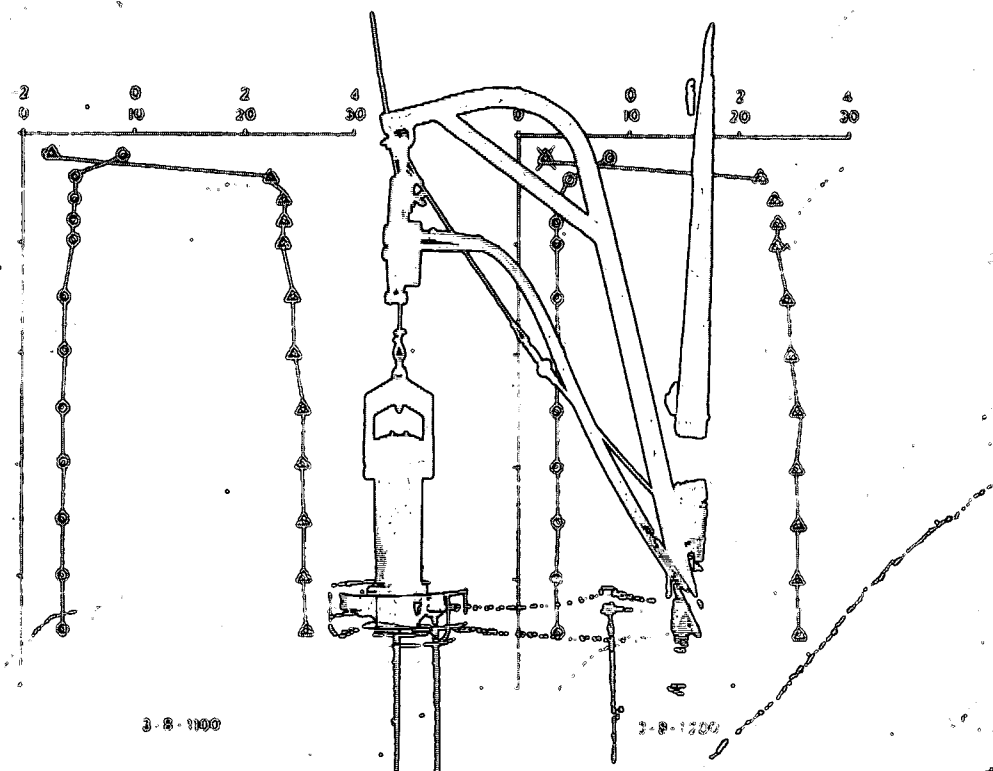
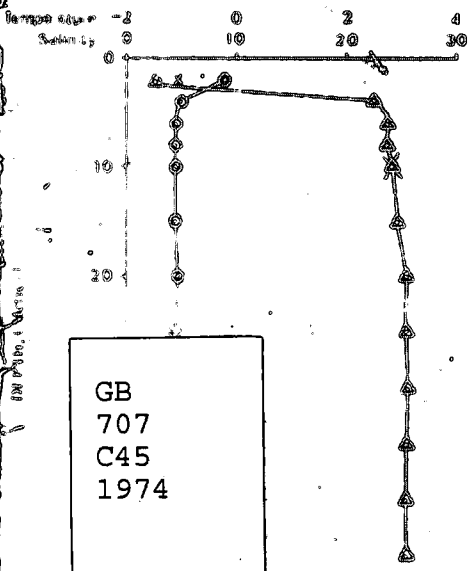
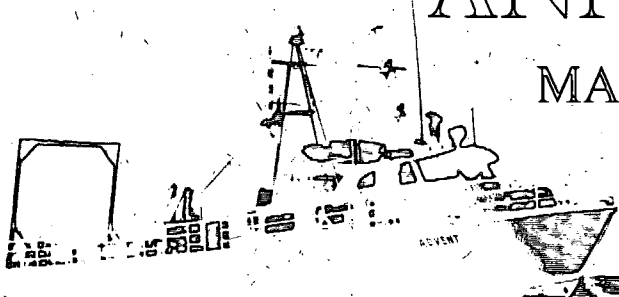




OCEAN AND AQUATIC AFFAIRS (CANADA), CENTRAL REGION, ANNUAL REPORT

ANNUAL REPORT 1974

MARINE SCIENCES, CENTRAL REGION
ENVIRONMENT CANADA
BURLINGTON, ONTARIO



C. I. W.
LIBRARY

ANNUAL REPORT 1974

CENTRAL REGION

MARINE SCIENCES DIRECTORATE

TABLE OF CONTENTS

	<u>Page</u>
MARINE SCIENCES, CENTRAL REGION OVERVIEW ...	1
HYDROGRAPHIC DIVISION	4
RESEARCH AND DEVELOPMENT DIVISION	15
SHIP DIVISION	33
ADMINISTRATION DIVISION	37
REPORTS AND PUBLICATIONS	41

MARINE SCIENCES - OCEAN AND AQUATIC AFFAIRS, CENTRAL REGION

T.D.W. McCULLOCH - Director

Overview

Marine Sciences, Central Region, forms a part of the Fisheries and Marine Service reporting directly to the Assistant Deputy Minister of Ocean and Aquatic Affairs. It consists of four Divisions; Hydrographic, Research and Development, Ships and Administration. The Hydrographic Division collects, processes and compiles data, for the construction and maintenance of navigation and resource charts, for the production of nautical publications, and for the support of engineering projects. Research and Development collects, processes and analyses physical oceanographic and coastal morphological data for engineering programs, marine transportation and in the assessment and prevention of environmental degradation. Launch and ship support is provided and maintained by Ship Division to Marine Sciences and Great Lakes Biolimnology Laboratory activities, as well as to EMS and EPS. Administrative, financial and material management along with personnel interface are provided by the Administration Division.

Marine Sciences, Central Region, operates within the approximate geographical boundaries from the Manitoba/Saskatchewan border in the west to Father Point on the St. Lawrence River in the east. In the north, Regional activities cover Hudson and James Bays and extend into the Arctic Islands. Within these areas, three main political issues can be identified within the scope of Marine Sciences' mandate in Ocean and Aquatic Affairs. These are:

- (1) Exploitation of Non-renewable Resources - Extensive hydrocarbon drilling has taken place from ice platforms in the Arctic Archipelago, from artificial islands in the Beaufort Sea and from conventional platforms in Hudson Bay. Various pipeline routes have been proposed to transport the gas to the industrial centres of the south, but recent studies have indicated that our knowledge of Arctic Waters is insufficient for the effective and safe extraction of the hydrocarbon and mineral resources of this area. Thus, increased program activity in Hydrography and Oceanography

is essential in these remote and data-deficient areas.

(2) Protection of the Environment - In Hudson Bay and around the eastern Arctic islands, there is still time to carry out bathymetric and oceanographic surveys to reduce the risk of navigational hazard and to assess the effect of potential disasters. In the South, the extensive dredging operation in the St. Lawrence River downstream of Quebec was completed in 1974, enabling 100,000-ton tankers to reach Quebec, and extensively altering the morphological and oceanographic regime of the river. High water levels on the Great Lakes and subsequent shoreland erosion and inundation necessitate increased activity, involving both the Federal and Provincial governments in developing more effective coastal zone management. In order to ensure continued safe and efficient navigation on the Great Lakes, increased bathymetric and revisory surveys are mandatory.

(3) Management of Renewable Resources - The native fisheries in James Bay, particularly the anadromous fish, must be protected when river modifications for the hydro power development disturb the present ecological balance in the river estuaries, increasing the need for physical and biological (FRD) site specific studies.

1974 Highlights

The 13th Annual Canadian Hydrographic Conference was hosted by Central Region; the activities were divided between the Canada Centre for Inland Waters and the Holiday Inn in Hamilton. Attendance was in excess of 200 persons with participants from Holland, the United Kingdom, Australia and Denmark as well as a healthy representation from south of the border, including Admiral Powell, Head of the National Ocean Survey.

A Hydrographic survey was completed of Chesterfield Inlet from the sea to Baker Lake using the automated data acquisition system (HAAPS). Efficient operation resulted in the completion of a two-year program in one year. Hydrographic surveys were carried out by contract in the Chenal de l'Ile d'Orleans in the St. Lawrence River and at Thunder Bay, emphasizing the government's policy of developing expertise in Canadian industry.

Coordination of oceanographic research in James Bay was established through a gathering of scientists at the James Bay Workshop, June 26, 1974. By the end of the year, Central Region had established a mandate for conducting oceanographic studies in Hudson and James Bays.

The Canada/Ontario Great Lakes Shore Damage Survey was completed and an interim report was submitted to the respective Ministers of Environment Canada and Ontario's Ministry of Natural Resources. Recommendations on shoreline management, planning and protection are being considered at this time.

Several group transfers occurred in 1974. The most notable one shifted the Tidal Instrumentation Development Group from Ottawa to Central Region. The Great Lakes Monthly Water Level Bulletin became the responsibility of the Hydrographic Division following a similar transfer from Ottawa.

Instrumentation development was highlighted by the development and operation of the INDAPS data processing system, whereby hydrographic data may be collected and processed in the field. This system was successfully utilized on the Lake Winnipeg Survey. The Electronics Shop greatly increased the signal strength and range of the Minifix system by utilizing 70' towers and 100 watt transmitters. In oceanographic instrumentation, six Aanderaa Recording Current Meters were successfully converted to profiling C.T.D. units (conductivity, temperature, depth) and simulated Arctic tests were carried out.

The Nelson 34, a diesel-powered, semi-displacement hull vessel was delivered, tested and should be fully operational in 1975.

HYDROGRAPHIC DIVISION

A.J. KERR

Aims and Organization

The work of the Central Region Hydrographic Division is primarily the collection and preliminary processing of hydrographic data. In addition, some attention is given to providing navigational assistance and advice to other groups working at the Canada Centre for Inland Waters.

The hydrographic operations are directed into three main geographic thrusts and are supported by three types of technical support.

The three geographic thrusts are as follows:

1. Surveys of the St. Lawrence River and Great Lakes System for commercial navigation.
2. Surveys of the Inland Lakes and Waterways to produce charts and publication for recreational boating.
3. Surveys of Arctic waters for navigation and resource development.

In the first of these areas much of the original survey work has been completed, although there remains extensive areas where soundings were collected by leadline. The emphasis is placed on maintaining the charts by re-surveys and revisory surveys.

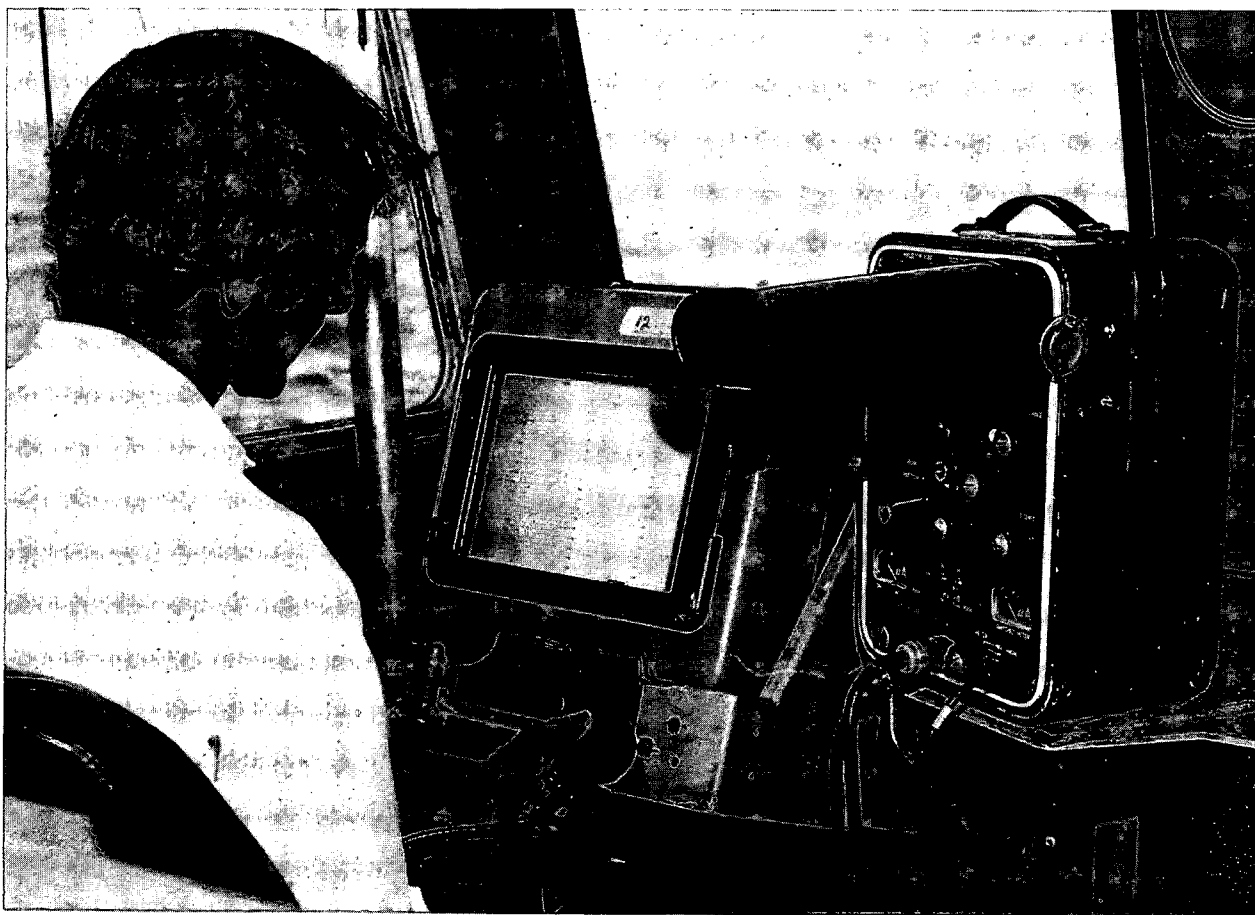
In the second area, the burgeoning population of Central Canada, in particular Ontario, has more and more time to spend on leisure. Recreational boating is particularly popular and surveys are needed to produce special charts and publications to meet the needs.

