Inquiry on Federal Water Policy
Research Paper # 13

THE SAINT JOHN RIVER: DETERIORATION AND RESTORATION

by

Owen V. Washburn

Washburn & Gillis Associates Limited
April 1985
Fredericton

THE INQUIRY ON FEDERAL WATER POLICY

The Inquiry on Federal Water Policy was appointed by the federal Minister of the Environment in January of 1984 under the authority of the Canada Water Act. The members were Peter H. Pearse, chairman; Françoise Bertrand, member; and James W. MacLaren, member. The Inquiry was required by its terms of reference to review matters of water policy and management within federal jurisdiction and to make recommendations.

This document is one of a series of research papers commissioned by the Inquiry to advance its investigation. The views and conclusions expressed in the research papers are those of the authors. Copies of research papers and information on the series may be obtained by writing to the Enquiry Centre, Environment Canada, Ottawa, Ontario K1A OH3.

Frank Quinn
Director of Research

Abstract

The report traces developments in the Saint John River Basin from the end of World War II to the present. The impacts of industrialization and economic development on the water resource are considered along with the efforts of governments to restore a balance of water resource uses. Recommendations are made for the continuing role of federal and provincial governments in management of the water resources of the Saint John River Basin.

Résumé

Ce rapport retrace l'évolution du bassin de la rivière Saint-Jean de la fin de la deuxième guerre mondiale jusqu'à nos jours. Les effets de l'industrialisation et du développement économique sur la ressource eau sont examinés, de même que les efforts faits par les gouvernements afin de redonner un équilibre aux différentes utilisations de l'eau dans ce bassin. Des recommandations sont faites quant au rôle que les gouvernements fédéral et provincial doivent continuer à jouer dans la gestion des ressources en eau du bassin de la rivière Saint-Jean.

TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

The Saint John River is an important physiographical feature in the Province of New Brunswick and in the context of the Atlantic seaboard. Its watershed comprises thirty-eight percent of the area of the Province of New Brunswick. The boundary between Canada and the United States for approximately 212 km is formed by the Saint John River. Thirty-six percent of the river's watershed area is in the State of Maine. Thirteen percent of the watershed is in the Province of Quebec and the remainder (fifty-one percent) is in New Brunswick (Saint John River Basin Board, 1975). (See Figure 1)

Like many large rivers, the Saint John has provided an attraction for human settlements and industries. These have contributed to the inevitable resource use conflicts. An obvious example is the conflict between hydro-electric power dams and the migratory requirements of anadromous fish such as the Atlantic salmon. The resolution of water use conflicts is an essential goal of water management and must be considered in both planning and regulation. Regulatory controls, related to both land and water-based activities, are available to governments to manage water use. Regulatory authorities with jurisdiction over water uses in the Saint John River Basin are: various municipalities, the provincial governments of New Brunswick and Quebec, the State of Maine, and the national governments of Canada and the United States.

Planning studies, as well as regulatory efforts, have often been coordinated through inter-governmental committees. In 1969, the Atlantic

WASHBURN & GILLIS ASSOCIATES LTD.

