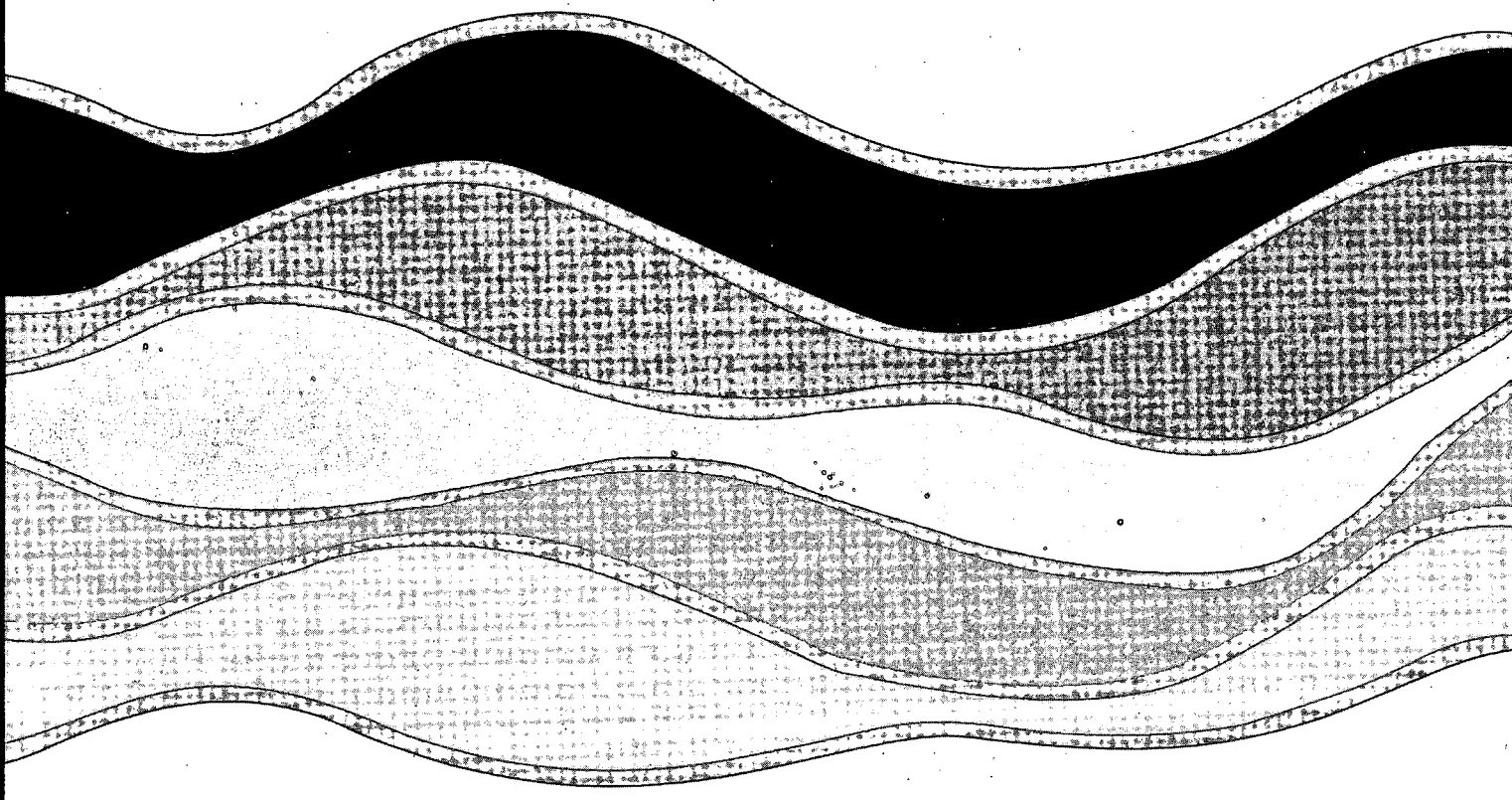
NATIONAL WATER RESEARCH INSTITUTE

INSTITUT NATIONAL de RECHERCHE sur les EAUX



# MEASUREMENT OF THICKNESS OF NEARSHORE SANDS BY HYDRAULIC JETTING

N.A. Rukavina and G.G. LaHaie

NWRI Contribution No. 91-14

# MEASUREMENT OF THICKNESS OF NEARSHORE SANDS BY HYDRAULIC JETTING

N.A. Rukavina[1] and G.G. LaHaie[2]

