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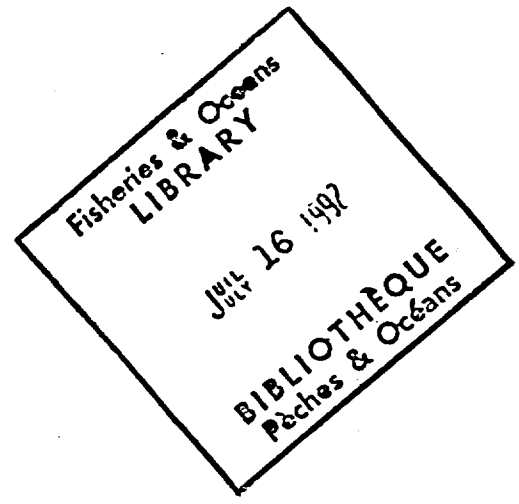

CANADA CENTRE FOR INLAND WATERS – 1974

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Cat. No.: En 36-412/1974

CONTRACT NO. KL 398-5-8027
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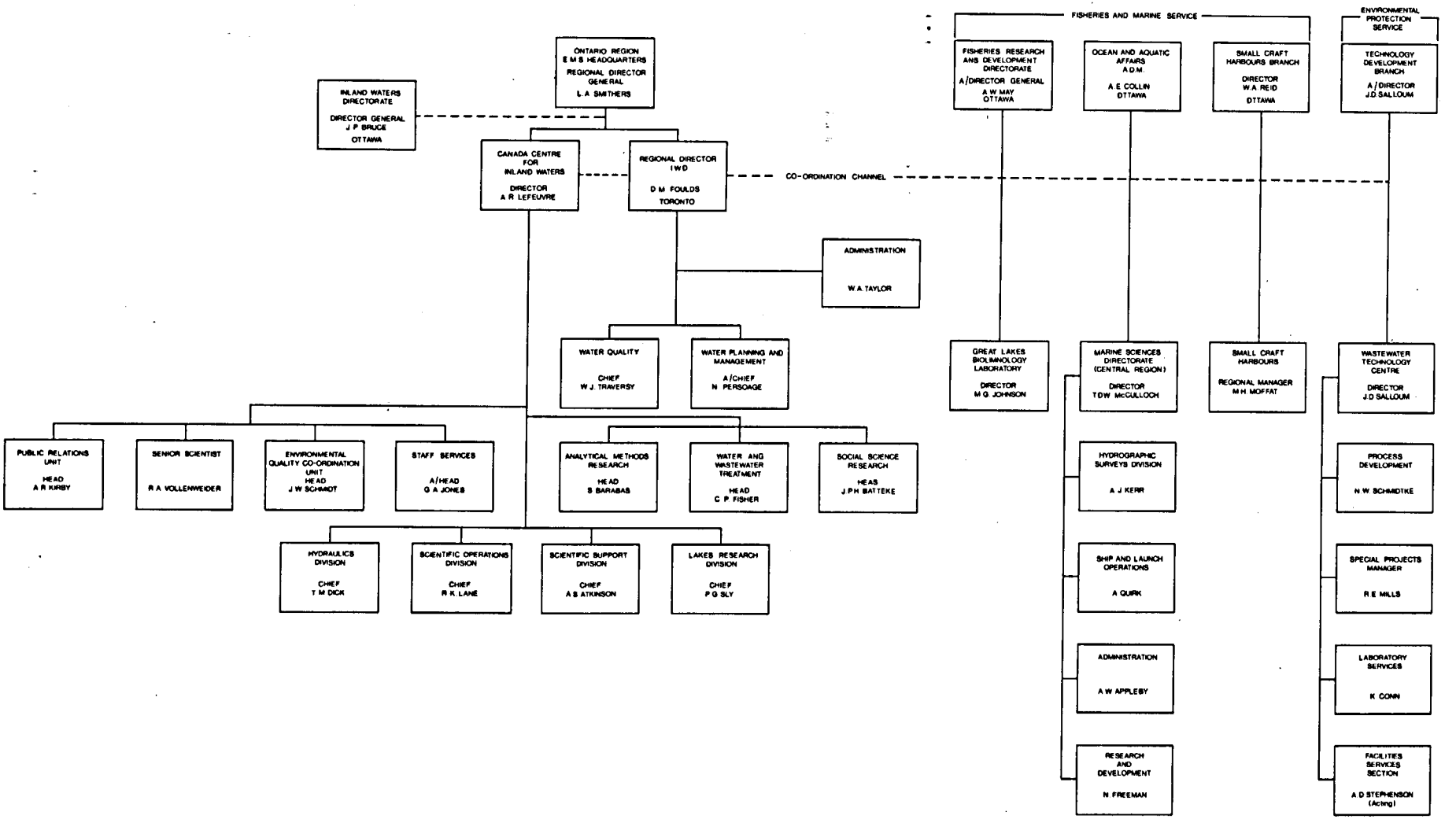


Canada Centre for Inland Waters Organization, December 31, 1974.

Highlights in Review

IMPLEMENTATION OF GREAT LAKES WATER QUALITY AGREEMENT

A major share of CCIW activities continued to be directed toward the implementation of programs required by the 1972 Canada-United States Great Lakes Water Quality Agreement. A significant number of staff members participated in the work of International Joint Commission (IJC) Boards, Committees and Reference Groups established under the agreement. Specific activities undertaken included:

1) For the Upper Lakes Reference, Inland Waters Directorate (IWD) and Great Lakes Biolimnology Laboratory (GLBL) components conducted comprehensive physical, chemical, sedimentological and biological surveys of Georgian Bay, the North Channel and Lake Huron. An evaluation of the impact and dispersal of a major industrial effluent source in Lake Superior was continued in collaboration with the industry involved. Inland Waters Directorate personnel, along with other agencies, developed a waste-loadings policy simulation model for the study of long-term waste discharges of approximately 50 nutrients and contaminants in the upper Great Lakes. Similar systems analysis techniques are now being used to estimate future patterns of land uses in the region.

2) In collaboration with the Ontario Ministry of the Environment (MOE), Inland Waters Directorate and Environmental Protection Service (EPS) personnel were actively engaged in studies of the reduction of pollution caused by combined sewer overflows and storm water discharges. The major effort was a contracted study to develop a mathematical model as a management tool to evaluate the impact of various control measures.

3) Surveillance programs on the lower Great Lakes and interconnecting channels continued in collaboration with the Ontario Ministry of the Environment and United States agencies. In addition, GLBL personnel conducted a pilot surveillance program on Lake Ontario to evaluate the impact of pollution control measures on water quality, particularly with respect to the biotic community. This is a long-term effort with anticipated expansion into the upper Great Lakes.

4) Great Lakes Biolimnology Laboratory personnel conducted preliminary laboratory experiments using lake-column simulators to test the effects and potential for biomagnification of contaminants detected in dredged spoils and agricultural land runoff. Experiments to determine the effects of dredged spoils disposal on the aquatic communities were also carried out on Lake Erie (Port Stanley) and Lake St. Clair (Mitchell Bay) in co-operation with the Ontario Ministry of Natural Resources (OMNR) and other agencies. IWD conducted hydraulic studies to determine the degree of spreading of dredged materials when dumped into deep waters, as well as geochemical studies of dredged sediments.

5) Physical, chemical and biological projects were undertaken to provide a sound scientific basis for water quality objectives for waste heat and some toxic substances listed in the agreement. Significant activities were field studies, conducted by GLBL personnel at the Nanticoke Thermal Generating Station on Lake Erie, to elucidate the temporal and spatial relationships in freshwater flora and fauna and their disruption in mixing zones caused by thermal effluents. Physical studies were conducted at Baie du Doré-Douglas Point as well.

6) Significant contributions were made to the development of the study plan of the Pollution from Land Use Activities Reference Group.

7) Activities were initiated involving the development of an Annex on Hazardous Polluting Substances for the agreement. A list of 1200 hazardous materials, in descending order of potential danger to the aquatic environment, was compiled according to the criteria of toxicity to aquatic life; amounts used in commerce and industry; and mode of transport and storage. This work was carried out under contract and monitored jointly by GLBL and EPS personnel.

8) In the International Joint Commission's Second Annual Report on Great Lakes Water Quality, research on the hazards of waterborne viruses was recommended. A number of virology contracts were supervised by scientists at CCIW. The research developed isolation and enumeration techniques for viruses found in sewage, sludge, effluent, receiving and recreational waters.

In November at CCIW, a meeting of Canadian experts was held to determine the feasibility of an epidemiological approach to assess existing and potential health hazards due

to viruses in water. At this meeting, two preliminary studies were proposed to relate viral infection to water supplies and to viruses present in raw and treated sewage.

Some of the major field projects undertaken follow.

HYDROGRAPHIC SURVEYS–MSD

A hydrographic survey was completed of Chesterfield Inlet from Hudson Bay to Baker Lake, using the automated data acquisition system (HAAPS). Efficient operation resulted in the completion of a two-year program in one year. Another successful hydrographic survey was carried out in the Chenal de l'Île d'Orléans in the St. Lawrence River. This survey, related to the deep dredging southeast of Île d'Orléans, was conducted under a contract with ComDev Marine.

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

BAY OF QUINTE PROJECT – LAKE ONTARIO

A research project, involving the co-operation of personnel from Fisheries Research and Development Directorate (FRD), Inland Waters Directorate and the Ontario Ministries of Natural Resources and the Environment, was continued on the Bay of Quinte. One of the principal objectives of this project is to determine the response of the biota to the phosphorus removal program undertaken in accordance with the Canada-United States agreement.

A set of limnocorrals has now been in position in the Bay for one and one half years. The path of phosphorus movement through the ecosystem to sediments was traced using radioactive phosphorus. The turnover period of the phosphate pool was evaluated to be as rapid as two minutes.

Measurements of the rate processes that influence the growth rate and abundance of algae in lakes were completed. Experiments included observations of changes in biomass that result from decreasing nutrient loading. Grazing experiments have shown that zooplankton can graze on up to more than 200% of the plankton each day.

POINT PELEE – LAKE ERIE

A comprehensive, multidisciplinary investigation of the respective roles of the physical processes, sediment transport and commercial dredging on the erosion losses at Point Pelee was launched by various components of IWD and MSD. Of concern was the impact of commercial dredging in the sand shoals off the coast of Point Pelee. The shoals are thought to be the source of sediments that is reinforcing the eastern coast of the Point. Wave measurement studies provided data on long-term erosion-accretion processes at Point Pelee. A number of remote sensing techniques were developed and used to determine sedimentary and littoral processes around the Point.

A report on the formation, evolution and effect of commercial sand dredging operations around the Point is nearing completion.

IWD PROJECTS OUTSIDE THE GREAT LAKES BASIN

A major physical limnological study was undertaken on Kamloops Lake, British Columbia. A number of short-term applied studies were also commenced in several other regions. These included a study of copper complexation in Babine Lake in British Columbia, a study in Lesser Slave Lake and assistance in the limnological aspects of a comprehensive study in the Shubenacadie River basin, Nova Scotia. Staff continued to participate in the planning of a federal-provincial study on Lake Winnipeg, and a draft plan was completed.

HIGH WATER ON THE GREAT LAKES

Erosion and flooding in the Great Lakes-St. Lawrence system, although not as extensive as in 1973, remained as serious problems, since lake levels remained high.

At CCIW, MSD and IWD staff continued shore erosion studies as part of the Canada-Ontario Shore Damage Survey. It is expected that the Technical Report and the Coastal Zone Atlas will be published in mid-1975.

INSTRUMENTATION DEVELOPMENT – MSD

Instrumentation development was highlighted by the design and operation of the INDAPS data processing system, whereby hydrographic data can be collected and processed in the field. This system was successfully implemented in the Lake Winnipeg Survey. The Electronics Shop greatly increased the signal strength and range of the Minifix system, by using 70-foot 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.

ENGINEERING AND SUPPORT SERVICES – IWD

During the year, Engineering Services supported IWD research activities. Developments involved remotely controlled sensor modules for water chemistry, inshore towers for air-water studies, programmed lighting systems for biological studies, standardized electronics and mechanics for water temperature surveillance, procurement and testing of fish censusing gear, design and procurement of flumes for the Hydraulics Division Laboratory, special coring devices for geological studies, long-term monitoring systems for lake dynamics, underwater light-scattering instrumentation, and automatic sampling gear for lake nutrient modelling, as well as general support such as consulting and maintenance.

Effort was also applied to the final design and construction of REX, a submersible system for *in situ* measurement of water quality parameters, and the final development phase of a long-term dissolved oxygen sensor.

ENVIRONMENTAL TOXICITY PROGRAM

Toxicity studies of lead and cadmium were conducted on various species of fish, algae and benthic invertebrates. Preliminary results indicated cadmium to be more toxic than lead to algae. Several experiments on the methylation of lead and the biofractionation of sulphur isotopes were conducted in collaboration with IWD scientists.

ASBESTOS FIBRES – GREAT LAKES WATER QUALITY AGREEMENT

In the past several years, questions have been raised about the potential hazard of asbestos fibres in water supplies. In response, several projects were initiated in collaboration with the Ontario Ministry of the Environment.

Mapping of the distribution of the fibres, both in the waters and in the sediments of Lakes Superior and Huron, was undertaken. Concentrations were determined in samples using electron microscopy in the Physical Sciences Laboratory.

A technique for the removal of the fibres from potable water supplies was developed by IWD personnel. The method removes 99.8% of the asbestos fibres and can be added to virtually all existing water treatment plants that have sand filtration equipment. Inland Waters Directorate is presently engaged in a joint project with the Ontario Ministry of the Environment to implement the process in a pilot plant.

GREAT LAKES MODELLING

The modelling program involved simulating water levels, currents, temperatures and the transport of suspended material in Lakes Ontario and Erie. The hydrodynamic phase of the modelling project in Lake Ontario was completed in 1974, with a verification study based on the physical data collected during the International Field Year for the Great Lakes (IFYGL).

A computer model for possible toxicant spills in Lake Ontario was developed. The model can accommodate one or more parameters, such as toxicant concentrations or counts of living organisms.

With respect to modelling efforts in Lake Erie, a computer model was designed for the lake-wide time-dependent simulation of the diffusive and advective transport of nutrients (chloride). The chloride model was also extended to include other substances, such as phosphorus.

The modelling program in Lake Ontario was directed toward the development and verification of biochemical submodels, using 1972 IFYGL data.

EPS WASTEWATER TREATMENT TECHNOLOGY DEVELOPMENT

A joint federal-industrial project, involving the operation of a pilot-scale two-stage activated sludge system treating kraft bleachery effluent, was carried out at Eddy Forest Products, Espanola, Ontario.

The biological nitrification research project, initiated with McMaster University in 1972, continued throughout 1974. Detailed studies were carried out to examine various flow and process configurations.

The joint federal-provincial-industrial study, started in 1972 for the development of mine and mill wastewater treatment technology in the base metal mining industry, continued. Pilot-scale studies for the biological oxidation of thiosalts were carried out at the Brunswick Mining and Smelting Corporation site in northeastern New Brunswick.

A study of the recycling of liquid sewage sludge on dredged river sand was completed in British Columbia.

ENVIRONMENTAL ASSESSMENT

Under the recently instituted Environmental Assessment Review and Protection (EARP) Process,

environmental aspects were considered in the planning and implementation of all projects with federal involvement, and environmental assessments were made of projects that may have significant adverse effects on the environment. Staff members at CCIW were involved in the administration and implementation of the Process, by reviewing projects for potential adverse environmental effects and advising on the need for and content of environmental assessments. CCIW staff also participated in base-line studies required for environmental assessments and in the review of environmental impact statements.

AMERICAN FALLS AT NIAGARA

The American Falls International Board Study of measures necessary to preserve and enhance the beauty of the American Falls at Niagara was completed, and the Final Report was submitted to the International Joint Commission. Support for this study was provided by Inland Waters Directorate Regional staff.

RESEARCH REPORTS AND CONFERENCES

About 365 papers by CCIW staff were presented at conferences and published in journals and departmental publications during 1974 (Appendix B). Dr. T. J. Simons again won the Chandler-Misener Award for the best paper presented to the International Association for Great Lakes Research (IAGLR).

In 1974, four major conferences were held by CCIW. In February, the staff of the Wastewater Technology Centre hosted a NATO/CCMS meeting. Seven countries were represented in the discussion of the status of the physical-chemical waste treatment demonstration pilot plant now under construction in the United Kingdom at Colehill. The United Kingdom is the pilot country; Canada is one of the co-pilot countries. In early March, the 13th Annual Canadian Hydrographic Conference, attended by 200 persons, was hosted by Marine Sciences Directorate, Central Region. The 17th Annual Conference on Great Lakes Research, co-hosted with McMaster University, was held on August 12 to 14, in Hamilton. In Toronto on September 18 and 19, staff participated in the 2nd Canada-Ontario Agreement Workshop, which had the theme, "Sludge Handling and Disposal."

PUBLIC RELATIONS

In June, the Public Visits Program completed a highly successful 10-month series of lectures covering a wide spectrum of topics given by various scientists. These presentations were enjoyed by a total of more than 3200 people.

During the year, program emphasis shifted from the local to a national audience. This decision coincided with completion of two films, "Not Man's to Command" and "Second Frontier." The first film shows the regulation and control of lake levels. In association with the National Film Board and with the co-operation of the Ontario Public Library system, "Not Man's to Command" was viewed by audiences numbering several hundred thousand. "Second Frontier," which explains the Centre's work and purpose, will be distributed nationally.

The Unit was also asked to assist the International Joint Commission in a series of public hearings to discuss further regulation of Great Lakes levels.

INTERNATIONAL INVOLVEMENT

In 1974, CCIW was formally designated as the World Health Organization (WHO) International Collaboration Centre for Surface and Ground Water Quality. Thus the Department can more effectively assist the developing nations with their water management programs.

CCIW remained the lead institute for the North American contribution to the Organization for Economic Co-operation (OECD) measurement program on lake eutrophication.

Faits saillants

MISE EN APPLICATION DE L'ACCORD RELATIF À LA QUALITÉ DE L'EAU DANS LES GRANDS LACS

Les efforts du CCEI ont porté en grande partie sur la mise en application de l'Accord canado-américain de 1972 relatif à la qualité de l'eau dans les Grands lacs. Un nombre important de membres du personnel ont collaboré avec les organismes établis en vertu de l'accord: conseils de la Commission mixte internationale, comités et groupes d'acquisition de données. Voici quelques-unes des activités entreprises:

1) Pour ce qui est de l'acquisition de données sur le bassin supérieur des Grands lacs, certains services de la Direction générale des eaux intérieures et du Laboratoire de biolimnologie des Grands lacs ont entrepris des relevés physiques, chimiques, sédimentologiques et biologiques approfondis de la baie Georgienne, du chenal Nord et du lac Huron. L'évaluation des conséquences et du degré de dispersion dans le lac Supérieur d'une source importante d'effluents industriels s'est également poursuivie en collaboration avec l'industrie responsable. Le personnel de la Direction générale des eaux intérieures a mis au point, avec d'autres organismes, un modèle de simulation pour la politique de déchargement des déchets; ce modèle servira à l'étude de déversements à long terme d'environ 50 substances nutritives et contaminants dans le bassin supérieur des Grands lacs. Des techniques semblables d'analyse de systèmes servent actuellement à évaluer des futurs modes d'utilisation des terres dans la région.

2) Avec l'aide du ministère de l'Environnement de l'Ontario, le personnel de la Direction générale des eaux intérieures et celui du Service de la protection de l'environnement ont effectué des études sur les façons de réduire la pollution causée par les débordements des systèmes unitaires d'égout et par l'évacuation des eaux de pluie. Le principal effort de recherche a consisté en une étude donnée à contrat, et visant à mettre au point un modèle mathématique qui servira d'instrument de gestion pour l'évaluation des résultats des diverses mesures antipollution.

3) Les programmes de surveillance du bassin inférieur des Grands lacs et des chenaux de raccordement se sont poursuivis en collaboration avec le ministère de l'Environnement de l'Ontario et des organismes des États-Unis. En outre, le personnel du Laboratoire de biolimnologie des Grands lacs a mené un programme pilote de surveillance du lac Ontario afin d'évaluer le résultat des mesures antipollution sur la qualité de l'eau et sur la communauté biotique en particulier. Cette surveillance constitue un projet à long terme qui devrait normalement s'étendre au bassin supérieur des Grands lacs.

4) Le personnel du Laboratoire de biolimnologie des Grands lacs a effectué des expériences préliminaires en laboratoire au moyen de «simulateurs de colonnes lacustres» pour déterminer les effets et les possibilités de bioaccumulation des contaminants détectés dans les déchets recueillis par dragage et les eaux de ruissellement des terres agricoles. Il y a également eu des expériences conjointes avec le ministère ontarien des Ressources naturelles et d'autres organismes en vue de déterminer les effets de l'élimination des déchets dragués sur les communautés aquatiques du lac Érié (Port Stanley) et du lac Sainte-Claire (Mitchell Bay). De plus, la Direction générale des eaux intérieures a procédé à des études hydrauliques visant à déterminer le taux de dispersion des substances draguées, une fois rejetées en eaux profondes, et à des études géochimiques sur les sédiments provenant du dragage.

5) On a entrepris des projets d'étude physique, chimique et biologique afin que les objectifs de qualité de l'eau, à fixer dans le cas de la chaleur résiduaire et de certaines substances toxiques qu'énumère l'accord, puissent se fonder sur une base scientifique solide. Il faut signaler comme activité importante des études sur le terrain menées par le personnel du Laboratoire de biolimnologie des Grands lacs à la centrale thermique de Nanticoke, sur le lac Érié; ces études visaient à expliquer les relations de temps et d'espace qui existent dans le domaine de la faune et de la flore aquatiques, ainsi que les perturbations qui les affectent dans les zones de mélange causées par les effluents thermiques. Des études physiques se sont aussi déroulées à la baie du Doré et à la pointe Douglas.

6) L'élaboration du plan d'étude du groupe d'acquisition de données sur la pollution causée par l'utilisation des terres a bénéficié d'importantes contributions.

7) Des activités préparatoires ont débuté en vue de l'établissement d'une annexe sur les substances polluantes dan-

gereuses, à joindre à l'accord. La liste de 1,200 produits, classés selon un ordre décroissant du risque qu'ils représentent pour le milieu aquatique, se fonde sur les critères suivants: toxicité pour la vie aquatique; quantités employées dans l'industrie et le commerce; mode de transport et d'emmagasinage. Le travail s'est fait à contrat, sous la surveillance conjointe du personnel du Laboratoire de biolimnologie des Grands lacs et du Service de la protection de l'environnement.

8) Dans son second rapport annuel sur la qualité de l'eau des Grands lacs, la Commission mixte internationale a recommandé la réalisation de recherches sur les dangers des virus transportés par l'eau. Les scientifiques du Centre canadien des eaux intérieures ont supervisé un certain nombre d'études de virologie effectuées à contrat. Les recherches ont permis la création de techniques d'isolation et d'énumération des virus trouvés dans les eaux d'égout, les boues, les effluents et les eaux réceptrices et récréatives.

Des experts canadiens se sont rencontrés en novembre, au Centre canadien des eaux intérieures, pour discuter de la faisabilité d'une étude épidémiologique qui permettrait d'évaluer les dangers réels et virtuels que représentent pour la santé les virus logés dans l'eau. Les entretiens ont donné lieu à deux propositions d'études préliminaires visant à rattacher les infections virales à l'approvisionnement en eau et aux virus des eaux d'égout traitées et brutes.

Quelques principaux projets entrepris sur le terrain suivent.

ENQUÊTES HYDROGRAPHIQUES – DIRECTION GÉNÉRALE DES SCIENCES DE LA MER

Un relevé hydrographique couvrant la partie de l'anse Chesterfield comprise entre la baie d'Hudson et le lac Baker et mettant à contribution le système automatisé de saisie des données (HAAPS) a maintenant pris fin. Grâce à un travail mené rondement, ce programme qui devait durer deux années, a pu se dérouler en une seule. Une autre enquête hydrographique a connu de bons résultats, soit celle du chenal de l'île d'Orléans, dans le fleuve Saint-Laurent. Il s'agit d'un relevé effectué à forfait par la ComDev Marine et concernant le dragage en profondeur de la partie sud-est de l'île d'Orléans.

Un groupe de scientifiques se sont rencontrés le 26 juin 1974, à l'atelier de la baie James, pour coordonner la recherche océanographique dans la baie James. À la fin de l'année, le bureau régional du Centre avait établi un mandat pour la réalisation de levés océanographiques dans la baie d'Hudson et la baie James.

PROJET À LA BAIE DE QUINTE – LAC ONTARIO

La Direction de la recherche et du développement (Pêches), la Direction générale des eaux intérieures et les ministères ontariens des Ressources naturelles et de l'Environnement ont poursuivi un projet de recherche conjoint à la baie de Quinte. L'un des objectifs premiers de ce projet est de déterminer la réaction des biotes au programme d'élimination du phosphore entrepris en vertu de l'accord canado-américain.

Un ensemble d'enclos lacustres est maintenant en place depuis un an et demi dans la baie. Le parcours du phosphore dans l'écosystème, en direction des sédiments, a pu être tracé grâce au phosphore radioactif. La période de renouvellement dans l'enclos s'est révélée être d'une durée estimative de seulement deux minutes.

Les procédés ayant une influence sur le taux de croissance et l'abondance des algues dans les lacs ont fait l'objet de mesurages. Les expériences ont comporté des observations sur les modifications que les déversements décroissants de substances nutritives ont provoqué sur la biomasse. Des expériences sur l'alimentation ont démontré que le zooplancton peut brouter sur au-delà de 200% de plancton chaque jour.

POINTE PELÉE – LAC ÉRIÉ

Divers éléments des Directions générales des eaux intérieures et des sciences de la mer ont entrepris une étude approfondie et multidisciplinaire des rôles joués respectivement par les processus physiques, le transport des sédiments et le dragage commercial dans les pertes dues à l'érosion et constatées à la pointe Pelée. Les conséquences du dragage commercial sur les bancs de sable situés au large de pointe Pelée ont fait l'objet d'une attention particulière. Il semblerait que ces bancs soient la source de sédiments qui renforcent la côte est de la pointe. Les études des mesures des vagues ont fourni des données relatives aux processus d'accroissement à long terme par érosion, à la pointe. On a mis au point un certain nombre de techniques de télédétection qu'on a utilisées pour déterminer les phénomènes relatifs à la sédimentation et au littoral dans les alentours de pointe Pelée.

Un rapport sur la formation et l'évolution de pointe Pelée ainsi que sur les effets des opérations commerciales de dragage dans les environs est sur le point de se terminer.

PROJETS DE LA DIRECTION GÉNÉRALE DES EAUX INTÉRIEURES POUR LA ZONE EXTÉRIEURE AU BASSIN DES GRANDS LACS

Une étude physique et limnologique importante du lac Kamloops, en Colombie-Britannique, a maintenant pris son essor. Un certain nombre d'études appliquées à court terme ont aussi débuté dans diverses régions. Citons, parmi ces dernières, une étude de la formation de complexes de cuivre dans le lac Babine, en Colombie-Britannique, une étude du Petit lac des Esclaves et un apport à l'investigation limnologique d'une étude approfondie du bassin de la rivière Shubenacadie, en Nouvelle-Écosse. Le personnel a continué de participer à la planification d'une étude fédérale-provinciale concernant le lac Winnipeg et a élaboré un plan provisoire.

NIVEAU ÉLEVÉ DE L'EAU DES GRANDS LACS

L'érosion et les inondations du système formé par les Grands lacs et le fleuve Saint-Laurent, tout en étant moins fortes qu'en 1973, constituent encore un problème sérieux car le niveau des lacs demeure élevé.

Le personnel de la Direction générale des eaux intérieures et celui de la Direction générale des sciences de la mer, au Centre canadien des eaux intérieures, poursuivent les études sur l'érosion du littoral dans le cadre de l'enquête canado-ontarienne sur les dommages causés au littoral. Le rapport technique et l'atlas de la zone côtière devraient paraître vers le milieu de 1975.

MISE AU POINT D'INSTRUMENTS — DIRECTION GÉNÉRALE DES SCIENCES DE LA MER

L'élément le plus important dans ce domaine a été la création et l'application du système de traitement des données INDAPS qui permet de recueillir et de traiter sur le terrain des données hydrographiques et qui a donné d'excellents résultats dans l'étude du lac Winnipeg. L'*Electronics Shop* a considérablement augmenté la force et la portée du signal du système minifix en utilisant des tours d'une hauteur de 70 pieds et des émetteurs de 100 watts. Dans le secteur océanographique, il a été possible d'effectuer la conversion de six courantomètres Aanderaa en unités C.T.P. (conductivité, température, profondeur) et de procéder à des essais de simulation dans l'Arctique.

SERVICES D'INGÉNIERIE ET DE SOUTIEN — DIRECTION GÉNÉRALE DES EAUX INTÉRIEURES

Le Service d'ingénierie a, au cours de l'année, contribué aux activités de recherche de la Direction. Les réalisations comprennent les divers points suivants: modules de télédétection contrôlée en chimie de l'eau, tours côtières pour études air-eau, systèmes programmés d'illumination pour études biologiques, appareils électroniques et mécaniques standardisés pour contrôler la température de l'eau, acquisition et essai d'un dispositif de dénombrement des poissons, conception et acquisition de canaux d'amenée pour le laboratoire d'hydraulique, dispositif spécial de carottage pour études géologiques, systèmes de contrôle à long terme de la dynamique lacustre, instruments de dispersion de la lumière sous l'eau, dispositif d'échantillonnage automatique pour la formulation de modèles pour les substances nutritives des lacs, assistance générale telle que consultations et travaux de maintenance.

Le personnel s'est également consacré à la conception finale et à la construction du système submersible REX, qui peut mesurer sur place les paramètres de la qualité de l'eau, ainsi qu'à la dernière phase du développement d'un détecteur à long terme d'oxygène dissous.

PROGRAMME DE TOXICITÉ ENVIRONNEMENTALE

Diverses espèces de poissons, d'algues et d'invertébrés benthiques ont fait l'objet d'études relatives à la toxicité du plomb et du cadmium. Les résultats préliminaires démontrent que le cadmium est plus toxique que le plomb pour les algues. Avec la collaboration des scientifiques de la Direction générale des eaux intérieures, il y a eu plusieurs expériences conjointes sur la méthylation du plomb et la bioséparation des isotopes de soufre.

FIBRES D'AMIANTE — ACCORD RELATIF À LA QUALITÉ DE L'EAU DANS LES GRANDS LACS

Au cours des dernières années, le danger virtuel que représentent les fibres d'amiante dans les approvisionnements en eau a soulevé une certaine préoccupation. Pour répondre à ce problème, le ministère de l'Environnement de l'Ontario a collaboré à plusieurs projets.

L'établissement de cartes montrant la répartition des fibres dans les lacs Supérieur et Huron, ainsi que dans leurs sédiments, a maintenant débuté. Grâce à la microscopie électronique, le personnel du Laboratoire des sciences physiques a pu déterminer les concentrations présentes dans des échantillons.

Le personnel de la Direction générale des eaux intérieures a mis au point une technique d'élimination des fibres contenues dans les réserves d'eau potable. Cette méthode permet d'éliminer 99.8% des fibres d'amiante et

peut servir virtuellement dans toutes les installations de traitement des eaux disposant de filtres à sable. La Direction générale des eaux intérieures et le ministère ontarien de l'Environnement participent actuellement à un projet conjoint qui rendra possible l'application de ce procédé à l'échelle d'une usine pilote.

CONSTRUCTION DE MODÈLES DES GRANDS LACS

Le programme de construction de modèles s'est concentré sur la simulation des niveaux, des courants, des températures et du mode de transport des particules en suspension dans les lacs Ontario et Érié. La phase hydrodynamique du projet de construction de modèles pour le lac Ontario s'est terminée en 1974 par une étude vérificative fondée sur les données physiques recueillies au cours de l'Année internationale d'études des Grands lacs.

Il y a eu conception d'un modèle informatique sur les déversements possibles de produits toxiques dans le lac Ontario. Le modèle permet de traiter un ou plusieurs paramètres tels que la concentration des produits toxiques ou le nombre d'organismes vivants.

Pour le lac Érié, les efforts ont porté sur la mise au point d'un modèle informatique conçu pour l'ensemble du lac et simulant le transport de diffusion et d'advection des substances nutritives (chlorure) en fonction du temps. Le modèle a également touché des substances telles que le phosphore.

Des travaux de cette nature se poursuivent pour le lac Ontario et visent à la conception et à la vérification de sous-modèles biochimiques utilisant les données de l'Année internationale d'études des Grands lacs (1972).

DÉVELOPPEMENT DE TECHNIQUES DE TRAITEMENT DES EAUX USÉES – SERVICE DE LA PROTECTION DE L'ENVIRONNEMENT

C'est à *Eddy Forest Products*, Espanola (Ontario) que les services fédéraux et l'industrie ont réalisé un projet conjoint dans le cadre duquel ils ont mis en œuvre, à l'échelle pilote, un système qui traite en deux étapes et aux boues activées l'effluent produit par le blanchiment de la pâte kraft.

Le projet de recherche conjoint sur la nitrification biologique, mis sur pied par l'université McMaster en 1972, s'est poursuivi tout au long de 1974. Des études détaillées ont permis d'examiner diverses formes d'écoulement et différentes configurations de procédés.

Il y a eu poursuite de l'étude conjointe que des agents fédéraux, provinciaux et industriels avaient entreprise en 1972, en vue de développer des techniques pour traiter les eaux résiduaires des fabriques et des mines faisant partie de l'industrie des métaux non précieux. De plus, on a réalisé à la *New Brunswick Mining and Smelting Corporation*, dans le nord-est du Nouveau-Brunswick, des études à l'échelle pilote visant l'oxydation biologique des thio-sels.

Une étude concernant le recyclage des boues liquides d'eaux d'égout, effectuées sur les lits de sable des rivières draguées, en Colombie-Britannique, est maintenant terminée.

ÉVALUATION ENVIRONNEMENTALE

Depuis la récente création du Processus d'évaluation et de révision environnementales (PERE), les considérations environnementales entrent en ligne de compte dans la planification et l'exécution de tout projet auquel participe le gouvernement fédéral; de plus, les projets qui peuvent avoir des conséquences néfastes sur l'environnement sont soumis à des évaluations environnementales. Les membres du personnel du Centre canadien des eaux intérieures s'occupent de l'administration et de l'exécution du Processus en examinant les projets du point de vue des effets néfastes possibles et en donnant des conseils sur le besoin et l'orientation d'évaluations environnementales. Le personnel du Centre participe également aux études de base qu'exigent les évaluations environnementales et à l'examen des énoncés sur les incidences environnementales.

CHUTES NIAGARA DU CÔTÉ AMÉRICAIN

L'*American Falls International Board* a terminé son étude des mesures à prendre pour préserver et embellir les chutes Niagara du côté américain et a présenté son rapport final à la Commission mixte internationale. Le personnel du bureau régional de la Direction générale des eaux intérieures a contribué à cette étude.

RAPPORTS DE RECHERCHE ET CONFÉRENCES

Environ 365 documents, rédigés par le personnel du Centre canadien des eaux intérieures, ont paru dans des revues et des publications ministérielles (annexe B) au cours de 1974. M. T.J. Simons a remporté, encore une fois, le prix Chandler-Misener, décerné à l'auteur du meilleur ouvrage paru à l'Association internationale pour la recherche sur les Grands lacs.

En 1974, le Centre canadien des eaux intérieures a tenu quatre conférences importantes. En février, le

personnel du Centre de traitement des eaux usées a reçu les délégués de l'OTAN à une réunion du Comité des défis de la société moderne. Des représentants de sept pays ont assisté aux entretiens visant à définir le statut de l'usine pilote pour la démonstration du traitement des déchets par action physique et chimique; cette usine, située à Colehill (Royaume-Uni), est actuellement en construction. On a choisi le Royaume-Uni comme région pilote pour ce projet alors que d'autres pays, dont le Canada, sont des régions pilotes secondaires. Au début de mars, la Direction générale des sciences de la mer, bureau régional du Centre, a organisé la 13e conférence canadienne annuelle sur l'hydrographie et environ 200 personnes y ont pris part. On a tenu du 12 au 14 août, à Hamilton, la 17e conférence annuelle sur la recherche dans les Grands lacs, organisée conjointement avec l'université McMaster. Le personnel a également participé au deuxième atelier sur l'accord canado-ontarien, qui a eu lieu les 18 et 19 septembre à Toronto, et dont le thème était «Manutention et élimination des boues».

RELATIONS PUBLIQUES

Dans le cadre du Programme des visites publiques, une série de conférences données par divers scientifiques et couvrant un large éventail de sujets a pris fin en juin après dix mois d'activités couronnées de succès. Plus de 3,200 personnes ont assisté à ces présentations.

Dans le courant de l'année, le programme s'est de plus en plus concentré sur un public national que régional. Cette décision a coïncidé avec l'achèvement de deux films: *Not Man's to Command* et *Second Frontier*. Grâce à la participation de l'Office national du film et des bibliothèques publiques de l'Ontario, plusieurs milliers de personnes ont pu visionner le premier film, qui traite de la régularisation et du contrôle du niveau des lacs. Le second film, qui explique le but et le travail du Centre, connaîtra une distribution nationale.

La Commission mixte internationale a également demandé l'aide de la sous-section pour organiser une série d'audiences publiques concernant la régularisation accrue du niveau de l'eau des Grands lacs.

PARTICIPATION INTERNATIONALE

En 1974, le Centre est officiellement devenu le Centre international de collaboration de l'Organisation mondiale de la santé (OMS) pour la qualité des eaux superficielles et souterraines. Le Ministère sera donc mieux placé pour conseiller efficacement les pays en voie de développement sur leurs programmes de gestion de l'eau.

Le Centre canadien des eaux intérieures continue d'agir comme meneur du programme visant à mesurer l'eutrophisation des lacs, programme instauré par l'Organisation de coopération et de développement économiques (OCDE).

Environmental Management Service

Inland Waters Directorate

HYDRAULICS DIVISION

COMMISSION

The Hydraulics Division is responsible for service and research programs in hydraulics, which are national in scope.

A national calibration service for hydrometric instruments, particularly current meters of all types, is provided. Other types of testing may also be undertaken. Tests of a calibration nature are done according to the user's specifications.

Research studies and tests are conducted directly in the Division's laboratory or indirectly by contract. Subjects of study are basic fluid dynamics, mobile boundary hydraulics, density currents, ice and cold weather hydraulics, wave dynamics erosion, coastal engineering and urban hydraulics. The aims are to establish by systematic studies a thorough understanding of natural hydraulics processes, to provide estimates of the changes in regime caused by land and water developments, and to seek the most effective development practices and design methods that will reduce undesirable environmental changes.

RESEARCH PROGRAMS

River Systems and Fluid Mechanics

Dispersion of Dredged Material Dumped in Deep Water

Experiments were carried out in an observation tank in the Hydraulics Laboratory to study the dispersal of the granular material released as a slug from the water surface. The results of the experiments show that the motion of the particles can be treated in two distinct phases, namely the initial "entrainment" phase and the final "settling" phase. During the entrainment phase the size of the "cloud" grows because of the incorporation of the external fluid, while the vertical downward velocity diminishes. During the settling phase, when the vertical downward velocity is the same as the fall velocity of the individual solid particles constituting the cloud, the increase in the cloud size is solely due to ambient turbulence. Based on these results, a method has been proposed to predict the vertical height and the horizontal size of the "mound" formed from the deposition of the dredged material at the bottom of the deep water. The parameters governing the characteristics of the mound are 1) the volume of the dump, 2) the size distribution of the dredged material, 3) the height of the deep water, and 4) the ambient current. This method is useful for providing guidance for the selection of optimum dump size and the location for the disposal of the dredged material.

Dispersion in Meandering Channels

The transverse dispersion processes in natural rivers are being studied in the Hydraulics Laboratory with the aid of laboratory channels having different meandering configurations. The experiments performed indicate that the transverse dispersion coefficient increases with the growth of the amplitude of meander. A unique feature of the present experiments is that the bed of the channel is covered with sand and the bed forms are scoured by the flow itself, so that the flow conditions are as close to nature as possible.

Fall Velocity of Solid Particles of Different Shapes

The measurement of fall velocity of solid particles of various shapes, e.g., cubes, parallelepipeds, spheres, cylinders, and discs, is undertaken at the Hydraulics Laboratory. The results of the measurements made indicate that the fall velocity of sand particles moving in water is independent of the particle shape, as long as the size of the particle is less than 0.250 mm.

Diffusion Coefficients in Rivers

There have been wide variations in published values of the transverse diffusion coefficient, and it is suspected that these variations are caused by differences in the width to depth ratios of the channels and their friction factors. Systematic experiments are underway to resolve the problem.

Evaporation in Rivers

Owing to the lack of a method of measuring evaporation from flowing water, a study of the feasibility of using radioactive tracers for such measurements was started.

Some base-line experiments without tracers were performed in a small wind tunnel, and measurements with tracers will begin shortly.

Flow Criteria for Oil Boom Design

A review of the criteria for containment of oil slicks in rivers by using booms was completed. It revealed that all but one of the proposed theories had serious flaws. It was concluded that some experimental work was necessary before oil containment criteria and strategy could be established in practical situations. Experiments have begun in a tilting flume.

Mobile Boundary Studies

Hydrophone Technique

The feasibility study was continued for the detection and measurement of bed-load transport in rivers. Extensive field observations were carried out in the Vedder and Fraser Rivers in British Columbia during the 1974 spring runoff. Approximately four hours of sound recordings were successfully obtained during periods of bed-load transport, as verified by conventional sampling. Recorded data have been analyzed for spectral characteristics to identify the sediment noise from the background noise in the rivers. Acoustic noise, generated by collisions among the moving and the stationary bed particles, was simulated under ideal conditions in the laboratory. The results, indicative of the nature of sound generated by particle collisions and of the acoustic transmission characteristics between the source and receiver, were employed in the development of a theoretical transfer function relating the rates of bed-load transport with measured sound pressure levels. The theoretical analysis of an idealized system, which considered the multiple particle collision sources and their range to an omnidirectional receiver, showed that the measurement of sound pressure levels at a known distance from the river bed is not sufficient to establish the rate of bed-load movement. Furthermore, the acoustic method has no merit if bed particles saltate. The analysis indicated, however, that the technique may be feasible with the use of directional hydrophones and independent determination of the acoustic power generated by individual collisions. The project will be completed in early 1975.

Hydrographic Technique

A study to establish field measurement criteria for the determination of bed-load transport from repeated surveys of the movement and geometry of sand dunes in large rivers has been initiated in the laboratory. The instrument carriage of the two-metre sediment flume has a constant speed drive system. Procurement of equipment for automatic observation and recording of bed-form geometry and water levels has been completed during the year. Experiments will commence and continue throughout 1975.

Initiation of Sediment Motion

In support of dredging studies for the Canada-United States Water Quality Agreement, a compendium on initiation of sediment motion data has been completed under contract by a consultant. Specifications were also prepared, and a contract was awarded to consultants for a comprehensive report on the engineering aspects of the cessation of motion phenomenon and its relevance in the control of sediments in dredged channels.

Urban Water Systems

Several studies have been undertaken in support of the Canada-United States Water Quality Agreement with respect to reducing pollution caused by uncontrolled storm water discharges and combined sewer overflows. A contract study to assess the existing urban runoff models, which was commissioned to a consultant by the Hydraulics Division, has been completed. The Storm Water Management Model of the United States Environmental Protection Agency, identified as the most versatile and comprehensive model, was recommended for further use and modification. Most of these modifications will be implemented in a current study of the development of a Canadian version of the Storm Water Management Model. This study also involves two other government agencies, the Environmental Protection Service (EPS) and the Ministry of the Environment (MOE) and is being done in close co-operation with two consulting engineering companies. The need for model modification was motivated by the necessity to account for Canadian climate, economy, engineering practices and environmental concerns. It was realized in the early stage of the current research program that there was an urgent need for accurate data on runoff and overflow quantity, quality and frequency. Further advancement of the study of runoff modelling is presently impaired by the lack of adequate data. Consequently, the Hydraulics Division has continued and expanded the data collection program. Besides the established test area in Burlington, three other test areas were instrumented in Burlington, Hamilton and Toronto.

Both Burlington areas are served by separate sewers; one site is a residential development, the other site is a commercial plaza. An example of an observed and computer-simulated runoff event on the former area is shown in Figure 1. The Toronto area is operated by a consultant. Data collection will concentrate on monitoring the quantity and quality of runoff during the snowmelt period. The Hamilton area is served by combined sewers and will be very valuable in assessing the pollution loads from combined sewer overflows. So far, the entire research program has created considerable interest among consulting and

municipal engineers, and some results of this research are already being implemented. The models under development will also serve government agencies in assessing pollution originating on urban watersheds.

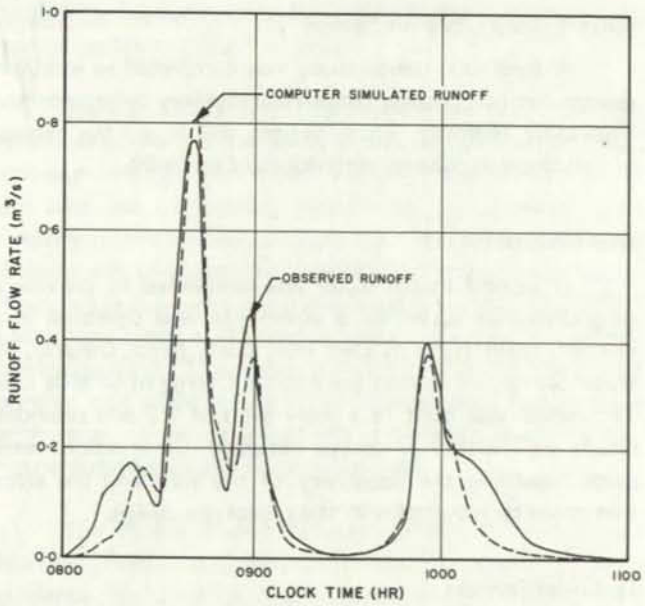


Figure 1. Observed and simulated runoff on Burlington test area.

Ice Studies

Cold Rooms

During 1974, experimental cold rooms were completed. One of these rooms will be used for scientific studies. A unique feature of the facility is that the system requires no defrosting cycle. At present, apparatus for preliminary testing of frazil ice production is installed.

Ice Piling on Shores

In 1974, the field projects concerning ice piling on lake shores and the friction loss of ice-covered rivers were completed. For the ice-piling project, the meteorological, limnological and ice parameters were simultaneously recorded at the Lake Simcoe site. The study confirmed previous work that ice piling is an activity of short duration. The change of wind direction from offshore to onshore is the primary cause of ice piling.

Friction of Ice Cover

For the study of friction loss because of ice cover, both winter and summer data have been collected from the three sites on the Grand River in Ontario. Preliminary analysis showed that the hydraulic gradient of a river remains the same under both open water and ice-covered conditions.

