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1981/82

TURKEY LAKES WATERSHED PROGRAM

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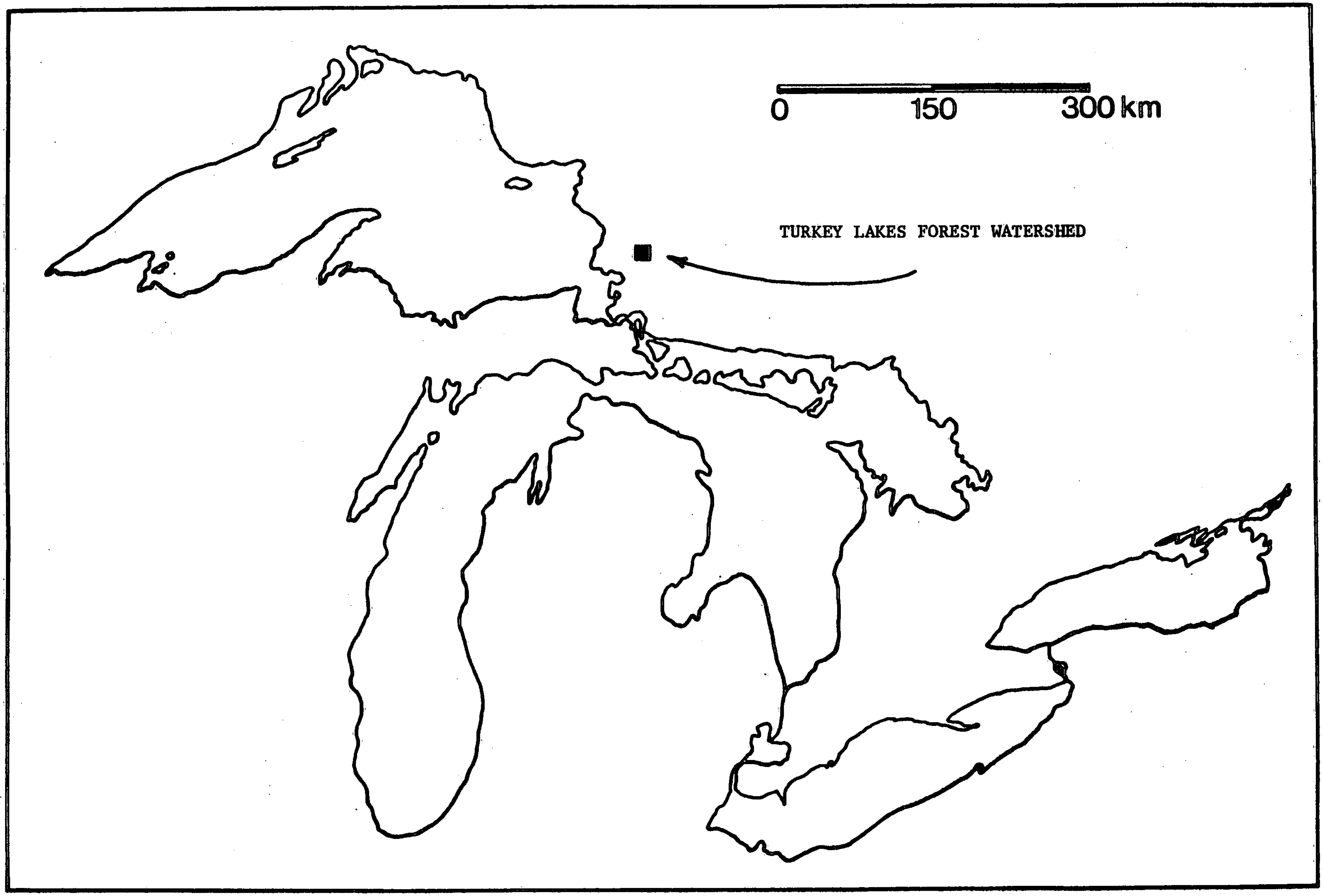
0
150
300 km
TURKEY LAKES FOREST WATERSHED

TURKEY LAKES FOREST WATERSHED PROGRAM

ANNUAL ACTIVITY SUMMARY

1981/82

December 11, 1981

F.H. Don
Technical Operations Division
National Water Research Institute

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SUMMARY

TURKEY LAKES WATERSHED PROGRAM

It has been recognized for many years, in Canada, that the long range transport of pollutants may cause serious environmental and health problems. Federal activities toward "acid rain" have been organized under the Long Range Transport of Air Pollutants (LRTAP) Program and include Department of Environment, Department of Fisheries & Oceans, Atmospheric Environmental Service and the Canadian Forestry Service.

The Turkey Lakes Watershed in the Algoma District was chosen as an intensive study site because it has lakes and geology that are sensitive to atmospheric pollutants and its remoteness leaves little chance of being affected by pollutants other than air-borne.

The watershed consists of five small lakes in a chain located in forests representative of the Great Lakes-St. Lawrence type (chart 1). The area is located in rugged hills of Precambrian rock with elevations 466 metres above Lake Superior. The elevation rise and the fact that Lake Superior is only 25 kilometers due West causes considerable snow and rain to fall on the watershed (chart 2).

