determine the distance to the nearest 0.5 Km and enter the figure into the columns under the heading of "Location". A simple description is entered into the space for "Description of Features".

Morphological features such as rapids or shoals or a combination of these must be identified according to both the written description and their limits in distance in Km from the mouth. Some other features, to name just a few, include discoloured industrial effluent, logs, jams, mine tailings and levees.

Refer to Chapter 20.9, 20.9.1, 20.9.2, 20.9.5. Record the dates that the videotaping took place. List the names of all investigators involved in the compiling of information on this form.

26.2 Completing the River Survey Summary Form 2 (Station Summary)

This form is provided for the recording of physical, chemical and biological data which has been collected during an on site investigation. The station may have been selected through the criteria for a representative or a critical reach. Refer to the completed form in this chapter as an example.

Section A — Identification Key

List the MNR district the station is located in and the year that the station is surveyed. Record the coordinates of the centre of the river station as determined from a 1:50,000 topographic map, to the nearest tenth of a minute.

Section B — Location Data

This information describes the station only, not the entire river.

Local names can vary widely from mouth to source, e.g., Long Rapids, Smoky Falls, Great Bend, to name a few on the Mattagami River. The local name is assumed to be the same as the topographic name (Chapter 1.6) when no other information is available.

List the station number. These should run in sequence from mouth to source. The name of the Topo. Map and edition number refers to the map sheet on which the station is found.

Reach Type designates whether the station was selected from a representative reach or a critical reach. Order refers to the stream order rating on the river at the point of the station.

The elevation, in metres, of the station is entered in the appropriate space provided. Refer to Chapter 19.8 for an elaboration on averaging the elevation between two contour lines.

Section C — Water Chemistry

Refer to Chapter 21 and see the completed form in this chapter as an example. Sampling is done at the deepest point in the station.

Although space has been provided for recording chemistry data for up to three sites (one on either side, and one in the middle of the station), you may find that additional sites are required between stations. In that case use additional forms and relate the site to the closest station. Sites are numbered alphabetically from A to Z.

Section D — Physical Data

This section is provided for the entry of the physical data which has been collected according to the instructions presented in Chapter 25.

The elevations of a headstake, bank and the water, relative to the benchmark will be determined to the nearest cm while the staff gauge will be read to the nearest 0.5 cm.

Profile Transects are described by their habitat type which may include the features from riffle to bar. Mark the appropriate space for habitat type. Where the check list of features does not adequately describe a transect, describe the habitat type in the space provided beside "other".

Each profile transect will consist of 9 or 10 panels, each of which will be measured for depth and width to the nearest 10 cm. Check only one substrate type per panel of the ten substrate types listed across the row.

For the measurement to be valid, the water elevation must not change more than one percent of the mean depth during the Discharge Measurement. The staff gauge established at the discharge measurement transect must be checked and the water level values entered into the appropriate spaces prior to and immediately after a discharge measurement has been made.

Discharge transects consist of 20 panels. Each panel is measured for width and depth to the nearest cm, velocity to the nearest cm s^{-1} and discharge is calculated to the nearest cm^3s^{-1}.

Directly after the discharge measurement has been made, the water level elevations at each transect with respect to the bench mark are entered into the spaces provided on the Form.

Bank Description is summarized under the categories of vegetative cover, bank composition and stability. For cover, an estimate of the percentage of the bank that is covered by the categories: Treed, Bush, Grass and Barren is required. For bank composition the percent composition of the bank according to the categories of subtrate listed is estimated and entered into the spaces provided. These must add up to 100 percent. Check the appropriate box for bank stability.

Terrain Characteristics are fully outlined in Chapter 16.8. Mark the description which typifies the terrain characteristics at each transect.

Note the location of the benchmark and describe its appearance.

Section E — Fish Species

Insert the fish code in the appropriate box and the number of specimens in the following box of each station.

Small fish coding is not to be done until positive identifications are received from main office.

Section F — Aquatic Vegetation

Refer to Chapter 25.8.

Section G — General Comments

Note the occurrence and extent of pollution present at the station, history, special features or any observations worth recording.

26.3 The Gradient Profile

The river gradient profile will include the hydraulic head measurements to provide extra detail and to complement the elevations derived from topographical maps. The gradient profile is to be completed on graph paper.

26.4 Template Map

Mark all the stations onto the template maps and make a copy set of topographic maps. Send the copy set to Main Office. File the original template at the Regional Office. Additional copies can be sent to the appropriate District offices if requested.

26.5 Filing the Completed River Survey Report

Once the river survey is completed, the maps, forms and field notes must be filed in at least two separate locations as insurance against loss of either one. Send the original complete set to the Regional Office and copies may be sent to each District Office which shares a portion of the study river. In addition, send one complete set of the template map and Forms 1 and 2 to Main office (Fisheries Branch).

Ministry of Natural Resources
Ontario

Aquatic Habitat Inventory
River Survey Summary
Form 1
(Prefield Summary)

Instructions
▼Numbers only
▼Checking only [X]

A. Identification Key

M.N.R. District No.: 35
Survey years: 19 85 | 19 | 19
Lat.: 49°49'
Long.: 82°00'

Location Data

Gazetteer Name	Topographic Map Name	Local Name
KAPUSKASING RIVER	KAPUSKASING RIVER	KAPUSKASING RIVER

County or Judicial District	Township	Elevation at Mouth	Stream Order
COCHRANE	HOPKINS	198 m	5

Name and No. of Topo. Map	Edition No.	Name and No. of Topo. Map	Edition No.
BENNET CREEK 42G/16	1	ALLENBY CREEK 42B/15	2
PEARCE LAKE 42G/9	1	ELSAS 42B/10	2
KAPUSKASING 42G/8	2		
LOST RIVER 42G/7	2		
WOMAN FALLS 42G/2	2		

Main Channel Length: 198.0 km
Source Length: 324.6 km
Average Gradient to Source: 0.6 m km^{-1}
M.N.R. District Nos. (mouth to source): 31 35

Main	Trib.	Watershed Code	Drainage Area	Main	Trib.	Watershed Code	Drainage Area
X		4LF 01	261028 ha		X	4LE 06	9713 ha
	X	4LF 02	34804 ha		X	4LE 07	79321 ha
	X	4LF 03	100770 ha		X	4LE 08	30353 ha
	X	4LF 04	72036 ha		X	4LE 09	37030 ha
X		4LE 11	17807 ha		X	4LE 10	65157 ha
	X	4LE 01	56253 ha				ha
	X	4LE 02	25091 ha				ha
	X	4LE 03	8094 ha				ha
	X	4LE 04	46945 ha				ha
	X	4LE 05	18616 ha				ha

C. Major Tributaries to Main Channel

Name	Stream Order	Latitude	Longitude	Survey Year 19	No Survey
CHAPLEAU RIVER	5	48°29'	82°57'	85	
NEMEGOSENDA RIVER	4	48°32'	82°53'		X
DUNRANKIN RIVER	4	48°47'	82°51'		X
WINGHAM CREEK (NL)	4	48°55'	82°52'		X
SAGANASH RIVER	4	49°22'	82°28'		X
LOST RIVER	4	49°34'	82°22'		X
REMI RIVER	4	49°43'	82°11'		X
		° '	° '		
		° '	° '		

D. Lakes in Main Channel

Name	Latitude	Longitude	Survey Year 19	No Survey
KAPUSKASING LAKE	48°30'	82°57'	80	
	° '	° '		
	° '	° '		
	° '	° '		
	° '	° '		
	° '	° '		
	° '	° '		
	° '	° '		
	° '	° '		

1594

E. Station Selections

Reach	Repr.	Crit.	Station No.	Location (distance in km from mouth)		Comments
A	X		1	18.4	to 19.4	SLOW CURRENT, SWAMPY FORESHORE
B	X		2	41.5	to 42.5	NARROWER CHANNEL, DEFINITE FORESHORES
C	X	X	3	62.8	to 63.3	BELOW DAM, ROCKY FORESHORES, HEAVY BARK
				.	to .	DEPOSITS.
D	X		4	79.0	to 81.5	AREA BEHIND SPRUCE FALLS DAM
E	X		5	115.5	to 116.7	SWAMPY FORESHORES & WIDE CHANNEL
F	X		6	144.0	to 145.0	CHANNEL NARROW, WINDING; SWAMPY FORESHORE
G		X	7	151.0	to 152.0	ROBUST RAPIDS, EXCELLENT SPAWNING AREA
G	X		8	159.0	to 160.0	MED. WIDTH CHANNEL, CLAY FORESHORE
G	X		9	160.8	to 161.5	ROBUST RAPIDS
H	X		10	194.7	to 195.0	WIDE CHANNEL LINED BY SWAMP

F. Complementary Data Sources

Agency	Data Type	Year	Publication Title
Ontario Water Resources Commission	Water Quality	1964	A report on Spruce Falls Power and Paper Company Ltd. Kapuskasing, Ontario.
Beak Consultants Ltd. for SFP and P Corp.	Water Quality	1977	Assimilative capacity study of the Kapuskasing River.
Ministry of Envir.	Water Quality	1976	Operation of a pulp and paper mill; its uses of the effects upon the Kap. River.
Ministry of Envir. (Not for publication. Internal report.)	Water Quality	1982	Preliminary report. Impact of log driving activities in the dissolved oxigen in the Kapuskasing River.
Environment Ontario	Water Quality	1985	Water quality monitoring data
Environment Canada	Hydraulic	1983	Surface water data - Ontario.

Section B — Location Data

This information describes the station only, not the entire river.

Local names can vary widely from mouth to source, e.g., Long Rapids, Smoky Falls, Great Bend, to name a few on the Mattagami River. The local name is assumed to be the same as the topographic name (Chapter 1.6) when no other information is available.

List the station number. These should run in sequence from mouth to source. The name of the Topo. Map and edition number refers to the map sheet on which the station is found.

Reach Type designates whether the station was selected from a representative reach or a critical reach. Order refers to the stream order rating on the river at the point of the station.

The elevation, in metres, of the station is entered in the appropriate space provided. Refer to Chapter 19.8 for an elaboration on averaging the elevation between two contour lines.

Section C — Water Chemistry

Refer to Chapter 21 and see the completed form in this chapter as an example. Sampling is done at the deepest point in the station.

Although space has been provided for recording chemistry data for up to three sites (one on either side, and one in the middle of the station), you may find that additional sites are required between stations. In that case use additional forms and relate the site to the closest station. Sites are numbered alphabetically from A to Z.

Section D — Physical Data

This section is provided for the entry of the physical data which has been collected according to the instructions presented in Chapter 25.

The elevations of a headstake, bank and the water, relative to the benchmark will be determined to the nearest cm while the staff gauge will be read to the nearest 0.5 cm.

Profile Transects are described by their habitat type which may include the features from riffle to bar. Mark the appropriate space for habitat type. Where the check list of features does not adequately describe a transect, describe the habitat type in the space provided beside "other".

Each profile transect will consist of 9 or 10 panels, each of which will be measured for depth and width to the nearest 10 cm. Check only one substrate type per panel of the ten substrate types listed across the row.

For the measurement to be valid, the water elevation must not change more than one percent of the mean depth during the Discharge Measurement. The staff gauge established at the discharge measurement transect must be checked and the water level values entered into the appropriate spaces prior to and immediately after a discharge measurement has been made.

Discharge transects consist of 20 panels. Each panel is measured for width and depth to the nearest cm, velocity to the nearest cm s^{-1} and discharge is calculated to the nearest cm^3s^{-1}.

G. History

Dam built at Kapuskasing to create reservoir and power for SFP and P mill. Harman Dam in Mattagami controls water level on the extreme lower section of the Kap River. The river u/s of Kap is used to transport logs to the mill. Log dumps are located along middle sections of the river. Some farming is undertaken along sections of the river around Kap. Extensive sportfishing is conducted between Kap and Cedar Rapids.

H. Pollution

Bark and wood related products are present in the river particularly around Kap as well as effluent for the SFP and P and the town of Kapuskasing. Potential future pollution may result from planned phosphorous mining operations in Cargill Twp.

I. Video Tape Review (River Features Summary)

Reach	Location (distance in Km from mouth)			Description of Features
A	0.0	to	30.0	SWAMPY FORESHORE, AREA AFFECTED BY LITTLE LONG RAPIDS DAM
		to	3.1	CURRIE CREEK
		to	4.8	TUCKER CREEK
		to	5.6	NORTH CHANNEL
		to	7.2	OVER FLOW CHANNEL
		to	10.3	TORRANCE CREEK
		to	13.3	HOPKINS CREEK
		to	19.3	REMI RIVER
		to	26.0	ISLAND
		to	29.5	ISLAND (COUNTER No. 118)
B	30.0	to	58.2	CHANNEL NARROWER, LESS SWAMP
		to	36.0	LARGE ISLAND
		to	38.2	LILY RIVER
		to	39.5	FRED FLAT ROAD (COUNTER 154)
		to	42.5	LOST RIVER (COUNTER 166)
		to	48.0	O'BRIEN CREEK
		to	49.4	TEETZEL CREEK (COUNTER 194)
		to	58.2	STURGEON FALLS
C	58.2	to	63.5	RAPIDS SEPARATED BY DEEP CHANNELS
		to	62.0	RAPIDS
		to	63.0	SPRUCE FALLS DAM
D	63.0	to	80.0	RIVER ALTERED BY SPRUCE FALLS DAM & LOG BOOMS
		to	70.8	SAGANASH RIVER (COUNTER 257)
		to	76.9	BIG BEAVER CREEK
		to	79.7	ALDER CREEK
		to	80.0	BIG BEAVER FALLS
		to		

I. Video Tape Review (River Features Summary)

(continued)

Reach	Location (distance in km from mouth)			Description of Features
F	80.0	to	117.0	DAM HAS NO EFFECT, LOG DRIVES STILL HELD
	86.0	to	87.0	LOG DUMP
	.	to	92.7	RAPIDS
	.	to	93.5	BAKATASE FALLS (COUNTER 324)
	.	to	95.5	ISLAND
	.	to	97.2	RAPIDS
	.	to	99.9	WHITE OTTER FALLS
	.	to	100.0	ISLAND, WHITE OTTER RAPIDS
	.	to	105.2	PINETTE CREEK
	.	to	106.0	ISLAND
	.	to	106.9	OLD WOMAN FALLS
	.	to	110.0	WOMAN FALLS
	110.0	to	112.5	LOG DUMP
	.	to	114.7	S.F. CAMP 15
	.	to	116.6	GRAVEVARD CREEK
F	117.0	to	151.9	CHANNEL IS NARROWER, SWAMPY FORESHORES
	.	to	112.7	MOSS CREEK
	.	to	129.8	OSCAR CREEK
	.	to	133.3	ALLENBY CREEK
	.	to	134.4	TEEPEE CREEK
	.	to	147.4	MACLINTOSH CREEK
	.	to	151.5	CEDAR RAPIDS
G	151.5	to	191.0	NUMEROUS RAPIDS, POOLS & RIFFLES
	151.5	to	151.9	CEDAR RAPIDS
	.	to	160.0	DUNRANKIN RIVER (COUNTER 533)
	.	to	162.0	CLOUSTON RAPIDS
	.	to	168.8	BUCHAN FALLS (COUNTER 533)
	.	to	170.8	LOON RAPIDS
	.	to	172.6	JACKPINE RAPIDS
	.	to	191.0	RAPIDS
H	192.7	to	198.0	WIDE, SLOW CHANNEL; SWAMPY FORESHORE
	.	to	196.0	NEMEGOSENDA RIVER
	.	to	198.0	O.N.R. BRIDGE
	.	to	.	
	.	to	.	
	.	to	.	
	.	to	.	
	.	to	.	
	.	to	.	
	.	to	.	

Investigator(s)	Video Tape Dates:	Year 19	Month	Day	Year 19	Month	Day	Page
		85	06	08				1 of
								1

1594

Ministry of Natural Resources
Ontario

Aquatic Habitat Inventory River Survey Summary Form 2 (Station Summary)

Instructions
▼Numbers only
▼Checking only: X

A. Identification Key

M.N.R. District No.: 35 — Survey year: 1985
Lat.: 49°34.5' — Long.: 82°20.7'

B. Location Data

Gazetteer Name	Topographic Map Name	Local Name
KAPUSKASING RIVER	KAPUSKASING RIVER	KAPUSKASING RIVER

Station No.: 2 — Distance from mouth: 41.5 km to 42.5 km — Survey Dates: Year 19 85, Month 07, Day 31 to Year 19 85, Month 08, Day 01

County or Judicial District: COCHRANE
Name and No. of Topo. Map: PEARCE LAKE 42G/9 — Edition No.:
Watershed Code: 4LF01 — Stream Order: 5
Township: TEETZEL
Approx. Elevation: 198.0 m — Bench mark: — Contour: X
Investigator(s): L.MARION, J. NEWTON
Reach Type: Representative: X — Critical:

C. Water Chemistry

MNR Field Analyses

Site No.	Distance from mouth – km	Site Depth – m	Secchi Depth – m	Cloud %	Time hrs.	Surface Clm	Surface Rpl	Surface Wvy	Surface Rgh	Colour No	Colour Y/Br	Colour Bl/G	Year 19	Date Month	Day
1	41.9	.	0.6	60	1540		X				X		85	07	29
	.	.	.												
	.	.	.												