Frazil Ice

A project to study the formation of frazil ice in water with surface waves was initiated, and preliminary experimental equipment was set up.

St. Clair-Detroit River Studies

Studies on the ice conditions on the St. Clair and Detroit Rivers and the containment and recovery of spilled oil from the two rivers under winter conditions have also been conducted. The studies showed the necessity of measures for winter oil spill control and that ice and oil can be contained and possibly separated by specially designed booms that are properly deployed.

Environmental Flume

To study the winter flow conditions in a controlled environment, an environmental recirculation flume with a wind tunnel has been designed and is under construction. The completion date is expected to be in the spring of 1975.

Coastal Systems

Wind-Wave Flume

During 1974, all of the major equipment for the wind-wave flume was installed. Although all of the components were not yet fully commissioned, work had advanced sufficiently to conduct the first large test. This test was the design evaluation of a rubble mound breakwater, armoured with dolos units, proposed for a new harbour at Grande Baie, Newfoundland. The test was done for the Department of Public Works. Two important results of the test were 1) larger armour units than initially proposed would be required to withstand the maximum design storm and 2) construction procedures were established to minimize erosion of the small core material from typical summer storms. A view of the flume is shown in Figure 2.

Figure 2. Inside view of wind-wave flume from beach end.

Point Pelee Studies

Problems of erosion have developed along the shore of Point Pelee National Park. As part of CCIW's effort to understand and document these problems, waves were measured off both sides of the Point throughout the 1974 field season. The problem of successfully mooring Waverider buoys in relatively shallow water, encountered in previous years, occurred again at Point Pelee, resulting in the loss of one Waverider. Otherwise the measurement program was successful and provided valuable wave data for the other field project carried out concurrently.

Work started in 1974 to estimate the net littoral drift at Point Pelee. The approach being used is to establish the frequency of occurrence of wave heights and directions off the Point from wind climate data. Numerical methods are then employed to route the wave energy with the near-shore zone. Empirical relations between wave energy in the breaker zone and littoral drift are then used to establish the net drift. It is hoped that this project will produce significant data on the long-term erosion-accretion processes at Point Pelee.

SERVICE PROGRAMS

Hydrometric Service

National Calibration of Current Meters

A brochure entitled "Current Meter Calibration" was prepared and distributed. During 1974, 703 current meters were calibrated, ranging from simple streamflow meters, such as the Ott and Price, to more elaborate types for lake and ocean surveys, such as the Geodyne, Plessey or Aanderaa (Table 1).

Table 1. Meter Distribution

Agency	Number of meters
Water Survey of Canada	382
CCIW	120
Other federal agencies	35
Provincial agencies	124
Universities	28
Private sector	14
	703

Low Temperature Testing

There is a need to test and evaluate existing instrument packages, such as recorders, under simulated cold climate conditions to ensure success in recording data under harsh environmental conditions. For this reason a torture-testing cold room was constructed and will be fully developed in 1975.

Various Engineering Studies

Culvert Design for Fish Passage

A hydraulic model study was completed to establish designs for fish passage facilities in highway culverts on the Mackenzie Highway. These designs should aid the passage of fish through culverts with slopes of up to 5%.

Weir Calibration

A second model study was completed to provide a stage-discharge curve for a composite weir operated in a research basin at Perch Lake near Chalk River, Ontario, by Water Survey of Canada for Atomic Energy of Canada Ltd. The model was built to a scale ratio of 1:2 and provided results well within prototype accuracy. Observations were made regarding the sensitivity of the weir and the error that could be incurred with the prototype design.

Technical Services

The function of Technical Services is to provide assistance to the scientists and engineers of the Division. The responsibility also extends to the general upkeep of the laboratory and the maintenance and operation of major installations, such as the one-metre and two-metre flumes, the pumping stations, the sediment-handling equipment, the recently completed wind-wave flume and the cold rooms.

Technical support is provided by seven hydraulics technicians who are assigned to projects under the guidance of the engineer or scientist in charge. Their tasks involve setting up experiments; collecting, evaluating and analyzing data; designing; plotting graphs; and writing reports.

Support is also provided by a "light" machine shop where repairs are made and specialized small parts are manufactured for experiments. Work of a complicated or non-urgent nature is done by the Central Machine Shop or is contracted out. A full-time carpenter joined the Unit early in the year.

The electronics service shop responds to the maintenance and set-up needs in the laboratory.

LAKES RESEARCH DIVISION

The objective of the Lakes Research Division, in the broad terms of reference of Environment Canada and the Environmental Management Service, is to provide the government with the scientific knowledge for managing the

freshwater resources of Canadian lakes.

The Division has two essential functions: 1) to perform basic research to increase scientific knowledge in the field of limnology, i.e., the science of lakes and lake behaviour or processes and 2) to deliver scientific tools needed by management to solve present and future environmental problems related to lakes.

During 1974, the organization of the Division remained ostensibly the same as during the previous year, although changes were made that were expected to make the best use of existing and limited manpower and to simplify reporting relationships. The Lakes Resources Subdivision was re-named the Applied Limnology and Physical Processes Section and was formulated to include an Applied Limnology Unit, a Physical Processes Unit and a Systems Modelling Unit. The remainder of the Division was incorporated into a Sedimentary and Chemical Processes Section with four Units covering sedimentology, geochemistry, nutrient dynamics and toxic substances.

The Pacific Region detachment and the Prairie and Northern Region detachment continued to receive scientific guidance for their programs, although line management responsibilities were transferred to the new regional structure of the Environmental Management Service. The Palaeoenvironmental Research group of the Water Resources Branch became closely associated with this Division's activities during 1974 and will be completely integrated in the 1975 program.

During 1974, the primary concerns of the Division have been studies related to the Canada-United States Agreement on Great Lakes Water Quality. In addition, a major research study was centred on Kamloops Lake in British Columbia. A number of short-term applied studies were also undertaken in several other regions of the country, e.g., Lesser Slave Lake, copper complexation in Babine Lake, a specific study of the southeast bend cutoff in Lake St. Clair, and the Shubenacadie Lakes Project.

APPLIED LIMNOLOGY AND PHYSICAL PROCESSES SECTION

The Applied Limnology and Physical Processes Section undertakes and coordinates multidisciplinary lake studies in support of IJC Reference Groups, federal-provincial agreements under the Canada Water Act, the Great Lakes Water Quality Agreement and support of regional requirements supplemental to the work of CCIW groups already established in the Regions. As the latter part of the name implies, basic research in the field of physical limnology is also carried out within the Section to increase scientific knowledge of lake processes.

A strong link between these two general activities and the research of other units is present in the development of computer modelling. The modelling effort, originating in the study of lake hydrodynamics, has moved to verification of its ability to simulate water levels, currents and temperatures for Lake Ontario, based on data collected in 1972, as a part of the International Field Year for the Great Lakes. With the computation of the three-dimensional water circulation, the next step will be directed toward development and verification of biochemical submodels. With these same computations, the modelling of toxicant spills has been undertaken as well.

The work of the Section is strongly (although not exclusively) centred on the Great Lakes large lake systems. The modelling studies mentioned, up to now, pertain to Lake Ontario. The results of a hydrodynamic model for Lake Erie have also been tested against 1970 data for the distributions of a conservative and a non-conservative material (chloride and phosphorus) with the "fitting" of the model centred on the choice of a suitable horizontal eddy diffusion coefficient. The coefficient so fitted gave a similar range to that determined in dye studies.

The other approach taken in the Section for lake-wide studies is the descriptive lake-assessment technique characteristic of the Applied Limnology group. The primary field effort in this direction in 1974 consisted of open-lake research surveys of Georgian Bay and Lake Huron in support of the IJC Upper Lakes Reference Group. Staff were also involved in the planning and analysis of data collection programs from less intensive surveys carried out in Lakes Ontario and Erie in support of surveillance and surveillance design studies. Open-lake survey efforts consist of sampling programs for physical, biological, geological, chemical (including toxic substances) and microbiological parameters. As such, they are co-operative programs planned by the scientific staff of the Lakes Research Division, the Great Lakes Biolimnology Laboratory and the Scientific Operations Division, with technical operations assistance from the Scientific Operations Division and analytical services from the Great Lakes Water Quality Laboratory of the Water Quality Branch. Coordination with Ontario agencies and United States federal and state agencies is effected through the working groups of the Upper Great Lakes Reference Group.

Parallel with these survey programs, analysis progresses on current and past data. These analyses for the upper Great Lakes are directed toward the definition of base-line conditions, the identification of major water masses and their movement through the lakes, the description of the interrelations between physical, biological and chemical parameters, the identification of the principal processes governing open-lake water quality conditions, and the study of the trends in water quality for these lakes.

The analysis for trends and the continuing assessment of lake conditions extend to the lower Great Lakes in a program of surveillance research, including water quality conditions and lake circulation climatology.

A major and somewhat separate component of the IJC Upper Great Lakes Study concerns atmospheric loading as a significant source of materials with respect to water quality. The program is directed from CCIW with the Lakes Research Division and the Water Quality Branch in leading roles. The program consists of an extensive sampling network of both a routine and experimental nature, and a numerical atmospheric deposition model. Co-operating agencies include the Atmospheric Environment Service, the Ontario Ministry of the Environment, the United States Environmental Protection Agency and the Michigan Water Resources Commission. Portions of the program are conducted under contract with Acres Consulting Services and Earth Sciences Consultants.

In support of studies to meet the needs expressed in the Canada-United States Water Quality Agreement, an investigation was completed jointly through contract with Acres Consulting Services to establish existing and future water loss because of evaporation produced by waste heat being injected into Great Lakes waters.

Both the Applied Limnology and Physical Processes groups are engaged in additional studies pertaining to waste heat disposal. These include an assessment of near-shore temperature climatology and an investigation of near-shore physical processes that produce differing onshore-offshore exchange regimes.

The basic research of the Physical Processes group in the past year has been directed, in large part, to the Great Lakes. Much of the research relates to the analysis of the data collected in the International Field Year for the Great Lakes. Studies extend to investigation of vertical transfers of heat in relation to wind stress, thermal structure and velocity profiles, heat stored in Lake Ontario, definition of the thermocline and internal waves.

Tidal generation processes have been investigated with particular attention to Lake Ontario where earth tide effects are also evident.

Air-water interaction studies relating profile measurements to flux measurements over a wide range of stability conditions have been reported and are still under investigation. The work assists the lake-wide assessments of heat, momentum and moisture fluxes required for the comprehensive IFYGL studies; work has also been carried out on the scale of the size of thermal plumes to establish the relative importance of heat transfer to the atmosphere and to ambient waters in the dissipation of heat discharged from power plant condensers.

Turbulent diffusion studies, conducted in the field under widely varying environmental conditions, have demonstrated the dependence of turbulent eddy diffusivities on observed environmental parameters in a form useful for modelling practical diffusion problems.

Basic studies pertaining to coastal dynamic processes, such as upwelling, downwelling, transport and dispersal in the coastal zone, have also been undertaken.

Small lakes systems have come under investigation in all three groups of the Section. An analytical model of upwelling for a mountain lake has demonstrated the behaviour of the thermocline for this type of situation. The thermal structure and circulation of Kamloops Lake, B.C., have been under study, in support of the program of the Pacific detachment of CCIW. Finally, a staff member of the Applied Limnology Unit assisted in the limnological aspects of a study of the Shubenacadie River basin. This study was a co-operative effort between the Inland Waters Directorate and the Province of Nova Scotia and was directed toward determination of the impact of land use on water quality. About 20 lakes form elements of this basin, demonstrating a wide spectrum of impact.

SEDIMENTARY AND CHEMICAL PROCESSES SECTION

The Sedimentary and Chemical Processes Section of the Lakes Research Division was formed during 1974 with a mandate to investigate chemical and geological lacustrine processes. The Section is composed of four Units.

Sedimentary Processes Unit

The Sedimentary Processes Unit was established to carry out research on the processes controlling the dispersion and deposition of sediments in lake systems, both in the near-shore and offshore lake environment; to study problems associated with shoreline erosion, littoral transport, siltation and beach and bar formation; to determine the mechanisms controlling sediment-sorting (including turbulent reworking), insofar as the textural properties are related to the geochemical characteristics of the sediment with associated uptake and release of nutrient and toxic elements.

Geochemistry Unit

The Geochemistry Unit was formed to conduct research leading to an understanding of the geochemical cycles of inorganic and organic compounds at the sediment-water interface and in buried sediments; to evaluate

the regional distribution of elements in lake systems; and to evaluate mass geochemical budgets.

Toxic Substances Unit

The Toxic Substances Unit was established to examine the occurrence and movement of refractory organic material in the aquatic environment. (Here refractory refers to material that is not readily degraded in open waters.) Such material persists and is potentially biomagnified to the degree at which it may become deleterious to the environment. Of particular concern is the lower molecular weight fraction, usually neutral, which is introduced by man.

Nutrient Dynamics Unit

The Nutrient Dynamics Unit was formed to conduct research on the pathways of nutrients (P, C and N) in the lacustrine system; it includes measurements of primary productivity and algal standing crop as a function of nutrient availability, sedimentation and decomposition (heterotrophic activity), zooplankton-grazing, uptake and release rates of P, C and N compounds and release of nutrients from the sediments.

Paleoecology Unit

The Paleoecology Unit was established to conduct a systematic sampling program of Canadian fresh waters for shelled invertebrates to facilitate the interpretation of the paleoclimatology of Canada for the past 2000 to 3000 years. These recorded data are also being used to determine an index of the aging process of lakes.

NEAR-SHORE SEDIMENT STUDIES

In 1974, the mapping of the Lake Erie near-shore zone was extended from Port Glasgow to Point Pelee.

Figure 3. Assembly of the Vibracore sampler, Kingsville Harbour.

Jetting measurements of sediment thickness were continued in Lake Erie with surveys of near-shore deposits between Long Point and Point Pelee. Coring operations based on the Beachcor hydraulic corer were completed in Lake Ontario with surveys at Toronto and Brighton. Under contract, cores collected during the 1973 surveys have now been analyzed for pollen content. Results indicate that pollen-dating is applicable to sandy near-shore sediments, providing the silt content exceeds 10%.

Tracer studies based on an acoustic "pebble" are now in progress, as part of a study to measure the mobility of near-shore sediments in the pebble-size to boulder-size range.

CANADA-ONTARIO SHORE DAMAGE SURVEY

Regional Survey of Long-Term Recession Rates

Due to the predominance of bedrock-protected shorelines in the upper reaches of the Great Lakes, the survey was confined to more than 2000 km of the erodable shoreline extending from Port Severn (Georgian Bay) to Gananoque (Lake Ontario). A total of 703 recession measurements corresponding to intervals of approximately 30 years were collected using data previously published, supplementary data collected in 1973, and the precise comparison of shoreline points on aerial photographs taken in the 1950's and in 1973. The data from aerial photography were analyzed by means of digitized cross sections and were valuable in highlighting recession related to a high-low-high lake stage sequence. These data also complemented the data on recent erosion (since 1970) collected by the Shore Properties Section of the Marine Sciences Directorate.

In-depth interpretation of the results of the survey are included in the Coastal Zone Atlas and the Technical Survey Report to be released in early 1975.

Point Pelee Studies

A comprehensive, multidisciplinary investigation of the respective roles of physical processes, sediment transport and commercial dredging on the continuing erosion losses at Point Pelee was launched in 1974 by personnel from the Lakes Research Division, the Scientific Operations Division, the Hydraulics Division and the Marine Sciences Directorate. A contract study by staff of the University of Windsor also supplied data on the effect of winter ice conditions on beach erosion.

Seven long cores were collected over the Point Pelee shoal using a 40-foot long vibratory sampler (Vibracore) supplied by Alpine Geophysical Associates, Inc., of Norwood, New Jersey (Fig. 3). Detailed core logs have

been prepared to determine main sedimentary units and their stratigraphic sequence. Field and laboratory data, including radiocarbon dating, will be used for the interpretation of depositional history of the study area.

PLEISTOCENE AND HOLOCENE STRATIGRAPHY OF THE LAURENTIAN GREAT LAKES

A detailed study was made of the stratigraphy of unconsolidated sediments in northern Lake Superior (north of latitude 48°) by means of echo-sounding and coring. Although in recent years many investigations of sediments in Lake Superior have been conducted, details of the northern part of the lake have remained incomplete because of the necessity of taking very long cores to penetrate the complete late-glacial and postglacial sequence. Over 80 piston, gravity and benthos cores ranging in lengths of up to 18 m were collected and studied.

A study of the palynology, stratigraphy and mineralogy of a long sediment core from South Bay, Lake Huron, is underway. The occurrence of well-formed pyrite nodules associated with organic matter in this core is noteworthy. Although generally a rare mineral in the Great Lakes, pyrite may have formed in this sediment because of the presence of sufficient sulphur, which was possibly introduced in sulphate-bearing groundwater.

TASK FORCE 8

In February, subsurface investigation was carried out at the site of a trial dredgings disposal area in Lake St. Clair near Mitchell Bay, Ontario. The investigation involved the coring and continuous sampling of the recent and Pleistocene deposits down to the bedrock level. A series of sedimentological, geotechnical and geochemical tests were performed later in the year to determine dredge spoil and lake-bed sediment conditions at the site.

A series of laboratory physico-chemical tests were conducted on representative samples of sediment from the lower Great Lakes to determine changes which take place in dredge spoil material during land disposal. The tests showed that drying and oxidation increased the cation exchange capacity and decreased the plasticity of recent fine-grained sediments, whereas in the case of the Pleistocene sediments, these properties remained unchanged. The study will continue in 1975 with a subsurface coring investigation at the Toledo Island disposal site where the dredge spoil material has been exposed to groundwater percolation and sub-aerial processes from 7 to 14 years.

PALYNOLOGICAL AND GEOLOGICAL STUDIES BY THE GEOLOGICAL SURVEY OF CANADA DETACHMENT

Sediment descriptions, photography and x-ray radiography were completed on all piston and gravity cores that had been collected from Lakes Ontario, Erie, Huron, and Georgian Bay prior to 1974. The Lake Ontario data enabled the compilation of a postglacial sediment thickness map and stratigraphic cross sections of the basin sediments. An immediate use for this information is as support data for a geological map of Lake Ontario under preparation by GSC personnel, Ottawa, for IFYGL.

Acoustic-profiling and coring cruises were carried out on Georgian Bay and Lakes Erie and Ontario. Sediment velocity and thickness data were obtained on the Georgian Bay cruise so that proper interpretations could be carried out on the echogram and seismic reflection data already available. A total of 30 long piston, 7 (6 m) gravity and 70 benthos (1 m) cores were taken at selected areas throughout Lakes Ontario and Erie in an effort to solve some specific problems of stratigraphy, sediment distribution and bottom configuration.

Table 2. Annual Natural and Anthropogenic Inputs of Heavy Metals and Nutrients to the Sediments of Lakes Huron, Erie and Ontario (metric tons per year)

Element	Lake Huron		Lake Erie		Lake Ontario	
	Anthropogenic	Natural	Anthropogenic	Natural	Anthropogenic	Natural
Hg	0.30	0.48	11.7	5.0	12.6	0.5
Pb	430	90	3,230	900	1,090	125
Zn	500	285	7,815	3,750	2,380	435
Cd	3	4	88	42	23	5
Cu	100	135	965	1,140	310	190
Cr	85	165	4,450	1,830	550	420
Ni	170	190	2,010	2,000	405	600
Org-C	35,400	123,900	794,000	478,000	188,000	88,000
N	4,880	16,600	114,000	57,200	25,100	9,710
P	1,340	3,410	18,600	32,200	5,120	3,900

Pollen horizon determinations were continued on 5 long cores from central Lake Erie. The pollen horizons were dated by correlation with other radiocarbon-dated profiles in the Lake Erie basin, and thus provide chronologic control for paleomagnetic and isotope studies on these cores by Professor K. Creer, University of Edinburgh, United Kingdom, and Professor P. Fritz, University of Waterloo, respectively. The results of these studies are consistent with and complement the pollen and sedimentological data, increasing our knowledge of the late-Quaternary history of Lake Erie.

Studies on the paleoecology and Holocene chronology of buried plant detritus beds were expanded in the Great Lakes. Six radiocarbon dates were obtained on plant detritus in Lake Huron sediments. Plant macrofossils, pollen, insect remains, molluscs, and ostracodes were extracted from the detritus and identified. Pollen analyses were commenced, and radiocarbon dating was carried out on cores containing plant detritus from embayment sites in Lake Ontario and Georgian Bay.

Ambrosia (ragweed) and *Castanea* (chestnut) pollen horizon determinations for estimating recent sedimentation rates were completed on approximately 50 cores from Lake Ontario by Lakes Research Division staff in co-operation with the Geological Survey of Canada.

GEOCHEMICAL INPUTS TO GREAT LAKES SEDIMENTS

Trace elements and nutrients were determined for 14 core locations, representing basins of fine-grained sediment in Lakes Ontario, Erie and Huron. The concentrations of Hg, Pb, Zn, Cd, Cu, Cr and Ni are enriched in the surface sediments relative to base-line concentrations below the *Ambrosia* horizon (~ 120 years BP). The enrichment of the heavy metals is related to the increasing anthropogenic loading of these elements in recent years. Enrichments are much greater in Lakes Ontario and Erie, which have large industrial cities in their drainage basins, than for Lake Huron with its lesser urban population. Surface sediment concentrations of the elements in Lake Ontario are similar to those of suspended sediment samples from river mouths around Lake Ontario, whereas the base-line values in the sediment match those of glacial tills around the lake. Nutrient elements (organic carbon, N and P) have similar characteristics to the heavy metals reflecting the increasing anthropogenic loading of P to the lakes with commensurate increases in primary productivity.

Preliminary estimates of the anthropogenic and natural inputs of the heavy metals and nutrients to the offshore sediments are shown in Table 2. The estimates clearly show the impact of human activities in the three lakes. The anthropogenic inputs parallel the populations of the three drainage basins and also reflect the heavy industry of the Lake Ontario and Lake Erie basins.

It is not possible to pinpoint the sources and dispersion pathways of the anthropogenic inputs. There is evidence that atmospheric inputs are an important source of heavy metals and nitrogen to the lake sediments, accounting for all the anthropogenic load of these elements to northern Lake Huron. The anthropogenic elements are mainly deposited in the downstream location in each lake, a considerable distance from the primary source areas. The statistical relationship of the heavy metals to the organic matter indicates that part of the heavy metal input to the lakes is incorporated into the food chains and is sedimented with the particulate organic matter. The large quantities of fly ash in the sediment suggest that part of the heavy metal input originates from fossil fuel consumption in the region.

STABLE ISOTOPE VARIATIONS APPLIED TO POLLUTION STUDIES

The studies on the use of $^{34}S/^{32}S$, $^{13}C/^{12}C$ and $^{15}N/^{14}N$ ratios as tracers to determine the sources and behaviour of certain pollutants in lake environment were continued. The applicability and limitations of sulphur isotopic variations as source indicators in the lower Great Lakes are typefied by the data for Lake Erie shown in Table 3. The most notable feature of the data is that the mean $\delta^{34}S$ values of the various sources and sinks are different. Potentially it is thus possible to use the isotope ratio differences to determine the sources of sulphur in the waters of the lake and the mixing patterns of the various masses of water in the lake.

Table 3. Mass and Isotopic Balance for Sulphur in Lake Erie

Source/sink	$SO_4 \times 10^{10}$ g	Mean $\delta^{34}S$(‰)
Detroit River (L. Huron outflow)	267.8	+6.4
Runoff, all sources	110.1	+4.8
Precipitation onto lake's surface	16.3	+6.0
Sewage and other industrial discharges	58.7	+2.2 (estimated)
Total input	452.9	+5.4
Outflow, Niagara River	424.2	+5.2
Outflow, Welland Canal	14.6	+5.2
Total outflow	438.8	+5.2
Lake Erie: western basin	50.2	+6.4
central basin	649.3	+5.2
eastern basin	353.1	+5.2
Organic matter pool in lake water	0.426	same as lake water
Total in lake water	1,053	–

TOXIC SUBSTANCES

Studies in this group centred on three major topics in fields related to toxic materials: identification of organics, fate of toxicants and metal relationships.

Under organic identification, gas chromatography–mass spectrometry (GC–MS), was employed to identify Mirex, a C_{10} H_{12} compound, in fish samples from the Bay of Quinte. The major effort under the identification program involved a study at a kraft process pulp mill at Red Rock, Ontario. Dye was used to follow the effluent plume, and samples have been obtained from the discharge, the discrete plume over time, and water, seston, sediment and biota forms from outside the plume. These are all to be examined employing GC–MS. In addition, the problem of fish-fainting is being examined to identify causative compounds.

Several problems concerning the fate of toxicants were examined. Biodegradation of three non-ionic surfactants under both laboratory and field conditions showed 90% degradation in approximately three weeks. The relationships of water soluble components of oils and the aquatic environment were undertaken during the latter part of the year, while the evaluation of oil herders was continued. A study of the feasibility of using water-solvent partitioning as an index for likely bioaccumulation at the phytoplankton level was initiated.

The relationships between metal complexing capacity and primary productivity, chlorophyll *a*, bacterial numbers and respiration were examined for a synthetic medium. The ability of various sediments to biologically methylate lead (yielding Me_4Pb) was demonstrated, and similar work is being undertaken with selenium. The rate of loss to air and the forms of mercury in dredged sediments were also investigated.

NUTRIENT DYNAMICS

The measurements of the rate processes that influence the growth rate and abundance of algae in lakes were completed in the Bay of Quinte. These experiments included changes in biomass that result from decreased nutrient-loading. The quality and degree of light penetration were considerably increased, but many traditional limnological methods failed to detect any improvement. Dynamic models are being constructed using data obtained from transport measurements of radioisotopes ^{32}P-PO_4 and ^{14}C-HCO_3 that were added to "limnocorrals," enclosures measuring 25 square metres, in water 4 metres deep. Some other interesting aspects of the study were measurements of atmospheric contribution, i.e., nitrogen fixation, carbon dioxide invasion, and nutrients in precipitation.

The movement to the sediments was calculated using both mass balances of radioisotopes and sediment traps. The latter method was found to be particularly useful in defining the important transport pathways to the sediments. An index was developed for corrections for sediment resuspension owing to wind-induced turbulence. This can be applied to most lake systems. Many myths concerning phosphorus regeneration during winter months were exposed, and factors that influence internal loading from sediments with an oxidized microzone were discovered.

The determination of adenosine triphosphate (ATP) content of the planktonic organisms within the limnocorrals was continued. This provides an estimate of total living biomass and, when combined with total particulate carbon and chlorophyll, can be used to categorize a community into relative importance of autotrophic and heterotrophic organisms, plus the abundance of dead particulate material. Two of the basic problems associated with biomass determinations via ATP are 1) the separation of algal and bacterial biomass after the removal of zooplankton and 2) the variation of ATP content in certain organisms under different nutrition conditions. A preliminary study has shown the majority (83%) of the bacteria passes through a one-micron Nuclepore membrane filter, while all recognized algal species are retained. ATP determination can then be made on these two fractions. Millipore filters cannot be used for size fractionation. The second problem is currently under investigation, and it is proposed that the determination of the sum of the adenosine nucleotides (AMP, ADP and ATP) will reflect biomass changes better than ATP alone.

Research is progressing on the purification of a high molecular weight ($> 10^6$) polysaccharide isolated from the dissolved organic carbon fraction of limnocorral no. 3 surface water. This polysaccharide is composed of galactose and xylose units and is believed to be of algal origin. The structure, biodegradability, and chelating properties of this compound will be investigated.

Although zooplankton represent a small fraction of the total biomass of a lake (1.5%), they are extremely important in nutrient regeneration. They eat an amount equivalent to 1/10 to 4 times the entire algal and bacterial biomass each day.

MULTICOMPONENT BRINES

Vapour pressure measurements have been completed for the system H_2O – NaCl – Na_2SO_4 – $MgCl_2$ – $MgSO_4$ at 298.15 K and at any composition. Other studies are underway on the thermodynamic properties (including solubilities) of relatively soluble phosphate minerals and of naturally occurring metal-organic compounds.

SCIENTIFIC OPERATIONS DIVISION

The Scientific Operations Division (SOD) consists of five Sections: Microbiology, Physical Sciences Laboratories, Technical Operations, Remote Sensing, and Data Management. Its functions are

1) providing services to many or virtually all of the other scientific organizations at CCIW,
2) conducting research and development studies related to the methodology of each Section, and
3) conducting or participating in environmental research projects related to the specialization of each Section.

In addition, through the office of the Division Chief, there is considerable involvement in the planning and direction of multi-agency programs of study concerning effective management of lake systems.

ADMINISTRATION

In addition to the supervision and administration duties pertaining to SOD, functions related to membership on various national and international committees required approximately one-third of the Division Chief's time. Of major concern was his position as Canadian Co-Chairman of the International Joint Commission Upper Lakes Reference Group. During 1974, the Upper Lakes Reference Group continued its three-year multi-million dollar study of Lakes Superior and Huron to be completed by the end of 1975, involving five states and Ontario, as well as the United States and Canadian governments.

In late 1974, membership on a federal-provincial Lake Winnipeg Water Quality Study Working Group led to the preparation of a three-year study agreement for consideration by the governments.

MICROBIOLOGY LABORATORIES SECTION

The 1974 projects of the Microbiology Laboratories Section were oriented in three directions: development and evaluation of microbiological, virological and mycological techniques used to assess water quality; involvement in microbiologically oriented environmental research; and provision of support and guidance to in-house, provincial and foreign projects.

Methodology studies included assessment of various media and filtration practices to enumerate fungi in water; assessment of a variety of membrane filters and incubation temperatures on the recovery of health-oriented indicator bacteria from natural waters and effluents; development of a computer-assisted identification scheme for routine characterization of enteric indicator organisms; evaluation of ATP estimation procedures for ascertaining microbial biomass; assessment of fecal sterol preservation techniques and the relationship between bacterial populations and fecal sterol levels; evaluation and modification of freeze-drying techniques for bacterial preservation; and, in contracted studies, development and assessment of techniques for isolating and enumerating viruses from runoff from land-deposited sewage and sludge, from calcium hydroxide (high pH) treated sewage and sludge and from relatively uncontaminated river and lake water.

Environmental research studies were mainly centred on assimilation capacity of water bodies, microbial taxonomy and mycological studies. Assimilative capacity studies were undertaken in the field by means of a zonal grid sampling pattern to ascertain the impact and influence of effluent from a northern Ontario pulp mill on Lake Superior inshore and offshore waters. These field studies were supported in the laboratory by lake-simulating chemostat studies using the pulp mill effluent, lake water and indigenous microbial populations and various temperature regimes. Mycological studies were related to attempts to differentiate between eutrophic, mesotrophic and oligotrophic water by the distribution, density and taxonomy of fungal populations. Numerical taxonomic studies of bacteria isolated from Lakes Superior, Huron and Erie, and Georgian Bay are revealing the great differences between the freshwater isolates and the named or type-cultures that are used as representatives of existing taxa. The results indicate that carefully selected and often novel criteria (such as the use of a wide range of sole carbon sources at low levels) are necessary to produce significant clusters of organisms. Using such techniques, it appears possible to determine differences in bacterial population-composition corresponding with trophic levels.

Among the many projects supported by the Microbiology Laboratories Section's staff, those projects involving IJC commitments used approximately 80% of our support manpower. This support varied from advice, guidance and the loan of equipment to United States government-sponsored Great Lakes winter cruises to microbiological water quality studies of the St. Lawrence and St. Marys Rivers. During the year, 7 surveys of Lake Huron, North Channel and Georgian Bay (247 samples and 77 stations per survey) were completed by the Water Quality Assessment Unit, to collect base-line data and

provide information for the development of non-degradation water quality criteria.

The following contracts were monitored by the Microbiology Laboratories Section:

1) Studies on the Detection of Animal Viruses in Farm Effluent (Phase II) (Dr. J.B. Derbyshire, University of Guelph, Guelph, Ontario),
2) Development of Methods of Virus Analyses in Selected Areas of Lake Erie (Dr. E.L. Medzon, University of Western Ontario, London, Ontario),
3) Virological and Epizootiological Studies of Fish Neoplasms in Polluted and Non-Polluted Waters of Great Lakes (Dr. R.A. Sonstegard, University of Guelph), and
4) Examination of St. Lawrence River, Ottawa River, and Recreational Waters for the Presence of Human Pathogenic Viruses (Dr. J.C.N. Westwood and Dr. S.A. Sattar, University of Ottawa).

PHYSICAL SCIENCES LABORATORIES SECTION

Most of the effort of this Section was devoted to projects related to the IJC Upper Lakes Reference Study during 1974. Radioecological studies continued in the Radiochemistry Laboratory, where sediment cores from Lakes Superior and Huron were sliced into 0.5-centimetre sections for the determination of the vertical distribution of γ-ray emitting radionuclides. Radionuclides encountered other than those occurring naturally were ^{144}Ce, ^{137}Cs, ^{125}Sb and ^{155}Eu, which originated from nuclear weapon-testing in the atmosphere. They were found to be concentrated in the top 2 cm to 5 cm of the sediment cores and the concentrations of individual radionuclides varied markedly from core to core. These variations are probably due to differing absorptive capacities of sedimenting particulates in the lakes. Preliminary work on bioaccumulation of radionuclides through the aquatic food chain showed a concentration factor for ^{137}Cs of 6×10^3 from water to lake trout.

The distribution of asbestos fibres in Lake Superior was investigated by the Electron Microscope Laboratory to determine the impact on the lake of dumping taconite tailings containing cummingtonite asbestos off the Minnesota shore. Analyses of water samples taken during 1973 survey cruises were done at CCIW and by contract at the Ontario Research Foundation and McMaster University. The results for about 90 samples show that concentrations ranged mainly from 0.5 to 10 million fibres per litre with very few in the 10 to 100 million per litre range. The majority of samples contained chrysotile asbestos fibres only, with a mean length of 0.2 μm; cummingtonite fibres were identified only in samples from the extreme western arm of the lake near the tailings dump.

Other radiochemistry projects included a determination of the direction of sediment motion by following the movement of a radioactive glass sand with a submersible detector. This project was carried out in co-operation with the Geophysical Limnology and Engineering Sections off the east shore of Point Pelee on Lake Erie. A distinct northward movement of the sediment was found by measuring the radioactivity for several days on a circular grid pattern around the point of injection of the radioactive artificial sediment.

A method was developed to analyze for ^{210}Pb ($T\frac{1}{2}$ = 22 yr) in lake sediments, which is being applied to sections of a Lake Huron core. This radionuclide is a daughter product of ^{222}Rn, which maintains a fairly constant value in the atmosphere. The ^{210}Pb flux to the lakes is therefore also constant, providing a convenient tracer for the study of sedimentation processes.

The translocation of lead in algal cells grown in sub-lethal concentrations of lead salts has been studied in co-operation with Great Lakes Biolimnology Laboratory using the transmission electron microscope. A technique for fixing the original location of the lead in the cell employing sodium rhodizonate was developed, which was then used to identify the process whereby lead absorbed by *Stigeoclonium tenue* is translocated to the two large cell vacuoles.

The scanning electron microscope with its x-ray fluorescence analyzer was used to study the structure and composition of pyrite concretions, about 150 μm in diameter, in co-operation with the Geophysical Limnology Section. This instrument was also used for taxonomic studies of phytoplankton and bacteria.

DATA MANAGEMENT SECTION

The Data Management Section is responsible for the maintenance of the CCIW Data Archives, the IFYGL data bank and the provision of programming and technical services in support of CCIW projects. It is comprised of three Units.

Computer Applications Unit

The Computer Applications Unit provides direct software support to CCIW projects. In addition, the

program library has been expanded to contain approximately 300 subroutines; improvements have been made to the PDP-15 operating system for the production of 16 millimetre film to permit the program to co-exist with the plotting packages; an on-line data editing program using the graphics display console on the PDP-15 has been developed; and EROS, a direct access retrieval program written under contract, has been implemented and a program for establishing communications and handling messages to and from the ROBOT experimenter has been developed.

Data Archives Unit

The Data Archives Unit maintains, updates, and edits vessel survey data. Access to the USEPA STORET data bank via a terminal located at CCIW permits the retrieval of United States IFYGL limnological data gathered from Lake Ontario and its drainage basin. The University of Toronto Great Lakes Institute data for 1960-1969 and bathythermograph data for all years have been processed and exist in both the STAR and EROS formats. The data banks in operation are STAR, EROS, STORET for vessel survey data, STAR, for current meter and meteorological time series data and SAFRAS for geological and socio-economic data.

Special Projects Unit

The Special Projects Unit provides direct technical and clerical support to CCIW projects. Computer programs were developed to produce a subfile of the STAR data base and updating programs were written. A concentration of effort was expended in developing digitizing programs for the Hewlett Packard 9100 calculator digitizer to alleviate hand-scaling of analog data rolls.

A statistician under contract provided consulting services on data collection techniques, statistical data analysis, and mathematical model verification.

TECHNICAL OPERATIONS SECTION

As in the past, the majority of the field work for the Inland Waters Directorate at CCIW was carried out or supported by Technical Operations personnel on major research vessels and in field parties based onshore.

Tables 4, 5, 6 and 7 list the major vessels and the types of cruises completed with Technical Operations support.

Surveillance Unit

During 1974, a Surveillance Committee, with members from the Lakes Research Division, the Great Lakes Biolimnology Laboratories and the Technical Operations Section, initiated a Great Lakes Surveillance program. Eighteen cruises were successfully conducted and reported by the Surveillance Unit of the Technical Operations Section.

Table 4. General Cruise Data

Vessel	Number of cruises	Miles steamed	Types of cruises
CSS LIMNOS	27	10,430.8	Current meter moorings; dynamic mooring analysis; sediment velocity studies; surveillance; engineering trials; sediment inventory; toxic materials survey; survey; sediment, seismic and coring
MV MARTIN KARLSEN	19	19,650.6	survey; surveillance; geolimnological studies; geochemical studies
CCGS PORTE DAUPHINE	14	9,063.8	surveillance; point source studies

Sensor Network Unit

The Sensor Network Unit, with an objective of installing, monitoring, and retrieving meteorological and specialized limnological equipment for CCIW, supported eight projects located at the Bay of Quinte, Main Duck Island, Lake Simcoe, Georgian Bay, Lake Huron, Morson Lake and Kamloops Lake. These systems consisted of meteorological buoys and towers, fixed temperature profiling systems, rain gauge systems along with special solar radiation measuring equipment. All of the data collected were edited by the Unit prior to submission to the project leader.

Diving Unit

The Diving Unit, which carries out all underwater activities in support of scientific programs, supported 24 projects in 1974, with over 400 underwater hours logged by CCIW and contract divers. These dives involved installation of scientific towers, installation of special current meters and wreck investigations and surveys.

SHORE-BASED SCIENTIFIC PROGRAMS

Major scientific programs based onshore supported by the Technical Operations Section are

Red Rock – a point source study in Nipigon Bay, Lake Superior, to study effluent containing toxic properties and nutrient energy (paper mill) on the aquatic community,

Table 5. Great Lakes Studies, CSS LIMNOS, 1974

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
JAN			1	2	3	4	5
	6	7	8	9	10	11	12
	13	14	15	16	17	18	19
	20	21	22	23	24	25	26
FEB	27	28	29	30	31	1	2
	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
MAR	24	25	26	27	28	1	2
	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18 Depart CCIW 0905	19 Lake Ontario	20 Moorings	21 Lake Ontario	22 Moorings	23 Lake Ontario Moorings
	24 Arrive CCIW 1216	25 CCIW	26 Dep. CCIW L.Ont 1000 Mooring	27 Arr.CCIW L. Ont. 1700 Analysis	28 CCIW	29 CCIW	30 CCIW
APR	31 CCIW	1 CCIW	2 Dep.CCIW L. Ont 0920 Side Scan &	3 Arr. CCIW L. Ont. 1500 Seismic Sur.	4 CCIW	5 CCIW	6 CCIW
	7 CCIW	8 CCIW	9 CCIW	10 CCIW	11 CCIW	12 CCIW	13 CCIW
	14 CCIW	15 CCIW	16 Dep. CCIW L. Ont 1025 Sedimentation	17 Arr.CCIW L. Ont. 1210 Velocity	18 CCIW	19 CCIW	20 CCIW
	21 CCIW	22 CCIW	23 CCIW	24 CCIW	25 CCIW	26 CCIW	27 CCIW
MAY	28 CCIW	29 CCIW	30 CCIW	1 CCIW	2 CCIW	3 CCIW	4 CCIW
	5 CCIW	6 CCIW	7 CCIW	8 Depart CCIW 0555	9 Georgian Bay &	10 Lake Huron	11 Moorings
	12 Georgian Bay &	13 Lake	14 Huron	15 Moorings	16 Georgian Bay &	17 Lake Huron	18 Moorings
	19 Arrive 1300 Owen Sound	20 Owen Sound	21 Depart 1442 Owen Sound	22 Georgian Bay	23 Seismic And	24 Coring Survey	25 Arrive 0655 Owen Sound
	26 Owen Sound	27 Transit	28 Transit	29 CCIW	30 CCIW	31 CCIW	1 CCIW
JUNE	2 CCIW	3 Depart 1055 CCIW	4 Lake	5 Erie	6 Sediment	7 Inventory	8 Lake
	9 Erie	10 Sediment	11 Inventory	12 Arrive 0010 CCIW	13 CCIW	14 CCIW	15 CCIW
	16 CCIW	17 Depart 1004 Sediment	18 Arrive 1440 Velocity	19 CCIW	20 CCIW	21 CCIW	22 CCIW
	23 CCIW	24 CCIW	25 CCIW	26 CCIW	27 CCIW	28 CCIW	29 CCIW
JULY	30 CCIW	1 CCIW	2 Depart 0909 CCIW	3 Sediment	4 Coring	5 Lake	6 Huron
	7 Arrive Owen 0707 Sound	8 Owen Sound	9 Depart Owen 0745 Sound	10 Georgian Bay	11 Sediment Survey	12 Arrive Owen 0113 Sound	13 Owen Sound
	14 Owen Sound	15 Owen Sound	16 Depart Owen 0450 Sound	17 Huron and	18 Georgian Bay	19 Moorings	20 Huron and
	21 Georgian Bay	22 Moorings	23 Arrive 0945 Goderich	24 Goderich	25 Goderich	26 Goderich	27 Goderich
AUG	28 Goderich	29 Depart 1600 Goderich	30 Huron	31 Georgian	1 Bay	2 Lake	3 Superior
	4 Toxic	5 Materials	6 Arrive Sault Ste 0500 Marie	7 Transit	8 Transit	9 CCIW	10 CCIW
	11 CCIW	12 CCIW	13 CCIW	14 CCIW	15 Depart CCIW Sediment	16 Arrive CCIW Velocity	17 Open House Toronto
	18 Open House Toronto	19 Depart 0917 CCIW	20 Lake	21 Ontario	22 Surveillance	23 Arrive 1615 CCIW	24 ---
	25 ---	26 ---	27 ---	28 DOWN TIME	29 ---	30 ---	31 ---
SEPT	1 ---	2 ---	3 ---	4 DOWN TIME	5 ---	6 ---	7 ---
	8 CCIW	9 Depart 1010 CCIW	10 Sediment Velocity Studies	11 Arrive 1545 CCIW	12 CCIW	13 CCIW	14 CCIW
	15 CCIW	16 Depart 0900 CCIW	17 Transit	18 Arr. Douglas Pt. 1100 Area	19 Moorings	20 Lake Huron	21 Transit
	22 Transit	23 Arrive 2010 CCIW	24 CCIW	25 CCIW	26 CCIW	27 CCIW	28 CCIW
OCT	29 CCIW	30 CCIW	1 CCIW	2 CCIW	3 CCIW	4 CCIW	5 CCIW
	6 CCIW	7 CCIW	8 CCIW	9 CCIW	10 CCIW	11 CCIW	12 CCIW
	13 CCIW	14 CCIW	15 Depart 0928 CCIW	16 Lake Ontario	17 Surveillance	18 Arrive 2120 CCIW	19 CCIW
	20 CCIW	21 Depart 1126 CCIW	22 Eng. Trials Lake Ontario	23 Arrive 0950 CCIW	24 CCIW	25 CCIW	26 CCIW
NOV	27 CCIW	28 CCIW	29 CCIW	30 CCIW	31 CCIW	1 CCIW	2 CCIW
	3 CCIW	4 CCIW	5 CCIW	6 CCIW	7 CCIW	8 CCIW	9 CCIW
	10 CCIW	11 Depart 1025 CCIW	12 Georgian Bay	13 Lake Huron	14 Moorings	15 Georgian Bay	16 Lake Huron
	17 Moorings	18 Georgian Bay	19 Lake Huron	20 Moorings	21 Georgian Bay	22 Lake Huron	23 Moorings
	24 Georgian Bay	25 Lake Huron	26 Moorings	27 Georgian Bay Lake Huron	28 Moorings	29 Arr. Goderich	30 Goderich
DEC	1 Goderich	2 Goderich	3 Goderich	4 Monitor	5 Georgian Bay &	6 Lake Huron	7 Monitor
	8 Georgian Bay	9 Lake Huron	10 Lake Erie	11 Lake Erie	12 Arr. CCIW	13 CCIW	14 CCIW
	15 CCIW	16 Dep. Lake 1400 Ontario	17 Moorings	18 Arr. CCIW 0300	19 CCIW	20 CCIW	21
	22	23	24	25	26	27	28