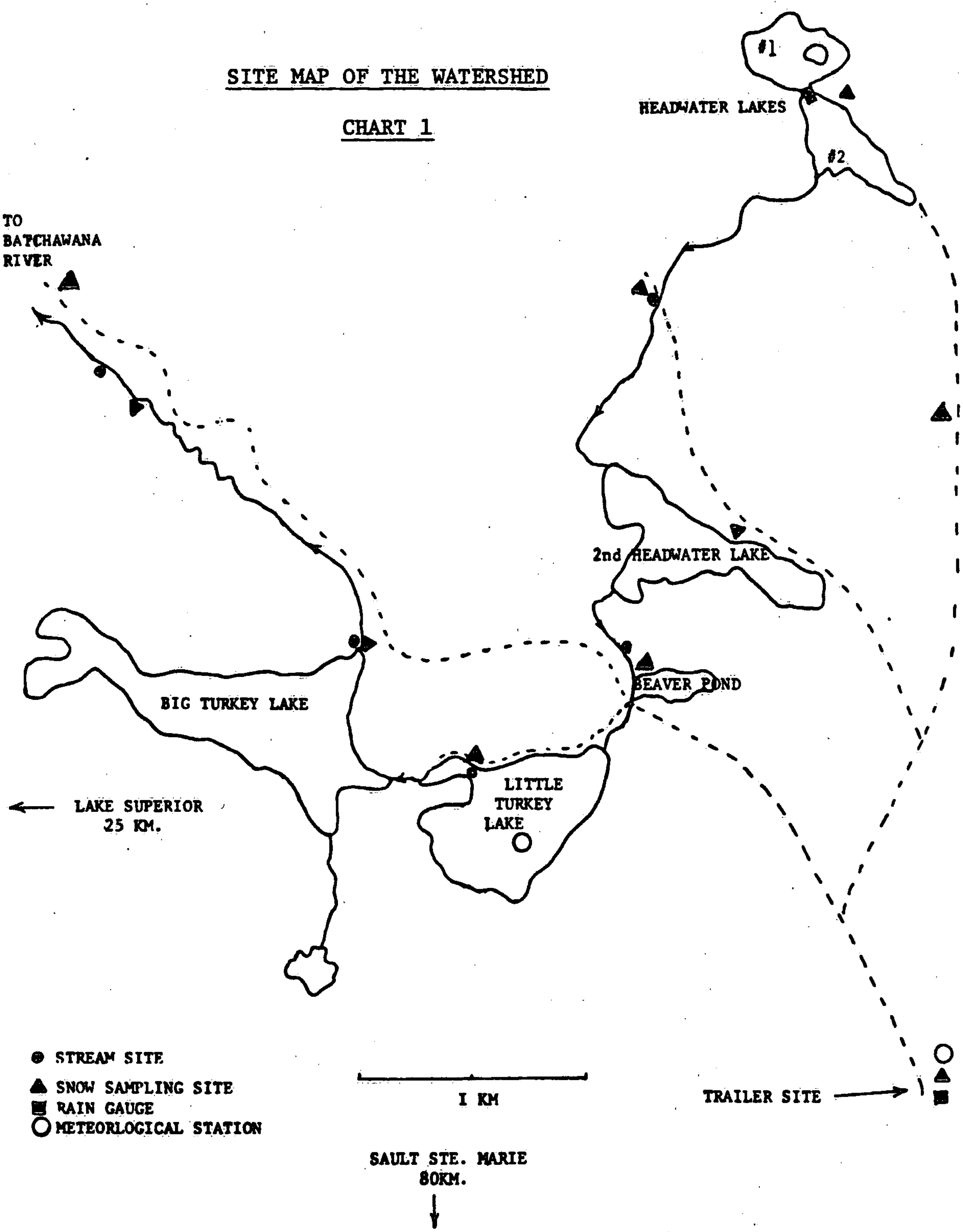
Technical Operations Division supplied one vehicle (4 x 4) and Senior Marine Technologist who acted as Project Co-ordinator to the Environmental Contaminants Division to study the effects of atmospheric precipitation on the hydro-chemistry of the Turkey Lakes Watershed. The study monitored all precipitation by means of rain gauges, snow gauges and a meteorological station in the watershed. Stream and lake samples were collected on a bi-weekly basis for chemistry and physical parameters. Winter sampling will take place on a monthly basis, collecting samples from lakes, streams and the snow-pack. From this data, the chemical changes that occurred between the precipitation and when the water left the lake system were monitored throughout the year.

From March 25 to April 9, an intensive sampling was undertaken during the snow-melt runnoff. Lakes were sampled four times using a helicopter (206 Jet Ranger), streams were measured for flow and samples taken on eight occasions. Snow cores and samples were collected. The Spring runoff sampling is the most important sampling period of the field year. Runoff '81 was a complete success with much of the work accomplished under adverse conditions. Numerous other samples such as lake sediments, rainwater, lake and stream water were collected and shipped to other agencies.

This was the first year of a five-year program. The work site has been improved with roadwork, shed construction, dock construction, heli-pad and concrete stream weirs. The installation of a house trailer is expected to complete the setup at the base camp. All required sampling schedules were completed. The field year was a success.

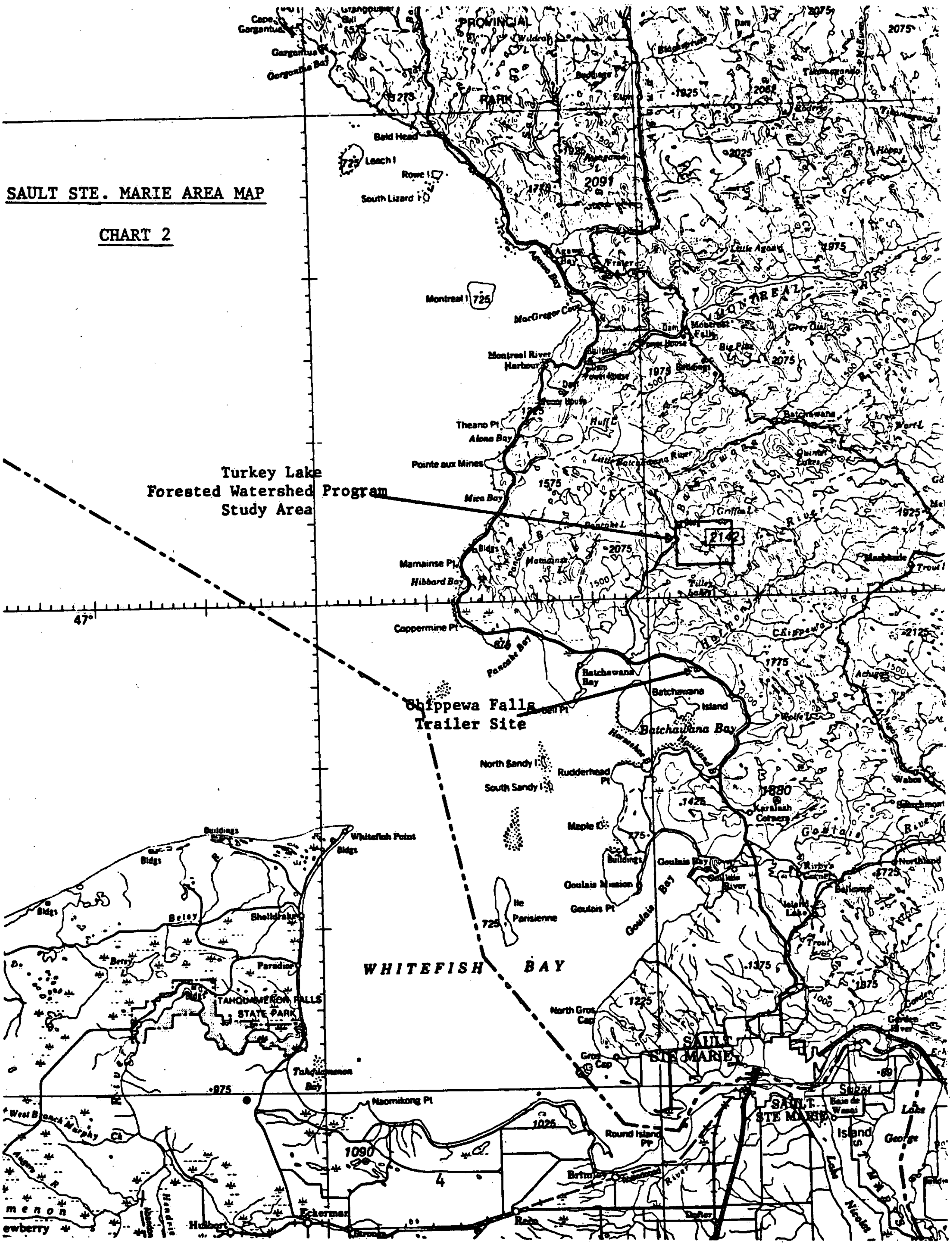
SITE MAP OF THE WATERSHED

CHART 1



SAULT STE. MARIE AREA MAP

CHART 2



INTRODUCTION

The study area selected centres on a small chain of lakes in Norberg and Wishart Townships some 50 km due North of Sault Ste. Marie. The principal and lowermost lake in the system is Turkey Lake. Agreement to attempt to secure the Turkey Lake site, subsequently named the Turkey Lake Forest Watershed, was made in August 1979 and an agreement for its use was secured from Ontario Ministry of Natural Resources in September 1979. Organizations participating in the Algoma Long Range Transport of Airborne Pollutants Project at Turkey Lakes are CFS, Sault Ste, Marie; GLBL, Sault Ste. Marie and Burlington; IWD, Sault Ste. Marie and Burlington; Lands Directorate, Burlington; OMNR, Sault Ste. Marie District.