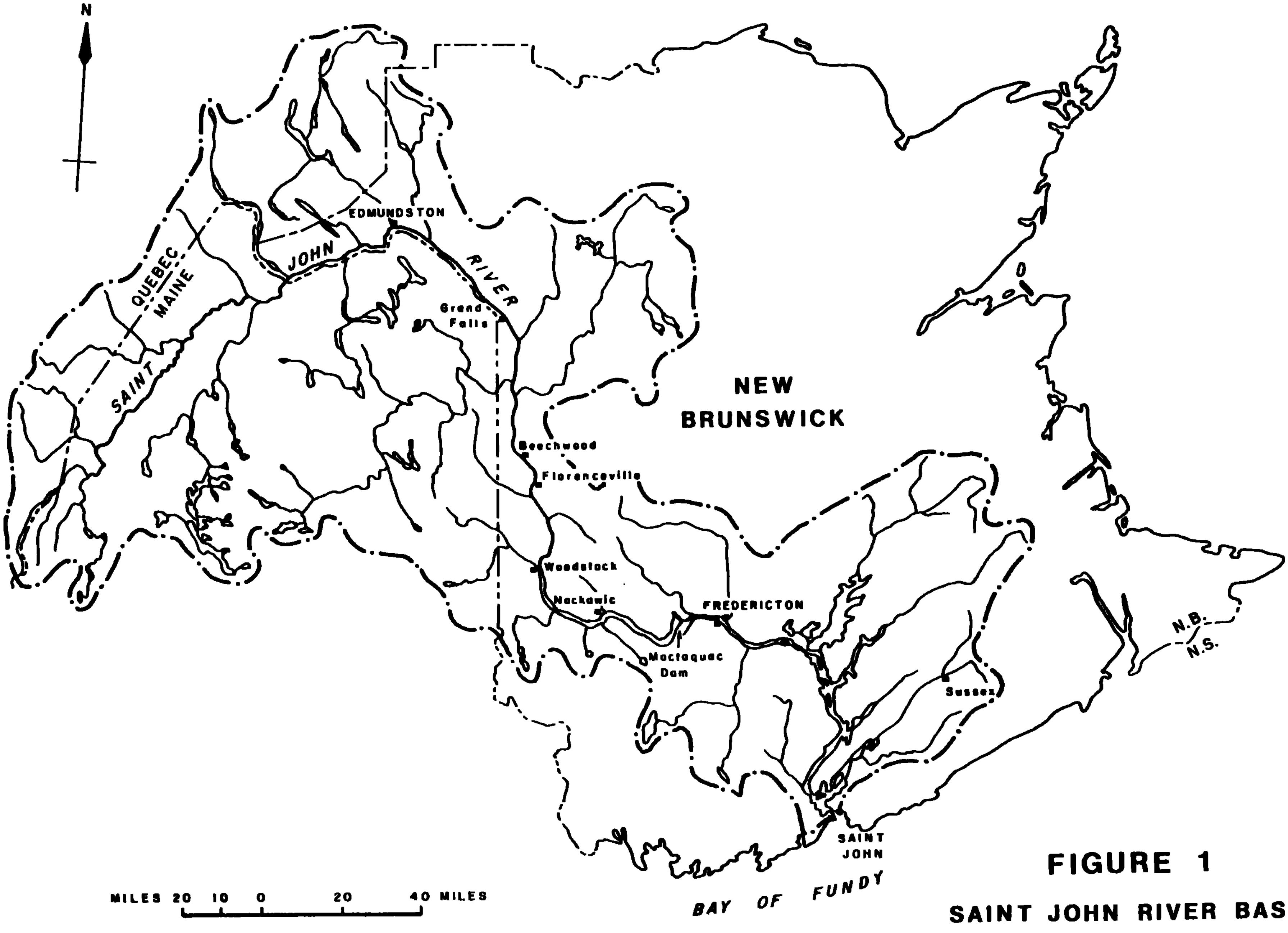

FIGURE 1

SAINT JOHN RIVER BASIN

Development Board, an agency funded by the federal and Atlantic provincial governments, prepared a study on the water resources of the Atlantic Region which included a report on the Saint John River. This report identified the potential for development and some of the problems of water quality degradation. A comprehensive river basin planning exercise was undertaken over the period 1970-1974 by the Saint John River Basin Board. The board was a joint undertaking of the federal government and the Province of New Brunswick. In addition to a final report which identified issues and presented a framework for management, a number of sector reports were published. These provide an important information source of the physical, biological and socio-economic resources of the river basin up to 1973.

In addition to these studies, several inter-governmental committees have been active, and are still active, in coordinating regulatory and planning activities (e.g., The International Saint John Water Quality Committee, The Saint John River Basin Hydrology Committee, The Canada-New Brunswick Flood Damage Reduction Steering Committee).

The present paper has been commissioned by the Inquiry on Federal Water Policy as a case study on the Saint John River, its degradation and restoration from the post-World War II period up to the present. This study was commissioned in order to provide a case history of a river basin in Canada which has experienced developmental pressures resulting in water quality and quantity stresses but which has at least partly recovered through co-operative inter-governmental and government-industry programs.

The objectives of the paper are to review stresses on the water environment created during postwar economic development of the Saint John Basin; and to assess progress of and remaining needs for intergovernmental co-operation in restoring a satisfactory balance among water uses.

The statement of work prescribed in the contract is as follows:

1. Review post-World War II developments in the Saint John Basin, with emphasis on forestry, agriculture, energy projects, resource-processing industry and growth of urban communities and their impacts on the basin's water resources, e.g., flow control, erosion and sedimentation, waste discharges, flooding, aquatic habitats;
2. Describe the major intergovernmental programs, with an emphasis on the value of river basin planning, which have focussed on Saint John waters and water use issues over the past two decades, including those of the Atlantic Development Board, Saint John River Basin Board, International Saint John Water Quality Committee, Saint John River Basin Hydrology Committee, and Canada-New Brunswick Flood Damage Reduction Steering Committee, and assessing generally what has been achieved and what issues remain outstanding; assessing in particular why certain recommendations were not carried out;
3. Assess in particular the progress of clean-up resulting from government-industry negotiations, court actions and (community) assistance programs throughout the Canadian portion of the Basin; and the impact of presently untreated wastes, e.g., Florenceville, Edmundston.
4. Recommend measures for improving water management or acceleration remedial programs in the Saint John Basin which bear upon federal responsibility and performance.

Although the Saint John River Basin is in two provinces, New Brunswick and Quebec, as well as the State of Maine, this paper concentrates on the New Brunswick portion of the Basin without ignoring interprovincial or international concerns. There are several practical reasons for this approach. Planning studies such as that of the Saint John River Basin Board have focused on the New Brunswick portion of the river. Much of the economic data is aggregated at a provincial level. While this allows meaningful extrapolations to be made to the Basin in New Brunswick, a similar extrapolation would not be meaningful in Quebec since the Basin represents such a small part of that province. A significant portion of the Basin is in Maine. While water quality of tributaries entering New Brunswick from Maine has been considered, regulatory and planning aspects which would affect these tributaries are outside the mandate of the Government of Canada and, therefore, have not been considered except in the context of international committees.

1.1 Physical Description of the River

The Saint John River is approximately 700 km long. It flows from Little Saint John Lake on the boundary between Maine and Quebec to the point where it empties into the Bay of Fundy at Saint John, New Brunswick. Its watershed encompasses 54,900 sq km. The headwaters of the river are in the Notre Dame Mountains of Eastern Quebec and the Chaleur Uplands of Northern New Brunswick and Northern Maine. Its highest point of elevation is about 480 m above mean sea level at Little Saint John Lake. The river bed reaches mean sea level just above Fredericton, 80 km from its mouth. Major tributaries of the Saint John River include the Aroostook (drainage 6,275 sq km), the Tobique (drainage 4,325 sq km), the Salmon (drainage 3,885 sq km), the Allagash (drainage 3,260 sq km, and the Madawaska (3,050 sq km).