In the third area, the search for hydrocarbons and the use of better vessels is opening the Arctic to commercial navigation. The survey program must be accelerated to provide safe navigation and map the undersea resources.

Associated with the hydrographic surveys is the provision of information on tides, tidal currents and water levels. A small cartographic unit provides a graphic capability and a strong Technical Development Group ensures that the surveys are provided with equipment and software that assists in efficient operations.

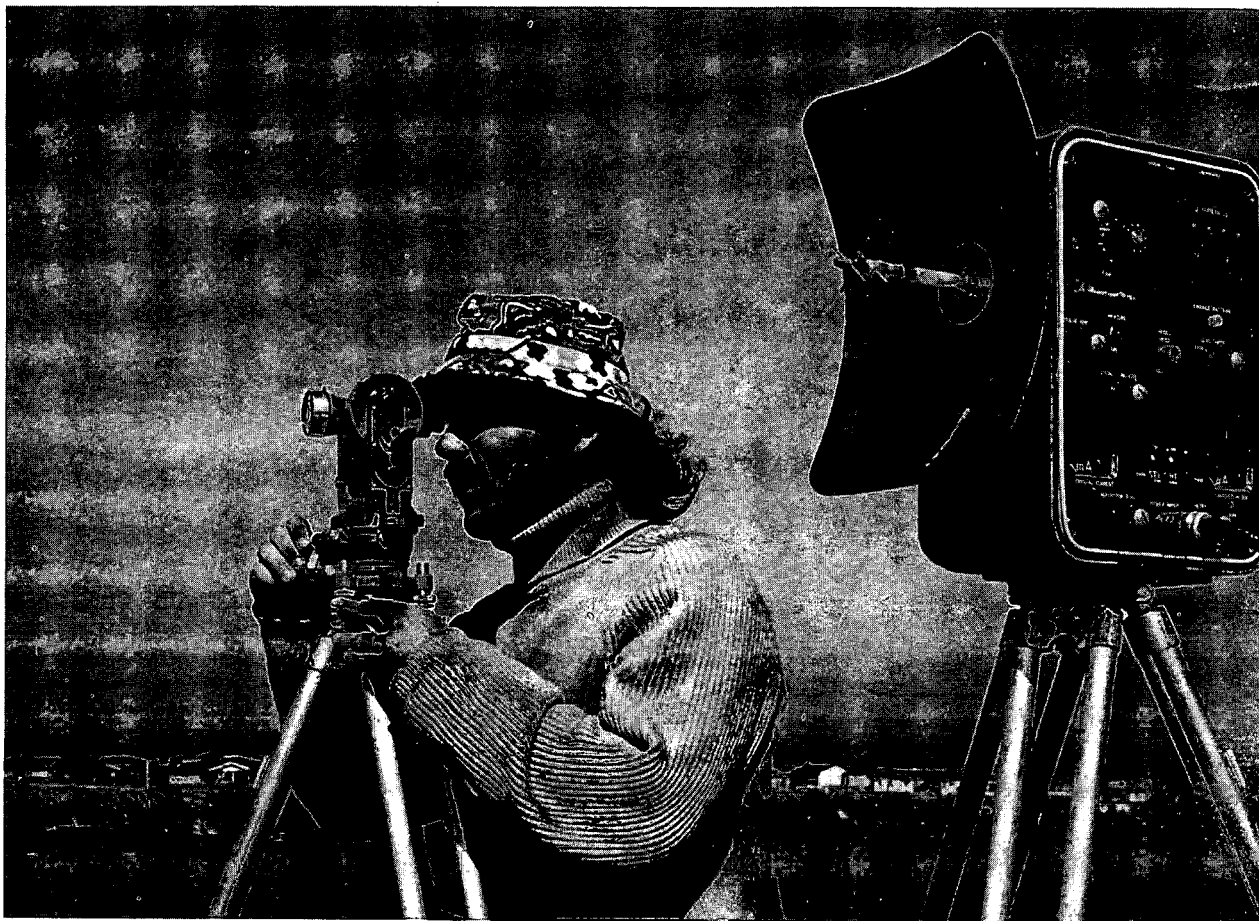
Survey Projects - Review

In the St. Lawrence River, a large survey unit worked out of Montmagny, surveying the channels in the vicinity of Ile aux Oies and Crane Island. Later in the season, a survey of Chenal de l'Ile d'Orleans was carried out under contract. These surveys of the Lower St. Lawrence River were started in 1969 and are aimed at providing new charts from the Saguenay to Quebec by 1976. This will coincide with completion of the deep dredging of the North Traverse, south-east of Ile d'Orleans.



MRB 2 Hydrodist and Raytheon Echo Sounder

In the Great Lakes work was carried out in conjunction with in-shore surficial geology studies along the north shore of Lake Erie in the general vicinity of Point Pelee. In Lake Huron a new program was started to survey the offshore bathymetry in order to improve our knowledge of these large basins. This survey used the high speed cutter ADVENT which proved successful. It also utilized the HAAPS (Hydrographic Acquisition and Processing System). Locally, a survey of Frenchman's Bay, near Toronto was completed. A survey of Toronto Harbour was started.



MRB 2 Hydrodist Shore Station when used
in Range/Bearing Mode

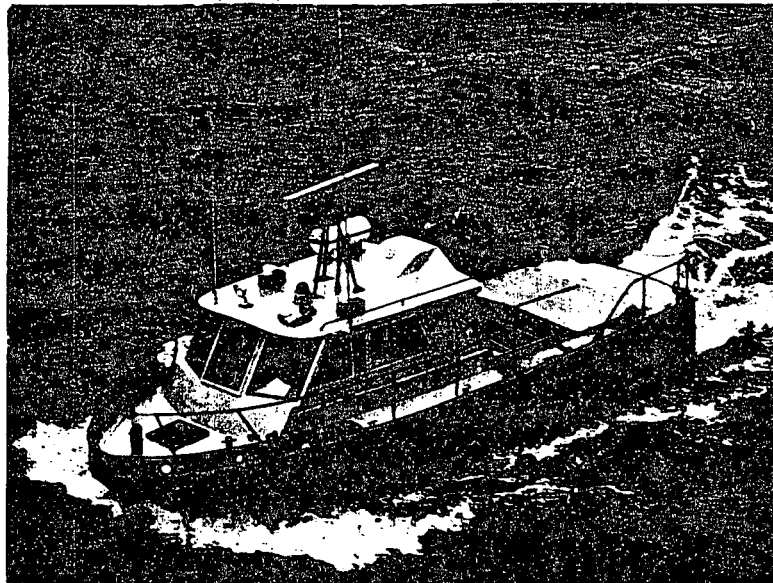
The program of chart revision has now been arranged in a cyclic system. Every second year charts of those parts of the Lake that undergo frequent change are revised and every fourth year the charts of areas that are less changeable are revised. The large survey launches VEDETTE and VERITY worked in Lake Superior and the Lower St. Lawrence River respectively.

The program in Lake Winnipeg was in its second year. This operation has two components. The northern half of the lake itself is being surveyed and the harbours are being surveyed separately. The off-shore surveys got off to a faltering start with many problems of chartering ships, instrumentation and launch failures. Fortunately, matters improved greatly towards the end of the season and the chartered vessel LADY CANADIAN equipped with the latest automated equipment measured many productive survey miles. The harbours of Hecla, Gull Harbour, Manigotogan River and Gimli were completed.

A very active program was maintained in the Arctic. Hydrographers working with the Polar Continental Shelf Project and utilizing helicopters and through-ice sounding methods, surveyed almost the entire fiord system of Eureka Sound and Nansen Fiord. This operation was marred only by a helicopter accident towards the end, which was fortunately not fatal.

In Hudson Bay, a survey was completed of Chesterfield Inlet from the sea to Baker Lake. This remarkable achievement resulted in NARWHAL reaching the settlement at Baker Lake, the largest ship to make this passage to date. NARWHAL is provided by the Ministry of Transport and provided an ideal base as a mother ship for two large launches and later as an oceanographic platform in James Bay.

35-foot survey launch STURDY
used in Chesterfield Inlet

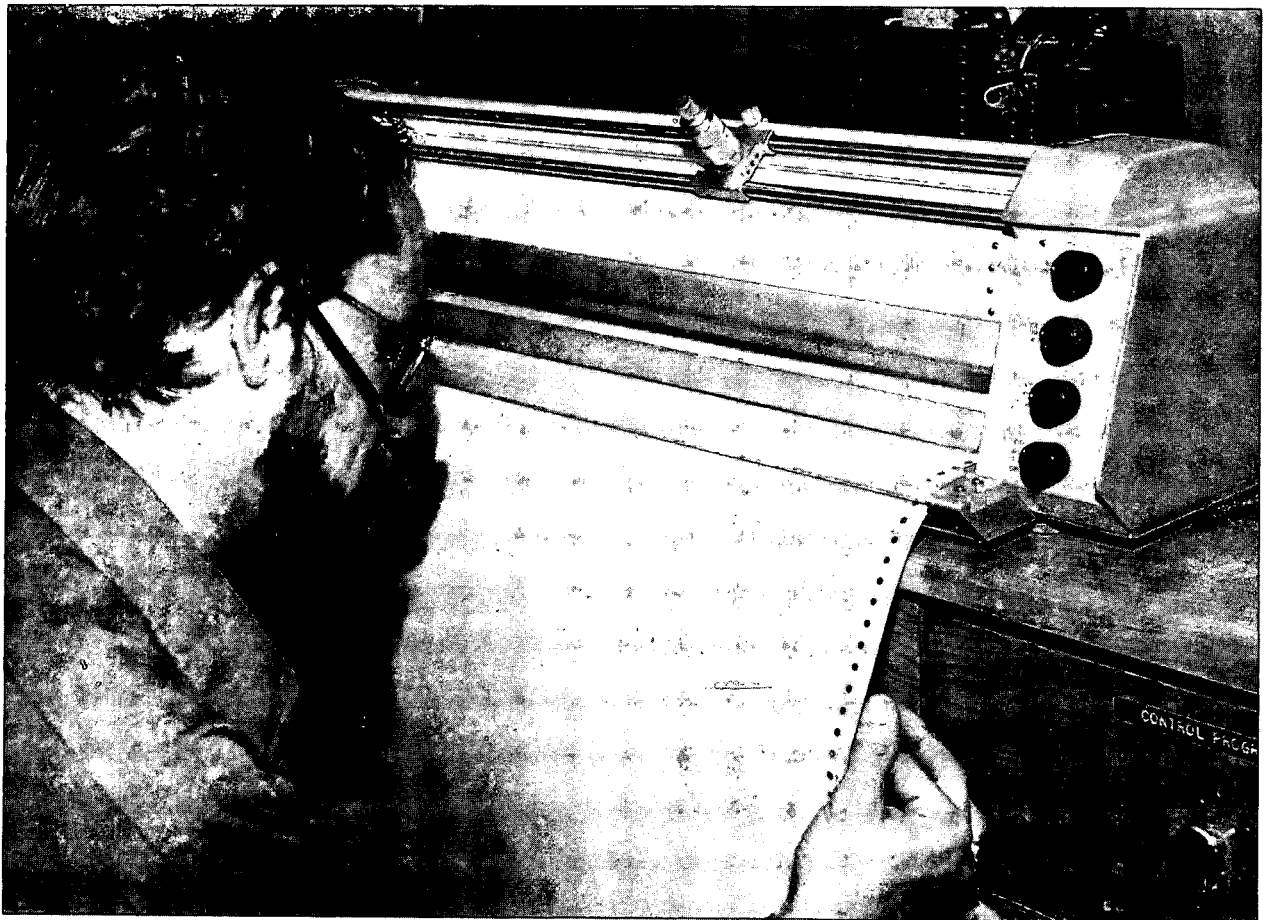


The following table summarizes the survey program and some of the significant equipment used:

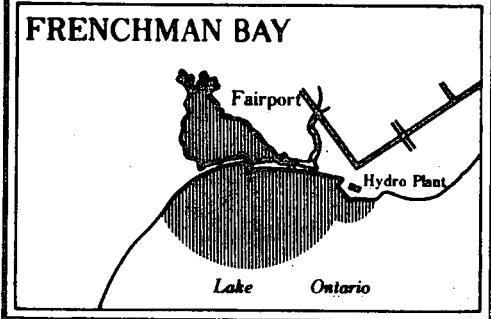
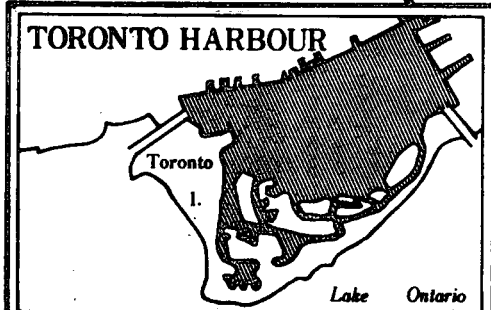
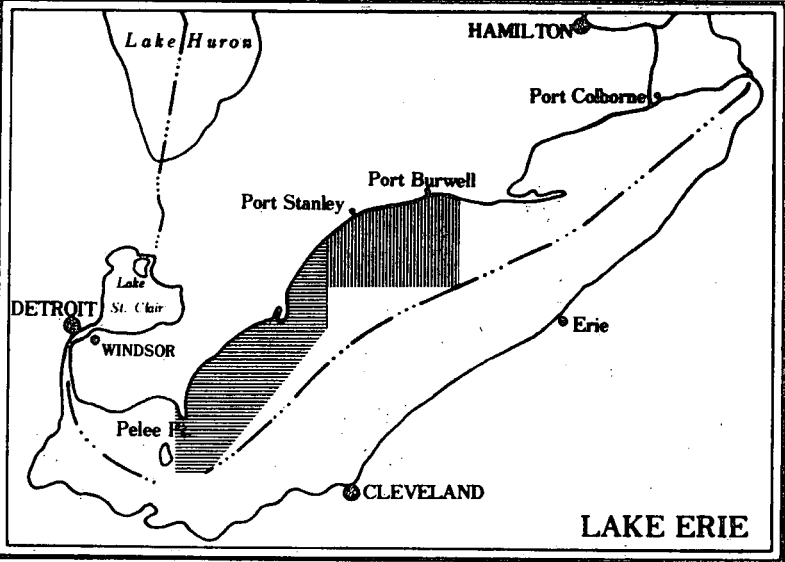
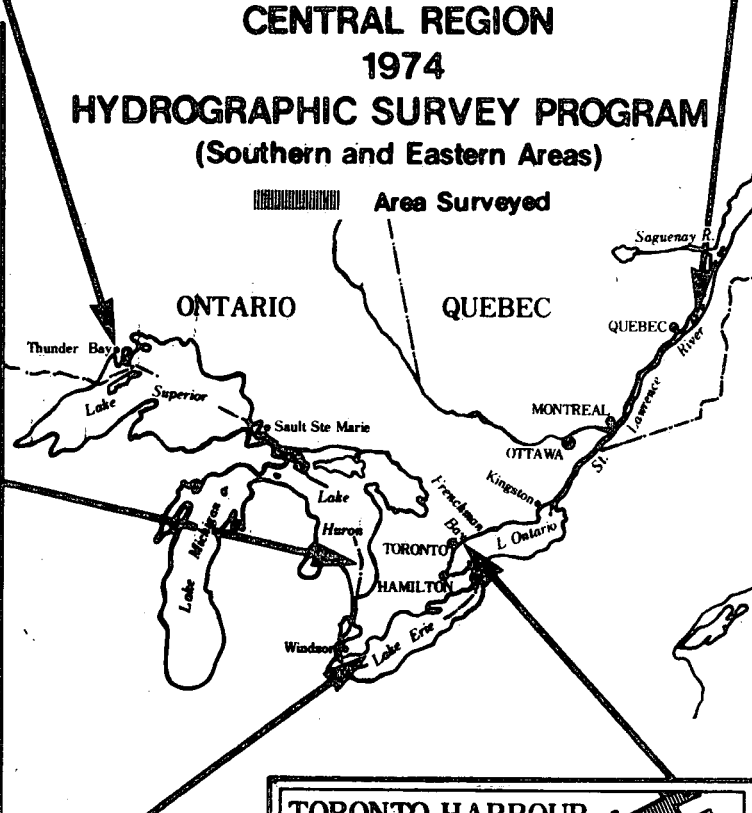
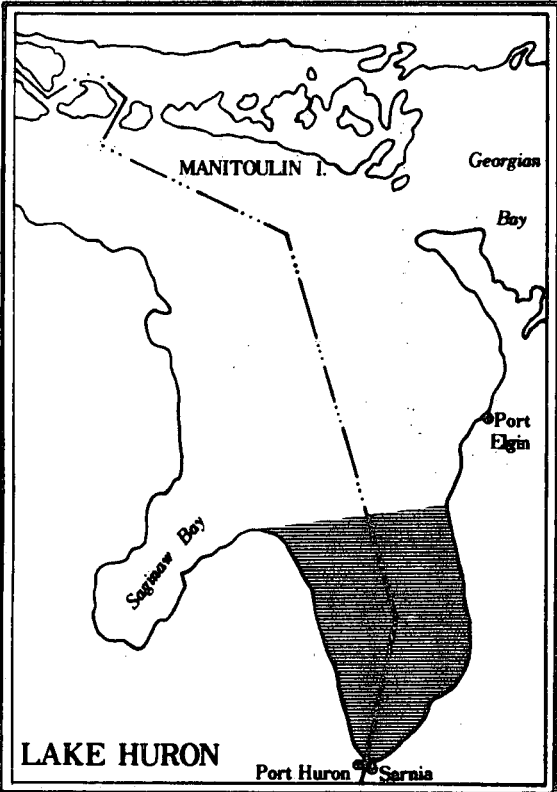
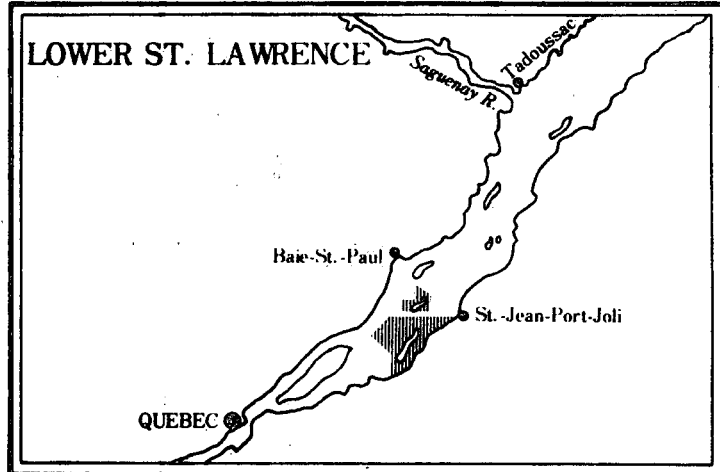
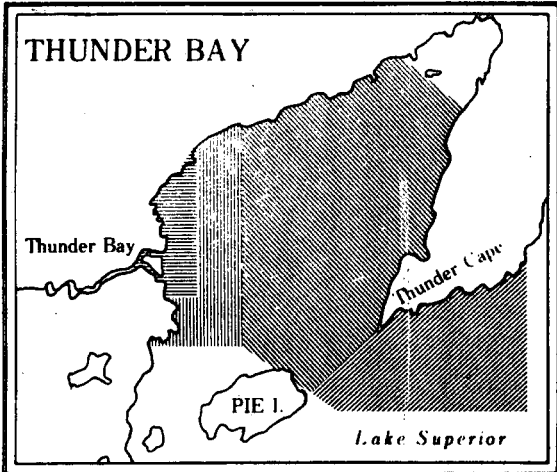
Survey Area	Vessels	Positioning System	Field Data Processing
Lower St. Lawrence	2 x 35 feet 4 Botved 22 ft.	Mini-Ranger, Hydrodist	HAAPS (part time)
Lake Erie	Bertram 25 ft.	RPS, Mini-Ranger	Manual
Lake Huron	ADVENT (77 ft.) BRUCE (31 ft.) VEDETTE (48 ft.)	Minifix	HAAPS
Toronto Harbour	1 Botved 22 ft.	Hydrodist	Manual
Thunder Bay	- Contract -		
L. Winnipeg Off-shore	4 Hydros. (25 ft.) LADY CANADIAN	Minifix	INDAPS
L. Winnipeg Hbrs.	3 x 20-25 ft.	Hydrodist	Manual
Polar Shelf	3 x 206 Helicopters	RPS	Manual
Chesterfield Inlet	2 x 35 feet 1 x 20 feet	Mini-Rangers	HAAPS
Revisory-St. Lawrence	VERITY	Hydrodist	Manual
Revisory-Superior	VEDETTE	Hydrodist	Manual

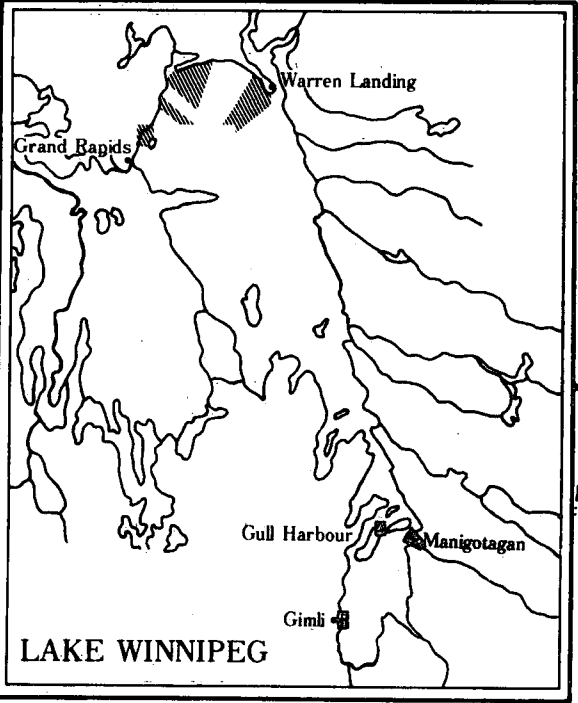
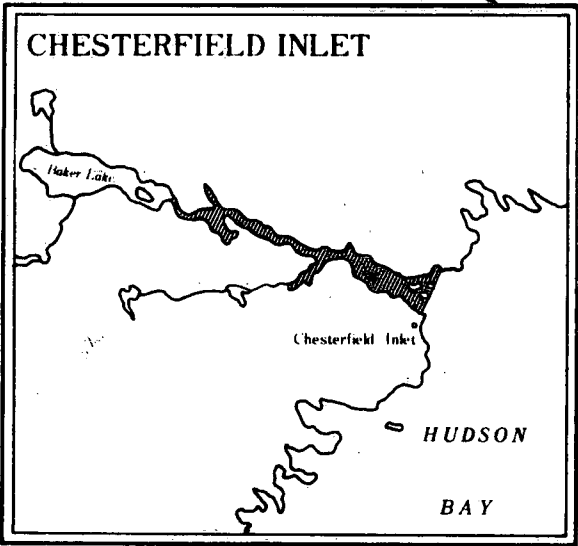
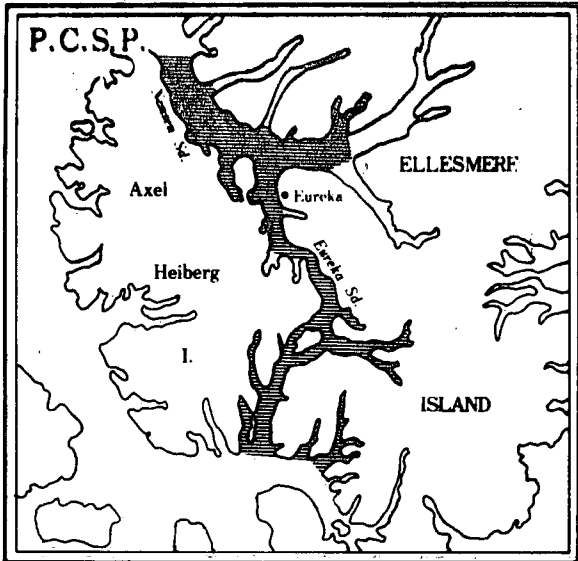