Table 6. Great Lakes Studies, MV MARTIN KARLSEN, 1974

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
JAN			1	2	3	4	5
	6	7	8	9	10	11	12
	13	14	15	16	17	18	19
	20	21	22	23	24	25	26
	27	28	29	30	31	1	2
FEB	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	1	2
MAR	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	29	30
APR	31	1 Depart 1210 CCIW	2 Shakedown Cruise	3 Lake Ontario	4 Arrive 1017 CCIW	5 CCIW	6 CCIW
	7 CCIW	8 Coring for Uni Wat	9 CCIW	10 CCIW	11 CCIW	12 CCIW	13 CCIW
	14 CCIW	15 CCIW	16 CCIW	17 CCIW	18 CCIW	19 CCIW	20 Open House CCIW
	21 Depart 0905 CCIW	22 Transit	23 Arr. Sarnia 0200 Dep. Sarnia 1500	24 Lake Huron	25 Survey	26 Lake Huron	27 Survey
MAY	28 Georgian Bay	29 Survey	30 Georgian Bay	1 Arrive 2240 Owen Sound	2 Depart 1030 Owen Sound	3 Arrive 0830 Sarnia	4 Sarnia
	5 Sarnia	6 Sarnia	7 Sarnia	8 Sarnia	9 Sarnia	10 Sarnia	11 Sarnia
	12 Sarnia	13 Depart 0930 Sarnia	14 Lake Huron	15 Survey	16 Lake Huron	17 Survey	18 Georgian Bay
	19 Survey	20 Georgian Bay	21 Survey	22 Arrive 2200 Owen Sound	23 Owen Sound	24 Owen Sound	25 Owen Sound
	26 Owen Sound	27 Owen Sound	28 Depart 1535 Owen Sound	29 Transit	30 Lake Superior	31 Coring	1 Lake Superior
JUNE	2 Coring	3 Lake Superior	4 Coring	5 Lake Superior	6 Coring	7 Lake Superior	8 Arrive 1610 Thunder Bay
	9 Thunder Bay	10 Thunder Bay	11 Depart 1405 Thunder Bay	12 Lake Superior	13 Coring	14 Arrive 0900 Thunder Bay	15 Transit
	16 Arrive 0845 Owen Sound	17 Depart 2117 Owen Sound	18 Georgian Bay	19 Survey	20 Georgian Bay	21 Survey	22 Georgian Bay
	23 Survey	24 Lake Huron	25 Survey	26 Lake Huron	27 Survey	28 Arrive 0715 Sarnia	29 Sarnia
JULY	30 Sarnia	1 Sarnia	2 Depart 1615 Sarnia	3 Lake Erie	4 Piston Coring	5 Lake Ontario	6 Piston Coring
	7 Lake Ontario	8 Arrive 1540 CCIW	9 Depart 0917 CCIW	10 Lake Ontario	11 Coring	12 Lake Ontario	13 Coring
	14 Lake Ontario	15 Coring	16 Arrive 0830 CCIW	17 Depart 1700 CCIW	18 Transit	19 Arrive 1500 Sarnia	20 Sarnia
	21 Sarnia	22 Depart 1510 Sarnia	23 Lake Huron	24 Survey	25 Lake Huron	26 Survey	27 Lake Huron
AUG	28 Lake Huron	29 Survey	30 Georgian Bay	31 Survey	1 Georgian Bay	2 Arr. 0405 Owen Dep. 1000 Sound	3 Transit
	4 Transit	5 Arrive 0200 CCIW	6 Depart 1210 CCIW	7 Lake Ontario	8 Survey	9 Arrive 0130 CCIW	10 CCIW
	11 CCIW	12 Depart 1055 CCIW	13 Lake Ontario	14 Monitor	15 Lake Ontario	16 Arrive 1820 CCIW	17 CCIW
	18 CCIW	19 CCIW	20 Depart 1730 CCIW	21 Lake Erie	22 Survey	23 Lake Erie	24 Survey
	25 Lake Erie	26 Arrive 0235 CCIW	27 Lake Huron	28 Survey	29 Lake Huron	30 Survey	31 Georgian Bay
SEPT	1 Survey	2 Georgian Bay	3 Survey	4 Georgian Bay	5 Arr. 0905 Owen Dep. 1300 Sound	6 Arrive 1500 Sarnia	7 Sarnia
	8 Sarnia	9 Sarnia	10 Sarnia	11 Sarnia	12 Transit	13 Transit	14 Transit
	15 Arrive 0200 CCIW	16 CCIW	17 CCIW	18 CCIW	19 CCIW	20 CCIW	21 CCIW
	22 CCIW	23 CCIW	24 CCIW	25 Depart 0900 CCIW	26 Transit	27 Arrive 0200 Sarnia	28 Sarnia
OCT	29 Sarnia	30 Depart 1400 Sarnia	1 Lake Huron	2 Survey	3 Lake Huron	4 Survey	5 Lake Huron
	6 Georgian Bay	7 Survey	8 Georgian Bay	9 Survey	10 Georgian Bay	11 Arr. 0830 Owen Dep. 1400 Sound	12 Transit
	13 Transit	14 Arrive 0230 CCIW	15 Dismantle Ship	16 Dismantle Ship	17 Dismantle Ship	18 Depart 1930 CCIW	19 Transit
	20 Transit	21	22	23	24	25	26
NOV	27	28	29	30 CFF CHARTER	31	1	2
	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	29	30
DEC	1	2	3	4	5	6	7
	8	9	10	11	12	13	14
	15	16	17	18	19	20	21
	22	23	24	25	26	27	28

Table 7. Great Lakes Studies, HMCS PORTE DAUPHINE, 1974

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
JAN			1	2	3	4	5
	6	7	8	9	10	11	12
	13	14	15	16	17	18	19
	20	21	22	23	24	25	26
FEB	27	28	29	30	31	1	2
	3	4	5	6	7	8	9
	1	11	12	13	14	15	16
	17	18	19	20	21	22	23
MAR	24	25	26	27	28	1	2
	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20	2	22	23
	24	25	26	27	28	29	30
APR	31	1	2	3	4	5	6
	7	8	9	10	11	12	13
	14	15	16 Depart 1220 CCIW	17 Lake Ontario	18 Surveillance	19 Lake Ontario	20 Arrive 0220 CCIW
	21	22 Depart 0930 CCIW	23 Lake Erie	24 Surveillance	25 Lake Erie	26 Surveillance	27 Arrive 2319 CCIW
MAY	28	29 Depart 1235 CCIW	30 Lake Ontario	1 Surveillance	2 Lake Ontario	3 Arrive 0230 CCIW	4
	5	6	7	8	9	10	11
	12	13 Depart 0930 CCIW	14 Lake Ontario	15 Surveillance	16 Lake Ontario	17 Arrive 0030 CCIW	18
	19	20	21	22	23	24	25
	26	27	28	29	30	31	1
JUNE	2	3 Depart 1010 CCIW	4 Lake Ontario	5 Surveillance	6 Lake Ontario	7 Arrive 1735 CCIW	8
	9	10	11	12	13 NTA Hamil. Harbour	14	15
	16	17 Depart 0908 CCIW	18 Lake Ontario	19 Surveillance	20 Lake Ontario	21 Arrive 1600 CCIW	22
	23	24 Dep. 0840 Arr. 1930 CCIW	25 NTA Western L. Ont.	26	27	28	29
JULY	30	1	2 Depart 0900 CCIW	3 Lake Ontario	4 Surveillance	5 Arrive 1500 CCIW	6
	7	8	9 Depart 0900 CCIW	10 Transit	11 Transit	12 Transit	13 Arrive 0900 Red Rock
	14 Point	15 Source	16 And	17 Heat	18 Studies	19 Lake	20 Superior
	21 Point	22 Source	23 And	24 Heat	25 Studies	26 Lake	27 Superior
AUG	28 Point	29 Source	30 And	31 Heat	1 Studies	2 Lake	3 Superior
	4 Point	5 Source	6 And	7 Heat	8 Studies	9 Lake Superior	10 Depart 0600 Red Rock
	11 Transit	12 Transit	13 Transit	14 Arrive 0100 CCIW	15	16	17
	18	19	20	21	22	23	24
	25	26	27	28	29	30	31
SEPT	1	2	3 Depart 1400 CCIW	4 Lake Ontario	5 Surveillance	6 Arrive 2320 CCIW	7
	8	9	10	11	12	13	14
	15	16 Depart 0900 CCIW	17 Lake	18 Ontario	19 Surveillance	20 Arrive 0600 CCIW	21
	22	23	24	25	26	27	28
OCT	29	30 Depart 0935 CCIW	1 Lake Ontario	2 Surveillance	3 Lake Ontario	4 Surveillance	5 Arrive 0020 CCIW
	6	7	8	9	10	11	12
	13	14	15	16	17	18	19
	20	21	22	23	24 Depart 1230 CCIW	25 Dry Dock	26 Port Weller
NOV	27 Dry Dock	28 Port Weller	29 Dry Dock	30 Arrive 2050 CCIW	31	1	2
	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25 Depart 1005 CCIW	26 Lake Ontario	27 Surveillance	28 Arrive 2125 CCIW	29	30
DEC	1	2	3	4	5	6	7
	8	9	10	11	12	13	14
	15	16 Depart 0945 CCIW	17 Lake Ontario	18 Surveillance	19 Arrive 1540 CCIW	20	21
	22	23	24	25	26	27	28

Nanticoke – a point source study on the effects of electric generating plants, primarily waste heat discharge upon the Great Lakes ecosystem,

Quinte – a study at the Bay of Quinte, Lake Ontario, on the biogeochemical processes in lakes, and

Kamloops – a joint federal-provincial study on the physical, chemical and biological processes of a small lake– Kamloops Lake, B.C.

REMOTE SENSING SECTION

During 1974, the Remote Sensing Section conducted programs centred on airborne photographic and infrared reconnaissance, satellite data evaluation and retransmission, lake optics, and sensor evaluation. Targets for intensive study included the Great Lakes and surrounding basin, Lake Winnipeg, the Nanticoke Power Generating Station, the Red Rock Pulp Mill, the Point Pelee and Rondeau landforms, Cootes Paradise and Lake St. Clair. Some of the pertinent results of these remote

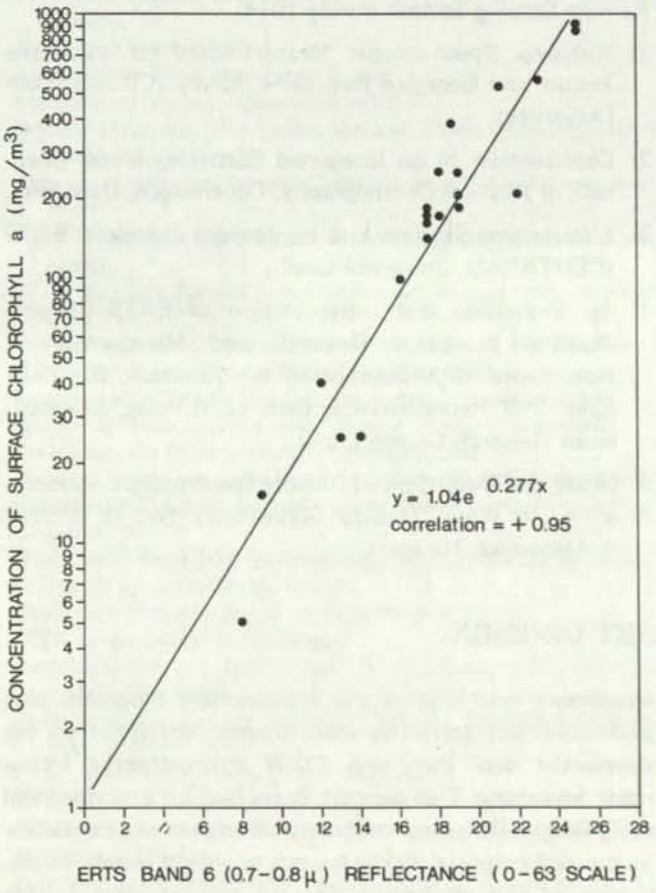


Figure 4. Correlation between ERTS-1 Band 6 (0.7-0.8μ) reflectance values and the concentration of surface chlorophyll *a*.

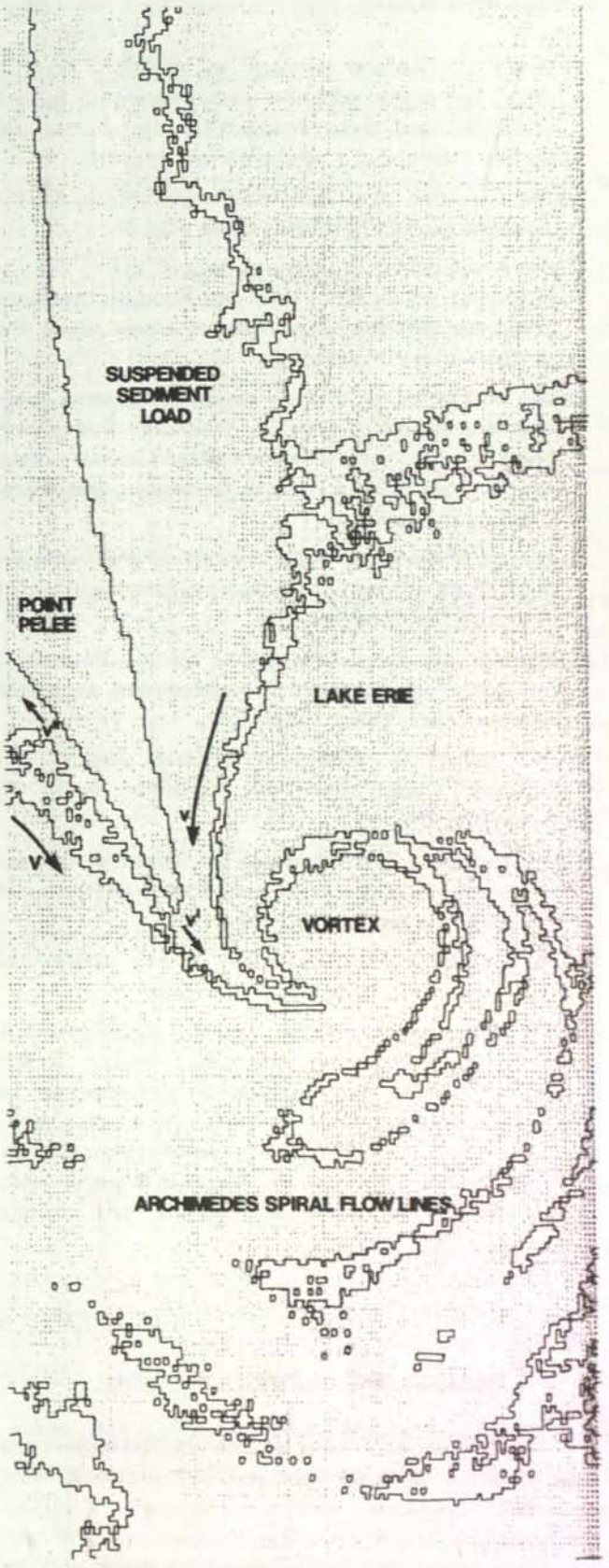


Figure 5. ERTS-1 observation of Archimedes spiral/vortex geophysical formation off Point Pelee in Lake Erie.

sensing studies include

1) direct correlations between the ERTS-1 Band 5 (0.6-0.7μ) digital data and surface turbidity; Band 6 (0.7-0.8μ) and Band 7 (0.8-1.1μ) digital data and surface chlorophyll *a* concentrations (Fig. 4),
2) the indication of a "back-flow model" theory for the temporal evolution of Point Pelee (Fig. 5),
3) the development of a "mirror-image" theory for the generation of the Point Pelee and Rondeau landforms based on bifurcated sediment transport along the northern shore of Lake Erie,
4) the delineation of distinct sediment transport zones in the Lake Huron-Lake St. Clair-Lake Erie system and the consistency between transport avenues determined from remote sensing techniques and shore-profiling networks,
5) the generation of maps delineating the temporal dependence of the optical transmission properties of several of the Great Lakes,
6) progress in correlating water quality data with intrinsic remotely sensed parameters (such as volume reflectance and colour indices),
7) the ability to distinguish between organic and inorganic loading using the Kullenberg scattering meter (Fig. 6),
8) the Nanticoke thermal plume was localized in space and displayed a maximum temperature difference of 7°C from the ambient lake waters,
9) the meteorologic dependence of the wastewater plume emanating from Red Rock, and
10) the Data Communications Package (DCP) network study, initiated as an interaction vehicle in the ERTS-1 satellite, was extended to applications to the GOES satellite and the proposed all-Canadian satellite. Progress has been made in establishing an agreement between DOE and the National Oceanographic and Atmospheric Administration (NOAA) in this regard.

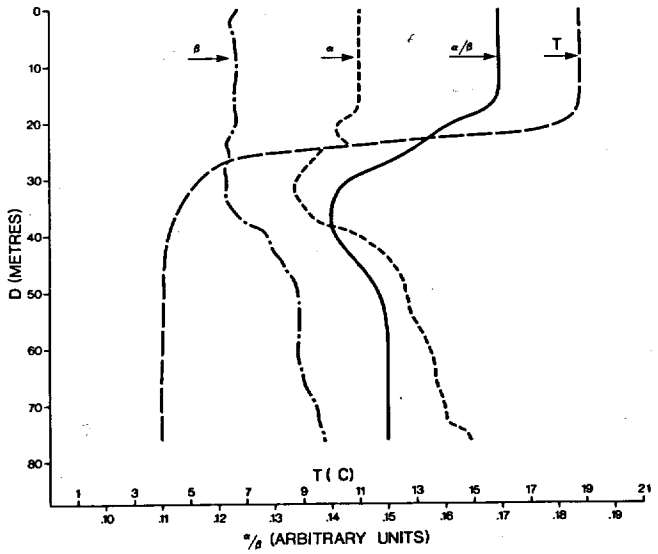


Figure 6. Typical scattering, transmission, temperature and α/β depth profiles in Georgian Bay.

During 1974, Dr. K.P.B. Thomson left his position as Acting Section Head to join the Applications Division of the Canada Centre for Remote Sensing in Ottawa.

The following contracts were monitored by the Remote Sensing Section during 1974:

1) Airborne Spectroscopic Measurements for the Lake Huron and Georgian Bay 1974 Survey (CRESS, York University),
2) Construction of an Integrated Scattering Meter (Institute of Physical Oceanography, Copenhagen, Denmark),
3) L'étude limnologique avec les données digitales d'ERTS (CENTREAU, Université Laval),
4) An Evaluation and Interpretation of ERTS Imagery Relating to Lakes Research and Management in Accordance with Submission for Research, Big Quill Lake IHD Representation Basis (J. Whiting, Saskatchewan Research Council), and
5) Study and Evaluation of Remote Spectroscopic Measurements in Water Quality Surveillance (W. R. McNeil & Associates, Toronto).

SCIENTIFIC SUPPORT DIVISION

ENGINEERING SERVICES SECTION

The Engineering Services Section provides engineering support services to all divisions at CCIW, including those not in IWD.

These services emphasize innovative design and development engineering initiated both in the Section and as requested by the scientific users. Also featured are various equipment modification and improvement programs, plus preventive and corrective maintenance performed on the substantial and increasing CCIW environmental instrument inventory. This support is centred on a professional design-engineering and maintenance-engineering capability in the technological fields related to inland waters instrumentation and equipment. Services also provided include technical drafting, illustrating, equipment-testing, instrument calibration, machine-shop prototype manufacture,

and technical supervision of procurements from Canadian industry.

Shown in Table 8 is a list of significant activities performed in the Engineering Services Section during 1974. Some highlights of the projects that were completed with major impact on other areas are outlined. Many projects, still underway or in the initiation stages, are not mentioned. No attempt has been made to group projects according to the two Units within the Engineering Services Section because many, if not most, were realized through a co-operative effort.

Table 8. Summary of Engineering Systems, Projects and Services for 1974

Acoustic Bed-Load Transport Monitor (for river system studies)
Moored FTP Systems (increased to 9 systems; winter and summer configurations)
Special Low Cross Section Towers
MDIR System (reconfiguration for fish-monitoring)
Standard Submersible Battery Power Supply Design (primary and secondary)
In Situ Interstitial Water Sampler
Programmed Fluorescent Dimming Systems (further expansion of the 1972-1973 programs)
CCIW EBT Systems (ES-007/Engineering Rationalization Program), quantity: 7
Automated Water Sampling
Aquatic Biota Photo-stimulation System
Improved Instrument Calibration Facilities
Satellite-Telemetry Monitoring Systems (Lake Winnipeg, GOES Satellite), quantity: 2
Accurate Calibration Services (temperature, pressure, conductivity *et al*)
CCIW Timelapse Photo-logger Systems (underwater and above water)
CCIW Acoustic Release Units (improvement program), increased from 7 to 24
In Situ Fluorometer (study-improvement program), dye diffusion
Specialized Coring Devices (Point Pelee; light weight)
Environmental Data Storage Modules (survey of magtape units)
Moored Metbuoy Systems, with Sensors (inventory 22 systems)
Comprehensive Extensive Maintenance Operations
Moored Current-Measuring Buoys, quantity: 90 self-recording units
Acoustically Triggered Bottom Camera System (application at Point Pelee)
Wind-Wave Flume Data Acquisition System (continued consulting)
Crystal Temperature-Sensor Module
Flumes for Hydraulic Studies in Cold Room Trials
CCIW Transmissometer Technology
Auto-sequencer and DO-Profiling Winch System (in-house lake-column simulators)
Electromagnetic Current Sensors (Technical Evaluation Program, Point Pelee)
CCIW Active Towed-Body System Engineering
Electro-optical Measurements Facility
Fish Population Density Monitor System (acoustic echo analysis)
Recirculating Flume
Portable Towed Temperature Profiling System (shallow water FRB system)
Solid-State Relative Humidity Sensor Module
Conductivity Sensor Technology
Multichannel (multiparameter) Environmental Monitoring System Development
Diode-Matrix Sequencer Unit
Extensive Illustration Services
Standard CCIW Digital Integrator Module
Signal Conditioning System for Boundary Layer Data Analysis
In Situ Temperature Recorders
Towed Temperature-Profiling (ADDS) System (testing, calibration, maintenance)
Towed Radioactivity Bottom-Tracer Detection System (less navigation equipment)
CCIW Turbidity Measurement Techniques
CCIW Divers Sonic Communication and Location Techniques
Auto-sequenced Profiling Winch System with Pumping
Fish-Tracking Biotelemetry System
Sidescan Sonar System Upgrade
Acoustic Pebble Tracking Technology

SYSTEMS, PROJECTS AND SERVICES—1974

Aquatic Biota Photo-stimulator (Project BL011)

Late in 1973, design engineering commenced to develop a functionally flexible photo-radiation system for use by Great Lakes Biolimnology Laboratory (GLBL) biologists in studying the photo-responses of aquatic invertebrates and other biotic specimens. Early in 1974, this system was defined, specified, procured, assembled, tested, and installed in the environmental toxicology laboratory. It can transmit into biotic test chambers incident light radiation of a wide intensity range (50db); varying radiation incidence (vertical to horizontal); and fully controlled spectral distribution (monochromatic to polychromatic).

Bed-Load Transport Acoustic Monitor (Project HY011)

An important measurement problem in river system studies is the movement or transport of riverbed material. In this connection, it has been hypothesized that the underwater noise patterns produced by such bed-load movement may be recognizable, and characteristic. To aid these studies, a special low-drag wide-bandwidth acoustic recording system was engineered during 1974. Figure 7 shows this system, which recorded considerable acoustic field data in spring runoff conditions. These river noise recordings are being analyzed by CCIW Hydraulics staff, and an unpublished report has been prepared on the system.

Sediment Dynamics, Point Pelee (Project LR071)

This project concerned the determination of the causes of erosion of Point Pelee. An Alpine Vibracorer was leased to obtain sand cores in the vicinity and Engineering Services helped in its deployment. Experience gained has since been applied to the modification of the CCIW Jackhammer corer. Also required for the project were four

electromagnetic current meters mounted close to the lake bottom. Special support structures were designed and built for these meters and were installed by using a water-jetting technique. To enable the Radiochemistry group to measure sediment transport using radioactive tracers, prototype equipment was designed, built and field-tested for depositing and tracking the radioactive material using a scintillation detection unit. Particular care was taken with respect to safety in handling the tracer material (Fig. 8). Several sand traps were also designed and manufactured, and a diver-operated vacuum cleaner was constructed for collecting the sand samples.

Acoustically Triggered Underwater Photo-system (Project LR070)

Frequently CCIW geolimnological studies of lake sediments require photo-images of the bottom regions where core samples are taken. These necessitate a method of repeatedly taking bottom photographs at a known, short distance from the bottom, without making contact; a short-range acoustic depth sounder was used, with an adjustable digital threshold and bottom-lock facility so that bottom exposures were taken on the descent at a known, preset height above the sediments. The entire photo-system was completed this year (Fig. 9) and used intensively during the Point Pelee studies.

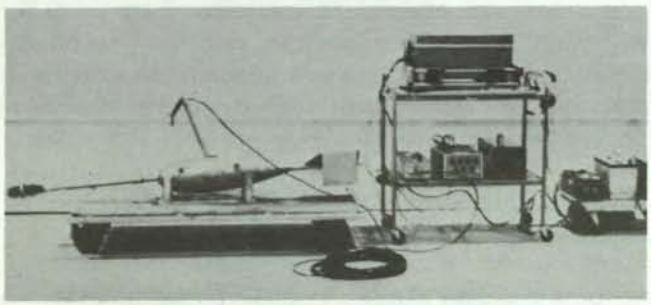


Figure 7. Bed-load transport acoustic monitoring system.

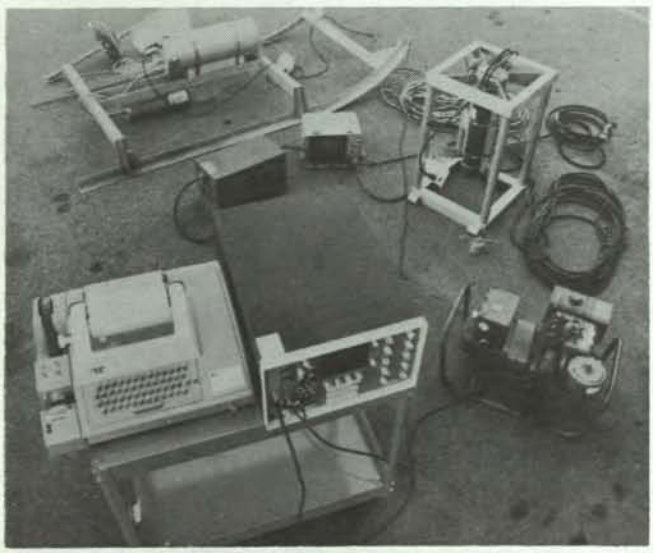


Figure 8. Prototype neutron-activated sediment-tracking system.

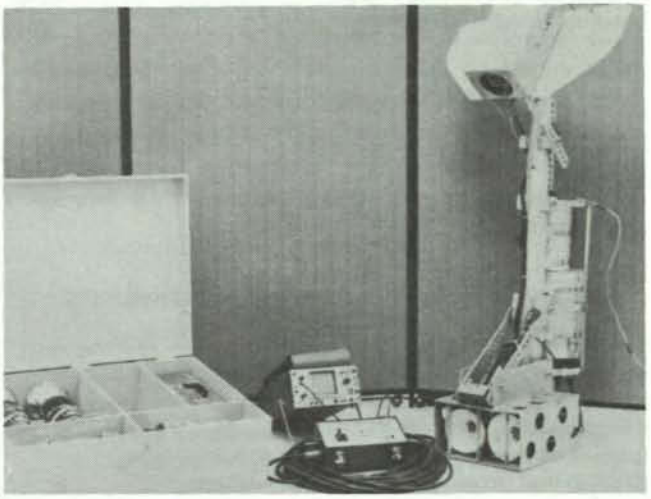


Figure 9. Acoustically triggered underwater photo-system.

Portable Towed Thermistor Array System (Project BL017)

To establish clearly the thermal regime in areas being studied by GLBL, a portable 8-channel temperature-recording system to be towed by small boats was required. This system (Fig. 10), largely created from standard CCIW modules, features a light-weight V-fin towbody, high-speed resistive sensors, a locally made electromechanical cable assembly, and a multistylus analog display. Very good results were obtained.

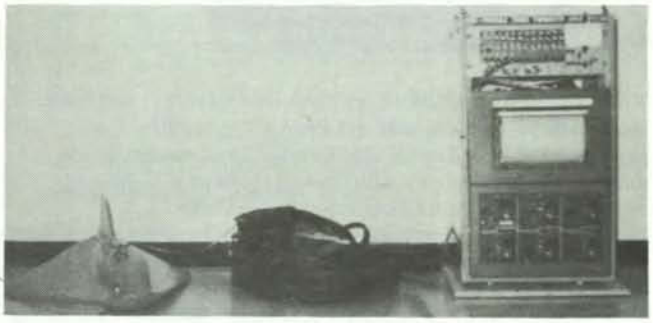


Figure 10. Portable towed thermistor array system for GLBL studies.

Wind-Generated Waves (Project LR070)

Engineering participation in this project was to obtain some fundamental design criteria for lake towers, i.e., dynamic loads under storm conditions. This was necessary because of the failure of two towers in Lake Ontario during 1973. Two types of towers were tested: the first is a cylindrical column with a base that can be floated to the site and sunk in position and the second is an aluminum lattice-type (Millard) structure. Both towers

were installed off Burlington Beach and instrumented by Orenda ($12,000 contract) with strain gauges and accelerometers. A computer dynamic analysis program using the data obtained from the tests is now being prepared in conjunction with Multiple Access ($7000 contract). Figure 11 shows the towers installed.

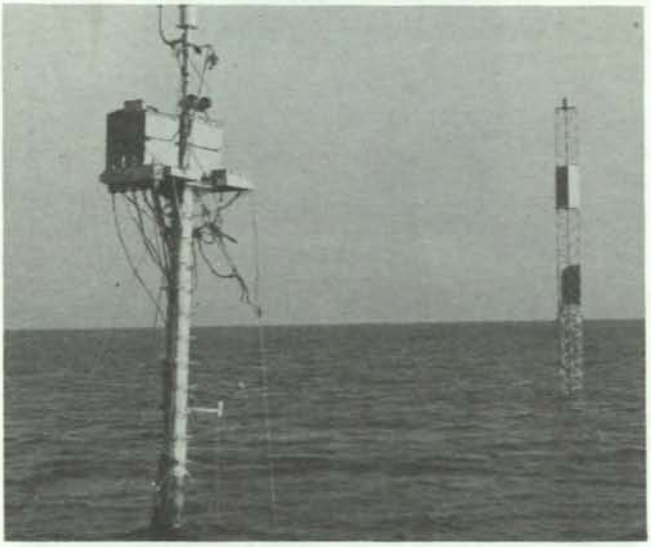


Figure 11. Towers under environmental test.

A contract was awarded to Whitman-Benn Associates to design a portable independent platform, which includes, in addition to the actual tower structure, a telemetry system. This contract, valued at $21,000, will enable Engineering Services to provide a standard tower for use in the Great Lakes and similar bodies of water in support of scientific study programs.

Portable Towed *In Situ* Fluorometer System (Project LR011A)

The prediction of the movement of liquid pollutants in Canadian lakes and rivers is helped by experiments involving the controlled release of an artificial tracer liquid such as rhodamine dye. The subsequent distribution and concentration of this dye tracer are readily measured by detecting its fluorescence when optically stimulated. A simple system, comprising an improved underwater fluorometer, towing winch, and multichannel chart displays, was completed and tested satisfactorily during the year (Fig. 12).

Towed Underwater Platform (Project ES-4)

The use of ships and staff, and the compatability of data obtained from different parts of a lake would be increased if instruments could be towed continuously at high speed or if samples of water could be collected continuously across a lake. In a survey of existing towed bodies, the Batfish, developed by the Bedford Institute of

Towing winch

Multi-sensor display

Tow-body with sensors

Figure 12. Portable towed *in situ* fluorometer system.

Oceanography, Halifax, was selected as the most suitable towed body. A study on how to increase the payload of the actual body resulted in an additional pod being attached to the belly of the Batfish, and this configuration was lake-tested with excellent results. The design of a pumping system for the Batfish has been completed; the components of this system will be available for testing in 1975. Initial consideration has been given to a dynamic study of the towed platform so that the effect of changes to the system can be quickly determined. Also, a bottom-following device is being designed for the Batfish in order that it can be towed within several metres from the lake bottom (Fig. 13).

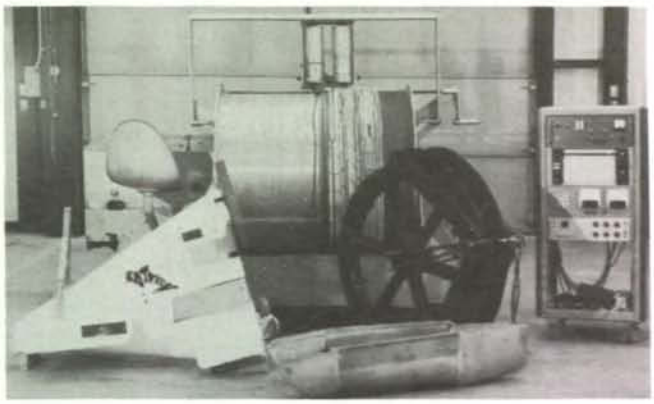


Figure 13. Active towed body, Batfish.

Sonic Fishtags and Biotelemetry (Project EL017 *et al*)

In 1974, for the first time at CCIW, a limited engineering effort was applied to biotelemetry, particularly to the evaluation of specifications and the use of sonic fishtags. This work was in support of both the GLBL and Wheatley research station programs, mainly in connection with the Nanticoke studies. Such fishtags, when used along

with shipboard tracking receivers, provide valuable data on fish-life behaviour in different near-shore zones.

Electro-optical Measurements Laboratory (Project SSD014)

One of the Scientific Support Division's projects was the establishment of an electro-optical measurements laboratory, with appropriate staff capability. This provides a hardware-oriented engineering support to the considerable inventory of CCIW optical limnology equipment and a design capability and industrial overview with respect to electro-optical instrumentation. In late 1974, this project was completed. Figure 14 shows typical CCIW photodetector instruments undergoing performance tests in the laboratory.

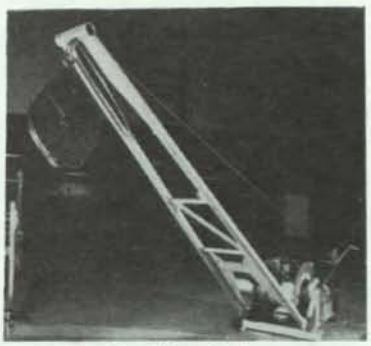
Figure 14. Tests on submersible photometric instruments in Electro-optical Measurements Laboratory.

Automated Water Sampling (Project WQ 16)

Since the need for a 48-hour cycle, variable interval water-sampling system could not be met by existing commercial units, it was designed and built at CCIW. The system enables water to be pumped from a lake or river to the shore where it is collected in 24 sterile bottles. Contamination of each discrete water sample is avoided by having the supply of sample water pumped continuously, so that no residual water from a previous sample can remain in the supply line. The prototype unit is presently operating on the Niagara River where it will be evaluated for winter sampling.

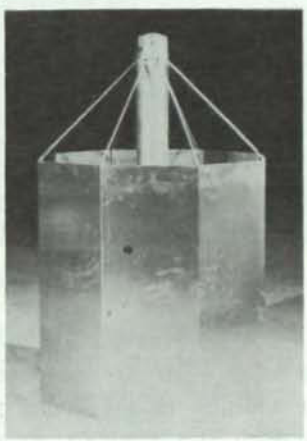
Kamloops Lake Regional Study Instrumentation (Project LR067)

In 1974, a major regional multidisciplined environmental study was conducted at Kamloops Lake, B.C., and its adjacent Thompson and Fraser River sections. In support of this program, CCIW Engineering Services specified, prepared, tested and dispatched the following major shipment of environmental measuring instrumentation: 4 fixed temperature profiling (FTP) systems; 2 shore-based metpack systems; 4 submersible digital recorders; and 1 turbidity-temperature profiling system, as well as spares. Figure 15 shows the latter system, complete with sensor cage, profiling winch, remote control units and system displays.



Profiling winch

System displays



Sensor cage

Figure 15. Temperature-turbidity-depth profiling system.

Improved Instrument Calibration Facilities (Project SSD003)

Some limited work was done in 1974 with respect to improved CCIW calibration facilities for electronic instruments used for inland waters research. Existing in-house facilities, such as for depth, pressure, temperature, were augmented to include *in situ* conductivity and boundary-layer relative humidity (Fig. 16). In many instances, of course, such work is contracted to Canadian industry (e.g., underwater acoustic calibrations).

In Situ Interstitial Water Sampler (Project LR072)

In the past at CCIW, interstitial water has been obtained by taking a sediment core sample and squeezing it to remove the water. Since it is known that both temperature and time can affect the composition of the interstitial water in the core, a new sampler was designed to extract the interstitial water *in situ* directly from the sediment. The principle was originally evolved by the Woods Hole Oceanographic Institute and has been adapted to our application. The sampler is shown in Figure 17.

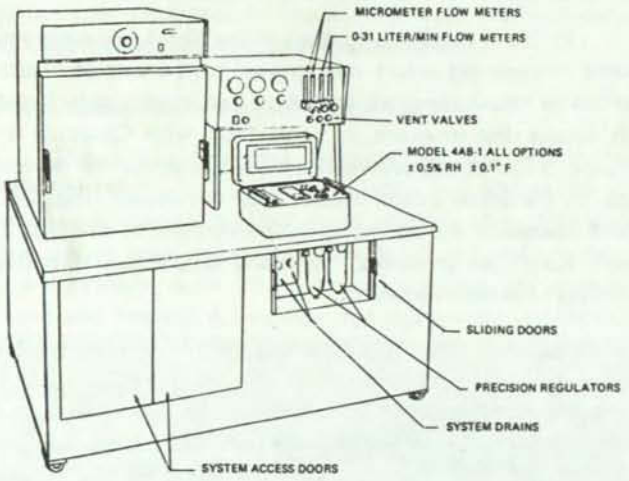


Figure 16. Improved instrument calibration facilities.

Acoustic Fish-Censusing Systems (Project BL017)

For GLBL biologists, considerable engineering effort was applied to prototyping an improved acoustic echo analysis system that could obtain higher resolution data on inland waters fish stocks, their distribution and variations. This prototype system was completely designed and developed during 1974 (Fig. 18). It features a directive acoustic transducer with over-the-side mounting rig; ultrasonic transceiver; fibre-optics intensity display; hardcopy digital printout; digital magtape storage; and a digital-logic echo analysis unit with full operator controls. This prototype system was extensively used on the CCIW ship AQUA in Lakes Superior and Erie, against both natural fish populations and standard geometric targets for *in situ* system calibration.

While this development was underway, a similar prototype system was required by OMNR biologists at Wheatley research station. This second system was also prototyped using system engineering services from Canadian industry, installed on Wheatley's vessel KEENOSAY and regularly used this field season.

Hydraulics Division Ice-Wave Flume (Project 4-IW-HY009)

This flume consists of a wave-generating apparatus mounted in a trough to produce waves of desired amplitude and frequency. The flume has a 4-metre long working section with temperature-controlled windows for observation purposes. Connected to the flume is an insulated cold-water reservoir with full pumping facilities. Design of the flume was started during 1973, but the unit has now been built and tested in co-operation with Hydraulics personnel (Fig. 19).

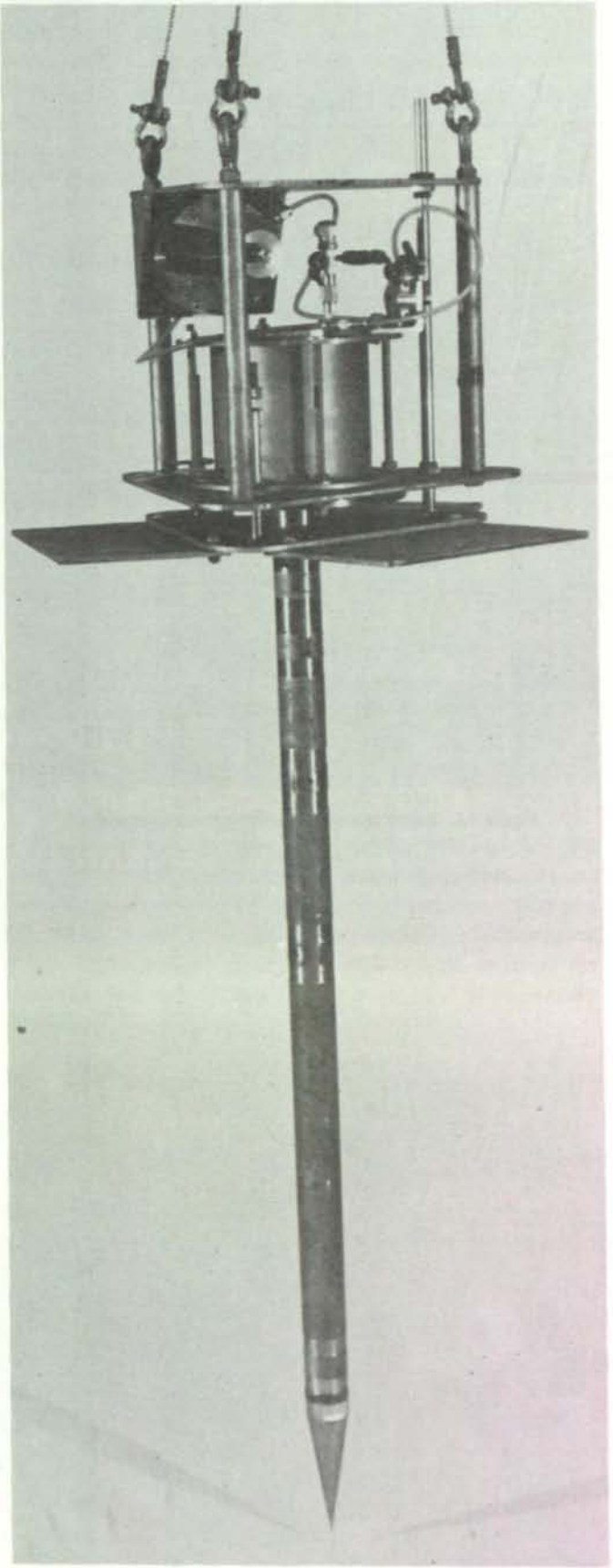


Figure 17. Interstitial water sampler.

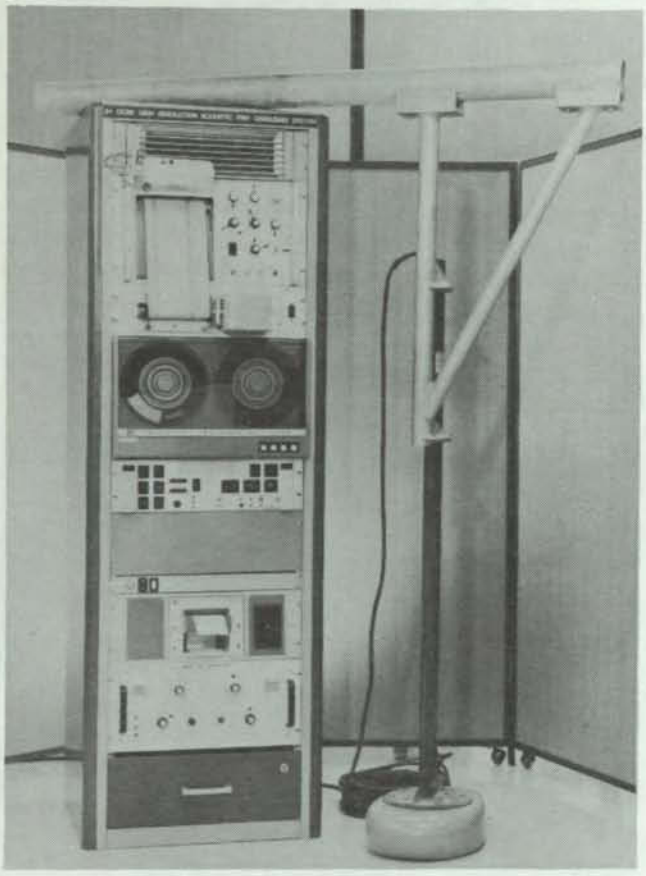


Figure 18. Prototype acoustic fish-censusing system.

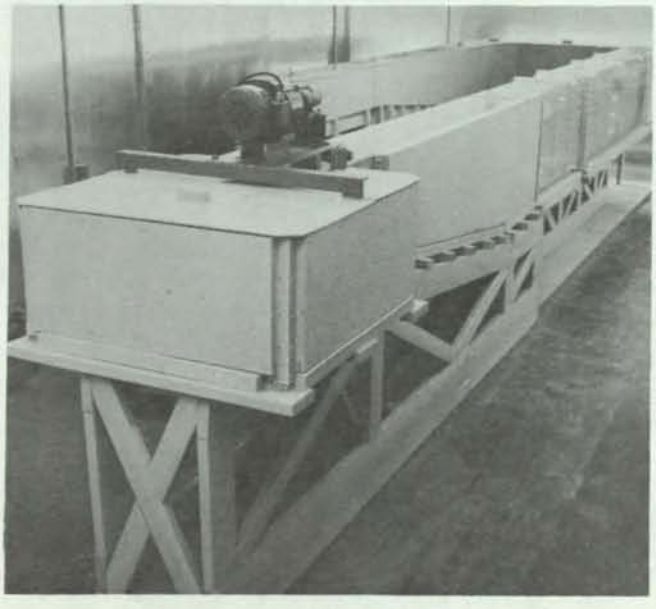


Figure 19. Flume for cold conditions studies.

CCIW Submersible Turbidimeters (Project LR067)

In 1974, chiefly in support of the Kamloops program, some engineering effort was applied to the area of *in situ* turbidity monitoring, which before had been largely based on Secchi disc methods. In association with Canadian industry, a low-power wide-range turbidity sensor for general use in Canadian inland waters was developed (Fig. 20). Both manually and remotely scaled versions of this instrument have been produced, and many satisfactory turbidity profiles have been recorded.

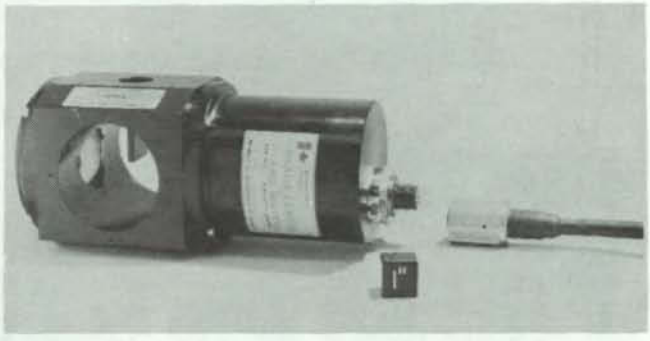


Figure 20. Submersible turbidity sensor developed in co-operation with Canadian industry.

Hitachi Mass Spectrometer Improvement Program

As part of the normal instrumentation improvement and modification program, engineering effort was expended to reduce system self-noise and residual drift (correspondingly increasing the analysis detection limits) and to improve the overall performance of the Hitachi/Perkin Elmer RM6-U mass spectrometer system (Fig. 21) in the Analytical Methods Research Section. This work included programmable EHV power supply for the ion-accelerator; stable 5-kV voltage for the electron-multiplier, solid-state femtoamp electrometer preamplifier; improved

Figure 21. Incorporation of improved system modules to CCIW Hitachi mass spectrometer installation.

Gaussian filtering of the spectral signal; and low-noise buffering to the computer input. Preliminary results show a noticeable reduction in system noise and drift.

Recirculating Flume (Project 4-IW-HY010)

The flume has been designed for the Hydraulics Division, which will be studying the flow behaviour of water under winter conditions. It consists of an 11-metre long trough working section with insulation and temperature-controlled walls; the viewing windows are double-glazed and heated. A headbox and tailbox are installed at the ends of the working section, and water is recirculated by a pumping system. Above the working section is a wind tunnel for studying the effects of wind on heat exchange and ice behaviour. The flume is pivoted at one end so that it can be tilted by electrically driven jacks up to a maximum slope of 3%. A contract for the manufacture and installation of the flume has been awarded.