Site No.	Temp. Air °C	Temp. Water °C	D.O. $mg\ L^{-1}$	pH	TFE Alk. $mg\ L^{-1}$	T.D.S. $mg\ L^{-1}$	Sp. Conductivity $umhos\ cm^{-1}$	Cell Temp. °C
1	21.0	16.0	8.0	7.0	41.0	77.4	100.0	18.0
	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.

Diurnal Water Temperature

Site No.	Year 19	Date Month	Day	Water Temp. °C Max.	Min.
1	85	07	31	22.0	.
	85	08	01	24.	.
				.	.

MOE Laboratory Analyses

Site No.	Sample Date Year 19	Month	Day	Cond. 25°C $umhos\ cm^{-1}$	TIP Alk. $mg\ L^{-1}$
1	85	07	29	116.9	53.9
				.	.
				.	.

pH	Turbidity F.T.U.	True Colour Hazen Units	PPUT $mg\ L^{-1}$	PP04FR $mg\ L^{-1}$	NNTKUR $mg\ L^{-1}$	NNOTFR $mg\ L^{-1}$	NNO2FR $mg\ L^{-1}$
7.81	2*	144	0.015	0.0025	0.650	0.015	. N/A
.			.	.	.	.	.
.			.	.	.	.	.

D. Physical Data

Elevations Relative to Bench mark

Trans. No.		Position – m	Headstake – m	Bank – m	Water – m	Staff Gauge – cm
1	L	00+00	99.590	99.190	98.680	35.0
	R	00+00	100.770	99.795	98.680	.
2	L	01+05	99.725	99.120	98.680	.
	R	01+12	100.000	99.560	98.680	40.0
3	L	05+09	99.795	98.425	98.680	.
	R	05+10	100.005	99.720	98.680	50.0
		+	.	.	.	.
		+	.	.	.	.

Station Length: 510 m

1595

Habitat Profile

Transect No.	Riffle	Pool	Run	Flat	Rapid	Chan.	Bar	Other	Description
1						X			

Panel No.	Distance from L H.S, m	Panel Width m	Panel Depth m	Bed-rock	Bldr.	Rubble Cobble	Gravel Pebble	Sand	Silt	Clay	Muck	Marl	Detr.
1	11.3	5.0	.				X						
2	21.3	10.0	.		X								
3	31.3	10.0	.		X	X							
4	41.3	10.0	.		X	X							
5	51.3	10.0	.	X									
6	61.3	10.0	.		X								
7	71.3	10.0	.	X									
8	81.3	10.0	.			X							
9	91.3	10.0	.				X						
10	98.3	5.0	.				X						

Distance from L H.S, to near bank 0.4 m
Distance from L H.S, to near shore 1.3 m
Width of River (shore to shore) 100.0 m
Distance from H.S, to far shore . m
Distance from L H.S, to far bank 101.5 m
Width of Transect (H.S, to H.S,) 104.2 m
Water Elevation 98.680 m
Staff Gauge 25.0 cm

Habitat Profile

Transect No.	Riffle	Pool	Run	Flat	Rapid	Chan.	Bar	Other	Description
2						X	X		

Panel No.	Distance from L H.S, m	Panel Width m	Panel Depth m	Bed-rock	Bldr.	Rubble Cobble	Gravel Pebble	Sand	Silt	Clay	Muck	Marl	Detr.
1	23.6	25.0	2.2							X	X		
2	36.1	12.5	3.3								X		
3	48.6	12.5	3.1								X		
4	61.1	12.5	2.5	X									
5	73.6	12.5	3.3	X									
6	86.1	12.5	4.2	X		X							
7	98.6	12.5	4.5	X		X							
8	111.1	12.5	4.6	X									
9	123.6	12.5	3.6										X
10	136.1	25.0	0.5										X

Distance from L H.S, to near bank 4.1 m
Distance from L H.S, to near shore 5.1 m
Width of River (shore to shore) 150.0 m
Distance from L H.S, to far shore . m
Distance from L H.S, to far bank 159.5 m
Width of Transect (H.S, to H.S,) 160.1 m
Water Elevation 98.680 m
Staff Gauge 30.0 cm

Bank Description

Transect	Vegetative Cover (%) Treed	Bush	Grass	Barren	Bank Composition (%) Rock/ Bedrock	Boulder/ Rubble	Clay	Sand	Soil	Aggre-gate	Stability Stable	Mod. Stable	Un-stable
L 1		100					100				X		
R 1	60	35	5				90		10		X		
L 2	50	50					100				X		
R 2	40	50	10				90		10		X		
L 3	30	70					90		10		X		
R 3	50	50					100				X		

Habitat Profile

Transect No.	Riffle	Pool	Run	Flat	Rapid	Chan.	Bar	Other	Description
3						X			

Panel No.	Distance from L H.S, m	Panel Width m	Panel Depth m	Bed-rock	Bldr.	Rubble Cobble	Gravel Pebble	Sand	Silt	Clay	Muck	Marl	Detr
1	8.4	12.5	2.2	X									
2	20.9	12.5	4.2	X		X							
3	33.4	12.5	4.3	X		X							
4	45.9	12.5	4.3	X		X							
5	58.4	12.5	4.0	X		X							
6	70.9	12.5	3.6				X	X					
7	83.4	12.5	2.9	X		X							
8	95.9	12.5	2.9				X	X					
9	108.4	12.5	2.9	X	X								
10	120.9	12.5	2.6				X	X					

Distance from L H.S, to near bank 1.2 m
Distance from H.S, to far shore . m
Water Elevation 98.680 m
Distance from L H.S, to near shore 2.4 m
Distance from L H.S, to far bank 128.3 m
Width of River (shore to shore) 125.0 m
Width of Transect (H.S, to H.S,) 133.1 m
Staff Gauge 40.0 cm

Habitat Profile

Transect No.	Riffle	Pool	Run	Flat	Rapid	Chan.	Bar	Other	Description

Panel No.	Distance from H.S, m	Panel Width m	Panel Depth m	Bed-rock	Bldr	Rubble Cobble	Gravel Pebble	Sand	Silt	Clay	Muck	Marl	Detr.
	.	.	.										
	.	.	.										
	.	.	.										
	.	.	.										
	.	.	.										
	.	.	.										
	.	.	.										
	.	.	.										
	.	.	.										
	.	.	.										

Distance from H.S, to near bank . m
Distance from H.S, to far shore . m
Water Elevation
Distance from H.S, to near shore . m
Distance from H.S, to far bank . m
. m
Width of River (shore to shore) . m
Width of Transect (H.S, to H.S,) . m
Staff Gauge . cm

Terrain Characteristics (Check appropriate box)

Transect	Cult.	Firm Past.	Mea-dow	Upld. Hdwd.	Upld. Con.	Swamp Hdwd.	Swamp Conif.	Shrub Marsh	Open Marsh	Lawn	Imper-vious
L 1								X			
R 1				X	X						
L 2				X	X			X			
R 2				X	X						
L 3				X				X			
R 3				X	X						

Bench mark description and site location

Bench mark located on large white cedar (25-30cm dbh) on right side of river 112m from the top of the station.

Discharge Measurement (Dimensions)

Transect No. 1 L side to R side

Water Elevation rel. to B.M. 98.580 m

Date: Year 19 85 Month 07 Day 31

Start Time 1200 hrs. Staff Gauge 25.0 cm

Finish Time 1315 hrs. Staff Gauge 25.0 cm

Panel No.	Panel Width w (m)	Panel Depth d (m)	Panel Velocity — v (m s^{-1}) v·2d	v·6d	v·8d	$\bar{v}$	Panel Discharge q ($m^3 s^{-1}$)
1	5.00	1.19	0.03	.	0.03	0.03	0.09
2	5.00	2.20	0.09	.	0.16	0.13	1.43
3	5.00	2.11	0.70	.	0.23	0.47	4.96
4	5.00	1.67	0.83	.	0.51	0.67	5.59
5	5.00	1.93	0.88	.	0.56	0.72	6.95
6	5.00	1.78	0.89	.	0.37	0.63	5.61
7	5.00	1.52	0.74	.	0.26	0.50	3.80
8	5.00	1.68	0.85	.	0.43	0.64	5.38
9	5.00	5.22	0.83	.	0.13	0.48	12.53
10	5.00	2.00	0.81	.	0.25	0.53	5.30
11	5.00	1.25	0.85	.	0.66	0.76	4.75
12	5.00	2.13	0.87	.	0.39	0.63	6.71
13	5.00	3.40	0.79	.	0.51	0.65	11.05
14	5.00	3.81	0.76	.	0.62	0.69	13.14
15	5.00	4.03	0.77	.	0.59	0.68	13.70
16	5.00	3.40	0.73	.	0.65	0.69	11.73
17	5.00	3.49	0.70	.	0.34	0.52	9.07
18	5.00	2.87	0.68	.	0.51	0.60	8.61
19	5.00	2.43	0.68	.	0.56	0.62	7.53
20	5.00	1.64	0.51	.	0.47	0.49	2.01
	.	.	.	.	.	.	.

Distance from L H.S. to near bank 0.4 m

Distance from H.S. to near shore 1.3 m

Width of River (shore to shore) 100.0 m

Distance from H.S. to far shore . m

Distance from L H.S. to far bank 101.5 m

Width of Transect (H.S. to H.S.) 104.2 m

Total Discharge Q ($m^3 s^{-1}$) 139.94

E. Fish Species

Code	No.	Code	No.	Code	No.	Code	No.	Code	No.	Code	No.
334	8	331	3	131	3	091	1	163	1		

F. Aquatic Vegetation (occurrence)

Some emergent and floating vegetation along left side of river.

G. General Comments (History, Pollution, etc.) see attached page.

- paper mill and town of Kapuskasing upstream.
- large solids (bark) floating downstream.
- a shoal composed of almost entirely bark was within this station.

* True Colour : sample filtered - filtrate analysed.

APPENDIX

APPENDIX 1

CONVENTIONAL SIGNS AND REFERENCES SYMBOLS AQUATIC HABITAT INVENTORY SURVEYS

	PEN NO.
BOUNDARIES	
International	2
Provincial	1
County, District	1
Township Surveyed	1
Township Unsurveyed	1
Map Border	1
ROADS	
Main Highways (11)	1
Secondary Highway (56)	3
All Weather Road	1
Dry Weather Road	1
Trail, Portage (T. / P.)	00
PUBLIC UTILITIES	
Railway	00
Level Crossing	3
Power Transmission Line	00
Telephone Line	00
Air Base	000

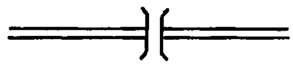
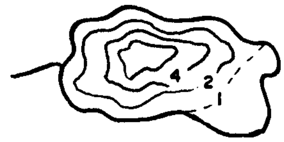
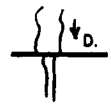
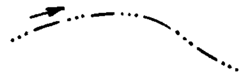
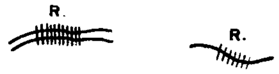
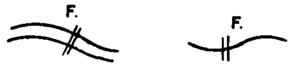
APPENDIX 1

SLOPE ANGLE OF TERRAIN		PEN NO.
Flat — 0°- 8° angle	8° 0°	00
Rolling — 9°-17° angle	17° 9° 0°	00
Hilly — 18°- 24° angle	24° 18° 0°	00
Mountainous — 25°-31° angle	31° 25° 0°	00

FISH LOCATION SITES		
Dip Net	D.N.	00
Gill	G.N. I	00
Seine	S.	00
Minnow Trap	M.T.	00
Night Line	N.L.	00+2
Angling	A	00
Small Fish Station	S.F. St. 4	00
Piscicide	P	00
Electrofishing	E.F.	00

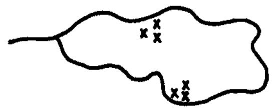
DEVELOPMENT OF SHORELINE		
Resort		1
Cottage		1
Subdivision		1+00
Public Access Point	ACCESS	00
First Aid Post		1

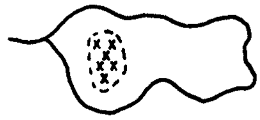
APPENDIX 1

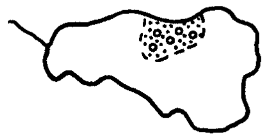
		PEN NO.
Bridge — Overpass		1
Underpass		1
CAMPSITE		
Serviced		00
Not Serviced		00
Picnic Area		00+2
WATER FEATURES		
Shoreline		2
Contours		00
Dam		1
Public Wharf		00
Inlet, Outlet		00
Non-Perennial (Intermittent)		00
Rapids		00
Falls		00
Beaver House		1
Beaver Dam		1+00

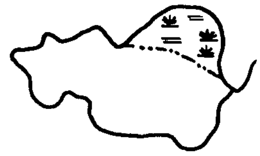
PEN NO.

Rocks — isolated or

scattered ....  00

Rocky reef, Shoal ....  00

Gravel, Sand Shoal ....  00

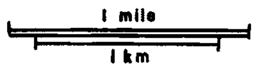
Aquatic Vegetation ....  00

Wet Swamp or Marsh ....  00

Treed Muskeg ....  00

Open Muskeg ....  00

MISCELLANEOUS

Map Scale .... 

00

North Direction .... 

000

Elevation

Water above Sea Level .... 210 m — — — — — 0

Point of Maximum Depth .... ·110 m 0

Bench Mark ....  B.M. 00

Water Chemistry Station ....  00

APPENDIX 2
MASTER LIST OF CODE NUMBERS and NAMES OF FISH SPECIES (March, 1987)*

010. PETROMYZONTIDAE — Lamprey family

- 011. American brook lamprey – *Lampetra appendix*
- 012. northern brook lamprey — *Ichthyomyzon fossor*
- 013. silver lamprey — *Ichthyomyzon unicuspis*
- 014. sea lamprey — *Petromyzon marinus*
- 015. *Ichthyomyzon sp.*

020. POLYODONTIDAE — Paddlefish family

- 021. paddlefish — *Polyodon spathula*

030. ACIPENSERIDAE — Sturgeon family

- 031. lake sturgeon — *Acipenser fulvescens*
- 032. caviar (commercial fish use only)

040. LEPISOSTEIDAE — Gar family

- 041. longnose gar — *Lepisosteus osseus*
- 042. spotted gar — *Lepisosteus oculatus*
- 043. *Lepisosteus sp.*

050. AMIIDAE — Bowfin family

- 051. bowfin — *Amia calva*

060. CLUPEIDAE — Herring family

- 061. alewife — *Alosa pseudoharengus*
- 062. American shad — *Alosa sapidissima*
- 063. gizzard shad — *Dorosoma cepedianum*
- 064. *Alosa sp.*

070. SALMONINAE - Salmon and trout subfamily

- 071. pink salmon — *Oncorhynchus gorbuscha*
- 072. chum salmon — *Oncorhynchus keta*
- 073. coho salmon — *Oncorhynchus kisutch*
- 074. sockeye salmon — *Oncorhynchus nerka*
- 075. chinook salmon — *Oncorhynchus tshawytscha*
- 076. rainbow trout — *Salmo gairdneri*
- 077. Atlantic salmon — *Salmo salar*
- 078. brown trout — *Salmo trutta*
- 079. Arctic char — *Salvelinus alpinus*
- 080. brook trout — *Salvelinus fontinalis*
- 081. lake trout — *Salvelinus namaycush*

*LAST REVISION March 1987.

