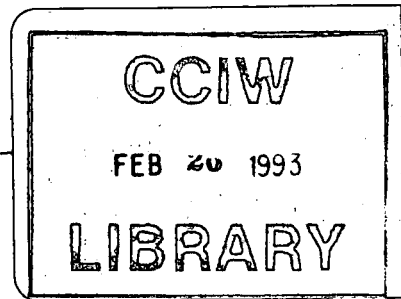




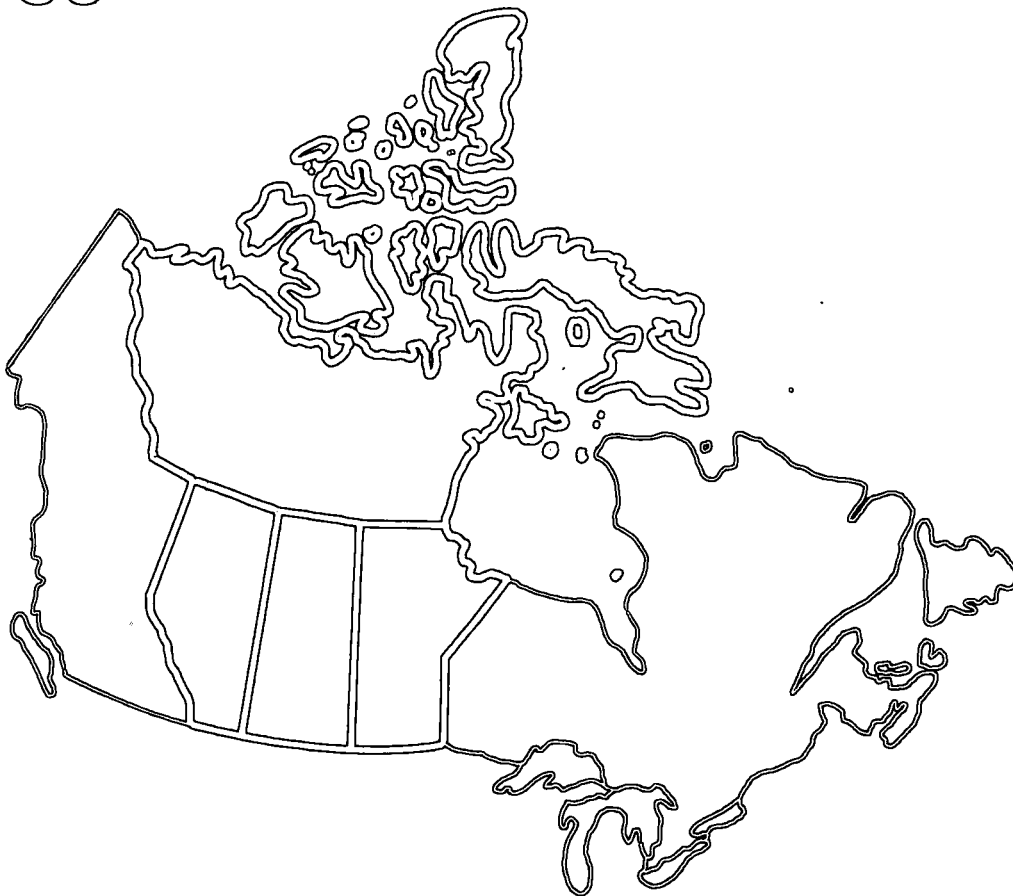
Environment Canada



INLAND WATERS DIRECTORATE
WESTERN AND NORTHERN REGION

ANNUAL REPORT

1984-85



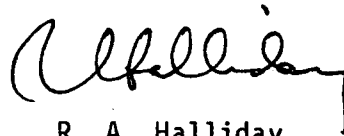
GB
707
C43
1984/85

BER 1985

LETTER OF TRANSMITTAL

This report covers the activities of the Inland Waters Directorate, Western and Northern Region for the fiscal year ending March 31, 1985.

The Directorate continues to provide a wide range of water management services to the public and other agencies, with most of our resources directed to the provision of data, interpretation and advice on water quantity and quality issues. Major future directions will be influenced by recommendations arising from the Inquiry on Federal Water Policy which was initiated during 1984-85 and may lead to changing program priorities and directions in the near future.



R. A. Halliday
Regional Director
Inland Waters Directorate
Western & Northern Region

TABLE OF CONTENTS

	<u>PAGE</u>
Letter of Transmittal	i
Table of Contents	ii
1.0 HIGHLIGHTS/FAITS SAILLANTS	1
2.0 INTRODUCTION	2
3.0 RESOURCES	2
4.0 1984-85 ACTIVITIES	
International	2
Interprovincial	3
Flood Damage Reduction	4
Water Quality Management	5
Hydrometric Monitoring Programs	6
Research	11
Toxic Chemicals	12
Environmental Assessment	12
5.0 FUTURE DIRECTIONS	12
6.0 PUBLICATIONS	13

1.0 HIGHLIGHTS

Mackenzie River Basin: Draft agreements on an integrated monitoring network and spring ice break-up studies were completed and a general agreement granting the territorial government's full membership on the committee is under consideration.

Water Quality: A strategy for developing and implementing a more comprehensive water quality program in the NWT was completed. This document outlines the current status of the program and future directions. Negotiations are continuing with the three prairie provinces to develop comprehensive water quality agreements.

Hydrometric Agreements: Data collection platforms to provide access to data by satellite were installed at 52 sites in the region and 26 new hydrometric stations were constructed under the Alberta expansion program.

Flood Damage Reduction: The communities of Carman and Lorette, Manitoba and Hay River, NWT were designated under the program.

International Issues: A United States Commission recommended in December 1984 a number of changes to the Garrison Diversion project which, if fully implemented, should meet all Canadian concerns.

Toxic Chemicals: A major redefinition of resources assigned to the measurement and assessment of toxic chemicals in the aquatic environment was implemented with an increase from 3.3 to 12.8 person-years of effort.

Federal Water Policy: A National Inquiry on Federal Water Policy was initiated under the chairmanship of Dr. P. Pearse. Extensive consultations were held with the public, special interest groups and federal and provincial water management agencies.

1.0 FAITS SAILLANTS

Bassin du fleuve Mackenzie: Des ébauches d'accords sur un réseau de contrôle intégré et des études sur le bris des glaces au printemps ont été achevées, et un accord, permettant au gouvernement territorial d'être membre à part entière du comité, est à l'étude.

Qualité des eaux: On a terminé la mise au point d'une stratégie de développement et de mise en oeuvre d'un programme plus complet sur la qualité des eaux, dans les Territoires du Nord-Ouest. Ce document donne les grandes lignes de l'état actuel du programme et de son orientation future.

Accords sur le réseau hydrométrique: Des plate-formes de recueil des données permettant l'accès aux données par satellite ont été installées à 52 endroits dans la région, et 26 nouvelles stations ont été construites dans le cadre du programme d'expansion de l'Alberta.

Diminution des dommages causés par les inondations: Les localités de Carman et de Lorette (Manitoba) et de Hay River (Territoires du Nord-Ouest) ont été désignées dans le cadre de ce programme.

Questions internationales: Une commission américaine a recommandé, en 1984, un certain nombre de changements au projet de dérivation Garrison qui, s'ils sont apportés, satisferont à presque tous les intérêts canadiens.

Produits chimiques toxiques: Une importante amélioration a été apportée aux ressources consacrées à l'évaluation et au mesurage des produits chimiques toxiques dans l'environnement aquatique, grâce à l'augmentation de 3,3 à 12,8 du nombre d'années-personnes de travail.

Politique fédérale des eaux: Une enquête nationale a été entreprise, sous la direction du Dr. P. Pearse, sur la politique fédérale des eaux. On a procédé à des consultations de grande envergure auprès du public, de groupes d'intérêts spéciaux et des organismes fédéraux et provinciaux d'aménagement des eaux.