The mean annual precipitation varies from about 89 cm in the headwaters to about 140 cm near the Bay of Fundy. In the northern and western portions of the Basin annual snowfall is 250 to 350 cm, and in the southeast it is 180 to 200 cm. The annual average discharge of the Saint John River, measured at Pokiok gauging station, is 728 m^3/sec with a maximum of 1,149 m^3/sec and a minimum of 467 m^3/sec having been recorded. Although the timing of high and low flows varies from year to year, high streamflows or floods usually occur in April or May. There are typically two usual periods of low flow: late summer (August to October) and mid-winter (February).

1.2 Historical Uses of the River

Before the arrival of Europeans, the Saint John River was used by the native Indian population as a means of transportation, as well as an important source of food through its support of an abundant fish population. The floodplains of the river provided areas for settlement, agriculture and hunting. For these same reasons early European settlers concentrated their activities along the river. By the end of the seventeenth century the Acadians had begun settling the lower Basin between Fredericton and Saint John. The uses of the river system by early Europeans were not markedly different from those of the indigenous population, except that agricultural activity was expanded and water was used to power grist mills. With the fall of Acadia in 1758 the French settlers were replaced by New Englanders.

Up to 1783 their numbers remained small and their uses of the river were similar to the Acadians.

The intensive settlement of the Saint John River Basin began in 1783 with the arrival of the United Empire Loyalists at the close of the American War of Independence. By 1806, the population of New Brunswick had increased to 35,000 and many of the new arrivals settled in the Saint John River Basin. Not only did numbers increase, but settlement expanded up the river. Natural population increase and extensive immigration, particularly from the British Isles, increased the population by about forty times over the next 150 years (Statistics Canada, 1984). The population of the New Brunswick portion of the Basin was 160,000 by 1901, and 231,000 by 1951 (Saint John River Basin Board, 1975).

Water-driven mills probably created the first impacts on the river system's natural environment, since they resulted in many small tributaries being dammed thus blocking fish migration. With the creation of stable settlements the importance of the river as a transportation system greatly increased. The river was, in fact, the most important means of transportation in the Basin until road and railway systems were created in the nineteenth century.

By the end of the 17th century, forestry had become an important economic activity in the Basin. New Brunswick white pine became a source of spars and masts for the French navy (as they did for the British navy two generations later) (Tweeddale, 1974). Stream driving, a part of early forestry operations, produced the first widespread impact on water quality. Bark and wood from log holding areas also contributed to the physical degradation of aquatic habitat. Stream driving on the Saint John River system continued on the main stem until the construction of Beechwood Dam, and on some tributaries (for example, the Nashwaak) at least until 1969 (T. Fellows, personal communication, 1985).

Waste disposal was not a concern of early settlers. The dilution and disposal of domestic wastes were not important uses of river waters until communities began collecting and disposing of their sewage at a central point. Early waste disposal practices did, however, undoubtedly lead to the contamination of groundwater. With the development of process industries, e.g., pulp and paper mills, the disposal of industrial wastes became an important determinant of surface water quality.

The first use of the Saint John River System for hydro-electric power generation was in 1904 when a station was constructed on the Meduxnekeag River to serve the town of Woodstock. Other plants were constructed in the early part of this century at Tinker Falls, Squapan and Caribou on the Aroostook River in Maine, and on the Madawaska and Green Rivers in New Brunswick. The first hydro-electric facility on the main stem of the river was built at Grand Falls in 1928 (Sigvaldason, 1975).

1.3 Post World War II Conditions in the Basin

1.3.1 Development in the Basin

In 1951 the population in the New Brunswick portion of the basin was 231,000. Of this number, 42,000 lived in northwestern New Brunswick

(Grand Falls and above), 39,000 lived between Grand Falls and Fredericton, and the remainder lived in Fredericton and below, including the city of Saint John (Saint John River Basin Board, 1975). The economy of the middle and upper Basin was dominated by forestry and agriculture. In Edmundston, for example, the main industry was the Fraser Companies Ltd. pulp and paper mill. Many other communities, such as Plaster Rock, depended on sawmills. Although the food processing industry was not built up until the 1950's, agriculture provided the economic base for many of the communities in the Basin.

The only area in the Basin for which mining was a significant economic activity was the Minto-Chipman area, where coal was mined. The cities of Fredericton and Saint John were major service areas in the southern portion of the Basin. Saint John was also the most important manufacturing area in the Basin.

1.3.2 Waste Loading and Water Quality

At the end of World War II, the awareness of environmental problems, including the impacts of releases of untreated domestic and industrial wastes on aquatic systems, was not as well developed as it was to become in the next few decades. Therefore, waste loadings were not well documented, nor were extensive water quality surveys made.

The first widely published water quality survey on the Saint John River was undertaken in 1960 (Department of National Health and Welfare Canada, 1961). An indication of the state of pollution of the river at that time is shown in the following which is taken from the synopsis of their report.

> "This report indicates that conditions, resulting from pollution in the international reach of the river between Edmundston and Grand Falls, represent gross pollution. The effects of chemical pollution in this section produced average values of dissolved oxygen below the "objective" of 5 p.p.m. and minimums of 0.0 p.p.m. which resulted in fish kills which were observed and recorded. Sewage, contributed to the river, creates grossly polluted conditions below each major centre of population. A physical and chemical pollution problem existed at East Florenceville due to waste discharges from a food-processing plant."

In 1946 similar conditions to these would be expected to have existed for the reach from Edmundston to Grand Falls and immediately downstream of major municipalities. Below East Florenceville water quality problems probably did not occur before the opening of the McCain Foods Limited plant in 1957.

