NWP 65

GREENEX A/S

SOUTH LAKES, MARMORILIK
Runoff Measurements 1978 and 1979

DECEMBER 1979

ARCTIC CONSULTANT GROUP
RÅDGIVENDE INGENIØRER OG ARKITEKTER A/S
TEKNIKERBYEN 19 . DK 2830 VIRUM . TELEFON: 02-85 96 55 . TELEX: 37 120 PERMFR DK . TELEGRAM: ARCCONSULT KØBENHAVN

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1. INTRODUCTION AND SUMMARY

1.1 Object

The object of the field investigations is to gauge the runoff from the South Lake Area.

1.2 Main Results

The total runoff from the Upper South Lake was in 1978 measured to be: $94{,}4 \times 10^6$ m^3 and in 1979: $63{,}9 \times 10^6$ m^3.

2. STAFF AND ACTIVITIES

2.1 1978

Staff

The following persons have participated in the field investigations in 1978:

Ole Holm-Jensen, engineer, ACG
Erik Vagner Eriksen, engineer, ACG
Anna-Lise Borring, engineer, Greenex A/S.

Activities

The investigations were carried out as follows:

July 5-6	:	Establishment of the gauging station
July 8	:	Inspection of the gauging station and discharge measurement.
July 14	:	Inspection of the gauging station and discharge measurement.
July 22	:	Inspection of the gauging station and discharge measurement.
August 2	:	Inspection of the gauging station and discharge measurement.
August 8	:	Inspection of the gauging station and discharge measurement.
August 21	:	Inspection of the gauging station.
August 26	:	Inspection of the gauging station and discharge measurement.
September 5	:	Inspection of the gauging station and discharge measurement.
Sept. 19	:	Inspection of the gauging station and discharge measurement.

Sept. 22	:	Inspection of the gauging station.
October 4	:	Inspection of the gauging station.
October 12	:	Inspection of the gauging station.
November 18	:	Stop of gauging station.

2.2 1979

Staff

The following persons have participated in the field investigations in 1979:

Erik Vagner Eriksen, engineer, ACG
Jørn Steen Larsen, engineer, ACG
Bjørn Eriksen, tech.assistant, ACG
Hanne Roden, tech.assistant, ACG
Karen Pedersen, tech.assistant, ACG
Anna-Lise Borring, engineer, Greenex A/S
Preben Jessen, surveyor, Greenex A/S
Eli J. Nielsen, surveyor, Greenex A/S

Activities

The investigations were carried out as follows:

June 29	:	Visit at the gauging station site
July 4	:	Start up of the gauging station
July 10	:	Inspection of the gauging station
July 17	:	Inspection of the gauging station
July 21	:	Inspection of the gauging station
July 25	:	Inspection of the gauging station
July 30	:	Inspection of the gauging station
August 3	:	Inspection of the gauging station
August 9	:	Inspection of the gauging station
August 15	:	Inspection of the gauging station
August 21	:	Inspection of the gauging station
August 28	:	Inspection of the gauging station
Sept. 4	:	Inspection of the gauging station
Sept. 9	:	Inspection of the gauging station
Sept 18	:	Inspection of the gauging station
October 2	:	Inspection of the gauging station
October 13	:	Stop of gauging station.

3. RUNOFF MEASUREMENTS

3.1 Location of Gauging Station

The geographical location of the gauging station and the extent of its catchment area is shown on Appendix 1. It should be kept in mind that the major part of the runoff from this area stems from the melting icecap and not from precipitation on the land outside the ice.

Data for the gauging station and its location by the outlet of the Upper South Lake is shown on Appendix 2. Furthermore there is a photo on Appendix 3 showing the gauging station area.

3.2 Automatic Water Level Recording

At the gauging station continuous measurements of the stream stage are carried out by means of a water level recorder of the bubble gauge type (make: Telimnip, Neyrtec, France). This pneumatic level recorder transmit the pressure head of water over a bubble orifice at a fixed elevation in the stream through a gas fed tube to a mercury manometer. The gas pressure in the tube is equal to the head over the orifice at any time. A float carried by the free surface of the mercury moves a recorder pen on a chart, continuously tracing the water stage with respect to time (see Appendix 4).

At the gauging site two reference marks have been selected in order to maintain a fixed datum from which periodical checks of the recorded water level can be made (see Appendix 2).

3.3 Discharge Measurements

Through the 1978 season eight discharge measurements have been carried out evenly distributed between low and high water level.

The discharge measurements have been carried out by using the current meter method. This method is based on the determination of velocity profiles in 10 to 15 verticals of the stream cross section. In each vertical 3-8 velocity measurements have been carried out. A boat fixed to a steel wire stretched across the stream was used with the current meter lowered on a rod from the boat. The meter used is a universal current meter (make: A. Ott, Kempten, Germany).

3.4 Stage-discharge Relation

It can be anticipated that the discharge rating is permanent over the years as the river appear with a stable bed consisting of big boulders and with the downstream control section cut in rock formation.

The teoretical relation between stage and discharge is a parabola or a curve consisting of parabolasegments.

This means that the data plotted on logarithmic paper have to form straight lines. By linear regression analysis these lines are found and the stage-discharge relation is given in analytical expression.

For the outlet of the Upper South Lake it appears that the stage-discharge relation consist of only one parabolasegment. The analytical expression is as follows.

$$q = 17.43\ (h+0.17)^{2.055}$$

where h is the water level expressed in meters (m) and q the corresponding discharge in cubic meters per second (m^3/sec.). On Appendix 5 the stage-discharge relation is shown on simple coordinate plotting paper. From this graph the accuracy with which the relation has been defined can be visually evaluated.