The HAAPS Processing System



CALCOMP plotter for HAAPS



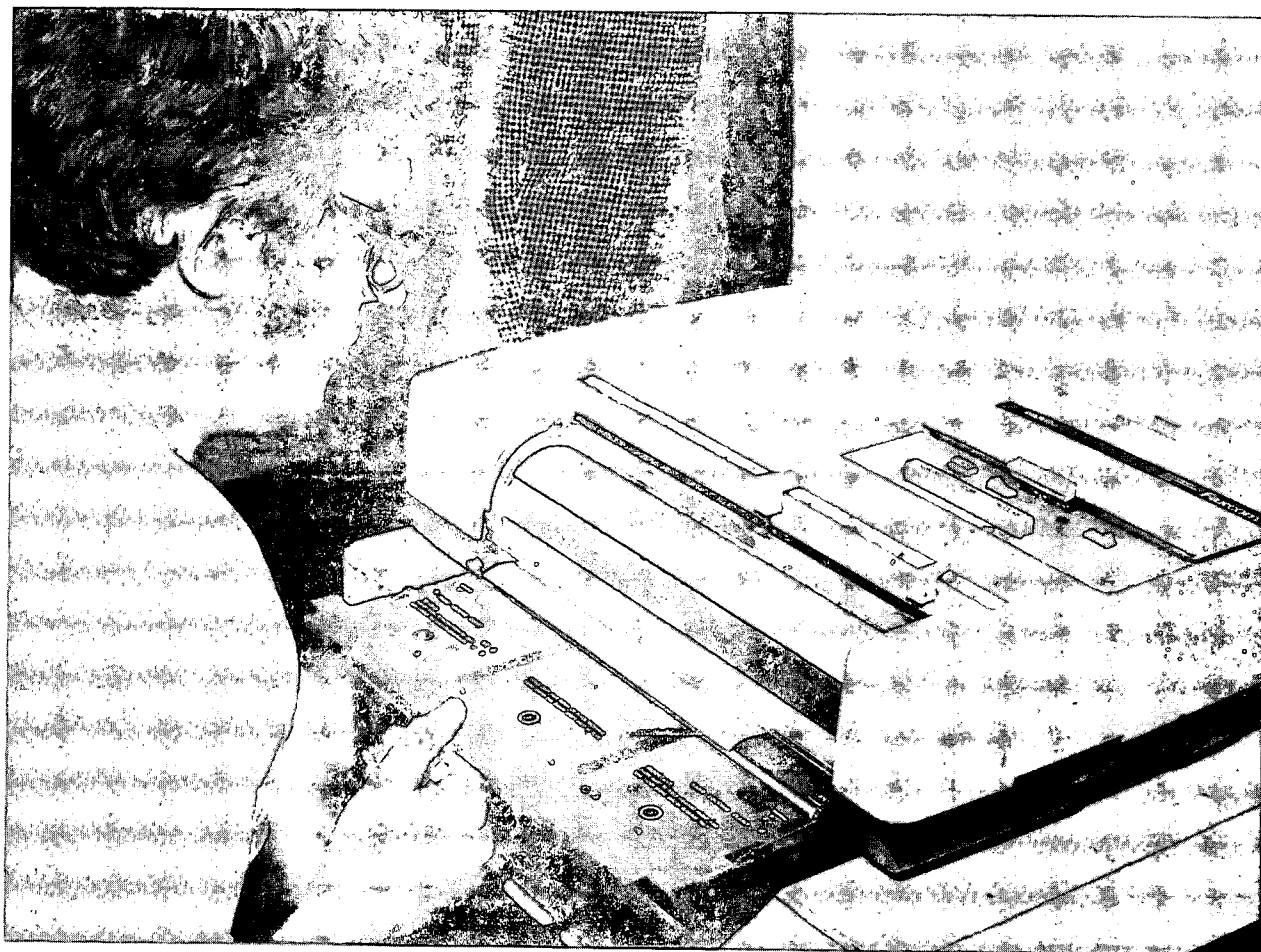


**CENTRAL REGION
 1974
 HYDROGRAPHIC SURVEY PROGRAM
 (Western and Northern Areas)**
 Area Surveyed

Tides, Currents and Water Levels

The year marked a major increase in tidal affairs. The responsibility for tidal matters concerning navigation was returned to the Hydrographic Division. At the same time, a Tidal Instrument Development Group was transferred to the Region from Headquarters. The new tidal support group has been established with three men. Their responsibility will be to provide advice and assistance to the hydrographic survey parties on location of gauges, preparation of co-tidal charts, datums and the analysis of data. The monthly and weekly water level bulletins for the Great Lakes have been redesigned and are now produced by this group. Assistance was provided in running a current survey in the St. Lawrence utilizing the BAYFIELD.

The Tidal Instrument Group has undergone the administrative turmoil of re-establishing itself. Work has continued on a system to retransmit data via satellite. Responsibility for monitoring a major contract to maintain the permanent gauge telemetering network has been transferred to this group. A future program thrust has been developed.



Telecopier used for communicating tidal data
with the Lower St. Lawrence Survey

Significant Development Projects

The Regional Office continues to promote an active program of technical development. Two major projects have been the development of a new automatic data collection and processing system, designated INDAPS (Integrated Navigation, Data Acquisition and Processing System) and the evaluation of a Magnavox Satellite Doppler Sonar Integrated Navigation System. The INDAPS development has had the remarkable record of being designed, built and into productive use within the year. It is in fact, an improved design on the HAAPS (Hydrographic Acquisition and Processing System). The Satellite Doppler Sonar System promises to provide navigation of a high order of accuracy for research ships on the Great Lakes, but to date has not reached its specifications.

The GERBER 22 plotter has again been used extensively in the preparation of the final field sheets. The side scan sonar has been used in several areas but has had considerable electronic trouble.

Staff Exchange Program

Once again, staff have been exchanged with the National Ocean Survey in order to encourage the exchange of ideas and technical information.

Hydrographic Conference

The Annual Hydrographic Conference was sponsored by Central Region CHS/CHA (Canadian Hydrographers' Association) this year. The Conference, held in March, attracted a large delegation of U.S. Hydrographers and several European Hydrographers.

Cartographic Unit

Marine Sciences, Central Region, assumed the responsibility of producing the Great Lakes Monthly Water Level Bulletins in April, 1974. The Cartographic Unit at that time purchased the equipment necessary for in-house photo-mechanical reproduction. This facility enables the Unit to have all reproduction material ready for the printer's press within 24 hours of receipt of the water level data. Generally, the unit was able to lessen its dependability on commercial photographic services with a resultant saving of time and expenditure.

Some major projects during 1974 were design and preparation of programs, tickets, etc. for the 1974 Canadian Hydrographic Conference; design of new covers for C.H.S. reports; design and preparation of multi-coloured illustrations for the Great Lakes Shore Damage Interim Report; design and preparation of charts and graphics for the 1975 Toronto Boat Show.

Plans for 1975

The Survey of the Lower St. Lawrence is to be completed. In the Great Lakes hydrographers will continue to work with the geologists in the western end of Lake Erie. The bathymetric survey of Lake Huron will be continued. Revisory Surveys will be working in Georgian Bay, Lake Ontario and the Upper St. Lawrence. The Survey of Toronto Harbour will be completed.

Surveys in Lake Winnipeg will continue. It is planned to complete the harbour surveys, but the offshore area will take several more years.

In the Arctic, hydrographers will be working with the Polar Continental Shelf Project in Nares Strait. The most important new project will be a major offshore bathymetric/geophysical survey of Hudson Bay. Associated with that survey will be a shore-based survey at Povungnituk. Another new project will take place in the Spring in James Bay. Working with the Dominion Observatory, a through-ice survey is planned for the area, extending over two years.

Some important plans are afoot for improvements in the technology. It is planned to use an integrated Satnav/Loran-C System for navigation on the Hudson Bay multi-parameter survey. Based on the success of the INDAPS it is planned to equip both the Lake Huron and Lake Winnipeg surveys with that equipment. The HAAPS will be used with the St. Lawrence Surveys.

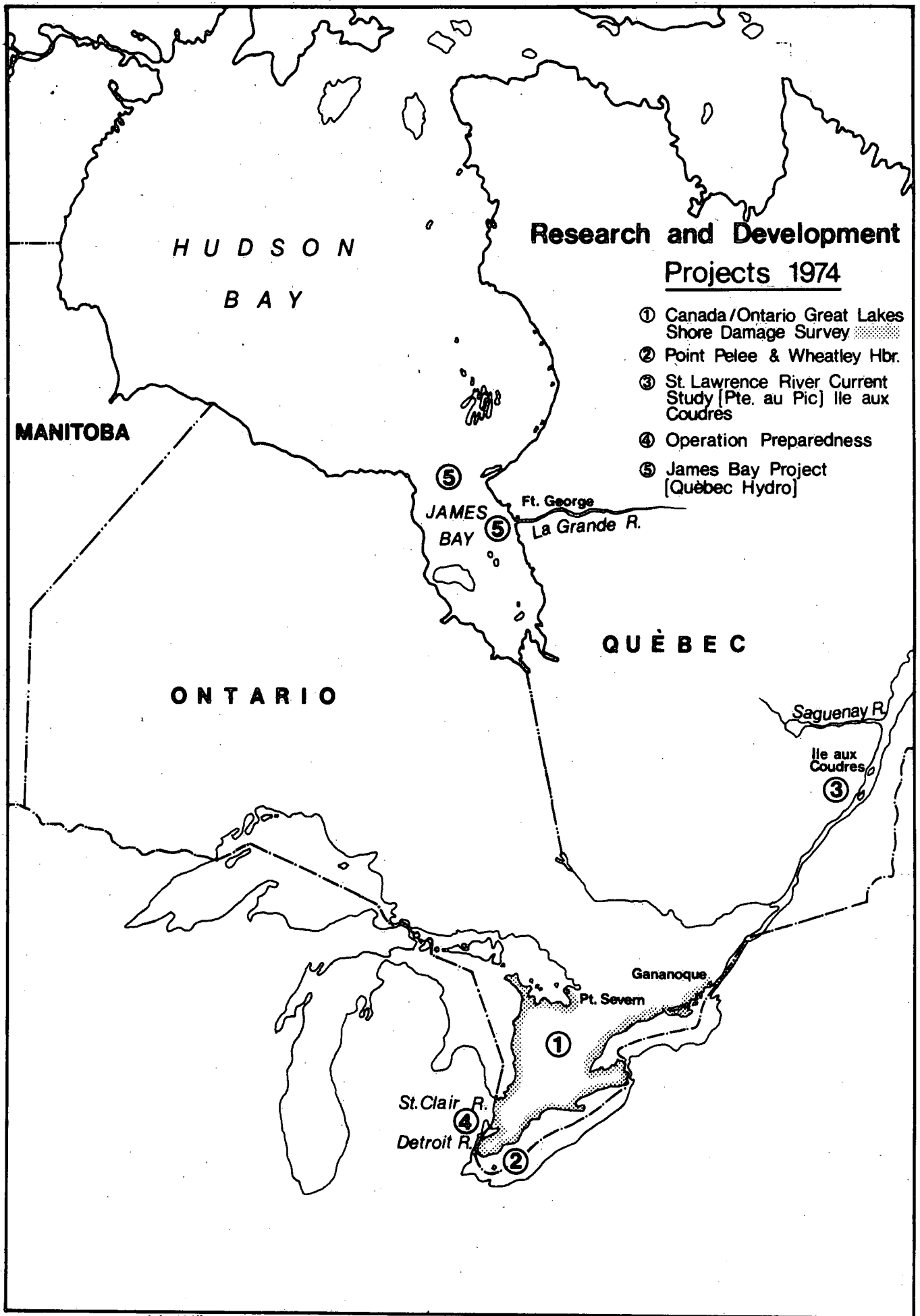
RESEARCH AND DEVELOPMENT DIVISION

N.G. FREEMAN

The Division's main thrust in the past year and over the next few years is to develop an oceanographic research competence, particularly in physical and chemical oceanography, for the study of processes in the James Bay - Hudson Bay system. As a result of a meeting held on January 14, 1975, with the A.D.M. and the corporate management of Ocean and Aquatic Affairs, the Director, Central Region was officially given jurisdiction over Hudson - James Bays for oceanographic studies, in addition to the previously obtained jurisdiction for hydrographic surveys. In addition, the Division was involved in a number of multi-service and multi-agency programs, particularly: the St. Clair River Current Study, commonly called "Operation Preparedness" with E.P.S.; the Federal/Provincial Agreement for a Shore Damage Survey with E.M.S. and O.M.N.R.; and the Storm Surge prediction work with E.M.S. and A.E.S.

The programs in 1974 had the following objectives and were carried out by the four sections: Hydrodynamics, Shore Property Studies, Oceanographic Research, and Survey Electronics.

- 1) to provide information on current predictability and spatiality in the St. Clair - Detroit Rivers for "Operation Preparedness";
- 2) to provide a descriptive and predictive capability for the tides and currents in the Middle St. Lawrence River Estuary;
- 3) to provide a marine and estuarine environmental impact assessment of the James Bay Power Project;
- 4) to utilize the results of the Canada/Ontario Great Lakes Shore Damage Survey for developing more efficient coastal zone management and planning policies;
- 5) to investigate the feasibility of photogrammetric methods in erosion rate monitoring;
- 6) to provide survey electronics support to the Hydrographic and Limnological field programs; and
- 7) to establish increased instrument development capability in hydrodynamics and physical oceanography.



New program thrusts for 1975 include:

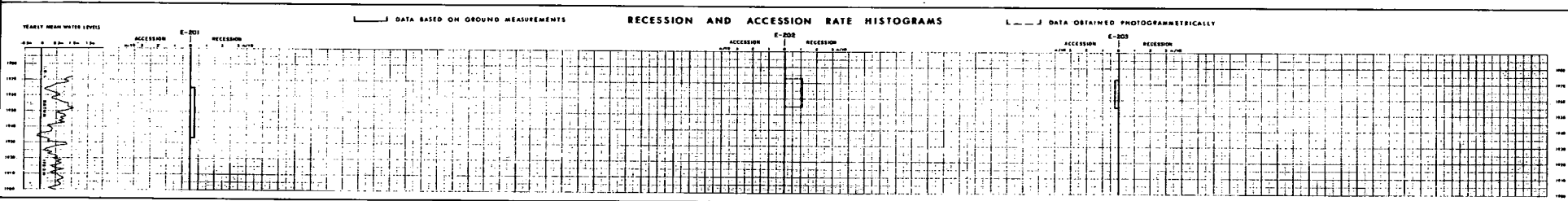
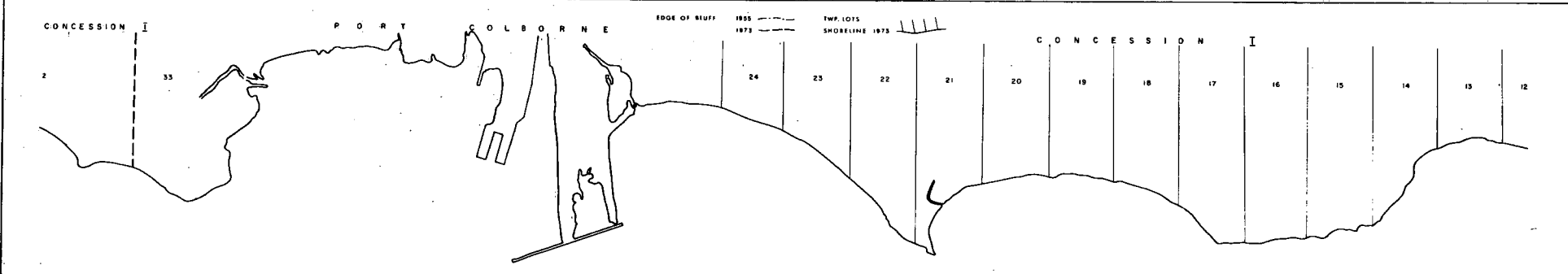
- 1) a physical oceanographic study in Hudson Bay;
- 2) formation of an Environmental Assessment Section to support the James Bay Impact Statement and for representation on the Screening and Coordinating Committee of the Environmental Assessment and Review Process;
- 3) a hydrodynamics study in connection with the Gulf of St. Lawrence program; and
- 4) establishment of long-term shore protection sites on the lower Great Lakes.