1.3.3 Flow Regulation and Hydrology

At the end of World War II there was only one hydro-electric plant (Grand Falls) on the main stem of the river. In the Canadian portion of the basin there were also small hydro-electric developments on the Madawaska River at Edmundston (2,000 kw capacity) and on the Green River at Second Falls (1,200 kw capacity) (see table 1.1 from Sigvaldason, 1975). In Maine there were dams at Tinker and Caribou. Montreal Engineering Company Limited (1969) lists 88 dams on the New Brunswick portion of the Saint John River. Approximately half of these were in existence in 1946. Most of these were small dams on tributary streams which were used for recreational purposes or forestry operations. Very few, however, had fish passage facilities.

2.0 DEVELOPMENT IN THE BASIN

In his book on Environmental Management MacNeill (1971) states,

> "The genesis of environmental deterioration is to be found in increased population, urbanization, industrialization and technological innovation and their derived products."

All of these factors have contributed to pressures tending to degrade the water quality of the Saint John River system and place limitations upon the uses of the resource. As development increased, more and more wastes entered the water courses and problems with river flooding became more acute particularly on developed river floodplains In the following sections, development activities in the Basin, particularly in regard to interactions with the river water quality and flow regimes, are described.

2.1 Changes in Population, Economic Activity and Land Use

The post-war boom years in North America were reflected in changes in economic activity in the Saint John River Basin. From 1951 to 1971, the population of the Basin increased from 231,000 to 299,000, an increase of nearly 30 percent (Saint John River Basin Board, 1975). During the same 20-year period, the population of New Brunswick increased by 23 percent and Canada as a whole by 54 percent (Statistics Canada, 1981a).

In Canada, since World War II, the population has shifted from rural to urban. In 1951, for example, 62 percent of the population was urban whereas in 1981, 76 percent was urban (Statistics Canada, 1981b). During the same period, New Brunswick has shifted from 42 to 51 percent urban. Changes in the population of municipalities in the New Brunswick portion of the basin are shown in Table 2-1. The figures are difficult to interpret because of amalgamations and boundary changes, nonetheless the data show that some municipalities have experienced little or no growth (e.g., Hartland) while others, such as Fredericton, have experienced more substantial growth. In fact, most of the growth has been centred in the larger urban centres of Saint John and Fredericton.

TABLE 2-1

POPULATION CHANGES IN MUNICIPALITIES IN THE BASIN

(Statistics Canada, 1984)

Municipality	Population 1951	Population 1981
Edmundston	10,753	12,044[1]
St. Leonard	1,419	1,566
Grand Falls	2,365	6,203[1]
Hartland	1,000	846
Woodstock	3,996	4,649[1]
Fredericton	18,170[2]	43,723
Oromocto	661[3]	9,064
Sussex	3,224	3,972[1]
Saint John	50,779	80,521[1]

Notes:
1 Includes boundary change
2 Marysville added to 1951 figure
3 Figure for 1956 used for Oromocto

Urbanization tends to create pollution problems by concentrating waste loadings at outfalls rather than dispersing the waste as would be the case, for example, with septic tanks. More paved streets and parking lots also change the characteristics of run-off and contribute to run-off related water quality problems.

Related to changes in population were changes in economic activity. Table 2-2 shows some comparative statistics for New Brunswick for the period covered by this report. Similar trends would be expected for the basin.

TABLE 2-2

INDICATORS OF ECONOMIC ACTIVITY SINCE WORLD WAR II

Indicator	Beginning of Period	1983
Employment	163,000[1]	247,000
Salaries and Wages (thousands of dollars)	201,112[1]	3,870,200
Domestic Exports (thousands of dollars)	11,760[2]	1,667,680
Gross Provincial Product (millions of dollars)	505[3]	6,630[4]

Notes:
1 in 1948
2 in 1970
3 in 1951
4 in 1982

With the exception of the cities of Fredericton and Saint John, the economy of the Basin is based on the production and processing of forestry and agricultural products. Development in these sectors has had a significant impact upon the Basin.

2.1.1 Development of the Forest Products Industries

Several important trends have characterized the evolution of the forest industries in New Brunswick during the past thirty years. These trends, which have a complex cause-and-effect relationship are:

i) increase of the importance of pulp and paper production in relation to the production from sawmills;

ii) the expansion of wood-processing facilities with the attendant requirement for greater annual harvest from the forest;

iii) the mechanization of forest harvesting including clear-cutting;

iv) the change of log transportation methodology from stream driving and booming to the use of an extensive forest road network;

v) extensive pest control operations; and

vi) the development of reforestation programs.

The shift in emphasis in the New Brunswick forest industries from sawlogs to pulp and paper production has been going on for most of this century. At one time there were more than 600 sawmills in New Brunswick with the highest recorded production figure being in 1915. By 1971, there were fewer than 150 sawmills, whereas the number of paper mills had increased to 11. At that time the annual value of pulp and paper products was about $190,000,000 per year compared to $50,000,000 for the products from sawmills (Tweeddale, 1974). In the past 15 years, the sawmill industry has made a comeback to the point where paper and allied products were 70 percent of the value of forest products (Watson, 1983); down from the 79 percent in 1971 as reflected in the above figures. Similar statistics are not available for the Basin, however, a comparable shift likely took place.