3.5 Runoff Calculations

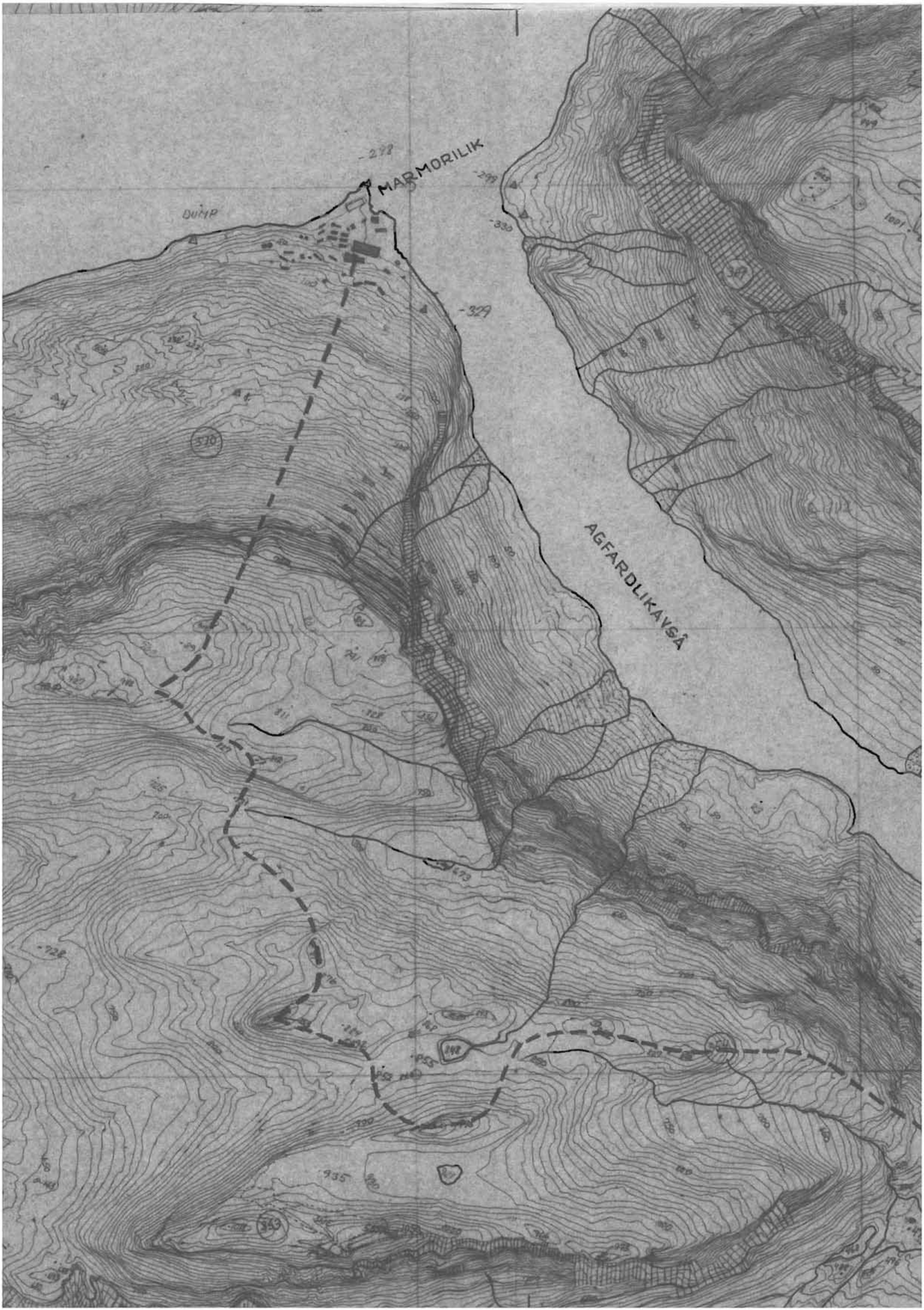
Based on the continuously recorded water stage and the established stage-discharge relation the hydrographs have been drawn as shown on Appendix 6 and 7.

By nummerical integration of the continuously recorded runoffs and the information obtained about the flow conditions before the start of the gauging station, the mass diagrams have been found (see Appendix 6 and 7).

This gives the annual runoff as follows:

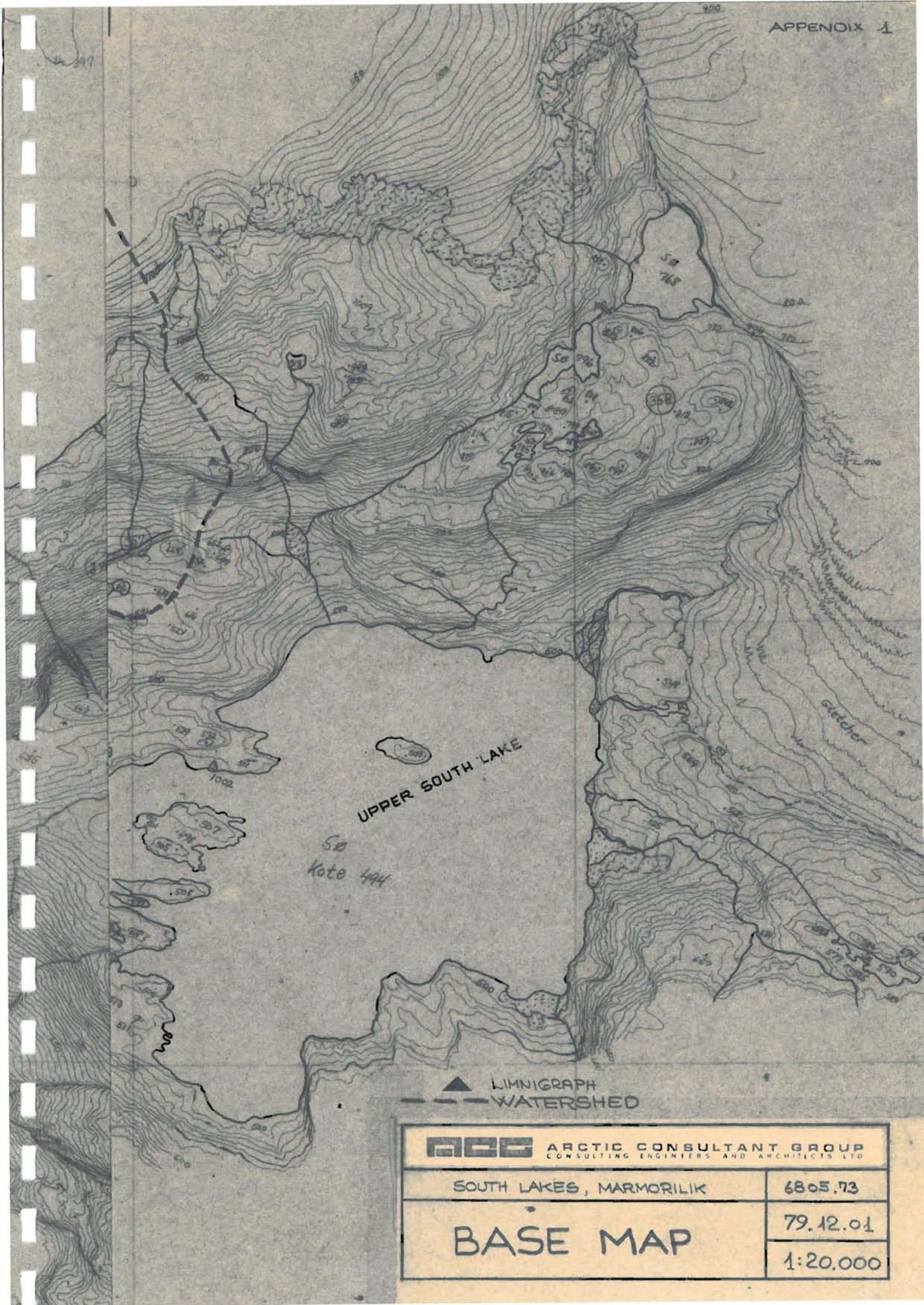
	Measured	Estimated	Total
1978	$92,9 \times 10^6 m^3$	$1,5 \times 10^6 m^3$	$94,4 \times 10^6 m^3$
1979	$60,8 \times 10^6 m^3$	$3,1 \times 10^6 m^3$	$63,9 \times 10^6 m^3$