082. splake — *Salvelinus fontinalis x Salvelinus namaycush*
083. Aurora trout — *Salvelinus fontinalis timagamiensis*
084. *Oncorhynchus sp.*
085. *Salmo sp.*
086. *Salvelinus sp.*

090. COREGONINAE — Whitefish subfamily

091. lake whitefish — *Coregonus clupeaformis*
092. longjaw cisco — *Coregonus alpenae*
093. cisco (lake herring) — *Coregonus artedii*
094. bloater — *Coregonus hoyi*
095. deepwater cisco (chub) — *Coregonus johannae*
096. kiyi — *Coregonus kiyi*
097. blackfin cisco — *Coregonus nigripinnis*
*098. Nipigon cisco — *Coregonus nipigon*
099. shortnose cisco — *Coregonus reighardi*
100. shortjaw cisco — *Coregonus zenithicus*
101. pygmy whitefish — *Prosopium coulteri*
102. round whitefish — *Prosopium cylindraceum*
103. chub — *Coregonus sp.* (Cisco species other than *C. artedii*)
106. *Coregonus sp.*
107. *Prosopium sp.*

110. THYMALLINAE – Grayling subfamily

111. Arctic grayling — *Thymallus arcticus*

120. OSMERIDAE — Smelt family

121. rainbow smelt — *Osmerus mordax*

130. ESOCIDAE — Pike family

131. northern pike — *Esox lucius*
132. muskellunge — *Esox masquinongy*
133. grass pickerel — *Esox americanus vermiculatus*
134. *Esox sp.*
135. chain pickerel — *Esox niger*

140. UMBRIDAE — Mudminnow family

141. central mudminnow — *Umbra limi*

150. HIODONTIDAE — Mooneye family

151. goldeye — *Hiodon alosoides*
152. mooneye — *Hiodon tergisus*

160. CATOSTOMIDAE — Sucker family

161. quillback — *Carpiodes cyprinus*

*Scott and Crossman (1973) synonymize this species with C. artedii.

162. longnose sucker — *Catostomus catostomus*
163. white sucker — *Catostomus commersoni*
164. lake chubsucker — *Erimyzon sucetta*
165. northern hog sucker — *Hypentelium nigricans*
166. bigmouth buffalo — *Ictiobus cyprinellus*
167. spotted sucker — *Minytrema melanops*
168. silver redhorse — *Moxostoma anisurum*
169. black redhorse — *Moxostoma duquesnei*
170. golden redhorse — *Moxostoma erythrurum*
171. shorthead redhorse — *Moxostoma macrolepidotum*
172. greater redhorse — *Moxostoma valenciennesi*
173. river redhorse — *Moxostoma carinatum*
174. black buffalo — *Ictiobus niger*
176. *Catostomus sp.*
177. *Moxostoma sp.*
178. *Ictiobus sp.*

180. CYPRINIDAE — Minnow family

181. goldfish — *Carassius auratus*
182. northern redbelly dace — *Phoxinus eos*
183. finescale dace — *Phoxinus neogaeus*
184. redside dace — *Clinostomus elongatus*
185. lake chub — *Couesius plumbeus*
186. common carp – *Cyprinus carpio*
187. gravel chub — *Hybopsis x-punctata*
188. cutlips minnow — *Exoglossum maxillingua*
189. brassy minnow — *Hybognathus hankinsoni*
190. eastern silvery minnow – *Hybognathus regius*
191. silver chub — *Hybopsis storeriana*
192. hornyhead chub — *Nocomis biguttatus*
193. river chub — *Nocomis micropogon*
194. golden shiner — *Notemigonus crysoleucas*
195. pugnose shiner — *Notropis anogenus*
196. emerald shiner — *Notropis atherinoides*
197. bridle shiner — *Notropis bifrenatus*
198. common shiner — *Notropis cornutus*
199. blackchin shiner — *Notropis heterodon*
200. blacknose shiner — *Notropis heterolepis*
201. spottail shiner — *Notropis hudsonius*
202. rosyface shiner — *Notropis rubellus*
203. spotfin shiner — *Notropis spilopterus*
204. sand shiner — *Notropis stramineus*
205. redfin shiner — *Notropis umbratilis*
206. mimic shiner — *Notropis volucellus*
207. pugnose minnow — *Notropis emiliae*
208. bluntnose minnow — *Pimephales notatus*
209. fathead minnow — *Pimephales promelas*
210. blacknose dace — *Rhinichthys atratulus*
211. longnose dace — *Rhinichthys cataractae*
212. creek chub — *Semotilus atromaculatus*

213. fallfish – *Semotilus corporalis*
214. pearl dace – *Semotilus margarita*
215. silver shiner – *Notropis photogenis*
216. central stoneroller – *Campostoma anomalum*
217. striped shiner – *Notropis chrysocephalus*
218. ghost shiner – *Notropis buchanani*
221. *Phoxinus sp.*
222. *Hybognathus sp.*
223. *Nocomis sp.*
224. *Notropis sp.*
225. *Pimephales sp.*
226. *Rhinichthys sp.*
227. *Semotilus sp.*
228. *Hybopsis sp.*

230. ICTALURIDAE — Catfish family

231. black bullhead — *Ictalurus melas*
232. yellow bullhead — *Ictalurus natalis*
233. brown bullhead — *Ictalurus nebulosus*
234. channel catfish — *Ictalurus punctatus*
235. stonecat — *Noturus flavus*
236. tadpole madtom — *Noturus gyrinus*
237. brindled madtom — *Noturus miurus*
238. margined madtom — *Noturus insignis*
239. flathead catfish – *Pylodictis olivaris*
241. *Ictalurus sp.*
242. *Noturus sp.*
243. *Ictalurus sp.* (other than *I. punctatus*)
244. northern madtom – *Noturus stigmosus*

250. ANGUILLIDAE — Freshwater Eel family

251. American eel — *Anguilla rostrata*

260. CYPRINODONTIDAE — Killifish family

261. banded killifish — *Fundulus diaphanus*
262. blackstripe topminnow — *Fundulus notatus*

270. GADIDAE — Cod family

271. burbot — *Lota lota*

280. GASTEROSTEIDAE — Stickleback family

281. brook stickleback — *Culaea inconstans*
282. threespine stickleback — *Gasterosteus aculeatus*
283. ninespine stickleback — *Pungitius pungitius*
284. fourspine stickleback — *Apeltes quadracus*

290. PERCOPSIDAE — Trout-perch family

291. trout-perch — *Percopsis omiscomaycus*

APPENDIX 2

300. PERCICHTHYIDAE — Temperate Bass family

- 301. white perch — *Morone americana*
- 302. white bass — *Morone chrysops*
- 303. *Morone sp.*

310. CENTRARCHIDAE — Sunfish family

- 311. rock bass — *Ambloplites rupestris*
- 312. green sunfish — *Lepomis cyanellus*
- 313. pumpkinseed — *Lepomis gibbosus*
- 314. bluegill — *Lepomis macrochirus*
- 315. longear sunfish — *Lepomis megalotis*
- 316. smallmouth bass — *Micropterus dolomieui*
- 317. largemouth bass — *Micropterus salmoides*
- 318. white crappie — *Pomoxis annularis*
- 319. black crappie — *Pomoxis nigromaculatus*
- 320. *Lepomis sp.*
- 321. *Micropterus sp.*
- 322. *Pomoxis sp.*
- 323. Warmouth — *Lepomis gulosus*
- 324. orangespotted sunfish – *Lepomis humilis*

330. PERCIDAE — Perch family

- 331. yellow perch — *Perca flavescens*
- 332. sauger — *Stizostedion canadense*
- 333. blue pike (blue pickerel) — *Stizostedion vitreum glaučum*
- 334. walleye (yellow pickerel) — *Stizostedion vitreum vitreum*
- 335. eastern sand darter — *Ammocrypta pellucida*
- 336. greenside darter — *Etheostoma blennioides*
- 337. rainbow darter — *Etheostoma caeruleum*
- 338. Iowa darter — *Etheostoma exile*
- 339. fantail darter — *Etheostoma flabellare*
- 340. least darter — *Etheostoma microperca*
- 341. johnny darter — *Etheostoma nigrum*
- 342. logperch — *Percina caprodes*
- 343. channel darter — *Percina copelandi*
- 344. blackside darter — *Percina maculata*
- 345. river darter — *Percina shumardi*
- 346. tessellated darter — *Etheostoma olmstedi*
- 347. *Stizostedion sp.*
- 348. *Etheostoma sp.*
- 349. *Percina sp.*

360. ATHERINIDAE — Silverside family

- 361. brook silverside — *Labidesthes sicculus*

370. SCIAENIDAE — Drum family

- 371. freshwater drum — *Aplodinotus grunniens*

APPENDIX 2

380. COTTIDAE — Sculpin family
   381. mottled sculpin — *Cottus bairdi*
   382. slimy sculpin — *Cottus cognatus*
   383. spoonhead sculpin — *Cottus ricei*
   384. deepwater sculpin – *Myoxocephalus thompsoni*
   385. *Cottus sp.*
   386. *Myoxocephalus sp.*
   387. fourhorn sculpin – *Myoxocephalus quadricornis*

390. CYCLOPTERIDAE — Lumpfish and Snailfish family

   391. lumpfish — *Cyclopterus lumpus*

400. SALMONIDAE — Hybrids

500. ESOCIDAE — Hybrids

   501. *Esox lucius x Esox americanus vermiculatus*
   502. *Esox lucius x Esox masquinongy*

550. CATOSTOMIDAE — Hybrids

600. CYPRINIDAE — Hybrids

   601. *Carassius auratus x Cyprinus carpio*
   602. *Phoxinus* hybrid
   603. *Phoxinus eos x Phoxinus neogaeus*
   604. *Phoxinus eos x Semotilus margarita*
   605. *Phoxinus neogaeus x Semotilus margarita*
   610. *Notropis* hybrid
   611. *Notropis cornutus x Notropis rubellus*
   612. *Notropis cornutus x Semotilus atromaculatus*
   620. *Pimephales promelas x Pimephales notatus*

650. ICTALURIDAE — Hybrids

   651. *Ictalurus melas x Ictalurus nebulosus*

700. CENTRARCHIDAE — Hybrids

   701. *Lepomis* hybrids
   702. *Lepomis gibbosus x Lepomis macrochirus*
   703. *Lepomis cyanellus x Lepomis gibbosus*
   704. *Lepomis cyanellus x Lepomis megalotis*
   705. *Lepomis cyanellus x Lepomis macrochirus*
   706. *Pomoxis annularis x Pomoxis nigromaculatus*

750. PERCIDAE — Hybrids

   751. *Stizostedion canadense x Stizostedion vitreum*

APPENDIX 2

800. COTTIDAE — Hybrids

801. *Cottus bairdi x Cottus cognatus*

FOR COMMERCIAL FISH USE ONLY

998. roe
999. mixed scrap (animal food)

FOR FISH POPULATION ANALYSIS ONLY

000. all or any species
997. Baitfish
997N. Non-Baitfish
070N. Non-Salmonid

APPENDIX 3

METRIC CONVERSIONS AND NOTATION

LINEAR	1 centimetre (cm) = 10 millimetre (mm)	
	1 metre (m) = 100 cm	
	1 kilometre (km) = 1000 m	
CONVERSIONS	1 inch = 2.54 cm	1 cm = 0.39 inches
	1 foot = 30.48 cm	1 m = 3.28 feet
	1 mile = 1.61 km	1 km = 0.62 miles
AREA	1 cm^2 = 100 mm^2	
	1 m^2 = 10,000 cm^2	
	1 hectare (ha) = 10,000 m^2 = .01 km^2	
	1 km^2 = 100 ha = 1,000,000 m^2	
CONVERSIONS	1 sq. inch = 6.4515 cm^2	1 cm^2 = 0.1550 sq. inches
	1 sq. mile = 2.589 km^2	1 km^2 = 0.3862 sq. miles
	= 258.9 ha	= 247.1996 acres
	1 acre = 0.004 05 km^2	1 ha = 2.47 acres
	= 0.4047 ha	= 0.0039 sq. miles
VOLUME	1 m^3 = 0.000,813 acre feet	
	1 acre foot = 0.123 x $10^4 m^3$	
FLOW	1 cubic foot/sec. (c.f.s.) = 0.028 $m^3\ s^{-1}$	
	1 $m^3\ s^{-1}$ = 35.714 c.f.s.	
VELOCITY	1 m s^{-1} = 3.28 ft s^{-1}	

APPENDIX 4

TEMPERATURE CONVERSION

The numbers in the centre columns (*) are the degrees Celsius or Fahrenheit to be converted. When converting from Fahrenheit degrees to Celsius degrees, the equivalent Celsius degrees are in the left hand column. When converting from Celsius to Fahrenheit degrees, the equivalent Fahrenheit degree are in the right hand column.

C°	*	F°	C°	*	F°	C°	*	F°
–28.9	–20	–4.0	–8.3	17	62.6	12.2	54	129.2
–28.3	–19	–2.2	–7.8	18	64.4	12.8	55	131.0
–27.8	–18	–0.4	–7.2	19	66.2	13.3	56	132.8
–27.2	–17	+ 1.4	–6.7	20	68.0	13.9	57	134.6
–26.7	–16	3.2	–6.1	21	69.8	14.4	58	136.4
–26.1	–15	5.0	–5.6	22	71.6	15.0	59	138.2
–25.6	–14	6.8	–5.0	23	73.4	15.6	60	140.0
–25.0	–13	8.6	–4.4	24	75.2	16.1	61	141.8
–24.4	–12	10.4	–3.9	25	77.0	16.7	62	143.6
–23.9	–11	12.2	–3.3	26	78.8	17.2	63	145.4
–23.3	–10	14.0	–2.8	27	80.6	17.8	64	147.2
–22.8	– 9	15.8	–2.2	28	82.4	18.3	65	149.0
–22.2	– 8	17.6	–1.7	29	84.2	18.9	66	150.8
–21.7	– 7	19.4	–1.1	30	86.0	19.4	67	152.6
–21.1	– 6	21.4	–0.6	31	87.8	20.0	68	154.4
–20.6	– 5	23.0	0.0	32	89.6	20.6	69	156.2
–20.0	– 4	24.8	+ 0.6	33	91.4	21.1	70	158.0
–19.4	– 3	26.6	1.1	34	93.2	21.7	71	159.8
–18.9	– 2	28.4	1.7	35	95.0	22.2	72	161.6
–18.3	– 1	30.2	2.2	36	96.8	22.8	73	163.3
–17.8	0	32.0	2.8	37	98.6	23.3	74	165.2
–17.2	1	33.8	3.3	38	100.4	23.9	75	167.0
–16.7	2	35.6	3.9	39	102.2	24.4	76	168.8
–16.1	3	37.4	4.4	40	104.0	25.0	77	170.6
–15.6	4	39.2	5.0	41	105.8	25.6	78	172.2
–15.0	5	41.0	5.6	42	107.6	26.1	79	174.2
–14.4	6	42.8	6.1	43	109.4	26.7	80	176.0
–13.9	7	44.6	6.7	44	111.2	27.2	81	177.8
–13.3	8	46.4	7.2	45	113.0	27.8	82	179.6
–12.8	9	48.2	7.8	46	114.8	28.3	83	181.4
–12.2	10	50.0	8.3	47	116.6	28.9	84	183.2
–11.7	11	51.8	8.9	48	118.4	29.4	85	185.0
–11.1	12	53.6	9.4	49	120.2	30.0	86	186.8
–10.6	13	55.4	10.0	50	122.2	30.6	87	188.6
–10.0	14	57.2	10.6	51	123.8	31.1	88	190.4
– 9.4	15	59.0	11.1	52	125.6	31.7	89	192.2
– 8.9	16	60.8	11.7	53	127.4	32.2	90	194.2

APPENDIX 5

Minimum Features Required on Maps

	Outline Map	Transect Map	Contour Map	Physical Feature Map
Gazetteer Name	x	x	x	x
Local Name	x	x	x	x
M.N.R. District No.	x	x	x	x
Township	x	x	x	x
Lat. & Long.	x	x	x	x
A.C.F.	x	x	x	x
North Sign	x	x	x	x
Bar Scale	x	x	x	x
Access Roads	x	x	x	x
Survey Date		x	x	x
Sounding Transects		x		
Railways	x		x	x
Power Lines	x		x	x
Dams, Rapids, etc.	x		x	x
Direction of flow (streams)			x	x
Chemical Stations			x	x
Bench Mark			x	x
Depth Contours —				
1 m, 2 m, 4 m etc.			x	
Campsites			x	x
Cottages, resorts			x	x
Gill Net Locations				x
Small Fish Stations				x
Slope Angle of Terrain				x
Aquatic Vegetation				x
Point of Maximum Depth			x	x

APPENDIX 6

HELPFUL HINTS

1) The orderliness and cleanliness of equipment as well as its handling is an excellent indicator of the quality of the survey.

2) Read instructions for all equipment especially the care and maintenance of such.

3) All chemicals are to be replaced at the beginning of each survey session. Chemicals should be stored in a refridgerator or a cool, dark place when not in use. Do not freeze them however.

