
Review Of
Current And Alternate Organizations
For
Collection And Delivery Of Water Quantity Data

September 1985

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R.L. Walker & Partners
Ottawa

Acres International Limited
Niagara Falls

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For
Collection And Delivery Of Water Quantity Data**

September 1985

R.L.Walker & Partners
Ottawa

Acres International Limited
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September 25, 1985

Dr. G.A. Sainte-Marie
Deputy Minister
Environment Canada
Ottawa, Ontario
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Dear Dr. Sainte-Marie:

We are pleased to submit, herewith, our final report on the Review of Current and Alternate Organizations for the Collection and Delivery of Water Quantity Data.

The report is directed to addressing the benefits and disbenefits of maintaining the current organization of water quantity surveys, as conducted under the Water Resources Branch of the Department, or of turning over in whole, on in part, the functions and responsibilities of the Water Resources Branch to the private sector, or to the provinces, or to a crown corporation.

In reaching our principal conclusions that there is, on balance, no significant weight of advantages which would argue for a change from the status quo, we have examined and defined in some detail the current functions and responsibilities of the WRB and the needs of clients and users of water quantity data. Each alternative has been considered in terms of the feasibility of carrying out the various responsibilities and the likely benefits and disbenefits.

A review of organizational arrangements in other countries was carried out to identify any other organizational arrangement, which might be adapted to the Canadian situation. In fact no other applicable model was found.

A survey of opinions concerning the various alternatives was conducted covering provincial representatives and other clients and users across Canada. From this we can report there is strong support for maintenance of the status quo arrangements and universal satisfaction with the way in which the water quantity surveys are conducted by the Water Resources Branch in cooperation with the provinces.

Our report, nevertheless, offers suggestions for change in several aspects of current operations which have come to our attention. Whilst our terms of reference did not extend to examining each of these in detail, we believe they represent areas which warrant attention in the interest of maintaining the economy and efficiency of operations and possibly improving overall effectiveness through closer integration of the hydrologic and meteorologic network design and operations.

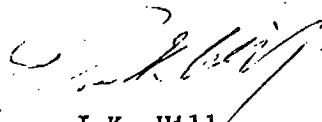
This review has been carried out by R.L. Walker & Partners in association with Acres International Ltd. We wish to acknowledge the fullest cooperation extended to us by the staff of the Inland Waters Directorate and the Water Resources Branch. We should also acknowledge the contribution of Mr. R.H. Clark, a former Senior Engineering Advisor and Chief Hydraulic Engineer of the Department of Environment, who has served as our advisor throughout this review.

Should you have any questions regarding the findings of our review or the suggestions of areas warranting further discussion, we would be pleased to discuss these matters with you at your convenience.

Respectfully,



R.L. Walker
Sr. Partner
R.L. Walker & Partners



I.K. Hill
Executive Engineer
Acres International Ltd.

REVIEW OF CURRENT AND ALTERNATE ORGANIZATIONS
FOR
THE COLLECTION AND DELIVERY OF WATER QUANTITY DATA

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CHAPTER 1 - EXECUTIVE SUMMARY

This review of current and alternate organizations for the collection and delivery of water quantity data has been carried out to provide Environment Canada with objective information and advice concerning the benefits and disbenefits of either maintaining the current organization for the conduct of water quantity surveys or of transferring responsibilities to the private sector, the provinces, or to a crown corporation.

The current arrangements for organization and conduct of water quantity surveys have evolved over the past 90 years. Since 1975 each of the provinces and, through Indian and Northern Affairs Canada, the two territories have entered into formal agreements under which the costs of operation of the hydrometric survey are shared.

The needs of clients and other users of water quantity data to manage and develop water resources, the configuration of natural drainage basins and the natural variations in climate have all influenced the direction and characteristics of water quantity surveys. Historically, water resources management focussed primarily on supply management and the equitable allocation of water supplies between users and between jurisdictions sharing common river basins. More recent perceptions of water issues in broader terms and economic factors have led to widespread recognition that conservation is an essential component of water resources management. This broader management approach, together with recognition of the economic benefits of providing timely forecasts of water supply conditions (particularly to avoid or mitigate flood and drought impacts) has introduced new requirements for consistent representative hydrometeorologic data.

The current functions and responsibilities of the Water Resources Branch have been examined in detail and defined in terms of what is done, how it is done and what is the output. Operations of the current system can be categorized under four major functions, within each of which various responsibilities have been identified:

- system planning;
- system operations;
- system outputs; and
- quality assurance.

Based on these considerations a preliminary analysis of the probable benefits and disbenefits of various alternatives was provided to representatives of provincial authorities and a sample of major clients and users. We can report there is a broad concensus supporting with our conclusion that there is no significant argument for a fundamental change from the current organization and conduct of water quantity surveys in Canada. Indeed, there is widespread acknowledgement of the need for a national water quantity survey and considerable satisfaction with the way in which the Water Resources Branch conduct these surveys in cooperation with the provinces.

The option of privatization is not considered feasible in terms of transferring broad responsibility for water quantity data collection and delivery to the private sector. Indeed, to have this done by the private sector would require the creation of new enterprises having exclusive territorial licences for systems operations. Insofar as the current operations of the WRB have been found to be well managed with due regard for economy and efficiency, the probability of private licencees being able to operate at the same or lesser level of cost is very unlikely. Considerable concern was expressed by the clients and users as to any change which could adversely impact the consistency and quality of the hydrometric data base records.

Under existing arrangements, a substantial amount of work is currently contracted out. While there may be areas where some further contracting out may be cost effective, this approach does not appear practical or economic in terms of major functions such as systems operations.

Operation by the provinces might be undertaken by some provinces, as has been the case with Quebec. However, the provincial water management agencies are well satisfied with the WRB operation and express little interest in taking on this responsibility. Indeed, the perception of the provinces is that they would likely face those additional costs currently borne by the system operators and this is seen as a significant deterrent by all other provinces. If adjustments to the cost-sharing arrangements were to be considered some provinces may wish to review their position. In such event, it should be noted that the federal government currently bears overhead administrative and support costs through the Department of Environment which are not currently identified as part of the costs of maintaining and operating water quantity surveys. It has not been possible to disaggregate these costs at this time. However, preliminary information suggests they are significant.

The final alternative of transferring responsibilities of the WRB to a crown corporation, is considered feasible. There are both advantages and disadvantages which may be attributed to such an organizational arrangement. However, on balance, the benefits do not seem to warrant the disruption which would arise if the water quantity survey activities alone were established under a crown corporation. Many of the advantages could be achieved through adjustments within the existing departmental organization.

It may be noted that examination of a crown corporation option led to consideration of the case for establishing under a crown corporation an arrangement which would bring together various national physiographic survey activities. While detailed examination of the functions and responsibilities of related survey activities were outside the scope of this review we should note that if, for other reasons, re-organization of water quantity surveys is to be considered, it would be worthwhile to examine the option of combining related data collection activities under a crown corporation.

Our basic recommendation is that the collection and delivery of water quantity data remain under the current arrangements within the Department of Environment. We have been made aware of certain areas of improvement which appear desirable to meet the needs of clients and users of the system. Again, our terms of reference do not extend to providing a detailed examination of basic operational matters. Nevertheless, we do note, hereunder, several areas which appear to warrant further consideration in the interests of achieving economy, efficiency and effectiveness in the conduct of water quantity surveys.

- greater integration of water quantity, water quality, and other data collection activities, particularly in remote areas;
- consideration of special arrangements for shorter-term measurements in response to user requirements. These do not fit into the structure of the overall program and a clearly defined mechanism for handling them is lacking, although these are generally cost-recovery items with revenue potential;
- provision of more resources for evaluation and incorporation of new equipment, which will help resolve problems of remoteness of stations and pressure of personnel costs;
- review of network requirements on a regional basis together with the provinces, to establish, an optimal spatial coverage of water quantity measurement stations, taking into account the opportunities for integration and correlation with climatologic data stations to provide a base network to meet client and user needs. Network planning should also support, to the extent possible, client and user requirements for measurement of water quality. Such a review might be expected to establish the network system which should be maintained in the public interest, and more clearly identify additional measurement stations that should be "contracted-in" on a full cost recovery basis for specific clients.
- review of charging policies and levels for publications, data and advisory services, in accord with the Common Services Policy of the government and practice in other departments and agencies, e.g. Statistics Canada;
- additional contracting out, wherever possible.

Consideration of the foregoing may require review of the cost-sharing arrangements with the provinces. It is noted that the operator of the network bears the non-shareable cost for water quantity surveys under its control. Under the current agreements the federal government bears non-shareable costs for all provinces and territories, except Quebec.

CHAPTER 2 - SCOPE OF REVIEW

2.1 Purpose

The purpose of the review reported upon herein is to provide DOE with objective information and advice concerning the benefits and disbenefits of alternate organizational arrangements for the collection and delivery of water quantity data. Water quantity data has been defined as water levels, water discharges, sediment concentration and loads, water temperatures and ice thickness.

The options examined include maintenance of the current organization under the IWD (status quo), privatization, operation by the provinces and operation by a crown corporation.

2.2 Terms of Reference

The review has been carried out under DSS Contract No. OS585-00065. The complete terms of reference for the study are contained in Appendix A.

2.3 Approach

The approach which has been followed required at the outset a detailed examination of documentation referenced herein*/ and discussion with IWD staff to determine the functional responsibilities involved in the collection and delivery of water quantity data. The responsibilities were defined in terms of what is done, how it is done and what is the output, and formally reviewed with IWD to ensure correctness and completeness.

The functional responsibilities were examined to determine how well they allow for meeting current and anticipated future requirements of clients and users, as described in both internal and external reports. Thereafter, each of the responsibilities was examined to assess the relative advantages and disadvantages which would be expected to arise under each alternate organizational option.

Information on organizational arrangements for the conduct of hydrometric surveys in the USA, France, UK, New Zealand and Australia was obtained through contacts with representatives of the responsible agencies. Additional information on organizational arrangements in other foreign jurisdictions was obtained from information published by the World Meteorological Organization. The organizational models adopted by other countries and the operational experiences reported were considered in assessing the effectiveness of each alternative.

*/ Numbers in parenthesis throughout the report refer to documents listed at the end of the report.

To elicit an indication of the probable attitudes of the provinces and of major clients and users to the alternatives under consideration, a summary presentation defining the status quo responsibilities and the consultant's preliminary findings with respect to the benefits and disbenefits of alternate organizations was circulated for review to provincial authorities and a representative sample of major clients and users in both governments and in the private sector. In total 102 respondents were requested to comment on their perception of the benefits and disbenefits of alternate organizations for water quantity surveys.

Telephone interviews were held with all of the Administrators or their representatives of the Federal/Provincial Cost Sharing Agreements for Water Quantity Surveys and with a number of other clients and users. In total a response was elicited from more than 50 respondents. The general consistency of the responses received suggests that these views may be considered to be representative of the majority of clients and users.

The findings and recommendations of the consultants have taken into account the views expressed from the opinion survey, information and opinions provided by staff of the Water Resources Branch and relevant observations from several national organizations representing many users of hydrometric data.

CHAPTER 3 - WATER QUANTITY (HYDROLOGIC) SURVEYS

3.1 System Requirements

Before considering alternate organizations for the conduct of water quantity surveys, it is necessary to review briefly the nature of the requirements of the clients and users of water quantity data and the geographic distribution of water resources across Canada which has dictated the development of a national rather than a regional or river basin orientation for organization of water quantity surveys and of other basic physiographic data systems.

The water resources of Canada are characterized by five major drainage systems. These principal drainage systems and average annual rates of runoff are given in Table 1.

Table 1

Surface Water Systems and Runoff in Canada

<u>Drainage System</u>	<u>Area</u> <u>km²</u>	<u>Avg. Annual Rate of Runoff*</u> <u>m³/s</u>
Pacific Drainage	1,001,300	21,200
Arctic Drainage	3,583,300	15,500
Hudson Bay Drainage	3,860,100	24,500
Atlantic Drainage	1,520,100	33,700
Gulf of Mexico Drainage	26,700	25
	9,991,500	<u>99,925</u>

* Flowing to sea, or at Canada/US border.

Source: Area⁽³⁾

Runoff⁽²⁾

(Converted from Imperial measure to metric measure).

Within the five geographic drainage systems there are some 19 major river systems which straddle one or more provinces and/or have portions of their drainage basins within the USA. These river basins account for some 51 percent of the area of the country. (If the Arctic seaboard and archipelago drainage is excluded, these 19 trans-boundary river basins occupy more than 61 percent of the remaining area of the nation.)

Thus, even though the provinces own, and are responsible for the management of water resources within their borders, there has been widespread acceptance of the need for a national water quantity data survey. Water quantity surveys had been undertaken in cooperation with the provinces for many years prior to 1975, when the current cost-sharing agreements between the federal and provincial authorities came into effect.

The inter-provincial and international characteristics of most of the major river systems have been, and remains, of importance in determining the need for a consistent national water quantity data system, as these data provide the fundamental basis for determination of the apportionment of shared water resources between jurisdictions.

Water quantity data are required to allow for economically efficient development of resources for a variety of uses - such as water supply, irrigation, navigation, hydro and thermal power - and for the management and conservation of resources including equitable allocations of supply between users and between jurisdictions as well as the maintenance of in-stream environmental qualities.

It must be recognized that water quantity data comprise only one component of the data base necessary to represent the spatial and temporal characteristics of the hydrometeorological cycle, and hence water resources availability. Moreover, the analysis and resolution of problems and issues concerning water resources development and management usually require related physiographic data covering water quality, stream and lake hydrography, geomorphology, and basin topography and geology. The design and development of a hydrometric network must be clearly coordinated with systems for measurement and definition of these related parameters. In turn all data systems must be oriented to anticipate the potential for development and for conflict between uses. Hence, periodic review of the data network is essential to ensure that an adequate and useful data base is being accumulated to serve present and future needs.

The stochastic nature of climatologic phenomenon, including runoff, imposes a need to acquire long-term continuous data records which adequately define regime conditions in terms of average resource availability and the probabilities of recurrence of various levels of extreme events. Continuous records from a representative network of base stations providing 30 years or longer periods of data are generally required to allow for optimal design of major water control facilities, to delineate flood hazard and drought prone zones to negotiate agreements for equitable apportionment of available resources between authorities.

Not all hydrometric station data need to be of such long duration. Short-term site specific data can be correlated with long-term runoff and rainfall records to interpolate design data requirement at specific locations. In the absence of perfect foreknowledge of developmental requirements it is appropriate to develop a network of long-term stations within each major catchment basin such that interpolation to other locations can be made with an assured level of reliability. Thus, the basic hydrologic data system has to be designed to provide for long term continuous records which provide both spatial and temporal definition of the variability of water quantity occurrence. These data must have an internal consistency which allows for transposition and interpolation of data to define regime conditions at any point of specific interest.

To some degree, inter-basin or regional interpretations of runoff characteristics can be made between similar drainage systems. Such interpretations are generally considered to offer somewhat lesser reliability than actual records. While useful in preliminary assessments of water requirement, significant developments based upon such regional analyses normally require confirmation through measurement of site specific data.

Increased understanding of the complex interdependancies between the natural ecologic and environmental systems has led to a better understanding of economic interrelationships between resource development and conservation. Previously water management concentrated on supply management and was primarily concerned with the equitable allocation of water resources and the regulation of the natural variation in runoff through construction of water control structures. Supply management has also involved direct augmentation of water supplies through diversions from one region to another.

Recognition of the importance of maintaining the quality of the water resources (which includes both water quantity and water quality) to preserve instream habitats for fisheries, and to support recreation and the aesthetic qualities of the environment have increased the needs for resource definition and for broad spatial consistency of data to allow for inter-basin comparisons.

The increasing use of water has led to constraints on future developments in some areas of the country, and to perceived limitation to supply management as being effective in other areas. At the same time, the increased costs of water resource developments has led to examination of the water use efficiency and the demonstration that the use of resources may be more economically and efficiently addressed through a combination of supply and demand management approaches. Demand management, or conservation, is expected to impose increasing needs for real-time water quantity data to enable more efficient operation of existing (and future) facilities through development of reliable near-term forecasts of water availability. The increasing losses from recurring of floods and droughts also require such forecasts as a basis for more effective land use management and loss reduction.