Furthermore the duration curves are shown on Appendix 6 and 7.


MARMORILIK
DUMP
AGFARDLIKAVSÅ


N
LOWER SOUTH LAKE
Sø
kote 481
SNE

APPENDIX 1


UPPER SOUTH LAKE
Sø
Kote 494
Gletcher
LIMNIGRAPH
WATERSHED
ARCTIC CONSULTANT GROUP
CONSULTING ENGINEERS AND ARCHITECTS LTD
SOUTH LAKES, MARMORILIK
6805.73
BASE MAP
79.12.01
1:20.000

GAUGING STATION DATA

Location : Outlet of The Upper South Lake

Instrument type and no. : Neyrtec Telemnip 78011

Operation started : 78.07.06

Operation terminated :

Bench mark no. 1, Elevation : 102.67

Bench mark no. 2, Elevation : 103.29

Elevation corresponding to left edge of chart : 100.00

Range for water level : 0-2,5 m

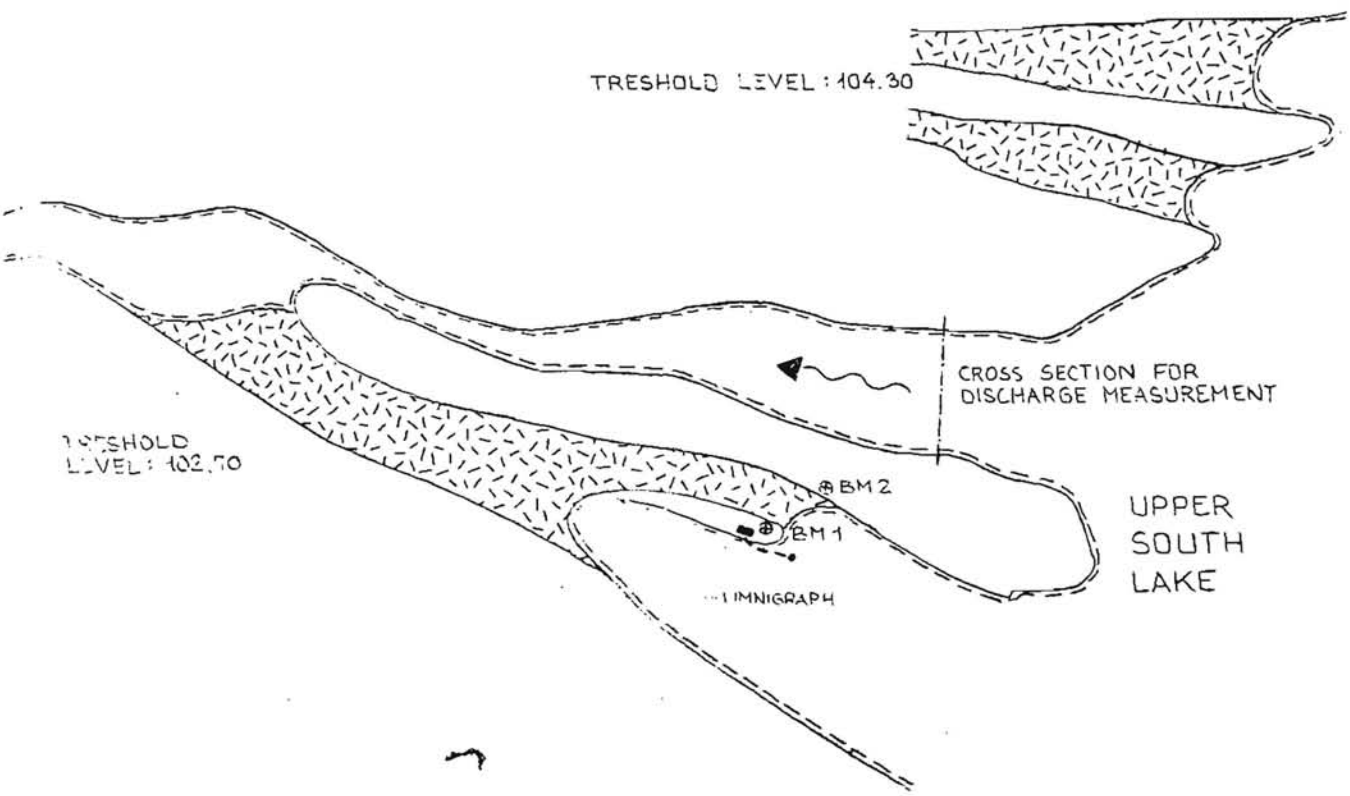
Chart speed : 2,5 mm/h

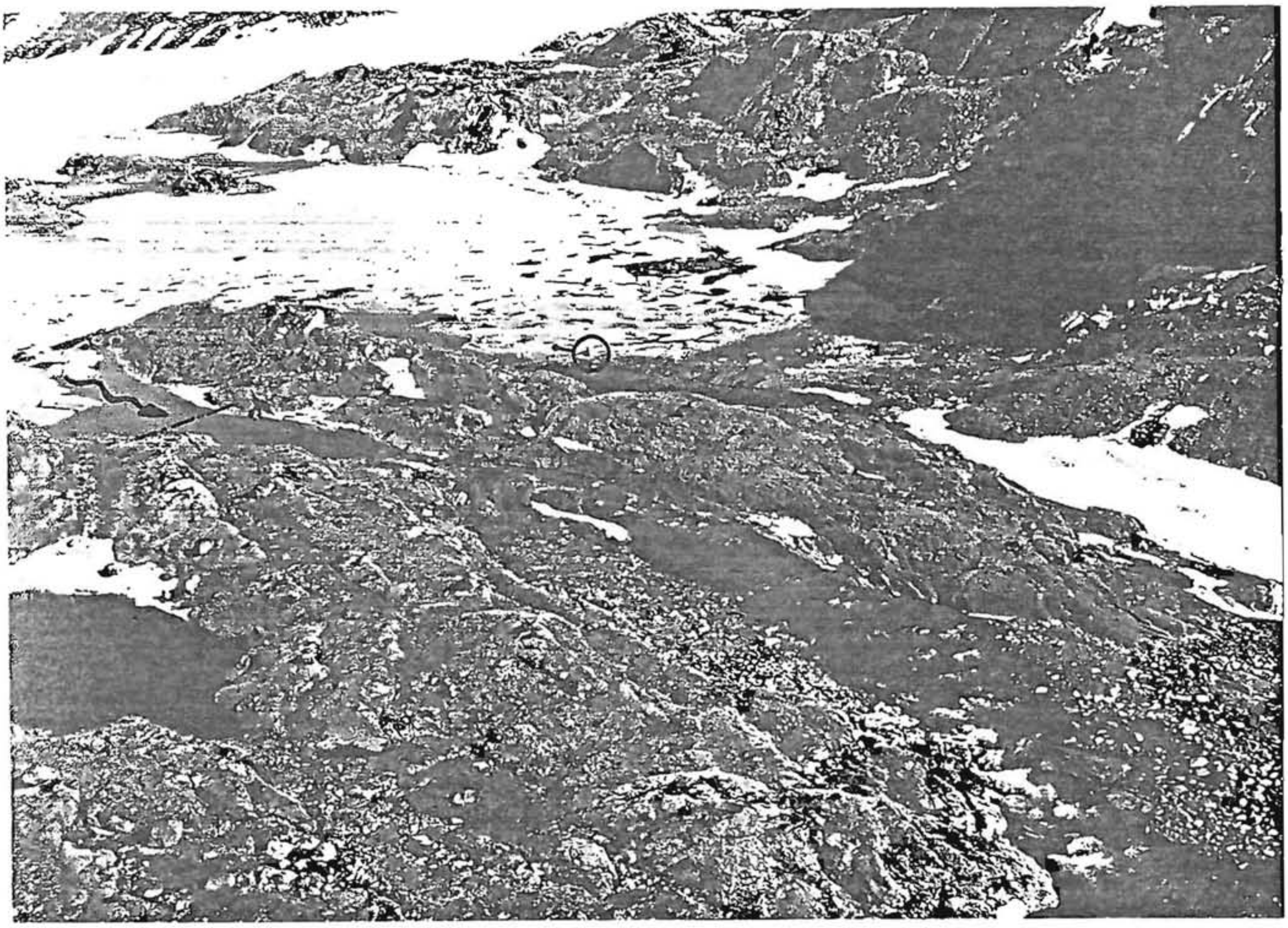
Type of rewinding system : manual

Elevation of pressure point : 99,70

Highest observed water level (m and date) : 101.41 (78.07.23)

Sketch of gauging station area:





GAUGING STATION

Limnigraph

Pipe to pressure point

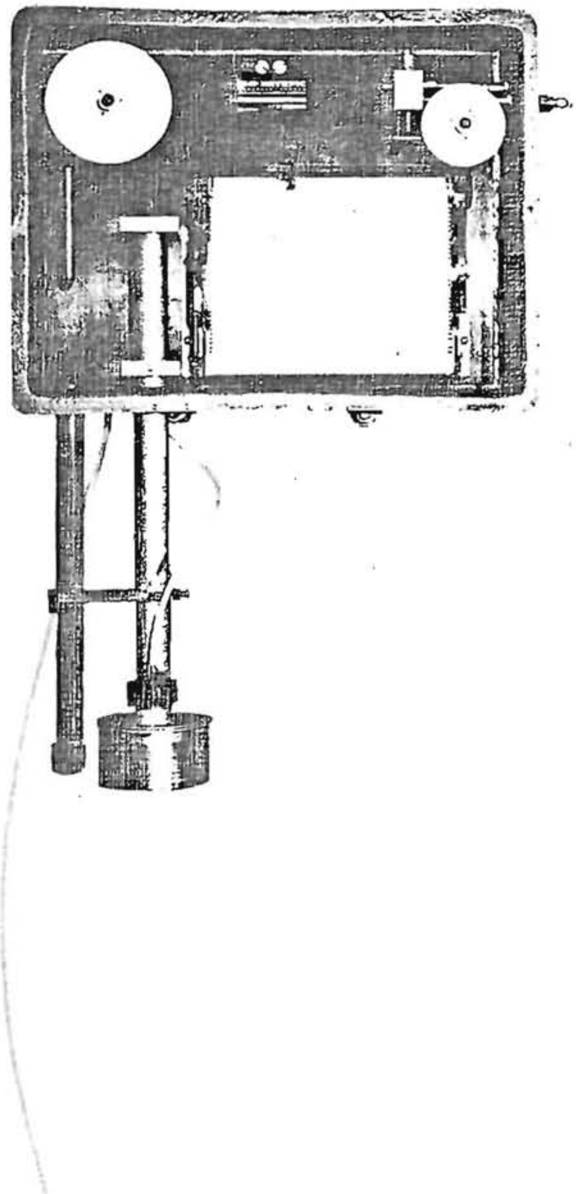
Cross section for discharge measurement

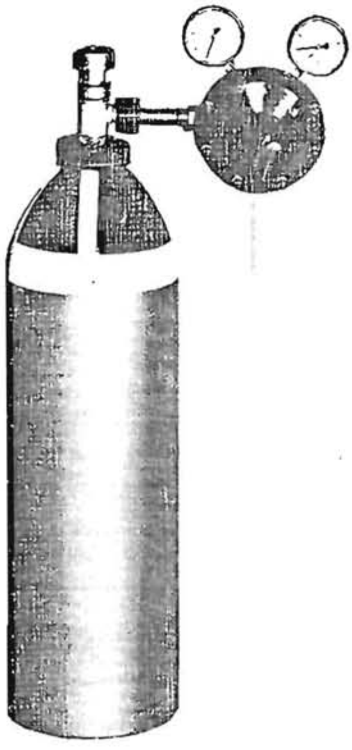
Direction of stream

déc. 73 M 3227

ALSTHOM
GROUPE CGE
DEPARTEMENT MESURES
NEYRPIC

telimnip precision pneumatic level recorder





application

The TELIMNIP is a level recorder which operates without a float well. It measures water level variations by responding to corresponding static pressure changes. It is used for recording slow level variations in rivers, canals, drains, reservoirs, wells and storage lakes, and for tidal measurements both with and without waves.

principle

A low flowrate of air is injected into piping connected to a "pressure point". Pressure in this piping permanently balances the pressure H of the head of water.

$P = \Delta H . \overline{\omega}$ where

$\overline{\omega}$ = specific weight of the liquid.

ΔH = water head above the pressure point.

This air pressure is measured by a mercury pressure gauge with a single vertical tube. A float responds to changes in the mercury level and transmits an amount of motion proportional to the recorder scriber.

advantages

1/ **Advantages proper to the air injection level measuring technique.**

No measuring well is required, with consequent saving in installation costs.

No ill-effect from freezing.