2.0 INTRODUCTION

The federal government's role in water resources management is to ensure that waters of the nation are protected and used "...for the greatest social and economic benefit of Canadians, including both present and future generations." In Canada, the federal government does not have a strong direct mandate for the management of resources. It does however, have certain clearly defined responsibilities and concerns with respect to how the management of resources at the provincial level will reflect on national interests. Most of the activities carried out by Inland Waters Directorate, Western and Northern Region are conducted in close cooperation with the provinces or territories, often under federal-provincial cost sharing agreements.

This report covers the activities of Inland Waters Directorate (IWD), Western and Northern Region for the fiscal year ending March 31, 1985. The region encompasses the provinces of Alberta, Saskatchewan, and Manitoba, and the Northwest Territories, with the regional office located in Regina and major district offices in Winnipeg, Regina, Calgary, and Yellowknife.

3.0 RESOURCES

During 1984-85 the Directorate managed and administered total resources of \$16.05 million and 218.5 person-years. These figures include operational funding as well as grants and contributions made under federal-provincial agreements. The following tables display the distribution of these resources by National Program and by Organizational Unit respectively.

Resource Summary by National Program

No.	NATIONAL PROGRAM Name	1984-85	
		p/y	000*\$
1.1	Interjurisdictional Waters	24.6	3,764.3
1.2	Flood Damage Reduction	6.0	721.0
1.3	Water Quality Management	12.9	1,226.8
1.4	Water Quantity Management	147.2	8,490.3
1.5	Water Management Research	8.0	515.6
1.6	Management	17.8	1,113.6
4.1	Toxic Chemicals	1.0	109.2
4.3	Environmental Assessment	1.0	106.3
TOTAL		218.5	16,047.1

Resource Summary by Organizational Unit

ORGANIZATIONAL UNIT Name	1984-85	
	p/y	000*\$
Regional Management	12.2	621.8
Water Quality	20.0	1,379.2
Water Planning and Management	18.5	3,577.0
WRB, Manitoba-NW Ontario	41.1	2,195.7
WRB, Saskatchewan	33.9	1,763.7
WRB, Alberta	52.2	2,822.4
IWD, Northwest Territories	26.7	2,857.9
NWRI	8.0	473.1
PPWB	5.9	356.3
TOTAL	218.5	16,047.1

4.0 1984-85 ACTIVITIES

INTERNATIONAL ACTIVITIES

Work continued on developing an accurate procedure for determining the natural flow of the Milk River in anticipation of the need for formal apportionment of the flows. Increased uses of the Milk River, both in Canada and the United States, and the possibility of a dam on the Milk River bring the need for apportionment ever nearer.

The United States recorded deficit deliveries on the St. Mary River in April and at the request of Canada agreed to refund the deficit in July, which was subsequently done. The natural flow of the Milk River fell to zero by mid-June, remaining at or near zero for the remainder of the year. To accommodate Canadian users, Canada requested the United States to deliver some of the Canadian share of the St. Mary River to the Milk River. The United States complied with the request, with 0.85 m³/s of Canada's share of the St. Mary River being diverted down the Milk River from June 25 to August 16 and 0.60 m³/s from August 17 to 23.

Field representatives from Water Resources Branch, Calgary Region and the United States Geological Survey, Helena, Montana made a joint presentation to the International Joint Commission (IJC) concerning the flows in the southern tributaries of the Milk River and the need for a ruling on their apportionment. The natural flow of the three Eastern Tributaries of the Milk River, Lodge Creek, Battle Creek, and Frenchman River, were apportioned in accordance with Rule III of the 1921 International Joint Commission Order, with deficits occurring during most of the division periods. By the end of the irrigation season all three tributaries remained in deficit. Flow on the Souris River from Saskatchewan to North Dakota was sufficient to meet Canada's obligations under the 1959 Interim Measures.

Canada's obligations on the Red River continue to be met through participation on the Red River Pollution Board. An automatic water quality monitor provided data to evaluate compliance of Red River water quality with established site specific objectives. Methodologies to improve these objectives were developed and approved by the IJC. A contingency plan was developed and instrumentation put in place in the event of potential spills on the U.S. portion of the Souris River. Canada continued to meet its obligations to monitor water quality on the East Poplar River.

Policy advice on international issues was provided to Environment Canada corporate groups responsible for assisting External Affairs in devising a Canadian position on water-related boundary issues. In 1984-85 issues of concern were the Garrison Commission Report, raising of Lake Darling water levels, Red River flood protection, flood protection along the Pembina-Aux Marais Rivers, and storage on the Milk River. In all of these issues IWD has been instrumental in the determination of a Canadian position. In December of 1984 a United States commission recommended changes to the Garrison Diversion pro-

ject which, if implemented, would go a long way to satisfy Canadian concerns with the project.

Regional staff members also contribute to the work of international bodies such as the World Meteorological Organization, International Organization for Standardization, the Decade of North American Geology Project, and the GEMS/WATER program.

INTERPROVINCIAL ACTIVITIES

Canada-Saskatchewan Agreement on Qu'Appelle River Channel Conveyance

A five year, \$4.75 million Agreement was signed on June 27, 1984. The Agreement is to be in effect from April 1, 1984 to March 31, 1989 and provides for the completion of the conveyance project. Expenditures under the Agreement are to be cost shared equally between the federal and provincial governments. During the 1984-85 fiscal year \$70 000 was spent by Canada on channel improvement work.

The work to be carried out under the Agreement is designed to improve the discharge capacity in constricted sections of the Qu'Appelle River making possible the conveyance of larger flows without overbank flooding. Improved channel conveyance will permit more efficient operation of the Qu'Appelle River system and will ensure that the terms of the Prairie Provinces Water Board Master Agreement on Apportionment are met.

Throughout the year negotiations have continued with the Piapot and Muskowpetung Indian Bands for a right-of-way agreement to carry out conveyance work on Indian lands upstream of Pasqua Lake. In February 1985, the Management Committee approved the construction of a \$800 000, 60 ha fish rearing facility to mitigate the effect of the project on fisheries.

Canada-Saskatchewan Interim Subsidiary Agreement on Water Development for Regional Economic Expansion and Drought Proofing (SAW)

The Agreement which expired on March 31, 1984, provided for DOE, Department of Regional Economic Expansion (DREE) and provincial government funding for development of a water management strategy for economic development. Draft reports on drought mitigation scenarios were written in 1984-85 with the reports to be completed by PFRA in 1985-86. A final report on Saskatchewan drought sensitivity and proposed mitigative measures will also be written by PFRA. All funding was completed under this Agreement on March 31, 1985.

Canada-Manitoba Interim Subsidiary Agreement on Water Development for Regional Economic Expansion and Drought Proofing (MAW)

This Agreement, which expired on March 31, 1985, also developed scenarios to mitigate the economic impacts of a drought. The scenarios, developed by the University of Manitoba under contract, reported the economic sensitivity and impacts of drought on the farm, regional and provincial economies. The remainder of the

Agreement included investigating and/or developing water supply projects for communities and agriculture in Manitoba.

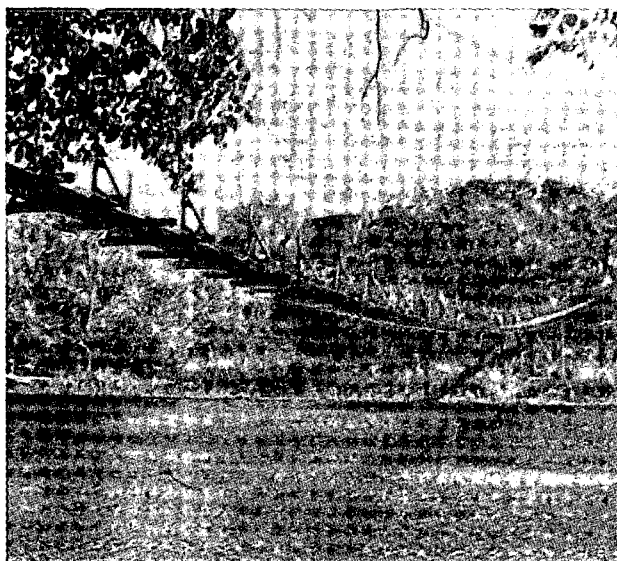
Canada-Manitoba Agreement on the Study and Monitoring of Mercury in the Churchill River Diverston

On March 31, 1985, the third year of this four year Agreement was completed. Good progress continues to be made on all aspects of the Agreement, with Agreement expenditures being under budget and 13 of the possible 14 projects begun.