As a study site, the Turkey Lakes Forest Watershed (page) is remote from strong point-source emitters being some 100 km South of an iron ore sintering plant at Wawa and 50 km due North of steel mill coke ovens at Sault Ste. Marie. Prevailing winds are from the West. The watershed as a whole is approximately 25 km due East of Coppermine Point on Lake Superior and 13 km inland from Batchawana Bay. The terminal stream from the watershed flows into the Batchawana River.

The Turkey Lakes Forest Watershed (page) is approximately 1413 ha in extent and contains six lakes: five in one chain and a sixth, a second headwater lake, draining directly into Turkey Lake. The lakes vary in size from 5 to 54 ha. An approximate breakdown of the total area of the watershed is as follows:

	AREA (ha)
Timber Forest	1192.8
Protection Forest	86.9
Open Wetland	18.9
Lake	115.4
TOTAL	1413.3

The principal topographic feature of the watershed itself is Batchawana Mountain (el. 640 m) which forms most of the North boundary. Elevation at the outfall on the other hand is approximately 244 m, or some 60 m above Lake Superior (el. 184 m) giving approximately 400 m of relief within the watershed. The watershed is underlain by greenstone bedrock over 93% of the area with Archean granite over 7%. Surficial materials in which the soils developed are largely bouldery ablation tills, variable in depth: generally shallow on crests and upper slopes and increasing in depth downslope. Mineralogy is mixed, the glaciers having moved generally in a North to South direction. Dominant profile type is Dystric Brunisol. The watershed is just beyond (*ca.* 4 km) the limits (latitude 47° 00') of the Canada Land Inventory; however, interpretation of types would place the bulk of the watershed within Capability Class 6 for Forestry and 7 for Agriculture (of 7 capability classes in each instance).

LAKE SAMPLING

Lake samples were collected bi-weekly and on an event basis. (Note: event sampling took place after a rain storm.) Samples were collected in the deep basin of each lake.

L1 - Upper Headwater (upper basin) - Depth 12 m (chart 3)
L2 - Upper Headwater (lower basin) - Depth 10 m (chart 3)
L3 - Second Headwater Lake - Depth 4 m (chart 4)
L4 - Little Turkey Lake - Depth 13 m (chart 5)
L5 - Big Turkey Lake - Depth 35 m (chart 6)

Sampling procedures varied depending on the thermal structure of the water column. Unstratified (Spring and Fall):

1. EBT taken
2. A 2ℓ tube (integrated) sample was collected to bottom minus one metre (Note: all lakes except Big Turkey Lake in which the tube sample was collected to 13 m)
3. A 2ℓ sample was collected at one metre and bottom minus one metre using a Van Dorn bottle
4. A 500 ml sample was collected at one metre for microbiology
5. A 250 ml sample of sediment was collected using an Ekman dredge. This sample was also for microbiology

Stratified (Summer):

1. EBT taken
2. A 2ℓ tube (integrated) sample was taken to the top of the thermocline
3. A profile (pH and conductivity) was taken using a pump and flow cell
4. A 2ℓ sample was collected at mid-thermocline and mid-hypolimnion
5. Once per month profile samples (250 ml) were collected every metre

6. During profile sampling, 2ℓ volume weighted samples were collected in the thermocline and hypolimnion (Note: volume weighted sample: an amount of water from each two metre interval in depth is proportional to the volume of the stratum sampled when added to a two litre sample bottle using a graduated cylinder)

Field analysis was restricted to measuring temperature, conductivity and pH (figure 1). The bulk samples were returned to the Water Quality Lab at the Great Lakes Forestry Research Centre in Sault Ste. Marie where the samples were split and analysed for:

a) metals: Cn, Ni, Zn, Pb, Cd, Fe, Mn, Al, Co all split to 1 glass 500 ml bottle with 1 ml HNO_3

b) major ions: Na, K, Cu, Mg, SO_4, Cl, Si all split to 1 plastic 125-200 ml bottle

c) nutrients routinely:
   1) Total P and total k, eldahl N split to 1 100 ml glass bottle with 1 ml 30% H_2SO_4, and periodically
   2) Soluble P, NO_3, NO_2, NH_4, DIC and DOC filtered through Sartorius filter and stored in 250 ml plastic bottle

STREAM GAUGING AND SAMPLING

Streamflows were measured in five locations with two additional stations to be added in 1982.

ST1 Stream between the Upper and Second Headwater Lakes

ST2 Inflow into the Beaver Pond

ST3 Outflow from Little Turkey Lake

ST4 Outflow from Big Turkey Lake

ST5 Turkey Creek one km downstream from ST4

Streamflows were measured at a minimum of twenty points equally spaced across the stream using a price or pygmy price hand-held current meter (figure 2). At each sampling point the number of revolutions of the current meter in 40 seconds was noted (chart 7). These readings were forwarded to the Water Survey Offices in North Bay where a computer was used to calculate the streamflows.

A two litre sample was collected at each stream station for water quality analysis. Before leaving the stream station the water level gauge was marked, recording the time and date of the streamflow measurement onto the chart paper. Field analysis was restricted to measuring temperature, conductivity and pH. The bulk samples were returned to the Water Quality Lab at the Great Lakes Forestry Research Centre in Sault Ste. Marie where the samples were split and analysed for:

a)	metals:	Cn, Ni, Zn, Pb, Cd, Fe, Mn, Al, Co all split to 1 glass 500 ml bottle with 1 ml NHO_3
b)	major ions:	Na, K, Cu, Mg, SO_4, Cl, Si all split to 1 plastic 125-200 ml bottle
c)	nutrients routinely:	1) Total P and total k, eldahl N split to 1 100 ml glass bottle with 1 ml 30% H_2SO_4 and periodically 2) Soluble P, NO_3, NO_2, NH_4, DIC and DOC filtered through Sartorius filter and stored in 250 ml plastic bottle

During September new concrete stream weirs were constructed at stations ST2, ST3 and ST4. They have made a tremendous improvement to the streamflow measurements (figures 3 and 4).

SPRING INTENSIVE STUDY

During the period March 30 to April 9 the major portion of the snow and ice melted in the watershed. It was during this runoff that an intensive sampling program took place. Streams were gauged and sampled on seven occasions. Three lake surveys were completed using a Bell 206 Jet Ranger helicopter (figure 5). Snow cores were collected once from each of the ten selected stations.