Canada/Ontario Great Lakes Shore Damage Survey

Under the project management of the Shore Property Studies Section, the field surveys of this Federal/Provincial Agreement were brought to a successful conclusion in 1973 while the collection of riparian property assessment data carried on until April, 1974. The rest of 1974 was spent analysing data and developing recommendations in conjunction with the Social Sciences and Water Planning and Management Sections of I.W.D. In October, an Interim Report was produced and forwarded to the respective ministers of Environment Canada and the Ontario Ministry of Natural Resources. The report contains the results of the survey and a number of recommendations dealing with shoreline management, planning and protection. By the end of the year, follow-up programs were being developed to examine the coastal zone management alternatives.

Monitoring of the erosion stations established in 1972 continued in 1974, providing erosion coverage during the high water periods of 1972-1974. Updating of the oblique-angle aerial photography was undertaken in 1974 involving sequential coverage from Port Severn to Sarnia on Lake Huron and from Niagara-on-the-Lake on Lake Ontario to Trois Rivieres on the St. Lawrence River.

The technical report of the Canada/Ontario Agreement is presently being finalized and will be ready for distribution early in 1975. The coastal zone atlas, which will depict various shoreline parameters such as land use, ownership, value and physical characteristics as well as histograms of recession or accretion rates, is nearing completion and should be ready within the same time frame as the technical report.



LEGEND

PROFILE LOCATION PHOTOGAMMETRIC E-2

EROSION STATION (E-6-15)

CONTOUR INTERVAL 3 METERS

COUNTY, REGIONAL MUNICIPALITY BOUNDARIES ESSEX COUNTY

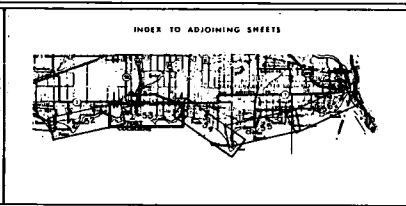
MUNICIPAL BOUNDARIES AS OF JAN. 1 1970 DELT

PREVIOUS MUNICIPAL BOUNDARIES DURHAM TWP

2 METER CONTOUR ELEVATIONS AND WATER LEVELS REFERRED TO INTERNATIONAL GREAT LAKES DATUM (1955) LAKE ERIE 173.5 m.

WATER LEVEL SHOWN ON PHOTO-WDS-3 IS ONLY MEAN VALUE AT DATE OF AERIAL PHOTOGRAPHY MAY 20 1973

1000 METER GRID SHOWN ON A 6° UNIVERSAL TRANSVERSE MERCATOR PROJECTION-ZONE 17



Environment Canada / Environnement Canada

CANADA - ONTARIO

GREAT LAKES SHORE DAMAGE SURVEY - 1973

REGIONAL MUNICIPALITY OF NIAGARA

SCALE 1:10,000

LAKE ERIE SHEET I-53



LEGEND		SHORELINE OWNERSHIP		SHORELINE LAND USE		SHORELINE PHYSICAL CHARACTERISTICS		LOW PLAIN		EXISTING PROTECTIVE WORKS IN MANAGED AREA			
1 SHORELINE DAMAGE STRUCTURAL DAMAGE DUE TO EROSION Severe \$2000/ft and up Moderate \$217/ft - \$199/ft Minor \$20/ft and less IMPROBATION DAMAGE Severe \$200/ft and up Moderate \$21/ft - \$19/ft Minor \$20/ft and less		2 SHORELINE OWNERSHIP Federal Government Provincial Government Municipal Government Private 3 SHORELINE VALUE 1971 - \$200/ft 1900 - 1900/ft 1901 - 1900/ft 19001 - 19000/ft 19000/ft and up		4 SHORELINE LAND USE Pastureland Seasonal Residential Residential Wildlife Habitat Agriculture Commercial Industrial Forest Underdeveloped Other		5 SHORELINE PHYSICAL CHARACTERISTICS Beach Bars and Spits Beach and Outer channels Wetland or marsh Bluffs > 5 m High glacial drift > 10 m High bedrock > 10 m Low glacial drift Low bedrock Low artificial fill		LOW PLAIN Glacial drift Bedrock Artificial fill EXISTING PROTECTIVE WORKS IN MANAGED AREA Seawall, without gabion, retaining wall Groynes, jetties Breakwater, salt-tolerant Breakwater, salt-intolerant Beach replenishment Dike		Environmental Canada Environment Canada CANADA - ONTARIO GREAT LAKES SHORE DAMAGE SURVEY - 1973 REGIONAL MUNICIPALITY OF NIAGARA SCALE 1:10,000 METERS 0 100 200 300 400 500 600 700 800 900 1000 FEET 0 100 200 300 400 500 600 700 800 900 1000		Ministry of Natural Resources LAKE ERIE SHEET 2-53	

Wheatley Harbour

The Shore Property Studies Section carried out a research program in Wheatley Harbour during 1974. With the cooperation of Public Works, Canada, sand material dredged from the approaches to the harbour was scow-placed at a point 4 Km. south-west of Wheatley. The material was placed in an approximate 3 metre depth in the zone of long-shore transport. Profiles taken at the dumping site and in the Point Pelee area will indicate the feasibility of nourishing beaches in this area by stock-piling.

Task D Land Drainage Reference Group - G.L.W.Q.B. - I.J.C.

Shore Property Studies represented the Division on this task force through participation at meetings and through the contribution of material on shore erosion and land fill. The Reference Group is seeking to determine the degree of pollution from land-based sources and our interest is that portion attributable to shore erosion and the related dispersion of materials. Inputs related to land fill are aimed at establishing the feasibility of stabilizing shorelines with artificial fill, through its effects upon natural shoreline processes.

Photogrammetric Bluff Surveying - Laval University

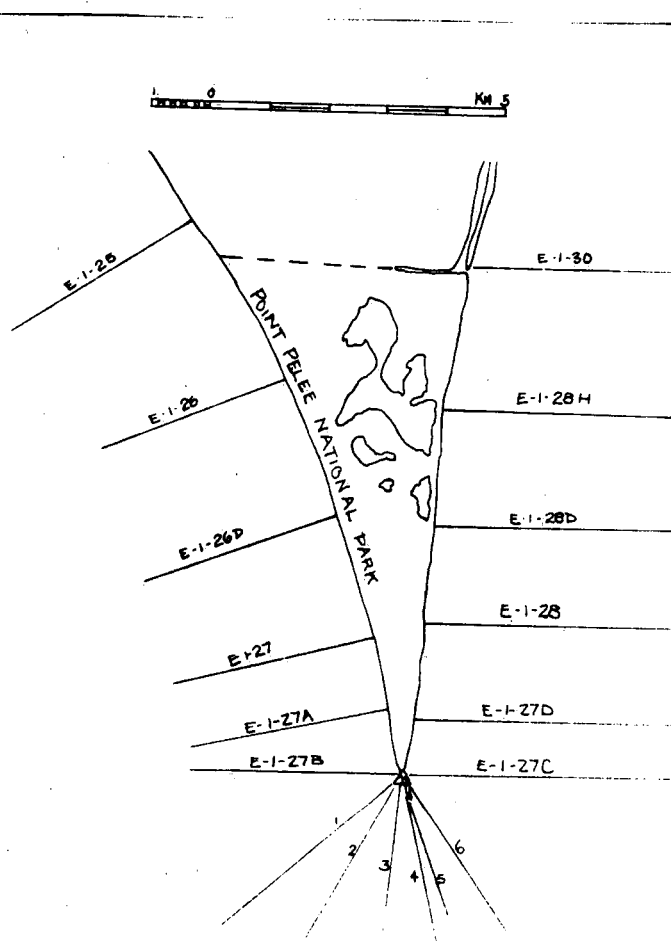
Shore Property Studies established a contract with Laval University of Quebec, which investigated the feasibility of measuring erosion and accession by photogrammetric methods. The purpose of the evaluation was to compare this method with the classical ground surveying methods presently being utilized. The results of the comparison showed that photogrammetric surveying could prove economically preferable in the long run, but that classical ground surveying methods should be continued where ground control has been established.

Point Pelee Erosion Survey - 1974

In order to determine the extent to which the commercial dredging activities and existing protection in the area have affected beach erosion

within the National Park, over and above the erosion which can be expected from natural causes, a joint study was undertaken by Parks Canada and Environment Canada. In conjunction with the Lakes Research Division, the Shore Property Studies Section established a network of profile stations around the Point and surveyed them on a continuous basis during the months of May-June and September-October.

Profiling consisted of an onshore survey using conventional topographic methods while the offshore sector was attained through hydrographic procedures. Changes in the nearshore zone were recorded by extending the onshore profile beyond the waters edge to approximately 1 1/2 metres depth. To supplement the sequential profile data, a current analysis was undertaken in order to determine sediment transport. Drogues were used during the May-June phase of the study, while two self-recording E.M. current meters were installed by the Mechanical Engineering Unit of CCIW for the September - October phase.



Point Pelee Erosion Survey Profile Locations

James Bay Oceanographic Studies

The main objectives of the Oceanographic Research Section's program in James Bay include:

- (a) The determination of the present distribution of salinity, temperature and dissolved oxygen in the

estuaries and the Bay, including the seasonal distribution.

- (b) The examination of the physical processes contributing to these distributions.

These studies must be completed and understood in order to provide the specific information upon which an assessment of the possible effects of the James Bay Power Project on the marine and estuarine environment can be made.

The 1974 James Bay summer field program consisted of reoccupying the stations set up and occupied in the 1972 and 1973 surveys. In September, discreet salinity and oxygen samples, bottom samples and mechanical BT casts were taken at 16 stations located on two latitudinal sections in the northern half of the Bay and two longitudinal sections off La Grande Riviere. Phytoplankton, zooplankton and water samples for nutrients analysis were also collected and sent to the Arctic Biological Station, FRD. The University of Quebec at Rimouski was awarded a contract to analyse the 1972 and 1973 data in order to map the geostrophic current in the northern portion of the Bay and to determine by indirect methods the transport and coupling between James and Hudson Bays.

Following a feasibility study in the winter of 1973, a number of stations were occupied on the shore-fast ice off Fort George. Salinity and temperature data were collected from January to May with one station being occupied twice weekly for the 4-month period. Measurements and hourly intervals were also taken at this station over a 13-hour period for comparison with similar observations taken the previous summer.

A survey was undertaken in September to measure currents, salinity and temperature over periods of 13 hours at 15 stations in the La Grande River and Estuary. Due to inclement weather, only eleven stations could be occupied, of which six spanned the full tidal cycle. An analysis of the data collected in the Estuary is underway to determine the spatial and temperal variations in the extent of the surface freshwater layer and the degree of mixing with the underlying saline water.

A combined program involving the Canadian Hydrographic Service, the Gravity Division of the Earth Physics Branch, EMR and the Oceanographic Research Section is being carried out this winter in James Bay. The oceanographic survey will involve through-the-ice measurements of temperature, salinity and dissolved oxygen over the entire Bay, including the Eastmain Estuary and Rupert Bay. Current meters will be moored in the La Grande Estuary to obtain in situ records for tidal stream analysis and a vertical profiling station will be occupied over two consecutive tidal cycles.

James Bay Workshop June 26, 1974

The First James Bay Workshop brought together scientists, working since 1971 on the physical and biological oceanography of James Bay, to present their data, analyses and interpretations as completed to date. Scientists from the Atmospheric Environment Service, Bedford Institute, Arctic Biological Station, McGill University, Université du Québec (Rimouski), the James Bay Development Corporation, Marine Sciences (Central Region), Geophysical Limnology and Great Lakes Bi-limnology, attended the one-day workshop to delineate present projects, propose future programs and bring out areas requiring further study.

Hudson Bay Oceanographic Studies

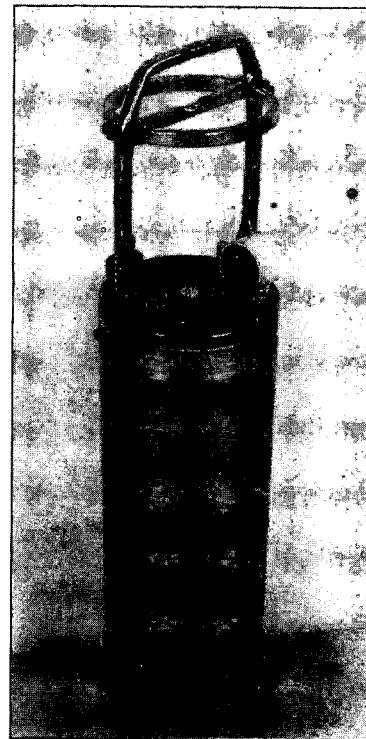
Planning has been undertaken in 1974 by the Oceanographic Research Section to participate in a multi-disciplinary summer survey in Hudson Bay. The general objective of the oceanographic program is to increase our understanding and predictability of the physical oceanographic processes in this mid-Arctic inland sea. This research will enable us to assess the environmental impact of accidents resulting from increased activity in hydro-carbon drilling, marine traffic, pipeline construction, and hydroelectric development. The program in 1975 will be oriented largely to field testing of new instrumentation and to collection of baseline oceanographic data.