Field studies and laboratory experiments are either underway or have been completed on a variety of projects. These projects include: an investigation of the potential sources of mercury in the study area; field experiments to determine the factors which affect the methyl mercury accumulation in fish; laboratory experiments to study the effects of such factors as pH and anaerobic conditions on methylation and demethylation; and the monitoring of mercury levels in fish, aquatic carnivores such as mink, and in people.

A public awareness program concerning mercury is also underway, with emphasis on meeting the special information needs of the native communities located within the study area.

The Agreement provides for an agreement summarizing progress and results of the Agreement projects for each year. A Final Agreement Report is expected in the late summer of 1986.



FLOOD DAMAGE REDUCTION

Saskatchewan

In Saskatchewan work continued on hydro-technical and floodplain management studies on a limited basis as the Mapping and Studies Agreement expired in 1982. A floodplain management study was completed for Lumsden and the hydraulic studies for Weyburn and Lumsden were updated. Several negotiating meetings were held on a new Mapping and Studies Agreement, and an Agreement Respecting Community Floodplain Management Measures. It is anticipated these agreements will be signed in 1985.

Northwest Territories

The flood hazard area of Hay River, Northwest Territories was designated and the designation of the communities of Aklavik, Fort McPherson, Fort Good Hope and Fort Simpson is scheduled for June 1985.

Manitoba

In Manitoba the communities of Carman and Lorette were designated. Hydrotechnical studies for Arborg, Lorette and Neepawa were completed and the Elie study was updated. Extensions to the Studies and Mapping Agreements are to be signed in 1985. The Mapping Agreement expired on December 1984. An additional \$160 000 will be added to the Mapping Agreement to complete the program.

The \$600 thousand agreement with Manitoba to improve the flood forecasting capability in the Assiniboine River, Red River and Souris River basins proceeded as scheduled. The HSPF hydrologic model was made operational on the mini-computer. Initial contact was made with the U.S. National Weather Service to coordinate the forecasting in the entire Red River basin.

Canada-Manitoba Ring Dykes Upgrading Agreement

A \$4.5 million Canada Water Act (CWA) agreement with Manitoba was signed in March 1983 to upgrade the level of protection of ring dykes at eight Red River Valley communities to the 1:100 level. Treasury Board has approved a \$1.6 million extension to include the dyking of Ste. Rose du Lac and dyking of the water treatment plant at Souris. Ministerial signing of this extension is anticipated in 1985. The dykes were completed at Brunkild and Morris with a majority of earthwork completed at St. Adolphe. Pumping facilities and landscaping will be completed in 1985. Agreements with the Province and the remaining communities to cost-share construction and maintenance are in place and in 1985 construction is scheduled for St. Jean and Lettelier. Negotiations continued with the United States on the construction and upgrading of the dyke to protect Emerson, Manitoba and Noyes, Minnesota.

Mackenzie River Basin

In the past year bilateral discussions between Alberta and Canada (for NWT) and Saskatchewan and Alberta were initiated as a first step towards implementation of Mackenzie

River Basin Committee (MRBC) study recommendation #1, development of a transboundary water management agreement. Discussions between Saskatchewan and Canada for NWT will commence shortly and all discussions involving British Columbia have been placed on hold pending formal direction from the B.C. Cabinet.

The MRBC continued preparatory work for the implementation of recommendation #2, development of an integrated hydrometric monitoring network and #5, monitoring of spring break-up processes on the Liard and Mackenzie Rivers. Draft implementation agreements for these recommendations have been prepared and reviewed as well as a general agreement which grants the governments of the Northwest Territories and Yukon full membership on the MRBC.

Regina-Moose Jaw Water Supply

The cities of Regina and Moose Jaw have experienced taste and odour problems with their municipal drinking water supplies for several years. A subagreement under the Canada-Saskatchewan Economic and Regional Development Agreement was signed in May 1984 to cost share, among the three levels of government, the construction of a granular activated carbon treatment facility to alleviate these problems. IWD oversees the federal management of the agreement to construct the \$15 million project which is scheduled for official opening early in June 1985.

Peace-Athabasca Delta

Evaluation of the performance of the Rivière des Rochers and Revillon Coupé weirs in the Peace-Athabasca Delta (in particular, concerns related to hydrology and biology) was undertaken at the request of the Peace-Athabasca Delta Implementation Committee. The evaluation is the joint effort of Alberta Environment, the Department of Fisheries and Oceans, and Environment Canada. Final reports are due in 1985-86.



WATER QUALITY MANAGEMENT

Water Quality Agreements

The commitment of the federal government to working cooperatively with the provinces and territories in assessing the quality of Canadian waters continued to be addressed through the negotiation of formalized Agreements and ad hoc arrangements. The formalization of long-term coordinated water quality monitoring activities including the collection of water quality data, the establishment of compatible data bases and the provision of accurate and timely information to managers and the public was the subject of continuing negotiations with Alberta and Manitoba. Informal meetings were held with DIAND at the Headquarters level in preparation for negotiation of a similar Agreement for the NWT. Arrangements for monitoring the Souris River in the event of spills originating in the U.S.A. were agreed upon with Manitoba with such arrangements to be included in the broader Agreement.

Annual ad hoc arrangements for water quality sampling and analysis were negotiated and implemented with Alberta and Saskatchewan as well as several agencies of the Federal Department of Environment.

Water Quality Monitoring

Sampling and analyses for water quality were conducted at 71 locations in the Prairie Provinces and 22 locations in the NWT on a regular basis. Analyses for a large suite of physical, chemical and biological characteristics with increasing emphasis on toxic metals and organic chemicals are becoming increasingly expensive. While manpower shortages led to 15 discretionary stations being temporarily dropped as of February 1, 1985, the major result of this increasing cost is the re-examination of monitoring philosophies and strategies with emphasis on surveys, sampling in other media, tools for screening samples for toxicity and comprehensive assessment of water quality. Considerable progress was made concerning the development of a water quality monitoring strategy in the NWT which incorporates these changes and a decreasing proportion of monitoring activities which are routine is expected throughout the region in future.

Ongoing efforts include the operation of the automatic water quality monitor transmitting continuous data via satellite on the Red River near Emerson, the identification and encouragement of research in support of improved monitoring and the resolution of data processing problems to make new information more readily available and existing information more useful.

Water Quality Objectives

Discussions were held with Parks Canada on approaches to water quality management in four Alberta national parks. Data have been analysed and methodologies for water quality objectives establishment recommended for the Alberta-Northwest Territories bilateral negotiations. Ongoing participation in the development of Prairie Provinces Water Board water quality

requirements continued. A new method for implementing water quality objectives on the Red River at the international border was devised under the auspices of the Red River Pollution Board and subsequently approved by the IJC. Significant contribution was made to the federal/provincial exercise, under the auspices of the Canadian Council of Resource and Environment Ministers (CCREM) compiling water quality guidelines. Guidelines pertaining to agricultural uses of water are being prepared in this region.

Laboratories

The Water Quality Laboratory in Saskatoon provides analytical services for Regional Branch monitoring programs and other federal and provincial agencies, including the National Water Research Institute, National Hydrology Research Institute, Canadian Wildlife Service and the Alberta and Saskatchewan Environment departments.