Thus, conservation of water resources is expected to introduce increasing requirements for real-time water quantity and of other climatologic data so as to extend the reliability of water supply forecasts from days to weeks.

3.2 Economic Value of Water Quantity Data

As in other countries of the world, economic development in Canada is dependent on water (quite apart from the social and health requirements of the Canadian people for this resource). Water plays a crucial role in the management and development of agriculture, energy, transportation, forestry, wildlife, inland fisheries, mining, recreation and tourism, and is vital for industrial, municipal and rural uses. Reliable information on the distribution, dynamic patterns, and likely availability of future supplies is essential to the management and sharing of this resource.

It is also the case that there are water quantity data collection and dissemination systems in nearly all countries of the world, both developed and developing. These data, like other statistical data on physical, economic and social conditions, are generally considered to be a public good, provided under the sponsorship of government authorities to satisfy requirements that are public in nature.

Water quantity data, like other public goods, has two purposes: to meet current needs; and to provide for known and undefined future needs.

The first of these, in terms of water quantity data, can be thought of in terms of specific or project data, obtained under particular arrangements and paid for (one way or another) by clients. These include Environment Canada on behalf of its own programs (including Government of Canada obligations under international treaties), other Federal Departments, Provincial Governments, and other client entities under special arrangements. A number of other users typically benefit from the existence of this data base.

The second purpose, provision for future needs, is where a longer term view of society's requirements must be taken and investments made ahead of developments whose course cannot be definitely known. This longer term aspect is particularly important in water matters where time series through long periods of varying conditions are precisely the information that is required. And since developments, and eventual users, cannot be known in advance, the costs of providing this public good for the future have to be met in the present.

For water quantity data, it is necessary that there be a basic network for general information accumulation over the longer term in addition to the specific network for clients' more immediate needs. Non-client users of the system will benefit from the overall network as they use it for their particular purposes. In Canada and elsewhere the practice has been that such benefits are obtained by non-client users at nominal or no cost.

The foregoing highlights two fundamental characteristics of water quantity data:

- it is considered a necessary component of a country's statistical data base, generally under government sponsorship as a public good;
- it is designed to meet current, known requirements and future, unknown requirements and therefore has both an operational and an investment component.

In Canada and elsewhere there have been attempts over the years to place a measure on the economic value of water quantity data. However, a rigorous and universally accepted methodology for this does not exist, given the numerous end uses, the mix of current and potential future benefits, and the basic characteristic of being a public good.

In Canada, a recent assessment⁽⁴⁾ commented as follows on the economic importance of water:

.... Over two billion dollars will be spent in 1980 on the design and construction of hydraulic structures (such as bridges, culverts, dams and irrigation projects and water control structures for hydroelectric power).

Flood damage and relief assistance amount to some 200 million dollars annually. (This amount has been escalating steadily and can only continue to increase as our standard of living rises and if people continue to build in flood zones). In contrast are the problems associated with the lack of water. The Manitoba Crop Insurance Corporation has estimated that if a full scale drought developed in Manitoba and crops failed throughout the province, claims amounting to more than 150 million dollars could be made

..... The contribution of water to the Canadian economy can be demonstrated by citing a few examples of the value of water based on the cost of the next best alternative for providing similar services and goods. About 68 percent of Canada's electricity was supplied from hydroelectric power in 1977. For 1980, the replacement value of hydroelectric generation in Canada, using thermal plants, would be 5.4 billion dollars using current domestic price for oil or 11.7 billion dollars using world price.....

Several studies have addressed the measurement of the economic value of water quantity data in assisting and enabling water management to play its role in effectively providing water for its multitude of uses. The results vary substantially, and the methodologies differ and are subject to greater degrees of estimation and judgement than is usual in such economic assessments. However all the studies indicate that the value of water quantity data is at least an order of magnitude greater than the cost of providing it.⁽¹⁴⁾ Comparison of the cost of water quantity surveys (currently about \$ 25 million in total for all entities involved) to the financial value of the economic activities in which water has a key role (some of which were mentioned earlier) supports the conclusion that collection and delivery of water quantity data is economically justified.

CHAPTER 4 - ORGANIZATION OF HYDROLOGIC SURVEYS IN CANADA

4.1 Current Organization

Since 1972, the collection and delivery of water quantity data has been organized under the Water Resources Branch of the Inland Waters Directorate of the Department of Environment. The WRB is composed of two divisions: the Water Survey of Canada Division and the Hydrology Division. Field operations of the WRB across Canada are managed through five regional offices of the IWD, with separate operating units in each of the Prairie provinces and the Northwest Territories. The organizational structure of the WRB within the IWD is highlighted in Figure 1*/*.

The operation of the hydrometric networks in nine provinces and in the Yukon and Northwest Territories is carried out by the WRB. In Quebec the WRB operates a few stations of national interest on the St. Lawrence River and on trans-boundary streams with the United States. The main hydrometric network within Quebec is operated by the provincial Department of Environment. As discussed in Section 4.4, all the provincial and federal interests in water quantity data are covered under federal/provincial cost-sharing agreements.

In addition to the federal and provincial water quantity network, miscellaneous measurements of water levels, discharges and other hydrologic parameters are carried out by other provincial agencies and private sector firms. Such data are usually collected for project design or operational purposes in connection with specific water resources developments. Wherever possible these miscellaneous data are obtained by the WRB from the agencies concerned and are included as part of the national data bank records as "contributed data".

The WSC Division is responsible for the collection of water quantity data from some 2,650 sites and for maintaining the data records from some 3,500 active and 3,700 discontinued stations in a central national data bank (HYDAT). As reported in July 1985, this data bank currently contains more than 83,000 station years of streamflow data, some 20,000 station years of water level data and 2,000 station years of sediment data.

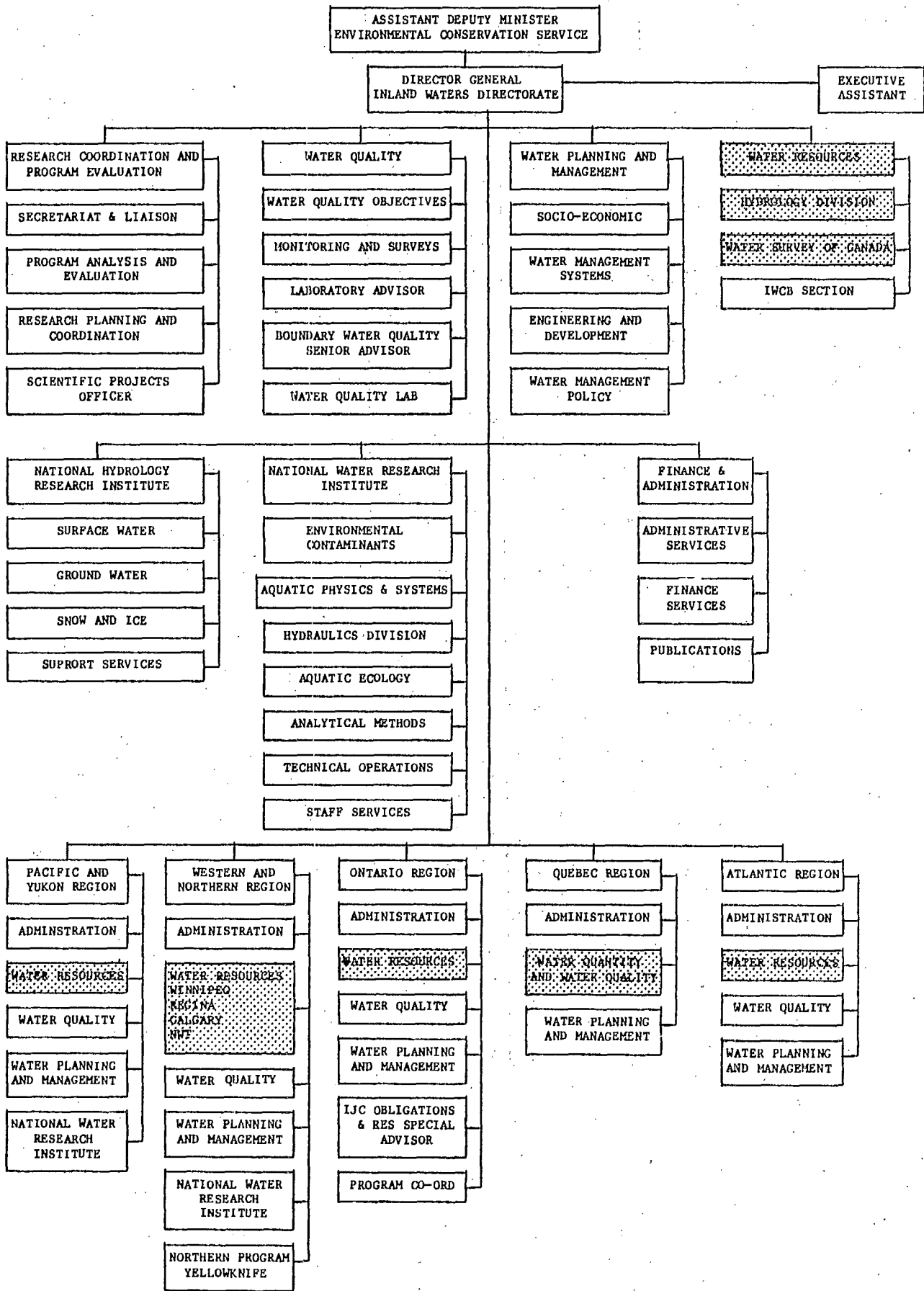
The Hydrology Division is responsible for analysis and interpretation of data series and for providing advise and assistance to the WSC Division in the evaluation and planning of the hydrometric network. The Hydrology Division operates the Canadian HOMS National Reference Centre, which forms part of the World Meteorological Organization program for the transfer of hydrologic technology among its member countries.

/ As indicated in Figure 1, the Lake of the Woods Control Board Section is administratively part of the WRB, but has no functional involvement in water quantity surveys.

FIGURE 1

ORGANIZATION OF THE INLAND WATERS DIRECTORATE

Environment Canada



4.2 Genesis and Mandate

The need for hydrologic data concerning water supply quantities stems from Canada's constitutional framework under which the federal and provincial governments together are responsible for managing the country's water resources and regulating their use.(2) Water quantity data are an essential element of the information base which is required to manage, conserve and develop water resources.

The conduct of systematic hydrometric surveys in Canada was initiated in 1894 under the Irrigation and Forestry Branch of the Department of the Interior in support of investigations of irrigation development in southern Alberta. More or less concurrent with these early surveys in Alberta, hydrometric surveys were initiated in British Columbia under the Railway Lands Division of the Department of the Interior to support assessments of the potential for hydroelectric power generation.

As illustrated in Table 2, from 1894 to 1970 hydrometric surveys were conducted under the sponsorship of a number of federal departments. Following establishment of the DOE in 1970, the current organization of the WRB evolved as part of the IWD. The federal government has been the accepted coordinator of hydrometric surveys for more than 90 years. Coverage of the hydrometric survey network was extended to all of the provinces by 1922, to the territories by 1944 and to Newfoundland in 1950.

Federal responsibility for the conduct of hydrometric surveys derives from a variety of legislation relating either directly or indirectly to the administration and management of water as a resource.(1,2,5,7,13)

Under the terms of the Constitution Act, ownership of natural resources is primarily vested in the provinces. Some exceptions are lands owned by the federal government within the province such as national parks, and the resources of the Yukon and Northwest Territories which are federally administered. However, under the constitution, the federal government has retained exclusive powers with respect to navigation and fisheries and responsibilities with regard to inter-provincial and international undertakings. The federal government has concurrent legislative power with the provinces with respect to agriculture, with federal legislation prevailing in case of conflict. The federal government can also legislate concerning works which, although entirely situated in one province, may be declared to be for the general advantage of Canada or two or more provinces.

In addition to the legislative authority discussed above, the federal government has certain general powers which could influence water development. Of particular importance to the conduct of water quantity surveys is the statistics gathering power under Section 91(6) of the Constitution Act.

Over the years, a variety of government programs and organizational structures have been established to manage the water resources of the several distinctive socio-economic regions of the country. Economic and

Table 2

SURFACE WATER SURVEYS IN CANADA

February 10, 1977

THE MANY NAMES

<u>Department</u>	<u>Branch</u>	<u>Survey</u>	<u>Period</u>	<u>Area of Survey</u>	<u>Remarks</u>
1. Interior	Forestry	-	1894-1909	Southern Alberta	J.S. Dennis started the surveys in 1894
2. Interior	Forestry & Irrigation	Hydrographic Surveys	1909&1910	Southern Alberta & Saskatchewan	This was the first specific appropriation by Parliament
3. Interior	Forestry & Irrigation	Irrigation Office	1911&1912	"	
4. Interior	Irrigation	Irrigation Office	1912-1920	"	Irrigation Branch established October 1912. Built and operated first current meter rating station at Calgary in 1911.
5. Interior	Dominion Lands	Railways Lands Division	1911	British Columbia	Partly in connection with Water Power Investigations
6. Interior	Dominion Water Lands	-	1911-1923	British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Nova Scotia, New Brunswick, Prince Edward Island	Alberta&Saskatchewan surveys were transferred to Water Power Branch July 1, 1920. Ontario surveys were transferred from Hydro-Electric Power Commission October 1, 1919 Nova Scotia surveys started 1915 New Brunswick surveys started 1918 P.E.I. surveys started 1919 Quebec surveys started 1922
7. Interior	Dominion Water Power and Reclamation Service	-	1923-1930	British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Nova Scotia, New Brunswick	
8. Interior	Dominion Water and Power Hydrometric Bureau	-	1930-1936	British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Nova Scotia, New Brunswick	Work on Prince Edward Island discontinued
9. Mines & Resources	Dominion Water & Power Bureau	-	Dec 1936- Jan 1950	British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Nova Scotia, New Brunswick, Yukon and Northwest Territories	Survey started in the Yukon and Northwest Territories in 1944

Table 2

10. Resources & Development	Water Resources Division	-	Jan 1950- Mar 1953	British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Nova Scotia, New Brunswick, Yukon, Northwest Territories, Newfoundland	Survey started in Newfoundland, March 23, 1950
11. Northern Affairs & National Resources	Water Resources Division	-	Apr 1953- Sept 1955	British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Nova Scotia, New Brunswick, Yukon Territory, Newfoundland, Northwest Territories,	
12. Northern Affairs & National Resources	Water Resources Branch	Operations Division	Sept 1955- Dec 1965	All of Canada	Surveys started again in Prince Edward Island in 1961 Quebec in 1964 started own surveys. Federal Government maintained small operation based in Montreal Operations Division established 1957
13. Mines & Technical Surveys	Water Resources Branch	Canadian Hydrometric Survey	Jan 1966- Sept 1966	All of Canada	
14. Energy Mines & Resources	Water Resources Branch	Canadian Hydrometric Survey	Apr 1966- Oct 1967	"	
15. Energy Mines & Resources	Inland Waters Branch	Water Survey of Canada	Apr 1967- Nov 1970	"	
16. Fisheries & Forestry	Inland Waters Branch	Water Survey of Canada	Nov 1970- June 1971	"	
17. Of the Environment	Inland Waters Branch	Water Survey of Canada	June 1971- Mar 1972	"	
18. Of the Environment	Water* Resources Branch	Water Survey of Canada	Apr 1972-	"	Formal agreements were signed with all provinces and with DIAND for the Territories effective April 1, 1975 for cost-sharing of water quantity surveys

* Part of Inland Waters Directorate which was established in April 1972.

technological developments have altered the character of water management problems and led to the strengthening of capacity to deal with them. Institutional arrangements to meet the changing character and scale of water resource problems have led to a more integrated approach in water resources planning and development at both federal and provincial levels.

In 1971, Environment Canada was established with a broad mandate to coordinate all federal agencies and programs in the water field. Several major water management and measurement functions which had been dispersed were brought together in the new Department of the Environment.

Nevertheless, a large number of departments and agencies in both the federal and provincial governments continue to share important direct and indirect responsibilities for water. Continued coordination is required for effective management when two or more agencies of the same government are involved, and also when provinces share watersheds or when the federal government shares responsibility with the provincial governments. In addition, there is a continuing need for consultation between Canada and the USA on matters affecting the development and utilization of international rivers and lakes.