Oceanographic Instrumentation Development

The Instrumentation Development Unit of the Hydrodynamics Section

is a support group for supplying and/or developing the required data collection instruments for Hydrodynamics and Oceanographic projects. During 1974, the Unit supplied the St. Lawrence current survey with 12 Aanderaa current meters (in-situ), 3 Endeco current meters (hand-held) and 2 R.S.5 profiling salinometers. All these instruments were thoroughly calibrated pre- and post-season. A report is in preparation on the total calibration procedure and first indications are that a small difference exists at high speeds between pre- and post-calibration and between the published and tow tank calibration curves. The James Bay Winter Study, February, 1975, will be supplied with 7 Aanderaa current meters and 2 R.S.5 salinometers. The Aanderaa current meters, 6 of which were converted to profiling C.T.D. units with a printer output at the surface, underwent simulated Arctic tests and calibration.

A surface-referenced mooring evaluation project was undertaken by the Instrumentation Unit as a result of a request from scientific staff to have a mooring capable of holding instrumentation at a constant depth irrespective of tidal movements. The mooring configuration was designed during 1973, but was updated in 1974. Instrumentation supplied to this project were; one Aanderaa current meter (in-situ), one Endeco 105 (in-situ) current meter, 3 tri-axial accelerometers, 2 inclinometers, a high speed 100 channel data logger, a dual buffered tape drive and peripheral control systems. In addition, a high speed data logger, a dual buffered tape drive, one inclinometer and one tri-axial accelerometer were supplied for the Pitch and Roll Project conducted by the Hydrographic Development Unit, Central Region. The high speed data logger and dual buffered tape drive was supplied to I.W.D. Engineering Services Section for their Tower Analysis project.



Modified Aanderaa R.C.M.

Development of Manual Techniques for the Real Time Prediction of Storm Surges on the Great Lakes

Flooding and erosion problems on the Great Lakes, resulting from short term rises in water level superimposed on abnormally high water levels in 1973 and 1974, have created an urgent need for forecasting these short term changes in real time.

A manual technique using a statistical approach to derive regression relationships has been developed. The level changes for Lakes Ontario, Erie, Huron and for Georgian Bay were calculated from values of the sea level pressures and air-water temperature differences with lag times of 0 and 6 hours as independent variables. For Lake St. Clair, hourly winds at Windsor with lag times of 0 and 1 hour replaced the sea level pressure as predictors.

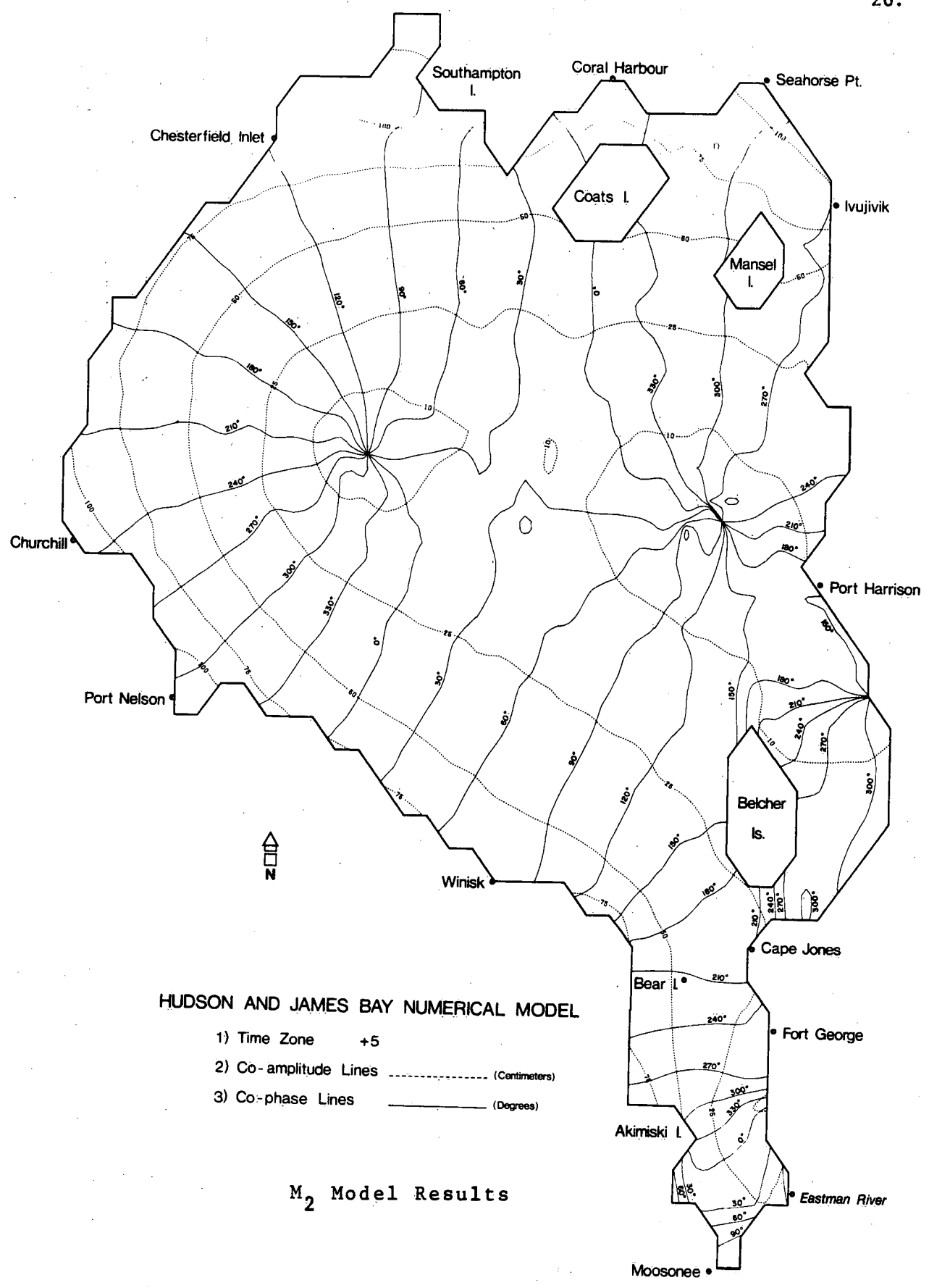
The proportion of variation of the water levels in the various lakes accounted for by this method ranges between 55 and 75%. The comparison of observed and predicted levels has been generally good with the best correlation of peak levels being obtained for Lake St. Clair. A drag coefficient value of 2.46×10^{-3} has also been derived for Lake St. Clair. The standard errors of estimate for all the lakes except Erie range between 0.2 and 0.3 ft. while it is close to 0.6 ft. for Lake Erie.

Two-Dimensional Numerical Tidal Model for the Hudson and James Bay System

The dynamical equations used in this model are the vertically integrated forms of the equations of motion and continuity in spherical polar co-ordinates as given in Heaps (1969):

$$\begin{aligned}\frac{\partial M}{\partial t} &= 2\Omega N \sin\phi - \frac{gh}{a \cos\phi} \frac{\partial \eta}{\partial X} - \frac{T_{BX}}{\rho} \\ \frac{\partial N}{\partial t} &= -2\Omega M \sin\phi - \frac{gh}{a} \frac{\partial \eta}{\partial \phi} - \frac{T_{B\phi}}{\rho} \\ \frac{\partial \eta}{\partial t} &= \frac{-1}{a \cos\phi} \left[\frac{\partial M}{\partial X} + \frac{\partial}{\partial \phi} (N \cos\phi) \right]\end{aligned}$$

The simple two-dimensional numerical model qualitatively reproduces the M_2 and K_1 tidal propagation in Hudson and James Bays. Good onshore station agreement is achieved, and the model results can be used to construct appropriate co-tidal charts and to analyse tidal propagation in the system.



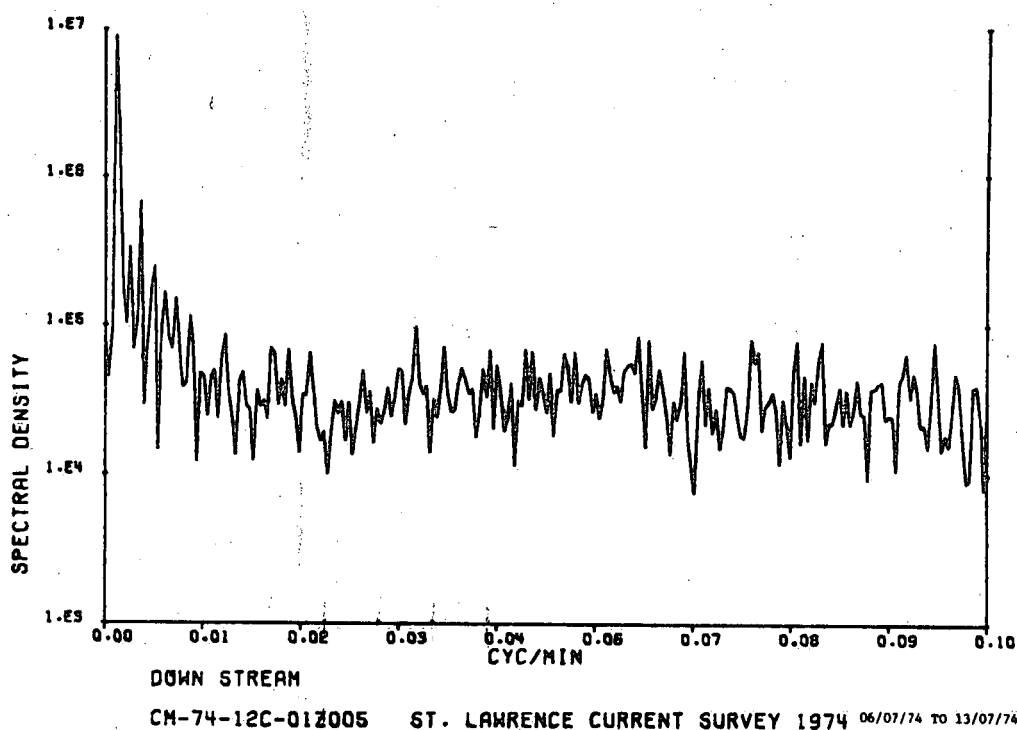
St. Lawrence Current Survey, 1974

One of the primary objectives of the St. Lawrence Estuary programme is to provide an updated tidal current atlas of the Middle Estuary for use as a navigational aid, in the prediction of oil slick movement, and in the design of deep water ports. Another objective is to study the spatial and temporal variability of the astronomically induced tides and currents, and the effects of meteorological forces on these tides and currents. In addition, the net non-tidal circulation patterns and their variability due to discharge, man-made changes in the bathymetry, and season are to be studied. The program provides for baseline oceanographic measurements to be taken, as well.

In the data processing field, the Aanderaa current meter data handling programmes were combined into a coherent system and preliminary documentation of the system has been completed. Edited current data files can be produced for Aanderaa, Plessey, and Geodyne current meters. Once edited files are created, tidal streams analysis and power spectral analysis are performed and progressive vector diagrams can be produced. A complementary data handling system for Endeco direct readout current meter data was also developed. Plots of the vertical profiles of current, salinity, and temperatures can be made. In addition, a contouring programme produces displays of the time variability of isohalines and isotherms.

The field work, operationally supervised by a senior hydrographer, consisted of two and one-half months of current measurement in the Pte.-au-Pic area. Eleven Aanderaa RCM-4 current meters were deployed, ten were recovered, and one meter was replaced under warranty by Aanderaa Instruments of Norway. The meters were distributed over four moorings. Thirty 13-hour stations were occupied measuring current speed and direction, salinity, and temperature at each one-tenth of the depth.

Analysis of the data is progressing and data reports for both the 1973 and 1974 surveys should be published early in the new year. The preliminary analysis has been completed and indicates that some interesting circulation patterns exist in the Middle Estuary. In addition, some of the data suggests internal waves may be occurring there. Further analysis will be required to determine the true nature of these phenomena, however.