The work required five people to complete the heavy workload (three Technical Operations). One team of two worked on lake stations while the other two-man team did the streamwork. The samples were returned to the trailer site where they were split and analysed by the remaining team member. Seven people (5 NWRI and 2 Forestry) stayed in a hunting cabin at the site for the duration of the program. This eliminated 3 1/2 hours of driving time per day when the roads could be travelled (during 4 days the road was under 4 feet of water in places (figure 6)).

The Spring Intensive Study of 1981 was a success, having completed all prior objectives. A similar study, both longer and more comprehensive, is being planned for 1982.

GROUNDWATER SAMPLING

Groundwater sampling took place at the Eastern end of the Second Headwater Lake. Three wells were sampled on two occasions. Field analysis was restricted to measuring pH, conductivity, temperature and Eh. Samples were filtered on site and returned to the Water Quality Lab at the Great Lakes Forest Research Centre in Sault Ste. Marie where they were analysed for SO_4, Cl, alkalinity, Ca, Mg, Na, K, Sr, Si, Al, Fe, Mn, Cu, Pb, Zn, Co, Ni and Cd.

During the Summer months, steel prefabricated sheds were built over three wells. The sheds were equipped with propane heaters to prevent the wells from freezing and halt the Winter Sampling Program.

MICROBIOLOGY SAMPLING

Microbiology sampling took place on a monthly basis for lakes and twice per month for streams. Lake samples were collected at one metre for water (500 ml) and a 250 ml sediment sample collected using an Ekman dredge. Stream samples (water) were collected by dipping the sample bottle into the streams. All samples were stored in ice-filled coolers and sent to Toronto via Air Canada for pick-up by Microbiology technicians.

SUPPORT TO OTHER AGENCIES

Great Lakes Biolimnology Laboratory personnel had the use of field equipment in the garage at the trailer site. They also used the boats stored at the various lakes along with a 17' MonArk, 25 hp engine and trailer for sampling other watersheds.

Natural Resources (Sault Ste. Marie) technicians made use of the boats at all lakes within the watershed.

Great Lakes Forestry technicians made use of the garage for storage of construction materials and skidoos.

WINTER SAMPLING

Winter sampling will take place for one week per month (January 11, February 8 and March 8). During this week all lakes will be sampled (including profiles this Winter), streams will be gauged and sampled and snow cores will be collected throughout the watershed.

Two Technical Operations personnel will fly to Sault Ste. Marie each month to support this portion of the project. Travel from lake to lake requires the use of the skidoos and Argo (figure 7).

METEOROLOGICAL SYSTEMS

One meteorological system was located on a 10 m tower on a hill behind the trailer site (figure 8). Parameters measured included: wind speed, wind direction, air temperature, relative humidity and solar radiation. The Met. can and solar radiation integrator with an H.P. strip-chart recorder was located in a heated shed at the base of the tower. The solar radiation sensor system at the Chippewa Falls trailer site has been discontinued.

One tipping bucket rain gauge was installed at the Met. site. This system was down for most of the season while waiting for replacement parts to be made in California.

Technical Operations supplied all equipment for the Met. system and tipping bucket rain gauge as well as the monitoring and maintenance on both systems.

VEHICLES

This was the second field year for vehicle 80-122 (Dodge 4x4) and it is literally falling apart. Two years of driving some of the roughest roads North of Sault Ste. Marie on a daily basis have taken their toll. This vehicle must be replaced in the Spring of 1982 if it lasts that long.

A new All Terrain Vehicle (ATV) was purchased late in the season (figure 9). It is much stronger, faster and easier to handle than its predecessor. This vehicle was used during those borderline periods when neither trucks nor skidoos could be used.

BOATS

Ten boats were required to do the major portion of the work. Two boats (one SEA NYMPH and one NALCO) were kept on each lake to eliminate daily transport from lake to lake. Two canoes placed at the trailer site were used for peak-use periods on various lakes in the system. Electric motors (3) were used to power these boats. These motors were powered with a standard 12 Volt car battery. They are light and can be moved from boat to boat with little difficulty. Electric motors are being used in place of standard gasoline/oil-mix outboards to keep all unnatural polluting inputs into the study area to a minimum. All boats have a set of oars, bailing can and one life preserver per person.

A 17-ft. MonArk with a 25 hp motor was issued to GLBL to continue acoustic work previously done on other small lakes in the Algoma and Sudbury areas. Two canoes based at the trailer site (Turkey LakesB were required for stream work.

Nine boats were returned to OSS for refurbishment during the Winter months. These same boats will be returned in the Spring.

TRAILER SITE

The Turkey Lakes base camp consists of two laboratory trailers supplied by GLFRC and GLBL, a survival-type trailer supplied by Technical Operations and a 22-ft. x 22-ft. storage garage supplied by NWRI (figure 10). A small (6' x 6') hut supplied by AES is located at the Met. site on the hill behind the trailer site.

Two 3 KVA Onan generators supplied by Technical Operations are housed in an 8 ft. x 10 ft. spacemaker shed. These generators supply all the power required for the site. The generators are run one at a time, 24 hours per day and rotate on a weekly basis. The generators are maintained by an NWRI contract person and Technical Operations with assistance from the Maintenance Shop personnel of the GLFRC.

RECOMMENDATIONS

1. Technical Operations should not issue field equipment to GLBL. The damage to the gear creates too many problems for others wishing to use the same equipment.
2. A replacement vehicle for 80-122 is a must.
3. Each Spring an Electronics Technician from Technical Operations should undertake a complete shakedown of electronic systems on site. This would eliminate downtime on the systems and repair time for the Technical Operations Co-ordinator.
4. The Technical Operations Co-ordinator should give his main support to Mr. R. Semkin as his program carries the "lion's share" of the work (this was the case in 1981 and it worked extremely well).

CONCLUSIONS

This was the second field year for this five-year Project. All objectives were met. Many construction projects undertaken this year will make future field work in the watershed much easier. The roads, both to and throughout the watershed, are still rough but are slowly being improved.

The problem of Acid Rain cannot be solved overnight. The ongoing studies in the Turkey Lakes Watershed are bringing us just a little closer each year to understanding its effects on the hydrologic cycle.

The 1981 field year in the Turkey Lakes Watershed was a complete success.