4) If equipment is broken, report it immediately to your supervisor, so action can be initiated on repair of the unit.

5) Remove all batteries from units when not in use for extended periods of time to reduce corrosion on contact points.

6) Clean Hach chemical kits every 2 weeks to remove spilled chemicals and dirt. Also, clean glassware is a must when conducting chemical tests since very minute contamination can alter chemical results.

7) Do not wash glassware and conductivity cells over the side of the boat. One slip and the part is at the bottom of the lake.

8) When refilling bottles with solutions such as sulphuric acid, rinse the bottle with the solution to be placed in the bottle at least twice before filling. Do not rinse containers with water or mix old solutions with new solutions. All solutions have a specific normality for the test involved. Any change in this normality will alter the results.

9) The map measurer, polar planimeter and pantograph should be tested periodically against known areas and distances. Units that are worn can cause errors.

10) Do not dry nylon gill nets, trap nets or seines in direct sunlight. The life of the net is shortened greatly if the net is dried in the sunlight as compared to drying in the shade.

11) Nets are set much easier if they are wet as opposed to being dry.

12) Ropes that are frayed such as the Kemmerer bottle or handline should be replaced.

13) When testing for total alkalinity, rinse glassware thoroughly since there is the possibility of sulphuric acid remaining in the flask from the previous test. This is especially prevalent when total alkalinities are less than 200 mg/L. Also do not mix the contents of the dissolved oxygen test in the flask used for total alkalinity.

14) Frequently check your echosounder against a graduated handline to ensure proper readings.

15) Thermistors should not have weights of over 1 kg tied to the probe as weights in excess of this, will cause fatigue on the cable.

APPENDIX 7

INITIAL SPECIFIC CONDUCTANCE umhos/cm

CELL TEMPERATURE °C

	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
15.0	17.2	16.6	16.1	15.6	15.1	14.7	14.3	13.9	13.5	13.1	12.8	12.5	12.2	11.9	11.6	11.4	11.1	10.9	10.6	10.4	10.2	10.0	9.8	9.6	9.4	9.3	9.1	15.0
15.5	17.8	17.2	16.6	16.1	15.6	15.2	14.7	14.3	13.9	13.6	13.2	12.9	12.6	12.3	12.0	11.7	11.5	11.2	11.0	10.8	10.5	10.3	10.1	9.9	9.7	9.6	9.4	15.5
16.0	18.4	17.8	17.2	16.6	16.1	15.7	15.2	14.8	14.4	14.0	13.7	13.3	13.0	12.7	12.4	12.1	11.8	11.6	11.3	11.1	10.9	10.7	10.4	10.2	10.1	9.9	9.7	16.0
16.5	18.9	18.3	17.7	17.2	16.6	16.2	15.7	15.3	14.8	14.5	14.1	13.7	13.4	13.1	12.8	12.5	12.2	11.9	11.7	11.4	11.2	11.0	10.8	10.6	10.4	10.2	10.0	16.5
17.0	19.5	18.9	18.3	17.7	17.2	16.6	16.2	15.7	15.3	14.9	14.5	14.2	13.8	13.5	13.2	12.9	12.6	12.3	12.0	11.8	11.6	11.3	11.1	10.9	10.7	10.5	10.3	17.0
17.5	20.1	19.4	18.8	18.2	17.7	17.1	16.6	16.2	15.7	15.3	14.9	14.6	14.2	13.9	13.6	13.2	12.9	12.7	12.4	12.1	11.9	11.7	11.4	11.2	11.0	10.8	10.6	17.5
18.0	20.7	20.0	19.3	18.7	18.2	17.6	17.1	16.6	16.2	15.8	15.4	15.0	14.6	14.3	13.9	13.6	13.3	13.0	12.8	12.5	12.2	12.0	11.8	11.5	11.3	11.1	10.9	18.0
18.5	21.2	20.5	19.9	19.3	18.7	18.1	17.6	17.1	16.6	16.2	15.8	15.4	15.0	14.7	14.3	14.0	13.7	13.4	13.1	12.8	12.6	12.3	12.1	11.8	11.6	11.4	11.2	18.5
19.0	21.8	21.1	20.4	19.8	19.2	18.6	18.1	17.6	17.1	16.6	16.2	15.8	15.4	15.1	14.7	14.4	14.1	13.8	13.5	13.2	12.9	12.7	12.4	12.2	11.9	11.7	11.5	19.0
19.5	22.4	21.6	20.9	20.3	19.7	19.1	18.6	18.0	17.5	17.1	16.6	16.2	15.8	15.5	15.1	14.8	14.4	14.1	13.8	13.5	13.3	13.0	12.7	12.5	12.3	12.0	11.8	19.5
20.0	23.0	22.2	21.5	20.8	20.2	19.6	19.0	18.5	18.0	17.5	17.1	16.6	16.2	15.9	15.5	15.1	14.8	14.5	14.2	13.9	13.6	13.3	13.1	12.8	12.6	12.3	12.1	20.0
22.5	25.8	25.0	24.2	23.4	22.7	22.0	21.4	20.8	20.2	19.7	19.2	18.7	18.3	17.8	17.4	17.0	16.6	16.3	15.9	15.6	15.3	15.0	14.7	14.4	14.1	13.9	13.6	22.5
25.0	28.7	27.7	26.9	26.0	25.2	24.5	23.8	23.1	22.5	21.9	21.3	20.8	20.3	19.8	19.4	18.9	18.5	18.1	17.7	17.3	17.0	16.6	16.3	16.0	15.7	15.4	15.1	25.0
27.5	31.6	30.5	29.5	28.6	27.7	26.9	26.2	25.4	24.7	24.1	23.5	22.9	22.3	21.8	21.3	20.8	20.3	19.9	19.5	19.1	18.7	18.3	18.0	17.6	17.3	17.0	16.6	27.5
30.0	34.4	33.3	32.2	31.2	30.3	29.4	28.5	27.7	27.0	26.3	25.6	25.0	24.4	23.8	23.2	22.7	22.2	21.7	21.3	20.8	20.4	20.0	19.6	19.2	18.8	18.5	18.2	30.0
32.5	37.3	36.1	34.9	33.8	32.8	31.8	30.9	30.1	29.2	28.5	27.7	27.1	26.4	25.8	25.2	24.6	24.0	23.5	23.0	22.5	22.1	21.6	21.2	20.8	20.4	20.0	19.7	32.5
35.0	40.2	38.8	37.6	36.4	35.3	34.3	33.3	32.4	31.5	30.7	29.9	29.1	28.4	27.7	27.1	26.5	25.9	25.3	24.8	24.3	23.8	23.3	22.9	22.4	22.0	21.6	21.2	35.0
37.5	43.1	41.6	40.3	39.0	37.8	36.7	35.7	34.7	33.7	32.9	32.0	31.2	30.5	29.7	29.0	28.4	27.7	27.1	26.6	26.0	25.5	25.0	24.5	24.0	23.6	23.1	22.7	37.5
40.0	45.9	44.4	43.0	41.6	40.4	39.2	38.1	37.0	36.0	35.1	34.2	33.3	32.5	31.7	31.0	30.3	29.6	29.0	28.3	27.7	27.2	26.6	26.1	25.6	25.1	24.7	24.2	40.0
42.5	48.8	47.2	45.7	44.2	42.9	41.6	40.4	39.3	38.2	37.2	36.3	35.4	34.5	33.7	32.9	32.2	31.4	30.8	30.1	29.5	28.9	28.3	27.8	27.2	26.7	26.2	25.7	42.5
45.0	51.7	49.9	48.3	46.8	45.4	44.1	42.8	41.6	40.5	39.4	38.4	37.5	36.5	35.7	34.8	34.1	33.3	32.6	31.9	31.2	30.6	30.0	29.4	28.8	28.3	27.8	27.2	45.0
47.5	54.5	52.7	51.0	49.4	47.9	46.5	45.2	43.9	42.7	41.6	40.6	39.5	38.6	37.7	36.8	35.9	35.1	34.4	33.7	33.0	32.3	31.6	31.0	30.4	29.8	29.3	28.8	47.5
50.0	57.4	55.5	53.7	52.0	50.5	49.0	47.6	46.2	45.0	43.8	42.7	41.6	40.6	39.6	38.7	37.8	37.0	36.2	35.4	34.7	34.0	33.3	32.6	32.0	31.4	30.8	30.3	50.0
55.0	63.2	61.0	59.1	57.2	55.5	53.9	52.3	50.9	49.5	48.2	47.0	45.8	44.7	43.6	42.6	41.6	40.7	39.8	39.0	38.2	37.4	36.6	35.9	35.2	34.6	33.9	33.3	55.0
60.0	68.9	66.6	64.5	62.4	60.5	58.8	57.1	55.5	54.0	52.6	51.2	49.9	48.7	47.6	46.5	45.4	44.4	43.4	42.5	41.6	40.8	40.0	39.2	38.4	37.7	37.0	36.3	60.0
65.0	74.6	72.1	69.8	67.6	65.6	63.7	61.8	60.1	58.5	57.0	55.5	54.1	52.8	51.5	50.3	49.2	48.1	47.1	46.1	45.1	44.2	43.3	42.4	41.6	40.8	40.1	39.4	65.0
70.0	80.4	77.7	75.2	72.8	70.6	68.6	66.6	64.7	63.0	61.3	59.8	58.3	56.9	55.5	54.2	53.0	51.8	50.7	49.6	48.6	47.6	46.6	45.7	44.8	44.0	43.2	42.4	70.0
75.0	86.1	83.2	80.6	78.0	75.7	73.5	71.4	69.4	67.5	65.7	64.0	62.4	60.9	59.5	58.1	56.8	55.5	54.3	53.1	52.0	51.0	49.9	49.0	48.0	47.1	46.3	45.4	75.0
80.0	91.9	88.8	85.9	83.2	80.7	78.4	76.1	74.0	72.0	70.1	68.3	66.6	65.0	63.4	62.0	60.5	59.2	57.9	56.7	55.5	54.5	53.3	52.2	51.2	50.3	49.3	48.4	80.0
85.0	97.6	94.3	91.3	88.5	85.8	83.2	80.9	78.6	76.5	74.5	72.6	70.8	69.0	67.4	65.8	64.3	62.9	61.5	60.2	59.0	57.8	56.6	55.5	54.4	53.4	52.4	51.5	85.0
90.0	103.3	99.9	96.7	93.7	90.8	88.1	85.6	83.2	81.0	78.9	76.8	74.9	73.1	71.4	69.7	68.1	66.6	65.2	63.8	62.4	61.2	59.9	58.8	57.6	56.5	55.5	54.5	90.0
95.0	109.1	105.4	102.0	98.9	95.9	93.0	90.4	87.9	85.5	83.2	81.1	79.1	77.2	75.3	73.6	71.9	70.3	68.8	67.3	65.9	64.6	63.3	62.0	60.8	59.7	58.6	57.5	95.0
100.0	114.8	111.0	107.4	104.1	100.9	97.9	95.1	92.5	90.0	87.6	85.4	83.2	81.2	79.3	77.4	75.7	74.0	72.4	70.9	69.4	68.0	66.6	65.3	64.0	62.8	61.7	60.5	100.0
125.0	143.5	138.7	134.3	130.1	126.1	122.4	118.9	115.6	112.5	109.5	106.7	104.1	101.5	99.1	96.8	94.6	92.5	90.5	88.6	86.7	84.9	83.2	81.6	80.0	78.5	77.1	75.7	125.0
150.0	172.2	166.5	161.1	156.1	151.4	146.9	142.7	138.7	135.0	131.4	128.1	124.9	121.8	118.9	116.2	113.5	111.0	108.6	106.3	104.1	101.9	99.9	97.9	96.1	94.2	92.5	90.8	150.0
175.0	200.9	194.2	188.0	182.1	176.6	171.4	166.5	161.9	157.5	153.4	149.4	145.7	142.1	138.7	135.5	132.4	129.5	126.7	124.0	121.4	118.9	116.5	114.3	112.1	110.0	107.9	106.0	175.0
200.0	229.7	222.0	214.8	208.1	201.8	195.9	190.3	185.0	180.0	175.3	170.8	166.5	162.4	158.6	154.9	151.4	148.0	144.8	141.7	138.7	135.9	133.2	130.6	128.1	125.7	123.3	121.1	200.0
225.0	258.4	249.7	241.7	234.1	227.0	220.4	214.1	208.1	202.5	197.2	192.1	187.3	182.7	178.4	174.2	170.3	166.5	162.9	159.4	156.1	152.9	149.8	146.9	144.1	141.4	138.8	136.2	225.0
250.0	287.1	277.5	268.5	260.2	252.3	244.9	237.9	231.2	225.0	219.1	213.5	208.1	203.0	198.2	193.6	189.2	185.0	181.0	177.1	173.4	169.9	166.5	163.2	160.1	157.1	154.2	151.4	250.0
275.0	315.8	305.2	295.4	286.2	277.5	269.3	261.6	254.4	247.5	241.0	234.8	228.9	223.4	218.0	213.0	208.1	203.5	199.1	194.8	190.8	186.9	183.1	179.6	176.1	172.8	169.6	166.5	275.0

$$TDS = \left[\frac{\text{(INITIAL CONDUCTIVITY umhos/cm)}}{1 + (0.02\,(\text{cell temp °C} - 25))}\right] \times 0.666$$