4.3 Current Functions and Responsibilities

The functions and responsibilities of the WRB stem from the need for basic data to support the various uses of water and the need for coordinated management of resource development and conservation in the national interest.

The basic functions and responsibilities of water quantity data collection and delivery systems, outlined in the federal-provincial agreements, and as followed by the system operators, are summarized in Table 3.

For the WRB, descriptions of each responsibility defining what is done, how it is done and the output are presented in Appendix B. These definitions of the "status quo" responsibilities provide the framework for evaluation of alternate organizational arrangements within which these basic functions and responsibilities might be carried on to meet the needs of clients, users and the public as required for purposes of water resources management and development in the national interest. Continuation of water quantity surveys under any organizational alternative must maintain historic continuity, internal consistency and quality assurance of the hydrologic data.

4.4 Cost Sharing Arrangements

Cooperative water quantity surveys were carried on for many years under a variety of informal federal/provincial arrangements for the purpose of securing coordinated and standardized basic data to facilitate resource planning and management in general and the design and implementation of projects relating to navigation, hydroelectric development, irrigation, drainage, flood control, recreation, domestic

Table 3

Functions and Responsibilities of Water Quantity Data Systems

- A. System Planning
 - A.1 Long term network evaluation and planning including development of methodologies and provision of guidance to the operational units.
 - A.2 Annual operational planning.
- B. System Operation
 - B.1 Development and testing of operational methodologies and techniques for hydrology analyses and data processing systems; transfer of technology between operational units.
 - B.2 Site selection, construction and maintenance of stations.
 - B.3 Equipment and instrumentation: development, testing, evaluation, adaptation.
 - B.4 Equipment and instrumentation: procurement, calibration, repair and maintenance.
 - B.5 Data collection instructions.
 - B.6 Conduct of the data collection program.
 - B.7 Processing and verification of hydrologic records, and data interpretations.
 - B.8 Archiving data records.
- C. System Outputs
 - C.1 Dissemination of hydrologic data.
 - C.2 Provision of information and advice on hydrologic interpretations as required by various clients and users.
 - C.3 Information on availability of system outputs to clients, users and the public.
- D. Quality Assurance
 - D.1 Promulgation of data collection and processing procedures
 - D.2 Ex-post review of data (internally generated or in response to user observations) to test for anomalies or inconsistencies.
 - D.3 Observance of practices, approaches and methodologies, in general use nationally and internationally.

and industrial water supplies and other purposes including the preservation of in-stream fisheries. These arrangements were formalized in 1975 under concurrent federal/provincial cost-sharing agreements for water quantity surveys which were entered into between the Department of Environment and each of the provinces and with DIAND for the operation of water quantity surveys in the Yukon and Northwest Territories.

In addition, WRB cooperates in the joint operation of a number of water level stations of particular interest to the Canadian Hydrographic Service in the Great Lakes and along the St. Lawrence River and on the Pacific Coast under a Memorandum of Understanding (1982) between the DOE and the Department of Fisheries and Oceans.

Under the agreements, the hydrometric network and data requirements in each province are identified on the basis of stations which are required by the federal authority to support the exercise of its constitutional and legislative responsibilities, common federal/provincial and/or federal/territorial stations which support programs of joint interest to Canada and the provinces and provincial and/or territorial stations which support programs of primary interest to the individual provinces and territories.

During 1983/84 (the latest year for which published data are available) the hydrometric network across Canada comprised 1,065 federal stations, 829 federal/provincial and/or federal/territorial stations and 1,041 provincial and territorial stations.(8) In addition data from 330 stations, which are not included under the cost-sharing agreement, were contributed to the national data bank.

Specified costs of operation of the hydrometric network are shared on the basis that the full cost of stations designated "federal" are borne by the federal government. Operating costs for "federal/provincial" and/or "federal/territorial" stations are shared on a 50/50 basis. All specified cost of operation of "Provincial" stations are paid for by the provinces, and of "territorial" stations by transfer payments from DIAND to DOE.

Shareable costs include manpower, equipment, contracting and operating expenses directly associated with the water survey program. Non-shareable costs include system and special studies, data storage and dissemination, establishment and control of standards, provision of water level recorders, current meter calibration and program coordination. There are, moreover additional administrative and overhead costs for the WRB covered through the Departmental budget. These are not readily disaggregated from the IWD and ECS budgets and hence are not included in the program costs discussed hereunder.

The program costs for 1983/84 covering all ten provinces and the two territories were estimated at \$ 22,700,900, of which the program costs for Quebec were \$ 2,083,400. Under the terms of the cost-sharing agreements, shareable costs were estimated at \$ 12,374,100. The federal share of this joint cost amounted to an estimated \$ 6,686,900 and the provincial/territorial share at \$ 5,687,200. Non-shareable costs

amounted to an estimated \$ 10,326,800 of which the federal government bore responsibility for \$ 9,708,400 and the Province of Quebec was responsible for an estimated \$ 618,400.*/

It is estimated that if federal non-shareable costs were apportioned on the same basis as applied to shareable costs, the provincial and territorial share of costs would rise by more than 100 percent.(8)

The total direct operating and capital costs of all entities involved in the national system are currently in the range of \$ 25 million, of which, about \$ 20 million is met by Environment Canada and some \$ 5 million by the provinces and other Federal Departments.

An analysis was made of the distribution of these Environment Canada costs (in headquarters and in the regions) over the functional responsibilities, as categorized in Section 4.2, and the results are presented in Table 4. In summary, about 80% of the effort in person years and in costs was devoted to System Operations, about 10 percent to System Planning (split about equally between Long-Term and Annual Operational Planning) and about 5 percent each to System Outputs and Quality Assurance. Some 10 percent of person years and costs were in headquarters; 90 percent were in the regions. Indirect and support costs (in terms of accommodation, personnel and finance, administration and other support) are in addition to those costs shown. Although these additional indirect costs have not been quantified, they represent a significant cost which would have to be recognized in any of the options which involve a significant transfer of responsibilities from the current to any alternate organizations.

For present purposes, the absolute size of the direct and indirect costs is not the significant consideration, but whether these are likely to be less or greater if the water data system operation was conducted under an alternate form of organization, as is addressed in Chapter 6.

4.5 Cost Recovery Arrangements

Water quantity data continue to be provided to clients and users without charge. The WRB advise that examination of the introduction of cost recovery charges for data publications indicated that the anticipated revenue would be largely offset by the increased administrative costs. Consideration is being given to establishing on-line access to the national data bank, and in this instance to the introduction of a cost recovery charge.

*/ The foregoing costs are estimated annually in accordance with the cost-sharing arrangements. Actual costs are recorded and adjustments made in succeeding years to account for over-estimate or under-estimate of costs and proportionate shares of shareable costs.

TABLE 4

Summary of Water Quantity Data Management Program Costs
Environment Canada - 1984-85

		<u>P/Y</u>	<u>%</u>	<u>\$'000</u>	<u>%</u>	<u>P/Y</u>	<u>%</u>	<u>\$'000</u>	<u>%</u>
<u>A. System Planning</u>									
A1	Long Term	17.1	5.0	877.3	4.3				
A2	Operational	14.4	4.2	816.6	4.0				
	Total					31.5	9.2	1,693.9	8.2
<u>B. System Operations</u>									
B1	Methodologies	27.9	8.2	1,616.8	7.9				
B2	Sites and Stations	22.8	6.7	1,885.5	9.2				
B3/4	Equipment	13.4	3.9	1,247.4	6.1				
B5/6/7	Data Program	208.7	61.2	12,087.9	58.8				
B8	Archiving	1.9	0.5	98.3	0.5				
	Total					274.7	80.5	16,935.9	82.4
<u>C. System Outputs</u>									
C1	Data	6.5	1.9	439.5	2.1				
C2	Information	9.7	2.8	392.9	1.9				
	Total					16.2	4.7	832.4	4.1
<u>D. Quality Assurance</u>									
						18.8	5.5	1,079.7	5.3
TOTAL PROGRAM						341.2		20,541.9	

4.6 Performance

During recent years a substantial number of audits and/or evaluations have examined the hydrometric activities of Environment Canada.(19,20,21,22,23) Some of these have been concerned with the functions and responsibilities of the Water Survey of Canada and others with the Inland Waters Directorate. Some have considered head office operations, and others have reviewed regions, groups of regions or the national picture. In addition to the audits and evaluations originating internally from the Internal Audit Branch of Environment Canada or as ongoing studies within the IWD itself, there has been a recent external review by the Auditor General of Canada covering operations for fiscal year 1983-84.(23)

In each of these reviews a number of observations and specific recommendations were made, and these have resulted in follow-up programs and action to bring about improvements.(24,25) However, the general findings of the reviews have been that program objectives were being achieved efficiently within the resources allocated. The major findings from the Auditor General's report, with respect to the Water Resources Branch was that the system was functioning satisfactorily, due regard was being given to economy and efficiency and the activity was well managed.

In view of these favourable findings, it is evident that efficiency and economy cannot be taken as grounds for considering an alternate form of organization. Rather the basis for assessment should be the third of the three criteria which are used for performance assessment by the Government of Canada - the effectiveness of the activity in achieving the desired result. The question to be asked is whether, given the underlying functions and responsibilities of a water quantity data system would any alternate form of organization achieve the desired overall objectives more effectively. This would be reflected either in better quality of performance using the same amount of resources or the same quality for less resources.

Our subsequent assessment of alternate organizations thus, concerns itself with the basic ability of the form of organization to discharge the functions and responsibilities of this activity effectively, rather than with questions of economy and efficiency.

CHAPTER 5 - ORGANIZATION OF WATER QUANTITY SURVEYS
IN FOREIGN JURISDICTIONS

5.1 Existing Patterns of Organization

According to the latest published survey carried out by the World Meteorological Organization(26), all 96 countries responding to the survey questionnaire indicated one or more national and/or provincial (state) governmental agencies carried out the functions of a hydrological service, with the exception of Brazil.

The WMO survey indicated that the organizational patterns with respect to hydrological services vary widely from country to country. Circumstances and constraints within a country determine the type of organizational structure that can best contribute to the effective and efficient implementation of technical programmes and projects. Four well-defined types of organizational patterns are:

- i) the hydrological and meteorological services are combined in a single agency;
- ii) the responsibility for most hydrological activities rests with a single water resources agency;
- iii) hydrological services are dispersed among several national agencies, sometimes including the meteorological service; and
- iv) hydrological services are largely under the jurisdiction of provincial or state governments, in conformance with water resource development policies.

Existing national structures are not likely to conform exactly with any of these broad patterns. A simple classification is most difficult.

However, according to several surveys of network density, operation and management of hydrological networks in member countries conducted by WMO over the past decade (taking into account the first-hand experience of WMO officials and experts involved in WMO-executed or assisted field projects in developing countries) the majority of hydrological networks are developed, operated and managed under three basic institutional arrangements:

- a) the network is designed, built, operated, managed and data collected by a government agency using exclusively government employees and paid field observers;
- b) the network is designed, built, operated, managed and data collected by several different government agencies which may:
 - i) entrust some or all of the above operation to another of the agencies, providing it with funds on a lump sum or real cost basis,
 - ii) hire non-governmental employees or public institutions or consulting firms to perform part or all of the operations, except the design of the network,

c) the network is designed by one or several government agencies and its operation is entrusted to private companies or to foreign public institutions. The latter arrangement is the case primarily in countries whose qualified manpower to operate the network is entirely lacking. In such cases, even the design of the network and data collection and processing is entrusted to the foreign institution (e.g. ORSTROM of France in a number of francophone African countries).

Arrangement a) is by far the most common in developed, industrialized countries of the world. There are, of course, various mixes of the operations characterized by arrangements a) and b) in such countries but, generally, arrangement a) prevails.

With regard to arrangement c), there are three conspicuous examples. The first relates to Brazil in the basin of the Amazon River. While there are at least three purely governmental agencies involved in data collection and several other "mixed" agencies interested in data collection and processing, funds are provided by all of the agencies to one agency which subcontracts the network operation to a private company HIDROLOGIA, S.A., which, in turn, subcontracts field activities to smaller local private companies. The consistency and quality of the hydrologic data base is reported to have deteriorated to the extent that uncertainties in the available data base has increased the costs of water resources development. This state of affairs has been criticized many times and action proposed to change to a full governmental operation. However, no change has been instituted as yet.

Another example relates to several francophone African countries which have subcontracted the building and operation of their hydrologic network to a French governmental institution, with the acronym OSTROM. Currently the costs of establishing and operating hydrologic surveys in these countries is being met fully through technical cooperation grants of the French government.

The third example, relates to a number of countries in Latin American and is also partly valid in Switzerland. Although in each instance there exists a fully governmental operation with respect to a "basic" network, many additional stations are operated by hydropower companies and, if their data are of interest to the government (provincial or federal) a subvention is paid to the power companies by the government for the operation of the stations. However, coordination and quality control of these data is frequently lacking.

Information on the management and operations of hydrologic surveys in the USA, UK, France, New Zealand and Australia is contained in Appendix C.

CHAPTER 6 - RESPONSE OF PROVINCES, CLIENTS AND USERS TO ALTERNATE ORGANIZATIONAL ARRANGEMENTS

6.1 Review of Options

The Terms of Reference indicate the requirement of Environment Canada to obtain objective information and advice on

"...the current internal government and alternative organizations external to government for the collection and delivery of water quantity data...."

and to

".... Consider the needs of the clients, users and public through review of internal and external studies, particularly the Pearse Inquiry, as well as interviews of selected users...."

and

".... Indicate the probable attitudes and responses of provinces and major clients to each of the alternate organizations considered...."

The first step in conducting the review was to assess in detail the basic functions and responsibilities of a water quantity data collection and delivery system, taking the existing WRB system as the departure point for this assessment. Functions and responsibilities were described in detail in terms of what is done, how it is done, and the output of the activity. They were also grouped into the four broad categories of System Planning, System Operation, System Outputs and Quality Assurance. This assessment was reviewed thoroughly with the IWD and WRB.

The result of the assessment was the listing of functions and responsibilities presented in Table 3, (see Section 4.3) and in Appendix B. This constituted a "status quo" scenario against which alternate forms of organization could be compared.

The options identified by the Terms of Reference for review were privatization, operation by the provinces, operation by a crown corporation, as well as maintenance of the status quo organization. Other options were to be considered if appropriate, but the foregoing were identified as the principal alternates.

A detailed assessment was made of each of these options in relation to each function and responsibility as established for the status quo scenario. The results of these assessments were summarized in three working papers which contained the initial conclusions of the consulting team regarding the feasibility of each of the alternates. These summary papers were reviewed with IWD and WRB representatives to ensure correctness as to facts, and subsequently used as the basis for

eliciting information concerning client and user needs and the probable attitudes and responses of provinces and major clients to each of the alternative organizations considered.

6.2 Survey of Responses to Alternate Organization Arrangements

The working papers on alternate organization arrangements together with the "status quo" statements of functions and responsibilities were circulated to the Administrators of the Federal/Provincial Water Quantity Survey Agreements, to the Coordinators of the Agreements, to the members of the Inter-departmental Committee on Water (except the ADM, DOE and DG, IWD), to Members of the Associate Committee on Hydrology, and to other water quantity data users as listed in Appendix E.*/

Telephone interviews were conducted with the federal and provincial Administrators and other selected individuals, and written comments were requested from the balance of those receiving the material to elicit an indication of the probable response of provinces, clients and users to alternates under consideration. The initial nature of the positions arrived at in the summary papers was stressed. Verbal or written replies were requested on the basis that comments would not be attributed to individuals and need not necessarily constitute the official position which the respondent's organization might eventually take on these matters.

Appendix E, which lists the individuals who were invited to comment on the preliminary findings of the review and related areas of concern has been annotated to indicate those who were interviewed by telephone and those who provided written responses. It may be noted that the survey of opinions covered all ten provinces and both territories and a representative cross-section of clients and users in addition to provincial authorities. Respondents cooperated quickly and fully. As a result a cross-country perspective on the contents of the working papers and on the issues involved was obtained.