Spectral Density of Current Velocity
at Goose Cape

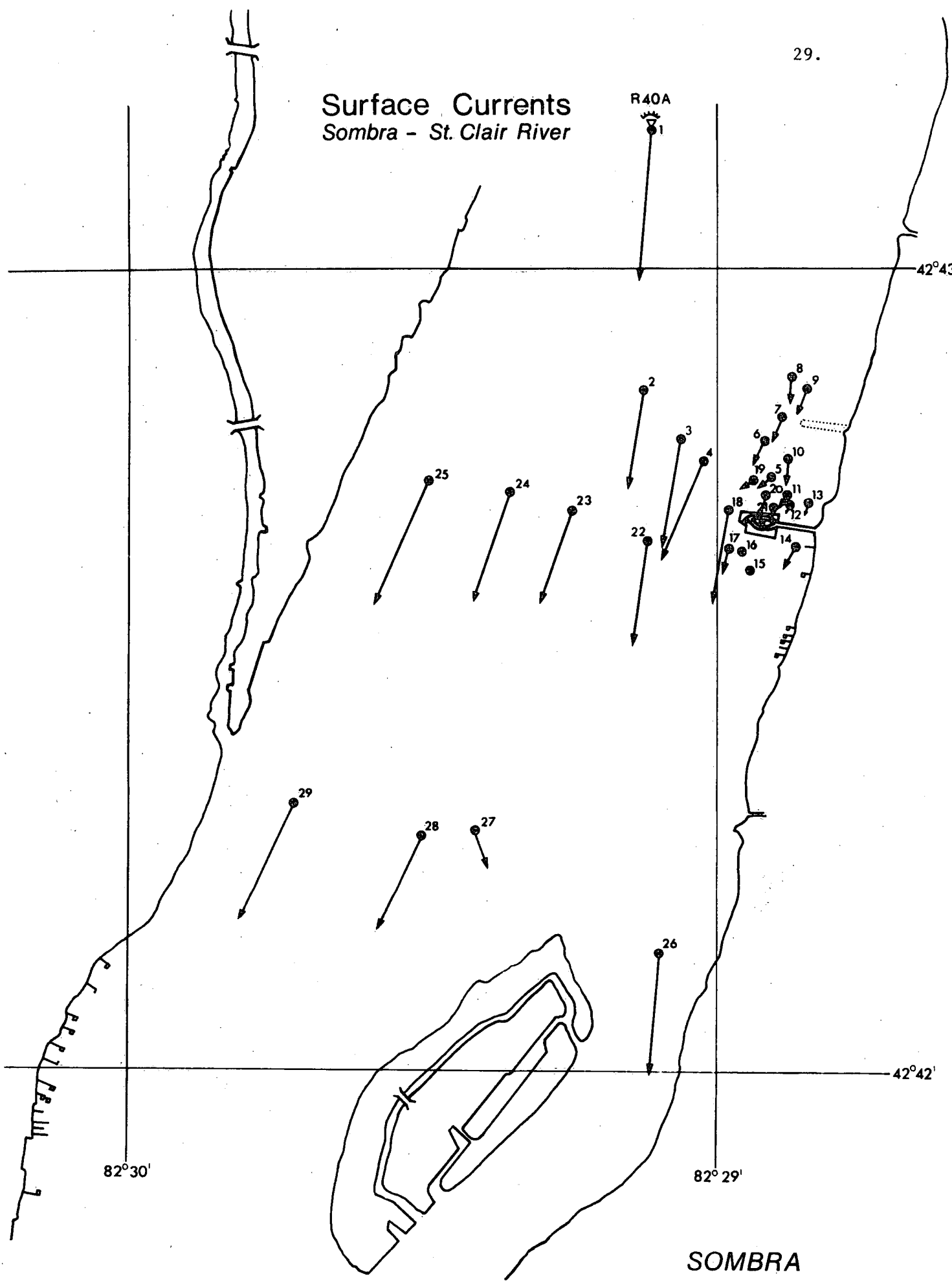
Operation Preparedness

The Hydrodynamics Section, through numerical modelling and a field program, is supplying current data to Operation Preparedness so that oil slick movement on the St. Clair/Detroit River system can be predicted. The development of a two-dimensional implicit river model is completed and a second contract is being let for the testing and application of this model to the St. Clair/Detroit River system. A one-dimensional river model has been developed and programmed in-house and will be tested and applied to the rivers early in the new year. A field survey on the St. Clair River was carried out in conjunction with E.P.S. in August of 1974. Data from this survey has been incorporated into a data report.

Surface Currents Sombra - St. Clair River

R40A
1

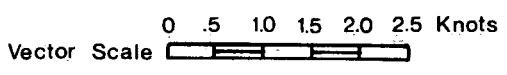
42°43'



82°30'

42°42'

82°29'



SOMBRA

Scale 1:11,225 1 in. = .285 km.

Aug. 13-16, 1974

Survey Electronics Support to Marine Sciences

The introduction of major new systems and the operation of a number of large and sophisticated surveys kept the Survey Electronics Section busy again this year. Some of the new equipment acquired included four Miniranger systems, two sets CA1000 Tellurometers, three new Ross Sounders and four digitizers, three INDAPS logging systems and one processing system, a number of new VHF radio systems and new gyro compasses and radars. Also during 1974, the Electronics Shop assumed responsibility for the three Digital Equipment Corporation computers. To keep up with this new technology, a number of training programs were undertaken. In addition to an RPS and a Tellurometer course provided to all staff, individual technicians undertook Minifix and Interdata courses and five technicians attended a course in logic provided by Hewlett Packard.

The Chesterfield Inlet survey required considerable electronic support, utilizing two Miniranger systems, two HAAPS systems and a processor, Ross sounders and a full time field technician. The intention was to utilize a Hifix system, but this system was not used due to the success achieved with the Miniranger systems and a change of program emphasis early in the season. The electronics on this survey operated within minimum down time, contributing to the successful completion of a two-year program in one year.

The Lake Winnipeg (North) survey also employed a full-time technician and made extensive use of electronic equipment. The survey utilized a Minifix system with 60' towers, and redesigned matching units. This resulted in useable ranges in excess of 60 miles whereas 35 miles was previously the maximum. The survey also employed the INDAPS logging system although several problems were experienced due to the fact that the system was new. A Minifix Slave Unit was lost during high water due to its location on low terrain. An electronic technician was also supplied to the Lake Winnipeg Harbour Survey. Equipment maintained included Edo Sounders, RPS, Hydrodist MRB 2's and new Hydrodist MRB 201's. Considerable problems arose in the general functioning of the MRB 201's.

The Lake Huron survey utilized high power Minifix transmitters in conjunction with 70' towers to give extensive coverage on the order of 70

miles or more. Problems resulted from high towers, heavy lightning activity on Lake Huron and interference due to high power. In addition to the Minifix, the survey also employed HAAPS loggers and Ross Digitizers and Sounders. The technician for this survey was supplied on call from Burlington.

The St. Lawrence River Survey utilized Minirangers, RPS and Hydrodist in conjunction with Edo Sounders. It became necessary to remove our RPS from service due to an interference problem with a similar system of M.O.T.

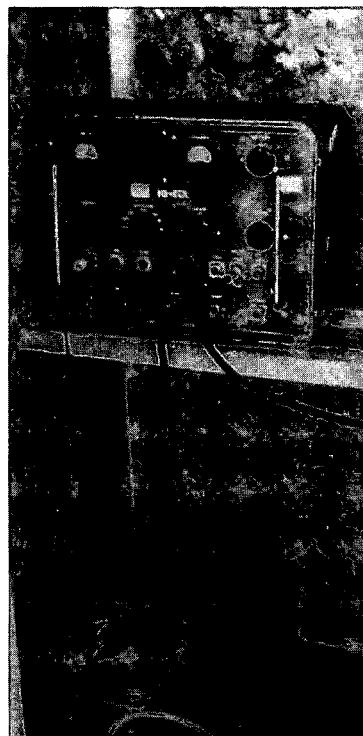
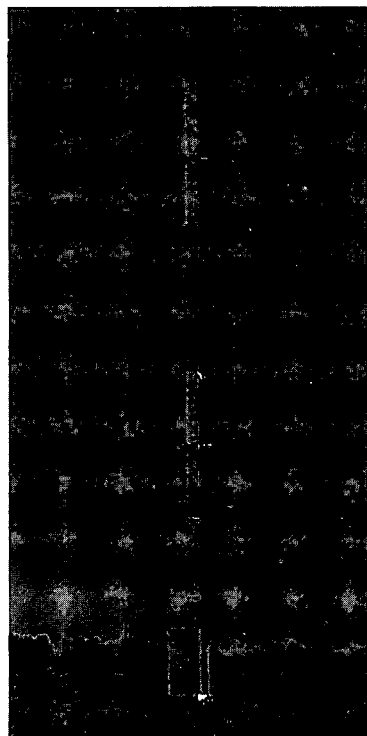
In addition to the above surveys, electronic support was provided to the Local Survey in Toronto Harbour and to both Revisory Surveys.

Survey Electronics Support to IWD Programs

As in the past, the section was responsible for all navigational electronics on the Limnos, Martin Karlsen and the large launches employed in scientific programs. Three launches working out of Wheatley on scientific programs were supported with a Miniranger and an RPS chain. A launch used by a Fisheries program at Nanticoke was similarly supported.

Survey Electronics Development Programs

The Electronics Shop endeavours to undertake a small amount of developmental work each year. This year, considerable developmental work was carried out to increase the maximum stable range of the Minifix system. The 30' telescoping Minifix antenna was replaced with 70' towers and with rebuilt tuning units. Signal increases on the order of 10 db were achieved. By raising the output power of the system from 50 to 100 watts, a significant additional signal gain was observed. As a result of these tests, both minifix systems were modified for use with 70' antennas and one of these systems incorporated 100 watt transmitters.



High Power Minifix Tower and Equipment

During the year, two test boxes for testing the HAAPS system were developed. One injects signals into the HAAPS system and the second monitors the outputs. A standard remote readout for RPS and miniranger systems was also developed. At the present time, work is continuing on the development of a new, more stable trigger circuit for the minifix receivers.

SHIP DIVISION

A. QUIRK

This year, all the Division's outboard engine work was placed with outside contractors which alleviated much of the work load on shop personnel, allowing more time to be spent in carrying out modifications and design work on major launches.

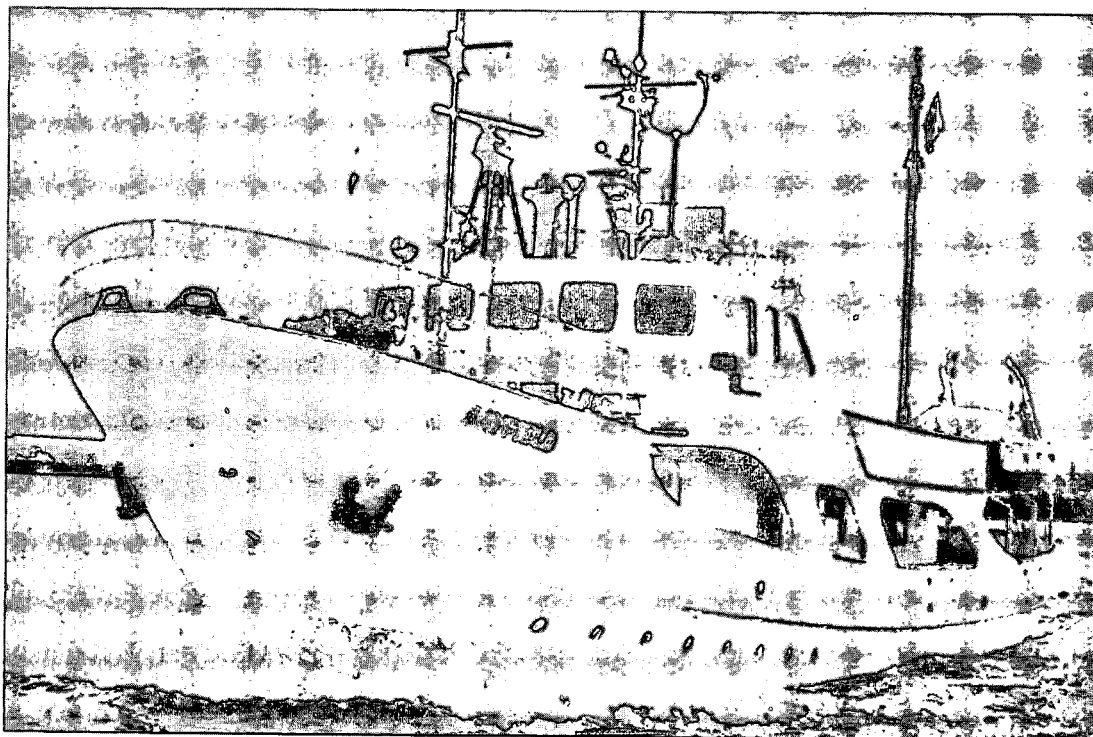
The repowering modifications on three Hydro launches were made based on exhaustive testing both under simulated load conditions and under field conditions in the latter part of the 1973 season. However, it was later determined that actual load requirements were far in excess of those predicted and that the engines for the three latest boats were of a different model than the one tested although identical in appearance. The result was that all three of these engines failed after an approximate period of 30 hours actual field conditions although Hydro II, the original boat outfitted and tested, was still operating at the close of the season.

Surge and Sturdy were both rebuilt during the early part of the year, with respect to decks and houses, while Sturdy was re-engined using the original Diesel engines from Hydro I and II. During a break-in period in the Lower St. Lawrence, the Sturdy experienced lubricating oil troubles, a problem similar to one which occurred on the East Coast when the engine required changing following a seize-up.

Lubricating oil problems persisted even with the new engine until it was determined that a mismatched dip stick was giving a false oil level reading. With the exception of a clutch failure on Surge which was repaired at Chesterfield Inlet by the ship mechanic, both vessels operated trouble free for the remainder of the season.

New Acquisition

CSS BAYFIELD modifications were delayed awaiting the awarding of the contract for electrical repairs, modifications to the main switch board, and necessary repairs for the vessel's recertification from a yacht to a scientific research vessel under the Canada Shipping Act. However, after her return to Burlington from Port Weller where modifications, provisioning and outfitting were carried out, the vessel departed for the Lower St. Lawrence on a 76-day Tidal Current Survey. During this time, valuable experience was obtained both in the operation of the vessel and also in determining the extent of further modifications necessary to make the vessel an even more valuable addition to the fleet. Some of these modifications were made during the dry docking of the vessel in the latter part of November, with the addition of Ross and Atlas transducers and a Sperry Doppler Speed Log.



C.S.S. Bayfield

C.S.L. Surf

This 38 ft. steel-hulled launch was acquired in a semi-completed condition early in the year and arrived at Burlington following the start of the season, too late for field operations. However, following a fitting-out period, the vessel created great interest in both hydrographic and scientific circles mainly due to her roominess and spacious working area in the aft cockpit.