The shift of product emphasis in the forest industry has had significant water management implications. In terms of processing, the waste products from sawmill operations are solid (bark, sawdust and wood residues) rather than aqueous pollutants. Sawmill operations can, however, lead to water quality problems. The two main sources of such problems are hot pond effluents and leachate from log storage and solid waste storage areas. Before environmental awareness was as prevalent as it is today, sawdust and other solid wastes were sometimes disposed of directly in watercourses causing severe local water quality problems and physical degradation of habitat. Sawmills were also often associated with dams which prevented fish migration, particularly on small tributary streams.

Pulp and paper mills are large users of water and add significant pollution loads to the environment unless effective wastewater treatment is used. Even a modern kraft mill, with a high degree of water reuse, can be expected to discharge 15,000-25,000 gallons (68,000 - 114,000 L) of effluent per ton of product with typical BOD[1] and suspended solids loadings of

[1]BOD (Biochemical Oxygen Demand) - the amount of oxygen consumed in the biochemical oxidation of organic matter present in water. It is usually measured over a five-day period and is sometimes written as BOD_5.

11 lb/ton (5.5 kg/tonne)(Bruley, 1974). From the same paper, Table 2-3 shows typical waste loadings from various pulp and paper effluents.

TABLE 2-3

BOD LOADS OF SOME PULP AND PAPERMAKING EFFLUENTS

Type of Effluent	Five-Day BOD lb/ton (kg/tonne)
Kraft Pulp	25 - 50 (12 - 25)
Groundwood Pulp	15 - 25 (8 - 12)
Sulphite Pulp (no recovery)	400 - 600 (200 - 300)
NSSC Pulp	250 - 450 (120 - 220)
Bleaching	12 - 200 (6 - 100)
Fine Papers (bond)	20 - 40 (10 - 40)
Coarse Papers (corrugating)	25 - 60 (12 - 30)
Newsprint	10 - 20 (5 - 10)

Source: Bruley, 1974.

In the conspectus of the report of the New Brunswick Forest Resources Study, the rapid increases in forest products processing capacity and its impact on wood harvesting is documented (Tweeddale, op. cit.). Up to 1968, man was harvesting only about one-third of natural annual growth of wood in the province. In the period 1972 to 1975, mill capacity expansion increased the requirement for wood from 6.2 million cubic metres to 11.9 million cubic metres. This figure exceeded the allowable cut to maintain stocks when consideration is given to the loss of wood due to natural predation and disease. This trend continued throughout the 1970's and early 1980's. Watson (op. cit.) estimated that in 1983 the production capacity of the forest industry was 3.1 million cunits[1] per year of softwood, whereas the maximum sustainable annual yield, including consideration of forest protection and silvicultural activities, was estimated to be 2.5 million cunits per year of softwood.

The expansion of the forest processing industry has had significant implications on water quality in two ways: the direct impact of greater waste loads to receiving waters and the impacts of more intense forestry operations. When only a fraction of the annual growth of wood was required, traditional forestry practices were adequate to meet demand. With the demand from processing industries exceeding the sustainable annual yield, and with much of the forest in a mature state, the use of mechanized harvesting as well as silvicultural and forest protection programs became imperative.

The mechanization of forestry operations affected the intensity of cutting activities (clear-cutting versus selective cutting), the harvesting techniques (fellers, bunchers and skidders versus chainsaws and horses), and required the provision of an adequate forest road system to handle heavy equipment and large logging trucks. Potential impacts of forestry

---

[1]A cunit is equivalent to 100 cubic ft (or 2.8 cubic metres) of solid wood, measured in the round.

operations on the aquatic environment include: increases in siltation, water temperature, nutrient loadings and discharge peaks. Other concerns include scouring of stream beds and loss of allochthonous organic material.

Impacts are difficult to quantify and the results are sometimes contradictory. For example, Welsh et al. (1977) found that streams in clear-cut watersheds had 17 percent fewer trout, 200 percent more sculpins (Cottus cognatus) and 26 percent fewer benthic organisms than control streams. In a different study, Englert et al. (1982) who reported work on the effects of logging on salmonid populations found that areas sampled downstream of clear-cutting and bank modification did not have significantly lower biomass[1] than control areas, while areas downstream of two stream crossings were found to have significantly lower biomass of salmon.

The Nashwaak Experimental Watershed Project was set up in 1970 with the principal objective of determining the effects in a forested watershed of:

1) the prevailing clear-cutting method on water yield, regime and quality, on aesthetics, on wildlife, and on forest and stream productivity;
2) fertilization with a nitrogen-source fertilizer on forest and stream productivity; and
3) spraying with insecticides on stream productivity.

---

[1] In Englert et al. (1982), biomass refers to the total weight of salmonids in a given area.

Three watersheds were used in the study. One watershed was treated with fertilizer in 1975 and a second was clear-cut from May 1978 to March 1979. The third watershed was used as a control.

Studies have been ongoing since the inception of the project. Some of the results reported to date (Powell, 1983) are:

1) Minor increases to suspended sediment loads were found to persist in the clear-cut for up to three years after clearcutting.
2) Elevated nutrient levels in water were found in the clear-cut watershed but were thought to be too small to adversely affect plant and animal habitats.
3) Distinct changes in the stream plant community composition were found in the clear-cut watershed.

None of these changes were considered to produce major impacts at this stage of the study.