Surface waters are examined for physical parameters (e.g., pH, conductivity, turbidity, colour), nutrients (phosphorus, nitrogen, carbon, boron), minor ions (e.g. cyanide, sulphide) and phenolic compounds.

During 1984-85, 35 350 tests were carried out on 1979 samples. Scientific equipment utilized in the laboratory includes Technicon Autoanalyzers, UV-VIS spectrophotometers and Infra-red detectors. A recent acquisition has been the Carlo-Erba Elemental Analyzer for the determination of carbon, hydrogen, nitrogen and sulphur.

Aquatic Quality Surveys

A draft report on the nutrient input and output of Fishing Lakes, produced through an involvement with the Qu'Appelle Implementation Board, was completed in 1984.

A second survey of mercury levels in Cookson Reservoir was conducted in 1984 in order to check results obtained in the initial September 1983 survey. A draft report covering both surveys was written and is now under review.

A joint Water Quality Branch-Saskatchewan Environment Study on nutrient and toxic chemical input, uptake and fate in Lake Diefenbaker was initiated in 1984/1985. Field work will be carried into 1985/1986. This study is partially funded through TOXFUND.

Water Quality Interpretation and Reports

During 1984/1985, one detailed data report and five interpretive reports were prepared. Considerable support was provided to Headquarters in the review of reports and policy documents. The section on publications includes reports prepared by WQB during this reporting period.

The Water Quality Branch has continued to enhance its electronic data processing capabilities, having switched its data base management system in early 1984 from a DEC PDP 11/34 in Calgary to a new VAX 11/750 minicomputer located

in Regina. Considerable improvement in the initial performance of the VAX was achieved through the installation of a BASIC compiler, and the adoption of the LABS 11 data base management system in March, 1985.

The three provincial WQB offices now have full graphics terminals, and are able to communicate with the Regina computer via DATAPAC and Centrex systems.

Ground Water

During 1984/1985, IWD attempted to clarify the federal ground water policy for W&NR. The regional ground water policy will, however, be strongly influenced by the findings of the Pearse Commission's National Water Enquiry, and as a result, policy discussions will continue into 1985/1986.

A study of the uranium and trace element hydrochemistry of the Hart Coal Seam in the Poplar River Basin was commissioned. In addition, IWD continued to provide ground water related input to the Poplar River Bilateral Monitoring Arrangement.



HYDROMETRIC MONITORING PROGRAMS

General

A major evaluation of Water Resources Branch programs within the Region was completed during 1984-85. Some resource transfers were made between the four offices and minor changes made in management practices to ensure that a comparable level of service is being provided across the Region. The Auditor General of Canada in

his report to the House of Commons for fiscal year ended March 31, 1984 reviewed the water quantity management data program of IWD and noted "that the system was functioning satisfactorily and that due regard was being given to economy and efficiency".

The federal-provincial agreements for water quantity surveys have been in place since April 1, 1975. Under the Agreements, hydrometric stations are classified as being of federal, federal-provincial or provincial interest for the purposes of allocating costs. The following table indicates by province and territory the number and designation of stations operated under the agreements as of April 1, 1984.

Number of Hydrometric Stations and Designation by Province as of April 01, 1984:

	Fed	Fed-Prov	Prov	TOTAL
Man.	97	111	89	297
Sask.	136	126	113	375
Alta.	126	214	159	499
NWT	70	34	34	138
NW Ont.	70	---	---	70
TOTAL	499	485	395	1379

The following Table summarizes the direct costs of operations under the hydrometric agreements for 1984-85.

Total Hydrometric Program Costs and Shareable Costs for 1984-85 (\$'000):

	Total Program	Shareable	Federal	Provincial
Man.	2010	1217	772	445
Sask.	2043	1148	729	419
Alta.	2843	1857	878	979
NWT	2379	1949	1283	666
NW Ont.	214	214	214	0
TOTAL	9489	6385	3876	2509

Total construction expenditures during 1984-85 are shown for the region in the Table below. Annual construction, upgrading and maintenance reports provide complete details on the construction program.

Summary of 1984-85 Construction Costs (\$'000):

Manitoba	211
Saskatchewan	109
Alberta	304
Northwest Territories	554
N.W. Ontario	150
TOTAL	1328

Northwest Territories

Summary of Hydrologic Events

In describing runoff events in such a large land mass, one can only generalize. The western Arctic experienced an early spring and a normal to below normal runoff. Upper Mackenzie River basin flows were 60 to 80 percent of normal following breakup. However, a series of early summer precipitation events over the western tributaries reversed this trend and resulted in normal to above normal flows for the balance of the open water season. With these conditions and a normal freeze-up, the commercial shipping industry experienced a successful season.

In the central Arctic, flows ranged from normal to much above normal with several streams approaching or exceeding maximum recorded flows. For example the Camsell River at Outlet of Clut Lake recorded a daily maximum flow of 229 m³/s versus a previous recorded daily maximum of 152 m³/s for the 20 year period of record.

Streamflows in the eastern Arctic were in the normal range. In all areas, recession flows and lake levels during the winter of 1984-85 tended to be in the normal to above normal range.

DOE/INAC Memorandum of Understanding for Water Quantity Surveys

During 1984-85, one joint Administrators/Coordinating Committee meeting and one Coordinating Committee were held. Significant items addressed at the joint meeting included: the review of resource data to be included with the 1983-84 cost-sharing report, approval of schedules A and D subject to an amendment to the latter document, a review of the 1983-84 construction report and the 1983-84 hydrometric investigations report. Additional agenda items included the 1984-85 network construction and maintenance plan, the submission to Treasury Board for network expansion in the Northwest Territories and several matters related to cost-sharing sediment surveys, computer hardware and capital expenditures in general. Construction and hydrometric survey activities in the Mackenzie River delta were also discussed. Items discussed at the Coordinating Committee meeting included a review of 1984-85 field survey operations, special hydrometric station investigations, Mackenzie River delta activities, the data collection platform program and network construction and maintenance. The results of a short term helicopter contract designed to improve the surface water data collection program in the Keewatin area were reviewed. Other subjects on the agenda included a review of Schedule A and station classification, cost sharing the sediment program at two stations formerly funded by British Columbia Hydro, a forecast of INAC's share of 1984-85 expenditures and an estimate of resources required for 1985-86. The agenda distributed for the National Coordinators meeting was discussed, particularly potential problems posed by cost-sharing electronic data processing equipment and the proposed direct readout ground station. The meeting concluded

with the note that Water Survey of Canada might be asked to provide supportive surveys for the Hydrology Working Group in relation to Alberta-Northwest Territories interjurisdictional rivers negotiations.

The 1984-85 field program included the operation of 138 hydrometric stations of which 70 were classified as federal, 34 as federal-territorial and 34 as territorial. The surveys were conducted by Staff based in Yellowknife, Inuvik, Fort Smith and Fort Simpson. Hydrometric surveys in the Eastern Arctic during the open water season were supported by staff temporarily stationed at Baker Lake. Despite a number of staff resignations, surveys were completed as scheduled by means of extra assignments, the use of senior staff for field work, the assistance provided by other regions and headquarters but most importantly, through the cooperation and good effort of all concerned.

The 1984-85 Northwest Territories construction program included the establishment of two new stations. Maintenance or upgrading was carried out at 29 stations and eight reconnaissance surveys were flown. Twenty-three data collection platforms were deployed along with peripheral equipment such as solar panels and heavy duty batteries.

Significant renovations were completed to the two houses at Baker Lake and the office at Inuvik. Additional work was carried out on offices at Fort Simpson and Fort Smith and the warehouse compound at Yellowknife.