CONDUCTIVITY — TDS CONVERSION CHART

March 1982

APPENDIX 7

CELL TEMPERATURE °C

INITIAL SPECIFIC CONDUCTANCE umhos/cm

Initial specific conductance umhos/cm	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Initial specific conductance umhos/cm
300.0	344.5	333.0	322.3	312.2	302.7	293.8	285.4	277.5	270.0	262.9	256.2	249.7	243.7	237.9	232.3	227.0	222.0	217.2	212.6	208.1	203.9	199.8	195.9	192.1	188.5	185.0	181.6	300.0
325.0	373.2	360.7	349.1	338.2	328.0	318.0	309.2	300.6	292.5	284.8	277.5	270.6	264.0	257.7	251.7	246.0	240.5	235.3	230.3	225.5	220.9	216.4	212.2	208.1	204.2	200.4	196.8	325.0
350.0	401.9	388.5	376.0	364.2	353.2	342.8	333.0	323.7	315.0	306.7	298.8	291.4	284.3	277.5	271.0	264.9	259.0	253.4	248.0	242.8	237.9	233.1	228.5	224.1	219.9	215.8	211.9	350.0
375.0	430.6	416.2	402.8	390.2	378.4	367.3	356.8	346.9	337.5	328.6	320.2	312.2	304.6	297.3	290.4	283.8	277.5	271.5	265.7	260.2	254.8	249.7	244.9	240.1	235.6	231.3	227.0	375.0
400.0	459.3	444.0	429.7	416.2	403.6	391.8	380.6	370.0	360.0	350.5	341.5	333.0	324.9	317.1	309.8	302.7	296.0	289.6	283.4	277.5	271.8	266.4	261.2	256.2	251.3	246.7	242.2	400.0
425.0	488.0	471.7	456.5	442.3	428.9	416.2	404.4	393.1	382.5	372.4	362.9	353.8	345.2	337.0	329.1	321.6	314.5	307.7	301.1	294.8	288.8	283.0	277.5	272.2	267.0	262.1	257.3	425.0
450.0	516.7	499.5	483.4	468.3	454.1	440.7	428.1	416.2	405.0	394.3	384.2	374.6	365.5	356.8	348.5	340.6	333.0	325.8	318.8	312.2	305.8	299.7	293.8	288.2	282.7	277.5	272.5	450.0
475.0	545.4	527.2	510.2	494.3	479.3	465.2	451.9	439.4	427.5	416.2	405.6	395.4	385.8	376.6	367.8	359.5	351.5	343.9	336.5	329.5	322.8	316.3	310.1	304.2	298.4	292.9	287.6	475.0
500.0	574.1	555.0	537.1	520.3	504.5	489.7	475.7	462.5	450.0	438.2	426.9	416.2	406.1	396.4	387.2	378.4	370.0	362.0	354.3	346.9	339.8	333.0	326.5	320.2	314.2	308.3	302.7	500.0
525.0	602.8	582.7	564.0	546.3	529.8	514.2	499.5	485.6	472.5	460.1	448.3	437.1	426.4	416.2	406.6	397.3	388.5	380.1	372.0	364.2	356.8	349.6	342.8	336.2	329.9	323.8	317.9	525.0
550.0	631.6	610.5	590.8	572.3	555.0	538.7	523.3	508.7	495.0	482.0	469.6	457.9	446.7	436.1	425.9	416.2	407.0	398.2	389.7	381.6	373.8	366.3	359.1	352.2	345.6	339.2	333.0	550.0
575.0	660.3	638.2	617.7	598.4	580.2	563.2	547.1	531.9	517.5	503.9	491.0	478.7	467.0	455.9	445.3	435.2	425.5	416.2	407.4	398.9	390.8	382.9	375.4	368.2	361.3	354.6	348.1	575.0
600.0	689.0	666.0	644.5	624.4	605.5	587.6	570.9	555.0	540.0	525.8	512.3	499.5	487.3	475.7	464.7	454.1	444.0	434.3	425.1	416.2	407.8	399.6	391.8	384.2	377.0	370.0	363.3	600.0
625.0	717.7	693.7	671.4	650.4	630.7	612.1	594.6	578.1	562.5	547.7	533.7	520.3	507.6	495.5	484.0	473.0	462.5	452.4	442.8	433.6	424.7	416.2	408.1	400.2	392.7	385.4	378.4	625.0
650.0	746.4	721.5	698.2	676.4	655.9	636.6	618.4	601.2	585.0	569.6	555.0	541.1	527.9	515.4	503.4	491.9	481.0	470.5	460.5	450.9	441.7	432.9	424.4	416.3	408.4	400.8	393.5	650.0
675.0	775.1	749.2	725.1	702.4	681.1	661.1	642.2	624.4	607.5	591.5	576.3	561.9	548.2	535.2	522.7	510.9	499.5	488.6	478.2	468.3	458.7	449.5	440.7	432.3	424.1	416.3	408.7	675.0
700.0	803.8	777.0	751.9	728.4	706.4	685.6	666.0	647.5	630.0	613.4	597.7	582.7	568.5	555.0	542.1	529.8	518.0	506.7	496.0	485.6	475.7	466.2	457.1	448.3	439.8	431.7	423.8	700.0
725.0	832.5	804.7	778.8	754.5	731.6	710.1	689.8	670.6	652.5	635.3	619.0	603.6	588.8	574.8	561.5	548.7	536.5	524.8	513.7	503.0	492.7	482.8	473.4	464.3	455.5	447.1	439.0	725.0
750.0	861.2	832.5	805.6	780.5	756.8	734.6	713.6	693.7	675.0	657.2	640.4	624.4	609.1	594.6	580.8	567.6	555.0	542.9	531.4	520.3	509.7	499.5	489.7	480.3	471.2	462.5	454.1	750.0
775.0	889.9	860.2	832.5	806.5	782.0	759.0	737.4	716.9	697.5	679.1	661.7	645.2	629.5	614.5	600.2	586.5	573.5	561.0	549.1	537.7	526.7	516.1	506.0	496.3	486.9	477.9	469.2	775.0
800.0	918.6	888.0	859.4	832.5	807.3	783.5	761.1	740.0	720.0	701.1	683.1	666.0	649.8	634.3	619.5	605.5	592.0	579.1	566.8	555.0	543.7	532.8	522.4	512.3	502.6	493.3	484.4	800.0
825.0	947.3	915.7	886.2	858.5	832.5	808.0	784.9	763.1	742.5	723.0	704.4	686.8	670.1	654.1	638.9	624.4	610.5	597.2	584.5	572.3	560.7	549.4	538.7	528.3	518.3	508.8	499.5	825.0
850.0	976.0	943.5	913.1	884.5	857.7	832.5	808.7	786.2	765.0	744.9	725.8	707.6	690.4	673.9	658.3	643.3	629.0	615.3	602.2	589.7	577.7	566.1	555.0	544.3	534.1	524.2	514.6	850.0
875.0	1004.7	971.2	939.9	910.5	883.0	857.0	832.5	809.4	787.5	766.8	747.1	728.4	710.7	693.7	677.6	662.2	647.5	633.4	619.9	607.0	594.6	582.7	571.3	560.3	549.8	539.6	529.8	875.0
900.0	1033.4	999.0	966.8	936.6	908.2	881.5	856.3	832.5	810.0	788.7	768.5	749.2	731.0	713.6	697.0	681.1	666.0	651.5	637.7	624.4	611.6	599.4	587.6	576.3	565.5	555.0	544.9	900.0
925.0	1062.2	1026.7	993.6	962.6	933.4	906.0	880.1	855.6	832.5	810.6	789.8	770.1	751.3	733.4	716.3	700.1	684.5	669.6	655.4	641.7	628.6	616.0	604.0	592.4	581.2	570.4	560.0	925.0
950.0	1090.9	1054.5	1020.5	988.6	958.6	930.4	903.9	878.7	855.0	832.5	811.2	790.9	771.6	753.2	735.7	719.0	703.0	687.7	673.1	659.1	645.6	632.7	620.3	608.4	596.9	585.8	575.2	950.0
975.0	1119.6	1082.2	1047.3	1014.6	983.9	954.9	927.6	901.9	877.5	854.4	832.5	811.7	791.9	773.0	755.1	737.9	721.5	705.8	690.8	676.4	662.6	649.3	636.6	624.4	612.6	601.3	590.3	975.0
1000.0	1148.3	1110.0	1074.2	1040.6	1009.1	979.4	951.4	925.0	900.0	876.3	853.8	832.5	812.2	792.9	774.4	756.8	740.0	723.9	708.5	693.7	679.6	666.0	652.9	640.4	628.3	616.7	605.5	1000.0
1050.0	1205.7	1165.5	1127.9	1092.7	1059.5	1028.4	999.0	971.2	945.0	920.1	896.5	874.1	852.8	832.5	813.1	794.7	777.0	760.1	743.9	728.4	713.6	699.3	685.6	672.4	659.7	647.5	635.7	1050.0
1100.0	1263.1	1221.0	1181.6	1144.7	1110.0	1077.4	1046.6	1017.5	990.0	963.9	939.2	915.7	893.4	872.1	851.9	832.5	814.0	796.3	779.4	763.1	747.6	732.6	718.2	704.4	691.1	678.3	660.0	1100.0
1150.0	1320.5	1276.5	1235.3	1196.7	1160.5	1126.3	1094.1	1063.7	1035.0	1007.8	981.9	957.4	934.0	911.8	890.6	870.3	851.0	832.5	814.8	797.8	781.5	765.9	750.9	736.4	722.5	709.2	696.3	1150.0
1200.0	1377.9	1332.0	1289.0	1248.7	1210.9	1175.3	1141.7	1110.0	1080.0	1051.6	1024.6	999.0	974.6	951.4	929.3	908.2	888.0	868.7	850.2	832.5	815.5	799.2	783.5	768.5	754.0	740.0	726.5	1200.0
1250.0	1435.3	1387.5	1342.7	1300.8	1261.4	1224.3	1189.3	1156.2	1125.0	1095.4	1067.3	1040.6	1015.2	991.1	968.0	946.0	925.0	904.9	885.6	867.2	849.5	832.5	816.2	800.5	785.4	770.8	756.8	1250.0
1300.0	1492.8	1443.0	1396.5	1352.8	1311.8	1273.2	1236.9	1202.5	1170.0	1139.2	1110.0	1082.2	1055.9	1030.7	1006.7	983.9	962.0	941.1	921.1	901.9	883.5	865.8	848.8	832.5	816.8	801.7	787.1	1300.0
1350.0	1550.2	1498.5	1450.2	1404.8	1362.3	1322.2	1284.4	1248.7	1215.0	1183.0	1152.7	1123.9	1096.5	1070.4	1045.5	1021.7	999.0	977.3	956.5	936.6	917.4	899.1	881.5	864.5	848.2	832.5	817.4	1350.0
1400.0	1607.6	1554.0	1503.9	1456.9	1412.7	1371.2	1332.0	1295.0	1260.0	1226.8	1195.4	1165.5	1137.1	1110.0	1084.2	1059.5	1036.0	1013.5	991.9	971.2	951.4	932.4	914.1	896.5	879.6	863.3	847.6	1400.0
1450.0	1665.0	1609.5	1557.6	1508.9	1463.2	1420.1	1379.6	1341.2	1305.0	1270.7	1238.1	1207.1	1177.7	1149.6	1122.9	1097.4	1073.0	1049.7	1027.3	1005.9	985.4	965.7	946.8	928.6	911.0	894.2	877.9	1450.0
1500.0	1722.4	1665.0	1611.3	1560.9	1513.6	1469.1	1427.1	1387.5	1350.0	1314.5	1280.8	1248.7	1218.3	1189.3	1161.6	1135.2	1110.0	1085.9	1062.8	1040.6	1019.4	999.0	979.4	960.6	942.5	925.0	908.2	1500.0
1550.0	1779.8	1720.5	1665.0	1613.0	1564.1	1518.1	1474.7	1433.7	1395.0	1358.3	1323.5	1290.4	1258.9	1228.9	1200.3	1173.1	1147.0	1122.1	1098.2	1075.3	1053.4	1032.3	1012.1	992.6	973.5	955.8	938.5	1550.0
1600.0	1837.2	1776.0	1718.7	1665.0	1614.5	1567.1	1522.3	1480.0	1440.0	1402.1	1366.2	1332.0	1299.5	1268.6	1239.1	1210.9	1184.0	1158.3	1133.6	1110.0	1087.3	1065.6	1044.7	1024.6	1005.3	986.7	968.7	1600.0

$$TDS = \left[\frac{(\text{INITIAL CONDUCTIVITY umhos/cm})}{1 + (0.02\ (\text{cell temp } ^\circ C - 25))} \right] \times 0.666$$

CONDUCTIVITY — TDS CONVERSION CHART

March 1982

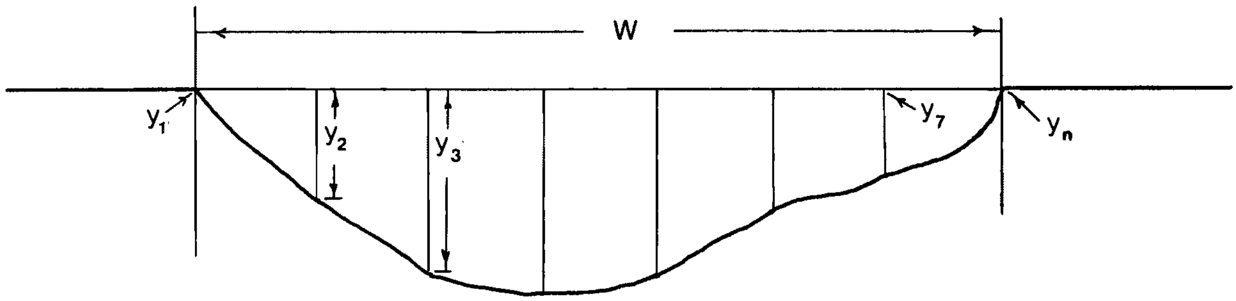
APPENDIX 8
SURVEY GEAR CHECKLIST

Gear	Lake	Stream
Map Measurer	x	x
Polar Planimeter	x	x
Proportional Dividers	x	
Pantograph	x	
Boat	x	x
Motor and gas	x	
Echo Sounder	x	
Weighted Handline	x	x
Kemmerer Bottle or Van Dorn Bottle	x	x
Secchi Disc	x	x
Conductivity Bridge	x	x
Thermistor	x	
Max-Min Thermometer	x	x
Chemistry Kit HACH AL36R	x	
HACH DR-EL	x	x
Nets		
Gill	x	
Seine	x	x
Minnow Traps	x	x
Dip Net	x	x
Electrofisher		x
Battery and Charger		x
Fish Measuring Board	x	x
Dissecting Kit		x
Metre Stick	x	x
Rope	x	x
Plastic Golf Balls		x
Surber Sampler		x
Vials		x
Kahle's Solution		x
Formalin	x	x
Whirl Pak Bags	x	x
Waders	x	x
Rain Gear	x	x
Pail		x
Rubber Hose		x

APPENDIX 9

STREAM DISCHARGE EXAMPLE

	W (m)	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	Y_7	Y_8	η	mean depth (m)
1.	8.00	0	0.05	0.11	0.10	0.10	0.09	0.04	0	8	0.07
2.	7.00	0.02	0.03	0.12	0.10	0.12	0.07	0.05	0	8	0.07
3.	6.50	0	0.04	0.06	0.08	0.10	0.11	0.10	0.02	8	0.07
4.	8.00	0.03	0.05	0.08	0.10	0.11	0.09	0.07	0.03	8	0.08
5.	6.50	0	0.02	0.05	0.08	0.10	0.07	0.04	0	8	0.05
6.	7.50	0	0.04	0.07	0.09	0.10	0.08	0.03	0	8	0.06
7.	9.40	0.02	0.05	0.06	0.10	0.10	0.07	0.02	0.02	8	0.06
8.	6.80	0	0.03	0.07	0.11	0.10	0.07	0.04	0	8	0.06
9.	4.50	0.03	0.05	0.06	0.09	0.09	0.08	0.03	0	8	0.06
10.	6.50	0	0.03	0.07	0.10	0.10	0.07	0.04	0.02	8	0.06
11.	7.50	0	0.03	0.07	0.09	0.10	0.08	0.04	0	8	0.06



$$\text{Mean Depth (Transect \#1)} = \frac{\frac{Y_1 + Y_2}{2} + \frac{Y_2 + Y_3}{2} + \ldots + \frac{Y_{\eta-1} + Y_\eta}{2}}{\eta - 1}$$

$$= \frac{\frac{0.05}{2} + \frac{0.16}{2} + \ldots + \frac{0.04}{2}}{7} = 0.07 \text{ m}$$

$$\text{Mean Depth} = \frac{\Sigma \text{ means}}{\eta} = \frac{0.70}{11} = 0.06$$

$$\text{Mean Width} = \frac{\Sigma W}{\eta} = \frac{78.20}{11} = 7.11 \text{ m}$$

Velocity

Recorded times for golf balls to travel a 40 m station (in seconds) are:

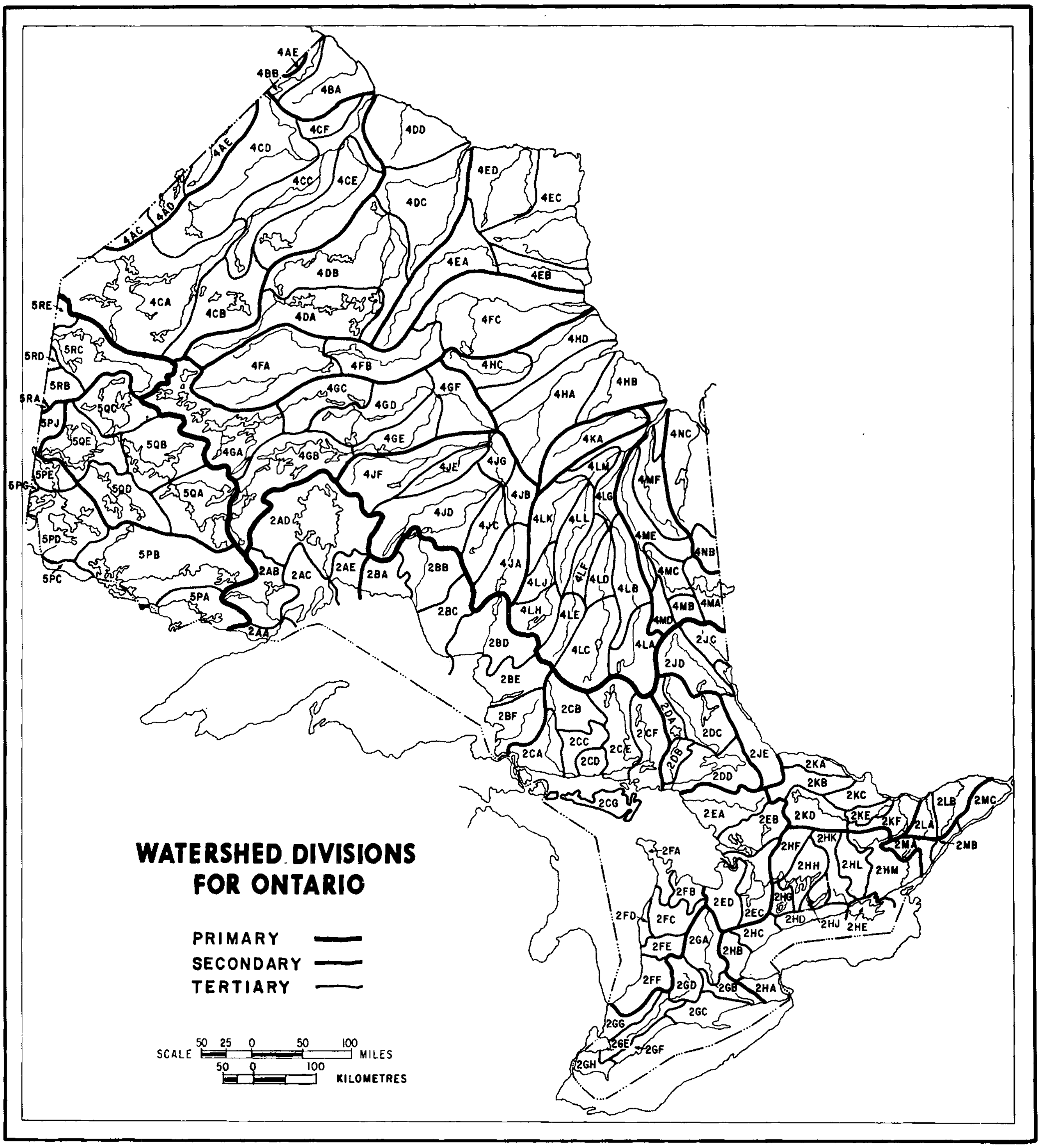
20, 35, 40, 21, 11, 17, 18, 32, 41, 38

$$\text{Velocity} = \frac{d}{\Delta t} = \frac{40.0}{27.3} = 1.47 \text{m s}^{-1}$$