The following is a digest of the responses regarding the individual alternate organizations.

6.2.1 Privatization

Opinion was unanimous that privatization is not a feasible alternate form of organization, for a variety of cited reasons.

The basic position with regard to privatization was that the nature of the activity does not lend itself to private operation since there is a small revenue base, the market is limited, and the operation could not be attractive to a private operator, except at higher levels of costs.

*/ The summary working papers, as circulated to provincial government organizations and a selection of clients and users of water quantity data, are contained in Appendix D.

Concern was expressed that data continuity would be impaired by periodic contractor changeover. There was a question whether a data bank or banks in private hands could operate on a national level. In the north, access difficulties and special procedures because of the climate and terrain were considered a major impediment to privatization.

With regard to contracting out, opinions were mixed. It was generally considered to be something that should always be considered; however some earlier experiences indicated higher costs. One opinion was that commissioning external conduct of hydrologic analyses and special studies could impair the consistency of data interpretations because of variation in approach and methodology; the contrary view was that such contracting out was a useful way to access new thinking and techniques. It was suggested that care should be taken not to contract out the more advanced and attractive parts of the operation, since this would lessen the satisfaction of permanent staff, who would be limited to performing only routine work.

6.2.2 Operation by the Provinces

There was overwhelming opinion preferring continuation of the current system with some possible improvements, to making a major change in operational responsibility. It was consistently stated that a national system was required to reflect the need for river basin evaluation, data consistency, and quality assurance. It was considered that there are savings in terms of operation costs and consistency in the quality of data from having a national system. There was no evidence that benefits from operation by the provinces would be enough to compensate for the disruptions which would occur. Quebec respondents noted that they had had responsibility for a substantial network prior to taking over the operation of the full provincial system.

In summary, there would be no value in making a change for change's sake, and a pragmatic approach to making the current system work well was to be preferred.

It was mentioned several times that the provinces found the existing system and the federal authorities very responsive to provincial needs and not biased toward federal interests. There were some differences from time to time, but these were normal and could be worked out, particularly because of the good relationships with the regional and district offices of Environment Canada. Provincial capabilities in this area had increased substantially and some provinces would likely wish to review the option of taking over the work if the provincial share of costs were to increase significantly under the current or crown corporation options.

Provincial sovereignty was stated not to be an issue with regard to the collection and delivery of water quantity data. Indeed, provincial officials welcomed the federal presence as supportive of their own efforts to obtain resources for water quantity surveys and related water management matters.

It was noted by some respondents that the overall responsibility for water quantity data lay at the federal level, which therefore should continue to assume all overhead and administrative costs, as it does now. In general, provinces were concerned that if they took over operational responsibility for hydrologic surveys, the costs to them would be higher than at present.

6.2.3 Operation as a Crown Corporation

In general, respondents could not see any advantage in operation as a Crown corporation. In part this may have reflected some lack of familiarity with what a Crown corporation type of organization can do, but it also reflected respondents' opinions on the relative balance of advantages and disadvantages. As a whole no great advantages were foreseen from this kind of organization. It was thought that total costs would be at least the same, and likely higher, with a crown corporation being responsible for water quantity surveys and the IWD continuing to handle its other existing functions. There was also concern that indirect costs not now attributed to water quantity data collection would be included in any revision of the current cost-sharing arrangements which would be likely to arise under this option.

If data collection and delivery were set off by itself in an organization separate from entities inside and outside government that use hydrologic data for water management purposes, there could be other difficulties. These disadvantages included loss of useful linkages between different parts of the overall system; decrease in job satisfaction for professionals employed in a relatively narrow, specialized field, with attendant difficulties in recruitment; and perhaps greater vulnerability to financial constraints. There could also be a loss of access and responsiveness.

It was not thought that there was need for greater autonomy than the water quantity collection and delivery system now has, and the question was asked as to why there should be a change, since the system is now functioning well within a department. The possibility mentioned in the last paragraph of the crown corporation paper, of grouping water quantity data responsibilities along with other physiographic data gathering functions in a larger crown corporation, was mentioned to be an interesting possibility. However, the above noted disadvantages would have to be guarded against.

6.2.4 Maintenance of the Status Quo

All respondents indicated a clear preference for maintenance of the status quo, with some improvements and changes.

The chief reasons for this position have been mentioned in the earlier comments on the alternate forms of organization. Generally, satisfaction was expressed with the way in which the existing system operated, and particularly with the good relationships and access to people in the regional and district offices of IWD. Together with enhanced capability at the provincial level, the result was a co-operative approach to water quantity matters and an improved level of performance.

Concern with budgetary constraints was widespread, and the tendency was noted of demands on the system to outrun the resources available at the provincial level.

A number of suggestions for changes and improvements in the existing system were made as follows:

- greater integration of water quantity, water quality, and other data collection activities, particularly in remote areas;
- consideration and institution of special arrangements for short-term and partial measurement in response to user requirements. These do not fit into the structure of the overall program and the mechanism for handling them is lacking, although these are generally cost-recovery items with revenue potential;
- provision of more resources for evaluation and incorporation of new equipment, which will help resolve the problem of servicing remote stations;
- contracting out wherever possible.

CHAPTER 7 - REVIEW OF ALTERNATE ORGANIZATIONS

The following sections review the benefits and disbenefits of organizing water quantity data collection and delivery for each of four major options. The findings of this review take into account the results of the review of previous reports, the survey of responses to change received from various representatives of provinces and territories as well as of other clients and users, and discussions held with staff of the IWD.

Prior to discussion in detail it is appropriate to define the four categories of organization considered. Within each category there is of course a wide variety of structural variations which are possible. The emphasis herein is on basic organizational differences that would affect broad policy and direction. The four alternates are:

- i) Maintenance of the Status Quo - Continued responsibility for operation and improvement of the system by the current operators; the WRB in nine provinces and the territories, and in Quebec the Quebec Ministère de l'Environnement.
- ii) Privatization - Operation of the system by a private contractor, or contractors, with government control only through the setting of broad objectives and performance standards. The operator would be free to manage the system within these objectives as he felt best met the market needs.
- iii) Operation by the Provinces - Broad operational control within each province by an arm of each provincial government, such as currently followed in Quebec.
- iv) Operation by a Crown Corporation - Separation of the activities and operational control of the hydrologic survey functions from Environment Canada and establishment of these functions and responsibilities under a Crown corporation with the freedom to operate within constraints similar to those applying to Statistics Canada.

The specific tasks to be undertaken by any of the above organizations could be carried out, using either in-house staff or by contract to other government agencies or private corporations. We have not examined specific variations such as the most appropriate level of in-house effort or the mechanism for long term planning which would be most appropriate.

However, during the course of the study we have noted a few areas warranting further examination with a view to improving the overall effectiveness of the hydrologic network and to establishing a more equitable basis for cost-sharing, as well as opportunities for cost recovery.

7.1 Status Quo

A comprehensive description of the status quo functions and responsibilities of the Water Resources Branch is provided in Section 4.3 and in Appendix B.

No evidence was obtained during the study that would indicate areas of weakness in the current organization requiring major structural change. Nor was any other agency identified that was clearly both competent to and desirous of taking over responsibility for operating the hydrologic network.

The ability of the regional and district offices to communicate with and serve provincial needs was universally appreciated. Feedback indicated that the present system was seen to be effective from the standpoint of clients and users. In part, this satisfaction arose from the rather low cost to the provinces of obtaining essential water quantity data relative to the total cost of operation of the hydrologic survey.

Some concerns were expressed, notwithstanding the comments above, that provincial funding for the water quantity surveys was becoming more difficult to obtain, and that the cost of meeting current obligations restricts the funds available for other water management programs. Potential means of alleviation that warrant consideration would be to promote a greater public and political awareness of the program. Ongoing review of methods to improve efficiency and to increase cost recoveries should be maintained.

A more fundamental concern is the need to address the effectiveness of the water management data systems. This requires identification of both the basic long term network coverage necessary to support the constitutional and legislative requirements of the federal and provincial governments for water resources management, and the additional network coverage needed to provide data for management of specific near-term problems or support the operation of water control systems. To address the overall needs for hydrologic data to support water resources management would require comprehensive examination of the hydrometric and climatologic networks. Such a network design study should take into account the technologic advances which have been made in operational hydrology and meteorology in recent years. It is reported by IWD that network design in this context was last addressed on a comprehensive basis some 15 years ago.

It is suggested that consideration be given to carrying out a detailed review of hydrometeorologic network requirements on a regional basis in cooperation with the provinces to establish, on the basis of current technology, an optimal base network of hydrometric and climatologic stations to meet current federal and provincial obligations and to provide for future needs through representative spatial coverage. Such a network should also support, to the extent practical, client and user needs for monitoring of water quality.

It may be expected that the outcome of such a review would establish the basis for transformation of existing networks into a long term hydrometeorologic network which should be maintained in the public interest, identify redundant stations and areas warranting additional coverage. Moreover, the network review would identify existing stations which should be maintained to serve specific interests and operational needs and should be subject to full cost recovery.

In addition to the concept of privatization discussed in Section 7.2, we comment below on possible contracting out components of the work now being undertaken in-house by the WRB or contracting-in mission oriented provision of operational data which could warrant full cost recovery. Such contracting could be undertaken by any of the four organizations discussed.

Examination of the current operation of the water quantity surveys indicate there are opportunities for contracting out. In several instances this is being done, presumably to the extent considered practical. Thus, under responsibilities A.1 and B.1 (see Table 3), a variety of planning and methodologic studies have been commissioned to the private sector. Under B.2, station construction is contracted for by some regions; where this is not done, there may be further opportunities which should be recognized. Under C.1, the printing of all published reports is contracted to the private sector through the Department of Supply and Services.

Other areas which warrant examination of the potential for further contracting include:

B.8 - Operation and maintenance of data banks.

C.1 - Installation and operation of real-time data systems.

For mission-oriented requirements such as has been proposed to improve the control of lake levels throughout the Great Lakes⁽¹⁷⁾, contracting-in with full cost recovery may be warranted, even though the archiving of such records in the public domain will provide a benefit to other current and future users.

Other forecasting needs such as are associated with flood hazard warning and improved water control to enhance recreational and environmental qualities are a public service.

C.2 - Hydrologic analyses

It is recognized that in-house involvement in such studies provides valuable user experience for WRB staff which in turn is fed back into system planning and operations of the data system. However, the utility of in-house experience does not and should not preclude contracting-out some of the activities carried out under this responsibility.

Partial operation of the data collection program by the private sector has been considered but not attempted in Canada. A three year trial by the USGS indicates that the costs of private sector operation were substantially higher than direct operation by the Geologic Survey.(15) This is not surprising as the contract services were carried out under a rigid specification to ensure the quality and consistency of the data. Essentially the costs provided for the normal cost of operation with added costs covering an increased level of quality control checks carried out by the USGS and the level of contractor's profit. In principle, contracting out under such a detailed specification is unlikely to lead to any savings in cost. Any attempt to contract out these activities could only offer potential for savings where the contractor was allowed the initiative to modify procedures and timing within specified performance criteria.

7.2 Privatization

Privatization is taken to imply a turnover to the private sector of functional responsibility for all, or some significant portion, of the hydrologic survey activities (water quantity data collection and delivery) currently carried out by the WRB. Privatization, as distinct from contracting-out, implies a significant control of decisions on what to do, how to do it and on what outputs to deliver.

From review of the "status quo" functions it is clear that, as federal responsibilities stem from constitutional and legislative requirements, the responsibilities for system planning and quality assurance could not be privatized. System operations and delivery of system outputs do not appear to constitute a viable commercial operation in conventional terms. The "market" for hydrologic data is limited. At any time managers and developers of water resources require these data (as input to the evaluation of resource uses and to the design of facilities) a substantial long-term data base must be available. The benefits derived from the hydrologic data base arise through more equitable resource allocations, and a variety of services and public goods ranging from domestic water supply to maintenance and preservation of natural environmental quality.

Important though these uses and benefits are, the number direct users of water quantity data is relatively small. Thus, there is limited potential to expand the market or to recover costs through user charges in a normal commercial sense. A further factor is that the data base must provide for both future and current requirements; there is therefore need to make considerable investments in advance of requirements. Whilst there are increasing needs for real time operating data, these same data will be of future as well as current use. Capital equipment used to develop or increase the efficiency of the system has little other use, making more difficult transfer of the network or parts of it from one network operator to another.

Privatization of the responsibilities for data collection and delivery could only be considered through the establishment of operating concessions which would likely require an increase in monitoring and quality assurance activities to ensure the consistency and quality of the data records desired to meet national and regional interests.

There is no private sector activity which is analogous to the operation and delivery functions for hydrologic data surveys and no indication of private sector interest in these activities.* To establish new private sector enterprises willing to carry out such activities would require significant financial incentives, including medium or long-term licensing agreements. The absence of any other market for such services would probably limit interest and the creation of a competitive market even for concessional licences seems unlikely as, over time, new entries would have no basis for establishing credibility against that of any existing licensee. Present users of the data and clients, typically governmental departments, did not see this as a desirable option.

Privatization is not considered to be a viable option. This conclusion was universally supported by respondents to the survey of opinions on alternate organizations.

7.3 Operation by the Province

Under the current federal-provincial cost-sharing agreements covering water quantity surveys, operation of the hydrologic survey network may be carried out either by the WRB or by the provinces. Quebec has opted to be an operator within its jurisdiction while all other provinces and territories have accepted the WRB as system operator. (Within Quebec, the WRB continues to operate federal stations which are mainly along the St. Lawrence River for navigation and Quebec/USA boundary for international treaty purposes).

Provincial authorities could take over operations within their jurisdiction by becoming the operator under the existing agreements. However, there would be many details to be worked out, including duties and obligations regarding the stations to be maintained for interjurisdictional purposes, standards to be followed in data collection and processing, allocation or sharing of overhead functions and costs, and the basis for sharing and charging for operating costs. While these matters were worked out successfully once, with Quebec, there is no assurance that they would be replicated easily with other provinces and with DIAND acting on behalf of the Yukon and Northwest Territories. Transfer of responsibility should be seen, therefore, not

*/ Consultants report that they are occasionally required to install water level gauges and measure other hydrologic parameters in support of site specific investigations. These stations are usually maintained for only a limited period sufficient to establish correlation with a long term Water Survey of Canada station. Services provided offshore to developing countries, occasionally include advisory services on hydrologic network planning and operational training and technical assistance to local hydrologic survey agencies. Neither the domestic or foreign assignments represent a significant or continuous commercial activity alone, and most often arise as components of a specific water resource development investigation program.

as a simple reversal of the form of the existing arrangements; rather there could be need for negotiation of 10 new agreements (possibly 11 if Quebec insisted on opening up its position).

There would be differences in the interest of individual provinces in taking over responsibility for water quantity surveys. In the event that some provinces are interested and others not, the result of partial change could be the emergence of a patchwork of arrangements, including federal authorities operating federal stations, federal authorities acting on behalf of some provinces, provinces acting on their own behalf, and provinces acting jointly. This could lead over time to divergence of standards, practices and procedures under these arrangements, with attendant variation in the consistency of water quantity data, despite the upgrading and spreading out of capability which has occurred over the last decade.

The current organization of the WRB provides for the operation of the hydrologic network through five IWD regional offices (with WRB district offices in each of the Prairie provinces and in the Northwest Territories). The regional operations represent a compromise between operational control within each province and operation rationalized on the basis of major watershed boundaries. The federal/provincial coordination committees for water quantity surveys, together with specially constituted boards, provide mechanisms for joint action by provinces which have interests in transprovincial waters. Any basic change in federal-provincial responsibilities would affect these mechanisms and could require the working out of new arrangements.

Other jurisdictions, such as the UK, France, and W. Germany, have established hydrologic surveys on the basis of managing and controlling water resources development within individual river basins. Australia maintains and operates its hydrologic surveys on the basis of state organizations but has super-imposed requirements for coordination and cooperation where major waterresources developments affect more than one state. In the United States, hydrologic surveys are conducted as a national responsibility under the USGS, primarily because as in Canada, major watershed boundaries do not correspond to jurisdictional boundaries. The experience in these countries illustrates the need to recognize the river basin as the basic natural resource unit, under varying state, provincial or national arrangements.