Air-Water Interaction (Micromet) Systems (Project LR033)

During 1974, the engineering effort was applied to this system with respect to the 1972 (IFYGL) model and the forthcoming (1975) configuration. For the IFYGL, the system was necessary for the optimal analysis of the Turbulence Subsystem field data, which are composed of many 4-track and 7-track field tapes. Considerable effort was directed to the area of tape-speed auto-compensation; 16-channel demultiplexers; phase/amp response of Bessel filters; and time-decode comparator to provide a flexible installation whereby up to 24 channels of wide-band turbulence data could be digitized prior to PDP-15 computer analysis (Fig. 22).

Figure 22. Electronic instrumentation for pre-processing IFYGL Micromet turbulence field data.

Transponding Acoustic Pebbles (Project LR021)

During 1974, a new technique was added to those used at CCIW for measuring the storm-induced movement of lakebed and riverbed material. This technique, essentially a tracer method, involves the use of acoustically transponding "pebbles" of natural size, shape, density, and surface roughness, intermixed with natural pebbles or shingle (Fig. 23). Field-monitoring involves a CCIW launch equipped with regular sidescan sonar. The sidescan triggers a response from the acoustic pebble, which is displayed as an intense echo-mark on the sidescan display. Various navigation references are possible, but the reference used in 1974 was two fixed similar "benchmark" transponders driven into the bottom.

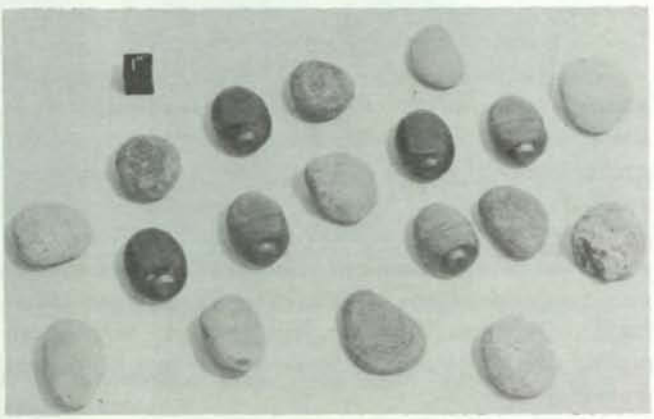


Figure 23. Acoustic transponding and natural pebbles.

Drafting and Illustration

The Drafting and Illustration group provides drafting services to all divisions in support of research programs at CCIW.

These services include: mechanical drawings for the manufacture and development of scientific instruments and related equipment; electronic schematic and block diagrams for instrumentation systems; approximately 2000 charts, graphs, cartographic maps and illustrations required for scientific and engineering publications, and photographic slides for seminars and conference commitments.

Maintenance, Repair and Calibration of CCIW Instrument Inventory (Project SSD003)

The Maintenance and Calibration group provides the CCIW scientific and technical community with instrumentation services encompassing incoming inspection, preventive maintenance, equipment modification and improvement, fault diagnosis, corrective maintenance, performance-testing and instrument calibration.

Equipment functional areas are
—electrochemical and analytical instrumentation,
—underwater data acquisition systems,
—electronic test equipment and instruments,
—basic standards and calibration, and
—contract technical supervision.

Servicing of some 1500 items of common-user equipment, worth approximately $3 million, continued during

the year. About 250 internal Work Orders covering non-standard requirements were processed in support of various scientific groups at CCIW. As well as to the Glaciology Division, DOE, some limited support was provided to outside agencies, such as Ontario Hydro and the Ontario Water Resources Commission, which were working on common programs with CCIW scientists in areas in which CCIW has the only high-accuracy calibration facility.

In accordance with federal policy, a considerable amount (approximately $200,000) of maintenance work was contracted out to Canadian industry, e.g., a CGE contract for $149,000. This is near the optimum for contract maintenance, since a contract should cover a reasonable quantity of relatively standard commercial equipment to be economical. These contracts covered such instrumentation items as current meters, digital data-loggers, Teletypes, boundary-layer sensors, temperature probes, chart recorders, radiation sensors and digital test units (Fig. 24).

Figure 24. Inland waters self-recording instruments under maintenance of Canadian industry.

An important continuing function is the checking and modification of the large amount of prototype equipment and of the systems developed and serviced during the year that are required to meet Ontario Hydro standards, and thus ensure the safety of CCIW personnel.

In mechanical engineering, a large proportion of the work in the workshops is devoted to the maintenance and repair of instruments and related equipment. Typical equipment includes corers, water-sampling devices, numerous types of pumps, electric motors and drives, towers and special winches. Preventive maintenance is always applied wherever possible to reduce down-time while in the field. Modifications are also made to equipment for a wide variety of reasons, such as better reliability, accuracy and safety, as determined necessary from field and laboratory experience. Other services offered are pressure-testing facilities for underwater equipment and a common-user workshop with light machinery, tools, and assistance available to CCIW staff.

Standard Submersible Power Supplies

In conjunction with Canadian industry, a standard battery module was developed for general application in a wide range of underwater measuring and recording systems and limnological instruments. This design achieves considerable flexibility in use, both electrically and mechanically, since various supply voltages and energy capacities can be readily generated, as different equipment or missions may require. Shown in Figure 25 are both the basic battery module itself and its packaged configuration for submersion in Canadian inland waters. Both the battery module and the underwater package are readily available in Canada.

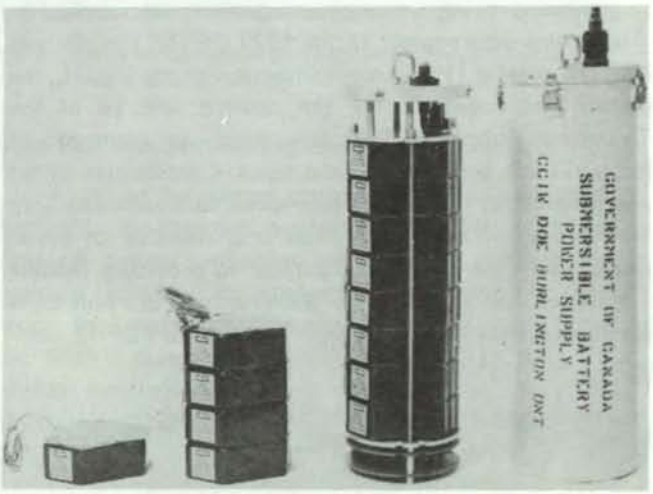


Figure 25. Configuration of the CCIW standard submersible power supply.

Auto-controlled Daylight Simulators (Project BL010)

To an increasing extent, CCIW laboratory experiments involving plant-life and animal-life processes require some degree of controlled daylight radiation to simulate natural conditions better. For this purpose, a portable, modular, controlled radiation system had previously been designed and developed in conjunction with Canadian industry. During the year, the fourth CCIW version of this system was assembled, tested, and installed in one of the environmental toxicology laboratories. Figure 26 shows the various system modules prior to installation.

Fixed Temperature Profiling (FTP) Systems

In 1974, these moored systems evolved from being an item under development to an accepted standard CCIW

measurement tool. Simultaneously, expanded scientific studies necessitated additional purchases of data-loggers, sensors, cable assemblies, and test units to increase the operating inventory from 4 (in 1973) to 9. These 21-channel digital recording thermistor-chain systems were deployed in Lake Ontario, Lake Huron and Kamloops Lake. A satisfactory data recovery factor (about 90%) has been achieved.

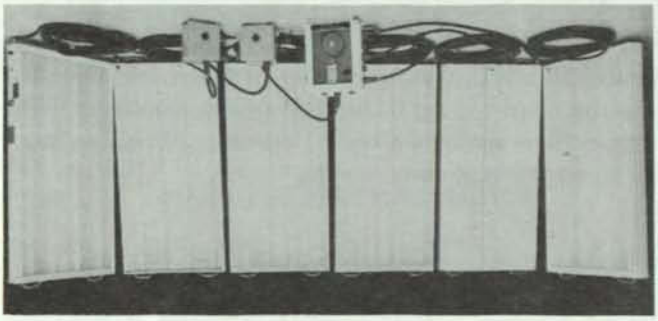


Figure 26. Auto-controlled daylight simulators.

CCIW Acoustically Triggered Underwater Release Units

As in other instrumental areas, once problem areas were eliminated and reliable operation attained, applications increased noticeably for acoustic release units, especially for use under the ice in winter. From a 1973 number of 6 units, 1974 operating inventory is now 17, and all 17 were deployed in winter moorings in various lakes (Fig. 27).

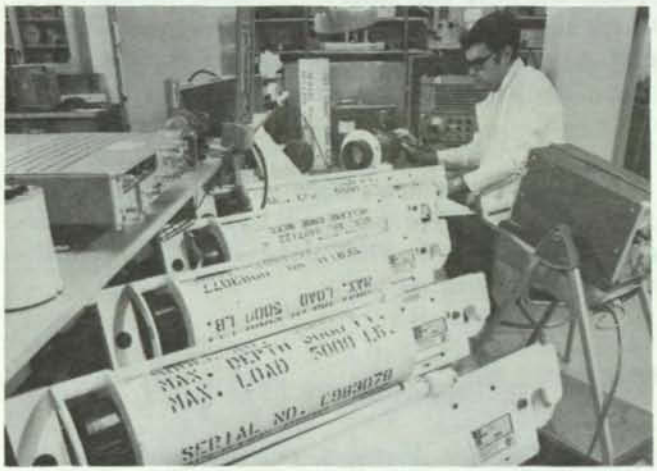


Figure 27. Acoustically triggered underwater release units.

CCIW Temperature-Depth Profiling (EBT) Systems

Engineering work to upgrade and standardize a diverse inventory of temperature-depth sensing equipment was finally completed in 1974. Equipment performance has been technically satisfactory and operationally more reliable. Logistically, especially with respect to interchangeability, the situation has improved greatly. As determined by much use, CCIW now has an inventory of 4 mainly automatic "major-ship" EBT systems designed for year-round use and 3 hand-operated portable EBT systems for use from CCIW launches (Fig. 28). Strong features of the systems are modular interchangeability for easy maintenance and Canadian manufactured content.

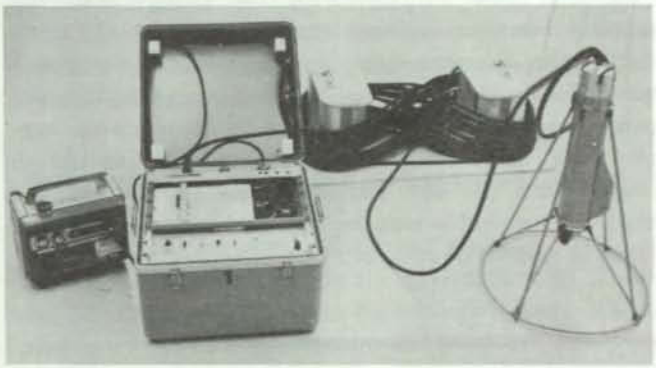


Figure 28. Portable EBT system for use from CCIW launches.

CCIW Submersible Data Acquisition Systems (Project SSD006)

For many years CCIW has used a wide variety of data-acquisition systems to measure inland waters parameters. Most of these systems were limited to one measurement operation only, and none effectively exhibited the functional flexibility, accurate digitizing, ultralow power and reliability in performance and operating economy that current solid-state electronic technology can provide. Against this background, work commenced in 1974 to use the specialist engineering services of Canadian industry, together with in-house applications experience and proven equipment methods, to prototype a special submersible mainframe digitizer and rackmount mainframe digitizer for evaluation in certain limnological experiments.

Standard Inland Waters Electronic Packaging

In 1973, a standard electronics packaging format for submersible inland waters use was in the final design stage.

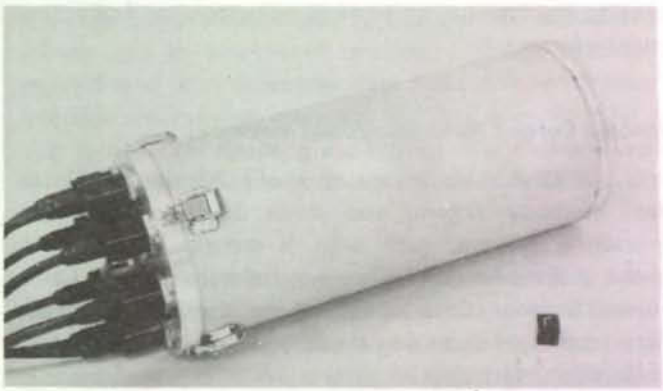


Figure 29. CCIW submersible electronics package for inland waters use.

Since then the design has proven very satisfactory. More than a dozen electronics packages been implemented with no leakages. In 1974, an accidental event produced an interesting "torture test" whereby a submersible digital recorder package (Fig. 29) was washed free on the Thompson River, B.C., during the spring flood. The recorder was carried down the Thompson River, across Lytton Bar, down the Fraser canyon, including the unnavigable "Hell's Gate" narrows, for a distance of 200 miles almost to tidewater at Chilliwack. Despite rocks, logs, abutments and other hazards, and after having had all sensors torn off and connectors severely battered, the electronics assembly was dry and undamaged — still digitizing to its original value of ±1 bit accuracy.

Air-Water Timelapse Photo-logger System

Effort was applied during the year to defining, selecting and requisitioning a functionally flexible 16-millimetre timelapse photo-logger system that is able to record extensive series of photo-images either underwater or above water, in the laboratory or in lakes. Many applications exist at CCIW for such a photo-logger. The system is modular and features sets of air-compensated and water-compensated lenses; incremental operation with wide-range timing controls (milliseconds to hours), strobe and/or photocell-inhibit; and digital recording in the image plane of data from associated environmental sensors.

Environmental Sensor Engineering

During 1974, engineering design work conducted in the area of improved environmental sensors for inland waters application was even more limited than in 1973, and this was a small fraction of what should be done. Examples of environmental sensors that received some limited engineering attention, however, are electromagnetic current sensors, turbidity sensors, and fluorescence sensors. There are many other parametric measurement areas in which CCIW methods can be improved in 1975 by using electronic sensing instrumentation of more contemporary and economic performance.

Moored Current Meter Buoys and Metbuoys

CCIW has on inventory about 20 air-water interface metbuoy systems and about 30 moored current-measuring systems, each with 3 meters. During 1974, about 250 moorings of these systems were made in Lakes Huron, Superior, Ontario, Simcoe, and Kamloops Lake; the data recovery factor was about 90%. All refurbishment, preparation, testing, and calibration of this equipment is contracted to Canadian industry, with generally satisfactory results.

Automatic Dissolved Oxygen Profilers (Project BL016)

In connection with various CCIW nutrient-dynamics and phosphate-control experiments, there are requirements for repetitively profiling the DO levels in restricted experimental enclosures. For this purpose special automatic DO profiling systems were developed, featuring DO and temperature sensors; digital integration facilities; automatic vertical and slewing controls by diode-matrix sequencer; 6-station operation; and 4-parameter displays. Two systems now exist: one system for the Bay of Quinte limnocorrals, and the other for the GLBL lake-column simulators, with step-and-slew profiling every 15 minutes, 24 hours a day, for an operation of many months.

LIBRARY SERVICES

A Vucom terminal was acquired by the library, courtesy of the Social Sciences Division for information retrieval purposes. The three systems regularly interrogated are WATDOC, CAN/OLE and RESORS. WATDOC provides access to an increasing variety of specialized data bases, including Health Effects of Environmental Pollutants. CAN/OLE, with its specific search strategy, is primarily used for retrieval from *Chemical Abstracts* and *Biological Abstracts,* whereas RESORS is comprehensive for remote sensing. The number of users of computer literature-searching is growing, and since the equipment is now more reliable and more data bases are available, this segment of library services will be used more in future years. Library staff demonstrated the terminal to visitors from nearby universities and other interested agencies, as well as to CCIW staff.

The volume of library work increased, as the diversity of CCIW research grew; interlibrary loans for staff members showed an increase to 3750. Volume 6 of *Collected Reprints* was published.

TECHNICAL SERVICES SECTION

The Technical Services Section is responsible for the operation and maintenance of all the present real property at CCIW, as well as developing the means to satisfy requirements for additional space, equipment, facilities and services throughout CCIW.

Two items of significance during 1974 were the transfer of the Department of Public Works (DPW) heating and power plant staff to CCIW, under the supervision of the head of this Section, and the transfer of all contractual responsibility for maintenance services and construction from Headquarters to CCIW. These services and construc-

tion contracts were previously managed locally by DPW and DSS for the Facilities Planning Branch in Ottawa. Several building renovations and modifications were carried out throughout the year with minimum disruption to on-going programs.

A major program on safety and fire emergency procedures, involving all components located at CCIW, was initiated. An internal sign-posting project, approved by Information Canada, was incorporated into the building complex.

COMPUTER SERVICES SECTION

The Computer Services Section has the responsibility for operating and providing software support for the major computer systems at CCIW, as well as providing off-line services such as key punching and consultation in the technical aspects of electronic data processing.

The Control Data (CDC) 3170 computer system, which was upgraded in late 1973, has been operated under the MASTER multiprogramming system throughout 1974 with no significant difficulties. The system has been operating from 8 to 12 hours per day during this year, and as the computer work load has not increased considerably, no serious strain has been placed on the computing facilities. During 1974, a total of 49,331 jobs were run, using 1369 hours of central processor (CPU) time. Detailed usage statistics are given in Table 9.

Table 9. Summary of Computer Services Usage–1974

Type of usage	Amount
CDC 3170 computer	
Number of jobs	49,331 jobs
Central processor usage	1,369 CPU hr
I/O channel usage	287 hr
Lines printed	47 million lines
Cards punched	1.45 million cards
Magnetic tapes mounted	27,886 tapes mounted
Private disk packs mounted	2,640 packs mounted
Total value of usage	$664,846
Average value/job	$13.48
Average CPU time/job	1.66 min
Average lines printed/job	952 lines
PDP-15 and plotter	
Number of plotting jobs	2,153 jobs
Total plotter usage	658 hr
Other PDP-15 usage	871 hr
Data preparation services	
Number of cards keypunched	316,517 cards
Number of cards interpreted	1,078,465 cards
Total value of Computer Services usage	$714,761

In addition to the CDC 3170 computer, the section has a DEC PDP-8 computer used to reformat instrumentation tapes to "computer-compatible" form and a large DEC PDP-15 used for special applications, such as plotting, interactive graphics, analog-to-digital conversion, and the production of time-sequence data displays on movie film.

INSTRUMENT RESEARCH AND DEVELOPMENT UNIT

The program of the Instrument Research and Development Unit was focused on the development of sensors and automatic sensing systems for monitoring water quality parameters *in situ*. Working from the conclusions of earlier requirement surveys, the decision was made to undertake developments which had potential for monitoring parameters, such as algal biomass, organics, nutrients and toxic substances, leaving the development of the typical five-parameter monitors (temperature, pH, conductivity, dissolved oxygen and turbidity) to several commercial concerns already active in this field.

The major effort centred on designing and constructing a submersible system of apparatus and sensor modules called the Robot Experimenter. It took the form of an *in situ* experimental station in which candidate techniques for measuring these water quality parameters could be tried and evaluated. The submersible apparatus modules produced included a family of precision pumps for handling water samples and reagents and standard solutions, a novel 8-port commutator valve, and a standardized flowcell block for electrodes and other small sensing devices. A high-speed cable telemetry subsystem was designed to provide remote control of these modules and to send back observations made by the sensing elements. The heart of the system is a minicomputer, which directs the detailed activities of the apparatus modules and performs simple data acquisition and analysis. The system will have facility for a user, located at central site, to program the experimental station and to observe its activity and data files by a conventional dial telephone data link. A novel software package was created especially for this minicomputer so that routines for directing the activity at the station could be written in a simple code and executed with real time controls.

Phase I of this experimental station project will be completed in the summer of 1975. It is expected to have the basic ability to measure the parameters of temperature, pH, conductivity, dissolved oxygen, chloride ion, total CO_2, total alkalinity, total heavy metals and a simple BOD index. These parameters will be taken as the results of simplified

analytical experiments conducted within a particular configuration of the apparatus modules and performed on a continuous schedule by a set of programmed routines in the minicomputer.

Another project of Instrument Research and Development Unit is the development of a new dissolved oxygen sensor to be used in applications where dissolved oxygen must be monitored for long periods of time, in the order of six months, without manual attention. Work has centred on a new measurement cell resembling the conventional polarographic probe, but which operates on a significantly different principle called semi-integral electro-analysis. This device employs an oxygen permeable membrane as a selectivity filter only. Consequently the cell does not suffer calibration drift associated with changes in the membrane permeability coefficient, which currently limits the measuring life of conventional probes. Since it is operated in a pulsed mode and has no need of an external agitating device, it requires very little power and allows long life for its active reagents.

Development of the operating principle theory, design criteria and the production of three prototype probes resulted from a research contract with Dr. K.B. Oldham, Trent University. Following favourable evaluation of these prototypes, a production version will be attempted and manufactured commercially.

SOCIAL SCIENCES DIVISION

This Division provides viewpoints and techniques of the social sciences for the development and operation of balanced water management policies and programs. This year the transfer of the Division from CCIW to the Inland Waters Directorate, Ontario Region, was discussed and scheduled for 1975. The Division Chief has been named Chairman of the newly established Socio-Economic Programs Sub-committee for the Ontario Region Environmental Management Service.

In 1974, the Division continued to diversify the skills in its field of activity. Data bases were expanded further, and much effort was applied to the development of economic and social models for water management. Staff members continued to participate in joint projects with other divisions, departments and government agencies.

Throughout 1974, various projects were undertaken.

ENVIRONMENTAL ATTITUDES AND BEHAVIOUR

The major project in this area was an evaluation study of the International Joint Commission's public hearing process. Eighteen public hearings conducted by the IJC in 1973 were examined. One of the main tools of evaluation was an analysis of a questionnaire sent to all of the participants at the hearings on the IJC list of attendees. The report was presented to the Commission at its annual October meeting by the Research Advisory Board, and as a result, some changes were instituted in the public hearing procedures. The Division was then asked to undertake a follow-up study of the hearings in the autumn of 1974, to examine the effect of these changes.

A study was completed by Resources Management Consultants to examine the public relations function of CCIW. Managerial personnel and members of the Public Relations Unit were interviewed. In addition, a sample survey was undertaken to determine the level of awareness of CCIW on the part of the general public and water managers in key areas across Canada.

ENVIRONMENTAL CONTAMINANTS

Progress continued with the composition of papers describing the production, use and distribution of environmental contaminants in Canada. Two reports, one concerning the sales of pest control products and the other describing the production and use of cadmium, were published in the new "Environmental Contaminants Inventory Series." Similar documents on lead, phthalates, selenium, beryllium and antimony are to be added to the Series in 1975. These reports form the basis for other natural science and social science studies in progress. Work has begun on the development of methodologies to determine the social costs that accrue as a result of the use of environmental contaminants in the Canadian economy.

ECONOMIC IMPACT STUDIES

The economic impact of waste-heat discharges was studied under contract by Canadian Resourcecon. Estimates were made of the direct costs involved in installing wet cooling towers on facilities discharging waste heat into the lakes. These direct costs were translated into electricity price increases, and the propagation of these price increases through the economy was examined.

As part of a contracted study on Regional Economic Activities by Informetrica, a general methodology is being developed to provide a quantitative assessment of the economic impact of the various policy instruments open to water managers.

LEGISLATIVE AND INSTITUTIONAL STUDIES

Four major projects were completed in this program area. A study of the legislative framework and administrative processes by which municipalities acquire sewage treatment facilities was concluded. Laws, agencies, regulations and administrative procedures were examined, as they operate both at the federal and provincial levels to provide sewers and sewage treatment plants for municipalities.

The second project involved the examination of legal, political and administrative aspects of public participation in resource management. A report outlining the legislative basis for public participation in Canadian water management was produced by C. G. Morley, Professor of Law, University of Manitoba. A more general presentation based on this paper was made at the 17th Annual Conference on Great Lakes Research in Hamilton.

Thirdly, a working paper on institutional arrangements for the management of the Great Lakes was completed in conjunction with staff of the Ontario Ministry of the Environment for Working Group A of the IJC Upper Lakes Reference Group. The paper outlined the legislation and the agencies involved in various aspects of water management at all levels of government. Staff also assisted the United States Great Lakes Basin Commission in compiling a directory of institutions involved in water management in the Great Lakes.

Finally, to develop management policies which will cover water quality problems of the future, a study has been contracted out to L. J. D'Amore and Associates to provide a largely intuitive, but adaptable, model of social, technological, legislative and institutional trends to the year 2020. The model is based on data from the Canadian portion of the Great Lakes basin and is designed to define the "unexpected results of reasonable trends," that is, the synergistic effects of developments in these areas. The results will be incorporated into waste-loading and land-use forecasting and policy simulation models being developed for the International Joint Commission's Reference Groups on Upper Lakes Water Quality and Pollution from Land-Use Activities.

DYNAMIC MODELLING

The Social Sciences Division is involved in developing a long-term dynamic model to assess the effects of population and economic activity on the waste loadings into Lakes Superior and Huron. The economic forecasts being used are obtained from the CANDIDE model of the Canadian economy, and the social, legislative, technological and institutional modules are being constructed from data obtained from the synergistics model. This policy simulation model, developed under contract, will contribute to both our level of knowledge and to government policy-making, as society makes its decision about the amount of waste materials to be added to our waterways.

SOCIO-ECONOMIC BASE-LINE STUDIES

Owing to the Social Sciences Division's responsibility for Canadian co-chairmanship of Working Group A of the Upper Lakes Reference Group, a considerable amount of socio-economic data describing the Upper Great Lakes basin were collected. Studies were developed using these data to describe the population distribution, market characteristics, recreational facilities and use, economic conditions and detailed economic activity, for selected river basins in the upper Great Lakes basin.

With respect to the Reference Group on Pollution from Land-Use Activities, the collection of background information on various land uses (mining, agriculture, manufacturing activities, etc.) is continuing. This information will be used to study the nature and location of land-use patterns in the entire Great Lakes basin. In addition, a report on specialized land uses was completed by Crysler and Lathem (consultants). When all the information is complete, a set of forecasts will be developed for all sectors and activities of land use that affect the drainage of pollutants into the Great Lakes.

As part of the federal-provincial Great Lakes Shore Damage Survey, an inventory of ownership, value and use of all properties along the Canadian shoreline of the Great Lakes is being compiled. Data have been collected and analyzed for Lakes Ontario, Erie and part of Lake Huron. A Coastal Zone Atlas, incorporating this information on data strips, is being produced.

A detailed set of long-term economic activity estimates for the Great Lakes basin has been developed by Informetrica. The first publication, the "A-Series," is based on a set of assumptions, compatible with a continued trend in the development of the service industry. On the basis of a range of alternative assumptions, work continues on a "B-Series" set of estimates.

CCIW LECTURE SERIES

The Division maintains responsibility for the CCIW lecture series. The objective is to provide scientific staff at CCIW, as well as at neighbouring universities and research institutes, and other government agencies in southern Ontario, with a series of lectures focussing on unifying principles in multidisciplinary environmental research. Speakers in 1974 included Dr. David Suzuki, Dr. Tuzo Wilson, Mr. David Estrin, Dr. O. M. Solandt and Dr. Donald Chant.

ANALYTICAL METHODS RESEARCH SECTION

The past Analytical Methods Research Section (AMRS) responsibilities with respect to a number of national and international programs have continued and in many areas broadened. Extensive consultations were held with the staff of the federal regional laboratories in Vancouver, Calgary, Burlington and Moncton, in which their current and near-future analytical research requirements were identified. A three-day training course on the application of the high-pressure liquid chromatography was given by the AMRS staff in December. The course was attended by eight chemists from the regional laboratories and a chemist from the EPS Laboratory in Ottawa.

During the year, a biochemist was engaged to conduct research on 1) biodegradation of surfactants, 2) estimation of biomass in water, and 3) determination of heavy metals in cells.

SCOPE

Presently, AMRS comprises six 2-man teams specializing in 1) gas chromatography/mass spectrometry (GC–MS), 2) high-pressure liquid chromatography, 3) selective-ion electrodes, 4) polarography and molecular fluorescence, 5) UV/visible/IR/and atomic absorption spectrometry, and 6) biochemical methodology.

All analytical research at CCIW is carried out in response to the needs expressed by the following: 1) any federal regional laboratory, 2) any research component of the CCIW, and 3) any international organization with which Canada is actively collaborating.

PUBLICATIONS

During 1974, AMRS staff published 14 papers; 13 additional papers were "in press" by the end of the year. Detailed references are listed in alphabetical order in Appendix B. A partial summary by discipline or instrumental techniques applied is provided here.

Chromatography-Mass Spectrometry

A variety of organochlorinated pesticides, their photo-products, dithiocarbamates and 1,4-oxathiins have been characterized, and analytical methodology for a number of industrial pollutants has been developed by means of gas chromatography, high-pressure liquid chromatography, thin-layer chromatography, tandem GC–MS, NMR and IR.

Determination of N,N-Dialkyl Dithiocarbamates in Wastewater by Thin-Layer Chromatography
(F.I. Onuska)

The procedure involves extraction of the organic pesticide in chloroform in the presence of a copper dichloride solution. The dried extract is first dissolved in ether, which is removed under vacuum, re-extracted with chloroform and applied to a precoated silica gel plate containing a fluorescent indicator.

Gas-Liquid Chromatography and Mass Fragmentography of S-n-Propyl N-Monoalkyl Dithiocarbamates
(F.I. Onuska and W.R. Boos)

Dithiocarbamates are esterified with 1-iodopropane to form S-n-propyl MADTC followed by gas chromatographic separation, mass spectrometric identification and mass fragmentographic quantitation. Individual compounds were characterized by means of Kováts retention indices. These values increase with increasing chain length of the hydrocarbon linked to nitrogen. Higher Kováts retention indices were obtained when the column was packed with polypropylene glycol adipate (Reoplex 400), than when it was packed with Apiezon L or silicone oil DC-200. MADTC showed two simple fragmentations with molecular ion most abundant in N-methyl-DTC.

Photoalteration of cis- and trans-Chlordane by UV Light: Isolation and Characterization of the Photoaltered Metabolites
(F.I. Onuska and M.E. Comba)

Ultraviolet irradiation of *cis*-chlordane and *trans*-chlordane yielded three photolysis products: one half-caged analog of *cis*-chlordane in high yield and two minor photoproducts of trans-chlordane, one of them being a half-caged isomer. The photoproducts were isolated by TLC and characterized by IR, NMR and MS.

Isolation and Characterization of Some Methanonaphthalene Photoproducts
(F.I. Onuska and M.E. Comba)

Photo-decomposition products of aldrin, dieldrin and endrin were characterized by means of GC–MS, NMR and IR. One isomeric product of aldrin and four endrin analogs were encountered. The mass spectra of eight photoproducts were presented with direct inlet spectra of endrin aldehyde and endrin.

A Highly Sensitive Technique for the Liquid Chromatographic Analysis of Phenols and Other Environmental Pollutants
(A.W. Wolkoff and R.H. Larose)

Phenols are extracted into n-butyl acetate from a 500-millilitre sample, acidified to pH 2 and back-extracted in 1.6N NaOH. The aqueous phase neutralized to pH 7 is adjusted to 10 ml, thus affecting a fifty-fold concentration. A sample portion is injected into the L.C. column with an acetonitrile water mixture as the mobile phase. The separated phenols in the effluent react each with a Ce (IV) solution in a fully automated system to give Ce (III), which has a fluorescence proportionate to the concentration of individual phenols.

Separation and Detection of Low Concentrations of Polythionates by High Speed Anion Exchange Liquid Chromatography
(A.W. Wolkoff and R.H. Larose)

A method is described for the separation and measurement of thiosulphate and polythionates by high-speed anion exchange chromatography. The sulphur-oxygen anions are oxidized by cerium (IV) and the fluorescence of the resulting cerium (III) is proportionate to the concentration of the polythionates. The detection limit is of the order of 1 ppm to 4 ppm.

Spectrophotometry: UV, Visible, Molecular Fluorescence, IR, Atomic Absorption

Analytical methodology has been developed in the analysis of organic pollutants (phenols, formaldehyde), inorganic pollutants (chlorides, arsenic, antimony, selenium) and detergents (phosphate, citric acid). Some of the methods developed are briefly summarized here.

The Determination of Formaldehyde and Related Compounds in Water and Industrial Effluents
(B.K. Afghan, A.V. Kulkarni, R. Leung and J.F. Ryan)

The method is based on the reaction of formaldehyde with 2,4-pentanedione and ammonia to form a fluorescent compound. The fluorometric method is more specific than the colorimetric procedure based on the reaction with chromotropic acid. The analysis rate is 10 to 20 samples per hour depending on concentration, and the detection limit is approximately 10 μg/l.

Automated Fluorometric Method for Determination of Citric Acid in Sewage and Sewage Effluents
(B.K. Afghan, R. Leung and J.F. Ryan)

Citric acid is first converted to citraconic anhydride in accordance with the Furth-Herman reaction, and then the latter is condensed with pyridine to form a fluorescent compound. The rate of analysis is 10 samples per hour. Fulvic acid, a common interference in the spectrophotometric and gas chromatographic methods, was found not to have an effect in the molecular fluorescence method. No other significant interferences were found.

A Modified Procedure for the Determination of Phosphorus in Detergents
(P.D. Goulden and M.C. Holton)

The ASTM Method (D820-72) for phosphorus in detergents has been modified to make it applicable to phosphate levels below 5% P_2O_5 by elimination of carbonate and some refinements in titration.

A New Automated Colorimetric Method for the Determination of Chloride Using Chromotropic Acid
(B.K. Afghan, A.V. Kulkarni and J.F. Ryan)

The new colorimetric method for chlorides is based on the catalytic action of chlorides to convert nitrate to nitrite and the colour reaction with chromotropic acid. The method is automated, allowing the analysis of 40 samples per hour in the range of 0.25-100 mg/l.

Electro-analytical Methodology

Publications under this heading describe activities mainly in the area of application of selective-ion electrodes to multi-element analysis and the development of new selective-ion electrodes. There has been also some advancement in voltammetric applications.

Simultaneous Determination of Sodium, Potassium and Ammonium Ions by Automated Direct Potentiometry
(I. Sekerka and J.F. Lechner)

A method is described for the simultaneous analysis of sodium, potassium and ammonium ions by automated direct potentiometry in natural and wastewaters, allowing the analysis of 20 samples per hour with the detection limits of 0.1 ppm for sodium and ammonia and 1 ppm for potassium. The relative error is ±2%.

Automated Simultaneous Determination of Water Hardness, Specific Conductance and pH
(I. Sekerka and J.F. Lechner)

The analysis can be performed at the rate of 20 samples per hour.

Determination of Nanogram Quantities of Carbonyl Compounds Using Twin-Cell Potential Sweep Voltammetry
(B.K. Afghan, A.V. Kulkarni and J.F. Ryan)

Twin-cell potential sweep voltammetry allows both the determination of the carbonyl compounds and the differentiation among the individual compounds in natural waters and industrial effluents. Detection limits in sub-ppb ranges are achieved. Standard deviation is of the order of 2.5-10%, depending on the nature of the carbonyl compound.

OTHER ACTIVITIES

The Analytical Methods Research Section participated in a number of international programs. Experimental studies were carried out on biodegradation of surfactants, in co-operation with the countries belonging to the Organization for Economic Co-operation and Development (OECD); state-of-the-art surveys were conducted on behalf of the International Joint Commission on the analytical methodology of the Great Lakes; and a co-operative program with Mexico was initiated on the detection of carcinogenic polynuclear aromatic hydrocarbons.

Dr. S. Barabas, who had visited the Soviet Union in December 1973, reported on water research carried out there.

WATER AND WASTEWATER TREATMENT RESEARCH SECTION

The Water and Wastewater Treatment Research Section conducts investigations of the treatment of water. The work of the Section is focused on methods of removing or destroying substances in water that may be harmful to humans or to industry. A brief description of the scientific projects conducted by the Section follows.

Reduction of Surface Inhibition on Reverse Osmosis Membranes
(H.K. Johnston)

This study was conducted with the assistance of the Engineering Services Section, CCIW. An efficient static test cell has been designed to minimize concentration polarization resulting in surface inhibition. This is evident by mechanically controlling the surface turbulence at the membrane-solution interface. Other dynamic test cells currently in operation will undergo modification to increase their performance efficiency.

Studies using idealized salt systems have been conducted to ascertain the stability and variability of membranes with time. Surface inhibition resulting in fouling of membranes and the effectiveness of various chemical cleaning agents and methods are being examined. Results have indicated that enzyme active detergents are the most effective. Other chemicals have proved useful in cleaning membranes after some specific foulings. Physical cleaning techniques using air-water mixture pulsation flow and ultrasonics are also being studied.

Modification studies of the membrane surface, aimed at reducing inhibition, have been started. The evaluation of various wetting agents, their stability and lifetimes will be examined in idealized (pure water type) systems. A research program is underway in co-operation with Dr. H. Gesser of the University of Manitoba. Dr. Gesser holds several patents on techniques used to modify permanently the wetting angles through a physico-chemical modification of the membrane surface. The techniques require dry membranes, and as a result, an efficient and completely reversible process has been successfully developed here to prepare dry cellulose acetate membrane from a wet state.

Modification of Cellulose Acetate Membrane to Permit Wider pH Application and Greater Mechanical Integrity
(H.K. Johnston)

This study has been carried out in co-operation with Dr. A. Rudin of the University of Waterloo, and the results are extremely encouraging. Part of the study has been aimed at grafting chemically, certain appropriate pH resistant and/or large mechanical strength polymers to the surface of an unshrunk cellulose acetate membrane.

Another part of the study is focused on the effect of cross-linking agents used to fabricate the reverse osmosis membranes. The use of these agents necessarily reduces membrane solubility and/or increases its strength. To incorporate the appropriate functional groups into the membrane, a fundamental study of the chemical structure of the membranes has been underway, using the FMIR infrared spectroscopy technique. Part of the study has been conducted at the University of Waterloo by Dr. D. Irish.

The surface structure of cellulose acetate membrane is also being evaluated using the electron microscopic technique at CCIW. Laser Raman spectroscopy techniques are being studied by Dr. T. Davis (Water Quality Branch, Ottawa), Dr. B. Morrow (Professor, University of Ottawa) and Dr. A. Hardin (Post Doctorate Fellow, Ottawa).

Development of Improved Reverse Osmosis Membranes through Modification of Casting Conditions and the Application of These Membranes to the Separation of Specific Contaminants
(H.K. Johnston)

The first stage of this project has been the design and assembly of a critically controllable, explosion-proof casting room and the casting equipment. This has now been completed, and attempts to improve the casting variables in terms of membrane performance are underway.

Good quality membranes of selected porosites can be fabricated to facilitate the study of the membrane separation criteria. The selective rejection of 19 heavy metal salts

of chlorides and nitrates by reverse osmosis membranes has been quantified and criteria for selective rejection have been proposed. Studies have now been extended to the alkali-salts where the criteria for both cation and anion rejections are being investigated.

An evaluation study of the ability of two different types of reverse osmosis membranes (cellulose acetate and aromatic polyamide) to reject different classes of phenols from pure water is near completion. This evaluation will be extended to both spiked and unspiked sewage systems. A sampling program to determine phenol levels in the sewage treatment plants throughout southern Ontario has been completed, and detailed sampling will be carried out at a plant that has been selected for this study. Classification of the phenols found in municipal effluent will also be undertaken with the assistance of Dr. A. Wolkoff at CCIW.

Evaluation of Reverse Osmosis Module Designs and Development of Efficient Pre-treatment and Post-treatment Techniques for Optimum Employment of Reverse Osmosis in Wastewater Renovation
(H.K. Johnston)

This project will be under the direction of a Post Doctorate Fellow. Equipment acquisition has been completed, and a module test system has been designed and assembled. All of the units are now functional and are being used intermittently to prepare large-volume samples for analysis and to obtain preliminary results for assisting the reverse osmosis pilot plant operation.

Additional studies are planned to improve pre-treatment techniques and, more importantly, to improve post-treatment and disposal techniques for the concentrate.

Treatment of Waste Treatment Plant Effluents by Reverse Osmosis—Canada-Ontario Agreement
(H.K. Johnston)

A complete reverse osmosis pilot plant has been designed and is mounted in a self-contained trailer to permit an on site evaluation of reverse osmosis as an advance wastewater treatment technique. The unit has been in operation almost continuously since April 1, 1974. The treatment of secondary sewage under a variety of controllable operating conditions has been studied. The unit functions within acceptable reliability and performance limits.

The short-term and long-term effectiveness of reverse osmosis as a treatment method and the operation and maintenance problems associated with operating this unit have been examined. The causes of membrane fouling and the methods of preventing and treating the fouling are being studied. Phase I of this program, completed in August, focused on the removal of nutrients and residual chemical additives from secondary sewage. Results indicate that the technique is effective. Phase II, which is expected to be completed in March 1975, has concentrated on heavy metal removal, as well as some toxic and persistent chemicals from secondary sewage. The removal of an additional 13 relevant chemical parameters (TOC, COD, TDS, etc.) by reverse osmosis is also being investigated. These investigations include the use of static and dynamic test cells. The studies have been regularly carried out in the laboratories to provide preliminary results in assisting the pilot plant operation.

Work is continuing on membrane fouling. Methods of treating and disposing of the concentrate obtained from the pilot process will be studied. The next phase of the program will emphasize the treatment of primary effluent, raw sewage and industrial wastewaters.

Removal of Trace Metals from Wastewater by Treatment with Lime and Discarded Automotive Tires
(A. Netzer)

A study was conducted to determine the effectiveness of removing trace metals from wastewaters. Prior to undertaking these studies, preliminary experiments were conducted to examine the potential of used rubber to remove aluminum, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, silver and zinc from aqueous solutions. These studies focused on the reactions between the metals and the various constituents of the rubber tire (e.g., sulphur, carbon black, synthetic rubber, antioxidants, fillers), especially the carbon black and the sulphur. In the experiments, the initial concentration of the stock solution of each metal was approximately 100 ppm. The percent reduction of metal by lime and discarded automotive tires varied from 0.1 ppm to >99.9 ppm and was pH dependent.

To explore more fully the potential of trace metals, continuous bench-scale studies were initiated using discarded automotive fires (DAT) in conjunction with lime. In the current studies, the removal of aluminum, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, silver and zinc solutions are being investigated.

The results indicate that discarded automobile tires can be used effectively to remove trace metals from aqueous solutions.

Advanced Physical-Chemical Treatment of Dye Wastes
(A. Netzer)

Industrial effluents containing dyes often create unpleasant sights in receiving waters. Furthermore, it is suspected that some dyes are carcinogenic. Since most dyes

are resistant to biological attack, conventional wastewater treatment techniques do not always achieve satisfactory colour, BOD and COD removals. It appears, however, that many forms of physical-chemical treatments can adequately treat these refractory pollutants.

The treatability of various commercial dyes used widely in the textile industries and effluents collected from several dyeing operations, were studied. The treatment processes investigated included biological oxidation, ozonation, activated carbon adsorption, synthetic resin adsorption, coagulation with lime and alum, and oxidation by hydrogen peroxide, potassium permanganate and sodium hypochlorite.

Some premetallized dyes were found to be toxic to the activated sludge. If ozonated prior to the activated sludge treatment, however, the wastes became more biologically degradable. Colour in most cases was easily removed by ozonation, hypochlorination and activated carbon adsorption. Unfortunately, hypochlorination sometimes created toxic substances, even after free chlorine was removed and the pH of the dye wastes was adjusted to neutrality. Hydrogen peroxide and potassium permanganate were found to be ineffectual in removing colour in nearly all cases. Depending on the chemical structure of the dyes, excellent removals were obtained by the weakly anionic, weakly cationic and non-ionic polymeric resins. These were used alone or were arranged sequentially. In these cases, the non-ionic resin is used to remove the bulk of the dyes, whereas the cationic and anionic resins serve as polishing steps. Alum and lime coagulation were observed to be capable of yielding high colour removals, although high dosage rates were necessary in some cases.

These studies demonstrate that dye wastes can be treated effectively by a number of physical-chemical means alone or in various combinations.

The Biotreatability of Industrial Textile Dye Wastes before and after Ozonation and Hypochlorination-Dechlorination
(A. Netzer)

Dye-bath effluents from various Ontario textile mills (e.g., from dyeing hats, rugs and yarn) without prior treatment were subjected to biological treatability tests, including batch extended aeration treatment. Subsequently they were classified as toxic or non-toxic and biodegradable, or non-biodegradable. These same effluents were treated by ozonation and hypochlorination-dechlorination and again subjected to biological treatability tests.

All of the non-biodegradable wastes became treatable after sufficient ozonation; following chlorination, however, only some of the wastes became biodegradable, whereas others remained unchanged. Furthermore, toxic wastes always became either non-toxic after ozonation, while toxicity was eliminated only in a few cases with chlorination. Therefore, it appears that ozonation can provide an effective pretreatment process for the biological waste treatment of refractory dye-bath effluents.

Colour and Heavy Metals Removal from Dye-Bath Effluents by Lime Precipitation
(A. Netzer)

Effluents from textile mills, carpet-dyeing and hat-dyeing operations often contribute to industrial pollution. Not only are these discharges characterized by the presence of obnoxious and persistent colours, but they also contain a high concentration of organics and considerable amounts of such heavy metals as Zn, Cr, Hg, Pb, Cu and Co. An effective and economical reduction of the colour intensity and heavy metal concentration of these streams can often be achieved by lime precipitation.

Numerous different dye-bath effluents from various dyeing operations were treated with both massive lime dosages and controlled lime dosages to study the effect of pH on colour and heavy metal removals. Colour was determined by the procedure recently proposed by the American Dye Manufacturers' Institute.

Metal removals, except for chromium, were in the order of 90% or greater. Colour removals varied from excellent to poor, depending on the chemical species of the dyes present in effluents.

Treatment of Dye Wastes by Ozonation
(A. Netzer)

Industrial dye-house effluents present many environmental problems: they are often difficult to degrade biologically; they often contain large quantities of inorganic salts; they are sometimes highly coloured; they may contain heavy metals (such as mercury, lead, copper, zinc, chromium and nickel); and many dyes are toxic and possibly carcinogenic.

Experiments were conducted to assess the effectiveness of treating dye-bath effluents by ozonation alone, ozonation in conjunction with physical-chemical treatment, and ozonation followed by biological treatment.

Excellent colour reductions were obtained with ozonation alone, but COD, TOC, heavy metal and inorganic salt levels remained essentially unchanged. Ozonation in conjunction with physical chemical treatment lowered the concentrations of heavy metals, TOC and COD. Ozonation prior to biological treatment provided a more biodegradable substrate for activated sludge organisms. Furthermore, ozonation tended to make the dye-house waste amenable to biological treatment.