Discharge

Discharge = Mean Depth × Mean Width × Velocity × K (constant)
= 0.06 × 7.11 × 1.47 × 0.9
= 0.56 $m^3 s^{-1}$

APPENDIX 10



Reprinted from :- Counts and Measurements of Ontario Lakes 1978 by :- E.T. Cox

APPENDIX 10

CODES AND NAMES OF ONTARIO TERTIARY WATERSHED DIVISIONS (AFTER COX, 1978)

Code	Tentative Name
2AA	Eight Superior Tributaries
2AB	Five Superior Tributaries
2AC	Twenty-three Superior Tributaries
2AD	Nipigon River
2AE	Twenty two Superior Tributaries
2BA	Twenty Superior Tributaries
2BB	Pic River and Two Other Superior Tributaries
2BC	Thirty Superior Tributaries
2BD	Thirty-one Superior Tributaries
2BE	Twenty-one Superior Tributaries
2BF	Twenty-two Superior Tributaries
2CA	Fourteen St. Marys River – North Channel Tributaries
2CB	Upper Mississagi River
2CC	Lower Mississagi River
2CD	Four North Channel Tributaries
2CE	Spanish River and One Tributary
2CF	Seven North Channel Tributaries and Tributary to Spanish River
2CG	Manitoulin Islands
2DA	Upper Wanapitei River
2DB	Lower Wanapitei River
2DC	Sturgeon River
2DD	French River and Pickeral River
2EA	Nineteen Georgian Bay Tributaries
2EB	Moon River and Go Home River
2EC	Seven River
2ED	Nottawasaga River and 13 other Tributaries
2FA	Bruce Peninsula Streams
2FB	Fourteen Georgian Bay Tributaries
2FC	Saugeen River
2FD	Twenty-three Lake Huron Tributaries
2FE	Maitland River and Two Other Tributaries
2FF	Eighteen Lake Huron Tributaries
2GA	Upper Grand River
2GB	Lower Grand River
2GC	Fifteen Lake Erie Tributaries
2GD	Upper Thames River
2GE	Lower Thames River
2GF	Nine Lake Erie Tributaries
2GG	St. Clair River and Lake St. Clair Tributaries

Code	Tentative Name
2GH	Essex County
2HA	Niagara River – Western Lake Ontario Tributaries.
2HB	Lake Ontario Tributaries
2HC	Lake Ontario Tributaries
2HD	Lake Ontario Tributaries
2HE	Prince Edward County
2HF	Cameron Lake Drainage
2HG	Scugog River
2HH	Kawartha Lakes Drainage
2HJ	Ontonabee River – Rice Lake
2HK	Trent River and Crowe River
2HL	Moira River
2HM	Lake Ontario Tributaries
2JC	Blanche River
2JD	Montreal River
2JE	Lake Temiskaming – Ottawa River
2KA	Holden Lake – Ottawa River
2KB	Petawawa River
2KC	Allumette Lake-Lac Des Chats – Ottawa River
2KD	Upper Madawaska River
2KE	Lower Madawaska River
2KF	Mississippi River – Lac Deschenes
2LA	Rideau River
2LB	Lower Ottawa River
2MA	Western St. Lawrence Tributaries
2MB	West St. Lawrence River
2MC	Lake St. Lawrence – Lake St. Frances
4AC	Upper Gods River
4AD	Lower Gods River
4AE	Echoing River
4BA	Twelve Hudson Bay Tributaries
4BB	Five Hudson Bay Tributaries
4CA	Upper Severn River
4CB	Windigo River – Shade River
4CC	Lower Severn River
4CD	Sachigo River
4CE	Fawn River
4CF	Beaver River
4DA	Upper Winisk River
4DB	Middle Winisk River
4DC	Lower Winisk River

APPENDIX 10

CODES AND NAMES OF ONTARIO TERTIARY WATERSHED DIVISIONS (AFTER COX, 1978)

Code	Tentative Name
4DD	Twenty-four Hudson Bay Tributaries
4EA	Upper Ekwan River
4EB	Lower Ekwan River
4EC	Five Hudson Bay Tributaries – 13 James Bay Tributaries
4ED	Sixteen Hudson Bay Tributaries
4FA	Upper Attawapiskat River
4FB	Middle Attawapiskat River
4FC	Lower Attawapiskat River
4GA	Upper Albany River
4GB	Ogoki Diversion
4GC	West Middle Albany River
4GD	Middle Albany River
4GE	Ogoki River
4GF	East Middle Albany River
4HA	Lower Albany River
4HB	Ten James Bay Tributaries
4HC	Upper Kapiskau River
4HD	Kapiskau River and Six Other James Bay Tributaries
4JA	Upper Kabinakagami River
4JB	Lower Kabinakagami River
4JC	Nagagami River
4JD	Upper Kenogami River
4JE	Drowning River
4JF	Little Current River
4JG	Lower Kenogami River
4KA	Kwataboahegan River
4LA	Upper Mattagami River
4LB	Middle Mattagami River
4LC	Upper Groundhog River
4LD	Lower Groundhog River
4LE	Upper Kapuskasing River
4LF	Lower Kapuskasing River
4LG	Cheepash River
4LH	Upper Missinaibi River
4LJ	South Middle Missinaibi River
4LK	North Middle Missinaibi River
4LL	Opasatika River
4LM	Lower Missinaibi River
4MA	Upper Abitibi River
4MB	Black River
4MC	Middle Abitibi River
4MD	Fredrickhouse River
4ME	Lower Abitibi River
4MF	French River
4NB	Upper Rivere Turgeon
4NC	Seven James Bay Tributaries
5PA	Upper Rainy River
5PB	Middle Rainy River
5PC	Lower Rainy River
5PD	Lake of the Woods and Drainage
5PE	Upper Winnipeg River
5PF	Lower Winnipeg River
5PG	Whiteshell River
5PJ	Oiseau River
5QA	Upper English River
5QB	Lac Seul Drainage
5QC	Pakwash River
5QD	Wabigoon River
5QE	Lower English River
5RA	Ten Lake Winnipeg Tributaries
5RB	Four Lake Winnipeg Tributaries
5RC	Upper Berens River
5RD	Lower Berens River and Others
5RE	Poplar River and Others

APPENDIX 11

WATER MONITORING AGENCIES AND ADDRESSES

Ministry of the Environment Regional Offices

Hydrology and Monitoring Section
Water Resources Branch
135 St. Clair Avenue West
Toronto, Ontario M4V 1P5

Technical Support Section
Toronto Regional Office
150 Ferrand Drive (Suite 700)
Don Mills, Ontario M3B 3C3

Technical Support Section
London Regional Office
985 Adelaide Street South
London, Ontario N6E 1V3

Technical Support Section
Thunder Bay Regional Office
P.O. Box 5000, 435 James St. S
Thunder Bay, Ontario P7C 5G6

Technical Support Section
Hamilton Regional Office
140 Centennial Parkway North
Stoney Creek, Ontario L8E 3H2

Technical Support Section
Sudbury Regional Office
199 Larch Street
Sudbury, Ontario P3E 5P9

Technical Support Section
Kingston Regional Office
133 Dalton Street
Kingston, Ontario K7L 4X6

Ontario Hydro Regional Offices

Central Region
5760 Yonge Street
Willowdale, Ontario M2M 3T7

Northeastern Region
590 Graham Drive
North Bay, Ontario P1B 8L4

Eastern Region
420 Dundas Street East
Belleville, Ontario K8N 5C3

Northwestern Region
34 Cumberland St. N., Rm. 304
Thunder Bay, Ontario P7A 4L5

Georgian Bay Region
93 Bell Farm Road
Barrie, Ontario L4M 1H1

Western Region
1075 Wellington Road
London, Ontario N6E 1M1

Environment Canada Offices

Chief
Inland Waters Publication Sec.
Environment Canada
Place Vincent Massey
Ottawa, Ontario K1A 0H3

Regional Chief
Water Resources Branch
Environment Canada
Federal Building
75 Farquhar Street
Guelph, Ontario N1H 3N4

Fisheries and Oceans Canada

Great Lakes Fisheries Res. Lab.
867 Lakeshore Road
P.O. Box 5050
Burlington, Ontario L7R 4A6

Sea Lamprey Control Centre
Ship Canal P.O.
Huron Street
Sault Ste. Marie, Ontario
P6A 1P0

APPENDIX 12

GLOSSARY OF TERMS

The following hydrological terms will help the surveyor to understand the hydrology in the text more fully.

Cross-Sectional Area (A) — the sum of the panel areas is equal to the cross-sectional area or the product of mean depth and width.

Depth (d) — the vertical distance from the water surface to the river bed.

Elevation — the height of an object with respect to a bench mark.

Energy Slope (Se) — the change in total energy (potential & kinetic) divided by the distance between cross-sections. The actual definition requires a discussion of Bernoulli's equation, however, for the purpose of this paper Se is roughly the difference in water-level elevations divided by the distance between the two cross-sections.

Hydraulic Radius (R) — the ratio of the cross-sectional area (A) to the wetted perimeter (WP); R - A/WP. For wide shallow channels R approximates mean depth.

Panel — a sub-area of the river profile. For each vertical there exists one panel which consists of the dimensions of width (w_i) and depth (d_i).

Roughness Coefficient (n) — the measure of resistance to flow caused by channel friction.

Stage — the height or vertical distance of the water surface above a datum which is usually the river bed.

Vertical (v_i) — the point from which a depth measurement is made. They are labelled as stations v_1, v_2, $v_3 \ldots . v_n$ across the river profile.

Wetted Perimeter (WP) — the distance along the bottom and sides of the channel which are in contact with water. Roughly equivalent to width plus 2 times the mean depth.

Cautionary Notes

1) Human Error: Taking discharge measurements is often a time consuming, repetitious and tedious procedure and it is under these conditions that errors due to inattention are likely to occur. Avoid time consuming rechecks by doing it right the first time.

2) Irrational Readings: The surveyor measures the water velocity at each panel across the river. Usually, if the site has been chosen with care, water velocity should increase from the banks to the centre of the channel and the water velocity measurements should be higher at .2d than at .8d. Large deviations from the normal may indicate either a flow irregularity, operator error or instrument failure. Recheck the measurement when this occurs. The increase or decrease in water velocity across the channel should be gradual. The difference in water velocity between adjacent panels should be small. Large deviations from this require rechecking of the water velocity.

3) Instrument Failure: If readings continue to be irrational, check the instrument for damage or blockage. The bucket wheel must spin freely. Remove blockage or repair damage whenever possible.

4) Discharge Check: Check the calculated roughness coefficient (n) against the general channel type:

$$n = (R^{2/3}\,Se^{1/2}A) \div Q$$

The calculated n should fall within the range of n associated with the channel type guidelines outlined in Chapter 25.12.4.

APPENDIX 13

BASIC PRINCIPLES OF LEVELLING

Levelling is the process of determining the difference in elevation between a point of unknown elevation and a point of known elevation. This is done by measuring the vertical distance between the horizontal planes that intersect the two points. The vertical height of all points is measured with respect to an established bench mark of a known height above sea level. In the absence of such information, all points are measured with respect to a bench mark that is assigned an arbitrary figure of 100.00 m.

THE INSTRUMENT

There are two types of levels that can be used in river surveys. These include the Dumpy level and the Automatic level. Each consists of a telescope, reticle (cross-hairs) and an eyepiece. Adjust the eyepiece to bring the cross-hairs into focus, then the object is brought into focus with the objective focussing dial. If the cross-hairs appear to travel over the sighted object when the eye is shifted slightly in any direction, parallax exists and further adjustment of either the eyepiece or the objective is required to eliminate this situation.

The level must be mounted snugly onto the tripod. Position the platform so that it is approximately level and set the legs firmly in the ground.

Dumpy Level: The dumpy level has four levelling screws. To level, the telescope is turned until it is over two diagonally opposed screws. The bubble is approximately centered in the level vial by turning both levelling screws in opposite direction. This procedure is repeated over the remaining two levelling screws. The screws should be readjusted three or four times since the level is often thrown off during cross levelling.

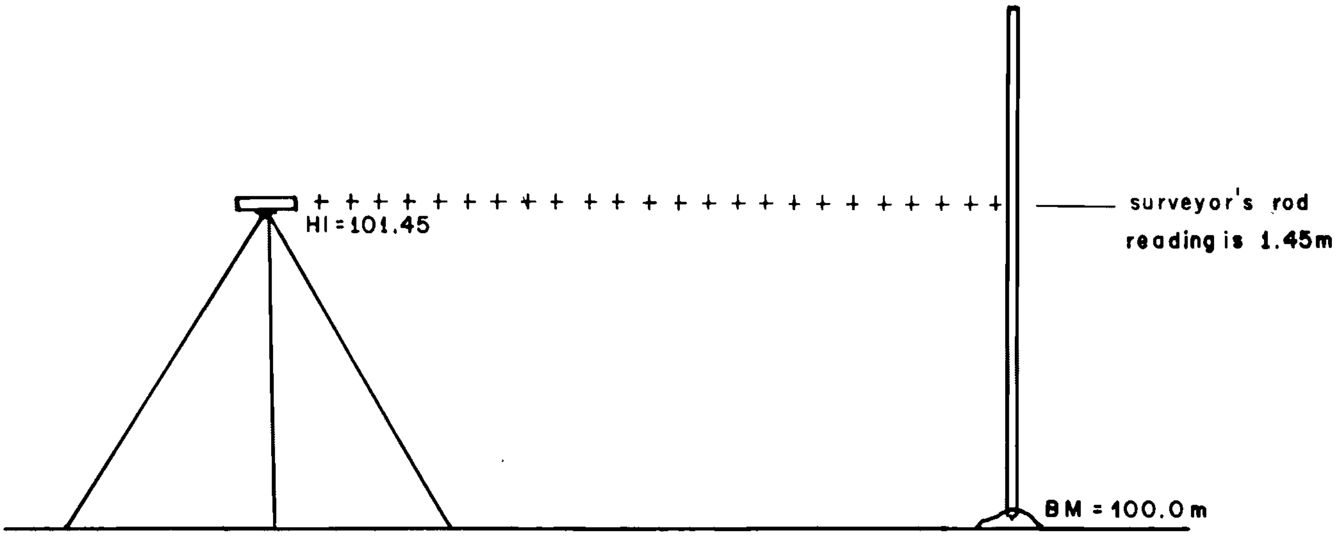
Automatic Level: The automatic level has a three screw head and bull's eye spirit. The three screws are adjusted until the bubble is positioned in the centre of the bull's eye. Internal mechanisms ensure that the instrument will remain level during rotation of the instrument.

The Level Rod: The level rod is used to mark the vertical height difference between two points. To read the level rod, focus the level onto the level rod and read the intersection of the cross-hairs. To ensure that the rod is plumb (vertical), the rodman must rest the butt of the rod on the object and rock the rod forward and backward. The minimum rod reading will occur when the rod is plumb.