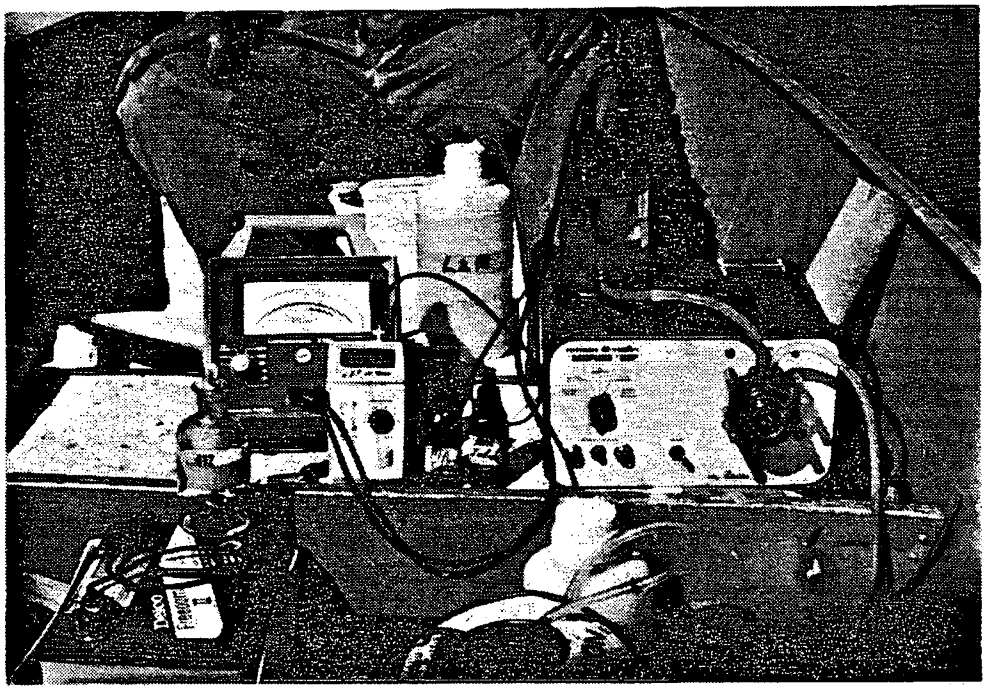


FIGURE 1: FIELD MEASUREMENTS DURING LAKE SAMPLING

FIGURE 2: MEASURING STREAMFLOW AT ST3

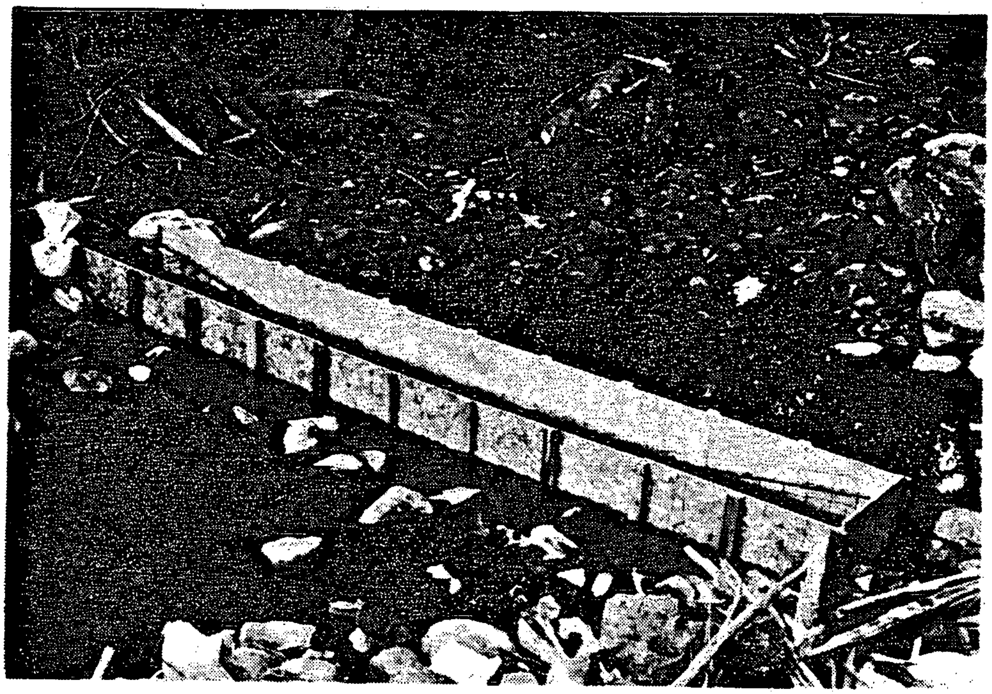


FIGURE 3: ST4 DURING WEIR CONSTRUCTION

FIGURE 4: COMPLETED WEIR AT ST4