[1]Lakes Research Branch
[2]Resarch Support Division
National Water Research Institute
Burlington, Ontario L7R 4A6

NWRI Contribution No. 91-14

## MANAGEMENT PERSPECTIVE

Hydraulic jetting is a simple, inexpensive procedure developed for direct measurements of the thickness of nearshore sand deposits in the Great Lakes, and used to estimate sediment volume for coastal-sediment budget calculations. It makes use of a high-pressure water jet to cut through unconsolidated sediments to underlying bedrock or glacial sediment. It can be used on its own or as a control for indirect geophysical-profiling procedures. Potential applications include measurements of the thickness of river sediments and coastal marine sediments, and estimates of sediment and substrate strength. Although the use of jetting as part of various coring procedures is well-established, no published information is available. This methods papers in a major research journal, the Journal of Sedimentary Petrology, is intended to make the sedimentological research community at large aware of a useful sediment-survey procedure.

## PERSPECTIVES DE LA DIRECTION

Le sondage au jet hydraulique est une méthode simple et économique, mise au point pour effectuer des mesures directes de l'épaisseur des dépôts avant-côtiers de sable et utilisée pour estimer le volume des sédiments dans les calculs du bilan des sédiments côtiers. Cette méthode fait appel à un jet d'eau sous haute pression qui est propulsé à travers les sédiments meubles jusqu'à la roche en place sous-jacente ou les sédiments glaciaires. Elle peut être utilisée comme telle ou comme contrôle pour des méthodes indirectes de détermination de profil géophysique. Les applications potentielles comprennent des mesures de l'épaisseur des sédiments fluviaux et des sédimentes marins côtiers ainsi que des estimations de la résistance des sédiiments et du substrat. Bien que l'utilisatioin du jet hydraulique comme partie intégrante de diverses méthodes de sondage soit bien établie, aucune information publiée n'est accessible. Les articles sur cette méthode parus dans une grande revue de recherche, the Journal of Sedimentary Petrology, sont destinés à faire connaître à l'ensemble de la communauté de recherche en sédimentologie, une méthode utile de sondage des sédiments.

RESEARCH METHODS PAPERS

# Measurement of Thickness of Nearshore Sands by Hydraulic Jetting

NORMAN A. RUKAVINA AND GRAHAM G. LAHAIE
National Water Research Institute
Burlington, Ontario
Canada, L7R 4A6

## INTRODUCTION

Conventional acoustic techniques (echo-sounding, sub-bottom profiling) are of limited use in measuring the thickness of Great Lakes' nearshore sand deposits. Higher frequencies give inadequate penetration, lower frequencies inadequate resolution; in both cases noisy records result from the reverberation experienced in shallow water.

As an alternative to the geophysical approach, we have developed a procedure for direct measurement of sediment thickness by hydraulic

Manuscript received_____; revised_____

jetting to refusal. The equipment is portable and can be operated from a small launch or barge. Sediment thickness can be resolved to 0.25 m and in some instances it is possible to identify the underlying material.

The method was suggested by the previous use of jetting as an aid to sampling unconsolidated sediments by Wilson (1941), Pincus et al (1951) and Coffee (1968). It consists simply of fluidizing bottom sediment with a water jet and recording jet penetration to refusal. We offer it as a simple, inexpensive alternative to, or control procedure for, shallow-water geophysical surveys of sediment thickness.