LEVELLING

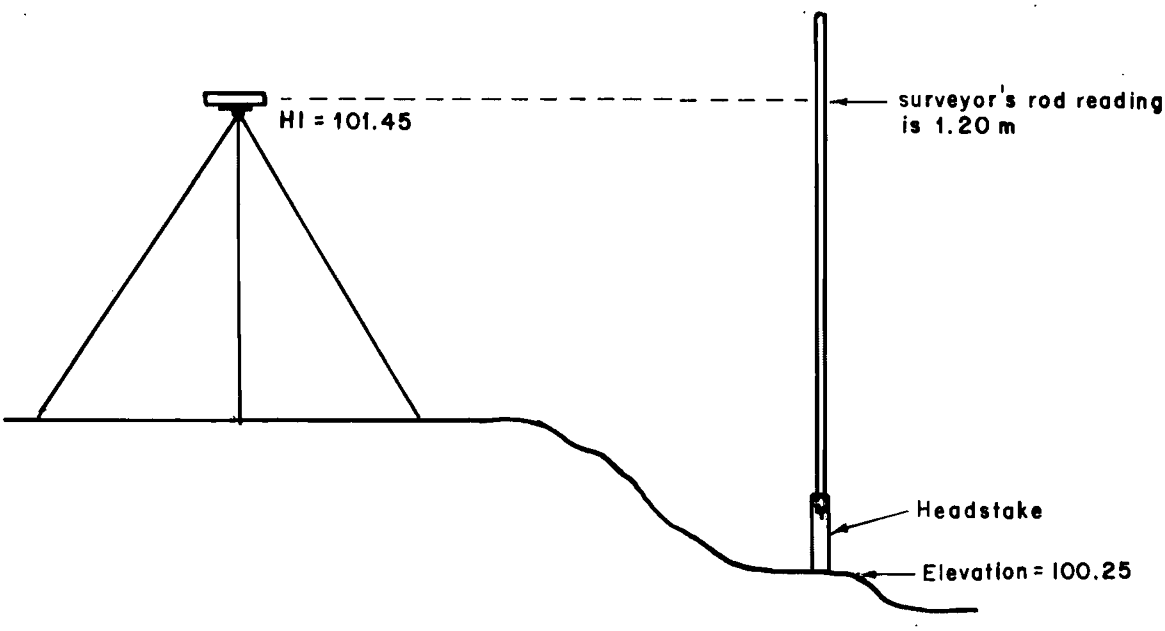
There are some basic definitions commonly used in all types of levelling. These include:

Backsight (BS): A BS is a rod reading taken on a point of known elevation such as a bench mark. It is the vertical distance between the line of sight and the known point. Except in extremely rare cases, the line of sight should be higher than the bench mark and thus the rod reading is added to the bench mark. The algebraic sign of the backsight is positive (+). The term backsight does not refer to the direction in which the instrument is pointed.

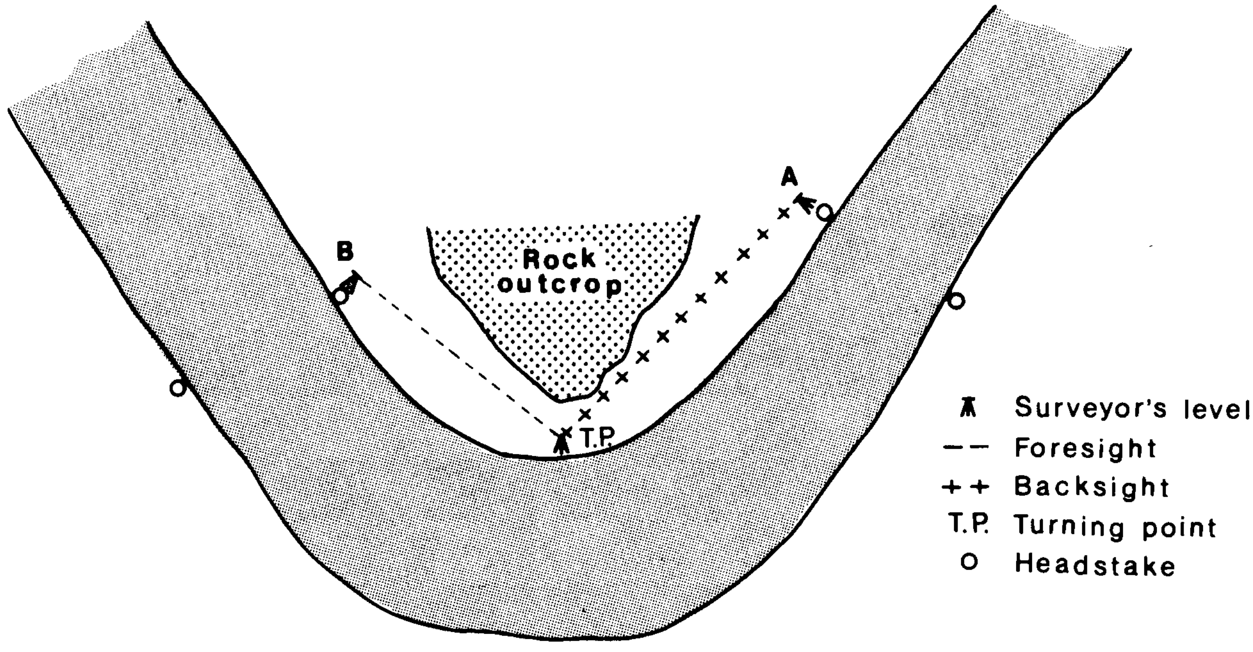


Height of the Instrument (HI): The HI is always the result of a backsight and is the sum of the known elevation and the BS rod reading.

Foresight (FS): The foresight is a rod reading taken on any point or object when HI is known. The elevation of the point is the difference from HI and the rod reading. The algebraic sign of the foresight is negative (–).



Turning Point (TP): The turning point is a temporary bench mark upon which FS and BS readings are taken to continue a line of levels. This is necessary where a shot may be too long or where there is an obstruction between the instrument and the point to be measured.

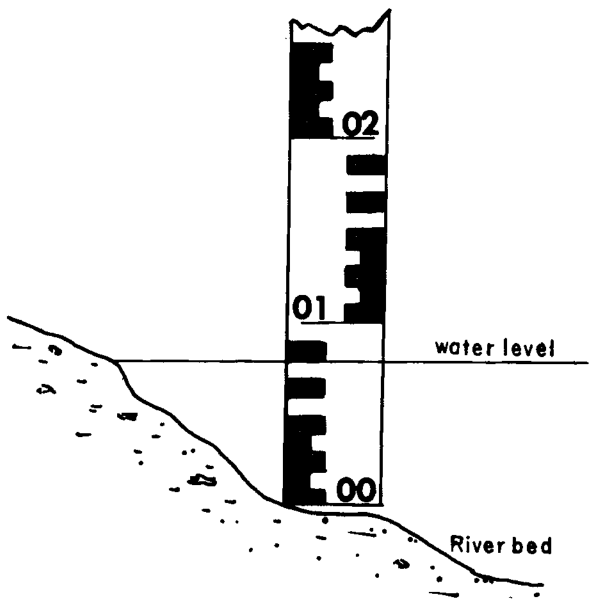


MEASURING POINTS

Headstake: Determine the elevation of the headstake by resting the butt of the rod on the headstake nail.

Bank: Determine the elevation of the bank by resting the butt of the rod on the lip of the bank.

Water Level: Determine the elevation of the water by resting the butt of the level rod in the water and on the river bed near shore. The rodman will read the height of the water on the level rod and this will be added to the foresight (HI - FS + height of the water.)



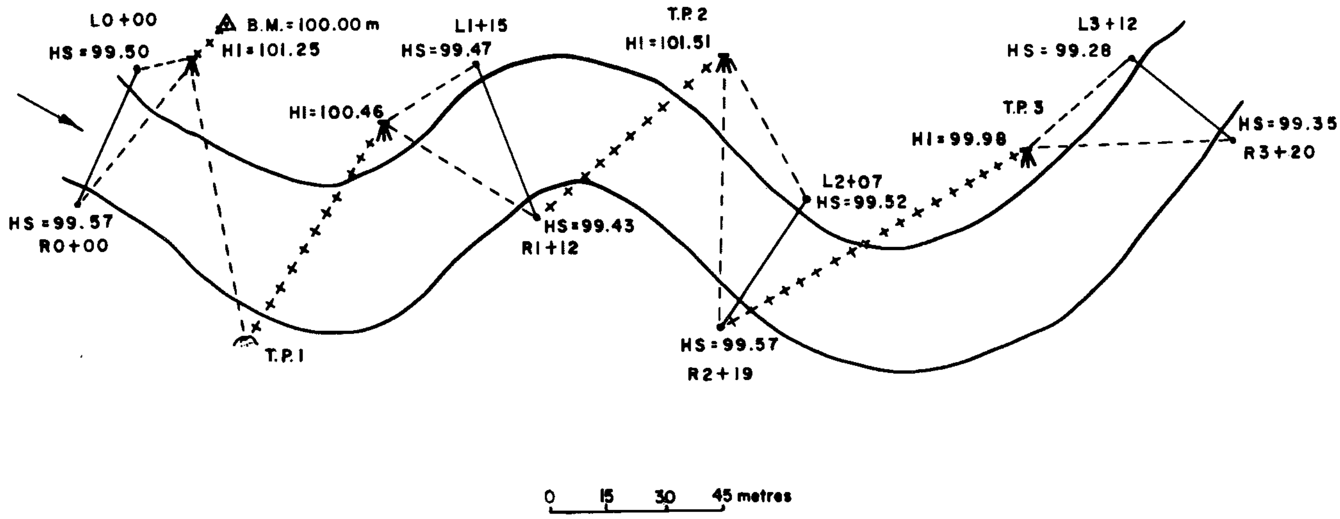
DIFFERENTIAL LEVELLING

Differential levelling is used to determine the elevations of headstakes, banks and the water level (with respect to the bench mark). Once the elevations of the components of the station have been determined, a return check of the headstakes must be made. This is used to determine the accuracy of the levelling. To do this, the level is moved or simply re-levelled and the elevations of the headstakes are surveyed back to the bench mark. Ideally, the final FS to the bench mark should reach 100.00 however, the allowable error is:

$$\pm .025\sqrt{K}$$

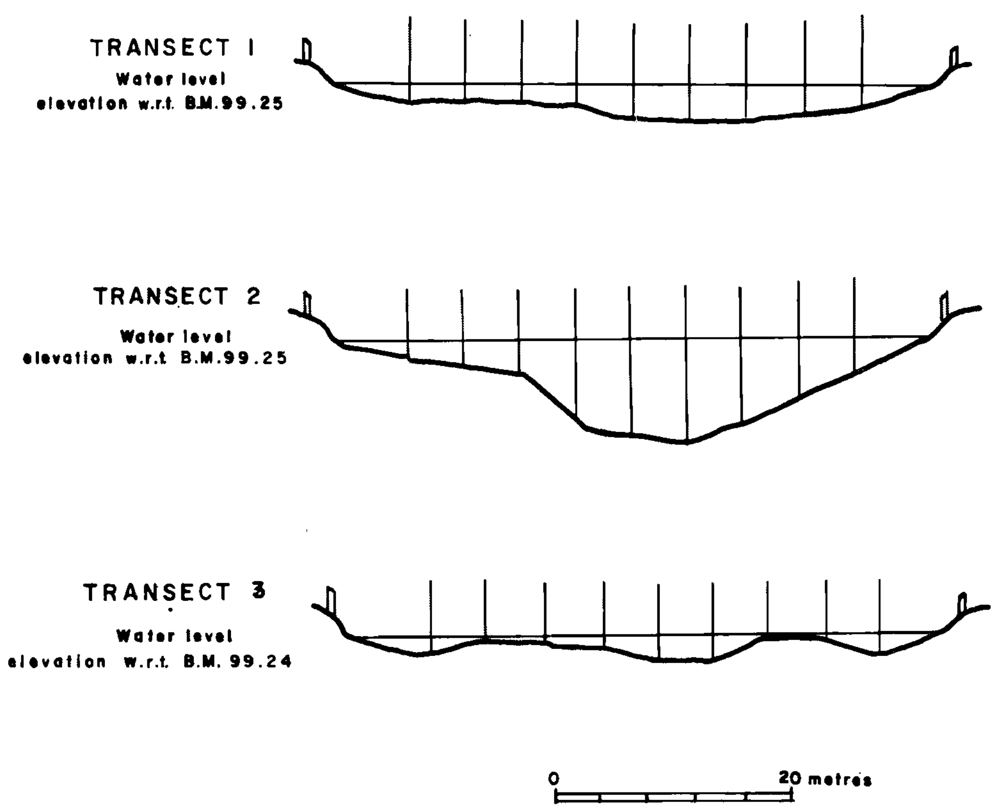
where K is the length of the level loop in km. For example, the allowable error for a level loop of 2.54 km is as follows:

$$\pm .025\sqrt{2.54} = \pm 3.9 \text{ cm}$$



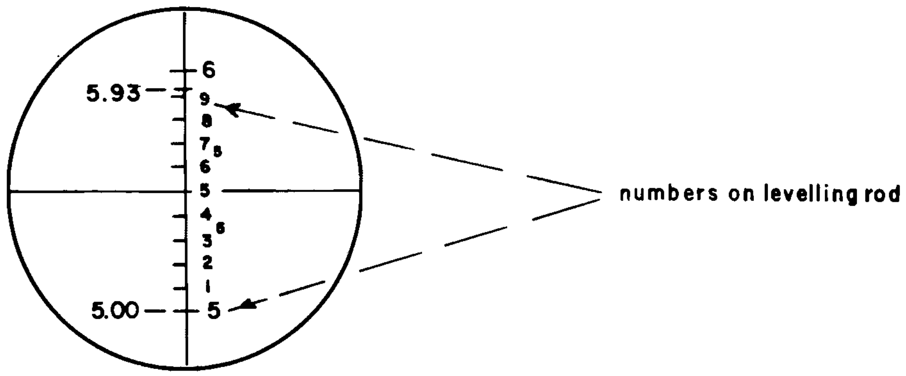
PROFILE LEVELLING (HABITAT PROFILES)

Profile levelling is a process where the elevations of points across the river bed and along the transect are determined. To do this, use the headstake elevation as the bench mark. In shallow water, the bed elevations can be taken directly with rod readings. In deep water the bed elevations can be determined by subtracting the depth of the water from the water surface elevation. Refer to Appendix 14 for water depth and water velocity measuring equipment. Only 9 equidistant verticals are required for simple transect profiles (see diagram below). The distance between verticals is calculated by dividing the river width by 10. Round decimals down to the nearest whole number. In some instances, this will require 10 verticals to complete the profile.



In deep water, measurements at verticals across the profile are taken most easily with the aid of a tag line. A 5 mm (3/16 in.) aircraft cable (tag line) calibrated in 1 m increments is recommended for rivers that are 100 to 200 m wide. Light coaxial tag line can be used for rivers that are less than 100 m wide. The aircraft cable or a light coaxial tag line is used both to measure and mark the distances across a river transect and to secure the boat virtually motionless over the intended vertical while the depth and water velocity measurements are being made. The polypropylene line and aircraft cable will sag for transects over 200 m long. The line and cable can be tightly drawn with a come-along winch and wire grips (use a come-along that is not rated higher than the breaking strength of the aircraft cable). Do not over-tighten the coaxial tag line otherwise the line will stretch and linear measurements will be incorrect. Never attach a tag line to a headstake since this will pull on it and change the elevations of the headstake. Use an available tree or drive an iron bar into the ground to attach the tag line. Record the distance of the bank, water's edge and each vertical from the designated headstake.

Since it is difficult to string a cable over 200 m of river, the surveyors should position the boat over the proper vertical with the aid of the stadia in the reticle of the level. The stadia are short cross-hairs above and below the main horizontal cross-hair, which may be used to estimate linear distances.



The distance from the level to the rod is determined by reading the rod heights that the stadia cross-hairs have intersected. Subtract the lower reading from the upper reading and multiply by a constant (usually 100, but this may vary with different instruments). For example, upper and lower stadia readings of 5.93 and 5.00 m, respectively, indicate that the rod is positioned 9.30 m (0.93 × 100) from the level.

To begin a profile or a discharge measurement, determine the positioning of the verticals across the transect according to the number required and add the distance of the level from the near shore. For example, a distance of 54.5 m is required for a vertical to be positioned 50 m from the left shore. The surveyor operating the level should set up a schedule of rod readings once the distances of each vertical from the level have been calculated (Table 1). To initiate the schedule, the surveyors in the boat must anchor the boat both fore and aft to eliminate yaw along the line of the transect. The rod should be positioned on the bottom of the boat and on the same spot with fluorescent paint and they must not shift any of the load during this type of measurement since it may change the level at which the rod is set. The surveyor at the level must then prepare a series of sights firstly by establishing the rod reading (x) that the main cross-hair intersects.