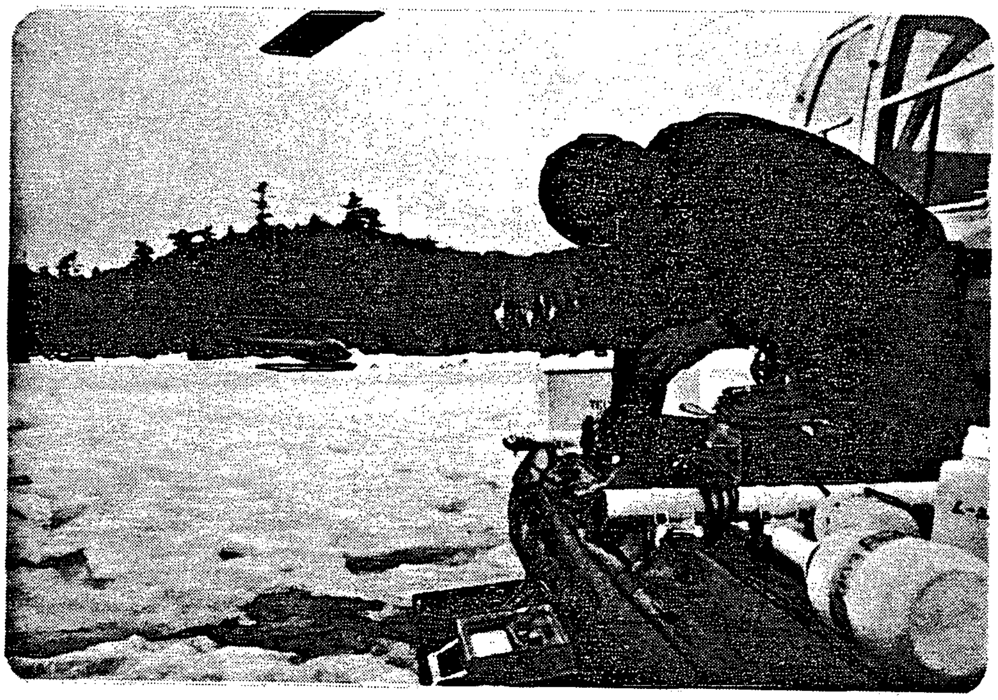


FIGURE 5: LAKE SAMPLING BY HELICOPTER

FIGURE 6: ROAD CONDITIONS DURING SPRING RUNOFF

FIGURE 7: ALPINE SKIDOO TRAVELLING BETWEEN LAKES

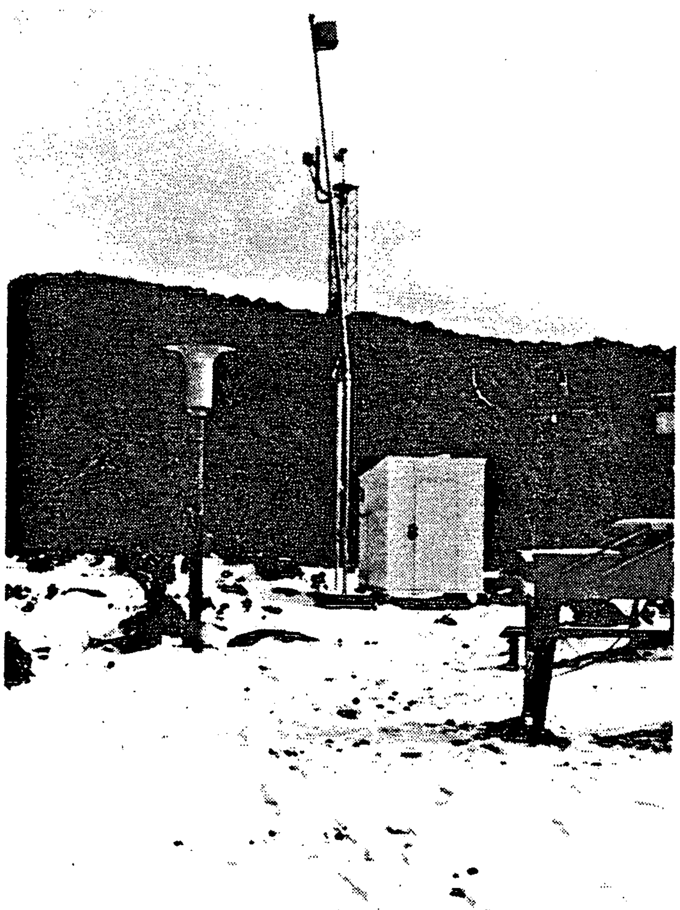