Another principal factor is that, although the provinces have constitutional powers respecting the natural resources (including water) within their boundaries, there are constitutional and legislative responsibilities for federal involvement in water resources management which could not be delegated to the provinces. Hence, determination of the extent of the system network required to satisfy federal obligations and its operation to consistent standards is necessary, to ensure equitable water management policies affecting more than one jurisdiction, and in resolution of international water issues and fulfillment of international obligations.

In principle, operational responsibility for functions B.2, B.4, B.6 and B.7 (see Table 3), are the principal responsibilities which could be transferred to the provinces without significantly impairing the quality and utility of a national hydrologic data system. While functions A.1 and A.2 could be transferred at least in part, a federal role would be necessary to maintain a national network including international and inter-provincial stations.

The technical resources available within each province for hydrologic survey operations are not known in detail. Some of the provinces have a capability for hydrologic survey work. However, even if existing operational staff of the WRB were transferred to the provinces, there would likely be some increase in the cost to the public of providing necessary hydrologic data arising from the creation of separate systems management and quality assurance activities in each operating jurisdiction.

Other problems that would arise, are the establishment and institution of common standards for stations under different jurisdictions, monitoring of quality of data collected, and archiving and delivery of data from combined, or from separate, data centres and data banks.

Most of the foregoing negative factors are not listed as overwhelming barriers to any change being made; they could possibly be resolved and accommodated if there were clear indications of benefits that would be worth the disruption and costs. Benefits which may be considered include:

- enhanced provincial sovereignty
- greater provincial responsiveness to their own needs
- financial ability to develop the system in scale and quantity.

As regards sovereignty, this does not appear to be an issue in respect of water quantity data. Provinces seem to accept the usefulness of having federal operation on their behalf as well as its own, and to recognize that Canada's responsibilities in boundary and trans-boundary waters necessitate a federal presence. Currently, there is a different arrangement and balance with respect to water quality and other environmental data components. However, it does not appear that any arrangements in effect in those areas have resulted in sovereignty being an issue for water quantity data.

As regards greater responsiveness to provincial needs, there are two aspects. The first is whether there is a serious difference in perception of needs, at the federal and provincial levels, and secondly the level of financial resources that are available to provide for these needs. Within any given level of resources (federal and provincial together) there need not, under any reasonable working arrangement, be a major divergence of view as to priorities and orientation. There will always be disagreements around the edges, but there is a central core of agreement which enables the parties to work together. (If there were not, and if a major difference in view arises, it would appear preferable to resolve it within the existing system if possible, rather than create a completely new system).

Should the difference relate, however, to the scale and quality of the system and to the speed of improvement, the matter is one concerning the availability of financial resources. Under the existing system, provinces may make demands on federal financial resources which cannot be met because of overall federal constraints and priorities. However, a serious, persisting deficiency could be attacked by channels that now exist inside and outside the existing water quantity data system, without need for a new system.

Based on feedback received from the survey of client and user responses to alternatives, there is no significant pressure for provincial control under the present cost-sharing arrangement. In the event that a larger portion of the total cost of the operation of the water quantity network was paid to the operator than at present, this could change. The degree of interest and capability to undertake such work varies widely from one province to another. It is also probable that the political commitment to fund a hydrometric program varies widely, causing concern over the ability of provincial systems to maintain network coverage and standards over a long period of time.

Of the alternatives examined, provincial operation is the only one for which there is Canadian experience. During discussions with users, no strong feedback was received indicating concerns over the operation of the Quebec system. Some differences between the WSC network and the Quebec network have developed. Costs for the Quebec network are somewhat lower than for the WSC on a cost per station basis. Further, the net number of gauges operated by Quebec has been reduced by about 100 stations over the period of provincial operation whereas the WSC operated network across Canada has increased by about 400 stations.

We have not examined the reasons for these differences or the significance or merits of the changes in network design. However, it would seem likely that the provinces would apply more severe budgetary constraints to the water survey operations with consequent network contraction.

If in the future other provinces indicated a desire to take over their segments of the network, a long term agreement would be required to ensure maintenance of the national data base and appropriate stability of the network.

In summary, there are limited benefits to set against the costs and disruption of a change to provincial operation of the water quantity survey system. There is a system in place which is functioning reasonably well. Review of practice in several other countries indicates a great variety of arrangements which have evolved to meet historic development requirements and current circumstances: there is no one best system for use everywhere. While it is appropriate to consider changes and improvements in Canada's existing system, however, based upon our review there appears to be no significant argument for change from the current WRB operation in cooperation with the provinces to separate provincial operation of water surveys.

7.4 Operation by Crown Corporation

Hydrologic surveys have been conducted in Canada since 1894 under the direction of various federal departments. Since 1971 operation of the Water Resources Branch has been under the Department of the Environment. The question arises whether the federal interest in hydrologic surveys could be better served if a crown corporation form of organization were to be used.

There are a great variety of types and functions of Crown corporations in Canada.(27) The Financial Administration Act distinguishes the following in its schedules.

- Schedule B: departmental Crown corporations which are treated in the same way as departments of government.
- Schedule C: Crown corporations for management of trading or service operations on a quasi-commercial basis.
- Schedule D: Crown corporations for the management of commercial and industrial operations relating to goods and services, on a commercial basis similar to corporations in the private sector.

The Schedule D corporation form is described as necessary to establish an environment which would attract businessmen to the management of an entrepreneurial activity on behalf of the public, to protect commercial secrecy, and to provide some measure of independence from personnel and budgetary constraints as a basis for business management in the marketplace.

As the discussion of Privatization in Section 7.2 make clear, the characteristics of hydrologic survey activity in Canada do not correspond to those of a commercial market. The functions and responsibilities of water quantity data collection and delivery cannot be associated with a Schedule D Crown corporation as described above, and it is concluded that this form of Crown corporation should not be considered.

However, either a Schedules B or C corporation may provide a viable model. Statistics Canada provides the nearest analogue to the activities of WRB (assembly and dissemination of specified, multi-user data) and Statscan falls within these categories of corporation (which can be adapted to suit the circumstances at hand). Hence, it is feasible to consider continued operation of the hydrologic survey, as carried out by the WRB, under a Crown corporation similar to that under which Statistics Canada operates. In such case a complete, rather than any partial, transfer of functional responsibilities is implied. Hence, transformation of the WRB into a Crown corporation would ensure the continuity, consistency and quality of the hydrologic data system. Such a corporation could replace DOE as the federal partner (and operator) under the existing cost-sharing agreements, and would need to maintain the regional operations of the WRB as already established.

The rationale for such a change must be considered in terms of the balance of advantages and disadvantages which could be expected. Briefly, the apparent advantages include:

- Clear separation of all costs associated with maintaining of water quantity survey, including all management and overhead costs, currently provided through Branch, Directorate, Service and Department. This would provide a sound basis for review of cost-sharing arrangements with the provinces.
- Improved responsiveness to provincial, client and user requirements.
- Direct cost recovery for mission-oriented activities for all clients and users could be rationalized and, with acceptance of cost recovery, could enhance capability to respond to client/user needs and undertake revenue generating activities directly for third parties.
- Somewhat more flexibility in personnel management and through capitalization of investments a more rapid introduction of new equipment improving the overall efficiency of operations.

The major disadvantages would include:

- Less direct linkage to related natural resource survey activities (water quality, climatologic, morphologic and hydrogeologic surveys) currently carried out under the DOE.
- Less direct linkage with the environmental protection and conservation functions of DOE, which itself is one of the major federal clients/users of water quantity data.
- Increased cost of separate management and administration currently provided at the Branch, Directorate, Service and Department levels, which would not likely be offset by a corresponding reduction within the Department.

A transfer of responsibilities to a crown corporation would have to take into account provincial concerns over any loss of the provinces ability to influence the water survey program.

The advantages attributed to operating the water quantity survey under a crown corporation may also apply to other national data survey activities relating to water quality, groundwater, climatology as well as to related systems of quantifying the physical environment (topographic surveys, geologic surveys and hydrographic surveys). The question arises as to whether such a change in organization should be considered for the water survey in isolation, or whether there is usefulness in considering the organization of all related physiographic survey units under similar arrangements or in closely inter-related combinations. Combining of physiographic survey units may offer additional advantages in terms of efficiencies gained through combining

of common functions, increasing opportunities for personnel development under a recognized centre of excellence embracing inter-related and inter-dependent disciplines, and increased potential for cost recovery through being able to offer a more comprehensive and integrated range of interpretive analyses.

Most of the benefits which have been attributed to the operation of water quantity surveys under a crown corporation could be achieved through adjustments under the existing arrangements. Conversely, most of the disadvantages attributed to a crown corporation could be avoided through establishing appropriate linkages between a crown corporation and other agencies concerned with water resources management. On balance there does not appear to be sufficient advantage to a crown corporation dealing only with water quantity surveys to justify the disruption which would inevitably arise with a change from the status quo.

The examination of the benefits and disbenefits of combining related national physiographic survey functions is a matter which is outside the scope of the current review, and the merits and disbenefits of this related alternative have not been examined. While the majority of responses to the suggested alternatives are in favour of maintaining the status quo, there was some interest in the option of combining related survey activities.

CHAPTER 8 - FINDINGS AND RECOMMENDATIONS

Based upon a detailed review of the functions and responsibilities of the WRB and consideration of how these functions might in total, or in part, be carried out under alternate organizational arrangements, we have found there is no significant balance of benefits which warrant a major change in the way in which the water quantity data collection and delivery system is organized and carried out across Canada. There is overwhelming consensus supporting this view from representatives of provincial authorities and from other clients and users of hydrologic data.

Privatization is not considered feasible in the light of constitutional and legislative responsibilities of the federal and provincial authorities for the management of water resources. The status quo arrangement already provides for a significant level of contracting out of work to the private sector. However, the notion of privatization under which a total transfer of functions and responsibilities for system operations was considered, does not appear viable. Maintenance of essential standards of quality and consistency of the data could only be obtained through long term licencing of private contractors covering exclusive service areas. Insofar as a number of internal and external audits of the activities of the WRB have found that the operations are well managed and carried out with due regard to economy and efficiency, there is little likelihood that private sector licencees could operate at the same, let alone lesser costs.

Transfer of operations to the provinces would not relieve the federal authority of responsibility for conduct of water quantity surveys in the territories or to support its constitutional responsibilities for the management of international affairs, navigation and fisheries. While some provinces presumably could undertake the system operation of the network, as is done in Quebec, the provinces would be reluctant to accept any change from the status quo which would be accompanied by an increase in their costs. As system operator any provinces would, under the current agreements, be subject to an increased burden in providing for non-shareable costs. While some adjustment to the current cost-sharing agreements may be warranted these adjustments could be made as easily under the current arrangements as under a transfer of system operation responsibilities to various provinces.

Any broader transfer of responsibilities to the provinces would inevitably lead to a patchwork of arrangements and the likelihood of a deterioration in the consistency of standards between jurisdictions. Moreover, budgetary constraints at the provincial level would likely vary across the country, and could lead to contraction of the network in some provinces.

Operation of the water quantity surveys under a crown corporation would be feasible. However, as a separate entity the balance of advantages and disadvantages do not appear to warrant such a change. Most of the advantages attributed to a crown corporation could probably be achieved through adjustment within the existing arrangement.

One alternative which has been identified but not pursued in detail would be to combine related physiographic survey activities under a crown corporation. It may be noted in this connection that closer coordination between the hydrologic and climatologic components of the DOE was identified as a desirable change regardless of the particular organizational arrangement.

At this time, we recommend that no change be made in the basic organizational arrangements for the conduct of water quantity surveys this activity. Should other, wider changes be considered as a result of the findings of the Pearse Commission or other internal and external reviews, we recommend that the characteristics and requirements of the water quantity system be fully recognized.

It was not our function to assess and recommend improvements to the existing system, but we wish to report a number of suggestions which emerged during the course of this review. These are as follows:

- greater integration of water quantity, water quality, and other data collection activities, particularly in remote areas;
- consideration of special arrangements for shorter-term and measurements in response to user requirements. These do not fit into the structure of the overall program and well-defined mechanism for handling them is lacking, although these are generally cost-recovery items with revenue potential;
- provision of more resources for evaluation and incorporation of new equipment, which will help resolve the problem of servicing remote stations.
- review of network requirements on a regional basis together with the provinces, should be undertaken to establish, an optimal spatial coverage of water quantity measurement stations, taking into account the opportunities for integration and correlation with climatologic data stations to provide a base network to meet client and user needs. Network planning should also support, to the extent possible, client and user requirements for measurement of water quality. Such a review might be expected to establish the basis for distinguishing more clearly the network system which should be maintained in the public interest from the separate additional measurement stations that should be "contracted-in" on a full cost recovery basis for specific clients.

- review of charging policies and levels for publications, data and advisory services, in accord with the Common Services Policy of the government and practice in other departments and agencies, e.g. Statistics Canada;
- additional contracting out, wherever possible.

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APPENDIX A

Terms of Reference

APPENDIX "A"

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TERMS OF REFERENCE FOR THE REVIEW OF
CURRENT AND ALTERNATE ORGANIZATIONS FOR COLLECTION AND DELIVERY OF
WATER QUANTITY DATA

PURPOSE

The Deputy Minister of DOE seeks to obtain objective information and advice on the current internal government and alternative organizations external to government for the collection and delivery of water quantity data. The purpose of the review is to examine the existing and alternative systems and to determine their benefits and disbenefits in order to recommend the most cost effective option.

TERMS OF REFERENCE

The final report of the review is to contain information and recommendations concerning the optimum organization (government or private) for the collection and delivery of water quantity data in Canada. For the purpose of the study, water quantity data is defined as water levels, water discharges, sediment concentrations and loads, water temperatures and ice thicknesses. Options to be examined must include status quo, privatization, operation by the provinces, and operation by a crown corporation. The report should outline the costs, savings (if any), benefits and disbenefits of each option and how, and within what time frame, each could be implemented. The study, at a maximum cost of \$40,000, is to be done during the period July 21 to September 27, 1985. It should include any relevant findings and comments of the Pearse Inquiry.

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The study must;

- consider the need for historical continuity, internal consistency and quality assurance of hydrometric data.
- consider the needs of the clients, users and the public through review of internal and external studies, particularly the Pearce Inquiry, as well as interviews of selected users.
- consider alternative organization for management, included status quo, operation by the provinces, private sector or crown corporation of the operation.
- for each alternative considered, review benefits and disbenefits, indicate costs and potential savings and indicate the procedure and time frame for implementation.
- review the results of studies and implementation of alternate organizations in other countries (USA, England, France and Germany) as well as studies conducted in Canada with respect to data collection, user access to data and information, funding arrangements and client satisfaction.
- indicate the probable attitudes and responses of provinces and major clients to each of the alternate organizations considered.

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METHODOLOGY

The methodology including a schedule of monthly progress meeting is to be established with the contractor at the start of the contract. The contractor will have access at all previous reviews and studies conducted or collected by the Department.

REPORTING SCHEDULE

The final report is to be delivered to the contracting authority by September 27, 1985.

APPENDIX B

Functions and Responsibilities

Water Resources Branch
IWD
Environment Canada

STATUS QUO

FUNCTION A: SYSTEM PLANNING

A.1 Longterm Network Evaluation Planning

What is Done

- Establish network needs
 - to satisfy constitutional and legislative obligations
 - to provide for management and development of surface water resources in national interest
- Anticipate future trends of data to be collected and appropriate network density.

How it is Done

- Regional network evaluations carried out to identify quality of existing stations and needs for long-term coverage (internal and contracted-out).
- Information obtained directly and through annual federal-provincial meetings on data needs
- Initiatives received from Provinces/DINA and other government agencies
- through membership on IJC Boards
- participation in river basin studies under federal-provincial sponsorship.
- program evaluations (internal and external).

Output

- Guidance to annual operational planning on potential network changes and system/data requirements
- Budgetary and personnel requirements

STATUS QUO

FUNCTION A: SYSTEM PLANNING

A.2 Annual Operational Planning

What is Done

- review existing network
- consider client/user requirements
- assess station closure/expansion
- decide on new equipment installations
- establish operating plans for coming year
- matching requirements to available budgetary resources.