In the example in Table 1, x = 1.51. Ideally, the main cross-hair will intersect the rod at 1.51 at each subsequent measurement across the transect. The upper and lower stadia reading for each vertical can be calculated as:

$$a = x + y/2 \text{ and}$$
$$b = x - y/2$$

where x = constant or main cross-hair intersection
y = distance in metres from the level
a = upper stadia reading
b = lower stadia reading

The stadia readings at vertical 05 for example were calculated as:

$$a,b = 1.51 \pm 1.18/2$$
$$= 2.095, 0.925$$

Closer inspection of the stadia data in Table 1 indicates that the rod readings are separating at a rate of 22 cm for each new vertical and thus the upper and lower stadia readings decrease and increase 11 cm respectively. The schedule can be easily calculated by establishing the stadia rod readings at transect one and adding and subtracting one half of the vertical interval divided by 100 to each subsequent vertical. For example in Table 1 this is:

$$22\text{ m} \div 2 \div 100 = 0.11$$

By watching either the upper or lower stadia, the surveyor on the instrument will indicate to the boat crew moving along the transect, when the boat is over the proper position.

TABLE 1

A hypothetical stadia schedule set up to aid in the positioning of the boat over the proper vertical.

Profile Transect	04	Horizontal cross hair	1.51 (x)
River width	246 m	Level to shore	7.0 m
Vertical intervals	22 m (z)		

Vertical	Dist. from Shore (m)	Dist. (y) from Level (m)	Upper Stadia (a)	Lower Stadia (b)
01	22	29	1.655	1.365
02	44	51	1.765	1.255
03	66	73	1.875	1.145
04	88	95	1.985	1.035
05	110	117	2.095	0.925
06	132	139	2.205	0.815
07	154	161	2.315	0.705
08	176	183	2.425	0.595
09	198	205	2.535	0.485
10	220	227	2.645	0.375
11	244	251	2.755	0.265

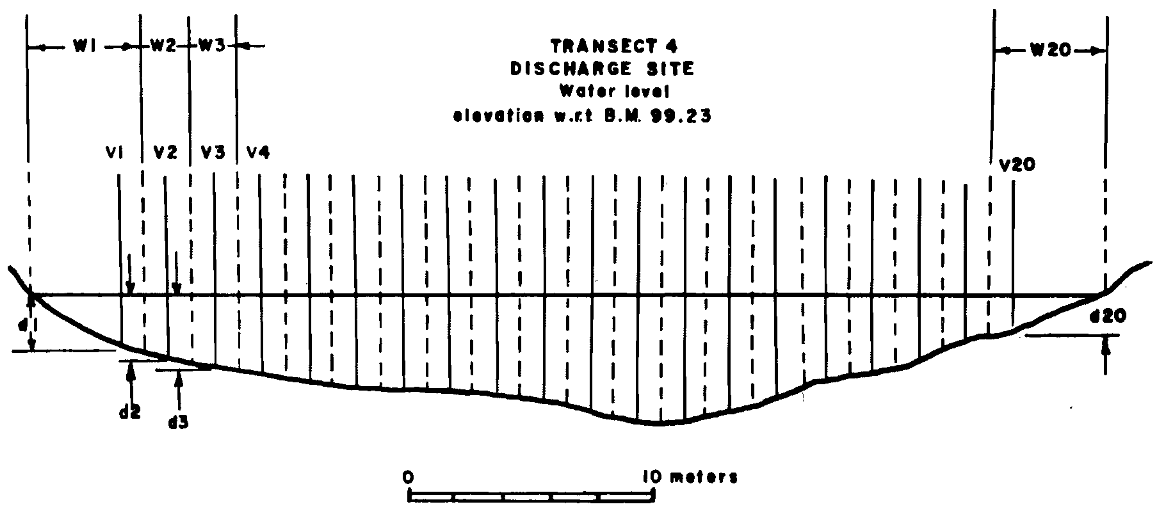
APPENDIX 14

RIVER DISCHARGE MEASUREMENTS

Discharge or flow volume is a four dimensional figure which is the combined products of width (m), depth (m) and flow velocity (m s^{-1}).

There are several different types of instruments and methods that can be used to measure discharge, however, the methods and the instrument described here are the more common types currently used.

The basic premises for river profiling remain true here but 20 verticals are required rather than 9 (refer to Appendix 13). The outside panels associated with verticals one (1) and 20 are usually wider than the 18 verticals between, since the near shore flow is often too small to measure and the verticals must be placed in an area of measurable flow (properties of laminar flow). The area of these outside panels is calculated as 0.5 ($w_i \times d_i$) where w_i is the panel width and d_i is the vertical depth of the panel. The remaining 18 verticals are spaced equidistantly so that the width of each panel is equal to the next.



The total depth and the water velocity are measured at each vertical. If the water depth is 1 m or less, then the velocity is measured at the proportion 0.6 of the total depth. If the water depth is greater than one metre then two velocity measurement are taken at the proportions 0.2 and 0.8 of the total depth. The average velocity is calculated as:

$$\bar{v}_i = \frac{v.2d + v.8d}{2}$$

where v.2d is the velocity at 0.2 of the total depth, v.8d is the velocity at 0.8 of the total depth and $\bar{v}_i$ the average velocity at each vertical.

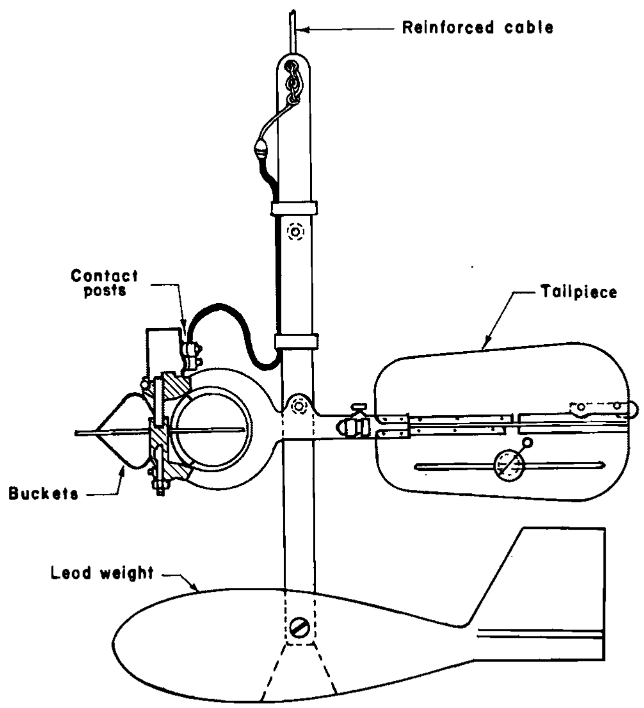
Partial discharge (q_i) is calculated for each panel as

$$q_i = \bar{v}_i \times w_i \times d_i$$

Total channel discharge is the sum of all of the partial discharges.

$$Q(m^3s^{-1}) = \Sigma q_i \ (m^3s^{-1})$$

The Gurly-Price current meter in conjunction with a level wind winch are used to determine flow velocity and water depth respectively.



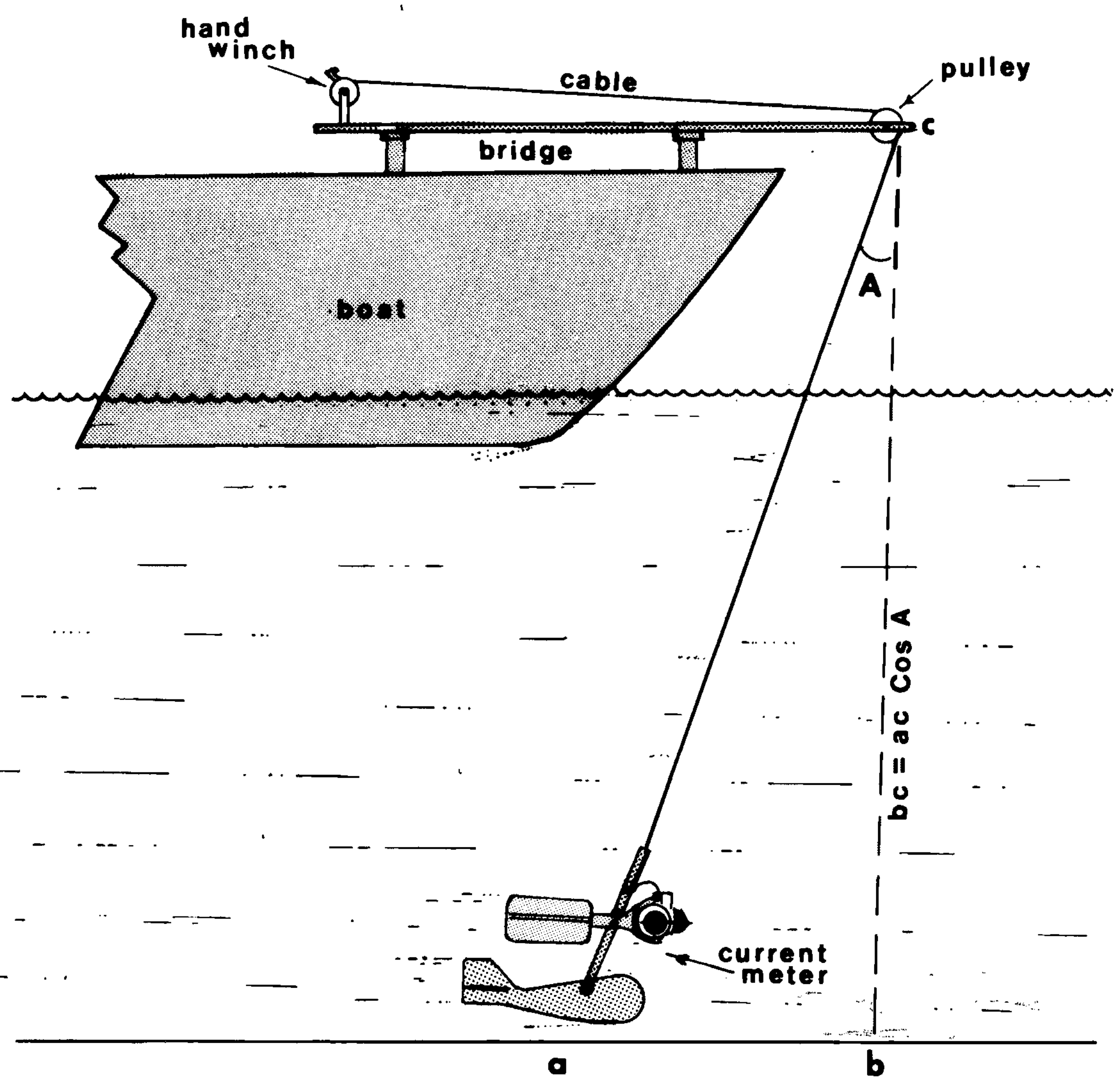
Gurley Current Meter

To measure flow velocity, the number of revolutions of the bucket wheel are counted for a given period of time and the flow velocity is derived either through formulae or a velocity chart. Specifications cannot be given here since each instrument may be calibrated differently from the next. The bucket wheel is connected to a cam shaft which will open and close an electric circuit one time per revolution. The "clicks" may be counted manually through connected headphones or with an electronic counter.

The level wind winch is used as a depth sounder and a mount for the current meter. It is equipped with a metric depth counter, 13.6 kg torpedo weight, hanger bar and an apparatus which will level wind the cable onto the drum to ensure that each revolution of the take up drum will hold on 0.5 m of the 20 m cable.

When taking measurements the winch is mounted on a bridge and over the bow or side of the boat. During the measurements, all persons in the boat must remain in the same seating position from the start of the profile to the end. This practice will ensure the boat will not tip and thus inadvertently change the actual depth reading. To zero the counter, the torpedo is lowered so that the water surface is up to the mid-section of the torpedo-weight (bomb), and then the counter is turned to zero. To measure depth, lower the bomb on and off the bottom to ensure that it is resting on the true bottom. Record the counter number. If the measurement is taken in very swift water the cable will not be plumb in which case the true depth is equal to the product of length of the cable from the pulley and the cosine of the angle from plumb minus the height of the cable above the water as depicted on the diagram.

To measure the water velocity at each proportion of depth (0.2d, 0.6d or 0.8d), the bomb is lowered to the calculated counter depth plus the distance between the mid-point of the bucket wheel to the mid-point of the bomb. This is done because the counter is set to measure the depth at the mid-point of the bomb and velocity must be measured from the mid-point of the bucket wheel.



REFERENCES

American Public Health Assoc. 1981. Standard Methods for the Examination of Water & Wastewater. 15th ed. Ed. by A. Greenberg et al. 1134p.

Brinker, R. C. and W. C. Taylor, 1963. Elementary Surveying. International Textbook Co., Cranton, Pa. 621 pp.

Coker, R. E. 1954. Streams, lakes, ponds. University of North Carolina Press, Chapel Hill, North Carolina. 327 pp.

Cox, E.T. 1978. Counts and Measurements of Ontario Lakes by Watershed Unit. Fisheries Branch, Ministry of Natural Resources 114pp.

Cummings, K. W. 1962. An Evaluation of Some Techniques for the Collection and Analysis of Benthic Samples with Special Emphasis on Lotic Waters. Am. Midl. Nat. 67: 477-504.

Electronic Switchgear (London) Ltd. 1966. Electrolytic conductivity measuring bridge Type MC3 and MC41, Operating Instructions. Lond. 6 pp.

Furuno Operator's Manual. Model FG-11/200 Mark-3. 1970. Furuno Electric Co. Ltd. Nishinomiya, Japan. 42pp.

Hach Chemical Co. 1973. Methods manual, for use with Hach DR-EL direct reading engineer's laboratory series. Ames, Iowa. 119 pp.

Hubbs, C. L. & K. F. Lagler, 1967. Fishes of the Great Lakes Region. University of Michigan Press. Ann Arbor. 213pp.

Hutchinson, G. E. 1957. A treatise on limnology. John Wiley & Sons, N.Y. Volume I, 1015 pp.

Hutchinson, G. E. 1967. A treatise on limnology. John Wiley & Sons, N.Y. Volume II, 1115 pp.

Hutchinson, G. E. 1975. A treatise on limnology. John Wiley & Sons, N.Y. Volume III, 660 pp.

Macan, T. T. 1963. Freshwater ecology. Longmans, Green and Company Ltd., London. 338 pp.

McCafferty, W. P. 1981. Aquatic Entomology. Science Books International Inc., Boston MA. 448 pp.

Merritt, R. W. & K. W. Cummins (ed.). 1978. An introduction to the aquatic insects of North America. Kendall/Hunt Publishing Company, Dubuqe, Iowa. 441 pp.

Pennak. R. W. 1978. Fresh-water invertebrates of the United States, 2nd ed. J. Wiley & Sons, Toronto, 803pp.

Reid, G. K. 1961. Ecology of inland waters and estuaries. Reinhold Publishing Corp., N.Y. 375 pp.

Robins, C. R., R. M. Bailey, C. E. Bond, J. R. Brooker, E. A. Lachner, R. N. Lea, and W. B. Scott. 1980. A list of Common and Scientific Names of Fishes from the United States and Canada. Fourth Edition. Amer. Fish Soc. Spec. Publ. 12:174p. Bethesda, Maryland.

Ruttner, F. 1952. Fundamentals of limnology. (English translation by Frey, D. G. and F. E. J. Fry). University of Toronto Press, Toronto. 243 pp.

Scott, W. B. 1967. Freshwater fishes of eastern Canada. University of Toronto Press, Toronto. 137pp.

Scott, W. B. & E. J. Crossman. 1969. Checklist of Canadian Freshwater Fishes With Keys For Identification. Life Sci. Misc. Publ., R. Ont. Mus. 104pp.

Scott, W. B. & E. J. Crossman. 1973. Freshwater fishes of Canada. 2nd ed. Fish. Res. Bd. Canada. Bulletin 184, Ottawa. 1966pp.

Steven, G. A. 1960. Nets. Routledge & Kegan Paul Ltd. London. 128pp.

Usinger, R. L. (ed.). 1956. Aquatic insects of California. University of California Press, Berkley. 508 pp.

Veatch, J. O. & C. R. Humphrys. 1964. Lake terminology. Bulletin 14, Michigan State University, East Lansing, Michigan. 271 pp.

Ward, H. B. & G. C. Whipple. 1959. Fresh water biology. (edited by W. T. Edmondson). John Wiley & Sons, Inc., N.Y. 1248 pp.

Welch, P. S. 1952. Limnology. McGraw-Hill Book Company, Inc., N.Y. 538 pp.

Wetzel, R. G. 1975. Limnology. W. B. Saunders Company. Philadelphia. 743 pp.