FIGURE 8: MET. TOWER AND SHED

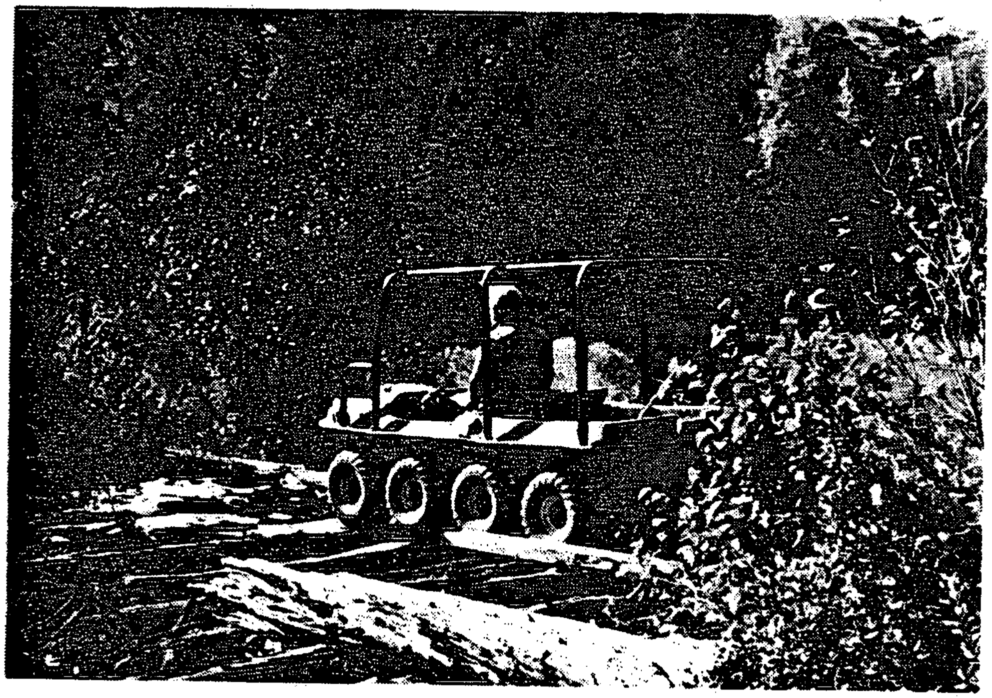


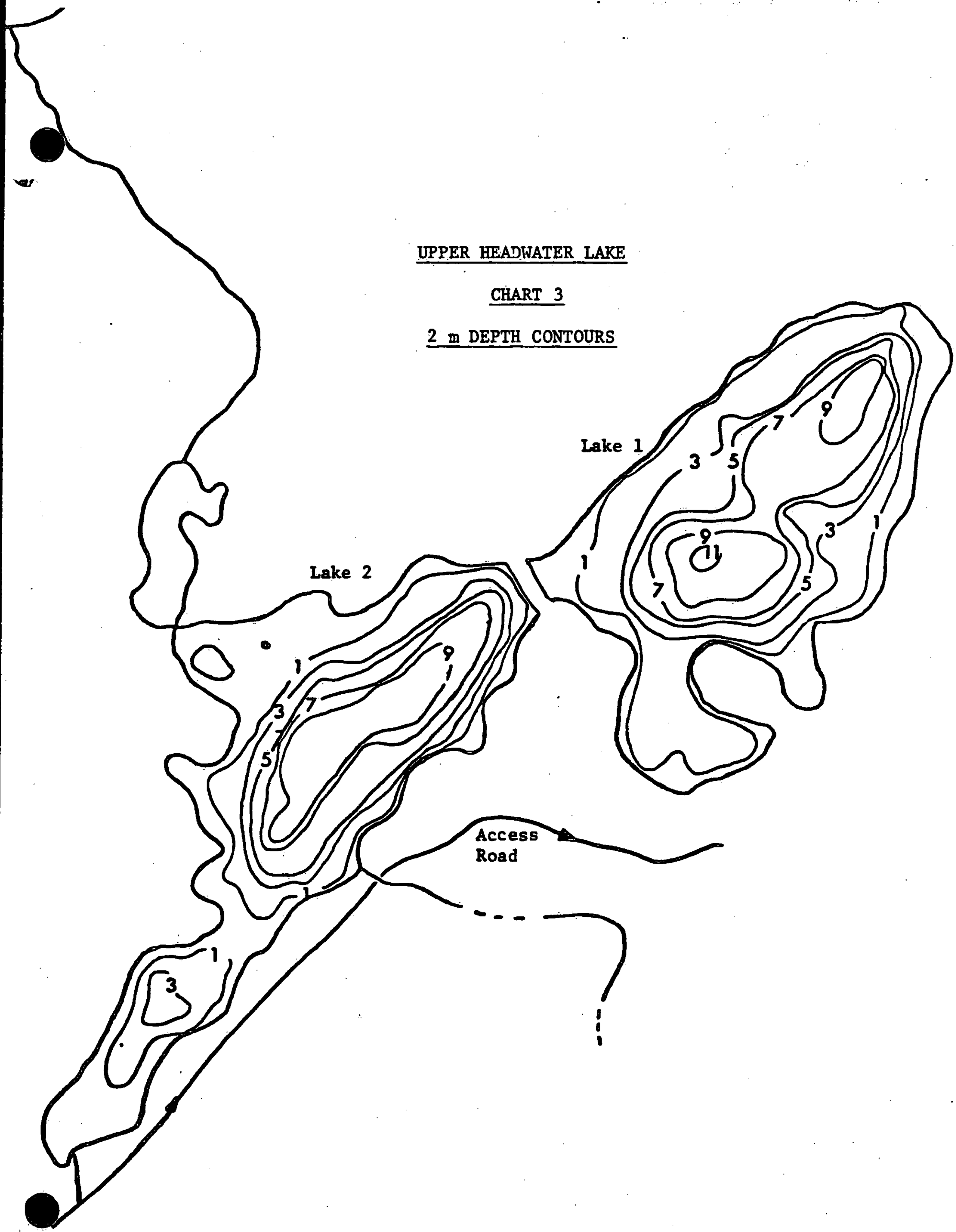
FIGURE 9: ARGO ALL TERRAIN VEHICLE

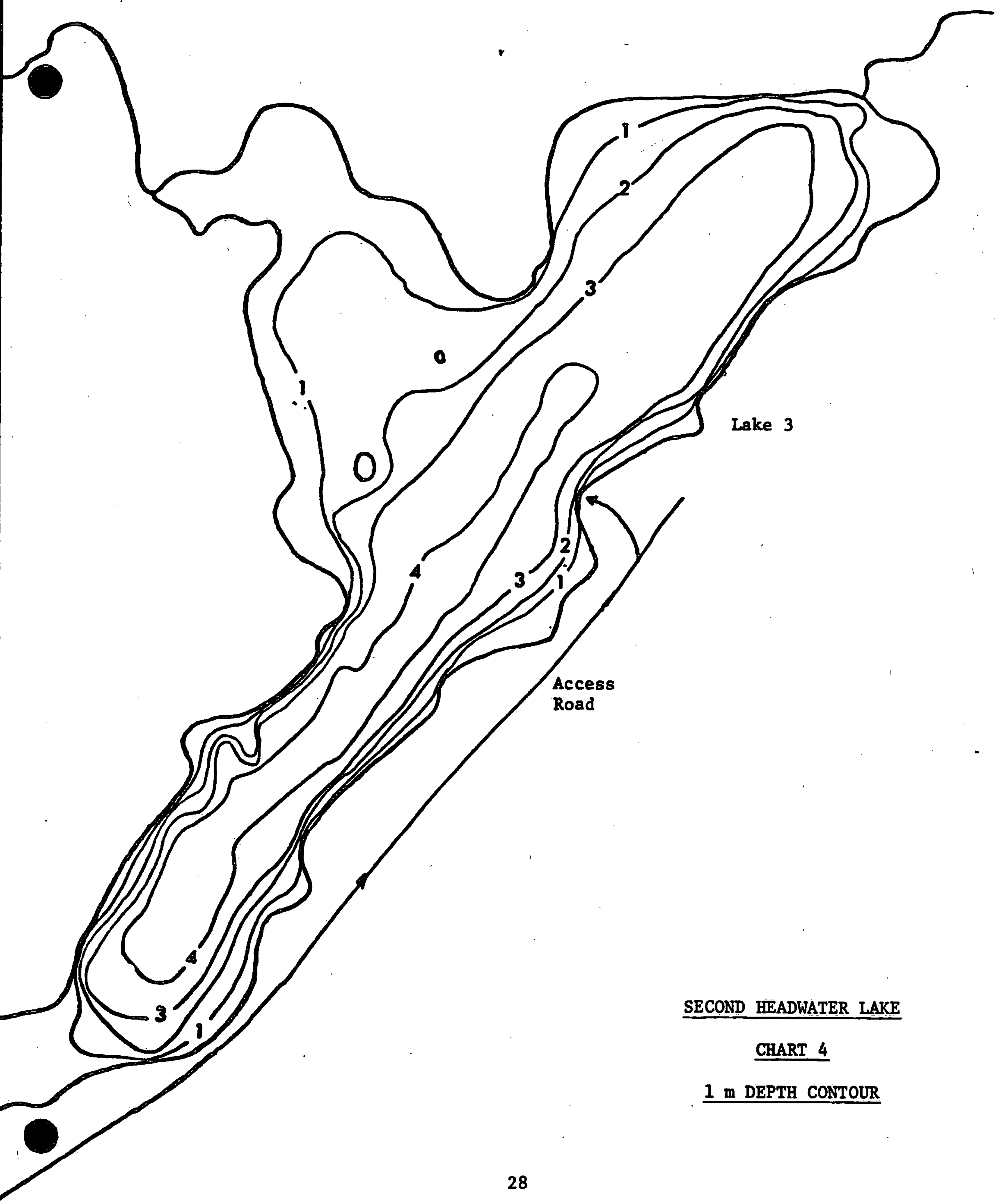
FIGURE 10: TURKEY LAKES TRAILER SITE (BASE CAMP)