How it is Done

- coordinating Committee meetings with individual Provinces under the terms of the Federal-Provincial agreements, by regional WRB personnel
- planning meetings at regional level by WRB staff responsible for the conduct of the operational program
- planning meetings by senior regional and HO staff.

Output

- agreements with each province on programs for the coming year
- plan of operations in each region for the coming year
- annual report under cost sharing agreements
- annual construction reports by region/district.

STATUS QUO

FUNCTION B: SYSTEM OPERATION

B.1 Development and Transfer of Operational Methodologies

What is Done

- Maintain an inhouse competence and understanding of hydrologic processes
- Develop necessary techniques and methods to support hydrologic network
- Test techniques and select those most effective for purpose
- Transfer the results of these activities to operational groups

How it is Done

- Review ongoing research in operational hydrology
- Inhouse research by headquarters and jointly with the regions on data evaluation methods
- Research by IWD for other government depts, utilizing hydrologic data
- Contracting out specific research or methodology studies
- Taking part in inhouse seminars and conferences
- Publication and circulation of results to practicing hydrologists and other data users.

Output

- Effective operation of the network at the regional level.
- Reports, in the public domain, describing methods of analyses
- Supporting documents for other government departments and agencies
- Analytical models and software programs of potential interest to other Canadian agencies and to other countries.

B.2 Site Selection, Construction and Maintenance of Stations

What is Done

- reconnaissance and site selection normally carried out one year before construction
- preparation of designs
- construction and maintenance of new stations
- maintenance and upgrading of existing stations

How it is Done

- in-house hydrologist responsible for site selection and design
- in-house regional construction group
- contracting out in the regions/provinces

Output

- functioning network of stations

STATUS QUO

FUNCTION B: SYSTEM OPERATION

B.3 Equipment and Instrumentation - Development and Evaluation

What is Done

- development, testing, evaluation and adaptation of equipment and instrumentation for basic data collection and real-time data transmission.

How it is Done

- monitoring of relevant industrial developments
- major reliance on equipment and instrumentation used elsewhere
- some testing and adaptation by WRB staff for Canadian conditions
- preparation of performance specifications covering developments to meet current and future needs.

Output

- identification of equipment and instrumentation appropriate to Canadian conditions and needs, including Canadian-made DCPs
- equipment and instrumentation for in-house use with potential applications elsewhere in Canada and in other countries (normally entered in WMO reference together with reports on operational performance)
- user manuals.

B.4 Equipment and Instrumentation - Procurement and Maintenance

What is Done

- procurement, calibration, repair and maintenance of equipment and instrumentation

How it is Done

- some procurement by HQ, some by the regions
- calibration, repair and maintenance by the regions, using in-house or contract resources
- current meters repaired and calibrated at CCIW
- DCP's serviced by manufacturer.

Output

- progressive introduction of new equipment and instrumentation appropriate to Canadian conditions and needs
- functioning of all equipment at an adequate level of performance, but increasingly affected by sophistication and servicing difficulties.

STATUS QUO

FUNCTION B: SYSTEM OPERATION

B.5 Data Collection Instructions

What is Done

- documentation of standard procedures to be followed in data collection.

How it is Done

- regular modification and adaptation by HQ of the existing body of standard procedures.

Output

- instruction manuals detailing the standard procedures to be followed.

B.6 Conduct of the Data Collection Program

What is Done

- field operation of the data collection program, including monitoring and inspection of equipment, instruments and stations, under flexible programs adapted to the annual variability of regime conditions.

How it is Done

- by technicians with suitable basic qualifications and 4-5 years in-house training on the job by senior technicians or WRB Area Engineers in the regions
- field supervision and quality control provided by Area Engineers in the regions.

Output

- functioning network of stations
- raw data and computation of results of field measurements.

STATUS QUO

FUNCTION B: SYSTEM OPERATION

B.7 Processing and Verification of Hydrologic Records and Data Interpretations

What is Done

- Compilation and verification of hydrologic data (water levels, flows, sediment loads, ice thickness, water temperature) by station in format suitable for archiving, and documentation of hydrologic data interpretations.
- receipt, examination and preparation for publication of "contributed data".

How it is Done

- systems and procedures, detailed in manuals by HQ, which are followed in the regions.
- EDP equipment in HQ and the regions - programs provide for error detection and infilling estimated values for unrecorded periods
- for contributed data - some verification in field.

Output

- computed hydrologic station records transmitted annually from regions to HQ
- documentation of hydrologic data interpretations provided to clients/users.

B.8 Archiving

What is Done

- permanent storage of all data collected

How it is Done

- compilation and maintenance of computerized National Data Bank (HYDAT)
- microfiche data files
- original data and records of data processing maintained in regional offices
- library of reports, software (referenced in WATDOC)

Output

- the National Data Bank
- data files
- reference documentation.

STATUS QUO

FUNCTION C: SYSTEM OUTPUTS

C.1 Dissemination of Hydrologic Data

What is Done

- provision of hydrologic data on a regular basis

How it is Done

- provision of data in various formats and covering different time frames
 - publications and microfiche
 - computer-compatible cards or tapes
 - historical data summaries
 - realtime data via direct access
 - provisional data

Output

- Public reports
 1. Surface Water Data Reference Index - biennial publication. A map supplement is published approximately every five years.
 2. Surface Water Data - annual publication of daily discharge or water level and summaries for each month and the year.
 3. Historical Streamflow Summary - summary of monthly and annual mean discharge and annual extremes of discharge period every three years.
 4. Historical Water Levels Summary - summary of monthly and annual water levels and annual extremes of water level updated every three years.
 5. Sediment Data Reference Index - biennial publication.
 6. Sediment Data for Canadian Rivers - annual publication giving the results of the sediment survey investigations in Canada.
 7. Historical Sediment Data Summary - summary of sediment survey results for period of record updated every three years.
- data in other formats
- reference index of data (WATDOC)

STATUS QUO

FUNCTION C: SYSTEM OUTPUTS

C.2 Provision of Information and Advise

What is Done

- provision of hydrologic data and interpretations in response to requests from clients and users
- participation in joint studies of water resources development/management.

How it is Done

- analysis and abstraction from existing data systems and publications of required information, by HQ and the regions
- preparation of reports
- contribution to water resource boards/committees of relevant hydrologic data and interpretations
- staff training for other Canadian agencies and for other countries.

Output

- data and information in various formats
- trained staff

C.3 Public Information

What is Done

- provision of information on availability of water quantity data, interpretive reports, analytic software models and instrumentation development.

How it is Done

- reference in WATDOC
- presentations to technical conferences/seminars
- listings in WMO reference documents and HOMS

Output

- determination of user needs
- identification of potential areas for cost recovery.

STATUS QUO

FUNCTION D: QUALITY ASSURANCE

D.1 Promulgation of Data Collection and Processing Procedures

What is Done

- formal documentation of standard procedures and guidelines to be followed in data collection and processing

How it is Done

- continuing modification and adaptation by HQ of the existing body of standard procedures

Output

- instruction manuals documenting the procedures to be followed.

D.2 Ex Post Review

What is Done

- Check of overall data collection and processing system reliability and quality
- ad-hoc, post-collection review of data collected - testing for anomalies and inconsistencies, internally generated or in response to user observation.

Output

- more reliable data of more consistent quality.

D.3 Observance of Practices in General Use

What is Done

- Observance of practices, approaches and methodologies in general use, nationally and internationally.

How it is Done

- Review of methodologies and techniques developed and circulated by the Water Resources Branch
- Review of work by others reported in Canadian and other learned journal articles
- Attendance and contribution to seminars and conferences at the provincial, regional, national and international level.

Output

- System planning, operation, and output at a high level of professional quality and acceptability.

APPENDIX C

Management and Operations of Hydrologic Surveys in the USA, UK,
France, New Zealand and Australia

APPENDIX C

Management and Operations of Hydrologic Surveys in the USA, UK, France, New Zealand and Australia

C.1 United States of America

In the United States the hydrological services are vested in several national agencies according to their assigned missions. The principal agencies with national responsibilities in operational hydrology are the following:

- i) Geological Survey which appraises the quantity and quality of water resources (both surface waters and groundwater) for operational hydrology;
- ii) Corps of Engineers which plans, designs and operates reservoirs for flood control, water supply, power generation and regulation;
- iii) National Weather Service which operates a river and flood forecast and warning service for the nation;
- iv) Soil Conservation Service which plans, designs and operates small watershed protection situations and a snow survey and water supply forecasting service for Agriculture.

Hydrological Service of the Geological Survey

The Water Resources Division, United States Geological Survey, Department of the Interior carries out the hydrologic programme. The Division's responsibility, national and comprehensive in scope, includes continuing appraisal of the source, quantity, quality and movement of the ground and surface-water resources of the United States, together with the collection and dissemination of basic hydrologic data needed for development, management and conservation of water resources. In connection therewith, the Division also conducts analytical and interpretive hydrologic studies and carries out supportive basic and problem-oriented research. These activities are closely interrelated; for example, data collection is a major component of all interpretive studies and most research projects and, conversely the theories derived from research activities are the foundation for data collection and interpretive studies.

The Hydrologic Programme of the Geological Survey is carried out through 46 district offices (about one for each state) and is concerned principally with streams, lakes, reservoirs, estuaries, glaciers and groundwater. It is concerned not only with water as a resource but also as a hazard. Data and studies cover both the quantity and quality of the water, including the sediment load of streams. The programme is also concerned with water use, the water balance, the relationship between elements of the hydrologic cycle and the relationships of water resources, resources development, land use and the environment.

United States National Water Data Network

Most of the Geological Survey's hydrologic programme centres in the National Water Data Network are made up of two principal programme elements. One is federally funded and given emphasis to data collection and hydrologic studies in areas of paramount federal interest, such as public domain, river basins and aquifers crossing state boundaries, and other areas of interstate and international concern. The other element of the programme is funded cooperatively on a matching basis with state agencies and emphasizes data collection and hydrologic studies of joint federal and state interest. The water resources investigations and data collection are also carried out on a reimbursable basis to meet the specific needs of other federal agencies and part of such activity contributes to the national network.

The basic and problem-oriented research carried out by the Water Resources Division has three main goals which makes such research an essential part of the National Water Data Network:

- a) improvement of techniques and methodology for hydrologic studies and for network design and operation and for associated data analysis;
- b) better understanding of hydrologic systems so that quantitative predictions of response of these systems to either natural or man-made stress can be made;
- c) applications of research fundings to resolve hydrologic aspects of critical national problems, such as resource management, environmental quality, subsurface waste disposal and energy.

In summary, through the Water Data Network, records are obtained on stream discharges and water levels, reservoir and lake storage, ground water levels, well and spring discharge and the quality of surface and ground water. These data provide a continuing record of the quantity and quality of the surface and ground water resources of the United States and thus, the hydrologic information needed by federal, state, local agencies and the private sector for the development and management of the land and water resources. These data are stored on the Geological Survey's data storage and retrieval system "WATSTORE" and also published by water year for each state..

National Water Data Acquisition Coordination

In 1964, the former Bureau of the Budget (now the Office of Management and Budget) gave to the Department of the Interior the responsibility for coordinating the water-data activities of all federal agencies. The Geological Survey through its Water Resources Division has the lead agency role in the acquisition of certain water data. This function is carried out by the Office of Water Data Coordination (OWDC) of the Water Resources Division with the goal of assuring effective management of federal resources to meet requirements for water resources information.

The coordination effort is accomplished through two major committees that advise the Secretary of the Interior on water-data acquisition. Federal interests are represented by 30 federal members on the Inter-Agency Advisory Committee on Water Data. An Advisory Committee on Water Data for public use has its members drawn from many professional societies, including consulting engineering.

The OWDC, with the assistance of involved federal agencies, prepares an annual federal plan for water data needs and activities, provides input to updating the design of the national network and maintains a central catalogue on water data and data collection activities. The Division administers the National Water Data Exchange (NAWDEX). This programme is a national confederation of water-oriented organizations working together to improve access to water data. Its primary objective is to assist users of water data in the identification, location and acquisition of needed data.

Hydrological Services of Other Federal Agencies

Corps of Engineers - The Corps of Engineers has been the U.S. Government's principal water resources development agency since 1824. The hydrological service of the U.S. Army Corps of Engineers is part of the Civil Works Directorate which provides projects and services for the direct benefit of the general public. The hydrological service therefore supports a variety of activities, including navigation, flood control, water supply, power generation, recreation, environmental protection, regulation and regional water resource planning. Much of the data required by the Corps is collected by other federal agencies through reimbursable agreements. Of the approximately 5,000 stations being funded by the Corps half are operated by the Geological Survey and the others by the Corps. The Corps and the National Weather Service cooperate in the operation of about 40 precipitation networks.

Soil Conservation Service - established in 1935, its mandate is to provide national leadership in the conservation, development and productive use of the nation's soil, water and related resources. Although large amounts of precipitation, water data and other related hydrometeorological data are used by the Service in planning and design, only snow and related hydrometeorological data have been collected on a continuing basis.

National Weather Service - its mandate in hydrology is the issuance of flood forecasts and the gauging and reporting of water stage levels. It is the only agency to issue official flood forecasts to the public. Flow forecasts are issued daily for major rivers and water supply forecasts are prepared for over 2,000 locations. Close cooperation is maintained by the Weather Service with the above-mentioned federal water service agencies.

Miscellaneous - other national agencies have hydrological programmes oriented towards meeting specific regional missions such as the Tennessee Valley Authority and the Bureau of Reclamation; the latter constructs, operates and maintains multi-purpose dams and irrigation distribution and drainage systems in the 17 western states.

The Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data, advises the federal agencies responsible for collection and compilation of Great Lakes data in both the USA and Canada. Through the Committee, internationally coordinated flow data, water levels, vertical control and other physical data covering the Great Lakes and its connecting channels are made available to all interests. Membership in the Coordination Committee in recent years has included the U.S. Corp of Engineers, the U.S. National Ocean and Atmospheric Administration and Environment Canada(17).

The Water Resources Division of the USGS operates or participates in a number of other nation-wide programmes and activities, such as the National Water Quality Networks Programme, the Acid Rain Programme and the Coal and Oil-Shale Hydrology Programme.

As the lead federal agency for describing and appraising the water resources of the United States, the Geological Survey, in cooperation with other federal and non-federal agencies, operates four networks for monitoring water quality. The Geologic Survey also participates in a coordinated network programme to monitor the chemical composition of precipitation and of selected streams and lakes that are or may be affected by acid precipitation. The Water Resources Division is also involved in defining the basic water supply available and the effects of development of coal and oil shale on water resources.

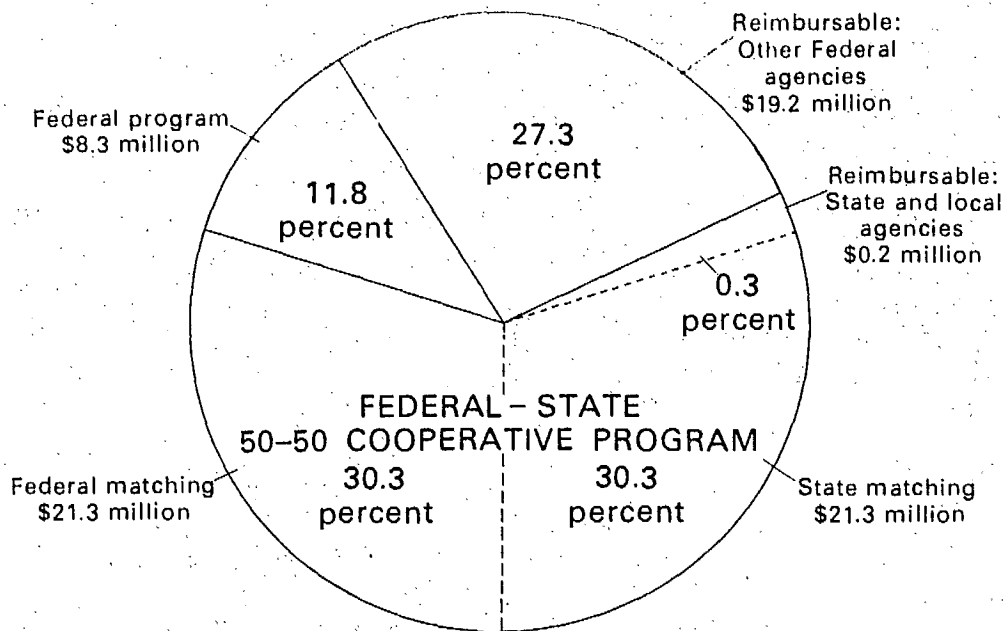
The sources and allocation of funds for the Water Data Program only, is illustrated by the attached figure for the United States fiscal year 1981.