Related activities supported by Water Survey of Canada staff included the operation of two hydrometric stations in the Yukon and three in Alberta, water quality field sampling at 17 Water Quality Branch stations and 22 DIAND sites and field servicing of 15 climate stations for the Atmospheric Environment Service. Additional field work included a number of flow measurements done for Cominco Ltd. on the Yellowknife River and Echo Bay Mines Ltd. on the Burnside River and Contwoyto River.

Information Services

Data publication deadlines were met for both water quantity and sediment data, the result in some part of the installation of a mini-computer and terminals which allowed staff to carry out computations entirely in-house. A start was made on extending electronic data processing to sub-offices with the purchase of a digitizer and micro-computer for the Inuvik office. Replies were prepared for 96 data requests from a broad range of users in the hydrologic community. The majority of these tended to be for rivers in the Western Arctic, particularly the Mackenzie River basin. The Mackenzie River stage forecast was prepared during the commercial shipping season and distributed daily by telex to various clients. The forecast is based on real-time data produced by a number of gauging stations on the Mackenzie River and major tributary streams.

A review of gross drainage areas for all active and discontinued hydrometric stations in the Northwest Territories was completed. A computer file containing data for all stream-flow measurements made in the Northwest Territories was created. This file will be particularly useful for data review.

Special Projects

A network of 11 stage stations was operated during the open water season in the Mackenzie River Delta. A set of 11 discharge measurements was also made on various channels in the Delta complex. These data and additional measurements scheduled for 1985-86 are intended to support attempts to develop a hydrodynamic model that will quantify flow distribution under various conditions. A better understanding of these processes will, in turn, lead to increased knowledge of the ecologic systems that support the renewable resources of the Delta region.

The concept of hydrometric field camps first attempted in 1983-84 was followed up with camps at three remote hydrometric stations in 1984-85. The intent of these short-term but intensive investigations is to test field equipment, observe and record break-up and runoff conditions, establish typical backwater values and extend stage-discharge relationships; in short, to upgrade water quantity data at existing stations and provide information that will result in the early publication of data for newly established stations.

A short-term helicopter contract was used to support spring hydrometric surveys in Keewatin. The unrestricted station access resulted in much improved record recovery, a number of high water measurements and the observation of breakup phenomena at a number of stations that previously had never been visited during the critical breakup period.

Alberta

Summary of Hydrologic Events

The southern half of Alberta experienced extremely dry conditions in 1984 with runoff volumes for the January to October 1984 period varying from 30 to 70 percent of the long-term means. Runoff volumes rivalled those of the drought year of 1975, with some sites recording slightly less, while others slightly more.

Some problems were encountered because of these conditions. The Lethbridge Northern Irrigation District had to shut down for a period in July as the internal storage reservoir, Kehoe Lake, was depleted. The natural flow of the Milk River dropped to zero by the end of June. Arrangements were made to divert some of the Canadian share of the St. Mary River through the Milk River for use by Canadian irrigators (from June 25 to August 23). Natural flow of the South Saskatchewan River system was very low as well, but Alberta managed to meet her delivery obligations, partially by releasing water through the Red Deer River from storage in Dickson Reservoir.

One major storm event was recorded in Alberta in 1984, this tracking through the northeastern portion of the province with streams draining the Cariboo and Birch Mountains most affected. Recorded peaks at the Ponton River and Birch River gauging stations were the highest for the period of record (data since 1962).

Winter struck extremely early, with the onset of a major blizzard on October 18 and 19, 1984 and a second blizzard in late October. Below normal temperatures were experienced throughout most of the remainder of 1984. Winter conditions moderated in early 1985 with conditions varying mostly in the normal to much above normal temperature range.

Federal-Provincial Memorandum of Agreement for Water Quantity Surveys

Under the Agreement with Alberta, Water Survey of Canada operated 116 federal, 211 federal/provincial and 143 provincial gauging stations in 1984/85. During the year 1 federal, 6 federal/provincial, and 17 provincial stations were discontinued and one station was redesignated from federal to federal/provincial. A total of 18 sediment stations were operated. In addition to the construction of 24 new gauging stations, major maintenance was carried out at 22 sites. A total of 4 satellite data collection platforms (DCPs) were installed and operated. Also, 71 solar panel charging systems were installed, bringing the number of stations with this type of installation to 90.

The Alberta-Canada Coordinating Committee met twice during the year, the major item of concern being budgetary, as Alberta is experiencing restraint with no increase for hydrometric operations expected in 1986/87. This puts the network expansion program on hold, with a maximum of 8 new stations slated for construction in 1985/86. A similar number will likely be discontinued to provide adequate operations funding.

Information Services

Data publications deadlines were met for both sediment and hydrometric data. In addition to major clients recovering the annual and historical publications and/or data tapes, 910 requests for data were fulfilled. Clientele included federal, provincial and municipal agencies, consultants, industries, educational organizations and private individuals. Approximately 30% of the requests were for interpretive and report data, while the remainder were for basic hydrometric information. Other data production and distribution included semi-monthly and annual apportionment reports on the St. Mary River, quarterly and annual apportionment reports on the South Saskatchewan River, daily flow messages on major streams to three provincial agencies and one federal agency; and distribution, on a monthly basis, of tentative hydrometric data for 51 gauging stations. During peak flow period streamflow discharge measurement results were entered in the mini-computer system for daily interrogation by the Alberta River Forecast Centre.

The Calgary Region, WRB, participated in Environment Week by manning a display booth in a Calgary Shopping Centre mall and by making all the local arrangements for Environment Week.

Special Projects

The major special project was the continuation of a cooperative study with the United States Geological Survey and the National Hydrology Research Institute on determination of Milk River natural flow. Included in the study were mapping of evaporation surfaces and evapotranspiration zones, and operation of evapotranspiration instrumentation. NHRI reports on ground water, evaporation and evapotranspiration were finalized during the year. Another international project, in cooperation with the U.S.G.S. was a field inspection of the southern tributaries of the Milk River and preparation of a report on these tributaries presented to the November 1984 meeting of the International Joint Commission.

Several studies were conducted for the Prairie Provinces Water Board. These included updating the South Saskatchewan River natural flow computer model and preparation of a user handbook; finalization of the report on irrigation return flow for determination of natural flow of the South Saskatchewan River; and preparation of a third draft handbook of natural flow procedures and hydrometric network requirements for small interprovincial streams.

The mini-computer system was upgraded with the installation, at the end of the year, of two additional RUA60 disc drives which has added sufficient memory to do one year of data computations without individual scheduling. The procedures software was upgraded to enable WSC to do all computations and processing of daily hydrometric data in-house.

Moving boat equipment was utilized for a number of measurements on the Peace and Athabasca Rivers.

The Alberta District's Peace River sub-office hosted a Canada-USA Winter Discharge Measurement Techniques and Instrumentation Working Group Workshop in January. About 40 persons attended representing the Water Survey of Canada and the United States Geological Survey as well as ice researchers from Canada and the USA. The workshop covered recent developments and future needs; it also included a one-day field evaluation of techniques and instruments on the Peace River in -40° weather.

Saskatchewan

Summary of Hydrologic Events

Spring runoff in 1984 was generally very low in southern Saskatchewan and below normal elsewhere. Recorded precipitation was extremely low throughout much of the southern area during the year and in combination with very hot temperatures in July and August, produced drought conditions which in many locations were the worst in a century. In contrast, central and northern areas experienced severe rainstorms in

May and June and a heavy snowfall on May 24. This resulted in significant land flooding.

Precipitation was widespread in September with up to 30 cm of snow being recorded in parts of central and east central Saskatchewan. Blizzard conditions prevailed in mid-October and up to 40 cm of wet snow was recorded in the province. Extremely cold temperatures by month-end prevented snow cover disappearance. Snow accumulation throughout the rest of the winter was below normal in the south and significantly above normal in central and northern areas of the province.

Temperatures were typically below normal in November and December but varied from -35°C to +8°C in January. The first two weeks of February were very cold but some thawing was evident by month-end. March temperatures were generally above normal and runoff began in the extreme south. A storm tracked across the south in the third week of March and left about 30 cm of wet snow.