## EQUIPMENT

Jetting equipment (Fig. 1) consists of a jet pipe, reinforced flexible intake and discharge hoses and a high pressure water pump. We use a 7.5 m long pipe made of 1.5 m sections of aluminum (2", schedule 40) and an end section of steel to add weight and resistance to abrasion. The working end of the steel pipe is threaded to serve as a sampler of the material in which refusal occurs. Hose is standard 2-inch fire hose or flexible reinforced plastic hose with clamp connectors. Both pipe and hose are calibrated in units of 0.25 m. A short length of flexible hose with a screened end piece serves as the water intake. The water

pump is a 6 H.P. gasoline-powered fire pump with a discharge of 60 gpm at 60 psi.

## OPERATION

Jetting is most conveniently carried out from a small catamaran or barge with low freeboard and a large deck area to facilitate handling of the hose. The minimal requirement for the operation in terms of space and stability would be a small Boston Whaler or equivalent.

The jetting platform is manoeuvred onto station and anchored fore and aft to minimize drift. The jet pipe is assembled and coupled to the pump with a hose length at least twice the water depth. The pipe is then lowered by hand (or by winch, if available) into contact with the bottom and the water depth is read from the hose markings (Fig. 2). The pump is started and the water jet from the pipe fluidizes a sediment column into which the pipe is advanced. Penetration continues until the jet encounters bedrock or semi-consolidated glacial sediment and no further progress is possible (Fig. 2). Pipe behaviour at this stage is often a clue to the type of underlying material. The pipe tends to bounce on bedrock or boulder bottoms and to stick in glacial till or glaciolacustrine sediment. When refusal occurs, depth of penetration is recorded from the hose markings and the pipe is withdrawn and examined for evidence of underlying material retained

in its end threads.

The jetting operation itself generally takes about 10 minutes in water depths of less than 20 m. Total site time including anchoring is about 20 minutes. Maximum penetration achieved to date has been 18 m.

## APPLICATIONS

The jetting procedure was designed specifically for thickness measurement of nearshore sands and gravels in lakes where it has been used as an aid to, or substitute for, conventional acoustic techniques. It should apply equally well to measurements in stream or beach deposits or in finer-grained basin or bay sediments. Limiting grain size with the equipment described is about 2-3 cm gravel. Coarser sediment cannot be fluidized because of pressure loss resulting from the high permeability.

We use jetting in advance of coring to define the geometry of the sediment body being investigated and to provide a basis for optimum siting of cores. Jetting itself should be able to provide a coarse sediment stratigraphy if descent rate is monitored and contacts defined by abrupt changes in the rate of penetration. Further refinement would involve calibration of descent rates with geotechnical information from adjacent cores. There has not yet been a serious effort to explore this potential use.

ln instances where point data on thickness are inadequate and geophysical profiling techniques must be used, jetting can still be helpful in the calibration of the geophysical records.

## REFERENCES

COFFEE, C. E., 1968, A new technique in sand coring: Undersea Technology, March 1968.

PINCUS, H. J., ROSEBOOM, M.L., AND HUMPHRIS, C.C., 1951, 1950 investigation of Lake Erie sediments, vicinity of Sandusky, Ohio: Ohio Division of Geological Survey, Report of lnvestigations No. 9.

WILSON, I. T., 1941, A new device for sampling lake sediments: Jour. Sed. Petrology, v. 11, p. 73-79.