2.1.2 Development of Agriculture

In the post-war years there has been a general decline in the amount of land farmed as the population moved from rural to urban centres. Between 1951 and 1971, although in the Basin the average farm size increased from 64 hectares to 107 hectares, the area farmed decreased by 53 percent and, in the province as a whole, there was a 62 percent decrease (New Brunswick Department of Agriculture and Montreal Engineering Company Ltd., 1974). This shift to fewer, but larger farms, is emphasized by the following: small farms (farms with sales under $1,200) in 1961 represented

56.4 percent of all farms, and 8.8 per cent of agricultural sales, while in 1971 these farms were 36.4 per cent of all farms and had only 1.9 per cent of total sales (New Brunswick Department of Agriculture and Montreal Engineering Company Ltd., op. cit.). The swing to larger farm size, more specialization and commercialization necessitated changes in management. Along with increased mechanization, there has been an increase in chemical use (pesticides and fertilizers) to produce greater crop yields.

Chemical fertilizers were used in excess between the 1940's and mid-1960's. By the late 1960's, it was realized that more was not necessarily better and that too much fertilizer could reduce crop yields. Farmers began to reduce amounts used, and by 1976 a balance had been reached (Parks, 1977). However, concerns remain about the amount of fertilizers used, and how runoff and seepage from agricultural land may affect the nutrient levels in surface and groundwater. A watershed study to monitor nutrients in samples taken from the Basin between April 1971 to June 1972 indicated that increased nutrient levels were found in ground and surface waters from areas of increased agricultural activity (New Brunswick Department of Agriculture and Montreal Engineering Company Ltd., op. cit.). It was also noted that in areas of increased agriculture there was an increase in population and other activities which could have had an effect on nutrient levels in the water supply.

In the amount of pesticide per acre used, potatoes rank third behind strawberries and apples. However, because of the large amount of farmland used for growing potatoes in the province, potato growers actually use more pesticide. The amount used will likely remain close to the present level because in potato production, crops are not usually rotated and the nutrients need to be replaced each year. In New Brunswick between 1970 and 1975, the amount of fertilizer used on farmland ranged from 54,000 to 62,000 tonnes per year. Approximately 70 percent of this was used in the Basin counties of Madawaska, Victoria and Carleton which are the main potato-growing areas of the province (Parks, op. cit.).

The Water Quality Branch of Environment Canada, Moncton, regularly tests samples from the Basin for pesticides. Elevated levels were found particularly after intense rainfall (because of runoff) but were below acute lethal levels reported in the literature (New Brunswick Department of Agriculture and Montreal Engineering Company Ltd., op. cit). One of the more important environmental concerns associated with the use of some pesticides (particularly chlorinated hydrocarbons) is their persistence in the environment. In 1976, Eldrin and DDT and their breakdown products were found in sampling, even though Eldrin had not been used since 1972 and DDT had been banned before that (Parks, op. cit.).

In the past there have been agriculture pesticide-related fish kills. These resulted from overspraying, or overfilling of equipment, or incorrect disposal and cleanup of pesticide containers and spray equipment. However, farmer education has reduced these incidents to the point where they rarely occur (Wilson et al., 1980).

Large-scale livestock feed lot operations, henneries and piggeries began in the mid-1950's and with it came manure management problems. Before the introduction of relatively low-cost chemical fertilizers, manure was used to increase soil fertility. With the animal waste all in one area, there was reduced incentive for the farmer to use it as a fertilizer (Parks, op. cit.). Unless the manure is properly used or treated, there is a concern that the soil will not be able to assimilate the nutrients and bacteria resulting in seepage to groundwater and runoff to streams, not to mention the odour problem.

Soil erosion in agriculture is always a concern as it will occur to some extent on farmed land with a slope greater than 3 percent (New Brunswick Department of Agriculture and Montreal Engineering Company Ltd., op. cit.). Farming occurs on steep slopes in the Grand Falls area, and erosion is a problem. Increased stone removal, increased farm size (where longer, continuous slopes are planted), decreased crop rotation (noted particularly when farming potatoes) have all increased the erosion problem (New Brunswick Department of Agriculture and Montreal Engineering Company Ltd., op. cit.). Bank erosion and flooding also contribute to the problem. Individuals have tried to stabilize banks on their property, but because of the dynamics of river systems, this usually results in more problems downstream. Erosion of agricultural land depletes the land of important topsoil and may result in increased sedimentation in streams.

2.1.3 Development of Commercial Fisheries

The commercial fishery in the Basin is located mainly in the Saint John estuary, with some smaller operations in the middle and upper basin (Meth 1973, 1974). Atlantic salmon (*Salmo salar*), American eel (*Anguilla rostrata*), gaspereau (*Alosa, pseudoharengus*), and shad (*Alosa sapidissima*) have traditionally represented the major catches of commercial fishermen. These species, except American eel (which is catadromous[1]) are anadromous[1] and must migrate upriver to spawn.

The Atlantic salmon was once the most valuable fishery in the Saint John, but the fishery has declined in recent years because of reduced stocks and imposed quotas (Dadswell _et al_., in press). The decline coincided with the decline in the sports fishery in the 1950's and again in the late 1960's (see Table 2-4). The New Brunswick commercial salmon fishery was closed from 1971 to 1980. When the fishery opened in 1981, stringent quotas and restrictions were imposed. Landings have decreased since 1981 and the status of the fishery for next year is in question.

The American eel has become an important species for the commercial fishery. Between 1967 and 1971, landings increased to over 6,800 kg (Meth, 1974) and by 1983 average landings per year were 50,000 kg (Dadswell _et al_. _op_. _cit_.)(see Table 2-5).

The shad fishery was large in the past, but has declined during the last 20 years. From 1947, until Beechwood Dam was build, shad were fished in the middle basin, but this ended with the construction of the dam. The decline may also be partly due to the alteration of habitat caused by the construction of the Mactaquac Dam (Meth, _op_. _cit_.).