Extensive choice of site installation since the apparatus may be installed at a distance from the measuring location.

Ease in changing measuring location if required.

2/ Advantages of the TELIMNIP

Simple design, with a hard-wearing, reliable direct mechanical system.

High sensitivity ensured by careful technological design.

Very few maintenance requirements, which can all be attended to by the operators.

description

A standard measuring unit comprising :

- The TELIMNIP apparatus proper
- Compressed air supply
- Pressure point with connecting piping.

1. **TELIMNIP components :**

A mercury manometer (19) responding to the pressure to be measured. On request, this manometer can be provided with a damping filter (31) to cut out rapid level variations.

A float (20) responding permanently to changes in the mercury level. The float is suspended from a wire (11) kept taut by a counterweight (12).

A set of pulleys (9) carrying the suspension wire (11), the motion of which is transmitted to a wire (7) carrying the scriber (10).

A chart table (23) with a manual or electrical clockworkrewind system.

Control valve block and sight chamber (5) for air feed adjustment to the pressure pick-up.

Quick-fitting unions (26) for the various air connections.

2. **Compressed air supply**

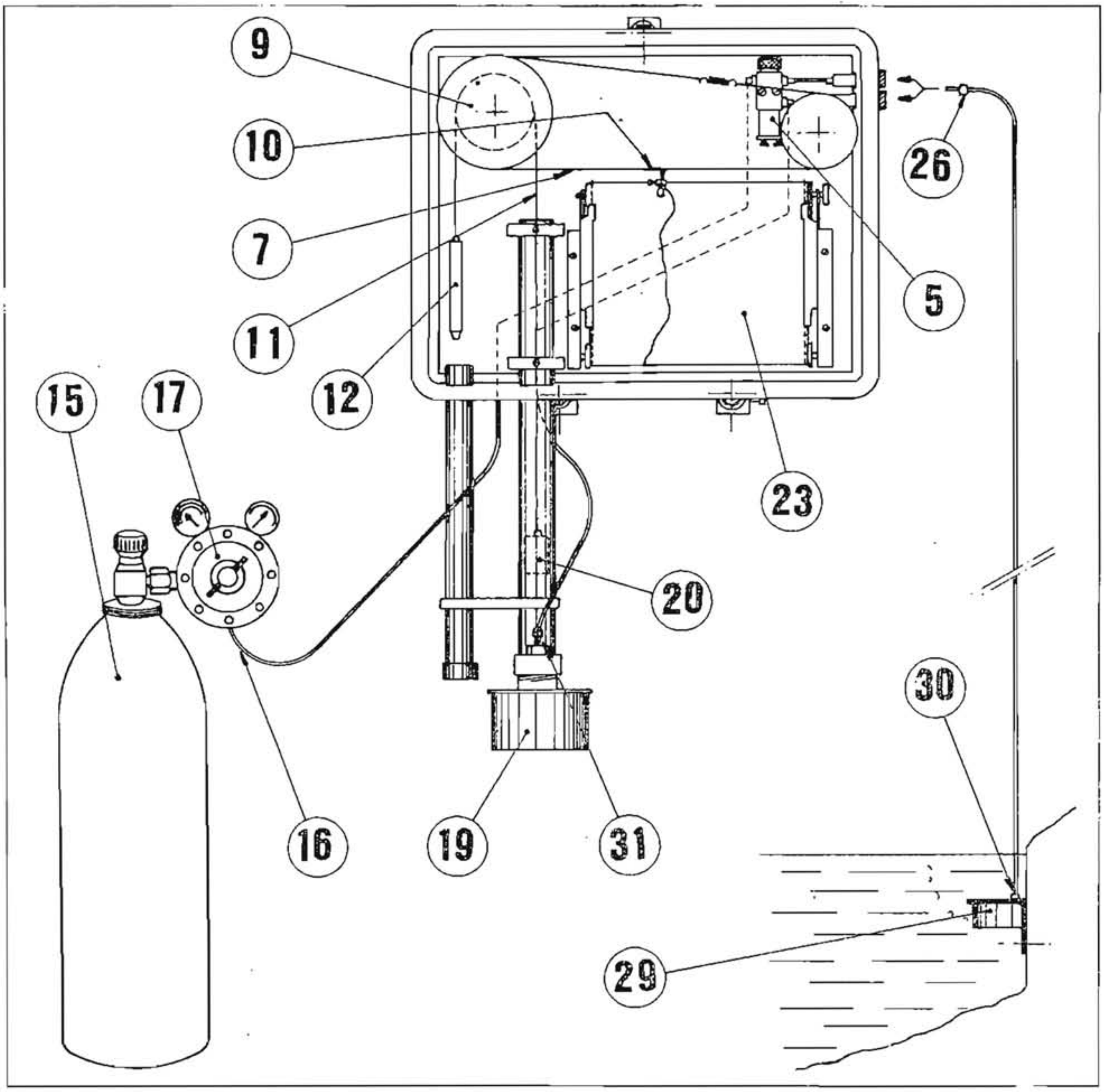
A cylinder (15) of compressed air with safety cock.