Federal-Provincial Memorandum of Agreement for Water Quantity Surveys

Hydrometric surveys undertaken within the 1984-85 fiscal year were of a routine nature. Emphasis was placed on the expansion and operation of satellite DCPs at various gauging sites. As of March 31, 1985 twenty-one data collection platforms were operational in the province. Ten installations scheduled for 1984-85 were delayed due to late equipment delivery.

The construction program consisted primarily of maintenance and upgrading activities. Only one new station was constructed during 1984-85. Station upgrading was performed at eight sites and maintenance at an additional fifty-nine sites. The project undertaken to assess the suitability of rod and screw-type bench marks continued.

Several special construction projects were undertaken during the year. These included: the installation of a 22m prefabricated metering bridge; design and construction of a prototype 2-man collapsible aluminum cablecar; and, the erection of a long prefabricated stairway at a remote site.

Hydrometric staff completed profiles for 205 stations during the year. These station profiles provide valuable information on the history and purpose of the gauging stations. The remaining profiles will be completed in 1985-86.

Information Services

Interactive data computation procedures using the DEC PDP 11/44 in-house, mini-computer were fully implemented during the year. In addition, the Prince Albert sub-office obtained a computer terminal and printer. This significantly improved computation turnaround time.

During 1984-85, 385 requests for data in either printed or microfiche format were fulfilled. Major clients continued to obtain data directly from a data tape at the SaskComp computer centre without contacting the Water Resources Branch.

Additional warehouse space was acquired during the year and renovations started. This will be completed in the subsequent year and will improve the ability of the Water Resources Branch to deliver the Water Management Data program.

Manitoba-Northwestern Ontario

Summary of Hydrologic Events

The 1984 spring runoff was much below normal in southern Manitoba due to a minimal winter snow cover. Many smaller streams produced only a trickle of water. Above-normal precipitation during April resulted in most controlled lakes and reservoirs being within their desirable range. Areas of Manitoba north of a line through The Pas and Berens River experienced an average to above average spring runoff. Slightly below average runoff occurred in Northwestern Ontario. Spring flows on the Assiniboine and Souris Rivers were well below normal. Red River spring flows were above average due to runoff in the United States portion of the basin. Flows on the Winnipeg River and the Saskatchewan River were slightly above average.

Below normal precipitation and above normal temperatures in later April and May came to an abrupt halt during June. June weather was highlighted by five major rain events in eastern Manitoba including the area in the vicinity of Winnipeg, northwestern Manitoba and parts of Northwestern Ontario. Some urban and agricultural flooding occurred in the vicinity of Winnipeg and Dauphin-Swan River areas. June 1984 was the second wettest for Winnipeg since records have been kept. The heavy intense precipitation in the Red River Valley resulted in the issuance of high water forecasts by the Manitoba Water Resources Branch twice during June.

During the winter of 1984-85 snowfall amounts resulted in a snow cover that was near normal over southern Manitoba and runoff was generally over by the end of March.

Federal-Provincial Memorandum of Agreement for Water Quantity Surveys

Under the Agreement with Manitoba a total of 215 discharge, 82 water level and 18 sediment stations were operated by WRB. The province was represented by the Water Resources Branch of the Department of Natural Resources. The Coordinating Committee met three times during the year. There was little change to the network. There were 50 construction projects in Manitoba, 14 upgrading projects consisting mainly of electrical service installation and shelter insulation, and 35 maintenance projects. In addition to these projects, satellite data collection platforms were installed at 8 sites. A cost sharing program between the Department of Natural Resources and Manitoba Hydro was initiated, allowing for WRB to install 55 DCPs over the next 5 years with cost recovery.

In Northwestern Ontario 39 discharge stations and 31 water level stations were operated by the Manitoba-Northwestern Ontario District, under the Canada-Ontario MOA which is administered by the WRB Ontario regional office located in Guelph. The sub-office at Fort Frances was closed and consolidated with the Keewatin sub-office into newer facilities in Kenora. The hydrometric network increased by two stations and three new stations were constructed. The bulk of the hydrometric work is undertaken for the Canadian and International Lake of the Woods Control Boards, and in the Experimental Lakes Area, for Fisheries and Oceans Canada. Cooperative arrangements were initiated with the Atomic Energy of Canada Limited for the construction of 4 gauging stations, two of which were completed. Other construction activity included a new station on Lac Seul and 3 upgrading and 1 maintenance projects. Data collection platforms were installed at 7 sites. At the end of the year the operational responsibility for 22 stations in the Experimental Lakes Area was transferred to the Department of Fisheries and Oceans.

Information Services

During 1984-85, approximately 760 data requests were received and answered, down somewhat from the previous year following a review of standing requests. Requests for current information represented 71% of the total. Historical data and special types represented 15% and 14% respectively. The various agencies of the Provincial government accounted for 29% of the data requests followed by Federal agencies with 27% and private users with 13%. Engineering consultants, hydro electric companies, education institutions and others account for the remaining 31%.

The in-house mini-computer system became fully operational in July 1984. The mini-computer was used for the computation of the 1984 streamflow and water level data. This in-house system of automated computations reduced computation time considerably once the learning phase was over. Purchase of 2 large disk drives has increased the storage capacity of the system from 32 to 442 online megabytes.

Public information activities, as distinct from the provision of hydrometric data, included the supply of general interest pamphlets, field demonstrations of stream gauging procedures to community college classes, and an Environment Week exhibit at a shopping mall.

Special Projects

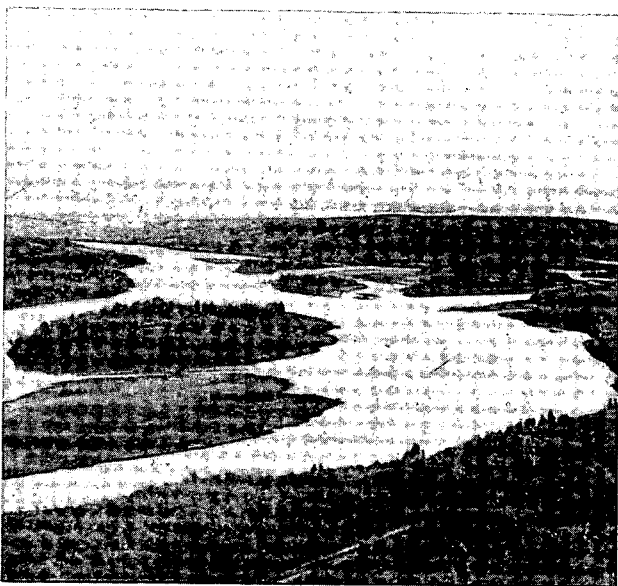
The existing procedure for the computation of discharges for the Saskatchewan River at The Pas was reviewed and, although adequate, was found to have some problems. A new computerized procedure was devised for computing discharge under the conditions of dynamic rapidly changing discharge and backwater from a downstream power reservoir. The procedure and report "Computation of Open Water Discharges" was accepted by the Prairie Provinces Water Board and is now the standard procedure for the station. The procedure could be applied to other low slope rivers under similar conditions.

Data were gathered and analyzed throughout the year for a regional program evaluation. The evaluation found that although there were year to year and district to district fluctuations the level of expenditures within the WRB program in the Western and Northern Region had been stable for the 1978 to 1983 period. There was little difference in the hydrometric station costs between the districts. The final report, "Water Resources Branch Program Evaluation Final Report" is available.

The micro-computer system used by the studies section was enhanced with the addition of a second micro-computer, a digitizing tablet, and much software. Procedures and programs for data transfer, plotting, drafting, information retrieval, hydrologic data interpretation and general data analysis were obtained, tested and used.

The Lake of the Woods Control Board Annual Snow Survey Program carried out by WRB was discontinued after 58 years of operation.