---

[1]Catadromous fishes mature in freshwater and migrate seaward to spawn in salt water. Anadromous fishes reach sexual maturity in salt water and migrate to freshwater to spawn.

TABLE 2-4

TOTAL ATLANTIC SALMON LANDINGS FOR SAINT JOHN RIVER

Year	Sport Landings (number)	Commercial Landings ($kg \times 10^3$)
1951	1200	90
1955[1]	650	36
1960	800	64
1965	2500	100
1970[2]	125	36
1975	850	>3*
1980	1750	>3*
1981	425	41

Source: Dadswell, *et al*. in press (taken from Fig. 53)

Notes:
1 Spraying for spruce budworm began in 1953; Tobique Dam built in 1954; Beechwood Dam built in 1957
2 Mactaquac Dam built in 1967
* This catch represented incidental catch in other fisheries.
The Atlantic salmon commercial fishery in the Saint John River was closed between 1971 and 1980.

TABLE 2-5

EEL LANDINGS IN SAINT JOHN ESTUARY

Year	kg x 10^3
1962[1]	9
1965	7
1970	70
1975	52
1977	98
1980	23
1981	24

Source: Dadswell *et al*. 1983 (taken from Fig. 51)

Notes:
1 First year of any sizeable catch

Like the shad, gaspereau were fished in the middle basin until the Beechwood Dam was constructed. The fishery was largely located in Saint John harbour until 1965, and has since moved to the lake-like sections of the estuary (Dadswell *et al*., *op*. *cit*.). Between 1970 and 1971 gaspereau landings increased dramatically, and became the most valuable fishery in the estuary (Meth *op*. *cit*.). Landings in the fishery now average 2,000 MT/year (Dadswell, *et al*., *op*. *cit*.)(see Table 2-6).

TABLE 2-6

GASPEREAU LANDINGS IN SAINT JOHN ESTUARY AND HARBOUR

Year	kg x 10^6
1947	1.3
1950	0.8
1955	0.9
1960	0.4
1965	2.8
1970	3.7
1971[1]	6.5
1975	1.8
1980	1.1
1982	0.8

Source: Dadswell *et al*. in press (taken from Fig. 52)

Note:
1 ban on commercial fishing for Atlantic salmon

2.1.4 Development of Tourism and Recreation

Tourism and recreation uses of the basin since World War II have provided both social and economic benefits. Jobs in the tourist industry represented 5% of the employed labour force in New Brunswick in 1981. Increased leisure time has allowed both residents and non-residents to enjoy the area. The following historical information was taken from "A Tourist Sector Strategy for New Brunswick" (Anonymous, 1982).

In the past twenty years the tourist trade has been variable. During the 1960's the number of people visiting the province increased by 10% a year. This increase slowed in the early 1970's and peaked in 1973 when more than 3.4 million tourists visited New Brunswick. Between 1974 and 1976 the number of visitors to New Brunswick declined and remained low until 1977. From 1977 to 1981 there was growth, and it is expected that this growth will continue. Table 2-7 gives tourist spending between 1971 and 1981. The figures given in 1978 dollars clearly illustrate the decline in the mid seventies and the gradual increase to 1981.

TABLE 2-7

Year	Tourist Spending $ Millions	Tourist Spending 1978 $ Millions
1971	111.4	200.1
1972	115.0	197.1
1973	125.0	199.9
1974	128.9	181.6
1975	140.0	173.7
1976	140.0	159.7
1977	170.0	181.1
1978	191.5	191.5
1979	225.0	202.0
1980	260.0	213.0
1981	290.0	214.0

Source: Anonymous, 1982

Another more recent trend observed is the shift to tourist travel during the off season. Traditionally the greatest tourist activity has been in July and August, where in 1971 67% of non-resident travel occurred at this time. In 1981, 54% of non-resident travel was during the summer, and an increase in activity during the fall was noted.

The basin is suited to various recreational activities, and is used by both resident and non-residents. New Brunswick residents are by far the more frequent users of recreational boating which includes yachting, sailing and power boating. In the basin, boating is concentrated in Kennebecasis Bay, Long Reach, Belleisle Bay, Washademoak Lake, Grand Lake and the Mactaquac headpond (Hustins, 1974). Canoeing is another popular recreational activity. There are a total of thirty canoeable waterways in the basin, with six rated as excellent, fourteen rated as good, and 10 rated as fair to marginal (Anonymous, 1970). Swimming activity in the province is located mainly on developed beaches with the majority of swimmers opting for inland tributaries and lakes rather than the main stem of the Saint John River (Hustins *op. cit.*). Other uses in the basin, called "appreciative recreation uses" by Hustins (*op. cit.*) include bird watching, photography, hiking, camping and site seeing.

Sports fishing occurs throughout the basin. The species most sought by the New Brunswick angler belong to the salmonid family, particularly brook trout (*Salvelinus fontinalis*) and Atlantic salmon (*Salmo salar*). Other sport fishes found in the basin include: landlocked Atlantic salmon, small mouth bass (*Micropterus dolomieui*), lake trout (*Salvelinus namaycush*), striped bass (*Morone saxatilis*), white perch (Morone americana), yellow perch (Perca flavescens) and chain pickerel (Esox niger). These species are generally not as exploited as they could be, however, events such as bass fishing tournaments have helped spark interest. In 1975 the number of smallmouth bass angled was 34,228, in 1980 this increased to 160,902 (Hooper, 1979; 1983).