A reducing valve (17) and supply piping (16) leading to the valve block.

Standard equipment includes two cylinders (one in service, one in reserve). They comply with French Standards which are valid in most countries. They are all officially stamped by French Authorities and painted in conventional colours.

If an electric power supply is available, an **air compressor** can be used.

3. **Pressure-point** (29) (which must be placed lower than or at the same level as the lowest level to be measured) with supply piping (maximum length 300m - 1000 ft.).



characteristics

I. THE INSTRUMENT

- Standard ranges : 0–2.5 m ; 0–5 m ; 0–7.5 m ; 0–10 m ; 0–15 m w.g. approx. : (8 ft ; 16 ft ; 24 ft ; 32 ft ; 48 ft)
- Reduction scales : 1/10 ; 1/20 ; 1/30 ; 1/40 ; 1/60
- Recording table :

— Effective chart width : 250 mm (approx. 10 in)

— Chart speed :

- manual rewind system : 2.5 and 5 mm/hr - 10 mm as an optional extra (approx. 0.1 and 0.2 in/hr)

- electric rewind system (batteries) : 5 mm/hr (0.2 in/hr) (2.5 mm/hr, 10 mm/hr or 20 mm/hr as optional extras)

- length of unattended operation

Manual rewind system : 4 weeks

Battery rewind system : 6 months, (depending on batteries)

- length of unattended operation relative to chart speed : at 2 mm/hr : 250 days ; at 5 mm/hr : 125 days.

— Dimensions :

- Instrument casing, without manometer : 59 x 48 x 15 cm (23 1/4 x 18 7/8 x 5 7/8 in)

- Height of manometer :
For 2.5 or 5 m ranges : 63 cm (25 in)
For 7.5 or 10 or 15 m ranges : 129 cm (51 in)

- Weight of instrument :
25 kg without mercury (55 lb)

II. GAS SUPPLY

- Cylinders for compressed gas
  - Diameter 18 cm (8 in), height 75 cm (30 in), weight 13 kg (29 lb), volume 10 dm3 (0.35 cu/ft)
  - Volume expanded air : 1500 dm3 (53 cu/ft)

- Standard model
  . test pressure 225 bars (3200 p.s.i.)
  . load pressure at 15°C : 150 bars (2130 p.s.i.)

- Model authorized for use in hot climates
  - test pressure 256 bars (3640 p.s.i.)
  - load pressure at 15°C : 150 bars (2130 p.s.i.)
  - maximum service pressure : 170 bars (2420 p.s.i.)

- Pressure reducer
  High pressure side : 0 - 315 bars (0 to 4480 p.s.i.)
  Low-pressure side : 0 - 6 bars (0 to 84 p.s.i.)

III. PNEUMATIC CIRCUIT

- **Length of gas circuit tubing** (from pressure-pick-up to instrument) :
  To customer's specification, not to exceed 300 m (1000 ft)

- **Level follow-up rate** : 3.5 m/hr (11.5 ft/hr)

IV. MERCURY

Quantity depending on application : see STANDARD SPECIFICATIONS on page 5

accuracy

± 1 cm w.g. (0.4 in) for 2.5 m and 5 m ranges (short manometer)

± 2 cm w.g. (0.8 in) for 7.5 m, 10 m and 15 m ranges (long manometer)

Temperature error is ± 0.1 % for ± 5°C ambient temperature difference from 20°C

standard specification

For detailed accessories and spare parts list, please ask for Specification Sheet N° 3227.