C.2 The United Kingdom

Water availability in the U.K. is a regional rather than a country wide problem. Difficulties arise from lack of supply and demand rather than an overall lack of the resource. The role and goal of water in the national economy is, therefore, basically one of ensuring an ample supply of water for municipal, industrial and agricultural purposes supported by complementary policies to provide adequate sewerage and sewage disposal facilities to ensure land drainage and flood protection and to make the widest possible use of water space for other purposes including recreation and amenities.

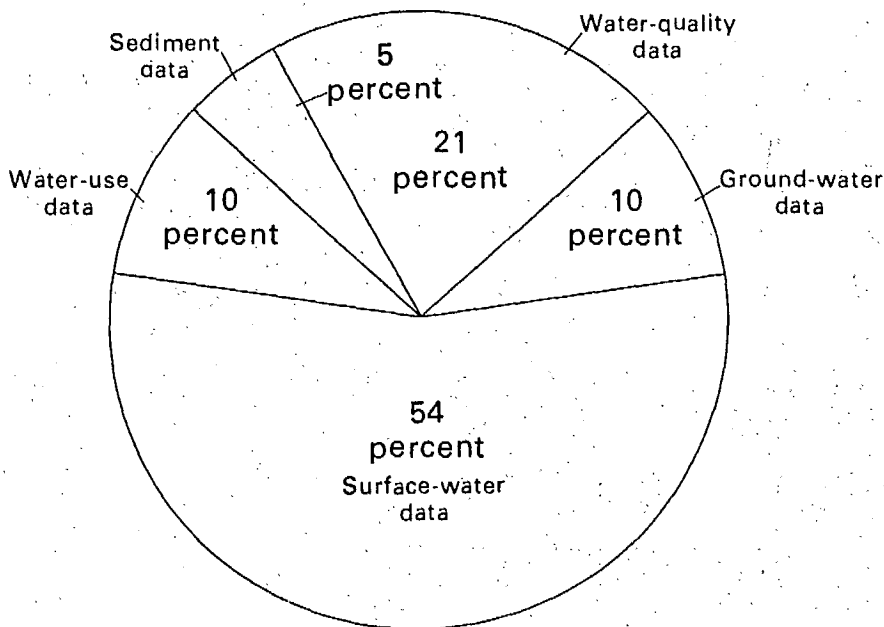
Between 1973 and 1975, three acts of Parliament produced a major change in the management of the water resources in the U.K. Previously, the Water Resources Act of 1963 had established 29 river authorities covering the whole of England and Wales. In addition to the general duty of ensuring and augmenting the water resources within their respective jurisdictions, they were specifically required to survey the water resources of their area, estimate future demand and make proposals for meeting it, to prepare hydrometric schemes for measuring rainfall, evaporation and river flows, to investigate the quantity and quality of underground water, to determine minimum acceptable flows within their jurisdiction and to control abstractions by a system of licensing. Prior to 1963 there had been an even greater dispersion and decentralized authority for water management and data collection, a situation which could not contend with the heavy and increasing demands upon water supplies.

SOURCES OF FUNDS



Total funding, \$70.3 million

ALLOCATION OF FUNDS



Sources and allocation of funds for the U.S. Geological Survey's Water-Data Program in fiscal year 1981.

The Water Act of 1973 established 10 regional water authorities in England and Wales whose responsibilities extend beyond river management to all aspects of water use, including fisheries, land drainage, recreation and amenities. In the reorganization in England and Wales, five new bodies were established with national responsibilities, namely:

National Water Council (NWC)
Water Space Amenity Commission (WSAC)
Central Water Planning Unit (CWPU)
Water Data Unit (WDU)
Water Research Centre (WRC)

The first three bodies, among them, provided a forum for the water authorities to discuss matters of common interest, advise the Department of the Environment and review the national and strategic aspects of water services planning and operation. The role of the Water Data Unit, Department of the Environment, was to advise on the information required for water management purposes and on the systems to be adopted for collection, processing, storage and publication of such data to ensure the establishment of common standards and methods of data collection by water authorities and to collate and publish such data as are required on a national basis.

There is no single body within the U.K. that has all the responsibilities of a "national hydrological service". However, the WDU, in cooperation with the water authorities, river purification boards and a number of other bodies, including the Meteorological Office, together carried out most of the tasks of such a service for England and Wales. The activities of the WDU fell into two categories: data acquisition and computing services. The hydrological network is operated in the field by the water authorities, the river purification boards and the Meteorological Office with the cooperation of a number of other bodies and individuals.

It was the primary task of the WDU to ensure uniform standards of data collection, storage and retrieval and this is achieved through the activities of working groups set up by the water authorities and the other bodies concerned. Some were run directly by the WDU and others were serviced by WDU under the aegis of the British Standards Institute. Another task of the WDU was liaison with international organizations other than the WMO; liaison with the latter is carried out by the Meteorological Office. Hydrological forecasting for flood warning and river regulation is largely the concern of individual water authorities. The research promoted by the WDU was mostly concerned with methods of acquiring data. Basic and applied research is also undertaken at the Institute of Hydrology.

The Water Data Unit had a staff of about 70 of whom 20 are qualified professionally. There are an estimated 4,000 to 6,000 staff of the other bodies involved who are either wholly or partly involved in operational hydrology and river management. Training of hydrometric staff was undertaken very largely through courses provided by the Training Division of NWC.

In April 1982, the Water Data Unit was disbanded and only its mandate related to the archiving of hydrological data was retained by the Department of Environment which has this responsibility through a number of statutory, international and other obligations. The responsibility for the water data archive and associated publications is now with the National Environmental Research Council (NERC) at Wallingford. The Institute of Hydrology has responsibility for the Surface Water Archive and the British Geological Survey, for the Ground Water Archive. The Institute of Hydrology with only eight staff assigned to the maintenance of the archive has no quality control mandate to ensure the high standard and uniformity of data, except to advise and hope an adequate standard can be maintained through goodwill and respect.

C.3 France

There is no single "national" hydrological service in France. The national government agencies responsible for collection of hydrological data are:

- i) Météorologic Nationale responsible for collection of rainfall data and maintenance of the data bank. Apparently a large number of agencies are involved in the operation of this network with the Météorologic Nationale operating 70% of the stations.
- ii) Directorate of the Technical Service for Electric Energy and Major Dams, Ministry of Energy, has seven operational units measuring discharges on certain rivers primarily to serve hydroelectric power purposes. The system for the acquisition and processing of the data from the approximately 550 hydrometric stations operated by the Directorate is oriented towards non-real-time data collection.
- iii) Central Service for Hydrology and the Environment measures flows of the major rivers to provide a basis for resource evaluation, land development, navigation, mitigating flood hazards and for construction of works. The current network has been established over time and a few stations, established specifically for flood warnings, have been in existence for more than a century. Nevertheless the network does not extend over the entire country. There are about 900 stations of which almost 1/3 are equipped with stage recorders.
- iv) The Ministry of Agriculture has 22 Regional Services of Water Planning whose regional networks aggregate to the national network of about 1,100 stations. The system does not involve real-time management of the water resources or flood warnings. The activities of these regional services with respect to hydrometric data collection are coordinated by the Hydraulic Service of the Ministry.
- v) "Service des Prolemes de l'Eau, Ministry of Environment and the Sphere of Life manages the water quality networks established in the six major hydrographic basins of France.

In addition to the foregoing national agencies, there are several national corporations who manage hydrometric networks for their own needs. The more important of these "private" networks are: the Electricity Board, the National Company of the Rhône, and regional basin development agencies.

There appears to be considerable diversity in the development of the data banks set up by each of the agencies engaged in hydrological data collection and processing. However, the various bodies which manage and operate the networks cooperate in specific working groups which deal with the problems of data collection and the validation of the results and their use.

C.4 New Zealand

The central government function is handled through a Government Department, the Ministry of Works and Development, through its Water & Soil Directorate. The gauge network of 700 stream flow recorders is split about half in half between those operated directly by the Ministry and those operated by local Catchment Authorities. Funding for the local boards is from the central government. In addition the Ministry undertake gauging work on a cost recovery basis on request and to encourage common standards will make available in exchange for the data produced, training of staff and assistance in selecting sites and setting up a program.

Data is collected and held by the Directorate and made available as computer files or listings free of charge on request. The data supplied includes the records together with gauging rating curves and a brief site description. Data is generally retained on a 1/4 hr interval. In addition to the data collection the centre is responsible for selecting stations to be maintained as a reference network and for quality control of these stations as well as of data obtained from other sources but forming part of the central data bank. The Hydrology centre in addition to setting up the quality control procedure, carries out research on hydrologic processes and can undertake up to 20% of their work on a cost recovery basis. Funds received in effect are additive to their basic budget. At present the funding is about NZ\$4,400,000 per annum plus an additional \$600,000 from the Power Corporation leaving a potential \$280,000 which can be obtained by sales of applied research. An example of this is the creation for sale of the data handling system microTIDEDA for time series data, particularly oriented to the manipulation of flow and rainfall data.

Sediment Data Network: there is a suspended sediment data network established in 1968 with data being collected routinely but little used. Cross-sections are surveyed every 5 years at 1 km spacing along some 30 rivers where river control works are maintained and used to monitor aggradation and degradation.

Rainfall Data: The Ministry and the Catchment Authorities operate 300 rainfall recorders. The Meteorological Service operate an additional network of 1600 volunteer observers returning daily volumes, plus hourly records at 26 airports. All this data is available from the Ministry of Works in the same form as the streamflow data.

C.5 Australia

Australia has a federal system of Government with responsibilities split between the two levels of government. Notwithstanding this similarity to Canada, the very different hydrologic regime and pattern of development has led to very different arrangements for water management including hydrometry.

The major permanent rivers are short, flowing across a narrow coastal plain and confined to one State. The notable exception is the Murray-Darling system, the catchment of which includes parts of four States.

With the exception of the Murray-Darling system, settlement of Australia, while very dependent on available water, was centered around local rivers with no major waterways to act as links between the major settled areas. Over most of the country development is limited by the available fresh water. As development of agriculture and industry has been dealt with at the State level, the associated development of water resources has been almost entirely a state responsibility. There has been little federal activity in water management except for very limited areas such as the Australian Capital Territory.

Each State carries out their own hydrometric data collection according to standards for collection and storage, that best suit their major users.

An example of a State system is the New South Wales Water Commission. The Commission operates the major network in the State either directly or upon request by other agencies or interests. Other networks include a fairly extensive network on the East Coast operated by the "Metropolitan Water, Sewage and Drainage Board", the major N.S.W. supplier of water for urban use and a second in the "Australian Capital Territory", a zone around the Federal Capital outside State jurisdiction. While all data is supposed to be put into a common archive with the Commission, the process is not effective at present. The data is considered a public good with charges levied to cover only the cost of printout or computer compatible output production.

With the clear need to coordinate efforts on the Murray system a River Murray Commission was set up including three States and the Federal Government. Interestingly although the basin of the Murray-Darling system lies partly in Queensland, that state is not part of the commission. A separate commission "The Border Rivers Commission" is being considered to cover the river in this northern area. The existing commission acts as a coordinating body with actual work being carried out by the three states. In locations of common interest, e.g. at interstate borders, the interested states work together to arrive at a common evaluation of the flow. It should be noted that the Murray is heavily used, and indeed probably overused for irrigation and urban supplies. Salinity problems, particularly in South Australia where it forms a substantial part of the fresh water supply to the state, are severe. Flows and water quality are particularly sensitive issues.

Concerns have been expressed in the past about the lack of a Federal network or common standards for collection, storage or supply of data. Some work has been done, including the development of standards for nationwide use. At present these standards have not been generally adopted, one argument being that they are too detailed to allow for efficient implementation in a variety of situations. Various efforts towards a national primary network are being looked at including funding of the State agencies, or possibly contracting-out, but to date nothing is in place. Within the Federal government, water policy is handled by the "Australian Water Resources Council", a council of ministers and the operating arm is the Department of Resources and Energy.

In summary, the need for a national network is recognized but the complexities of implementing this have prevented it happening to date. At this time there is no common archived data base or indeed commonality of data form between the various parts of the country. It would appear that without federal power to enforce a common system, the most likely route will be to encourage movement to common standards through funding from the federal government.

APPENDIX D

Working Papers on Alternate Organizations

REVIEW OF ALTERNATE ORGANIZATIONS2.1 Privatization

We have taken privatization to imply a turnover to the private sector of functional responsibility for all, or some significant portion, of the hydrologic survey activities (water quantity data collection and delivery) currently carried out by the WRB. Privatization, as distinct from contracting-out, implies a significant control of decisions on what to do, how to do it and on what outputs to deliver.

From review of the "status quo" functions it is clear that, as federal responsibilities stem from constitutional and legislative requirements, responsibility for system planning and quality assurance could not be privatized. System operations and delivery of system outputs do not appear to constitute a viable commercial operation in a conventional sense. The "market" for hydrologic data is limited in the sense that at any time the managers and developers of water resources require these data, as input to the evaluation of resource uses and to the design of facilities with widespread public benefits, a substantial long-term data base is required. The benefits derived from the hydrologic data base arise through more equitable resource allocations, and a variety of services and public goods ranging from domestic water supply to maintenance/preservation of natural environmental quality. Important though these uses and benefits are, the number of people using water quantity data is relatively small. There is thus little potential to expand the market or to recover costs through user charges in a normal commercial sense. A further factor is that the data base must provide for both future and current requirements; there is therefore need to make considerable investments in advance of requirements and whilst there are increasing needs for real time operating data, these same data will be of future as well as current use.

Privatization of the responsibilities for data collection and delivery could only be considered through the establishment of operating concessions which would likely require an increase in monitoring and quality assurance activities to ensure the consistency and quality of the data records to meet national and regional interests.

There is no private sector activity which is analogous to the operation and delivery functions for hydrologic data surveys and no indication of private sector interest in these activities.* To

*/ Consultants report that they are occasionally required to install water level gauges and measure other hydrologic parameters in support of site specific investigations. These stations are usually maintained for only a limited period sufficient to establish correlation with a long term Water Survey of Canada station. Services provided offshore to developing countries, occasionally include advisory services on hydrologic network planning and operational training and technical assistance to local hydrologic survey agency. Neither the domestic or foreign assignments represent a significant or continuous commercial activity alone, and arise as components of a larger resource development investigation programs.

establish private sector enterprise willing to carry out such activities would require significant financial incentives, including rather long term licensing agreements. The absence of any other market for such services would probably limit interest and the creation of a competitive market even for concessional licences seems unlikely as, over time, new entries would have no basis for establishing credibility against that of any existing licencee.

Hence, privatization is not considered to be a viable option.

However, examination of the current operation of the water quantity surveys indicate there are opportunities for contracting out and in several instances this is being done, presumably to the extent considered practical. Thus, under responsibilities A.1 and B.1 a variety of planning and methodologic studies have been commissioned to the private sector. Under B.2, station construction is contracted for by some regions. Where this is not done, there may be further opportunities which should be recognized. Normally government publication is handled through the Queen's Printer and where confidentiality is not a concern, the Queen's Printer frequently contracts with the private sector for printing of documents. Presumably most of the reports under C.1 are, or could be, contracted-out through the Queen's Printer.

Other areas which may warrant examination of the potential for further contracting out include:

- B.8 - Through private sector firms operating and maintaining data banks.
- C.1 - Installation and operation of real-time data systems, such as may be required to improve the control of lake levels throughout the Great Lakes and which are directly related to commercial activities (i.e. shipping and electric power generation). For such mission-oriented requirements, contracting-out with full cost recovery may be warranted, even though the archiving of such records in the public domain will provide a benefit to other current and future users. Other operational/forecasting data needs are associated with flood hazard warning and improved water control to enhance recreational and environmental qualities as a public good. To meet such needs will require review to ascertain appropriate cost-sharing apportionment.
- C.2 - Significant hydrologic analyses are performed by the private sector. It is recognized that in-house involvement in such studies provides valuable user experience for WRB staff which in turn is fed back into system planning and operations of the data system. However, the utility of in-house experience should not preclude contracting-out some of the activities carried out under this responsibility.