Ozone Applications for the Treatment of Pulp and Paper Effluents
(A. Netzer)

A practical solution was sought for the removal of refractive organic materials that impart colour to pulp and paper mill effluents. Since many of these substances are non-biodegradable, they often do not respond to conventional biological wastewater treatment. It has been illustrated that ozone is an efficient oxidant that can be used to decrease the colour of these wastewaters. Moreover, ozone does not require the high capital investments often required for other treatment methods.

The kinetics of colour removal and the rate of conversion of refractive compounds to biodegradable forms were determined in this study. This information has been applied to the design of an efficient ozone treatment process. The ability of ozone to improve biodegradability has been used to obtain the optimum combination of biological and chemical oxidation methods. This system of using ozone to partially oxidize the colour bodies and then allowing bioxidation to complete the task, often results in lower capital and operating costs, while providing satisfactory treatment.

Disinfection of Secondary Sewage Treatment Plant Effluents—Canada-Ontario Agreement
(A. Netzer)

Since chlorinated organics may be toxic, alternative methods of chlorination of secondary effluents are being investigated under a joint project conducted by EMS, MOE and EPS. The EMS Laboratory is investigating the effects of disinfection of various secondary effluents under different conditions using ozone.

The effectiveness of ozonation was investigated at various concentrations of bacteria, organics and suspended solids; ozone dosages; contact times; flow rates; and gas-liquid ratios.

As part of this project, a comprehensive bibliography on ozone disinfection was prepared and submitted for publication in the Canada-Ontario publication series.

Preliminary bench-scale experiments were conducted at CCIW. Future planned studies for ozone use will determine the efficiency of disinfection under actual continuous plant operation at the Brampton Sewage Treatment Plant. Special attention will be given to the destruction of Salmonella and virus in the effluents. Bacteriophage-tracing will be part of the study.

The Characteristics and Treatment of Combined Sewer Overflows—Canada-United States Agreement
(A. Netzer)

Many municipalities rely on combined sewers to convey sanitary wastes, industrial effluents and storm waters to local sewage treatment facilities. Although combined sewer networks are generally more economical because of the reduced capital expenditures involved, diversion of the excess untreated wastes into receiving streams is necessary when the flow capacity of the system is exceeded.

It appears that efforts to control and minimize pollution from combined sewer overflows should include some form of treatment. Accordingly, two studies were initiated to evaluate possible treatment techniques. The first study involved the use of hydrocyclones and air flotation to produce an effluent of acceptable quality; the second study examined, in detail, the application of microstraining followed by ozonation. Pilot-plant and field investigations demonstrated that excellent reductions in biochemical oxygen demand, suspended solids and coliforms can be attained consistently by these methods at a reasonable cost.

Research into Novel Vessel Waste Treatment Systems—Canada-United States Agreement
(A. Netzer)

A literature review covering shipboard wastes has been completed, as part of the Novel Vessel Waste Treatment Program. A survey was conducted and information on treatment techniques has been received from more than 50 companies in North America and Europe. During 1974, a number of treatment units were inspected. These included a system developed by W.F. Walsh Co. of Montreal; the Elsan-Yarrow system sold by J.F. Misener and Co.; and the Jered Co. vacuum collection-incineration system.

Bench-scale research was conducted to examine the treatability of shipboard sewage by coagulation-flocculation, activated carbon adsorption and chlorination. In addition, a number of related projects have been conducted by independent consulting engineering firms. Among these projects were the characterization of shipboard sewage; the evaluation of odour-controlling chemicals; and a technical and economical review of existing shipboard waste treatment methods.

Oxychlorination of Organic Pollutants — Contract
(A. Netzer)

A study to determine the products formed during hypochlorous acid treatment of organic compounds (such

as phenols and aromatic compounds, which often pollute water supplies) is being conducted at the University of Waterloo under a research contract administered and coordinated by the Water and Wastewater Treatment Research Section. The study is designed to establish whether highly chlorinated products of potential biological toxicity are produced under the conditions employed in the chlorination and superchlorination of municipal water supplies, sewage effluents and industrial waters.

The study has been initiated in response to concern about the possibility of hydrocarbon pollutants (e.g., Bunker C and other types of fuel oils) forming polychlorinated aromatic hydrocarbons such as polychlorinated biphenyls, as a result of chlorination.

The organic compounds being examined are those that are often observed as contaminants of water supplies. The study includes product identification and synthesis (e.g., rate of hypochlorous acid consumption, product isolation and chlorine content, model compound study).

Induced Biodegradability by Photochemical Processes
(B.G. Oliver)

Studies to determine the effectiveness of the application of ultraviolet light to the treatment of wastewaters were conducted. In one study it was shown that irradiation with ultraviolet light is a viable alternative to chlorination for disinfecting secondary effluents from conventional activated sludge treatment plants. Recent literature indicates that the usual method for wastewater disinfection, chlorination, produces effluent that is often toxic to the aquatic environment. These studies have shown that ultraviolet light effectively and economically disinfects the effluent and produces an effluent that is less toxic to aquatic organisms.

The photochemical conversion of a variety of organic materials in water has also been studied. Biologically resistant organic chemicals such as benzene, toluene and ethers have been converted into readily biodegradable molecules, such as phenols, alcohols and aldehydes, by sensitized ultraviolet irradiation. In addition, the colours of various aqueous dye solutions have been significantly reduced by photo-oxidation and/or photo-reduction.

The Removal of Heavy Metals from Industrial and Municipal Effluents
(B.G. Oliver)

Studies were conducted in 1974 to determine heavy metal removal efficiencies and concentration points in conventional activated sludge treatment facilities. These studies illustrate that more than 75% of most metals can be removed by the activated sludge process. Notable exceptions are bismuth, nickel and strontium, which are removed to only a limited extent in the facilities studied. Metals removed by the process are concentrated in the sludge. It is proposed that some method should be developed to reclaim the metals from the sludge before it is recirculated into the environment by land disposal.

The Decomposition and Conditioning of Sludge by Electrochemical Methods — Canada-Ontario Agreement
(B.G. Oliver)

The removal of heavy metals from industrial and municipal effluents, as part of the Canada-Ontario Agreement Project, was initiated. The purpose of this study was to remove and recover the heavy metals from sludges and sludge incinerator ash. Procedures comprising acid or basic leaching followed by electroplating and/or ion exchange and/or selective precipitation have been developed for the recovery of metals and nutrients from digested sludges and from sludge incinerator ash. Improvement of the processes and cost estimates will be evaluated in the last three months of the project.

The Removal of Asbestos Fibres from Surface Water
(J. Lawrence)

This study was undertaken because of the growing concern that ingested asbestos may be a potential health hazard. Several water treatment methods were improved and evaluated with respect to the removal of asbestos. Although simple sand filtration removes 80-90% of the fibres present, coagulation-flocculation with either ferric chloride or alum together with a polyelectrolyte reduces the concentration to below detectable limits ($<10^5$ fibres/l). Fibre concentrations were determined before and after treatment with a transmission electron microscope.

The Removal of Polychlorinated Biphenyls (PCB's) from Sewage
(J. Lawrence)

The purpose of this project was to develop a physical-chemical process to remove PCB's from raw sewage. The adsorption of PCB's was studied on a variety of media, including activated carbons, polymeric resins, polyvinyl chloride (PVC) and polyurethane foams; PVC was selected as the most efficient. A flow-through unit was used to demonstrate the feasibility of the final process.

Inland Waters Directorate, Ontario Region

WATER PLANNING AND MANAGEMENT BRANCH

In July, Mr. D.M. Foulds, Chief of the Water Planning and Management Branch, Ontario Region, was appointed Regional Director of Ontario Region, Inland Waters Directorate. Mr. N.P. Persoage, Head of the engineering staff in Burlington, was Acting Chief of the Water Planning and Management activities in Ontario.

The Branch includes the Great Lakes-St. Lawrence Study Office in Cornwall directed by Mr. D.F. Witherspoon and a suboffice, which is located in Niagara Falls.

The Water Planning and Management Branch carries out extensive studies related to water management problems in Ontario and is responsible for providing support to the International Joint Commission in various operational activities governing the control of the levels and outflows of the Great Lakes. Its members serve in various capacities on several Engineering Boards and Boards of Control established by the Commission and also on a number of joint Canada-United States International Committees.

In June 1974, responsibility for providing support to the International Lake Superior Board of Control, which regulates Lake Superior outflows, was transferred to the Great Lakes-St. Lawrence Study Office at Cornwall. The Burlington office assumed responsibility for providing support to the International Niagara Board of Control, which supervises water management operations in the Niagara River, and to the International Niagara Committee, which monitors the use of Niagara River water for power generation and scenic purposes in accordance with the Niagara Treaty of 1950 with the United States.

GREAT LAKES – LEVELS AND FLOWS

High water level conditions continued to occur on the Great Lakes during 1974. They showed, however, some improvement over the record high lake levels that occurred in 1973 on all of the unregulated lakes – Lake Huron, Lake St. Clair and Lake Erie. At the direction of the International Joint Commission, the International Lake Superior Board of Control continued to regulate the outflows of Lake Superior in a manner to provide relief from critical high water levels downstream without causing undue detriment to Lake Superior interests. During 1974, Lake Superior levels were about 7 inches above their long-term monthly means, and Lake Huron and Lake Erie, about 27 inches and 25 inches, respectively. Lake Ontario was about 22 inches above its normal seasonal maximum when it peaked in June, but it returned to near normal levels by the end of the year.

During the year, the Branch continued its program of informing shore property owners on the subject of high lake levels through correspondence, interviews by news media, and special meetings with water-use groups. In support of this activity, forecasts of the possible range of Great Lakes and Montreal Harbour levels for the ensuing six months were prepared every month and incorporated into a news release which accompanied the Monthly Water Level Bulletin issued by the Marine Sciences Directorate.

A film concerning the regulation of Lake Ontario, entitled "Not Man's to Command," was produced for the Water Planning and Management Branch in conjunction with the Public Relations Unit of CCIW. It was released in August and has had 54 public screenings, six television broadcasts, and two television cablecasts in 1974.

After the International Great Lakes Levels Board submitted its final report on the feasibility of further regulating the levels of the Great Lakes to the International Joint Commission in December 1973, Branch members continued to participate in the preparation of appendices to the final report. During October, November and December, the Commission held thirteen public hearings in Canada and the United States on the report.

Branch members played a major role in the work of a study team composed of Canadian and United States federal, provincial and state representatives appointed by the International Lake Superior Board of Control to carry out a feasibility study of remedial measures in the St. Marys Rapids to prevent the dewatering of crucial areas of the St. Marys Rapids under low-flow conditions and to resolve other fishery problems related to high flows and

velocities in the river (Fig. 30). A report, "The Feasibility Study of Remedial Works in the St. Marys Rapids at Sault Ste. Marie," which was forwarded to the International Joint Commission in September, concluded that remedial works are feasible and preferable to other possible measures, both economically and environmentally.

On the Niagara River, Branch members participated in the activities of the International Niagara Committee, which was established by the governments of Canada and the United States to determine the amount of water available for purposes of the Niagara Treaty of 1950. Branch members also provided support to the International Niagara Board of Control, which reports to the International Joint Commission. During the year, a study was completed which revealed the effects of land fill operations at Fort Erie on the levels of the upper Niagara River and Lake Erie. Work also continued on another study to determine whether or not the manipulation of the levels of Chippawa-Grass Island Pool would affect the outflows of Lake Erie. At the close of the year, a field program was commenced to collect meteorological and ice data in support of the Lake Erie-Niagara River ice boom study.

Branch members also participated in the American Falls International Board Study to investigate and report measures necessary to preserve and enhance the beauty of the American Falls at Niagara Falls (Fig. 31). The Board submitted its report to the International Joint Commission with a recommendation that no major works be undertaken at this time. It also concluded that "the guiding policy should be to accept the process of change as a dynamic part of the natural condition of the Falls, and that the process of erosion and recession should not be interrupted." The report is contained in one volume with seven appendices. At the end of the year, a brief summary brochure was prepared for public distribution in advance of the Commission's public hearing on the Board's report, to be held early in March 1975.

Branch representatives participated in the Canada-Quebec Committee on Flow Regulations – Montreal

Figure 30. St. Marys River control works at Sault Ste. Marie.

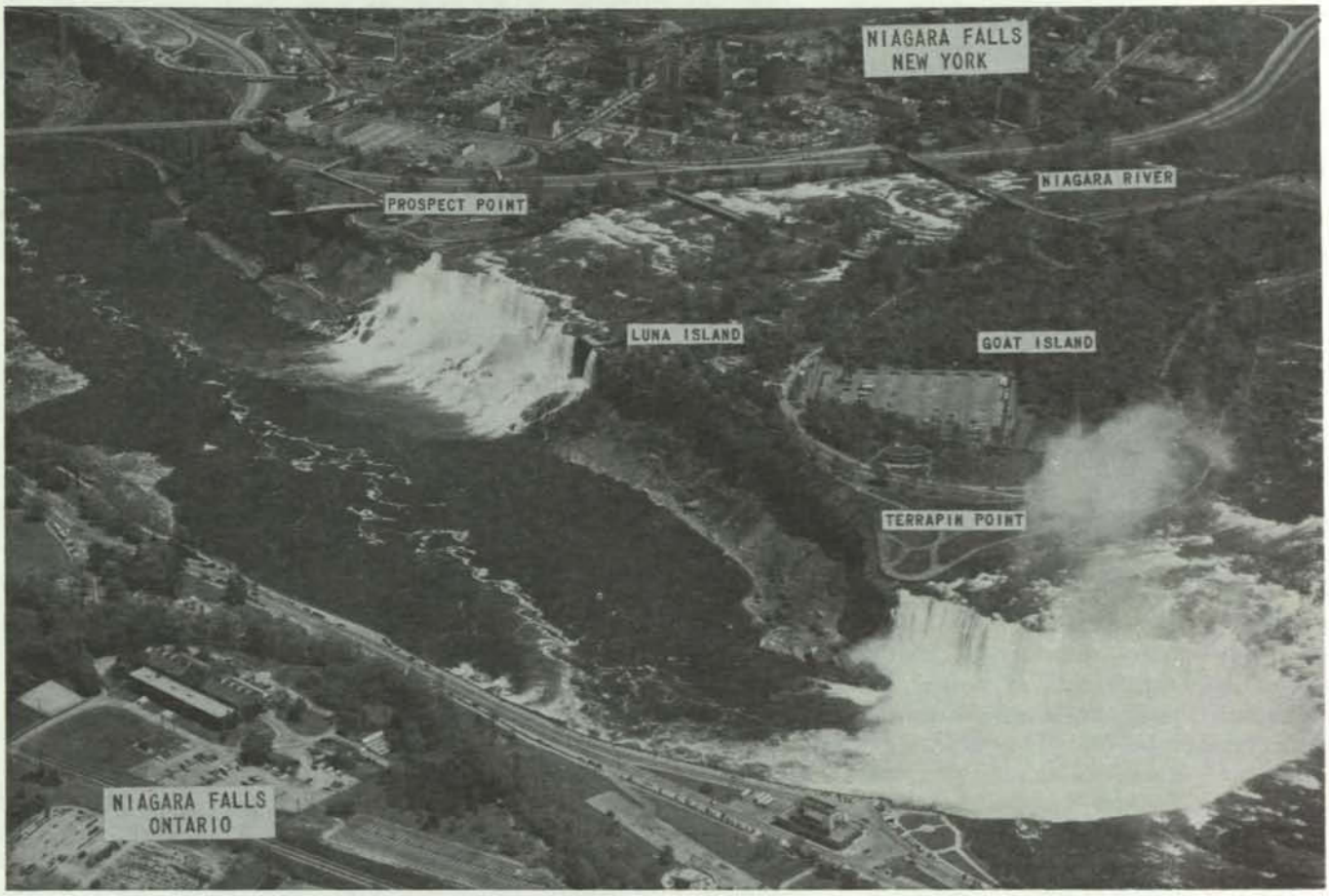


Figure 31. The American and Horseshoe Falls at Niagara. (Photograph courtesy of the Power Authority of the State of New York.)

Region. The Committee is conducting a two-year study to investigate possible ways of reducing the frequency of high and low levels on the St. Lawrence River near Montreal.

GREAT LAKES – EROSION AND FLOODING

Although erosion and flooding problems in 1974 were not as great as in 1973, they continued to be serious since lake levels remained high. Branch members served in the work of the Coordinating and Steering Committee which completed the Interim Report of the Canada-Ontario Shore Damage Survey, with recommendations designed to achieve more effective management and planning within the Great Lakes coastal zone. Federal and provincial Review Committees have been established to review the report and to develop approaches to the problem of shore erosion.

The report of the Federal Interdepartmental Task Force on Shore Erosion, entitled "Shore Erosion on the Great Lakes-St. Lawrence System," was completed early in 1974. This report, which compiled and analyzed all current information on the problem, had a wide distribution to the public and to various government agencies.

ENVIRONMENTAL ASSESSMENT

The Branch actively participates in the recently instituted Environmental Assessment Review and Protection (EARP) Process under which environmental considerations are to be reflected in the planning and implementation of all federal actions. Initiated by the Screening and Coordinating Committee on the Ontario Regional EARP Process, a Coastal Process Group, chaired by the Director, Inland Waters Directorate, Ontario Region, was formed to review shore construction and dredging projects that may lead to serious modifications of the coastal process and of the local terrestrial and aquatic environments. These projects range from proposals for the placement of docks to those involving large water intakes. Since August 1974, twelve such applications have been reviewed. The Environmental Management Service is the lead agency for the review of these projects, and the Water Planning and Management Branch plays the coordinating role, ensuring that all concerns of the various Services of the Department are considered in the environmental assessment of the project.

Under the EARP Process, a Power Generation Group was also formed. It is expected that this Group will become

active in the forthcoming year in the areas concerning the environmental aspects of power plants.

BRANCH PROJECTS

The activities of the Branch include

1) preparation of a report by a Working Group involved in the study of Water Quality in the Upper Great Lakes,

2) producing forecasts of water surface temperature in the Lake Ontario-to-Montreal reach of the St. Lawrence River, with respect to scheduling the end of navigation and the installation of ice booms,

3) studying backwater effects caused by ice jams in the lower St. Marys River at Sault Ste. Marie,

4) studying possible backwater effects caused by a proposed landfill operation at Sault Ste. Marie, and

5) developing an improved regulation plan for Lake Ontario.

WATER QUALITY BRANCH

The role of the Water Quality Branch (Ontario Region) is 1) to operate a water quality monitoring and surveys program on lakes, rivers and streams in Ontario and on the Great Lakes to provide ambient water quality data, interpretive information and advice and 2) to operate an analytical chemistry laboratory for quantifying the characteristics and constituents of waters, wastewaters, sediments and aquatic organisms and advising on analytical methodology.

MONITORING AND SURVEYS SECTION

The Monitoring and Surveys Section is responsible for carrying out field programs in the Ontario Region and evaluating the data obtained from them. This task is divided into three major programs: Water Quality Surveys, Water Quality Monitoring, and Precipitation Chemistry. Since many of the projects are joint federal-provincial projects, the Section maintains and visits periodically a liaison office at the offices of the Ontario Ministry of the Environment in Toronto.

Late in 1974, a new responsibility was assumed by the Monitoring and Surveys Section for the operation of the IWD Great Lakes Water Quality Surveillance Program. The Section is now responsible for surveillance programs in both the Great Lakes and the interconnecting channels. It is expected that this will create better coordination between these closely related programs.

Water Quality Surveys Program

In addition to projects on the St. Marys River and the St. Lawrence River, which were continuations of projects initiated in 1973, new water quality surveys were initiated on the lower Niagara River and in the region of the proposed deep water harbour on the St. Marys River. These surveys, conducted with support from other units at CCIW, are coordinated with those of the Ontario Ministry of the Environment. Their objective is to assess the present water quality of these channels 1) to determine compliance with the objectives outlined in the 1972 Canada-United States Water Quality Agreement, 2) to identify trends in water quality for evaluating the effectiveness of remedial programs, and 3) to locate any transboundary movement of pollutants.

For the 1974 field season, a trailer was outfitted for use as a field laboratory for the determination of pH, conductivity, dissolved oxygen and soluble nutrients, and for filtration and preservation of other samples for later analysis. Samples were brought back to CCIW for the determination of total nutrients, major ions, heavy metals, pesticides, PCB's, phenols, chlorophyll *a* and cyanides.

As in 1973, three 5-day surveys were carried out on the international section of the St. Lawrence River between Cornwall and Kingston. During each survey, 69 stations in 31 ranges or cross sections of the river were sampled at a depth of one metre.

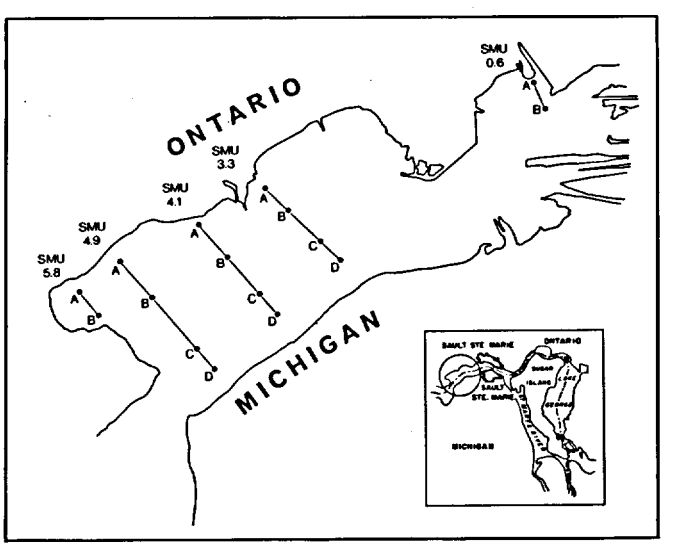


Figure 32. Sault Ste. Marie deep water harbour stations – 1974.

Three 5-day surveys of the St. Marys River were conducted; 34 stations in 7 ranges were sampled on each survey day. Three 3-day surveys were also made of the area of the proposed Sault Ste. Marie deep water harbour. A map of the area is shown in Figure 32. The data from the latter survey will be used for environmental impact assessment before construction and for comparison with future data after construction. Table 10 contains a summary of some of the data obtained from one survey.

Two new projects, a water quality survey project and a short-term variation study, were initiated on the lower Niagara River in 1974. An important objective of these projects is to refine the presently available loading estimates of nutrients and toxic substances from the Niagara River into Lake Ontario. The survey project consisted of five 3-day surveys of the lower Niagara River during the period from July to December, alternating with complementary surveys carried out by the Ontario Ministry of the Environment. Sixteen stations in three ranges were sampled on each survey day.

The short-term variation study will be carried out with the aid of an automatic water sampling device designed and built by the Engineering Services Section of the Scientific Support Division. The sampler was installed late in 1974 at the water intake of the Niagara-on-the-Lake Water Treatment Plant. The sampler will be operational early in 1975, providing data that will permit refined estimates of loadings (Fig. 33).

Figure 33. Precipitation collector used in the Water Quality Branch Precipitation Chemistry Network.

Water Quality Monitoring Program

The Water Quality Branch operates 28 water quality stations on rivers in Ontario and 54 stations on the Great Lakes, which are part of a network of about 600 stations across Canada. Samples from the river stations are presently being taken monthly or bimonthly by Water Survey of Canada or by local collectors. The Monitoring and Surveys Section coordinates the sampling and data handling for this program. Plans are being made for future quarterly

Table 10. Sault Ste. Marie Deep Water Harbour Data – July 13, 1974

Station number	Secchi depth (m)	Specific conductance 25°C (μmhos)	Nitrate + nitrite (mg/l-N)	Ammonia (mg/l-N)	Total Kjehdahl nitrogen (mg/l-N)	Soluble phosphate (mg/l-P)	Total phosphorus (mg/l-P)	Silicate (mg/l-SiO_2)	Chloride (mg/l-Cl)	Sulphate (mg/l-SO_4)
SMU-0.6-A	1.5	114	.245	.590	.860	.002	.014	2.60	4.3	6.0
B	4.5	93	.240	.019	.150	.001	.020	2.15	1.6	3.1
SMU-3.3-A	3.0*	93	.210	.004	.130	.001	.017	2.05	1.2	3.2
B	4.0*	93	.230	.003	.110	.001	.009	2.10	1.2	3.0
C	6.0	93	.240	.003	.120	.001	.009	2.15	1.2	3.0
D	5.5	95	.240	.002	.130	.001	.008	2.15	1.2	3.2
SMU-4.1-A	1.5*	92	.200	.011	.120	.001	.007	1.95	1.2	3.2
B	3.0*	92	.220	.005	.120	.001	.008	2.10	1.2	3.1
C	7.0	92	.225	.003	.120	.001	.009	2.10	1.4	3.0
D	5.0	92	.230	.004	.120	.001	.007	2.15	1.6	3.0
SMU-4.9-A	4.0	93	.200	.002	.120	.001	.007	2.05	1.2	3.1
B	4.0*	93	.205	.008	.110	.001	.006	2.10	1.4	3.6
C	8.0*	92	.225	.004	.110	.001	.011	2.15	1.2	3.1
D	4.5	93	.215	.006	.120	.001	.011	2.10	1.2	3.1
SMU-5.8-A	3.5*	93	.200	.004	.120	.001	.007	2.05	1.2	3.3
B	2.5*	93	.190	.010	.140	.001	.011	2.05	1.2	3.1
Mean	4.2	94	.220	.042	.169	.001	.010	2.12	1.5	3.3
Standard deviation	1.8	5	.017	.146	.184	.00025	.004	0.14	0.8	0.7

*Secchi disc on bottom

sampling at river stations by the staff of the Section to permit determination of those parameters for which more sophisticated sampling and preservation techniques are required.

Precipitation Chemistry Program

The operation of 22 precipitation chemistry stations in the Great Lakes basin was continued with emphasis on the upper Great Lakes. The program of rain collection and analysis on the major research vessels was maintained. The bulk of the shipboard samples collected in 1974 was from the Lake Huron-Georgian Bay region.

A new buoy-mounted precipitation sampler was designed and built in 1974. Three identical collectors were mounted on a standard meterological buoy, which was moored off the tip of the Bruce Peninsula.

The Section was involved in the development and awarding of a contract to two consulting firms for the evaluation of data from the precipitation chemistry program and the estimation of the effects of atmospheric inputs on the chemical budget of the Great Lakes. Since the awarding of the contract, the Section has been co-operating with the contractors by supplying precipitation chemistry data and has also participated in monitoring the contract.

ANALYTICAL SERVICES SECTION

The Analytical Services Section consists of three laboratories: an Inorganic Analysis Laboratory, an Organic Analysis Laboratory, and a Ships Support Laboratory. This Section provides analytical support for projects undertaken not only by the Monitoring and Surveys Section, but also by other groups at CCIW, other Units of the Inland Waters Directorate, and, to a lesser extent, other segments of the federal government. During 1974, the Section supported a total of 67 programs and was particularly active in support of IJC programs, such as programs of the Upper Lakes Reference Group and the Pollution from Land Use Activities Reference Group, and the River Survey programs.

More than 25,000 samples were analyzed during 1974, including 11,000 wastewater samples and about 6000 samples from surveys of the Great Lakes and interconnecting channels. Approximately 170,000 tests were conducted on these samples, including 27,500 tests performed on board ship and some 6000 in field laboratories.

Some of the major projects in which the Section participated are listed here.

Upper Lakes Survey

Analytical support was provided for all of the seven survey cruises on Georgian Bay and Lake Huron, which were conducted during 1974. This work was related to Task 12 of the Canada-United States Water Quality Agreement and was designed to provide chemical data for the annual report to the IJC. In addition, biota and sediment samples collected during a special survey cruise of Lake Superior, Lake Huron and Georgian Bay, were analyzed for a number of toxic substances.

Samples were also analyzed on behalf of the United States Environmental Protection Agency Region V Laboratory in Chicago for its Winter Surveys on the upper Great Lakes. There were frequent exchanges of samples among the laboratories during the year for quality control purposes.

Other Great Lakes Projects

Analytical support was provided to a number of other projects related to the Great Lakes including

1) lower Great Lakes surveillance in which the laboratory staff participated in two surveillance cruises on Lake Ontario and one on Lake Erie and provided analytical support to another 15 cruises on the lower Great Lakes,
2) field and laboratory support to the Monitoring and Surveys Section for surveys carried out on the Niagara, St. Lawrence and St. Marys Rivers and on the deep water harbour site at Sault Ste. Marie,
3) field and laboratory support to the Great Lakes Biolimnology Laboratory, the Microbiology Laboratory and the Lakes Research Division for the Point Source Study which was conducted in Nipigon Bay at Red Rock, Ontario, and
4) analysis of precipitation samples collected by the Monitoring and Surveys Section.

Wastewater Treatment Studies

Analytical support was provided to a number of projects related to wastewater treatment which included the removal of heavy metals from wastewater by adsorption; the evaluation of the efficiency of wastewater treatment by reverse osmosis; and a vessel wastewater treatment study.

Other Projects

The NTA Monitoring Program continued with analysis of samples from Lake Ontario and Hamilton Harbour, from the Western Region, and from municipal water supplies that were sampled early in the year.

The Section extended its analytical capabilities to include sediment analyses and chlorophyll *a* analyses. Automated methods were set up for the determination of cyanides and low-level total Kjeldahl nitrogen. An Autolab System IV computing integrator was installed in the Organic Analysis Laboratory to achieve a high degree of automation in the chromatographic analysis of pesticides. High-speed liquid chromatography is also being used for the clean-up step in organic analyses.

The Section collaborated with the Microbiology Laboratory in a study of degradation of fecal sterols. The study showed that mercuric chloride was far more effective as a preservative than sodium hypochlorite.

Sample Exchange

The laboratory participates in several continuing sample exchange programs including those conducted by the Upper Lakes Reference Group Committee for Data Quality, the Water Quality Branch, the United States Environmental Protection Agency, the Canadian Committee for Pesticide Use in Agriculture, and the Pollution from Land Use Activities Reference Group. The latter three agencies' programs involve organic parameters including chlorinated hydrocarbon and organophosphorus pesticides and phenoxy acid and triazine herbicides.

The laboratories have also participated in a number of special exchanges, including a field exchange with the Ontario Ministry of the Environment, an International Association of Geochemistry and Cosmochemistry intercalibration study, and special studies on metals in sludge and sediments, and on PCB's and chlorinated hydrocarbons in fish.

SPECIAL SERVICES SECTION

The Special Services Section carries out technical programs of national interest to the Water Quality Branch, which maintains laboratories in Calgary, Moncton and Vancouver as well as at CCIW. The programs include development of test methods and updating of the laboratory manual; operation of a quality control program among the laboratories; special advice and assistance to the laboratories regarding analytical problems and instrumentation; and provision of standards for organic compounds difficult to obtain through normal channels.

The Section consists of two laboratories — a Quality Control Laboratory and a Method Development Laboratory.

Quality Control

The quality control function is carried out primarily through two major programs.

The Inter-Regional Quality Control Program

In this program samples are distributed every month to the Water Quality Branch laboratories only for analysis of a complete range of parameters (major ions, physical properties, nutrients, trace metals, pesticides and other organics). The results are compared and the laboratories are notified of any discordant results. The results are analyzed to determine any small, but consistent, biases over a period of time. The program proved very useful during its first year of operation in 1974 by revealing a number of unsuspected problem areas that could have been serious if they had remained unnoticed.

The National Quality Control Program

In this program samples are distributed to a group of about 40 laboratories involved in water analysis across Canada including federal, provincial and municipal government laboratories, universities and private companies. The following studies were conducted during 1974:

Study No. 11 — boron, fluoride and silica,

Study No. 12 — cadmium, chromium, lead, manganese and nickel, and

Study No. 13 — copper, lead, zinc, cobalt, iron and aluminum.

The laboratory also provides assistance to the regional laboratories in matters related to quality control and participates in other projects such as IJC committees on quality control.

Method Development

Method development activities this year were primarily directed to methods for the determination of metals and nutrients in sediments, the determination of carbamate pesticides and the confirmation of organophosphorus and chlorinated hydrocarbon pesticides.

Important projects finished during the year include

1) a new approach to the confirmation of chlorinated hydrocarbon pesticides using a solid matrix for derivatization, which was further extended to apply to over a dozen pesticides in fish, water and sediment extracts. This approach is more rapid, sensitive and comprehensive than other existing methods. It has been adopted by several outside laboratories, as well as the by the Water Quality Branch laboratories,
2) a method for the determination of chlorinated hydrocarbon pesticides and PCB residues in sewage, developed for the needs of two EPS projects in the Ontario Region,
3) a method for the confirmation of the identity of

eight organophosphorus pesticides at sub-ppb levels, which is the most comprehensive and sensitive method available to date,

4) a method for the determination of inorganic, organic and total phosphorus in sediments by digestion with different acids followed by automated colorimetric determination of the phosphate produced,

5) a semi-automated procedure for the determination of mercury in sediments, currently in use at CCIW,

6) a procedure for the analysis of heavy metals in precipitation using atomic absorption spectrophotometry with a heated graphite furnace. The method is more sensitive than conventional flame atomic absorption and is needed when samples collected are too small for the conventional extraction procedure, and

7) the preparation of bulk sediment standards for quality control and method development use. Twenty-three samples of 1-5 kg were prepared for use as standards.

WATER SURVEY OF CANADA

The basic responsibility of the Ontario Region of the Water Survey of Canada is to maintain an inventory of the water quantity of the water resources in Ontario. The District Office is located in Guelph, with suboffices in Ottawa, North Bay and Sault Ste. Marie.

Operations of the network in the western and northwestern part of the Province are carried out by the Manitoba District of the Western Region, Inland Waters Directorate. In addition to the water quantity planning and monitoring programs, the Ontario Region, in co-operation with the United States Army Corps of Engineers, is responsible for monitoring programs on interconnecting channels in the Great Lakes and specifically in the Niagara River, where considerable work is done for the International Niagara Board of Control.

Operation and maintenance of water level stations on the Great Lakes are carried out for the Central Region, Marine Sciences, Ocean and Aquatic Affairs, and a limited sampling program is conducted in co-operation with the Water Quality Branch.

A review of the functions and operations of the Sections in the Ontario Region follows.

FIELD OPERATION SECTION

This Section consists of three prime work areas: hydrometric gauging stations, Great Lakes water levels, and sediment surveys.

A hydrometric network of 377 active gauging stations was operated in 1974. An extensive field program for collecting discharge measurements to determine or verify water level discharge relationships was carried out. This included an approximate total of 2700 measurements and six new gauging installations. Water level data extraction from recorder charts was made with a d-Mac Pencil Follower, and data were processed on an IBM 370 computer located at the University of Guelph Computer Centre. Sampling programs on behalf of the Water Quality Branch and Groundwater Division and the Water Resources Branch were also completed. One hundred and ninety water quality samples and two groundwater discharge measurements were collected and forwarded to the respective division involved.

Field surveys and slope sections were made at a number of stations on the Grand River watershed. Data from the survey were used to establish the extension of stage-discharge curves to determine the high flows experienced in May 1974. Isolated thunderstorms created record flows at nearly all stations with damage worth millions of dollars caused by flooding. Discharge measurements obtained were records in all areas, and in some cases, flows exceeded Hurricane Hazel.

In March 1974, an intense network of highly instrumented stations was constructed in the upper Duffin Creek basin. The program is part of an Environmental Impact Study of the proposed site of the new Toronto International Airport. A total of 13 stations, instrumented with 9 pumping water samplers, 8 thermographs and 1 telemark, monitor the upper Duffin and west Duffin Creek basins for surface flow, water quality and sediment transport.

The water monitoring program is integrated with a program for the North Pickering Community Development Project, which is conducted by the Ontario Ministry of the Environment.

A total of 41 water level stations located on the Great Lakes and St. Lawrence River were maintained for the Central Region, Marine Sciences, Ocean and Aquatic Affairs. A Telex Data Retrieval System is now installed and functioning at a minimum of one location on each of the

Great Lakes. The Kingston water level station was relocated to accommodate the part of the 1976 Olympics Program to be held in the Kingston Harbour. A temporary water level installation was constructed at Douglas Point to collect water data to evaluate the amount of fluctuation in levels of Lake Huron.

An annual sediment sampling program involving 12 stations in the regional network was completed. During 1974, 3200 bottled samples, 17 suspended sediment discharge measurements and 50 bed-material samples were collected. On the upper Duffin Creek basin, 264 water quality and sediment samples, 9 bed-load samples and 11 suspended sediment discharge measurements were taken.

Sediment discharge computations for 1973 data were computed and approved for four stations by District personnel; the remainder were forwarded to the Sediment Section of the Applied Hydrology Division in Ottawa for completion. Extensive field surveys were carried out at the Conestogo and Parkhill Reservoirs as part of a Reservoir Study program to be completed by the Sediment Section in Ottawa. Staff of the Ontario Conservation Authorities, Sediment Section of Applied Hydrology Division and the Ontario District of the Water Survey of Canada conducted the surveys.

SPECIAL STUDIES AND SURVEYS SECTION

In 1974, this Section maintained a number of measurement programs on the interconnecting channels of the Great Lakes.

The programs completed were

1) discharge measurements of the lower Niagara River taken from the Robert Moses cablecar to verify the Ashland Avenue gauge stage-discharge curve and discharge measurements at the cableway above Queenston to determine the extent of weed effect at the Ashland Avenue gauge,
2) discharge measurements to calibrate ten sluices of the Lake Superior control structure,
3) discharge measurements of the St. Lawrence River at Cornwall to determine the distribution of flow around Cornwall Island,
4) discharge measurements of the upper Niagara River to determine whether or not the outflow of Lake Erie is affected by the regulation of the Grass Island Pool, and
5) measurement program on the Niagara River at the outlet of Lake Erie near the Peace Bridge, as part of a critical depth study.

NIAGARA RIVER STUDIES AND CONTROL

This Unit participated in the functions of both the International Niagara Working Committee and International Niagara Board of Control. Responsibilities for the coordination of the International Niagara Committee and Lake Erie outflow – Lake Ontario inflow monthly reports were transferred to the Water Planning and Management Branch, Ontario Region, Inland Waters Directorate, effective October 1974.

The Leading Edge Flowmeter functioned during most of the year; it malfunctioned during the backwater study in November 1974. Major repairs were required, and the test was postponed until 1975.

DATA CONTROL SECTION

This Section is comprised of two main working groups: the Hydrometric Data Compilation and Quality Control group and the Data Review group.

In 1974 our major publication "Surface Water Data – Ontario – 1973" was compiled, quality-checked, printed and distributed to various data users throughout Ontario. A large percentage of the computation and publication procedures are now automated and in 1974, the publication was available three months ahead of distribution in previous years. This has reduced the amount of data requests handled to approximately 13,000 station years of record from the 22,000 of the previous year. Not included in the data were miscellaneous requests for river cross sections, velocity profiles, extremes for period of record, etc. During the year, 499 separate requests for data were provided to fifteen different agencies; these do not include numerous telephone requests for which data were supplied orally.

The Data Review group, which is involved in a systematic review of all data collected to 1970, has completed approximately 40% of the total planned program. The initial phase of the program was concentrated in the northern basins of Ontario and progressed to the southern and southwestern Georgian Bay basins. Work involved the examination and revision, if necessary, of the data.

NETWORK PLANNING AND FORECASTING SECTION

Some of the major projects completed during the year follow:

1) an Inter-District Flow Forecasting Seminar was

hosted by the Ontario Region. Various methods used were examined and organizations using flow forecasting in Canada were recognized,

2) data for five Ontario river basins were prepared and forwarded to Ottawa for inclusion in the *UNESCO World Catalogue of Very Large Floods,*

3) a paper entitled "Hydrometric Instrumentation" was prepared and presented in the *Summary Report of the Perch Lake Evaporation Study.* The paper was presented at a Symposium held at the Atomic Energy of Canada site, Chalk River, and

4) a federal-provincial cost-sharing agreement.

Environmental Protection Service

Environmental Protection Service

The Environmental Protection Service (EPS) was formed to ensure that the federal government's legislation, regulations and guidelines concerning the quality of the environment are approached in a manner consistent with national policy and enforced under appropriate circumstances. The Environmental Protection Service is involved in the development of guidelines and regulations, in the identification and solution of pollution problems, in problem surveillance and monitoring, and in the development and demonstration of waste treatment technology. It draws on expertise from the Resource Missions of the Department for the criteria necessary to develop effective regulations, guidelines, and codes of good practice and for the research required to support EPS responsibilities.

TECHNOLOGY DEVELOPMENT AND DEMONSTRATION DIVISION

The Technology Development and Demonstration Division, Technology Development Branch, Water Pollution Control Directorate, is responsible for the conception, development and implementation of technical development programs related to water pollution control for industrial and municipal wastewaters across Canada. The Division not only undertakes bench-scale and pilot-scale studies in its laboratories, but also participates in field demonstration projects at industrial sites.

To fulfill the mandate of the Technology Development Branch, EPS established a program at the Wastewater Technology Centre at CCIW. The Wastewater Technology Centre (WTC) is located in a two-storey building at the north end of the CCIW site. The building houses laboratories and provides 1395 m^2 (15,000 sq ft) of working area for a wide variety of modular wastewater and sludge treatment process equipment.

The Wastewater Technology Centre bases its program priorities on the requirements of the Abatement and Compliance Branch of the Water Pollution Control Directorate, inputs from the various regional branches of EPS and provincial environmental organizations, and federal, national and international commitments.

The staff of the Wastewater Technology Centre is organized into three main sections: the Process Development Section, the Laboratory Services Section and the Facilities Services Section, all supported by administrative personnel.

PROCESS DEVELOPMENT SECTION

The Process Development Section comprises four Units organized along process lines: the Biological Processes Unit, the Physical Processes Unit, the Chemical Processes Unit and the Soil Processes Unit.

Biological Processes Unit

This Unit is responsible for developmental work on biological processes used to remove components such as BOD, suspended solids and toxicity from municipal and industrial wastewaters. A Bioassay group, responsible for determining the fish toxicity of untreated waste streams and treated process effluents, was part of the Biological Processes Unit until October, when it was transferred to the Laboratory Services Section.

Biological Treatment of Kraft Bleachery Effluent

A joint federal-industrial project involving the operation of a pilot-scale two-stage activated sludge system treating kraft bleachery effluent was conducted at Eddy Forest Products, Espanola, Ontario. For comparison purposes, a conventionally loaded single-stage system was operated parallel with the two-stage system. Emphasis was placed on an assessment of the capabilities of the activated sludge systems for the reduction of acute toxicity to juvenile rainbow trout. Process efficiencies were determined and engineering design parameters were developed.

For the two-stage activated sludge system, volumetric loadings of 3.8 and 1.6 kg $BOD_5/m^3 \cdot$ day (235 and 100 lb $BOD_5/1000\ ft^3 \cdot$ day) provided BOD_5 reductions of 67% and 90%, respectively. The achievement of similar BOD_5 reduction required the operation of the single-stage system at volumetric loadings of 1.6 and 0.7 kg $BOD_5/m^3 \cdot$ day (100 and 45 lb $BOD_5/1000\ ft^3 \cdot$ day).

To compare the toxicity removal capabilities of the single-stage and two-stage activated sludge systems with

respect to fish, logarithmic probability distribution plots of median survival time (MST) in 100% effluent were developed (Fig. 1). The MST for the untreated bleachery waste is shown for comparison.

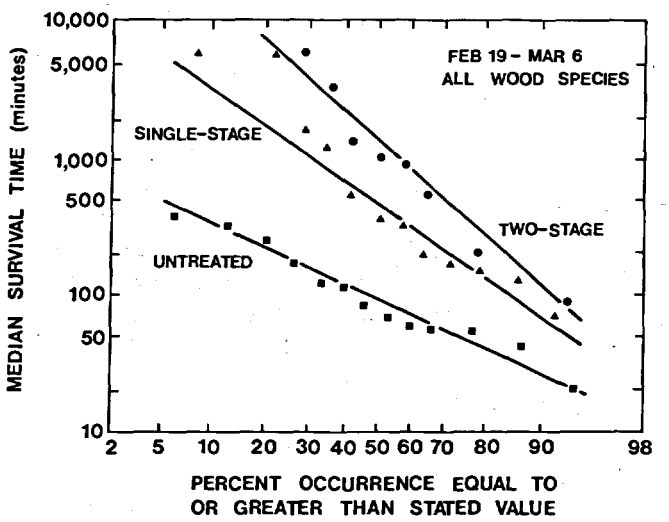


Figure 1. Probability distribution for median survival time for treated and untreated kraft bleachery effluent.

Even under organic-loading and volumetric-loading conditions considerably greater than for the single-stage systems, the two-stage system achieved consistently higher toxicity removal.

Effluents from the single-stage and two-stage activated sludge systems treating kraft bleachery effluent did not meet the toxicity requirements specified in the Pulp and Paper Effluent Regulations (1971), i.e., there must be 80% survival of rainbow trout after 96 hours in a 65% effluent solution. Preliminary bench-scale studies indicate, however, that the addition of alum and powdered activated carbon to the aeration cells of either activated sludge system will produce an effluent that meets the toxicity requirements specified in the 1971 regulations. Before a program is established to improve rates of chemical addition to the activated sludge system, bench-scale studies will be conducted to identify the chemical constituents of bleached kraft mill effluent that are the major contributors to fish toxicity and to determine the extent to which these toxic components are removed by the treatment process.

Biological Nitrification-Denitrification Studies

The joint research project initiated with McMaster University in 1972 was continued throughout 1974. Detailed studies were carried out to examine various flow and process configurations for biological nitrification.

The primary objective of this phase of the program was the evaluation of combined sludge and separate sludge, carbon-removal nitrification systems for the treatment of municipal wastewater. Specific alternatives evaluated were single-stage combined sludge, two-stage combined sludge and two-stage separate sludge systems. Pilot-scale reactors, as shown in Figure 2, were operated under pseudo steady-state conditions over a range of loading conditions and temperatures. Parallel reactor operation provided a mechanism for direct and sensitive comparison of operational and kinetic data.

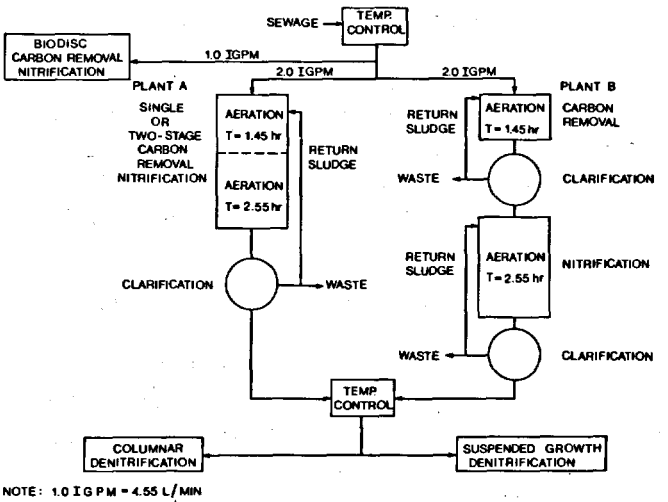


Figure 2. Flow diagram of 7200 Igpd nitrification-denitrification pilot plant.