Nelson 34

The G.R.F. Diesel-powered semi-displacement hull vessel was delivered in September following trials at the supplier's, where a top speed of 22.5 m.p.h. was obtained. Upon acceptance trials at the Centre, the vessel was found to be a fine craft to handle, particularly smooth through the water, and having a turning circle equal to two boat lengths.

Following acceptance, the vessel was subjected to even more stringent testing than was required under the purchase agreement. Repeated full ahead to full astern movements resulted in an early failure of the transmission. However, repairs were carried out under warrantee and the vessel performed adequately until hauled out for outfitting as a sophisticated hydrographic vessel. The major modifications were as follows:

- 1) Hull trepanned and two transducer wells and transducers installed,
- 2) Fuel tanks modified to double capacity,
- 3) Upper steering position moved,
- 4) Forward cabin stripped and rebuilt to accommodate sounders, instrument racks, chart tables and lockers,
- 5) Radar tower constructed and installed on aft cabin top,
- 6) Cockpit decking modified,
- 7) Engine and generator casing modified completely for access,
- 8) 24 volt scientific power to be separated from ship's power to be supplied from auxiliary generator and constavolt unit.

This vessel will be ready for full equipment trials immediately at the start of the 1975 season.

C.S.S. Advent

This vessel performed admirably during the season with down time limited to one day and 4 hours in total, the major portion consisting of the run down from Goderich to Sarnia and return for a propeller change following the striking of an unidentified object in deep water. Two interesting points were noted during this season's operation: 1) using the larger spare props at lower engine revs not only increased the vessel's speed by nearly 3 knots, but also significantly lowered fuel consumption; 2) with a barely noticeable scrape on the tip of one blade, engine revs dropped from 2200 to 1900 on that engine with subsequent loss in speed.

C.S.S. Limnos

The vessel operated trouble-free during the early part of the season, drydocking in May for the installation of the lower spool piece and sea valve for a Magnavox Doppler Transducer, part of the Sat/Nav System. The actual transducer and other equipment were installed in late June.

A diver's inspection found a crack in a previously repaired propeller, so that the spare propeller was installed during dry-docking.

Following the drydocking, problems occurred during a seismic survey, when power cables to the deck services fractured. Failure of the star-board steering gear bearings and oil leakage from the port harbour master unit were further problems encountered. However, a diver's examination revealed no physical damage to the lower units.

Repairs were carried out on the vessel's arrival back at Burlington and the vessel operated until the end of August when a routine inspection revealed a broken tooth in the upper gears of the Port Harbour Master Gear. Repairs were carried out with no loss of time.

Two consecutive engine failures resulted in a loss of three weeks at the end of October and beginning of November necessitating extensive repairs on a straight through basis. The vessel did complete her season's work, however, with an extended field season.

ADMINISTRATION DIVISION

A.W. APPLEBY

The loss of four senior supervisors and a number of key personnel to promotion at Canada Centre for Inland Waters created havoc to Administration's workload and general efficiency in the first half of 1974. Concurrently, Marine Sciences Headquarters administrative unit, providing guidance and other support went through a similar dilution of help with the formation of Ocean and Aquatic Affairs, placing more emphasis on regional autonomy. Fortunately, capable replacement staff have since been gradually obtained from within and outside government.

During the year 1974, the Administrative Support Division provided services to three major operating Divisions:

- (1) Hydrographic Survey Division operating from Lake Winnipeg in the west, and eastward throughout the Great Lakes System to the mouth of the St. Lawrence River; also James and Hudson Bays and the high Arctic, accounting for a total of eleven field parties plus sub-party activity.
- (2) Research and Development Division operating independently and in co-operation with the Hydrographic Service in the same general areas on hydrodynamics and oceanographic programs. Additionally, an intensive shore damage study was conducted on the Great Lakes, requiring considerable Administrative input. Four field accounts were administered, including one for the Electronics Support Section.
- (3) Ships Division provided ship and launch support to all Hydrography, Oceanography, Hydrodynamics and Shore Property programs, and also to Scientific Support for CCIW and other Service's programs throughout their areas of jurisdiction. A total of four Ships field accounts were administered, plus eleven launch sub-accounts funded by Ships Division.

The Administrative Division also carried a field account to support emergency purchases of equipment and to provide travel advance funding on a short notice basis.

Personnel

The Regional personnel office was moved to CCIW, Central personnel office on August 26, 1974. Master personnel files were transferred from Marine Sciences Headquarters (Ottawa) to CCIW in late September, 1974. Central Region Administration will provide the interface workload on a continuing basis.

In view of the seasonal nature of field operations, a large turnover in staff was experienced requiring close co-ordination between the central personnel office and Central Region Administration. The establishment of a personnel interface office was found to be essential to provide proper control of management records and other personnel activity.

A total of 164 manyears account for 155 staffing actions as follows:

FTC	13	employees
Term	55	"
Seasonal and Ships Crew	53	"
Career and Co-op Students	26	"
Contract Personnel	8	"

Peak staff level reached 215 during the summer of 1974.

Classification was active with 69 positions submitted for review or classification.

There were twenty-four promotions, nine acting appointments and fifteen employees were granted acting pay. A total of twenty-three personnel accidents were reported, three of a serious nature.

Accounts

Of a total Regional budget of \$5M annually, \$2.8M was processed through the Accounts Office representing \$2.3M O&M purchases and ships charters, and \$500,000 in capital expenditures. The remaining \$2.2M represented salaries and other personnel costs. The Accounts Office was also responsible for the processing of an additional \$375,000 in funds transferred for special projects supporting other Departments, agencies and DOE Services. Over the past year, the staff of three accounts clerks have

processed approximately 3,000 supplies invoices and 400 travel claims. Furthermore, the staff was involved in the preparation, payment and supervision of 20 field accounts and 11 sub-accounts.

With the decrease in Ocean & Aquatic Affairs, Headquarters involvement in Regional financial matters, the Accounts Office has increased its production of financial information for various segments of Departmental Headquarters and for local management consumption.

Supply Service

A central procurement and supply service consisting of six staff members maintained field support to all Hydrographic field parties, James Bay winter projects and Ships operations, accounting for 34 field inventories. Inventories held at about 6,000 accountable line items with stock value reaching \$14M. Control of 30 regional individual Standing Offers to maintain fuel, oils, food, material and field stores was provided.

The scope of 1974 procurement, valued at \$1.9M is as follows:

30 Regional Individual Standing Offers	\$ 250,000
350 Purchase of National Master Standing Offers	50,000
800 Regular Requisitions and Contracts	1,480,000
600 Memo Orders	60,000
Direct Transportation Costs	60,000
	<hr/>
	\$1,900,000

Approximately \$100,000 in value of obsolete equipment was processed through Crown Assets Disposal.

Mobile Equipment

The Regional mobile fleet consists of approximately 30 vehicles ranging from station wagons and travelalls to two ton trucks; 53 boat haul trailers and 16 workshop, living and office trailers. Additionally, 5 vehicles were leased to meet operational needs. All equipment was mobile in Manitoba, Ontario, Quebec and the Northwest Territories. Most maintenance was conducted through contract.

During 1974, Central Region vehicles travelled 375,103 miles. Ten accidents were recorded costing \$8,003.49. Of this amount, \$6,500.00 is estimated damage for one of the ten accidents. The final figure and main factor causing this accident has not been determined as of this date. Main cause factors for the other accidents, assessed either party, were:

- (1) Inattention
- (2) Failed to yield.

Although a degree of negligence was exhibited in two of the ten accidents assessed our drivers, it was judged to be of a minor nature and the drivers were not assessed damages.

During the month of December, 29 user drivers attended a Defensive Driving Course conducted at the Canada Centre for Inland Waters by an Ontario Safety League instructor. Safety standards are constantly being examined to improve driving safety and standard operating procedures. No professional drivers were employed on staff and, therefore, greater care was exercised in assigning user drivers to service vehicles.

Safety

Treasury Board emphasis on a more comprehensive attitude towards safe working practises has created greater activity at the Departmental and Regional levels. In response, both on site, (Canada Centre for Inland Waters, Burlington) and at field operational level, managers over the year have shown considerable interest in accident prevention programs and in identifying areas of hazards peculiar to a Marine-based operation.

Three accidents classed as serious and now under investigation were thought to have resulted from equipment failure; one a helicopter crash in the high Arctic, one a large launch and trailer under tow by road, and the failure of a high run on a ladder at low tide.

While numerous minor accidents were judged as work hazards; strains, cuts, bruises, etc., a number have developed into chronic ailments causing considerable loss of work and workmen's compensation activity, thus creating awareness of the accident prevention outlook by all supervisors and employees.

REPORTS AND PUBLICATIONS

- Agnard, J.P. and T.C. Hwang. Report on Photogrammetric Bluff Surveying and Mapping for Great Lakes Shoreline Erosion Studies. Prepared under contract to Marine Sciences, Central Region under the direction of Dr. A.-J. Brandenberger (Contract No. OSQ3-0525).
- BOULDEN, R. Canada/Ontario Great Lakes Shore Damage Survey - Interim (Editor) Report. Unpublished Report.
- BUDGELL, W.P. St. Clair River Current Survey 1974, Field Report and Equipment Evaluation. Unpublished Report.
- BUDGELL, W.P. St. Clair River Current Survey Data Report 1974. Unpublished Report.
- Bukata, R.P., W.S. HARAS, J.E. Bruton, J.P. Coakley. Satellite, Airborne and Ground-Based Observations of Suspended Sediment Transport off Point Pelee in Lake Erie. Unpublished Report.
- Bukata, R.P., W.S. HARAS, J.E. Bruton. The Application of ERTS I Digital Data to Water Transport Phenomena in Point Pelee - Rondeau Area. To be published in the Proceedings of SIL Conference, Winnipeg, 1975.
- COMDEV MARINE Hydrographic Survey - Chenal de L'Isle de L'Orleans. Prepared under contract to Marine Sciences, Central Region. (Contract No. KF 830-4-0199)
- CROAL, J.P. assisted by S. Tapiatic. Field Report, Winter Oceanography James Bay 1974. Unpublished Report prepared under contract to Marine Sciences, Central Region (Contract No. OSR3-0455).
- CRUTCHLOW, M. U.S. Army Corps of Engineers Conference on Automated Hydrography. Unpublished Report.
- DOEKES, C., J. GERVAIS. "WALDAPS" User's Manual. Unpublished Report.
- El-Sabh, M.I. and V.G. Koutitonsky. Physical Oceanographic Study in James Bay. Unpublished Report. Prepared under contract to Marine Sciences, Central Region (Contract No. OSQ3-0519)
- FREEMAN, N.G. Proceedings of the First James Bay Oceanographic Workshop. (Co-ordinator) Unpublished Report.
- FREEMAN, N.G. P.F. Hamblin, T.S. Murty. Helmholtz Resonance in Harbours of the Great Lakes. To be published in the Proceedings of the 16th Conference on Great Lakes Research.
- FREEMAN, N.G. and W.S. HARAS, S.O. Wigen. Hydrodynamic Surveys and the New Technology. Published in The Canadian Surveyor, Vol. 28, No. 3, September, 1974.

- KEAN, D.J. Spring Control Survey - Lake Erie, Lake Ontario, Lake Superior, Winnipeg River - Final Field Report. Unpublished Report.
- KEAN, D.J. Staff Exchange - CHS & NOAA. Unpublished Report.
- KIMMETT, D. Installation of a Temporary Tide Gauge at Moosonee. Unpublished Report.
- KIMMETT, D. Available Sources of Current Data Within Central Region. Unpublished Report.
- MARSHALL, R. St. Lawrence River Current Survey - Final Field Report. Unpublished Report.
- PULLEN, T.W. James Bay Data Report, 1973. Unpublished Report.
- REHBEIN, R. Rotational Assignment Report. Unpublished Report.
- ROGERS, A.R. International Symposium on Problems Related to the Redefinition of North American Geodetic Networks. Unpublished Report.
- ROGERS, A.R., P.V. Davies. Local Surveys - Port Weller to Pickering. Unpublished Report.
- STATHAM, S.J. St. Lawrence River Revisory II Survey. Unpublished Report.
- STUDENTS. Step I Course Critique. Unpublished Report.
- THOMPSON, E. Lower St. Lawrence Survey. Unpublished Report.
- Unny, T.E. and M. Chandrashenkar. Development of a Two-Dimensional Hydrodynamic Model Using Implicit Finite Difference Method. Unpublished Report. Prepared under contract to Marine Sciences, Central Region (Contract No. SS04 KF 830-4-0L95)
- VENKATESH, S. The Development of Manual Techniques for the Real Time Prediction of Storm Surges on the Great Lakes. Unpublished Report. Prepared under contract to Marine Sciences, Central Region (Contract No. OSP3-0248).
- WADE, G., K. HIPKIN. Lake Winnipeg Harbours Survey - Hecla Island & Gimli. Unpublished Report.
- WADE, G. Lake Winnipeg Survey. Unpublished Report.
- WELLER, J.H. Evaluation Trials of Bertram Launches November/December 1974 - Interim Report. Unpublished Report.
- WILSON, J. Arctic Surveys, Unpublished Report.

WRIGHT, B. Chesterfield Inlet Survey. Unpublished Report.

WRIGHT, B. Chesterfield Inlet Survey - Tide Gauge Program.
Unpublished Report.

WRIGHT, B. Chesterfield Inlet Survey - Recommended Aids to
Navigation. Unpublished Report.

LIBRARY
CANADA CENTRE FOR INLAND WATERS
867 LAKESHORE ROAD
BURLINGTON, ONTARIO, CANADA
L7R 4A6