## FIGURE CAPTIONS

Figure 1. Schematic of jetting system

Figure 2. Operation of jetting system

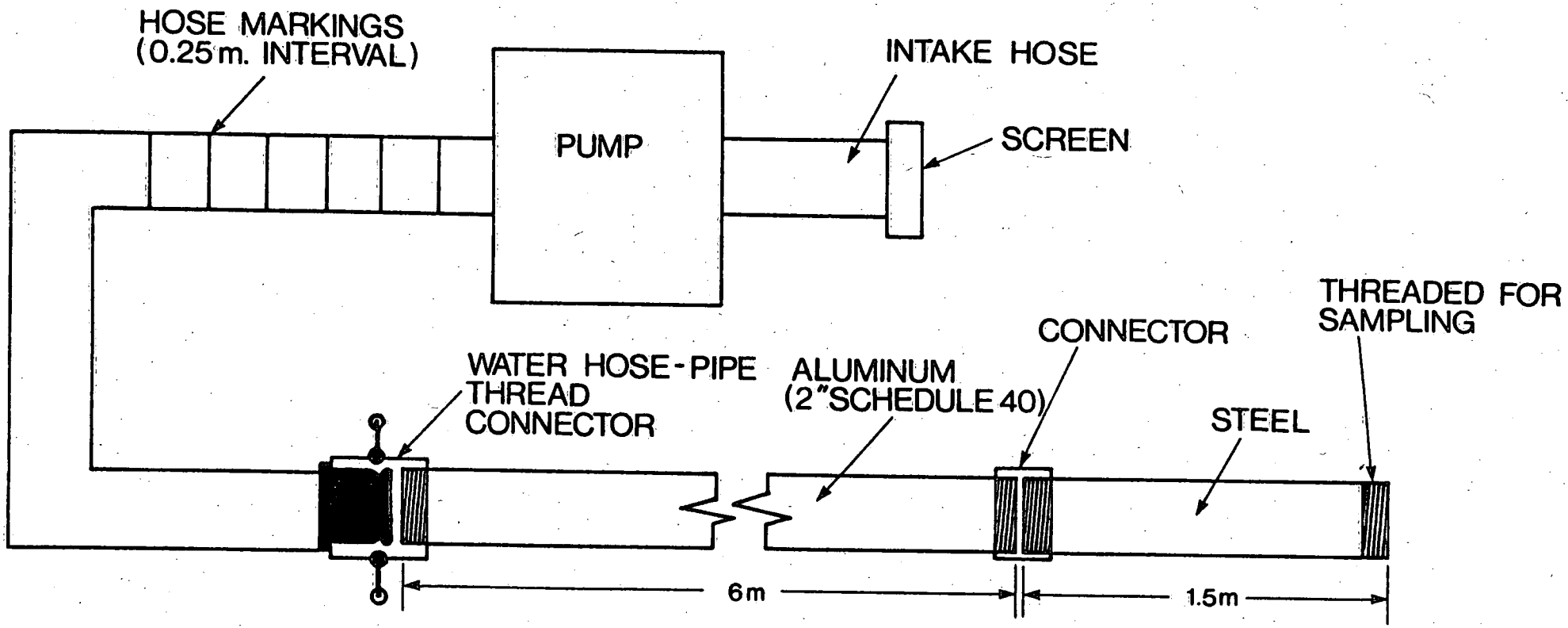

HOSE MARKINGS
(0.25m. INTERVAL)
PUMP
INTAKE HOSE
SCREEN
THREADED FOR
SAMPLING
CONNECTOR
WATER HOSE-PIPE
THREAD
CONNECTOR
ALUMINUM
(2"SCHEDULE 40)
STEEL
6m
1.5m