For each alternative, the degree of nitrification achieved was found to be dependent on the sludge age (i.e., solids retention time) in the system. Separate sludge systems removed a significantly greater amount of filterable TKN than the combined sludge systems at equal system solids retention times. In each system, the nitrification rate was found to be more sensitive to temperature than the rates of organic carbon removal, particularly at lower temperatures. To achieve complete nitrification at temperatures approaching 5°C, a minimum solids retention time of ten days appears necessary regardless of the alternatives selected.

A second phase of the nitrification-denitrification project involved the operation of a rotating biological contractor for nitrification and an upflow packed column for denitrification. The rotating biological contractor was operated parallel with a two-stage activated sludge system with intermediate clarification to compare rates of ammonia conversion for temperatures ranging from 5°C to 25°C. Nitrification rates for the fixed film reactor were found to be less temperature sensitive than for the suspended growth system.

Two upflow denitrification columns were operated to determine whether a high void fraction plastic packing could be used effectively to minimize liquid distribution and blockage problems. Tracer studies showed that there

was extensive short circuiting within the column, which was attributed to an accumulation of biological solids. The partial blockage of the column resulted in highly variable denitrification rates.

Refinery Effluent Toxicity Balance Study

A joint federal-provincial-industrial project was carried out at the Shell Refinery in Sarnia to quantify, in terms of toxic units, the toxicity contributed by the individual refinery process effluents. The Bioassay group conducted bioassay tests on site using the mobile bioassay laboratory and the mobile storage trailer (Fig. 3). Shell Canada, Imperial Oil Enterprises, and the Ontario Ministry of the Environment participated in the project.

Figure 3. Mobile bioassay and storage trailer at the Shell Refinery, Sarnia.

The method of expressing the toxicity of the wastewater was to measure the 96-hr LC50, the lethal concentration for 50% of the fish in a 96-hour period. The reciprocal of the 96-hr LC50 designated as the toxicity concentration, Tc = (100/96-hr LC50), and having units of toxic units, was used for the comparison of the results. For a specific crude unit that had a number of contributing streams, the toxic concentration multiplied by the proportion of the total system flow was determined for each contributing stream. If a toxicity balance existed, the sum of the toxic units of individual streams within the system would equal the toxic units of the total effluent from the system.

To establish a toxicity balance, the flow, chemical composition and 96-hr LC50 were measured for each refinery process effluent, the total effluent from each crude unit, the combined effluent from the two crude units, effluents at intermediate points in the treatment system and the final treatment system effluent. Results from each refinery process effluent were combined to establish whether a toxicity balance existed for the individual crude units or the combined effluent from the two crude units, i.e., the total oily water refinery effluent prior to treatment.

Treatment plant process effluents were included in the study to provide a quantitative measure of the toxicity removed by each process of the treatment system, i.e., the oily water separator, air flotation unit and biological oxidation unit. Reductions in toxicity were highly variable and inconsistent; the biological oxidation unit was the exception, as it produced a relatively constant percentage toxicity reduction. It was established that the complete treatment system was capable of reducing the toxicity to the level specified in the *Petroleum Refinery Effluent Regulations and Guidelines* published by EPS in 1974.

Biological Treatment of High-Strength Pulp and Paper Mill Effluents

Bench-scale studies were undertaken to determine whether the activated sludge process could be used to treat the effluent from a neutral sulphite semi-chemical (NSSC) pulp and paper mill that has an extensive water reuse program. Effluents obtained from the Domtar NSSC mill at Trenton had a BOD_5 of approximately 12,500 mg/l and a total dissolved solids (TDS) of 45,000 mg/l. Although the high-strength effluents were biodegradable, they could not be treated successfully in either a single-stage or two-stage activated sludge system. Oxygen deficiencies, excessive foaming and bulking sludge were the major operational problems.

Similar bench-scale activated sludge studies have been carried out at the Consolidated-Bathurst Research Centre in Grand'Mère, Quebec. In this joint project, high-yield bisulphite spent cooking liquors having a BOD_5 of 15,000 mg/l and a TDS of 45,000 mg/l were treated in both single-stage and two-stage activated sludge systems. Solid-liquid separation problems resulted in unacceptable performance of the activated sludge systems. Following dilution of the spent sulphite liquor to 2% TDS, the two-stage activated sludge system with a total aeration time of 1.5 days could be operated with an apparent improvement in sludge settling characteristics.

Physical Processes Unit

This Unit conducts research and development work on physio-chemical treatment processes for the removal of deleterious and toxic constituents from industrial and municipal waste streams. Active areas of concern include the development of design and operational criteria for the dewatering of municipal waste sludges, investigation of physical-chemical treatment (PCT) processes for small communities and the treatment of wastes from base metal mining, metal-plating and steel industries.

New Brunswick Acid Mine Drainage Treatment Project

In 1972, a joint federal-provincial-industrial study was initiated for the development of mine and mill wastewater treatment technology in the base metal mining

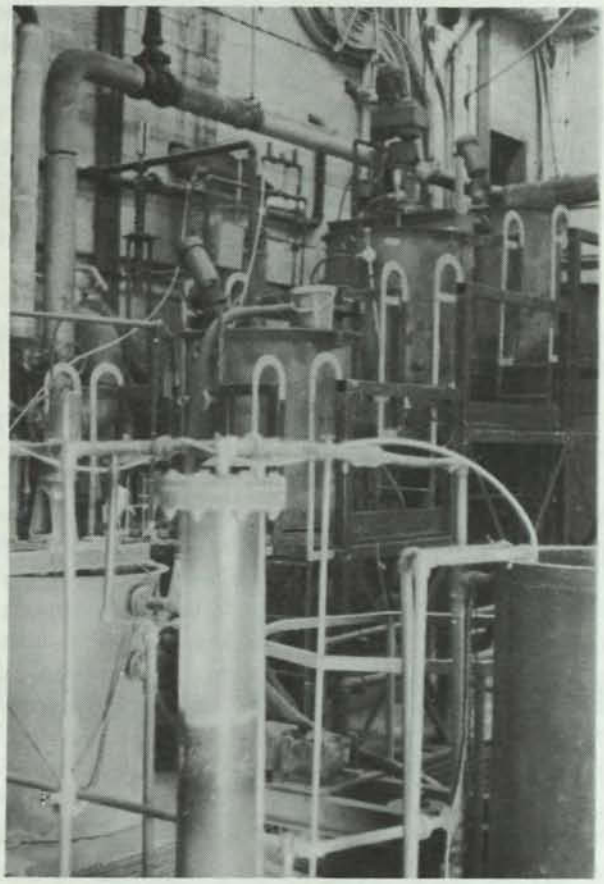


Figure 4. Physical-chemical pilot plant for treatment of acid mine drainage.

industry. Two pilot demonstration plants were established at the Brunswick Mining and Smelting Corporation site in northeastern New Brunswick (Fig. 4). One of the pilot plants incorporates state-of-the-art technology for the treatment of acid mine waters. Unit processes include neutralization and precipitation, polymer flocculation, sedimentation, sludge-handling and effluent-polishing. Effluent metal concentrations obtained from several mine waters using state-of-the-art technology are summarized in Table 1.

Table 1. Heavy Metal Concentrations (Total Metals) of Some Mine Waters after Physical-Chemical Treatment

Mine water	Pb (mg/l)	Zn (mg/l)	Cu (mg/l)	Fe (mg/l)
Clarification Brunswick mine smelting (BMS) no. 12	0.30	0.42	0.04	0.36
Heath Steele	0.11	0.65	0.08	0.51
BMS no. 6	0.30	0.52	0.06	0.54
Clarification and sand filtration Heath Steele	0.10	0.14	0.02	0.22

Figure 5 illustrates the excellent effluent-polishing achieved with sand filtration for removal of suspended solids carried over in the clarifier effluent.

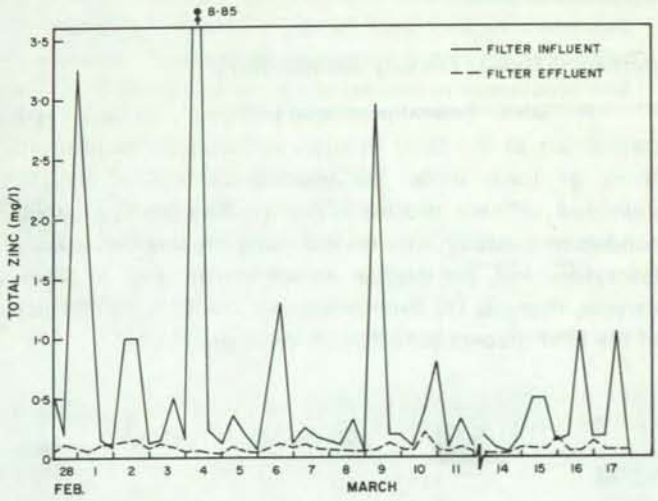


Figure 5. Zinc removal by sand filtration.

A pollution problem also existed from the milling of the ores containing a high sulphur content. Reduced sulphur compounds (thiosulphate and thionates), generated in the grinding and separation processes, were escaping from the mill in the tailings pond overflow. This caused a significant pH depression in the receiving water when indigenous bacteria oxidized these thiosalts to sulphate. Studies carried out at the Wastewater Technology Centre established the feasibility of two treatment processes: biological oxidation using a rotating biological contactor (RBC) and chemical oxidation in a stirred tank reactor using ozone. The RBC (Fig. 6) is currently in operation at the mine site to demonstrate this technology.

Physical-Chemical Treatment for Small Communities

Sewage treatment plants that serve small, isolated communities of a few thousand people or less, typically present unique design and operational problems that are not usually encountered in large plants. Many of the difficulties are directly related to the highly variable organic and hydraulic loads under which small plants must operate. In addition, small plants generally receive very little maintenance and monitoring. To ensure improved and consistent effluent quality, a program on the development and demonstration of physical-chemical treatment systems for small communities was initiated.

One experimental phase consisted of a chemical coagulant addition to an extended aeration pilot plant.

A second experimental program was conducted to determine the effects of chemical additions to raw sewage (including powdered activated carbon) on the primary treatment process efficiency.

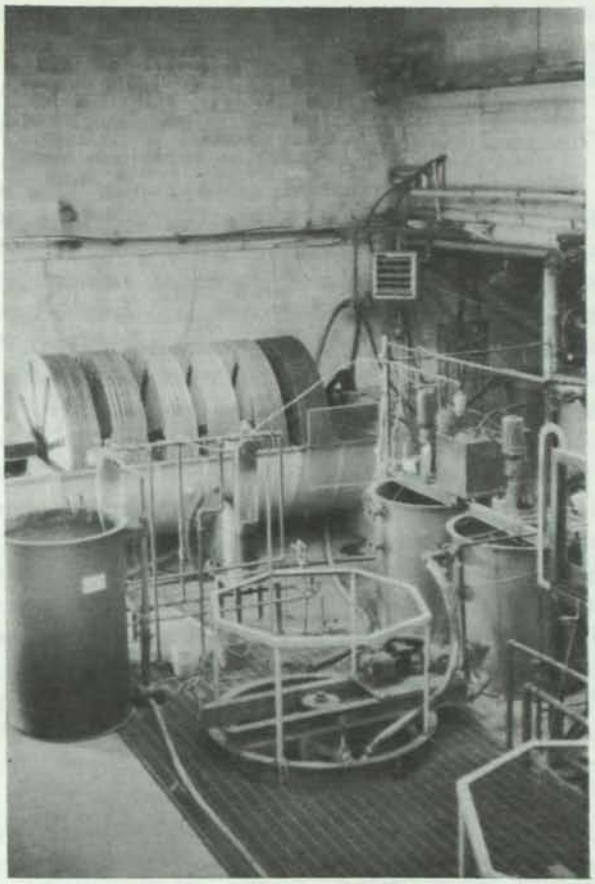


Figure 6. RBC pilot plant for thiosalt treatment.

A third experimental program, which is now in progress, involves conventional physical-chemical treatment. This pilot plant includes a programmed control system which enables us to simulate the variations in organic and hydraulic loading that are encountered in "real life" situations (i.e., small communities). As presently conceived, it includes the unit processes of chemical coagulation, solids separation, adsorption and sand filtration (Fig. 7).

Sludge Dewatering Process Development Studies

The Sludge Treatment Process Development Program is examining municipal waste treatment with respect to physical and chemical properties of the sludges. These properties are correlated with the efficiency of various sludge dewatering processes. At the same time, this program is designed to examine the control variables and scale-up techniques of the following sludge dewatering processes: vacuum filtration, centrifugation, dissolved air flotation, gravity thickening and pressure filtration.

To meet these objectives, the Wastewater Technology Centre developed a sophisticated analytical laboratory for measuring physico-chemical properties and established a mobile bench-pilot scale sludge dewatering facility (Fig. 8).

Figure 7. Physical-chemical treatment pilot plant for small communities.

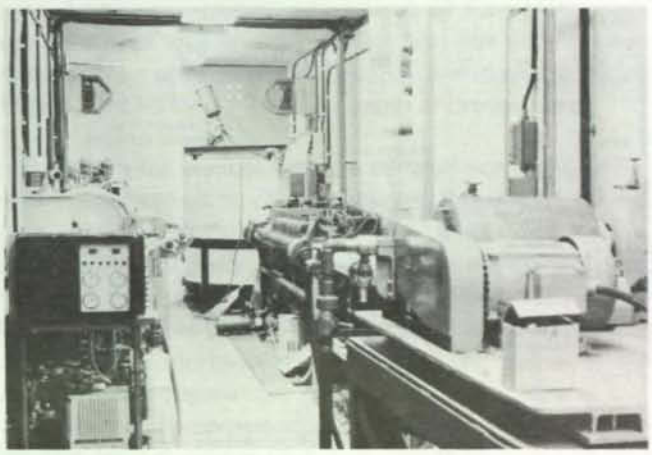


Figure 8. Bench-pilot scale mobile sludge dewatering facility.

During the past year, many sludges (waste activated, raw primary, mixed primary and waste activated, and digested) have been dewatered using the various processes available.

Chemical Processes Unit

This Unit carries out developmental work using chemical processes for the removal of undesirable and potentially harmful constituents from effluent waste streams. Of immediate concern and involvement is the removal of phosphorus by chemical means.

Full-Scale Phosphorus Removal Studies

Full-scale phosphorus removal studies, employing alum addition to the activated sludge treatment plant, were conducted at C.F.B. Trenton, Ontario. Treatment plant

performance with respect to BOD_5, total phosphorus, and suspended solids removals was closely monitored under base-line (no chemical addition) conditions and at various alum addition levels.

The required alum dosage for phosphorus removal was 3.0 mg/l to 3.5 mg/l as Al, and the most effective addition point was at the exit end of the aeration basins.

Sludge Incineration and Chemical Recovery

A field station was set up at the C.F.B. Borden, Ontario, Wastewater Treatment Plant for pilot-scale studies on sludge dewatering, incineration and chemical recovery. Multiple-hearth and rotary kiln incineration of alum, ferric chloride and slum sludges were investigated. The feasibility of recovering and recycling lime-iron from the incinerator ash was also explored. The calorific values of several sewage sludges are presented in Figure 9. A strong correlation between sludge volatile solids content and calorific value is evident.

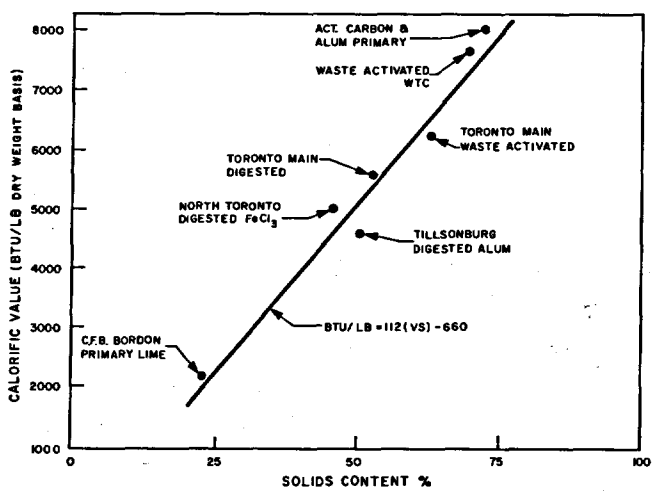


Figure 9. Calorific-value volatile-solids relationship for selected sludges.

Polychlorinated Biphenyls in Domestic Wastewater

A survey of polychlorinated biphenyl (PCB) concentration in the raw wastewaters from 33 Ontario municipalities was conducted. In addition, detailed investigations of the fate of PCB's during conventional secondary treatment were performed at the Hamilton Wastewater Treatment Plant. PCB concentrations in raw wastewaters ranged from less than 0.1 ppb to 1.8 ppb, of which the industrial areas of Hamilton, Toronto and Windsor exhibited the highest levels. The primary treatment facilities that were surveyed removed on the average 50% of the PCB load, whereas secondary plants averaged 66% removal. PCB concentrations in digested sludges ranged from 0.6 ppm to 76.6 ppm (dry weight).

As expected, the predominant mechanism of PCB removal during wastewater treatment is by concentration in the primary and/or waste activated sludge streams.

NTA Degradation in a Receiving Stream

Since the Canadian detergent reformulation legislation of 1972, NTA use in laundry detergents has increased. Considerable research effort has been devoted to determining the environmental implications of NTA (e.g., biological wastewater treatment degradation studies and investigations of potential metal transport problems). To date, limited studies have been carried out to ascertain the extent of NTA degradation within the receiving water.

In this investigation, NTA levels in Grindstone Creek, the receiving water for the Waterdown, Ontario, Wastewater Treatment Plant were closely monitored to determine the degree of NTA degradation under summer and winter conditions. Sampling stations were established at six points over the five-mile stretch of stream between Waterdown and Hamilton Harbour. Samples were collected under two influent wastewater NTA loading conditions (i.e., 16-20 mg/l and B-16 mg/l) during summer and winter. Steamflow and temperature were closely monitored.

During the summer period when NTA removal through the treatment plant was in excess of 95%, dilution and degradation combined to give downstream NTA concentrations consistently less than 10 μg/l. In the winter when stream temperatures were in the range of 0.5°C to 3.0°C and NTA removal through the plant was less than 45%, downstream NTA concentrations as high as 125 μg/l were encountered. At the same time, levels at the mouth of Grindstone Creek in Hamilton Harbour averaged 40-50 μg/l.

Activated Sludge Degradation of Metal NTA Complexes

A bench-scale batch activated sludge study was conducted to determine the biodegradability of NTA complexes with aluminum, cadmium, calcium, chromium, copper, iron, mercury, nickel, lead and zinc. Degradation rates were evaluated at NTA levels of 8 mg/l and 16 mg/l as H_3NTA, temperatures of 5°C and 15°C and various metal concentrations.

It was determined that the NTA complexes with Al, Ca, Cr, Cu, Fe, Pb and Zn degraded readily at first-order degradation coefficients ranging from 0.04 hr^{-1} to 0.10 hr^{-1}. The heavy metal NTA complexes of Ni, Cd, and Hg degraded poorly (i.e., degradation coefficients less than 0.02 hr^{-1}).

These experiments, reinforced by observations of other related studies, lead to the conclusion that the buildup of NTA in the aquatic environment, even during low winter temperatures, is extremely unlikely.

Development of Predictive Models for Phosphorus Removal

The objective of the study was to determine whether a correlation between influent wastewater characteristics and phosphorus removal by chemical addition exists and, if so, to define this relationship.

Available data from treatability studies were analyzed, but were found to be inadequate for the development of significant relationships. These data, however, were supplemented by conducting additional jar tests at 20 sewage treatment plants across Ontario. Each jar test study consisted of ten jar test runs using all three chemicals (ferric chloride, alum, lime) and, at the same time, analyzing the raw sewage for 28 parameters. The statistical model development is still in progress.

Soil Processes Unit

The areas of concern for this Unit are investigations of the suitability of various soil systems for the disposal of sludges and effluents on land, reclamation of acid mine tailings, as well as leachate characterization from sludge-soil systems, the role different soil systems play in removing various constituents, and the fate of heavy metals.

Reclamation of Acid Mine Tailings

This study was initiated to establish the reclaiming capability of lime precipitated sewage sludges on acid mine tailings. Improvement of the rate of lime sludge application for establishing successful vegetation on mine tailings was a further objective.

Attempts to grow clover plants on the surfaces of sludged tailings were unsuccessful. It was found, however, that reed canary grass can be supported on sludged acid mine tailings provided that the rate of sludge application is $\geq$300 t/ha (dry solids).

Disposal of Chemical Sewage Sludges on Land

To assess the environmental effects of chemical sewage sludge disposal on land, a long-range study program has been undertaken with the following objectives:

1) to investigate the maximum loading rate of chemical sewage sludges on agricultural soil systems,
2) to determine the biochemical degradation of organic and inorganic sludge constituents,
3) to measure the uptake, transport and accumulation of nutrients, minerals and metals through plant, leachate and soil systems, and
4) to monitor the survival and transmission of indicator bacteria in soil and leachate.

To date, results show that increasing rates of sludge application up to 900 kg TKN/ha have resulted in an increased yield of total dry matter. The highest rate of lime and iron sludges applied to silt loam soil produced 9% and 15% higher yields, respectively, than the 13.2 t/ha from the commercial fertilizer treatment.

Although concentrations of nitrate nitrogen in the leachate were higher at the highest rates of application, differences among the various types of sludges were statistically insignificant. Overall levels of total nitrogen in the leachate were not considered potentially hazardous to groundwater supplies. The grass grown on the lysimeters was identified as the major sink of N, P, K and heavy metals from all of the three sludges applied.

Recycling of Liquid Sewage Sludge on Dredged River Sand

A study to assess the impact of applying primary digested sewage sludge at different surface loading rates to dredged river sand was completed.

This field installation consisted of four plots, comprising a total area of 0.4 ha. Each plot was polyethylene lined with an underdrainage collection and discharge piping system covered by a 1.20-metre depth of dredged sand.

With plot number 1 as the control, primary digested sludge was applied to plot numbers 2, 3 and 4, at surface loading rates of 1560, 2860 and 6190 kg TKN/ha, respectively. Soil tests were conducted on the sludged plots in March 1973 and April 1974 to assess the fertility of stabilized sands. The organic matter content of the sands had increased by approximately 0.8% over control with the highest sludge application. A deficiency of Ca, Mg and K in sludged plots proportionally to the amounts of sludge applied was also determined.

Total dry matter yields of mixed grasses harvested during the period from April to December were 67, 1175, 1125 and 2170 kg/ha for plot numbers 1, 2, 3 and 4, respectively.

Increased amounts of sludge applied resulted in increased concentration of various sludge constituents in the plant tissues. In this study, metal toxicity to the grass was not observed.

State-of-the-Art Review of Potato-Processing Wastewater Treatment and Reuse

A review of the literature pertinent to the production and treatment of potato-processing wastewaters was conducted. An outline of the potato-processing industry in Canada was given, showing production emphasis in the french fry and potato chip branches. Typical unit operations

were described; wastewater volumes, COD, BOD_5 and suspended solids loads were estimated from published data; load contributions from the various unit operations were compared. Existing methods of in-plant treatment were described.

Characteristics of the final combined raw effluent stream, as reported in the literature, were compared to estimates from a recently conducted Environment Canada survey of the industry in Canada. Operating results of end-of-line treatment by various physical and biological systems were discussed. The use of sand filtration and the potential use of advanced waste treatment methods, such as reverse osmosis, were noted.

Leaching of Radioisotopes from Uranium Mine Tailings

This project attempts to quantify the leachability of radium and thorium radioisotopes from the uranium mine tailings and sediments. Containers, 0.3 m in diameter, providing a 1-metre depth of tailings, have been set up at the WTC to leach tailings under varying conditions. The leachates are being analyzed for radioisotopes.

The tailings and barium-laden sediment were obtained from the Elliott Lake area.

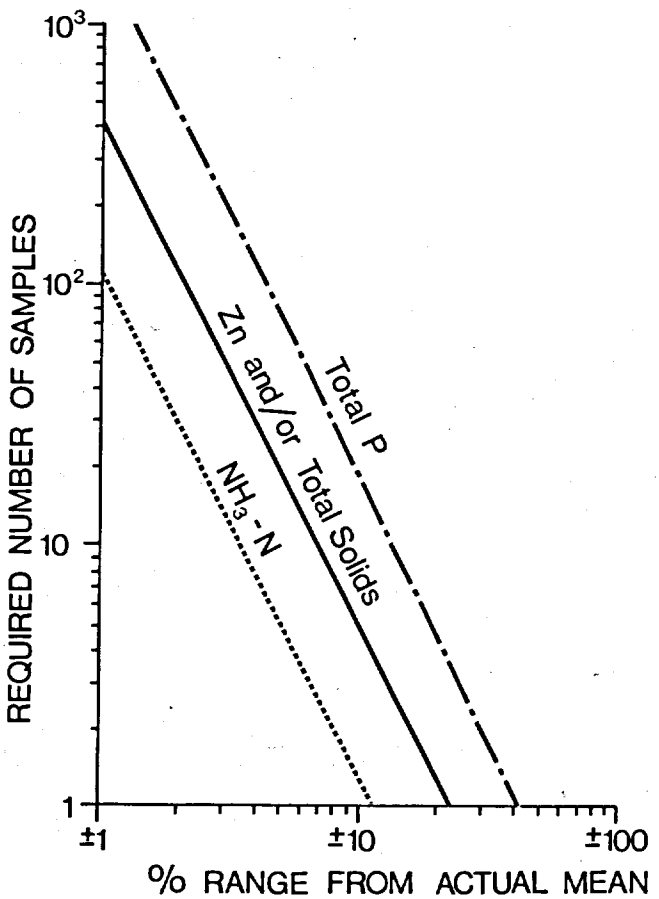


Figure 10. Relation of required number of samples to predict the mean concentration within a specified range.

Variability of Sewage Sludges, Sampling Methodology Development

Knowledge of the existence of a high variability in the nutrient and heavy metal content of digested sewage sludges led to the design of an intensive sampling experiment to define more precisely the nature of this variability and to provide a basis for practical implementation of future sampling programs. The initial phase has involved sampling at a lightly industrialized municipality (Simcoe, Ontario WPCP).

Conclusions of the initial phase of the program are that ammonia nitrogen (NH_3-N) and total phosphorus (Total P) were found to be the least and most variable parameters, respectively. Figure 10 relates the required number of samples to be analyzed to a predetermined, specified tolerance that is acceptable in the determination of an actual parameter mean concentration. As shown in Figure 10, five random grab samples were required to predict the mean total solids concentration within ±10% of the actual value. It was determined that zinc concentrations followed the same curve as total solids, meaning that its relative variability was identical. It is emphasized that this prediction depends on random grab sampling. Some statistically significant mean parameter concentration differences were observed among the study days. Large differences were not evident and appeared to be irregular events.

Fish-Processing Waste Screening Technology

A project to demonstrate screening technology for the fish-processing industry was completed in co-operation with the EPS staff of the Atlantic Region. This study demonstrated the attainable levels of solids removal for herring, shrimp and red fish processing waste. Preliminary data analysis indicates 40%, 60% and 30% suspended solids (SS) removal, respectively, when a number 25 mesh screen (after coarse screening) is used. Screening of a combined herring and shrimp waste resulted in 50% SS removal.

LABORATORY SERVICES SECTION

From a total of 29 projects, requests for analytical services continued at about the same number as in 1973. Approximately 31,000 samples were received requiring about 96,500 parameters. Of these parameters, one half were for metal analysis and the rest consisted mainly of various forms of nitrogen, phosphorus, carbon and sulphur. Sample types continued to be as varied as in 1973, but with an increase in the products from the various programs concerned with sludge disposal or treatment. New types of samples included crop roots, flour (from wheat grown in lysimeter studies) and incinerated sludges, all of which required studies to determine the best possible techniques of analysis.

The main analytical investigations during 1974 were as follows:

1) automation of COD determination for samples containing solids,
2) use of ammonia and chloride specific ion electrodes,
3) determination of sulphur in crops,
4) organic carbon in sludges,
5) effects of various grinding machines on crop analysis, and
6) complex and simple cyanides in industrial wastes.

The interlaboratory comparative study on heavy metals in sludge samples continued, with an increase in participating laboratories including two laboratories from the United States.

Bioassay Group

In October, the Bioassay group, formerly part of the Biological Processes Unit, was transferred to the Laboratory Services Section.

At the WTC the Bioassay group, comprised of two permanent biologists, supplemented by contract employees and/or Co-op students to meet program demands, occupies a small base laboratory, which has a capacity for 48 simultaneous tests. A 32-foot mobile bioassay laboratory trailer was purchased and equipped to carry out six fish bioassays simultaneously. In addition, a 45-foot effluent storage trailer was purchased and equipped with four 5.4-m^3 (1200-gal) and two 2.7-m^3 (600-gal) effluent storage tanks and associated cooling units to hold industrial effluents at 4°C for the duration of a toxicity study, usually 96 hours.

Programs in which the Bioassay group has participated are

1) toxicity removal studies on pulp and paper mill effluent both in the field at Espanola and at the WTC,
2) toxicity balance at the Shell Refinery, Sarnia,
3) assessment of toxicity of samples from selected textile and food-processing plants, and
4) treatment of bisulphite liquors.

Approximately 1500 tests were carried out in the course of these programs.

In addition, Bioassay staff were deeply involved in providing information to committees that were establishing toxicity requirements for effluent regulations.

FACILITIES SERVICES SECTION

The Facilities Services Section operates and maintains the various pollution control units in the Wastewater Technology Centre and ensures that services for new processes are assembled to meet design criteria generated by the Process Development Section.

During 1974, a fully automated 19.4 m^3/day (30 lgpm) physical-chemical pilot treatment plant was commissioned. One of the design features is the ability to program diurnal fluctuations of both organic and hydraulic loading, as experienced under "real" operating conditions. The plant features lime treatment, recarbonation, sand filtration and carbon adsorption.

During the year, the staff of the Facilities Services Section ensured the continuous operation of the various pilot plant modules, such as the nitrification-denitrification pilot plant, as well as the physical-chemical module used for phosphorus removal under various operating modes, e.g., polymer and powdered activated charcoal addition.

The 13.6-m^3/day (30,000-lgpd) extended aeration pilot plant, located outside of the Wastewater Technology Centre, was in continuous use, providing a source of sludge for the ongoing sludge treatment process development studies. Modifications to facilitate maintenance and upgrade safety conditions were made during 1974.

The temperature-controlled bioassay facilities were doubled in size to provide space for an industry-government commissioned study by Dr. J. Sprague and associates of the University of Guelph. This program investigates the sublethal toxic effects of petroleum refinery effluents on fish.

Increased demands of the raw sewage supply main have attained the design capacity of the existing system. Design modifications to accommodate the additional demands are under consideration. Similarly, demands on the power supply system have resulted in the installation of a 600-kVA transformer with plans for an early completion of the secondary distribution system.

During 1974, an extensive safety program was undertaken, resulting in the installation of catwalks, handrails, platforms, harnesses and breathing apparatus.

In addition, service and maintenance programs for the various pilot plant components were initiated, resulting in the streamlining of the operation of the Facilities Services Section and ensuring more reliable operation.

Some of the additional commitments of our senior staff included serving on the various Canada-Ontario Agreement Committees (Board of Review, Technical Committee,

Research Sub-committee, Land Disposal on Sludge Sub-committee, Storm and Combined Sewer Sub-committee and Technology Transfer Sub-committee). Membership was also held on the IJC Research Advisory Board's Sub-committee on Water and Wastewater Treatment Research.

In February, the staff of the WTC hosted a NATO/CCMS meeting. Seven countries were represented in the discussion of the status of the physical-chemical waste treatment demonstration pilot plant now under construction in the United Kingdom at Colehill. The United Kingdom is the pilot country for this project; Canada is one of the co-pilot countries. Our staff also participated in the second Canada-Ontario Agreement Workshop held in the fall in Toronto, which had as this year's theme, "Sludge Handling and Disposal." In addition, we participated in a workshop on physical-chemical treatment, "Activated Carbon Adsorption in Water Pollution Control," in Ottawa.

A summary of technical reports completed during the year and papers presented at various technical conferences is provided in Appendix B.

ENVIRONMENTAL EMERGENCY BRANCH

CENTRE OF SPILL TECHNOLOGY

The working staff of the Centre of Spill Technology (COST) presently includes two development engineers, one biologist and one technician.

Many of the projects were undertaken in liaison with consultants, industrial companies, universities and other government agencies. The following projects were either completed or in progress in 1974:

1) The testing and evaluation of oil spill skimmers was continued. During this year, the evaluation of skimmers was carried out in Bedford Basin. The Bedford Institute of Oceanography supplied vessels and coxswains for the operation. A consultant contracted to COST undertook the evaluation and analytical aspects of the test. The skimmers tested were the JBF DIP 2001, the SLICKLICKER MK II, the SLURP and the OIL MOP.
2) The testing and evaluation of oil spill treating agents continued. This was a three-part program undertaken by COST. The first part was the completion by Concordia University of the study on "Sinking Agents." The results of this study are being used to prepare *Guidelines on the Use of Sinking Agents.* Sorbents available commercially in Canada were evaluated by an industrial company under contract. The EPS Physiology Testing Laboratories at the Bedford Institute of Oceanography have tested commercial oil spill dispersants in accordance with the acceptability criteria of the *Guidelines on the Use and Acceptability of Oil Spill Dispersants.* All of these studies will be incorporated into the *Environmental Emergency Technical Handbook* of the Environmental Emergency Branch.
3) The Canada Centre for Remote Sensing developed a laser fluorosensor to detect oil spilled onto water. To assist them in the field trials of this unit, COST provided the ground support for an airborne experiment conducted at CCIW.
4) In conjunction with the EPS Northwest Region, the problems associated with spillage from petroleum product storage areas in the Northwest Territories were investigated. Particular attention was given to the dyking practices at the storage areas. This study was undertaken by an industrial company under contract. A report entitled *Review of Petroleum Spill Containment Dykes in the North* was issued in September.
5) At the request of the EPS Pacific Region, COST provided information on the revision of the Burrard Inlet (Port of Vancouver) oil spill countermeasures report. A workshop was held later to discuss this report in detail. COST presented papers on "Dispersants" and "Shoreline Clean-up" at the workshop.
6) The Hydrology Research Division, IWD, undertook a study for COST on the migration of hydrocarbons spilled into the sub-surface soils. Field work was done at Flin Flon, Manitoba, to ascertain the lateral and vertical movements of hydrocarbons. Research is underway to develop methods to remove the hydrocarbon from the soil and to prepare guidelines on the treatment of oil spilled into the substrata.
7) A joint IWD-COST study on the feasibility of tagging oil by halogenated polyaromatics was undertaken. A report on the results of this study was issued in December 1974.
8) To assist field operation people in determining the spill movements at an oil spill, COST commenced a study to assess the development of simple spill movement model and, if possible, provide an algorithm for guiding countermeasures operations.
9) A limited pilot project was started in all EPS regions under COST's guidance to develop seasonal environmental maps. These maps would provide information to "clean-up" crews and contingency planners on ecological and human protection priorities, potential danger areas and resources available.
10) A study undertaken by COST and consultants was initiated to determine the hazardous materials in Canada, the methods of counteracting accidental spills

of these materials and the state of preparedness to control these spills. The results of this study are due in early 1975 and will form the basis for future technology development work in this area.

11) Toxicity and effectiveness testing of commercial spill dispersants was undertaken for COST by the EPS Physiology Testing Laboratory at the Bedford Institute of Oceanography. On the basis of these tests, workshops were held in Burlington and Ottawa to formulate DOE policy on dispersants and to advise the Ministry of Transport (MOT). As a result of these meetings, a joint DOE-MOT dispersant field testing program is being planned for 1975.

12) COST is providing to the Department of Supply and Services engineering and scientific advice on the development of a prototype "OSCAR" oil spill recovery device. This unit is now under construction and will be evaluated by COST in 1975.

13) In the Beaufort Sea Project, a joint undertaking between DOE and the oil industry, COST is the oil spill countermeasures study coordinator for EPS. This study is reviewing the methods and techniques required to detect, contain, recover and dispose of an oil spill resulting from an accidental well "blow-out" at an offshore exploratory well in the Beaufort Sea. The work commenced in late 1974 and is to be completed by the end of 1975.

14) In co-operation with EPS Ontario Region, COST undertook the oil spill countermeasures program of "Operation Preparedness," a study to develop methods involving all of the aspects of oil spills on the St. Clair River. The study required locating sites on the St. Clair where oil could be contained and recovered and the actual field testing of containment and recovery equipment and techniques at each location. The field evaluations were commenced in August 1974. A report containing the results of the field program and the recommendations for future equipment requirements and countermeasures techniques was prepared and issued by COST in November 1974. Planning is now underway for the field testing of these recommendations in 1975.

15) In 1974, COST investigated oil spills in northern Ontario and the Gulf of St. Lawrence and participated in actual clean-up operations at the IMPERIAL SARNIA spill at Brockville, Ontario.

16) Papers were presented by COST at the Water Pollution Conference (Toronto), the Arctic Petroleum Operators Conference (Whitehorse) and the Conference on Prevention and Control of Oil Pollution (San Francisco). Other conferences attended were the Oil Pollution Symposium (Bedford), the Canadian Symposium on Water Pollution Research (Toronto), the Offshore Technology Conference (Houston) and the Hazardous Materials Conference (San Francisco).

17) COST gave advice on oil spill countermeasures to spill co-operatives in Hamilton, Sarnia and Halifax and the Canadian Forces Staff College, Toronto.

Fisheries and Marine Service

Fisheries Research and Development Directorate

GREAT LAKES BIOLIMNOLOGY LABORATORY

The Great Lakes Biolimnology Laboratory (GLBL) at CCIW conducts a research program on the relationships between wastewater inputs, water quality and aquatic resources in the Great Lakes. Excess nutrient loadings, increased primary production and altered species composition at all trophic levels constitute cultural eutrophication, which continues to be examined on a regional and local basis using a variety of approaches. Studies which began on a large scale in 1973 on the upper Great Lakes and studies on the effects of land use activities on water quality in the Great Lakes, both guided by IJC Reference Groups and the Great Lakes Water Quality Board, have required considerable participation by GLBL staff. Studies on the impact of toxic substances, waste heat and dredging activities were initiated in 1973, also under the terms of reference of the Canada-United States Agreement on Water Quality in the Great Lakes. All of these studies are to be continued in 1975. Field work on Lake Huron, Georgian Bay and Lake Superior, as part of the IJC Upper Lakes Reference Study, was finished in 1974, and analysis of the results will be completed in 1975.

The work is composed of three main programs: 1) Descriptive Biolimnology and Surveillance, 2) Environmental Toxicology, and 3) Ecosystem Metabolism Studies. The programs represent different, but complementary, approaches to the total array of problems, with each program differing in its needs for subdisciplinary expertise and logistic support.

Coordination of activities with other components within CCIW is facilitated in several ways, including the CCIW Management Committee and its Sub-committees (e.g., Assignment of Vessels Committee), the Scientific Council for Coordination and the Environmental Quality Coordination Unit.

DESCRIPTIVE BIOLIMNOLOGY AND SURVEILLANCE

This program is based on the examination of communities of algae, zooplankton, zoobenthos and fish 1) to determine damage to aquatic resources and, wherever possible, causes, 2) to establish base-line descriptions of aquatic resources to which future changes can be compared, and 3) to develop, prescribe and apply surveillance techniques on a sound statistical and economical basis.

Biolimnology of the Upper Lakes

Georgian Bay-North Channel

In 1974, a co-operative survey program was conducted on Georgian Bay and the North Channel of Lake Huron, as part of the IJC Upper Lakes Reference Study. Samples were collected on seven cruises from April to December for lake-wide estimates of chlorophyll *a* concentration, primary production, phytoplankton and zooplankton species composition and biomass.

Chlorophyll *a* concentrations, determined at approximately 75 stations, indicated seasonal cycles and a range of values similar to those found in the main body of Lake Huron in 1971.

From analytical results of zooplankton numbers and biomass calculated under contract by the University of Waterloo, numbers in the North Channel appear somewhat higher than in Georgian Bay, perhaps because of a greater "shore effect." Initial results of phytoplankton species composition and biomass analyses indicate conditions comparable to those in main Lake Huron.

Standing stocks and group composition of benthic macroinvertebrates in Georgian Bay were comparable to or higher than those found in Whitefish Bay, Lake Superior. All components, except *Pontoporeia,* tended to occur at minimum densities in the south and to increase to maximum densities in the northwest, with a large area of high standing stocks intervening in the east, adjacent to Parry Sound. Representative figures showed a total of about 2800 individuals/m^2 in the south end of Georgian Bay, increasing to about 5500 individuals/m^2 in the northwest.

Lake Superior

The analysis of samples and data collected from Lake Superior in 1973 was continued in 1974.

Surface distributions for chlorophyll *a* showed similar patterns and concentrations to those of other years. Values were generally the highest inshore, except in areas of upwelling along the north shore, and in the warmest inshore waters after July. Primary productivity rates, determined in a shipboard incubator, frequently were the highest in areas of low chlorophyll biomass and intermediate water temperatures. From these rates and values for light attenuation, it has been possible to estimate values for integrated daily production on each of the five cruises (Fig. 1) and from these, to estimate a value of 30-50 g carbon fixed/m²/yr for annual production. This closely approximates values reported in the literature.

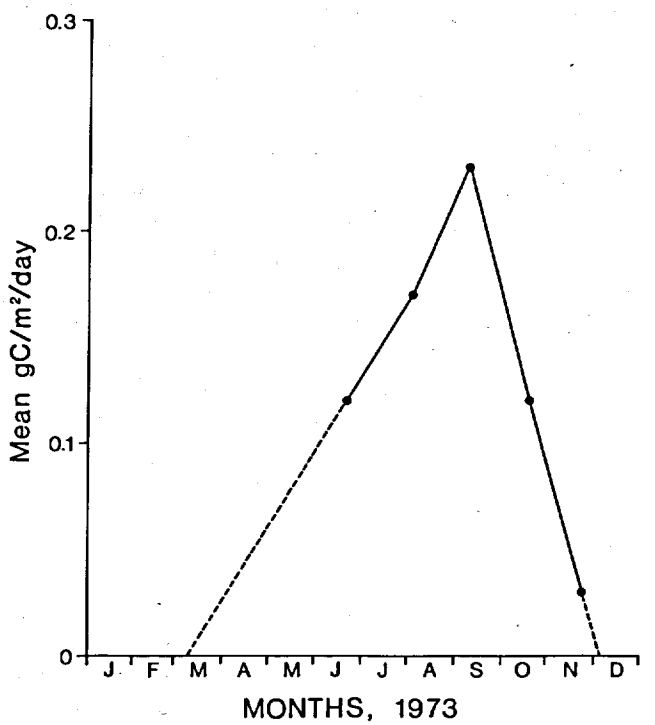


Figure 1. Seasonal pattern of primary production (^{14}C fixation) g/m²/day for Lake Superior, 1973.

Continuing analysis of 400 benthos samples collected in 1973 indicates that previous studies have tended to overestimate benthic populations because the samples were collected in the more productive areas of the lake. Based on a uniform grid pattern of about 400 stations, our lake-wide estimate of the total macrobenthos (for May 1973) was 525 individuals/m². Biomass estimates emphasize the numerical dominance of *Pontoporeia* and oligochaetes, but show nematodes to be of minor importance: standing stocks (ash-free dry weight) averaged about 0.05 g/m² lake-wide to which oligochaetes contributed 46%; *Pontoporeia*, 38%; sphaeriids, 8%; chironomids, 5%; and nematodes only 3%.

Several major regions were recognized in Lake Superior. On the basis of total macroinvertebrate abundance, standing stocks, species diversity and taxonomic composition, the following major trends were clear:

1) benthic populations increased dramatically toward the east end of the lake. In the extreme western basin where benthic populations averaged only 140/m² (0.02 g/m²), Whitefish Bay sustained the largest populations with 3000/m² (0.35 g/m²) and
2) large benthic populations tended to occur in areas where sediments were coarser grained, more diverse, and lower in organic carbon content, relative to midlake sediments. The eastern quarter of the lake (and Whitefish Bay) were such areas, as were the Apostle Island region, the southwest shore and Keweenaw Bay (910/m²; 0.09 g/m²).

Estimates of numbers, species composition and biomass of zooplankton and phytoplankton are still in preparation. Initial analysis reveals that biomass is low for both groups compared to the other lakes. One important finding is the relatively high proportion of phytoplankton biomass composed of various groups of flagellates in what has up to now been considered a diatom-dominated lake.

Comparative Studies on Great Lakes Biota

Data analysis on samples collected on Lake Ontario during IFYGL and on Lake Erie during 1970 continued at a slow pace during 1974. Cruise summaries of IFYGL zooplankton data are being prepared in conjunction with the Canadian Oceanographic Identification Centre, and papers are being written on the relationships between phytoplankton biomass, chlorophyll and primary production from OOPS cruise data on Lake Ontario.

During 1974, GLBL received a series of zooplankton samples collected on the lakes from 1960 to 1965 by the Great Lakes Institute, University of Toronto. Hopefully, these samples, when fully analyzed, will form a valuable base line for the study of changes in the quality and quantity of zooplankton communities in the lakes. Studies on the role of various size ranges of algae in primary production in the lakes have been initiated.

Surveillance of the Lower Lakes

In co-operation with several components of the Environmental Management Service at CCIW, a pilot surveillance program was conducted on Lake Ontario during 1974. The program concentrated on data collection to estimate the eutrophication impact on the lake. Initial program assessment indicates success in defining some areas where eutrophication effects (high biomass in surface waters, low hypolimnion dissolved oxygen and conductivities generally higher than IJC objectives) were of concern. Data analysis and evaluation continue to aid in the development of an ongoing long-term program for the lakes.

ENVIRONMENTAL TOXICOLOGY

The general purpose of this program is the development of criteria for aquatic life 1) for toxic materials of specific concern in the Great Lakes and 2) in relation to the accumulation of hazardous materials in aquatic food chains.

Lead Toxicity

Fish

A project on lead analysis methods showed that dry-ashing and pressure digestion with perchloric and nitric acids provided the best estimates of tissue lead concentrations. Lead loss during storage of aqueous solutions of lead was minimized by acidifying the samples. Unacidified samples lost 50% of total lead within one day and more than 90% after 32 days.

The nominal 96-hour LC50 of lead nitrate for guppies (*Poecelia reticulata*) ranged from 180 mg Pb/l (no mortality) to 240 mg Pb/l (100% mortality). The formation of a white precipitate caused a marked pH drop at or above 240 mg Pb/l. The drop was associated with an increase in dissolved lead from 1-5 mg/l (nominal lead concentration = 180 mg/1) at pH's greater than 6 to more than 40 mg/l (nominal = 240 mg/l) at pH's less than 6. It appeared that the buffering capacity of the test water was exceeded from 180 mg Pb/l to 240 mg Pb/l and the lower pH's promoted toxicity by increasing the solubility of lead.