UPPER HEADWATER LAKE

CHART 3

2 m DEPTH CONTOURS





SECOND HEADWATER LAKE

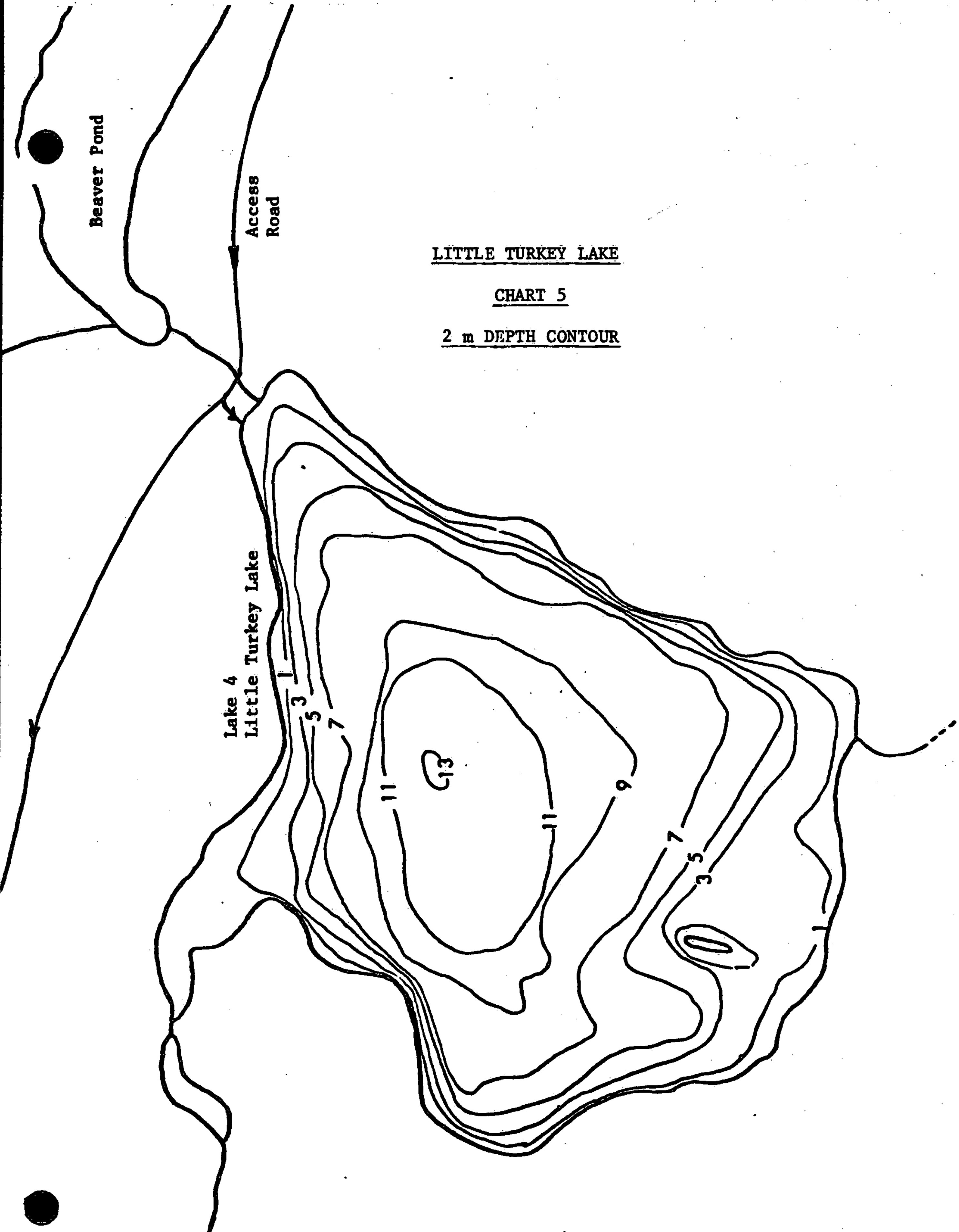
CHART 4

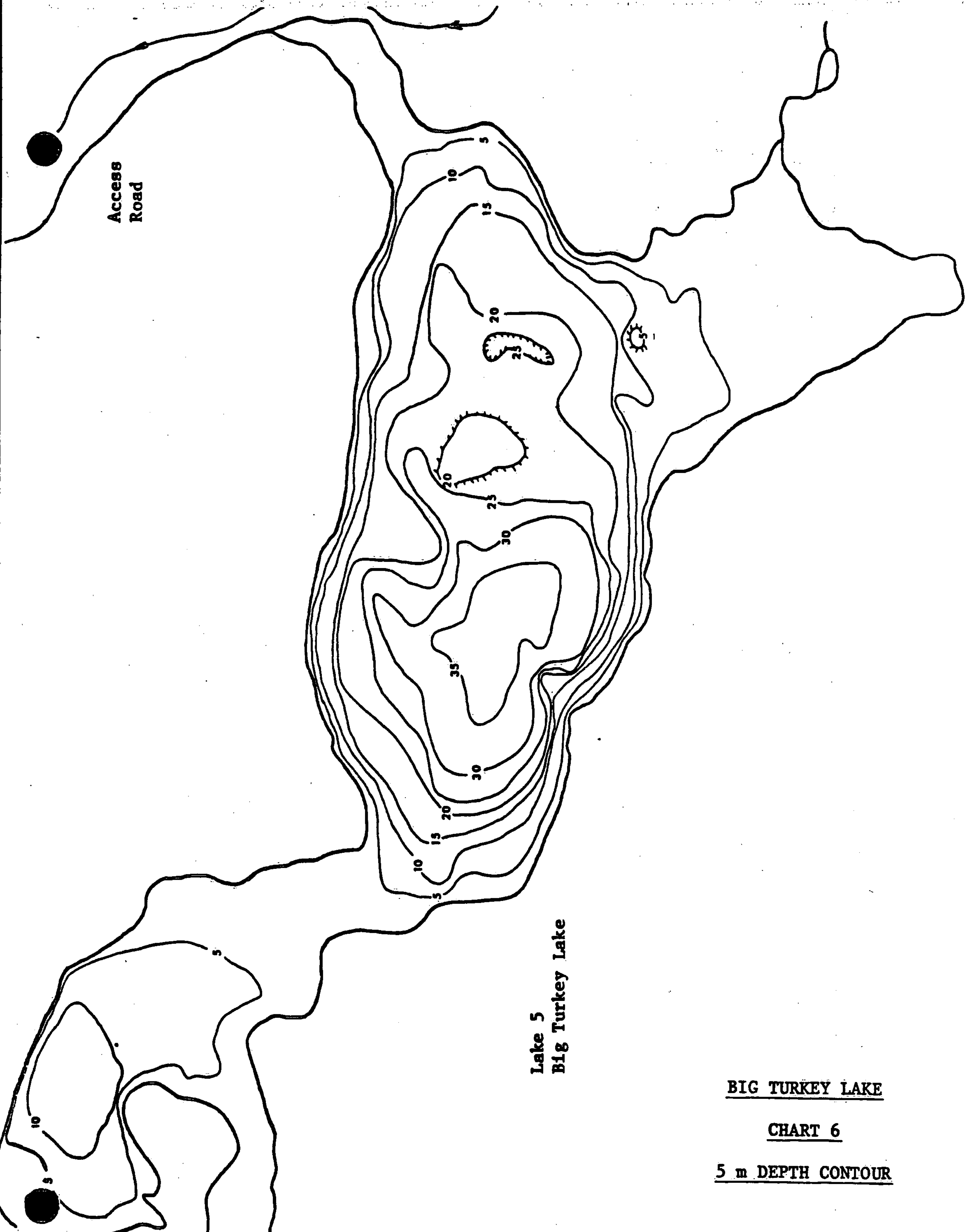
1 m DEPTH CONTOUR

LITTLE TURKEY LAKE

CHART 5

2 m DEPTH CONTOUR





BIG TURKEY LAKE

CHART 6

5 m DEPTH CONTOUR

HYDROMETRIC SURVEY NOTES

Station .... Sta. No. ....

Date .... 19 .... Party ....

Temp. A. .... °C W .... °C Width .... Area ....

Mean vel. .... Corr. M.G.H. .... Discharge ....

Measurement began at .... ended at ....

Levels obtained ....

Gauge Readings				
Time	Vertical	Pen	Inside	Outside
Weighted M.G.R.				
Correction				
Correct M.G.H.				

Meter number ....

Date calibrated ....

Current meter .... m

above .... weight.

Method .... Coeff. ....

No. of vert. sect. ....

Angle of flow ....

Observer visited ....

Book inspected ....

Recorder: Chart removed .... Supply roll .... days remaining

Weather conditions .... Wind ....

Measurement: Wading, cableway, boat, ice cover. Upstream, downstream side of bridge

.... m, km above, below gauge ....

Remarks: Include condition of station equipment ....

....

....

....

....

....

....

Computed by .... Checked by ....

(IW-2078-A (1/77) R21-A(M)

.0 .10 .20 .30 .40 .50 .60 .70 .75

Station .80

Distance from initial point	Width	Total depth	Depth under ice		Revolutions	Time	Velocity		Area	Discharge
		W.S. to bottom ice	Of water	Of observation			At point	Mean		

HYDROMETRIC SURVEY FORM

CHART 7

.85 .90 .92 .94 .96 .97 .98 .99 1.00 .99 .98 .97 .96 .94 .92 .90 .85 .80

.0 .10 .20 .30 .40 .50 .60 .70 .75