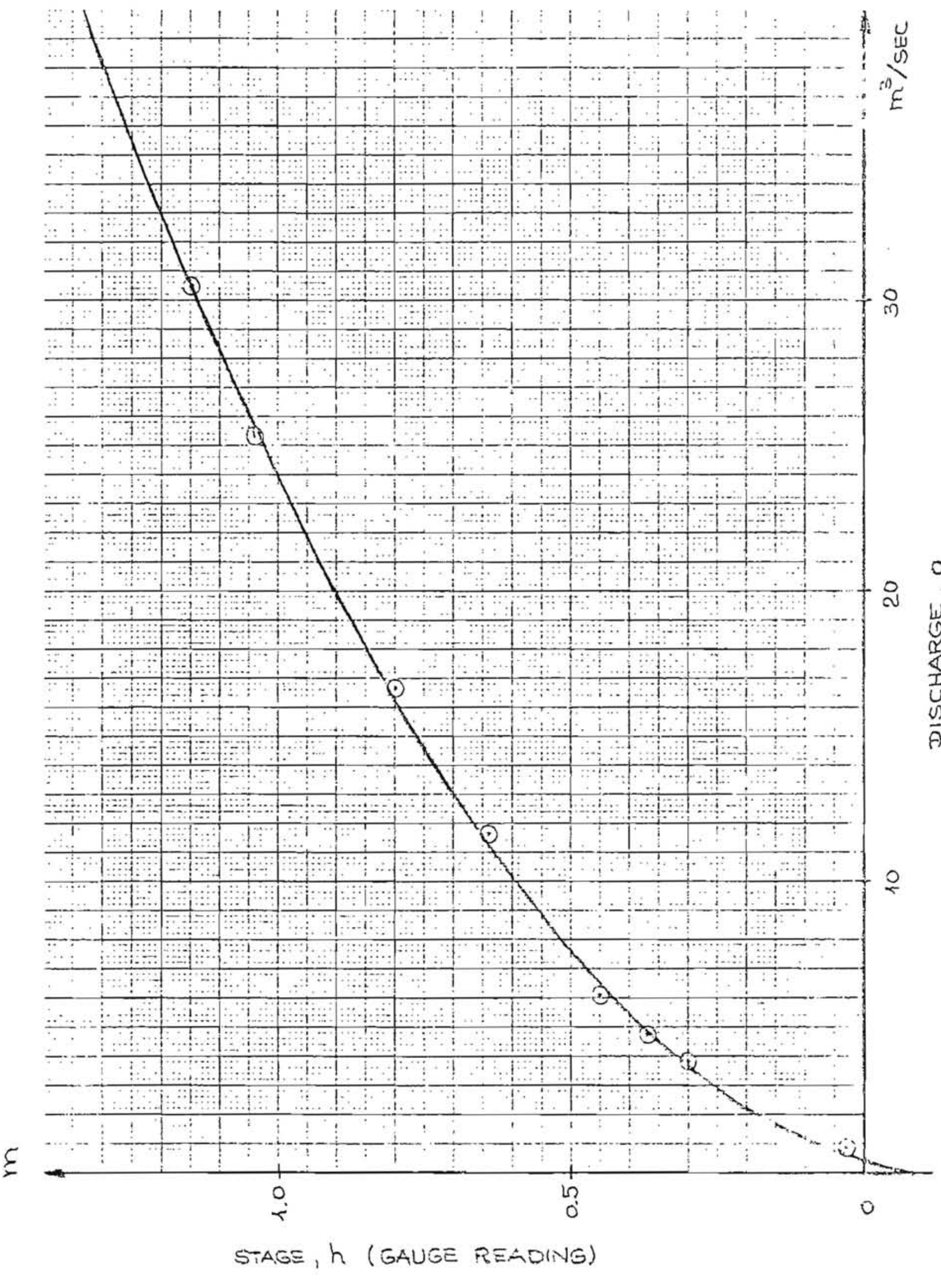
I. INSTRUMENT

Five standard ranges, chart table with manual or battery rewind system. Standard type designed for fresh water. Seawater version available on request. The instrument is supplied with an accessories box and a roll of chart paper.

TRADE REFERENCE TABLE FOR TELIMNIP INSTRUMENTS
(not including air supply) for various ranges, fresh or sea water versions and length of chart table operation.

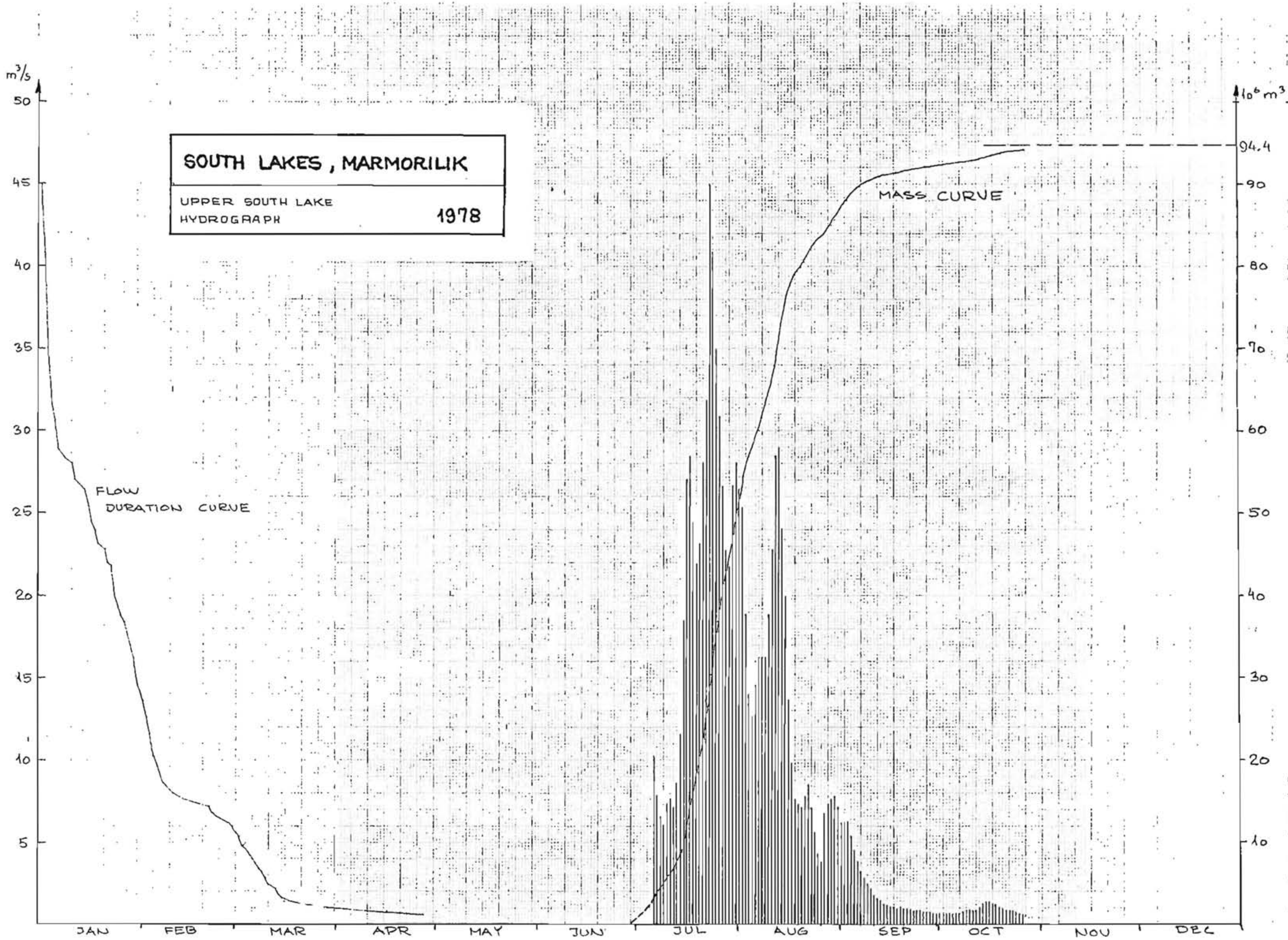
VERSION	Length of operation (rewind system)	STANDARD RANGES IN METRES w.g.				
		0-2.5	0-5	0-7.5	0-10	0-15
Fresh water	1 month (manual) 6 months (batteries)	3227 A 3227 AI	3227 B 3227 BI	3227 C 3227 CI	3227 D 3227 DI	3227 E 3227 EI
Sea-water	1 month (manual) 6 months (batteries)	3227 F 3227 F1	3227 G 3227 GI	3227 H 3227 HI	3227 J 3227 JI	3227 K 3227 KI