At the request of Ontario Hydro, a special monitoring program on Lake St. Joseph outflows (Rat Portage) was undertaken. The discharge measurement program was to verify the previously adopted rating under low and high flow conditions.



RESEARCH

The regional detachment of the National Water Research Institute serves the research needs of the three prairie provinces and the Northwest Territories. Increasing economic growth and the generally poor quality of water in many prairie communities has led to renewed attention to the historic water supply-demand imbalances in western Canada. Potential expansion of irrigated and dryland agriculture, increasing demands for water diversion and the continued development of resource industries and related industrial complexes are raising serious concerns over water supplies and the potential problems of toxic chemicals in western drainage systems. Potential mega-projects in the Mackenzie River Basin are also generating concern for the future of northern drainage systems. These developments are occurring at a time when the federal government is espousing the principles of sustained development without damage to ecological stability.

Research activities during the past year were focused on the rivers and lakes of the Qu'Appelle Valley (Saskatchewan), Southern Indian Lake and associated reservoirs (Manitoba) and the Saskatchewan River system. The Qu'Appelle system is a series of hyper-eutrophic river-lakes which receives domestic effluents from Regina and Moose Jaw and other smaller non-point sources. The presence of massively deformed chironomid larvae in Pasqua Lake, and the absence of benthic communities in the three remaining Fishing Lakes, suggest the system has been further degraded by industrial and/or agricultural contaminants. Research shows that mercury levels increase in streams below both cities and that mercury methylation and demethylation is enhanced by nutrient inputs from city effluents, particularly during periods of low flow. Modelling of total phosphorus dynamics suggest that the Fishing Lakes are saturated with phosphorus and that no net sedimentation of phosphorus has occurred during the 10 year period for which data is available. Research is continuing into the state of contamination of the lakes and the investigation of restoration measures to improve water quality.

Research in the Southern Indian Lake - Notigi Reservoir system addressed the problems of mercury mobilization and transmission from source materials to fish and the effects of impoundment on water circulation and nutrient supply under ice. Experiments showed that methylation rates were higher in the absence of oxygen, but suppressed by sulfides, and that the optimum pH for methylation and demethylation was about 7 to 8. Field studies showed that sedimentation processes affected the bio-accumulation of mercury through the benthic community through its affect on the availability of food for benthic organisms and the effectiveness of bacterial methylation/demethylation processes. Physical measurements using prototype instrumentation showed that currents were a significant factor in determining under-ice residence time of the water in Wupaw Bay with consequent implications for the redistribution of chemical elements vital to the ecology of lakes during the months under ice-cover.

Research on the Saskatchewan River system was focused on the introduction of contaminants from point and non-point sources, the processes of transmission and degradation, and the toxicological effects on biota in downstream reservoirs. Chemical and bioassay analyses have shown that the loading of contaminants to the system is comprised of a wide range of chemicals originating from point and nonpoint sources throughout the prairie region. The presence of morphologically deformed chironomid larvae in Tobin Lake indicates that these chemicals are degrading the aquatic environment.

TOXIC CHEMICALS

Because of DOE's concerns related to toxic chemicals, IWD, through the National Water Research Institute (NWRI) and WQB, carries out monitoring and studies to examine the presence of toxic chemicals, their abundance and prevalence in the aquatic environment, their geographic distribution, and their effects. Monitoring for metals in water was conducted at approximately 70 stations, and for synthetic organic compounds at about 30 locations.

With partial TOXFUND support, a study was initiated concerning the presence of trace metals in the main coal aquifer in the Poplar River Basin. This study will be carried over into 1985/1986.

A study of the acid rain sensitivity of lakes in the Northwest Territories and the Precambrian Shield portions of the prairie provinces was begun in 1984/85. As a part of the Northern Saskatchewan Agreement, the Province of Saskatchewan has provided for the submission of snow and lake water samples for analysis, as well as historical data for that part of the region.

During the past year NWRI continued research into the biogeochemical cycling of mercury and other heavy metals, the transmission, degradation and fate of contaminants in river, lake and reservoir systems, and the development of biological screening techniques for detecting and assessing contaminants in aquatic ecosystems. Research was conducted in the Qu'Appelle system, Tobin Lake, the North Saskatchewan River and the Southern Indian Lake - Notigi Reservoir system.

ENVIRONMENTAL ASSESSMENT

Under the auspices of the DOE Regional Screening and Coordinating Committee a variety of development proposals were reviewed. They ranged from heavy oil upgraders in Saskatchewan, a major Parks Canada regional park plan in Alberta to maintenance dredging in the Lake Winnipeg - Red River system in Manitoba.

In compliance with the intent of the federal Environmental Assessment and Review Process (EARP) the Directorate has developed a regional procedure for determining the environmental implications of its own programs. A one year trial has been successfully completed and the procedure will now become an integral part of the annual work planning process.

Support was given to the office of the Regional Director General and National Capital Region on a number of policy related items.

IWD participated with the Department of Indian Affairs and Northern Development's two main environmental committees for the Northwest Territories; the Regional Environmental Review Committee and the NWT Water Board Technical Advisory Committee.



5.0 FUTURE DIRECTIONS

Water Quality

Water quality objectives and comprehensive monitoring programs are required for water resource management in interprovincial, territorial-provincial, international, and National Park waters in order to maintain desired uses and protect quality for future generations.

These ongoing monitoring programs must be designed for both cost effectiveness, and the best methodology. This will necessitate accurate regional and national overviews of existing water quality, devised through effective communication between IWD's research and operational arms, and through effective technology transfer.

Mackenzie River Basin

An agreement through which transboundary water management issues can be addressed at border crossing points and which establishes a permanent mechanism to implement provisions of the Mackenzie River Basin Study is required.

Flood Damage Reduction

Efforts will be directed to renewing or establishing agreements with non-participating jurisdictions.

Toxic Chemicals

A major redirection and diversification of toxic chemical initiatives will result as part of the department's environmental sensing strategy.

Hydrometric Program

General upgrading of the existing network and improvements in data handling systems will be completed in the near future. No major changes in the network of gauging stations is anticipated, with the exception of ongoing adjustments for management purposes.

International Issues

Proposals to develop water storage works in the arid regions of the prairies requires continuing attention to ensure downstream interests are protected and that requirements of the International River Improvements Act are met.

Federal Water Policy

Program changes arising from recommendations in the Inquiry of Federal Water Policy report and from the Ministerial Task Force on Program Review will determine any changes in federal policy on water resources.

6.0 PUBLICATIONS

Water Planning and Management

Wiens, L.H., 1984. "Flood Frequency Analysis for Fort Liard and Nahanni Butte", Water Planning and Management Branch, Western and Northern Region, for the Canada-Northwest Territories Flood Damage Reduction Program.

Wiens, L.H. and A. Skibinsky, 1984. "Lumsden Hydraulic Study", Water Planning and Management Branch, Western and Northern Region, for the Canada-Saskatchewan Flood Damage Reduction Program.

Water Planning and Management Branch, 1985. "The Environmental Assessment and Review Process for the Annual Work Plan Activities of Inland Waters Directorate, Western and Northern Region". Inland Waters Directorate, Regina, 14p.

Water Planning and Management Branch, 1984. "Water and Economic Development in the Prairie Provinces" a submission to the Inquiry on Federal Water Policy, Inland Waters Directorate, Regina, 26p.

Northwest Territories - IWD

Canada-Northwest Territories Coordinating Committee, 1984. "Memorandum of Understanding between Department of Environment and Department of Indian Affairs and Northern

Development for Northwest Territories Water Quantity Surveys Annual Report 1983-84".

Water Resources Branch, 1984. "Northwest Territories Hydrometric Gauging Station Construction and Maintenance Annual Report 1983-84".

Canada-Northwest Territories Steering Committee, 1984. "Flood Damage Reduction Program Annual Report for 1983-84".