Invertebrates

Preliminary 96-hour LC50 experiments have been completed using $PbCl_2$ as the toxicant on *Lymnaea palustris* and *Orconectes immunis* in distilled water and aquarium-conditioned water. The values are approximately: *Lymnaea palustris* — 0.1 ppm $PbCl_2$ in distilled water and 10 ppm in aquarium water; *Orconectes immunis* — 0.1 ppm in distilled water and >10 ppm in aquarium water.

Total lead in the soft parts and shell of natural populations of *Lymnaea stagnalis* was found to be 0.944 ppm Pb in shell and 0.159 ppm Pb in body. These results will be correlated with weight of various tissues and shell and compared with laboratory-bred and other natural populations of *Lymnaea*.

White light responses and threshold limits of *Hyalella azteca* have been completed. Threshold appeared at 1.4 lux. Effects of $PbCl_2$ and $CdCl_2$ on light responses are being determined.

Algae

The toxicity of Pb on algae, as demonstrated by decreasing primary productivity and cell growth, depends on a number of factors including

1) incubation medium: Pb was more toxic to *Ankistrodesmus falcatus* and *Scenedesmus quadricauda* in filtered, sterile lake water than in a synthetic CHU-10 medium. It was also more toxic in a soft water (low carbonate) than in a hard water,
2) temperature: the lower the incubation temperature, the lesser the Pb toxicity. At 9°C, the toxicity was only 15% of that at 20°C,
3) chemical species: in general, organoleads were more toxic than inorganoleads, and
4) algal species: *Scenedesmus quadricauda* was more resistant to Pb than *Ankistrodesmus falcatus.*

Methylation of Lead

(in collaboration with Dr. Y.K. Chau, Lakes Research Division)

Sediment samples from Hamilton Harbour, Lake St. Clair and several lakes around Sudbury were found to contain micro-organisms capable of methylating several non-volatile leads into a volatile tetramethyl lead (Me_4Pb). Under optimal conditions, the maximum rate for the conversion was 6% in one week. Pure species of bacterial isolates from Lake Ontario were able to transform trimethyl lead acetate, but not inorganic leads, into Me_4Pb in chemically defined media and in the absence of sediment.

The primary productivity and cell growth of *Scenedesmus quadricauda* were found to decrease by 85% and 32%, respectively, when the alga was exposed to less than 0.5 mg Me_4Pb/l.

Me_4Pb was much more toxic to algae than other lead compounds.

Cadmium Toxicity

Cadmium appears to be more toxic to algae than lead. At levels as low as 25-250 µg Cd/l, the primary productivity of *Ankistrodesmus falcatus* was reduced by 17-20% of the control. At 500 µg Cd/l, the reduction was 50%. *Chlorella pyrenoidosa* was even more susceptible to Cd. At Cd concentrations from 25-1000 µg/l, the productivity decreased by 27-91% of the control. The alkaline phosphatase production in algae was a more sensitive indicator for the Cd toxicity than the primary productivity. At concentrations as low as 50 µg Cd/l, the enzyme production was reduced by over 40% of the control.

Fractionation of Sulphur Isotopes by Algae

(in collaboration with Dr. J.O. Nriagu, Lakes Research Division)

The biofractionation of sulphur isotopes is significant to the understanding of the biogeochemical cycling of sulphur in ecosystems, a question of considerable concern in view of the effects of sulphur pollution on environmental quality.

Chlorella grown in a large pool of sulphate could accumulate considerably more sulphur than was required for growth. The metabolic sulphate uptake was accompanied by preferential removal of the lighter ^{32}S isotope. The isotope fractionation factor between the cells and the medium was constant (6‰) and much larger than was generally believed. Selective transport of ^{32}S across the cell membrane was believed to be responsible for the observed isotopic effects.

Identification of Hazardous Polluting Substances in the Lower Great Lakes

This study, undertaken by James F. MacLaren Ltd., was presented in two volumes; Volume A details the results, conclusions and recommendations of the study and Volume B tabulates all of the supporting data.

A list of 1200 hazardous materials, in descending order of potential danger to the aquatic environment, has been developed according to the criteria of toxicity to aquatic life, amounts used in commerce and industry, and mode of transport and storage.

This project, pertinent to Task 11, Canada-United States Water Quality Agreement, was carried out in co-operation with the Environmental Protection Service to support possible measures to prevent or minimize damage to aquatic resources through accidental discharge of hazardous materials.

Pollution from Land Use Activities Reference

The designated activity of GLBL in the Reference Group's study plan is to employ lake-column simulators in the laboratory to test the effects and potential for biomagnification of contaminants detected in agricultural land runoff by other groups. This information will guide MOE biologists in field investigations of potentially adverse effects of pest control products. In 1974, the simulators were installed and preliminary experiments with varied nutrient loading rates, additions of algae and physical mixing were carried out to aid in the development of community characteristics most useful for the testing of contaminants in experimental additions in 1975-77.

ECOSYSTEM METABOLISM STUDIES

The general objective of this program is to elucidate temporal and spatial relationships in the freshwater flora and fauna and their disruption in mixing zones caused by additions of both thermal and toxic effluents, nutrients, and dredged spoils.

Waste Heat Studies

Studies on thermal discharges at the Nanticoke Generating Station on Lake Erie commenced at the beginning of April. In co-operation with the Electronic Engineering Section, CCIW, the acoustic fish census system used in 1973 was upgraded and further tested with mid-water trawls and artificial targets to determine the effects of discharges to the Great Lakes on fish abundance and distribution. In addition, temperature-sensing ultrasonic transmitters were attached to yellow perch, common white sucker and rock bass enabling their behaviour in various thermal regimes to be monitored (Fig. 2).

Figure 2. Monitoring the movement and behaviour of ultrasonic "tagged" fish in relation to the thermal discharge at Nanticoke Generating Station.

Net uptake of ^{14}C by phytoplankton samples collected from the discharge was 60-80% lower than those collected from the intake, but there was no obvious relationship to temperature increase. Chlorophyll levels on an average were only slightly lower in discharge samples. Filtering rates of zooplankters measured before and after passage through the condensers revealed that most of the animals survived the experience, but some species appeared to recover faster than others. In contrast, larval fish suffered 100% mortality. Compared with control samples, fragmentation of *Cladophora*, grown on artificial

substrates in areas influenced by the discharge water, occurred earlier only in the discharge canal.

Studies will be continued at a new thermal generating station site in 1975-76 and will be extended to include complementary laboratory investigations.

Paper-Mill Plume Studies

Many of the techniques used in the waste heat studies were employed at Red Rock on Nipigon Bay, Lake Superior, from mid-July to mid-August in 1974. CCIW research personnel from the Scientific Operations and Lakes Research Divisions were also on site collecting data on water chemistry and microbiological activity. The pulp and paper mill effluent plume was injected with a red dye and tracked by an aircraft in radio contact with a small boat. Drogues were also used with limited success to follow the plume over time and space. Performance indices of the biota showed that the plume had a deleterious effect on all trophic levels in the near-shore area.

Project Quinte

Co-operative research (with the Ontario Ministries of Natural Resources and the Environment) on the Bay of Quinte was continued to determine the response of biota to the federal-provincial nutrient removal program initiated in 1973. GLBL, OMNR and MOE staff worked on nutrient budgets, primary production, zooplankton, benthic macroinvertebrate communities and general limnology of the Bay of Quinte. GLBL involvement in the Bay of Quinte program will be increased in 1975 in preparation for a major program including a waste heat study at the Lennox Generating Station in 1976.

Spoil Disposal from Dredging Operations

Studies on the effects of dredged spoil disposal were initiated in 1973 in a co-operative study with the Ontario Ministry of Natural Resources and other groups, under the terms of reference of the Canada-United States Water Quality Agreement (Task 8). The work in Lake Erie (Port Stanley) included

1) phytoplankton and zooplankton bioassays of serial dilutions and ambient water during spoils disposal,
2) examination of benthic macroinvertebrate communities before, during and after spoil disposal, and
3) evaluation of the usefulness of electrical acoustic fish census techniques to determine the response of fish to spoil disposal events.

The latter technique provides a means of examining the pattern of solids sedimentation in time and space in relation to specific disposal events and will be extremely valuable in future work on fish. Similar bioassays of spoils and collections of benthic macroinvertebrate communities were also conducted at the pilot-scale artificial island in Lake St. Clair during 1974. This work will be continued in 1975 with a large effort directed toward a laboratory study employing 4.5-metre vertical lake-column simulators, which will be loaded at various rates with a variety of dredged materials.

Joint Projects with Universities

During 1974, GLBL staff co-operated with universities by supervision of FRD grants, development of contracts and supervision of graduate students. Those involved included Dr. G.M. Sprules, Biology Department, Erindale College, University of Toronto — zooplankton community structure in Ontario lakes (FRD Grant); Dr. J. Carter, Biology Department, University of Waterloo — zooplankton identification and enumeration, Georgian Bay (contract); Dr. J.M. Bristow and Miss A. Crowder, Biology Department, Queen's University — a study of aquatic macrophytes in the Bay of Quinte (FRD Grant); Dr. J.B. Sprague, Zoology Department, University of Guelph — Bay of Quinte studies (contract); Mr. E.E. Pickett, Mr. R. Sheath, University of Toronto; Mr. B. Drimmie, Dr. C. Mayfield and Mr. Tom Pickering, University of Waterloo; Mr. Scott Millard, Mr. K. Young, University of Guelph (graduate student direction and assistance).

Algology courses were presented at the Queen's University Biological Station (summer course) and at Scarborough College, University of Toronto. Staff also participated in a speleological expedition sponsored by Northwestern University, Evanston, Illinois, involving the systematics, zoogeography and ecology of oligochaetes.

This contribution to the CCIW Annual Report by the Great Lakes Biolimnology Laboratory is dedicated to

Dr. David G.S. Wright

who joined GLBL on October 10, 1973, following graduate studies at the University of Guelph and a post-doctoral fellowship at the University of British Columbia. Dr. Wright had developed invertebrate cultures and light-bench equipment and was conducting studies on the chronic effects of toxicants on photo-responses at the time of his death on October 26, 1974.

Marine Sciences Directorate, Central Region, Ocean and Aquatic Affairs

OVERVIEW

Marine Sciences, Central Region, is part of the Fisheries and Marine Service and reports 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, the production of nautical publications, and the support of engineering projects. The Research and Development Division collects, processes and analyzes physical oceanographic and coastal morphological data for engineering programs, marine transportation and the assessment and prevention of environmental degradation. Launch and ship support is provided and maintained by the Ship Division for Marine Sciences and Great Lakes Biolimnology Laboratory activities, and as well for 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 of 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.

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.

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 from Quebec will be completed in 1976, 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 consequent shoreland erosion and inundation necessitate increased activity, involving both the federal and provincial governments in the development of more effective coastal zone management. To ensure continued safe and efficient navigation of the Great Lakes, increased bathymetric and revisory surveys are mandatory.

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.

HYDROGRAPHIC DIVISION

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 CCIW.

The hydrographic operations involve three main geographic programs and are supported by three types of technical support. The three geographic programs are

1) Surveys of the St. Lawrence River and Great Lakes system for commercial navigation,

2) Surveys of inland lakes and waterways to produce charts and publication for recreational boating, and

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 remain 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 leisure time. Recreational boating is very popular, and surveys are needed to produce special charts and publications to meet public needs.

In the third area, the search for hydrocarbons and the use of better vessels are opening the Arctic to commercial navigation. The survey program must be accelerated to provide safe navigation and to 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 assist in efficient operations.

REVIEW OF SURVEY PROJECTS

In the *St. Lawrence River*, a large survey unit worked out of Montmagny, surveying the channels in the vicinity of Île aux Oies and Crane Island. Later in the season, a survey of the Chenal de l'Île-d'Orléans was conducted under contract. These surveys of the lower St. Lawrence River were started in 1969 and are aimed at providing new charts from the Saguenay River to Quebec by 1976. This will coincide with completion of the deep dredging of the North Traverse, southeast of Île d'Orléans (Fig. 3).

In the *Great Lakes*, work was carried out in conjunction with inshore 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 to improve our knowledge of these large basins (Fig. 4). This survey used the high-speed cutter ADVENT, which proved successful. It also employed the HAAPS (Hydrographic Acquisition and Processing System) (Figs. 5 & 6). Locally, a survey of Frenchman Bay near Toronto was completed. A survey of Toronto Harbour was commenced.

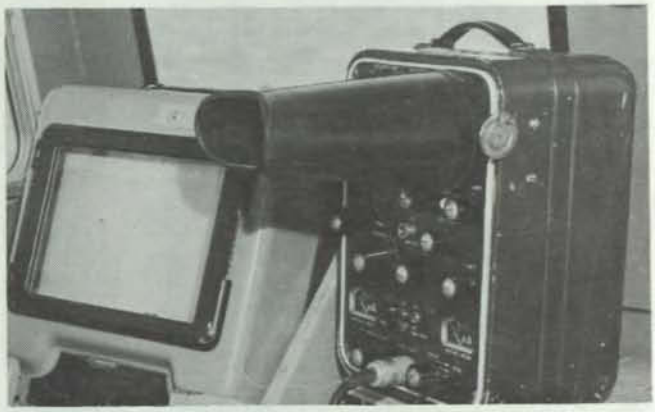


Figure 3. MRB 2 Hydrodist and Raytheon echo sounder used in the St. Lawrence River Survey.

Figure 4. MRB 2 Hydrodist shore station used in range-bearing mode on Lake Huron.

Figure 5. The HAAPS processing system.

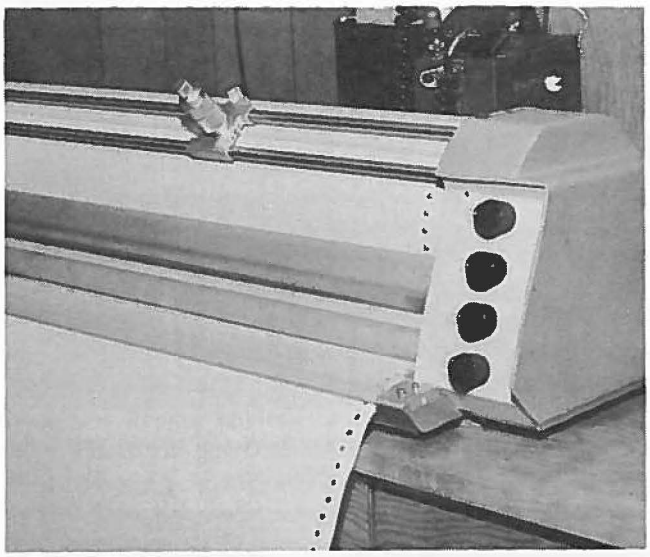


Figure 6. CALCOMP plotter for HAAPS.

The program of chart revision has now been arranged in a cyclic system. Every second year, charts of those parts of a 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 on Lake Superior and the lower St. Lawrence River, respectively (Fig. 7).

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 offshore surveys had a faltering start with many problems involving chartering ships, instrumentation and launch failures. Matters improved greatly toward 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, Manigotagan and Gimli were completed.

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

In Hudson Bay, a survey was completed of *Chesterfield Inlet* from the sea to Baker Lake (Fig. 8). This remarkable achievement resulted in NARWHAL reaching the settlement at Baker Lake, the largest ship to make this passage to date. NARWHAL, provided by the Ministry of Transport, was an ideal base as a mother ship for two large launches and later as an oceanographic platform in James Bay (Fig. 9).

Table 1 summarizes the Survey programs and some of the significant equipment used.

TIDES, CURRENTS AND WATER LEVELS

The year marked a major increase in tidal affairs. The responsibility for tidal matters concerning navigation was

Table 1. Survey Programs in 1974

Survey area	Vessel	Positioning system	Field data processing
Lower St. Lawrence	2 x 35 ft 4 Botved (22 ft)	Miniranger, Hydrodist	HAAPS (part-time)
Lake Erie	Bertram (25 ft)	RPS, Miniranger	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		
Lake Winnipeg offshore	4 Hydros (25 ft) LADY CANADIAN	Minifix	INDAPS
Lake Winnipeg harbours	3 x 20-25 ft	Hydrodist	manual
Polar Shelf	3 x 206 helicopters	RPS	manual
Chesterfield Inlet	2 x 35 ft 1 x 20 ft	Miniranger	HAAPS
Revisory–St. Lawrence	VERITY	Hydrodist	manual
Revisory–Superior	VEDETTE	Hydrodist	manual

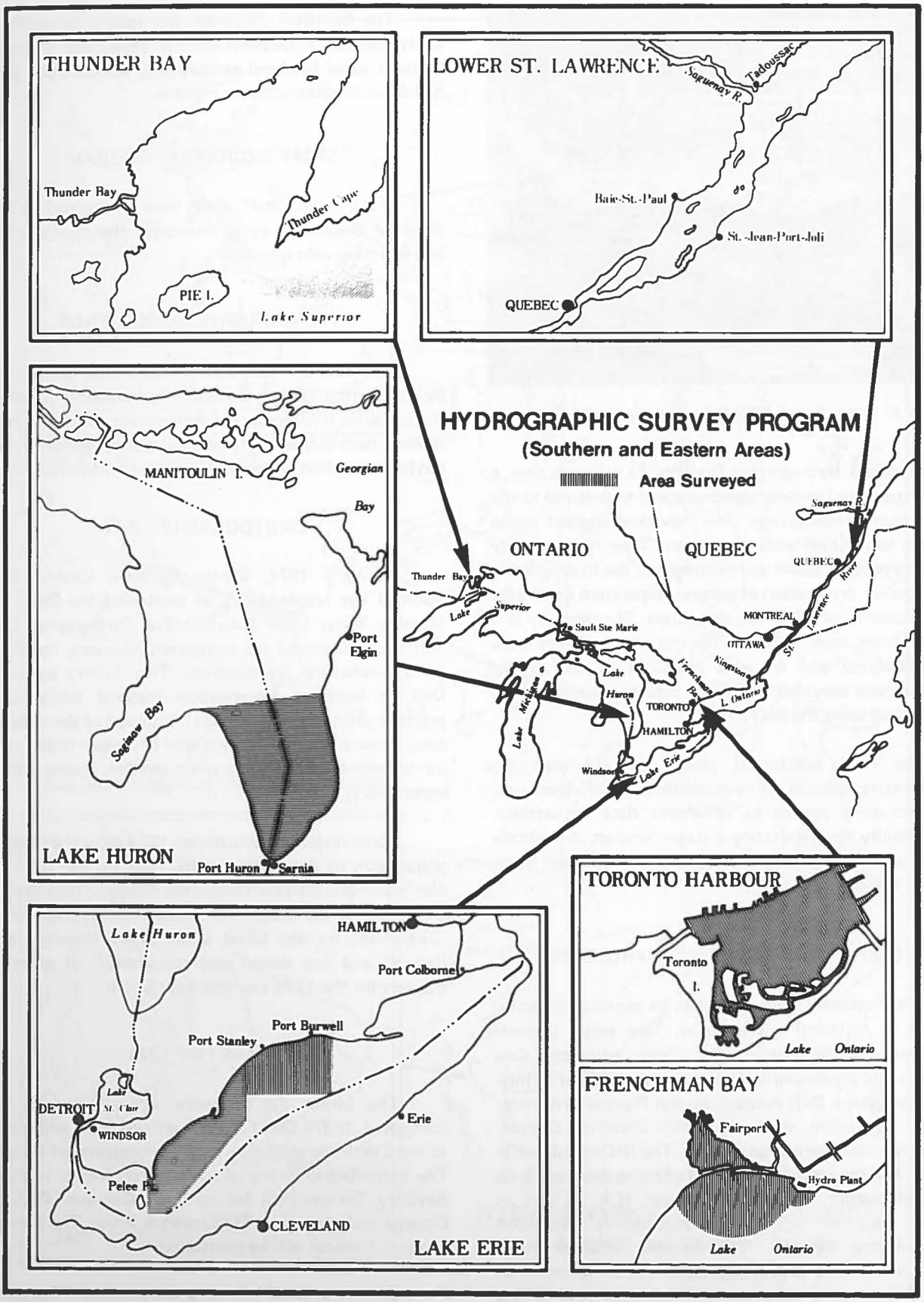


Figure 7. Central Region 1974 Hydrographic Survey Program (southern and eastern areas).

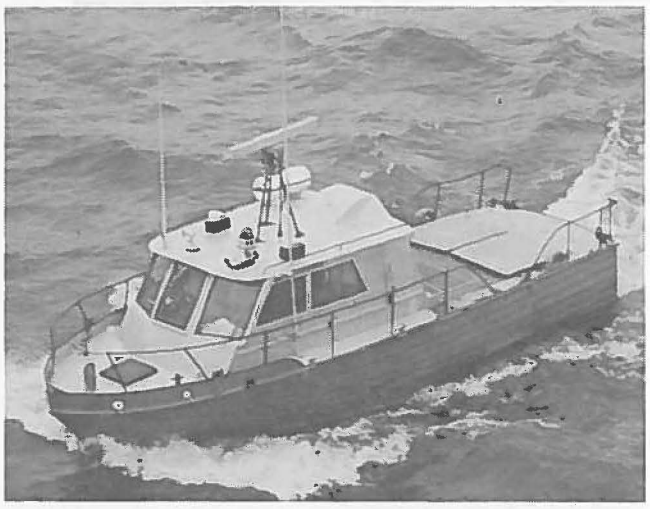


Figure 8. Survey launch STURDY used in Chesterfield Inlet.

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 using 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 (Fig. 10).

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 in productive use within the year. It is, in fact, an improved design of 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 sidescan sonar has been employed in several areas, but has had considerable electronic trouble.

STAFF EXCHANGE PROGRAM

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

HYDROGRAPHIC CONFERENCE

The Annual Hydrographic Conference was sponsored by the Central Region Canadian Hydrographic Service and the Canadian Hydrographers' Association this year. The Conference, held in March, attracted a large delegation of American hydrographers and several European hydrographers.

CARTOGRAPHIC UNIT

In April 1974, Marine Sciences, Central Region, assumed the responsibility of producing the Great Lakes Monthly Water Level Bulletins. 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, saving time and expenditure.

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

PLANS FOR 1975

The *Lower St. Lawrence River Survey* 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 made in Georgian Bay, Lake Ontario and the upper St. Lawrence River. The Survey of Toronto Harbour will be completed.

Surveys in *Lake Winnipeg* will continue. The completion of the harbour surveys is planned, but the offshore

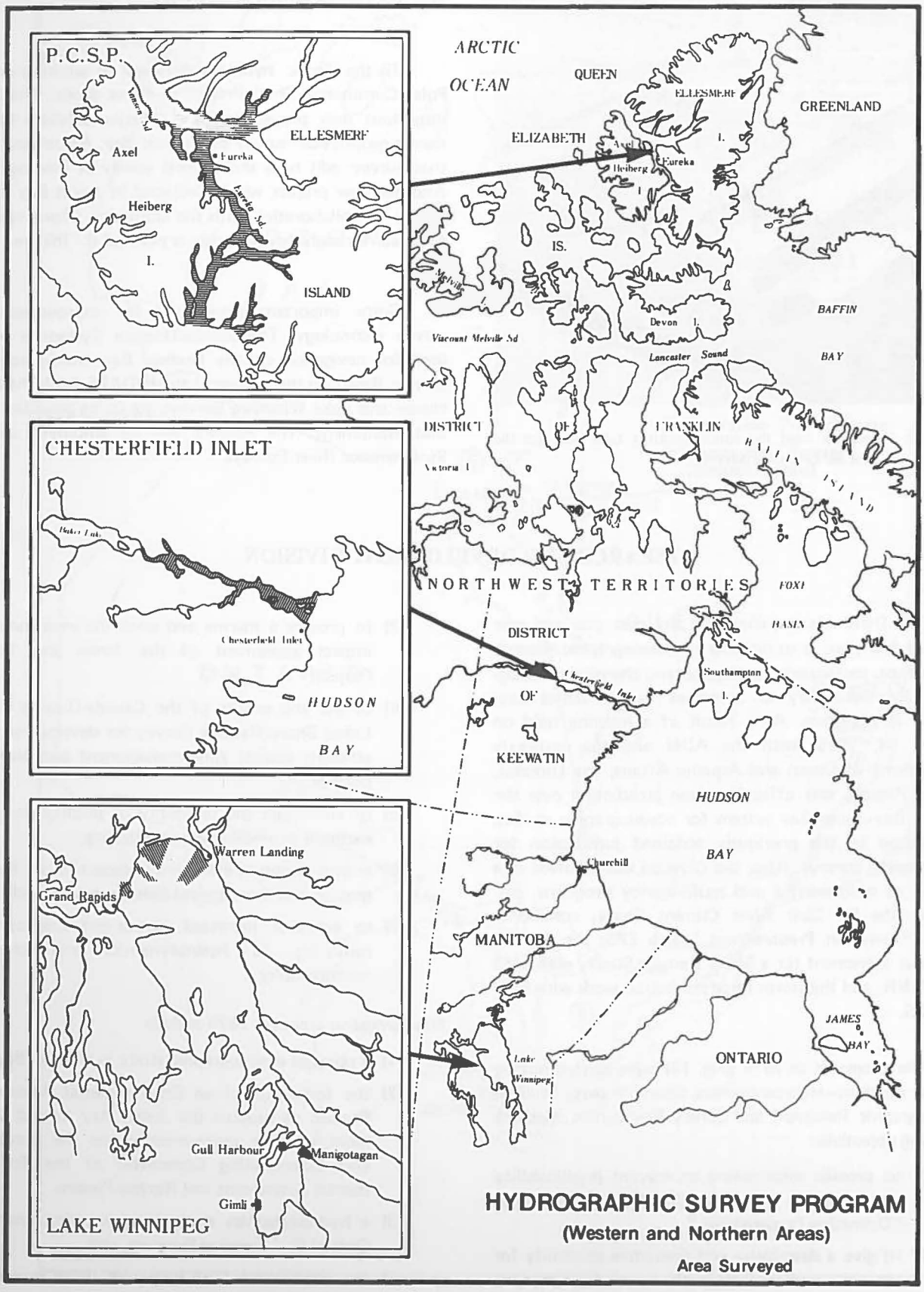


Figure 9. Central Region 1974 Hydrographic Survey Program (western and northern areas).

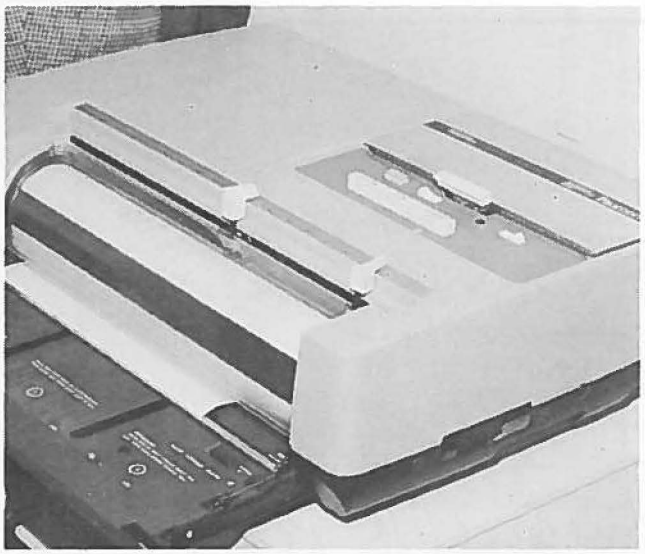


Figure 10. Telecopier used for communicating tidal data for the Lower St. Lawrence Survey.

area will require several more years.

In the *Arctic,* hydrographers will be working on 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 be initiated in James Bay in the spring. In collaboration with the Dominion Observatory, a two-year through-the-ice survey is planned for the area.

Some important plans exist for improvements in survey technology. The Satnav/Doppler System is to be used for navigation on the Hudson Bay multi-parameter survey. Based on the success of the INDAPS, both the Lake Huron and Lake Winnipeg Surveys are to be provided with that equipment. The HAAPS will be employed in the St. Lawrence River Surveys.

RESEARCH AND DEVELOPMENT DIVISION

The Division's major goal 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 ADM and the corporate management of Ocean and Aquatic Affairs, the Director, Central Region, was officially given jurisdiction over the Hudson Bay-James Bay system for oceanographic studies, in addition to the previously obtained jurisdiction for hydrographic surveys. Also, 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 EPS; the federal-provincial agreement for a Shore Damage Survey with EMS and OMNR; and the storm surge prediction work with EMS and AES.

The programs in 1974 (Fig. 11) were carried out by the four Sections—Hydrodynamics, Shore Property Studies, Oceanographic Research, and Survey Electronics, with the following objectives:

1) to provide information on current predictability and spatiality in the St. Clair-Detroit Rivers for "Operation Preparedness,"
2) to give a descriptive and predictive capability for the tides and currents in the upper St. Lawrence River estuary,
3) to provide a marine and estuarine environmental impact assessment of the James Bay Power Project,
4) to use 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 programs areas for 1975 include

1) a physical oceanographic study in Hudson Bay,
2) the 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) the establishment of long-term shore protection sites on the lower Great Lakes.

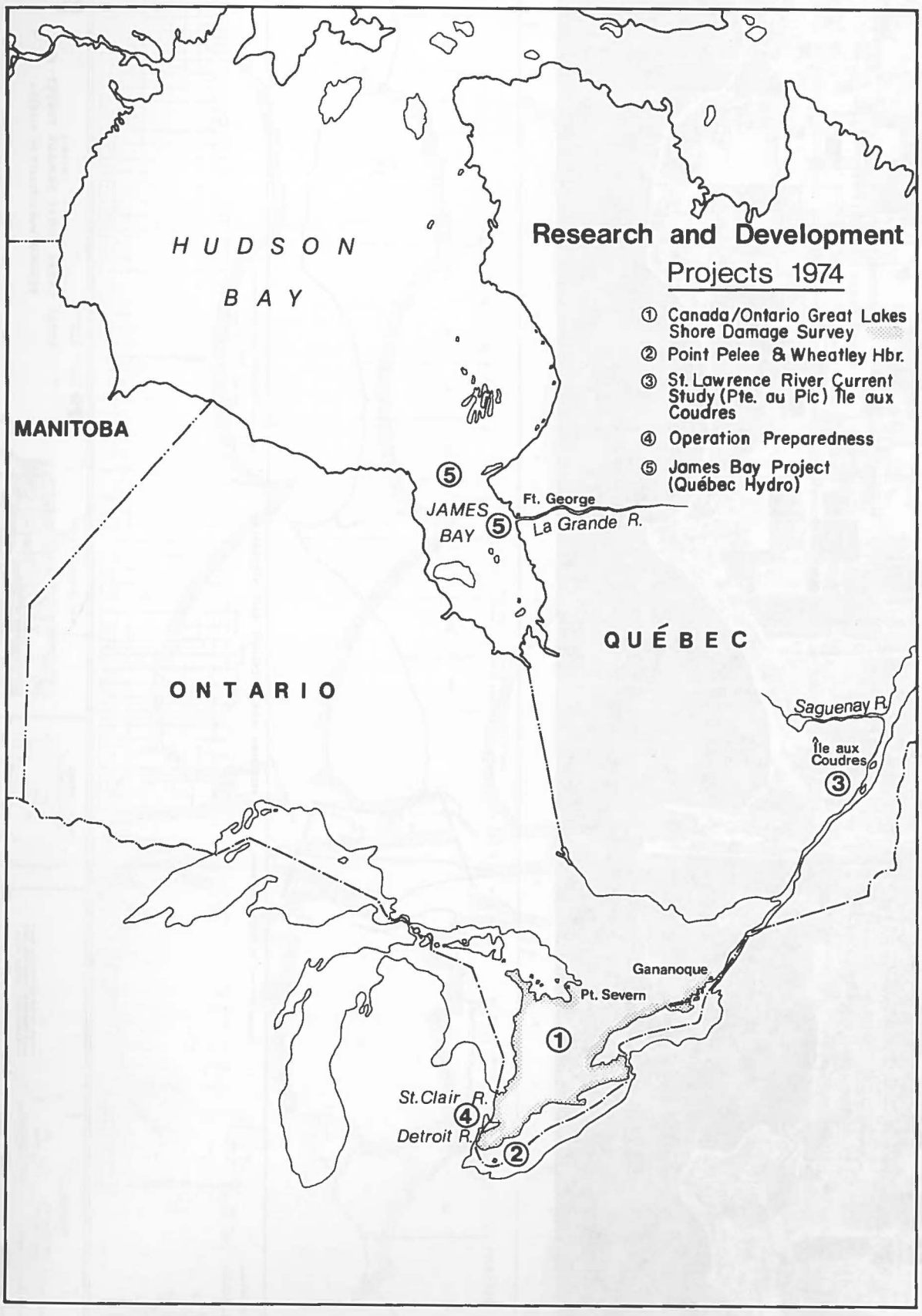


Figure 11. Research and Development Division projects for 1974.

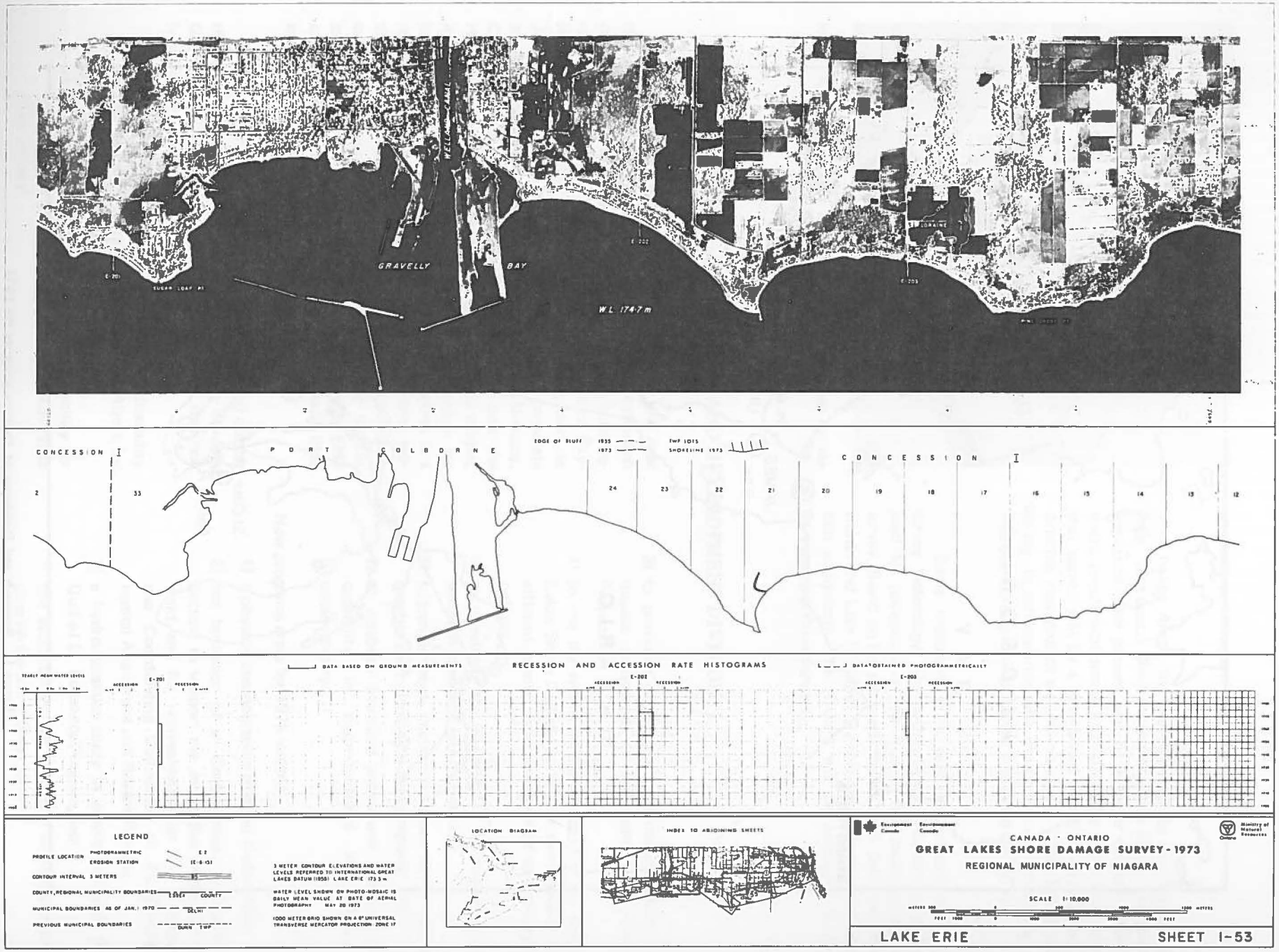


Figure 12. Coastal Zone Atlas – map sheet no. 1.

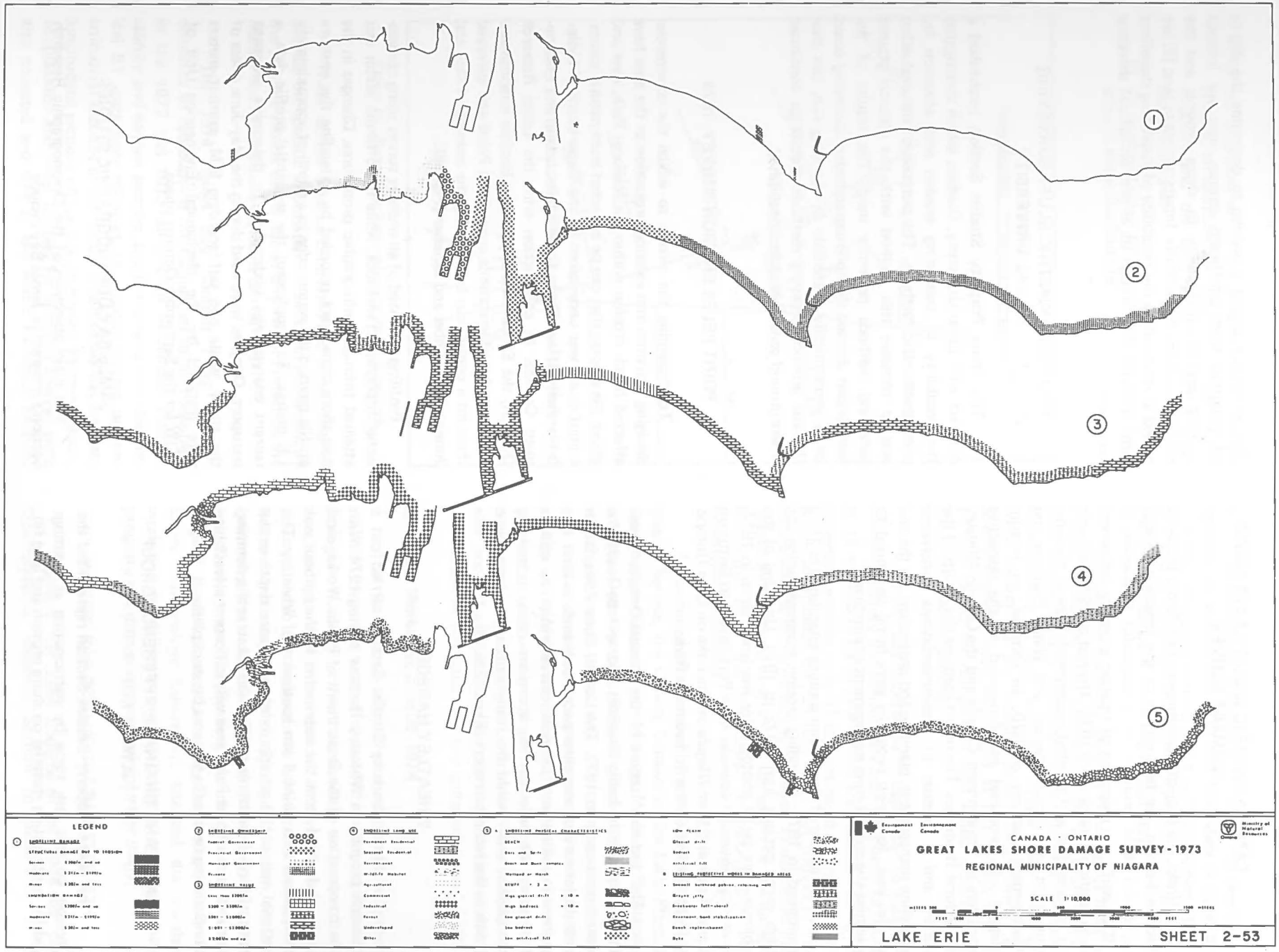


Figure 13. Coastal Zone Atlas – map sheet no. 2.

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 continued until April 1974. The rest of 1974 was used to analyze data and develop recommendations in conjunction with the Social Sciences and Water Planning and Management Sections of IWD. 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 concerning 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 from 1972 to 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-Rivières 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 accession rates, is nearing completion and should be ready within the same time frame as the technical report (Figs. 12 & 13).

WHEATLEY HARBOUR

The Shore Property Studies Section carried out a research program in Wheatley Harbour during 1974. With the co-operation of the Department of Public Works, sand material dredged from the approaches to the harbour was scow-placed at a point 4 km southwest of Wheatley. The material was put at 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 stockpiling.

TASK D LAND DRAINAGE REFERENCE GROUP (GLWQB–IJC)

The Shore Property Studies Section represented the Division on this task force by participating at meetings and by contributing 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 on natural shoreline processes.

PHOTOGRAMMETRIC BLUFF SURVEYING –LAVAL UNIVERSITY

The Shore Property Studies Section established a contract with Laval University, 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 used. 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

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 that can be expected from natural causes, a joint study was undertaken by the Department of Indian & Northern Affairs (Parks Canada Directorate) 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 and June and September and October (Fig. 14).

Profiling consisted of an onshore survey using conventional topographic methods, while the offshore sector was attained through hydrographic procedures. Changes in the near-shore zone were recorded by extending the onshore profile beyond the waters edge to a depth of approximately 1.5 metres. To supplement the sequential profile data, a current analysis was undertaken 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.

JAMES BAY OCEANOGRAPHIC STUDIES

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

1) the determination of the present distribution of salinity, temperature and dissolved oxygen in the estuaries and the Bay, including the seasonal distribution and

2) the examination of the physical processes contributing to these distributions.

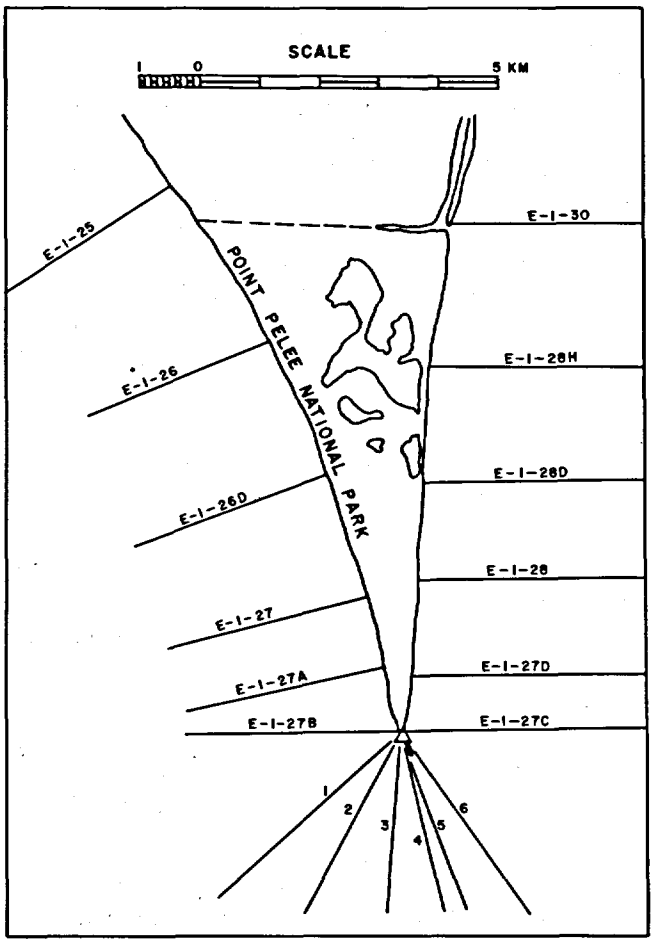


Figure 14. Point Pelee Erosion Survey profile locations.

These studies must be completed and understood to provide the specific information on 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, discrete 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-Rivière. 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 analyze 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 at 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 La Grande-Rivière and estuary. Owing to inclement weather, only 11 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 temporal 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 of the Department of Energy, Mines and Resources, 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 estuary of La Grande-Rivière 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, who had worked 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, the Bedford Institute, the Arctic Biological Station, McGill University, the University of Quebec (Rimouski), the James Bay Development Corporation, Marine Sciences (Central Region), the Geophysical Limnology Section, and the Great Lakes Biolimnology Laboratory, attended the one-day workshop to delineate present projects, propose future programs and discuss areas requiring further study.