Figure 1

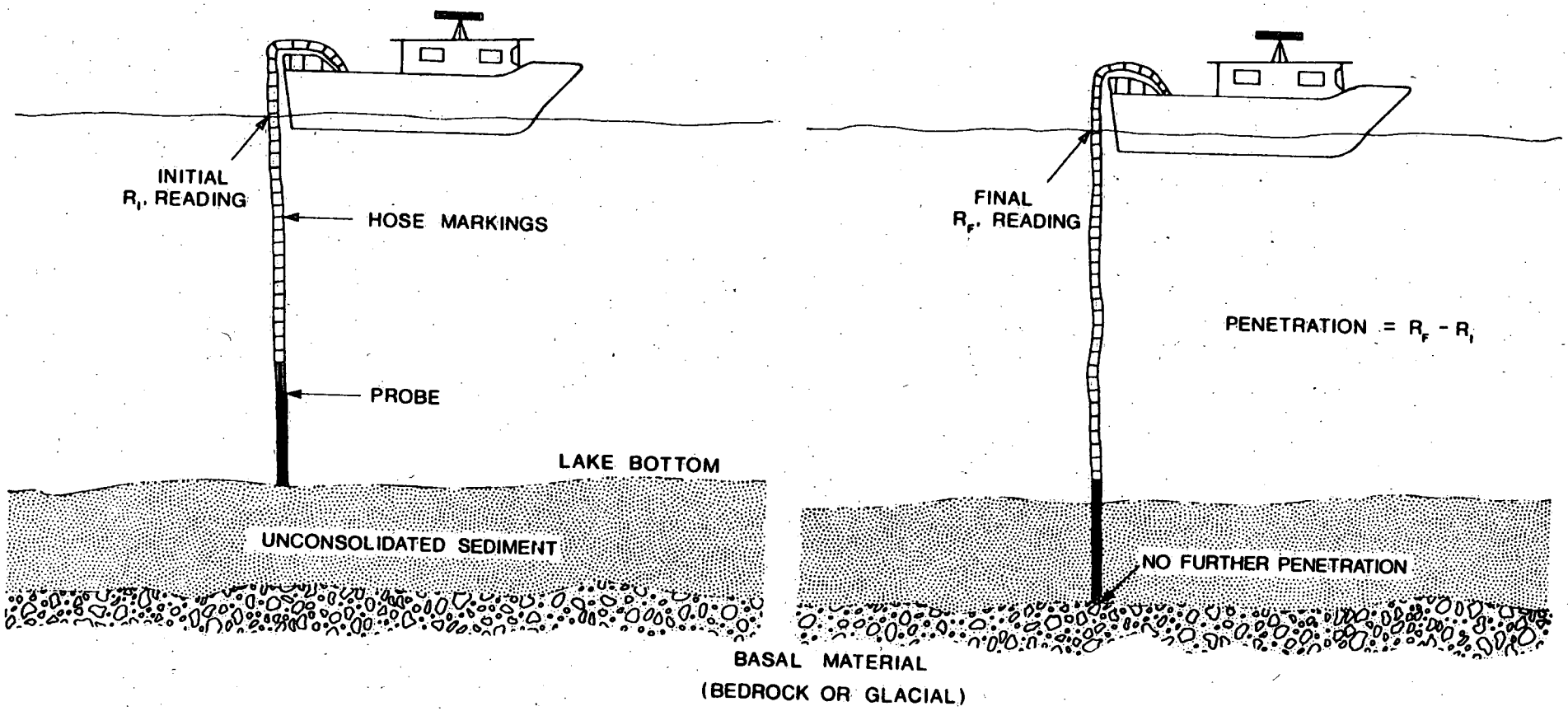
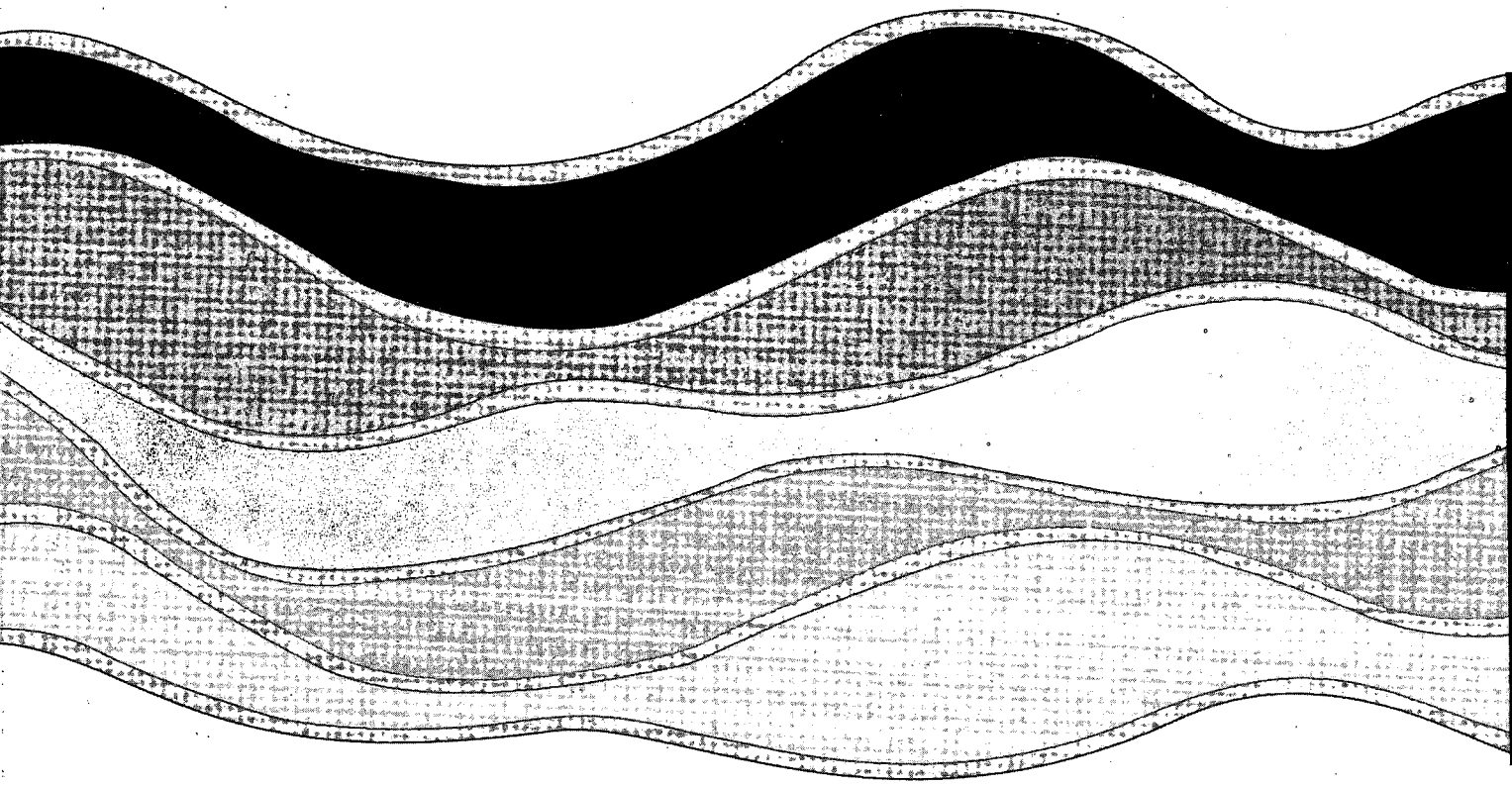

INITIAL
$R_I$. READING
HOSE MARKINGS
PROBE
LAKE BOTTOM
UNCONSOLIDATED SEDIMENT
FINAL
$R_F$. READING
PENETRATION = $R_F - R_I$
NO FURTHER PENETRATION
BASAL MATERIAL
(BEDROCK OR GLACIAL)

Figure 2



NATIONAL WATER RESEARCH INSTITUTE
P.O. BOX 5050, BURLINGTON, ONTARIO L7R 4A6

Environment Canada Environnement Canada

Canada

INSTITUT NATIONAL DE RECHERCHE SUR LES EAUX
C.P. 5050, BURLINGTON (ONTARIO) L7R 4A6

*Think Recycling!*

*Pensez à recycler !*