Partial operation of the data collection program by the private sector has been considered but not attempted in Canada. A three year trial by the USGS indicates that the costs of private sector operation were substantially higher than direct operation by the Geologic Survey.*/ This is not surprising as the contract services were carried out under a rigid specification to ensure that activities were performed identically to in-house services, with the added cost burden of an increased level of quality control checks carried out by the USGS and the level of contractor's profit. In principle, contracting out under a detailed specification is unlikely to lead to any savings in cost.

*/ An Assessment of the Collection and Analysis of Hydrologic Data by Private Contractors for the US Geologic Survey, USGS Water-Resources Investigation Report 83-4104.

2.2 Operation by the Provinces

Under the current federal-provincial cost-sharing agreements covering water quantity surveys, operation of the hydrologic survey network may be carried out either by the WRB or by the provinces. Quebec has opted to be an operator within its jurisdiction while all other provinces and territories have accepted the WRB as system operator. (Within Quebec, the WRB continue to operate federal stations which are mainly along the St. Lawrence River for navigation and Quebec/USA boundary for international treaty purposes).

Provincial authorities could take over operations within their jurisdiction by becoming the operator under existing arrangements. There would be many details to be worked out, including duties and obligations regarding stations, standards to be followed in data collection and processing, allocation or sharing of overhead functions and costs, and basis for sharing and charging for operating costs. While these things were worked out successfully once, with Quebec, there is no guarantee that they could be replicated easily with 10 other provinces (including DIAND acting on behalf of the Yukon and Northwest Territories). Transfer of responsibility should be seen, therefore, not as a simple reversal of the form of the existing arrangements; rather there would be need for negotiation of 10 new agreements (possibly 11 if Quebec insisted on opening up its position).

This current review is required to ascertain potential interest, or lack of interest, of individual provinces in taking over responsibility for water quantity surveys. In the event that some provinces are interested and others not, the result of partial change could be the emergence of a patchwork of arrangements, including federal authorities acting on behalf of federal stations and requirements, federal acting on behalf of some provinces, provinces acting on their own behalf, provinces acting jointly. This could lead to divergence of standards, practices and procedures under these arrangements over time, with attendant variation in the consistency of water quantity data.

The current organization of the WRB provides for the operation of the hydrologic network through five IWD regional offices (with WRB district offices in each of the Prairie provinces and in the Northwest Territories). The regional operations represent a compromise between operational control within each province and operation rationalized on the basis of major watershed boundaries. The federal/provincial coordination committees for water quantity surveys, together with specially constituted boards, provide mechanisms for joint action by provinces which have interests in transprovincial waters. Any basic change in federal-provincial responsibilities would affect these mechanisms and would require the working out of new arrangements.

Other jurisdictions such as the UK, France, W. Germany, Switzerland and a number of other countries have established hydrologic surveys on the basis of managing and controlling water resources development within individual river basins. Australia maintains and operates its hydrologic surveys on the basis of state organizations but has super-imposed requirements for coordination and cooperation where major water

resources developments affect more than one state. In the United States, hydrologic surveys are conducted as a national responsibility under the USGS, primarily because as in Canada, major watershed boundaries do not correspond to jurisdictional boundaries. The experience in these countries illustrates the need to recognize the river basin as the basic unit, under varying state, provincial or national arrangements.

Another principal factor is that there are constitutional and legislative responsibilities for federal involvement in water resources management which could not be delegated to the provinces. Hence, establishment of the extent of the system network required to satisfy federal obligations and its operation to consistent standards is necessary, to ensure equitable determination of water management policies affecting more than one jurisdiction and in resolution of international water issues.

In principle, operational responsibility for functions B.2, B.4, B.6 and B.7 are the principal responsibilities which could be transferred to the provinces without significantly impairing the quality and utility of a national hydrologic data system. We do not know what technical resources the provinces have available for hydrologic survey operations. However, even if existing operational staff of the WRB were transferred to the provinces, there would likely be some increase in the cost to the public of providing necessary hydrologic data arising from the creation of separate systems management and quality assurance activities in each operating jurisdiction.

Other problems that would arise are the establishment and institution of standards for stations under different jurisdictions, monitoring of quality of data collected, and archiving and delivery of data from combined, or from separate, data centres and data banks.

All of the foregoing negative factors are not listed as overwhelming barriers to any change being made; they could be resolved and accommodated if there were clear indications of benefits that would be worth the disruption and costs. Benefits which may be considered include:

- enhanced provincial sovereignty
- greater provincial responsiveness to their own needs
- financial ability to develop the system in scale and quantity

As regards sovereignty, this does not appear to be a major issue re water quantity data. Provinces seem to accept the usefulness of having federal operation on their behalf as well as its own, and to recognize that Canada's international responsibilities in boundary waters necessitate a federal presence. Currently, there is a different arrangement and balance with respect to water quality data and for other parts of the environmental system. However, it does not appear that these have resulted in sovereignty being an issue for water quantity data.

As regards greater provincial responsiveness to their needs as perceived by them, there are two aspects. The first is whether there is a serious difference in perception of needs, at the federal and provincial levels, and secondly the level of financial resources that are available to provide for needs. Within any given level of resources (federal and provincial together) there need not, under any reasonable working arrangement, be a major divergence of view as to priorities and orientation. There will always be disagreements around the edges, but there presumably is a central core of agreement which enables the parties to work together. (If there is not, and if a major difference in view arises, it would appear preferable to resolve it within the existing system if possible, rather than create a completely new system).

Should the difference relate, however, to the scale and quality of the system and to the speed of improvement, the matter is one of financial resources. Under the existing system, Provinces may make demands on federal financial resources which cannot be met because of overall relative federal constraints and priorities. However, a serious, persisting deficiency could be attacked by channels that now exist inside and outside the water quantity data system, without need for a new system.

In summary, there are few evident benefits to set against the costs and disruption of change for this activity. There is a system in place which is functioning reasonably well. Review of practice in several other countries indicates a great variety of arrangements which have evolved from their own circumstances and situations: there is no one best system for use everywhere. In these circumstances, it is well to consider changes and improvements in Canada's existing system. However, at the current stage of this review there appears to be no overwhelming argument for fundamental change.

2.3 Operation by Crown Corporation

Hydrologic surveys have been carried out in Canada under federal sponsorship since 1894. The basic functions of the hydrologic survey have, as indicated in the attached summary, been carried on under the direction of various federal departments. Since 1971 operation of the Water Resources Branch has been under the Department of the Environment. The question arises whether the federal interest in hydrologic surveys could be better served if a crown corporation form of organization were to be used.

There are a great variety of types and functions of Crown corporations in Canada.* The Financial Administration Act distinguishes the following in its schedules

- Schedule B: departmental Crown corporations which are treated in the same way as departments of government
- Schedule C: Crown corporations for management of trading or service operations on a quasi-commercial basis
- Schedule D: Crown corporations for the management of commercial and industrial operations relating to goods and services, on a commercial basis similar to corporations in the private sector.

The Schedule D corporation form was described (Source: P16) as necessary to establish an environment which would attract businessmen to the management of an entrepreneurial activity on behalf of the public, to protect commercial secrecy, and to provide some measure of independence from personnel and budgetary constraints as a basis for business management in the marketplace.

As the separate discussions of Privatization make clear, the characteristics of hydrologic survey activity in Canada do not correspond to those of a commercial market. The functions and responsibilities of water quantity data collection and delivery cannot be associated with a Schedule D Crown corporation as described above, and it is concluded that this form of Crown corporation should not be considered.

However, Schedules B and C corporations may provide a model. Statistics Canada provides the nearest analogue to the activities of WRB (assembly and dissemination of specified, multi-user data on a scale which is very much larger) and Statscan falls within these categories (which can be adapted to suit the circumstances at hand). Hence, it is feasible to consider continued operation of the hydrologic survey, as carried out by the WRB, under a Crown corporation similar to that under which Statistics Canada operates. Since a complete, rather than any partial, transfer of functional responsibilities is implied, transformation of the WRB into a Crown corporation would ensure the continuity, consistency and quality of the hydrologic data system.

*/ Government of Canada, Crown Corporations: Direction, Control, Accountability, Privy Council Office 1977.

The rationale for such change must be considered in terms of the balance of advantages and disadvantages which could be expected. Briefly, the apparent advantages include:

- Clear separation of all costs associated with maintaining of water quantity survey, including all management and overhead costs, currently provided through Directorate, Service and Department - this should provide for a more rationale basis for re-negotiation of cost-sharing arrangements with the provinces.
- Improved responsiveness to all provincial, client and user requirements, and avoidance of any inherent bias to satisfying in-house DOE needs as priority.
- Direct cost recovery for mission-oriented activities for all clients and users would be rationalized and, with acceptance of cost recovery, could enhance capability to respond to client/user needs.
- Somewhat more flexibility in personnel management and thus in efficiency of operations.

The major disadvantages would include:

- Less direct linkage to related natural resource survey activities (water quality, climatologic, morphologic and hydrogeologic surveys).
- Less direct linkage with the environmental protection and conservation functions of DOE, which itself is one of the major federal clients/users of water quantity data.
- Increased cost of separate management and administration currently provided at Directorate, Service and Department levels and may not be offset by corresponding reduction within the Department.

The net advantages ascribed to operating the water quantity survey under a crown corporation would presumably also apply to other national data survey activities relating to water quality, groundwater, climatology as well as to related systems of quantifying the physical environment (topographic surveys, geologic surveys and hydrographic surveys). The question arises as to whether such a change in organization should be considered for the water survey in isolation, or whether there is usefulness in considering the organization of all related physiographic survey units under similar arrangements or in closely inter-related combinations. Combining of physiographic survey units may offer additional advantages in terms of efficiencies gained through combining of common functions, increasing opportunities for personnel development under a recognized centre of excellence embracing inter-related and inter-dependent disciplines, and increase potential for cost recovery through being able to offer a more comprehensive and integrated range of physiographic interpretive analyses.

APPENDIX E

List of Individuals Circulated for Response to Alternate Organizations

	Telephone Comments	Written Comments
Mr. A.H. Abbot, Deputy Minister, Nova Scotia Department of Environment	X	X
Mr. B.B. Barnes, Deputy Minister, Department of Environment, Government of New Brunswick		X
M. M. C. Pesant, Directeur des Inventaires Ministère de l'Environnement	X	
Mr. M.R. Garrett, Director, Conservation Authorities and Water Management Branch, Ontario Ministry of Natural Resources	X	
Mr. T.E. Weber, Director, Water Resources Branch Department of Natural Resources	X	
Mr. D.L. MacLeod, Vice President of Resources Management, Saskatchewan Water Corporation	X	X
Mr. Deeprose, Director, Technical Services Division, Water Resources Management Service, Alberta Department of Environment	X	
Mr. R.D. Bailey, A/Chief, Water Resources Division, Northern Renewable Resources Directorate, Indian and Northern Affairs Canasa	X	
Mr. P.I. Campbell, Chief, Water Survey of Canada, Water Resources Branch, Environment Canada	X	
Mr. P.M. Brady, Director, Water Management Branch, Ministry of Environment	X	
Mr. G.E. Ganske, Assistant Regional Director, Renewable Resources, Yukon Region, Indian and Northern Affairs	X	
M. Lucien N. Martel, Chief, Division des programmes de qualité et de quantité de l'eau Direction des eaux intérieures Environment Canada		X
Mr. P.N. Gryniewski, Supervisor, Streamflow Forecast Centre Conservation Authorities and Water Manage- ment Branch, Ontario Ministry of Natural Resources	X	
Mr. L.J. Kamp, Regional Chief, Water Resources Branch, Inland Water Directorate, Environment Canada		X
Dr. Wasi Ullah, Director, Department of Environment, Government of Newfoundland & Labrador	X	X
Mr. R.D. McBride, Region Office, Water Resources Branch, Inland Waters Directorate, Environment Canada		X
Mr. W.F.G. Cardy, Director, Water Resources Branch, Department of the Environment, Government of New Brunswick	X	
Mr. Rory Francis, Chief, Water Resources Division, Department of Community Affairs, Government of Prince Edward Island	X	
Mr. V.M. Austford, Chief of Hydrotechnical Services, Water Resources Branch, Department of Natural Resources, Government of Manitoba		X
Mr. D. Richards, Manager, Operation Planning Service Resource Management Division, Saskatchewan Water Corporation	X	X

	Telephone Comments	Written Comments
Mr. P. Valentine, Head, Surveys Branch, Water Resources Management Services, Alberta Environment	x	x
Mr. G. Coles, Head, Water Surveys Section, Water Resources Management Services, Alberta Environment	x	
Mr. G.H. Morton, Regional Chief, Water Resources Branch, Inland Waters Directorate, Environment Canada		x
Mr. M.O. Spitzer, Regional Engineer, Water Resources Branch, Inland Waters Directorate, Environment Canada		x
Mr. C.H. Coulson, Head, Surface Water Section, Water Management Branch, Ministry of Environment		x
Mr. B. Letvak, Senior Hydrological Engineer, Surface Water Section, Ministry of Environment		x
Mr. J.N. Jasper, Senior Hydrologist, Water Resources Division, N.W.T. Region, Indian and Northern Affairs	x	x
Mr. J.L. Fowler, Head, Water Resources Branch, Inland Waters Directorate, Environment Canada		x
Mr. R. Hickman, Dept. of National Health & Welfare		x
Mr. K.A. Rowsell, Chief, Coast Engineering Department of Public Works		x
Mr. R. Lawford, Ministry of State for Science & Tech	x	
Mr. J. Kingham, A/Director General, Ontario Region, Environment Canada		x
Mr. G.H. MacKay, Director, Manitoba Affairs PFRA	x	
Dr. D. St. Jacques, Ocean Science and Surveys, Bayfield Laboratory for Marine Science & Surveys	x	
Mr. John Harris, Head, Drainage & Hydrology Section	x	
Prof. J.R. Burney, Head, Department of Agricultural Engineering, Technical University of Nova Scotia		x
Mr. J. Whiting, Environment Division, Saskatchewan Research Council	x	
Prof. M. Woo, Department of Geography, McMaster University		x
Mr. R. Eilers, Canadian Manitoba Soil Survey Unit, Research Branch, University of Manitoba		x
Dr. W. Hart, Technical University of Nova Scotia		x
Prof. J. Waterhouse, Faculty of Engineering and Applied Science, Memorial University of Newfoundland		x
Mr. J.A. Gillies, National President, Canadian Water Resources Association		x
Mr. E.M. Warnes, Conservation & Non-Petroleum Sector, Energy, Mines & Resources	x	
Mr. S.E. Gooch, Director, US Transboundary Division Department of External Affairs		x
Mr. W.I. Pugsley, AES Member, Interdepartmental Committee on Water, Environment Canada		x
Prof. G.L. Smith, Department of Geological Sciences, University of British Columbia		x

	Telephone Comments	Written Comments
Mr. C. Robinson, Head, Hydrometric Survey Section Water Resources Branch, IWD, Environment Canada		x
Mr. R.G. Sandilands, A/Regional Tidal Officer, Canadian Hydrographic Service, Fisheries & Oceans		x
Mr. J. Beausoleil, A/Director, Energy & Resource Policy Division, Department of Finance		x
Mr. H.M. Shah, Systems Development Engineer, Drainage & Hydrology Section, Ministry of Transportation & Communications		x
Ms. D. Laura, Chief, Office of International Hydrology, United States Department of Interior		x
Mr. D.A. Daugharty, Department of Forest Resources, University of New Brunswick		x
Mr. J. Spratt, Hydraulic Studies & Testing Depart- ment, Ontario Hydro	x	
Prof. G. Cavadias, Dept. of Civil Engineering and Applied Mechanics, McGill University	x	
Mr. L.A. Swick, Plans & Analysis Branch, Emergency Planning Canada	x	