Wilson, A.R. and C. Heron, 1985. "Report to the 1985 Athabasca-Mackenzie Waterways Workshop".

Environment Canada and Government of the North-west Territories, 1984. "Hay River Basin Overview".

Wedel, J.H., 1985. "Progress Report 1983-84 Mackenzie Delta Studies".

Water Resources Branch, 1984. "Northwest Territories Hydrometric Station Investigations Report for 1983".

Calgary WRB

Barnetson, R.B., "1983 Return Flow for Irrigation Districts in Alberta", Water Survey of Canada Division, Water Resources Branch, Environment Canada.

Canada-Alberta Coordinating Committee, "Canada-Alberta Memorandum of Agreement for Water Quantity Surveys", Annual Report 1983-84, Water Resources Branch, Environment Canada and Technical Services Division, Alberta Environment.

Committee on Hydrology, "Eyehill Creek Natural Flow Report to the Prairie Provinces Water Board", Water Resources Branch, Environment Canada.

Committee on Hydrology, "Irrigation Return Flow Report to the Prairie Provinces Water Board", Water Resources Branch, Environment Canada.

Day, T.T. and M.O. Spitzer, "Sediment Station Analysis, Highwood River near The Mouth", Water Survey of Canada, Water Resources Branch, Environment Canada.

Morton, G.H., "Arctic Rivers Work Group - Peace River and Slave River", Water Resources Branch, Environment Canada.

Phinney, R.B. and S.J. Figliuzzi, "Hydrometric Network Pilot Study for the Oldman River Basin", Water Resources Branch, Environment Canada and Technical Services Division, Alberta Environment.

Spitzer, M.O., "Reference Directory Update", Water Survey of Canada, Water Resources Branch, Environment Canada.

Wagner, H.M., "Alberta Gauging Stations Construction and Maintenance Annual Report, 1983-84", Hydrology Division, Water Resources Branch, Environment Canada.

Regina - WRB

Canada-Saskatchewan Coordinating Committee, 1984, "Memorandum of Agreement for Water Quantity Surveys, Annual Report 1983-84", Water Resources Branch, Regina.

Water Resources Branch, 1984, "Data Request Summary 1983-84" Saskatchewan Region, Regina.

Water Resources Branch, 1984, "Spruce River Diversion Project, 1983 Annual Report", Water Resources Branch, Regina

Water Resources Branch, 1984, "Cumberland Marshes Project, 1983 Annual Report, Water Quantity/Quality Monitoring Program", Prairie Provinces Water Board, Regina.

Wheelock, A.P. and J.H. Chubak, 1984, "Construction, Upgrading and Maintenance, 1983-84 Annual Report", Water Resources Branch, Regina.

Winnipeg - WRB

Canada-Manitoba Coordinating Committee, 1984, "Canada-Manitoba Memorandum of Agreement for Water Quantity Surveys Annual Report 1983-84", Winnipeg.

Pelletier, Patrice, 1985, "Computation of Open Water Discharges - Saskatchewan River at The Pas - 05KJ001 - A Method for Unsteady and Non-uniform Flow Calculations", Winnipeg.

Kenning, J.D. and R.E. Cote, 1984, "Manitoba-Northwestern Ontario District - Construction, Upgrading and Maintenance - 1983-84 Annual Report", Winnipeg.

National Water Research Institute - Winnipeg

Blachford, D.P., and E.D. Ongley, 1984. "Biogeochemical Pathways of Phosphorus, Heavy Metals and Organochlorine Residues in the Bow and Oldman Rivers, Alberta, 1980-1981". Inland Waters Directorate, Environment Canada, Scientific Series No. 138.

Jackson, T.A., 1984. "Mercury pollution in the Wabigoon-English-Winnipeg River system: Conclusion and recommendations based on results of the two-year joint study by the Governments of Canada and Ontario". In Mercury pollution in the Wabigoon-English River system of Northwestern Ontario, and possible remedial measures - Technical Report, p. 383-388. Published by Government of Canada and Government of Ontario.

Jackson, T.A. J.W. Parks, P.D. Jones, R.N. Woychuk, J.A. Sutton and J.D. Hollinger, 1984. "Dissolved and suspended mercury species in the Wabigoon River (Ontario, Canada): seasonal and regional variations". In Mercury pollution in the Wabigoon-English River system of Northwestern Ontario, and possible remedial measures - Technical report, p. 357-482. Published by Government of Canada and Government of Ontario.

Jackson, T.A., 1984. "Effects of inorganic cadmium, zinc, copper and mercury on methyl mercury production in polluted lake sediments". In Nriagu, J.O. (ed.), Environmental Impacts of Smelters, publ. by John Wiley & sons, p. 551-578.

Jackson, T.A. (submitted). "Mercury methylation in polluted prairie river-lake system: seasonal and regional variations, and the role of trophic conditions". Can. J. Fish. Aquat. Sci.

Joseph, H.C. and E.D. Ongley (submitted). "Solution and sediment chemistry of irrigation return flows in southern Alberta". Water Resources Research.

Kenney, B.C. (in press). "Sediment resuspension and currents in Lake Manitoba". J. Great Lakes Res. 11(2).

Kenney, B.C. (submitted). "Under-ice circulation in Long Bay, South Indian Lake". J. Geophys. Res.

Kenney, B.C. (in press). "On the dynamics of phosphorus in lake systems." IWD Scientific Series # 144, Environment Canada, Ottawa.

Kenney, B.C. (in press). "Dynamics in a chain of lakes: The Fishing Lakes". IWD Scientific Series (unnumbered at present). Environment Canada.

Ongley, E.D., 1984. "Regionalization of water quality in the upper Fraser River basin, British Columbia: Comment, Water Research". 18, p. 1059-1060.

Ongley, E.D., and D.P. Blachford, 1984. "Tributary effects on mainstream suspended sediment chemistry". Water Pollution Research Journal of Canada, 19(1). p. 37-46.

Ongley, E.D. (in press). "Considerations for network design for water quantity and quality surveys in Canada". Canadian Hydrology Symposium - 84 - Proceedings.

Ongley, E.D. (in press). "Review of Gregory (Ed.) Background to Palaeohydrology: A perspective". Hydrological Sciences Journal.

Ongley, E.D. (in press). "Detergent-Phosphorus Abatement: Point and Nonpoint Source Basin Response in Southern Ontario". Environmental Geology.

Schelske, C.L., D.J. Conley and W.F. Warwick (submitted). "Historical relationships between phosphorus loading and biogenic silica accumulation in Bay of Quinte sediments". Can. J. Fish. Aquat. Sci.

Warwick, W.F. (submitted). "Morphological abnormalities in Chironomidae (Diptera) larvae as measures of toxic stress in freshwater ecosystems: indexing antennal deformities in *Chironomus Meigen*". Can. J. Fish. Aquat. Sci.

Water Quality Branch

Crosley, R. and D. Munro, June 1984. "Souris River Automatic Water Quality Monitoring 1977 - 1982, Report 2: Evaluation of the Automatic Monitors". Environment Canada, Water Quality Branch, Regina, Saskatchewan. WQB-WNR-83-04.

Munro, D. and R. Crosley, June 1984. "Souris River Automatic Water Quality Monitoring 1977 - 1982, Report 1: Preliminary Data Evaluation". Environment Canada, Water Quality Branch, Regina, Saskatchewan. WQB-WNR-83-03.

Water Quality Branch, Western and Northern Region, April 1984. "Cumberland Marshes Water Quality", submission for inclusion in IWD Annual Report to the Prairie Provinces Water Board.

Water Quality Branch, Western and Northern Region, August 1984. "Summary of Water Quality Data from the Rocky Mountain National Parks (for the period 1980 to 1981)". WQB-WNR-84-02.

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

GB 707 C43 1984/85
Canada. Inland Waters D...
Annual report



Date Due