HUDSON BAY OCEANOGRAPHIC STUDIES

Planning has been undertaken in 1974 by the Oceanographic Research Section to participate in a

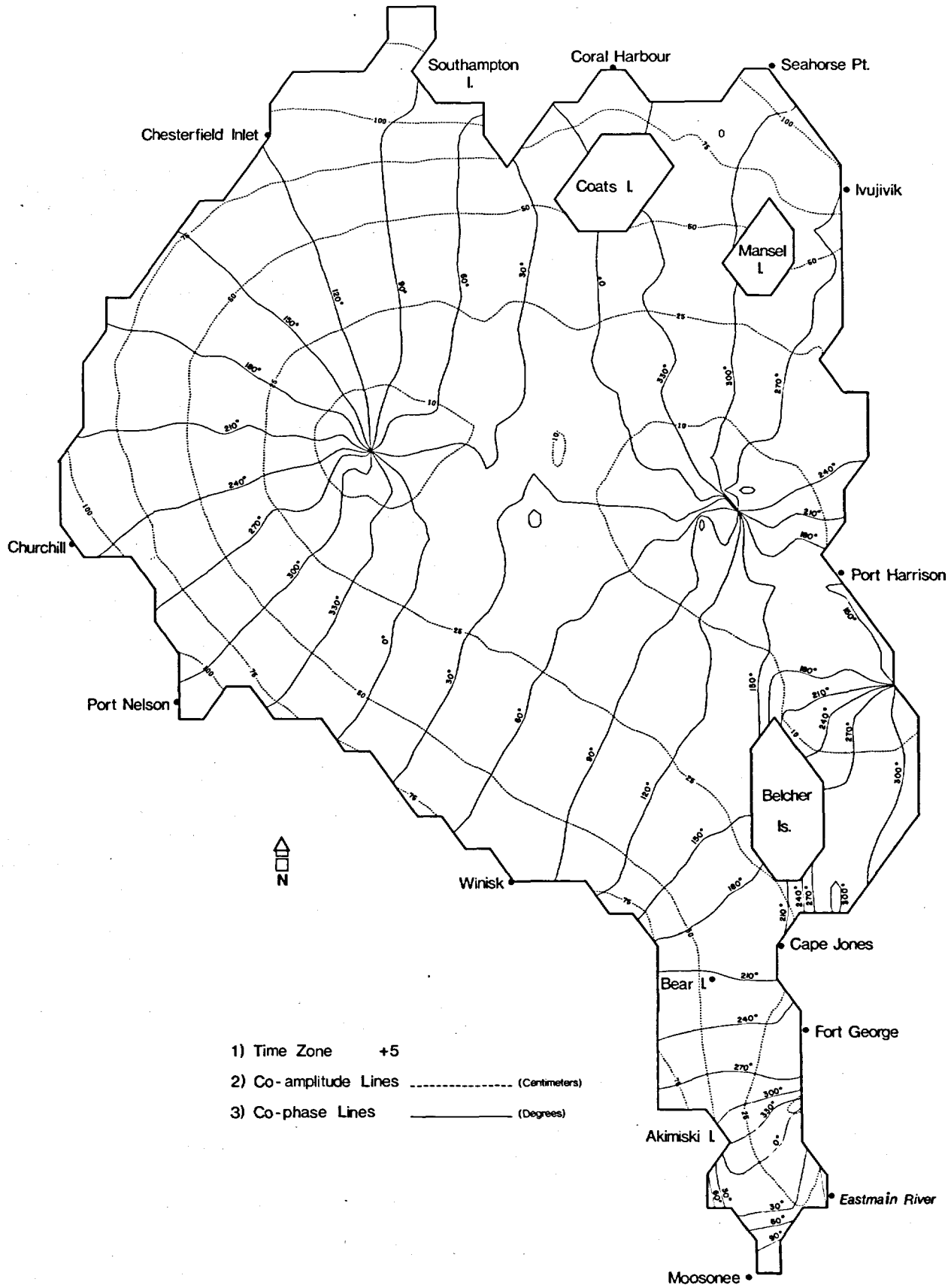


Figure 16. Hudson and James Bay numerical model.

continuity in spherical polar co-ordinates. A linearized form of bottom friction was used, and since there is no absolute way of choosing a friction coefficient, it was varied over a range of 0.01 cm/sec to 1.0 cm/sec.

The co-tidal diagram shows the co-phase and co-amplitude lines for the M_2 (semi-diurnal) tide using a friction coefficient of $R = 0.1$. The simple two-dimensional numerical model qualitatively reproduces the M_2 and K_1 (diurnal) tidal propagation in Hudson and James Bays (Fig. 16). Although at this stage precise station agreement is not achieved, the model results can be used to construct appropriate co-tidal charts and to analyze tidal propagation in the system.

ST. LAWRENCE CURRENT SURVEY, 1974

One of the primary objectives of the St. Lawrence Estuary Program 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 because of discharge, man-made changes in the bathymetry, and season are to be studied. Also, the program provides for base-line oceanographic measurements to be taken.

In the data processing field, the Aanderaa current meter data-handling programs 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. After edited files are created, tidal streams analysis and power spectral analysis are performed (Fig. 17), 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 program 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 Pointe-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 in the measurement of current speed and direction, salinity, and temperature at each one-tenth of the depth.

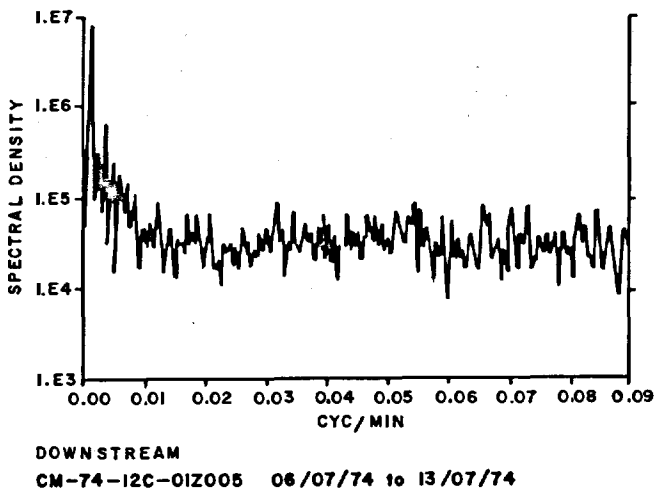


Figure 17. Spectral density of current velocity at Goose Cape, St. Lawrence Current Survey, 1974.

Analysis of the data is progressing, and data reports for both the 1973 and 1974 surveys should be published early in 1975. The preliminary analysis has been completed and indicates that some interesting circulation patterns exist in the middle estuary. In addition, some of the data suggest internal waves may be occurring there. Further analysis, however, is required to determine the true nature of these phenomena.

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 (Fig. 18). 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 EPS in August 1974. Data from this survey have been incorporated into a data report.

SURVEY ELECTRONICS SUPPORT TO MARINE SCIENCES

Owing to the introduction of major new systems and the operation of a number of large and sophisticated surveys, the Survey Electronics Section was busy again this year. Some of the new equipment acquired included 4 Miniranger systems, 2 sets of CA1000 Tellurometers,

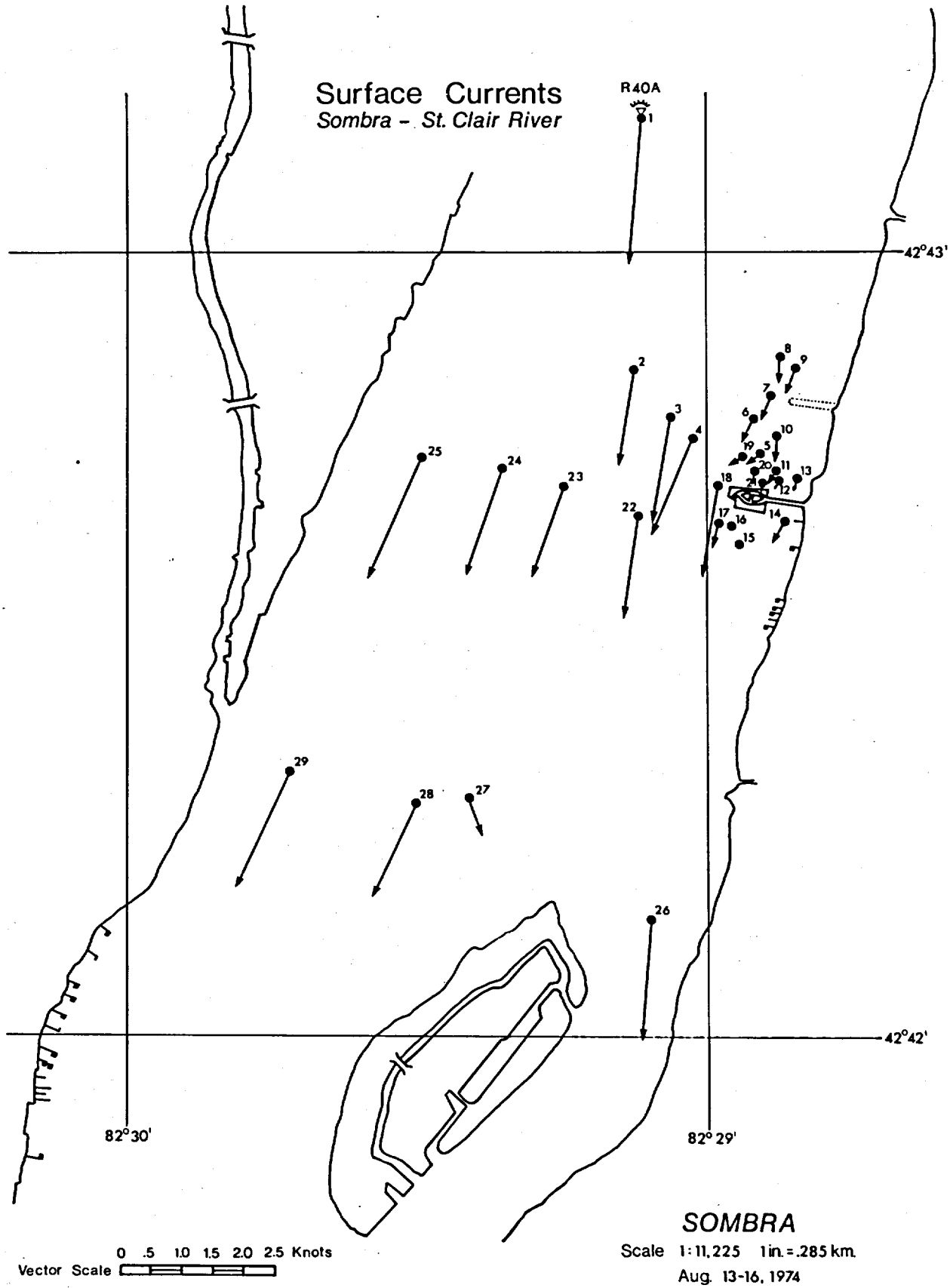


Figure 18. Surface currents at Sombra, St. Clair River, August 13-16, 1974.

3 new Ross Sounders and 4 digitizers, 3 INDAPS logging systems and a 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 learn this new technology, a number of training programs were undertaken. In addition to an RPS and a Tellurometer course provided to all of the 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, using 2 Miniranger systems, 2 HAAPS systems and a processor, Ross sounders and a full-time field technician. The intention was to use a Highfix system. This system was not used, however, due to the success achieved with the Miniranger systems. The electronics on this survey operated with 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 used a Minifix system with 60-foot towers, and redesigned matching units. This resulted in useable ranges in excess of 60 miles, whereas a 35-mile range was previously the maximum. The survey also employed the INDAPS logging system, although several problems were experienced because the system was new. A Minifix Slave unit was lost during high water due to its location on low terrain. An electronics 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 existed in the general functioning of the MRB 201's.

The *Lake Huron Survey* used a high-power Minifix transmitter in conjunction with 70-foot towers to give extensive coverage in the order of 70 miles or more. Problems resulted from high towers, heavy lightning activity on Lake Huron and interference because of 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* used Minirangers, RPS and Hydrodists in conjunction with Edo sounders. It became necessary to remove the RPS from service due to an interference problem with a similar system of the Ministry of Transport.

In addition to these 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, this 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-foot telescoping Minifix antenna was replaced with 70-foot towers and rebuilt tuning units, with signal increases in the order of 10 db being achieved. By raising the output power of the system from 50 watts 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-foot towers and one of these systems incorporated 100-watt transmitters (Fig. 19).

During the year, two test boxes for testing the HAAPS were developed. One injects signals into the HAAPS 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.

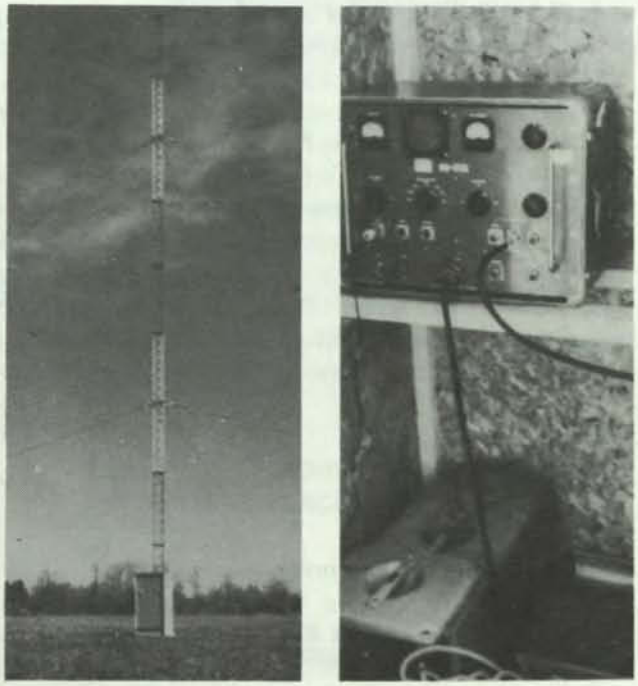


Figure 19. High-power Minifix tower and equipment.

This year, all of the Division's outboard engine work was placed with outside contractors, which alleviated much of the work load on shop personnel, allowing more time for 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. It was later determined, however, 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 they were identical in appearance. Consequently, all three of these engines failed after an approximate period of 30 hours under actual field conditions, although HYDRO II, the original boat that was outfitted and tested, was still operating at the close of the season.

SURGE and STURDY were rebuilt during the early part of the year, with respect to decks and houses, and STURDY was re-engined using the original diesel engines from HYDRO I and HYDRO II. During a break-in period in the lower St. Lawrence, STURDY experienced lubricating oil troubles, a problem similar to one that occurred on the East Coast when the engine required changing after 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 shop mechanic, both vessels operated without problems for the remainder of the season.

NEW ACQUISITION

CSS BAYFIELD modifications were delayed in waiting for the awarding of the contract for electrical repairs, modifications to the main switchboard, and necessary repairs for the vessel's recertification from a yacht to a scientific research vessel under the Canada Shipping Act (Fig. 20). 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 operating the vessel and 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.

Figure 20. CSS BAYFIELD.

CSL SURF

This 38-foot 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. Following a fitting-out period, however, the vessel created great interest in both hydrographic and scientific circles mainly because of her spaciousness and large working area in the aft cockpit.

NELSON 34

This GRF diesel-powered semi-displacement hull vessel was delivered in September, following trials conducted by the supplier where a top speed of 22.5 mph was attained. Upon acceptance trials at CCIW, the vessel was found to be a fine craft to handle, particularly smooth through the water, and to have a turning circle equal to two boat lengths.

Following acceptance, the vessel was subjected to even more stringent testing than required by the purchase agreement. Repeated full ahead to full astern movements resulted in an early failure of the transmission. Repairs were carried out, however, 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, and

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.

CSS ADVENT

CSS ADVENT performed efficiently during the season with down time limited to one day and four hours in total, the major portion consisting of the run 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 rev/sec not only increased the vessel's speed by nearly 3 knots, but also significantly lowered fuel consumption and 2) with a barely noticeable scrape on the tip of one blade, engine rpm dropped from 2200 rpm to 1900 rpm, with consequent loss of speed.

CSS LIMNOS

The vessel operated without problems during the early part of the season, dry-docking 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 located a crack in a previously repaired propeller, so that the spare propeller was installed during dry-docking.

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

Repairs were made on the vessel's arrival 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 without 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. The vessel did complete her season's work, however, with an extended field season.

ADMINISTRATION DIVISION

The loss of four senior supervisors and a number of key personnel to promotion at CCIW greatly increased the Administration's work load, decreasing general efficiency in the first half of 1974. Concurrently, Marine Sciences Headquarters Administrative Unit, providing guidance and other support, experienced a similar staff reduction owing to the formation of Ocean and Aquatic Affairs, which placed more emphasis on regional autonomy. Capable replacement staff have since been gradually obtained from within and outside the government.

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 work load on a continuing basis.

In view of the seasonal nature of field operations, a large turnover in staff was experienced, requiring close coordination 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 man years account for 155 staffing actions as follows:

Employees	Number
Full-Time Continuing	13
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, as 69 positions were submitted for review or classification.

There were 24 promotions and 9 acting appointments, and 15 employees were granted acting pay.

A total of 23 personnel accidents were reported.

ACCOUNTS

Of a total Regional budget of $5 million annually, $2.8 million was processed through the Accounts Office, representing $2.3 million for O & M purchases and ships charters, and $500,000 in capital expenditures. The remaining $2.2 million represents 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 3000 supplies invoices and 400 travel claims. Furthermore, the staff were involved in the preparation, payment and supervision of 20 field accounts and 11 sub-accounts.

With the decrease in Ocean and 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 contained about 6000 accountable line items with stock value reaching $14 million. 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 $1.9 million, is as follows:

Items	Amount
30 Regional individual Standing Offers	$ 250,000
350 Purchases off National Master Standing Offers	50,000
800 Regular Requisitions and Contracts	1,480,000
600 Government of Canada Purchase Orders	60,000
Direct transportation costs	60,000
	$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 30 vehicles ranging from station wagons and travel-alls to 2-ton trucks; 53 boat-hauling 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 $8003.49. Of this amount, $6500 is the estimated damage for one of the ten accidents. As of this date, the main factor causing this accident and the actual damage have not been determined. The main factors that caused the other accidents, assessed either party, were 1) inattention and 2) failure to yield. Although a degree of negligence exhibited in two of the ten accidents was assessed our drivers, it was judged to be of a minor nature and the drivers were not charged with damages.

During December, 29 user drivers attended a Defensive Driving Course conducted at CCIW 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 toward safe working practices has created increased activity at the departmental and regional levels. In response, both on site (CCIW) and at field operational level, managers during 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. These involved a helicopter crash in the Arctic, a large launch and trailer under tow by road and the failure of a ladder at low tide.

Although numerous minor accidents were judged as work hazards, e.g., strains, cuts, bruises, etc., a number have developed into chronic ailments causing considerable loss of work and workmen's compensation activity, thus increasing concern for accident prevention measures among all supervisors and employees.

Environmental Quality Coordination Unit

Environmental Quality Coordination Unit

The Environmental Quality Coordination Unit (EQCU) is responsible for the integration and/or co-ordination of research results from components of CCIW with research results produced by other groups to be used by federal, provincial and municipal water managers and to assist in departmental and ministerial policy decisions. A second significant role is a liaison function for the research activities of CCIW. This is performed by providing assistance to the Director in discharging a number of his committee responsibilities, as well as by representing the Branch on a number of departmental, interdepartmental, federal-provincial and international committees. In addition, EQCU provides assistance and advice to the Director on policy, program and other matters, provides technical support to both IJC Great Lakes Boards and Reference Groups and provides general coordination of the activities being conducted by the Branch pursuant to the Great Lakes Water Quality Agreement.

GREAT LAKES WATER QUALITY AGREEMENT

EQCU continues to be extensively involved in IJC activities; the Unit provides technical support for the Canadian chairmen of the Great Lakes Water Quality Board, the Research Advisory Board (RAB), the Pollution from Land Use Activities Reference Group and the Upper Lakes Reference Group and serves on a number of sub-committees that have been established. The Unit participated in the preparation of major reports for the Boards and Reference Groups of the IJC. These included the second annual report of the Water Quality Board, the third semi-annual report of the RAB and the semi-annual reports and detailed study plans for both the Upper Lakes and Pollution from Land Use Activities Reference Groups.

EQCU coordinates various aspects of the extensive research and surveillance program, as well as the Reference Group activities being undertaken pursuant to the Agreement. This has involved the preparation of program submissions for funding, status and progress reports and other activities.

CANADA-ONTARIO AGREEMENT

EQCU continued its coordinating role in support of the Canada-Ontario Agreement on Great Lakes Water Quality. Under the Agreement, a comprehensive research program has been developed concerning phosphorus removal processes, upgrading of sewage treatment facilities, advanced processes for treatment, the Sludge Handling and Land Disposal Program, and a Storm and Combined Sewer Research Program. Members of the Unit serve on the Technical Committee and the Sub-committees on Technology Transfer and Land Disposal of Sludge. Other activities involved administration and review of external contracts, assistance in the preparation of detailed financial statements and other administrative matters. Members also participated in the planning and management of a seminar on sewage sludge handling and land disposal, held in late September and attended by 400 people from industry, universities, and local, regional and national governments.

ENVIRONMENTAL CONTAMINANTS

The main concern in this field was the preparation of a report on the "Status of Non-Medical Studies on Asbestos in the Great Lakes and the St. Lawrence River." The report briefly describes hazards from occupational and non-occupational exposure to asbestos and the distribution of asbestos fibres in the Great Lakes-St. Lawrence River region, and documents some of the identification techniques used.

Members of the Unit also participated in departmental and interdepartmental activities directed toward the development of a Water Quality Agreement for hazardous polluting substances.

The Unit is responsible for general coordination of research activities related to environmental contaminants carried out at CCIW and has been actively involved in the coordination of these efforts with other departments and agencies.

WORLD HEALTH ORGANIZATION, INTERNATIONAL COLLABORATION CENTRE

A new dimension was added to EQCU activities this past year due to the designation of CCIW as the International Collaboration Centre for Surface and Ground Water Quality by the World Health Organization (WHO/ICC). The principal activity involved the preparation

of a document entitled "Guide to Water Quality Management." It is expected that a Coordinator for these activities will be appointed early in 1975.

OTHER ACTIVITIES

With the establishment of the Environmental Assessment and Review Process, the Unit provided the Chairman for the Ontario Region Screening and Coordinating Committee. Various discussion papers were presented for departmental review, and procedures and terms of reference for the Screening and Coordinating Committee were outlined.

Considerable effort was devoted to the preparation and coordination of material for the development of the EMS Green Paper. All of the staff actively participated in working groups, which outlined fifteen issues with which the Environmental Management Service should be concerned in the near future. A consolidated EMS Green Paper, representative of input from the five establishments within EMS Ontario Region, was prepared for the Regional Director General.

Members of the Unit participated in the Canada-Ontario Fisheries Strategic Planning Work Group. These strategic planning sessions defined goals, objectives and issues regarding fisheries in Ontario.

EQCU continued to represent CCIW on a number of interdepartmental committees, carried out a number of international functions pertinent to the work at CCIW and conducted extensive information programs entailing speeches and papers at a number of conferences and symposia throughout 1974.

Public Relations Unit

Public Relations Unit

As the public becomes increasingly aware of the importance of scientific research to effective environmental management, CCIW must constantly inform Canadian taxpayers of what has been accomplished and what remains to be done. In 1974, the Public Relations Unit found its task more challenging than usual, owing to the restrictions of reduced budgets and manpower as the Department's economy drive took effect.

Nevertheless, in June, the Public Visits Program completed a highly successful 10-month series of illustrated lectures given by scientists on topics ranging from hydraulics to microbiology to hydrography. Supported by special films, exhibits and demonstration displays, these presentations were enjoyed by over 3200 people from within driving range of CCIW.

Although local audiences were relatively well served by such programs, as well as by a vigorous effort in school visits and public speaking engagements, it was decided that the national public needed more attention. Thus the reduced resources of the Unit were focused on generating news and reports that would be conveyed by the mass communication media, both print and electronic.

Fortunately, this decision coincided with the completion of two films entitled "Not Man's to Command" and "Second Frontier." These films describe, respectively, the challenge of trying to regulate partially the fluctuating levels in the Great Lakes, and the work and purpose of CCIW. In association with the National Film Board and with the co-operation of the Ontario public library system, as well as television stations and networks, "Not Man's to Command" had already been seen by audiences numbering several hundred thousand by the end of the year.

"Second Frontier" will be distributed to a national rather than local public, explaining to its audiences not only what is done in CCIW laboratories, ships and field operations, but also why it is done. The film concludes with the important message that the effectiveness of CCIW work depends, to a large extent, on public attitudes toward the use and management of water.

As always, media liaison formed a large part of the year's work. Several news releases were issued and numerous interviews were arranged. Among the many media representatives received was a television film crew from Radio-Télévision Belge.

In response to individual requests during 1974, over 2200 replies were mailed from the Unit, a 50% increase over 1973. In addition, an estimated equivalent number of requests were handled by telephone.

Along with its regular work, the Unit was also asked in the fall to assist the International Joint Commission in a series of public hearings on the topic of further regulation of Great Lakes levels.

Appendix A • CCIW Staff List

CCIW Staff List

ENVIRONMENTAL MANAGEMENT SERVICE

CCIW BRANCH

Director, CCIW Branch – Dr. A. R. LeFeuvre
Secretary – Mrs. C. J. McMunn
Senior Scientist – Dr. R. A. Vollenweider
Secretary – Mrs. S. M. Horne
Receptionist – Mrs. S. Magee

PUBLIC RELATIONS UNIT

Head – A. R. Kirby
Information Assistant – Mrs. I. Powell
Visual Aids Officer – I. F. McGregor

ENVIRONMENTAL QUALITY COORDINATION UNIT

Head – Dr. A. R. LeFeuvre (until July)
Secretary – Mrs. H. Hetherington (until October)
– Mrs. J. Fiddes (Term)

Stenographic Staff – Mrs. S. Austin

Coordinators – J. W. Schmidt (A/Head after July)
J. D. Wiebe
G. A. Jones

Scientific Assistant – J. Osellame

Training Position – Dr. R. R. Weiler (until November)
Dr. K. L. E. Kaiser (after November)

Canada-Ontario Agreement Personnel – Mrs. B. Jones
Mr. D. F. Rhodes

HYDRAULICS DIVISION

Chief – T.M. Dick
Secretary – Mrs. A. Mueller
Administrative Officer – Mrs. E. Eidsforth

Scientific Staff

C.K. Jonys	– Sediment
B.G. Krishnappan	– Dispersion
Y.L. Lau	– Fluid Dynamics
J. Marsalek	– Urban Runoff
M.G. Skafel	– Wave Dynamics
G. Tsang	– Ice Studies

National Hydrometric Service Staff

Head – P. Engel
Towing Tank Supervisor – C. Bil
Carriage Operator – B. Leaney

Technical Services Section

Head – C. DeZeeuw
Research Technicians – E. Bohm, F. Dunnett, W. Ellis, D. Fekyt, J. Huehn, A. McEwen, W. Stage, G. Voros, W. Welmers

SOCIAL SCIENCES DIVISION

Chief – J.P.H. Batteke – economic studies and information systems
Secretary – Mrs. R. Riggs

D.E. Coleman	– dynamic modelling and geographic studies
T.D. Leah	– environmental contaminants
T.A. Muir	– economic studies
D.L. Robinson	– environmental management and planning
R. Shimizu	– legislative and institutional studies
M.R. Sinclair	– environmental attitudes and behaviour; public participation
R.A. Sudar	– coastal zone management; planning
Support Staff	– Mrs. S.D. Begin Mrs. J.I. Thomblison

SCIENTIFIC OPERATIONS DIVISION

Chief – Dr. R.K. Lane
Secretary – Mrs. R.E. Morrison
Administrative Officer – Miss L. Ram

Microbiology Laboratories

Head – B.J. Dutka – Methods development, water quality assessment
Secretary – Mrs. M.B. Jurkovic

Dr. W.E. Lowe	– Taxonomy Unit
Dr. S.S. Rao	– Water Quality Assessment Unit
Dr. A.A. Qureshi	– Mycology Unit (PDF)

Dr. D.A. Rokosh — Microbial fermentation
Dr. A. El-Shaarawi — Statistician (to spring 1974)
Technical Staff
— Mrs. D.J. Nuttley, Ms. K.D. Switzer-Howse, Mr. A.A. Jurkovic, Mrs. D.E. Doerffer, Mr. J.P. Henderson, Mr. S.R. Kuchma, Mr. K.K. Kwan, Mr. R. McGinnis

Physical Sciences Laboratories Section

Head — Dr. R.W. Durham
Dr. F.A. Prantl — radiochemistry
T.W.S. Pang — electron microscopist
R.J. Goble — radiochemistry technologist
R. Miles — radiochemistry technician
J. Fitzgerald — radiochemistry technician
Dr. B.A. Silverberg — electron microscope (PDF)
Dr. S. Joshi — radiochemistry (PDF)

Technical Operations Section

Head — H.B. Macdonald
Secretary — Mrs. A. Stern (on strength March 1974)
— Mrs. L.C. Bouverat (transferred to GLBL, February 1974)

D.J. Cooper — Senior Operations Officer
D.J. Brooks — Operations Officer, CSS LIMNOS
D.H. Hanington — Operations Officer, MV MARTIN KARLSEN
J.T. Roe — Senior Diving Officer
D.J. Williams — Standards and Development Officer (transferred to GLBL, December 1974)
P.R. Youakim — Program Coordinator
L.E. Benner — Sensor Network Unit
T.J. Carew — HMCS PORTE DAUPHINE
R.G. Chapil — Sensor Network Unit to May 1974
H.K. Cho
B.E. Clemmens — Pacific Region
J.R. Compton-Smith — Diving/MV MARTIN KARLSEN
F.J. DeVree — MV MARTIN KARLSEN
F.H. Don — Diving/MARTIN KARLSEN
H.E. Greencorn — Shop
P.M. Healey — MV MARTIN KARLSEN
G.J. Koteles — Point Source Studies
L.J. Lomas — Shop Foreman
M.R. Mawhinney — HMCS PORTE DAUPHINE
B.H. Moore — CSS LIMNOS
H.K. Nicholson — Sensor Network Unit
G.M. Perigo — Shop
S.B. Smith — Project Quinte — Biochemical Processes in Lakes
W.B. Taylor — Sensor Network Unit
M.R. Thompson — CSS LIMNOS
S.P. Withers — Western Region
H.W. Zimmermann — MV MARTIN KARLSEN

Remote Sensing Section

Head — Dr. K.P.B. Thomson (Acting) — remote sensing and lake optical studies, transferred to CCRS, September 1974
Dr. R.P. Bukata — satellite studies
Dr. W.R. McNeil — contract scientist from W.R. McNeil & Associates Inc. — optical studies
Dr. H. Howard-Lock — contract scientist, now at McMaster University — oil spills
Mr. G. Bobba — Land Drainage Reference studies
Technical Staff — H.W. MacPhail, J. Jerome, E. Bruton, W. Boham

Data Management Section

Head — Dr. H.S. Weiler (to July 1974)
Mrs. H. Comba (Acting from July 1974)

Computer Applications — H. Comba, K. Beal, G.S. Beal, J. Dowell, B. Hanson, E. Pyde (to July 1974), B. Duffield, K. Miles
Data Archiving — W. Nagel, J. Byron, M.G. Smith
Special Projects — R. Gottinger, D. Jordan

SCIENTIFIC SUPPORT DIVISION

Chief — A.S. Atkinson
Secretary — Mrs. C. Dean

Scientific Services Section

Instrumentation Research and Development

Research and Development Engineer — K.N. Birch

Computer Services

Head and Software Specialist — H.C. Pulley
Operations Supervisor — M. Kinder
Computer Console Operators — P. Moody, M. Thompson, P. Varga
Peripheral and Keypunch Operator — P. Kirkwood

Library Services

Head Librarian — Mrs. E.A.C. Fosdick
Technical Services Librarian — L.M. Brownlee
Technical Services Clerk — B.J. Davis
Cataloguing Clerk — J. Culp
Reference and Circulation Clerk — L.J. Watson

Engineering Services Section

Head — J.S. Ford
Secretary — S. McVey

Electronic Engineering

Head — A.S. Watson
Instrument Maintenance and Calibration — A. Eatock
Digital Systems/Logic Design — P. Dupuis
Electro-optical Design — R. Desrosiers
Digital Systems/Logic Design — J. Valdmanis
Electro-acoustic Design — B. White
Technologists — K. Mollon, M. Pedrosa, J. Kiaz, A. Fletcher, M. Moschos, E. Smith, A. Tyler, T. Nudds, M. Larocque

Mechanical Engineering

Head — A.E. Pashley
Mechanical Engineers — P. Ward-Whate, B. Brady, W. Gibson
Technologists — R. Boucher, J. Heidt, H. Savile
Tradesmen — D.H. Whyte, R.V. Chumley, K.K.P. Kalter, J. Bidinost

Drafting and Illustrating

Supervisor — W.D. Finn
Draftsmen — A. Gris, M. Donnely, J. Bodnaruk, P. Carney

Technical Services Section

Head — D.F. Stewart
Building Maintenance — G. Clim, J. Slaz
Stationary Plant Supervisor — B. Bodolay
Stationary Plant Support Staff — A. Hyslop, M. Connors, K. Fess, D. Clewley, L. Goghegan, B. MacDougall
Security — S/Sgt. K. Loughren and 12 members of the Canadian Corps of Commissionaires on rotation

Staff Services

Financial Services
Supervisor — A. Mitchell
CCIW Accounts Staff — D. Jefferson, C. Furlong, E. Mulvaney, M. Stepko, R. Money, Y. Hutton

Central Registry and Duplicating

Supervisor — E. Rae
Support Staff — B. Titley, H. Green, J.R. Sims, M. Solvason

Stores

Material Manager — C. Hicks
Procurement — J. Doerr
Inventory Control Clerk — B. Will
Driver — J. Ames
Warehouse — A. Mayes, R. Haswell
Support Staff — F. Kushner, T.A. Williams, R. Legg

LAKES RESEARCH DIVISION

Chief — Dr. P.G. Sly — distribution and variance of lake bottom sediments
Secretary — Mrs. J.E. Cunningham

Scientific Assistant — Dr. M.E. Thompson — specific ion electrodes, low temperature aqueous geochemistry
Administrative Officer — Mr. F. Boyd

Regional Laboratories (CCIW Detachment, Winnipeg)

A/Head — Dr. T.A. Jackson — biogeochemical research
B.C. Kenney — physical limnology (educational leave — University of Waterloo)
W. Warwick — paleoecological research on Bay of Quinte, "dissertation research for Ph.D." — interpretation of chironomid fauna
Support Staff — W.R. McGregor (left May 1974), J. Mollison, R. Woychuk

Regional Laboratories (CCIW Detachment, Vancouver)

Head — Dr. B.E. St. John — trace element geochemistry
Dr. C. Pharo — sedimentary geology of lakes and rivers
Dr. E.C. Carmack — (November 1974) — physics of fjord lakes
C.B.J. Gray — (May 1974) — organic geochemistry and chemical limnology of B.C. lakes
Dr. R.J. Daley — (May 1974) — primary and secondary production processes in lakes
Support Staff — G. Bengert (left September 1974), S. Jasper, B. Clemens

Paleoenvironmental Research

Head – Dr. L.D. Delorme – ostracode taxonomy and ecology, use of shelled invertebrates in defining trophic state indices and paleoclimatology.
Dr. L.L. Kalas – freshwater and terrestrial mollusc taxonomy and ecology
V.W. Hanson – programmer – systems analyst; paleoenvironmental research
Support Staff – M. Denford

APPLIED LIMNOLOGY AND PHYSICAL PROCESSES SECTION

Head – Dr. G.K. Rodgers – physical and descriptive limnology
Secretary – Mrs. S.M. Tapping

Applied Limnology Unit

Head – F.C. Elder – energy budgets of lakes
Dr. E.B. Bennett – circulation
Dr. N.M. Burns – nutrient cycles, especially organic sedimentation
H.H. Dobson – nutrients and water quality
A.S. Fraser – analysis of monitor cruise data: lower lakes
Dr. W.A. Glooschenko – toxic chemicals: chemical-biological relationships in lakes
D.G. Robertson – near-shore thermal regimes
Dr. P. Stadelmann – (leave of absence April 1974) – phytosynthetic production
N.D. Warry – analysis of monitor cruise data: upper lakes
Support Staff – R.G. Chapil, F. Chiocchio, J.A. Gilbert, M.F. Kerman, Mrs. H. Lam, F. Rosa, W.M. Schertzer, Miss S. Patrick

Physical Processes Unit

Head – Dr. P.F. Hamblin – circulation and seiches
Dr. J.O. Blanton – thermal structure and demonstration basin studies (left May 10, 1974)
F.M. Boyce – internal waves and heat content
J.A. Bull – physical limnologist
Dr. M.A. Donelan – air-lake interaction
Dr. C.R. Murthy – diffusion and circulation
H.Y. Ng – Okanagan Basin studies and retention times
Support Staff – K.C. Miners, W.J. Moody, K.D.K. Johnson, J.S. Falloon

Systems Modelling Unit

Head – Dr. T.J. Simons – hydrodynamical modelling
L.N. Allen – model verification
Dr. D.C. Lam (PDF) – numerical modelling

SEDIMENTARY AND CHEMICAL PROCESSES SECTION

Head – Dr. R.L. Thomas – distribution, occurrence and authigenesis of minerals, major elements and heavy metals
Secretary – Mrs. B. Blain

Sedimentary Processes Unit

A/Head – Dr. R.L. Thomas
Dr. T.W. Anderson (GSC) – palynology of recent sediments
J.P. Coakley – distribution, occurrence and relation to erosion, transportation and deposition of active sediments
Dr. V. Damiani (PDF) – sedimentology and applied geochemistry of lakes (left August 15, 1974)
Dr. C.I. Dell – stratigraphic correlation and mineralogy, including clay mineralogy, of recent sedimentary sequences
R.K. McMillan – geophysical instrumentation
Dr. J.-M. Jaquet (PDF) – mathematical geology and modelling of sedimentary processes
Dr. S. Guppy – suspended material in lakes (PDF as of October 1974)
Dr. N.A. Rukavina – interpretation of sediment distributions in the nearshore area; grain size analysis
A. Zeman – geotechnical and sedimentological studies of glacial and postglacial sediments
Support Staff – W. Booth, G. Duncan, Mr. G. LaHaie, R. Sandilands, D.A. St. Jacques, Mrs. L. Oelze, J. Horseman (GSC – left October 1974)

Toxic Substances Unit

Head – Dr. W.M.J. Strachan – organic chemistry applied to lakes
Dr. Y.K. Chau – chemical and biochemical processes of trace metals in the environment – complexation and methylation

Dr. B. Brownlee	– detergents and organic substances in freshwater systems
Dr. E. Nagy	– oil-water studies
Dr. K. Kaiser	– toxic substances (PCB's, pesticides, NTA) in the environment (as of November 1974 with EQCU)
H. Saitoh	– trace elements, especially mercury compounds in lakes
K. Lum-Shue-Chan	– metal organic interactions in natural water (on educational leave as of September 1974)
M.E. Fox	– organic compounds in lakes
Support Staff	– J. Hart

Geochemistry Unit

Head – Dr. A.L.W. Kemp	– sedimentation rates and geochemical budgets
Dr. J.D.H. Williams	– sediment-water interface exchanges; geochemical processes in sediments
Dr. J.O. Nriagu	– stable isotopes; stabilities of authigenic minerals
Dr. V. Cheam	– metal fulvate complexes; geochemistry of dredging
Mrs. A. Mudroch	– geochemistry of dredging
Dr. P. Pang (PDF)	– nitrogen transformation in lakes by isotope ratio method

Support Staff – T.W. Morton, J. Capobianco, Mrs. N. Harper, H. Wong, R. Coker, G. McInnis

Nutrient Dynamics Unit

Head – Dr. D.R.S. Lean	– phosphorus, carbon and nitrogen dynamics in lake ecosystems
Dr. B.K. Burnison	– microbial ecology
Dr. R.R. Weiler	– worked with EQCU until November 1974
Dr. R.F. Platford	– electrochemistry of mixed salt solutions
Dr. R.M. Baxter	– biodegradation of resin acids; phosphorus cycle in lakes
Dr. C. Laio (PDF)	– nitrogen metabolism in lakes

Support Staff – M. Charlton, T. Murphy (educational leave fall 1974) Miss K. McEacheran, Miss S. Jackman

WATER AND WASTEWATER TREATMENT RESEARCH SECTION

Head – Dr. Charles P. Fisher
Secretary – Mrs. Nancy Semenuk
Dr. Aharon Netzer, Head, Research Contract Liaison Coordination Unit
Dr. Barry G. Oliver – Research Scientist
Dr. John Lawrence – Research Scientist
Dr. H. Kirk Johnston – Research Scientist
Mr. Paul Wilkinson – Research Technologist
Mr. Ernest Cosgrove – Research Technologist
Mr. Henri Huneault – Research Technologist
Mrs. Helle Tosine – Research Technologist
Dr. John Carey – Post Doctorate Fellow
Mr. Heng S. Lim – Project Engineer (contract)
Mr. Stephen Beszedits – Project Engineer (contract)
Mr. Henry Miyamoto – Project Engineer (contract)
Miss Karen Bothen – Assistant Research Technologist (contract)
Miss Martha Olijnyk – Assistant Research Technologist (contract)

ANALYTICAL METHODS RESEARCH SECTION

Head – Dr. S. Barabas
Secretary – Mrs. J.M. Giles

Research Scientists –	Dr. B.K. Afghan	Dr. I. Sekerka
	Dr. P.D. Goulden	Dr. R.S. Tobin
	Dr. F.I. Onuska	Dr. A.W. Wolkoff
Research Technologists –	D. Anthony	R. Larose
	P. Brooksbank	J. Lechner
	M. Comba	J. Ryan

INLAND WATERS DIRECTORATE, ONTARIO REGION

Director – D. M. Foulds
Secretary – Miss W. Grant
Administrative Officer, Ontario Region – W. A. Taylor

Water Planning and Management Branch

Toronto Office

A/Chief – N.P. Persoage (Burlington)

Burlington Office

Engineer-in-Charge – N.P. Persoage
Secretary – Mrs. E.M. Kerr
Engineers – W.M. Jones, D.W. Brown, P.P. Yee, C.W. Cheng
Technical and Support Staff – R.J. Lloyd, Mrs. C.J. Ferry, Mrs. J.M. Silk

Cornwall Office

Engineer-in-Charge – D.F. Witherspoon
Secretary – Mrs. S.A. Lowe
Assistant Engineer – J.R. Robinson
Technical and Support Staff – R.J. Young, E.G. Allen, Mrs. A.L. David

Niagara Falls Office

Technical Staff – V.J.M. Johns

WATER QUALITY BRANCH, ONTARIO REGION

Chief – W.J. Traversy
Secretary – Mrs. V. Walker

Analytical Services Section

Head – F.J. Philbert
Ship Support Laboratory – O. Elkei
Inorganic Analysis – D. P. Sturtevant
Organic Analysis – R. C. J. Sampson
Support Staff – H. Alkema, N.C. Arafat, K.D. Austen, L. Babjak, D.T. Bennie, W.D. Blythe, P.D. Bothwell, A.D. Bobrowski, J. Gamble, S. Hicks, G. Jamro, J.R. Leacock, K. Li, R. Luft, D. Marsh, R.C. McRea, P.W. McDermott, M.J. Pacenza, G.M. Paquette, J. Patterson, B. Saly, D.B. Sergeant, Y.M. Sheikh, M. Smith, K.A. Terry, H.H. Tse, E. Tuk, I. Valdmanis, J. Verlinden, R.W. Wales, R.J. Wilkinson

Special Services Section

Head – A. S. Y. Chau
Quality Control – D. McGirr, J. Carron
Method Development – K. Aspila
Chemists – H. Agemian, J. Coburn

Monitoring and Surveys Section

Head – M.T. Shiomi
Support Staff – K.W. Kuntz, C.H. Chan

WATER SURVEY OF CANADA

A/District Engineer – M.H. Quast
Secretary – Miss M.R. Milson
Assistant District Engineer – M.H. Quast
Administrative Officer – R. Mertens
Support Staff – Mrs. G.M. Rolston, Mrs. A. Berry, Mrs. I. Cook, L.E. Dawson

Network Planning and Forecasting – J.E. Slater

Special Studies and Services – B.D. Poyser
Support Staff – R.A. Rees

Niagara River Board of Control – W.M. Archer

Field Operation Section

Southern Ontario – Area Engineer – W.M. Archer (Acting)
Support Staff – M.J.W. Abrahamse, D.J. Copeland, E.J. Firman, F. Kovats, D.J. Lawlor, R.S. LeBlanc, R.A. Mace, F.B. Pelley, G.R. Melendy, J. Ritchie, P.J.W. Ryan, B.D. Smith, R.P. Stephens, J.W. Ward
Northern Ontario – Area Engineer – F.M. Sullivan
Support Staff – R.T. Bishop, J.J. Doucet, R.E. Hayward, O.D.E. Larsen, B.D. Magee, F.J. Rading, D.G. Rowe, J.H. Swann, G.P. Wiggins, E.G. Waugh

Data Control Section

Head – R.J. Myslik
Data Review – Engineer – Vacant
H.A. McGarvey
Mrs. F.C. Howitt
Hydrometric Data – Mrs. V.L. Smith
Mrs. D.M. Lucchetta

Construction Section

Head – K.L. Brimacombe
Support Staff – L.W. Campbell, K.D. Munn

ENVIRONMENTAL PROTECTION SERVICE

TECHNOLOGY DEVELOPMENT AND DEMONSTRATION DIVISION

Director – Dr. J.D. Salloum
Secretary – Mrs. V. Westaway (on leave – September)
Miss K. Mikoda (Acting)

Process Development Section

Head – Dr. N.W. Schmidtke
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EPS Accounts – Mrs. G. Mulvaney (Acting)
Stores – D.M. Niles

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P.J. Crescuolo
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D.H. Ide
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E.J. Ladouceur
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S.C. Lee
N.C. Longhurst
E.G. Luxon
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P.A. Van Hardeveld
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Dr. M. Munawar – phytoplankton
Dr. D.G. Cook – benthos
Mr. J.B. Wilson – zooplankton
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Dr. P.V. Hodson – fish
Dr. D.G.S. Wright – invertebrates
Dr. M. MacKinnon – ATP lakes (PDF)
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Dr. J.M. Cooley – zooplankton ecology and production
Mr. R. Love – macrophyte production
Mr. J.E. Moore – primary production
Mr. J.K. Leslie – electronic techniques
Dr. C.K. Minns – systems ecology
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G. Goldsteen – Revisory I
J. Kean – Spring Control
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C. Gorski
K. Hipkin
P. Keilland
R. Langford
R. Lasnier
C. Leadman
R. Lewis
D. Livingstone
G. Macdonald
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R. Mahaffy
J. Medendorp
B. Power
D. Pugh
W.H. Pulkkinen
R. Rehbein
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R. Solvason
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Hydrographic Development

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Head — A. Rogers
Technical Staff — E. Gervais, D. Robertson, R. Treciokas

Canada-United States Exchange Program

Canada — J. Kean
United States — Lt. D. Winter

Cartography-Drafting

Head — J. Elliot
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P. Budgell
S. Baird
D. Robertson
L. Barfoot
V. Leroux

Oceanographic Research Section

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S. Peck
J. Croal
G. Pudsey

Survey Electronics Section

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Shop Foreman — W.W. Smith
B. Waldock
G. Kavanaugh
I. Padgett
T. Dyas
D. Pyatt
W. Montgomery
H. Boyce
R. Coons

Environmental Assessment

R.S. Boulden

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Secretary — Mrs. F. Haaka
Engineering Superintendent — A.T. Hughes
Shore Captain — W.S. Corkum
Shop Foreman — K.D. Robertson
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Officers — R. Dean, J.G. Leigh, T.C. Kenney, G. Sproule, J. Stansfield (11 Ship's Crew)

CSS BAYFIELD

Master — Captain M.C. Birchall
Officers — R. Carson, R.R. Charles (6 Ship's Crew)

CSS ADVENT

Master —Captain I. Williams
Officer — D. Blackwell (2 Ship's Crew)

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Hydrographic Surveys — 70 Seasonal Ship's Crew

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Secretary — Miss J. Major

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Transportation — C.J. Fulton
Support Staff — J.G. Rothwell, B. Day, J. Mellon, P. Furlong, R. Goodman, Mrs. K. Allen, Mrs. A. Thompson, Mrs. G. Mulvaney, Miss J. Anderson

Appendix B • Publications and Presentations

Publications and Presentations

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