APPENDIX 5

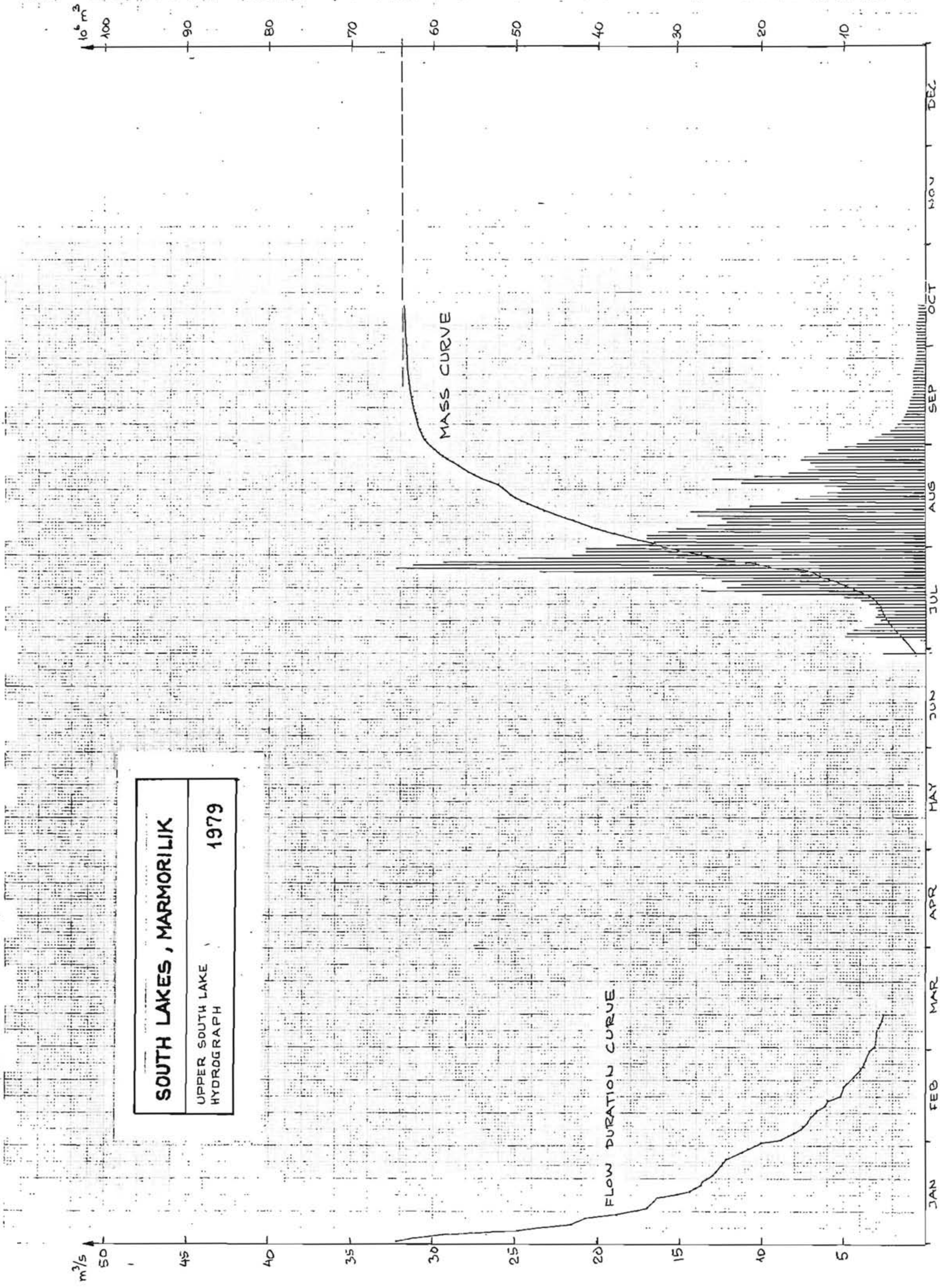


SOUTH LAKES , MARMORILIK

STAGE - DISCHARGE RELATION


SOUTH LAKES, MARMORILIK
UPPER SOUTH LAKE
HYDROGRAPH
1978
m³/s
10⁶ m³
94.4
MASS CURVE
FLOW
DURATION CURVE
50
45
40
35
30
25
20
15
10
5
90
80
70
60
50
40
30
20
10
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

APPENDIX 6


SOUTH LAKES, MARMORILIK
UPPER SOUTH LAKE HYDROGRAPH
1979
MASS CURVE
FLOW DURATION CURVE
$10^6 m^3$
100
90
80
70
60
50
40
30
20
10
m^3/s
50
45
40
35
30
25
20
15
10
5
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
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