The brook trout is by far the principal sports fish in the basin. Between 1957 and 1966 the number of brook trout angled averaged 205,454 per year (A.P.W.R.S fish resources data - Saint John River, September 1967 as reported in Montreal Engineering Company Ltd., 1969). In recent years the number of fish angled has increased from 199,000 fish in 1970, to 1,228,264 fish in 1975 and to 1,810,860 in 1980 (Hooper, 1974; 1979; 1983).

The number of Atlantic salmon angled in the basin has varied from year to year. Between 1951 and 1966 the catch averaged 2604/year (Montreal Engineering Company Ltd., ibid.) There was a decline in numbers of fish caught in the 1950's during the time when forest spraying for spruce budworm was first initiated, and the Tobique and Beechwood Dams were constructed. In 1971 the population collapsed probably due to the negative impact of the Mactaquac Dam (Hooper and Ayer, 1984). Landings increased after this crash, likely due to the smolt production hatchery and fishway at Mactaquac, which helped mitigate the negative effects of the dam. These efforts, along with the federal ban on commercial salmon fisheries in New Brunswick rivers (from 1972 to 1981) helped to trigger the interest of the salmon anglers to the extent where angling effort for Atlantic salmon has increased by 78% between 1965 and 1983 (Hooper and Ayer op. cit.). In 1978 there was a sharp decline in the number of salmon angled. This was thought to result from high mortalities from unknown causes on the high sea. In August, 1979, a policy was established whereby only grilse could be killed (Hooper, Dept. of Natural Resources, personal communication). The last peak in the salmon population was in 1980, when approximately 27,000 salmon were transported over Mactaquac (P. Cronin, Dept. of Natural Resources, personal communication). In 1983 the population crashed again and the "grilse only" regulation along with "hook and live release" for large salmon was reinstituted from the start of the 1984 salmon angling season. It is expected that this law will be in force again in 1985. Commercial fisheries for salmon were also curtailed in 1984.

2.2 Water Quality

2.2.1 Background Water Quality

The waters of the Saint John River have been described as being very soft with moderate to high colour and quite low alkalinity (Sprague, 1964 and Montreal Engineering Company Limited, 1969). Table 2-8 gives the range of values found by Sprague (op. cit.) in three surveys in 1959.

TABLE 2-8

BACKGROUND WATER QUALITY

	UNITS	RANGE
Colour	colour units	40 - 120
Hardness	mg/l	29 - 67
Alkalinity	mg/l	17 - 53
pH	pH units	70 - 8.0

While these values may be influenced by pollution in some reaches of the river, they probably give a good representation of background water quality. Other parameters such as dissolved oxygen and nutrient concentrations show a far greater influence of pollution loadings. Heavy metals in the river are mainly determined by the bedrock geology of the basin. In many instances they may be higher than recommended standards. Table 2-9 compares typical values from Montreal Engineering Company Limited (1975) with Water Quality Guidelines for the protection of aquatic life.

TABLE 2-9

TYPICAL LEVELS FOR METALS

Parameter	Medium Level Found in Saint John River	Guideline
	(all values in mg/l)	
Cadmium	0.001	0.002
Copper	0.015	0.005
Lead	0.05	0.03
Zinc	0 to 0.03	0.03

Groundwaters in the basin are generally of good chemical quality although they are more mineralized than surface waters. (Montreal Engineering Company Ltd. op. cit.). Since the quality at any one place depends upon the bedrock geology at that place, differences in groundwater quality can occur.

High levels of iron and manganese occur in waters from various places throughout the basin. High chlorides are found in a few areas: near Edmundston in the upper basin, south of Fredericton and in the Sussex-Hampton area.

2.2.2 Changes in Surface Water Quality

Early water quality surveys on the Saint John River identified serious pollution problems. Sprague (1964) found low dissolved oxygen conditions in the reach between Edmundston and Grand Falls with levels of 0.5 mg/L at St. Leonard and 1.7 mg/L in the Grand Falls headpond being recorded in August 1960, which was a period of drought and therefore very low flows. The Department of National Health and Welfare also surveyed the river in 1960 and found similarly low levels of dissolved oxygen with some of them occurring at average flow conditions. Depressed dissolved oxygen levels in the Beechwood headpond were also noted in both of these studies.

Sprague also noted that the influence of pulp and paper wastes, as measured by ammonia and nitrates, could be detected well downstream from Woodstock. The Department of National Health and Welfare survey also included coliform bacteria. There was at that time no sewage treatment in the basin above Oromocto and a zone of gross pollution was noted below each community.

The Maritime Provinces Water Resources Study (Montreal Engineering Company Limited) assembled data from water quality surveys up to 1968. The Saint John River Basin Board planning study updated this information to the early 1970's (Montreal Engineering Company Limited, 1975). Both of these studies reported similar results to the surveys undertaken 10 years earlier. Findings 1, 2, 4 and 7 of the latter study emphasize this point. They are reproduced below:

1) "The massive discharge of organic wastes at Edmundston has a marked effect on the water quality of the river for at least 175 miles downstream (i.e., to below Mactaquac Dam). These wastes account for approximately 80 per cent of the B.O.D. discharged into the main stem of the river above the tidal reaches of the estuary.

2) The most important long term concerns indicated by the data assessed are the deficiency of oxygen in the lower depths of the main stem headponds and the excess of nutrients being discharged into these water bodies.
4) The data available on fecal coliform levels indicate that acceptable limits for recreation and drinking are sometimes exceeded in the Basin and particularly in the upper reaches of the river.
7) The Aroostook, Presquile and Meduxnekeag Rivers have an important adverse effect on the water quality in the main stem of the Saint John River."

Since 1975 waste loads in the river have been drastically reduced. The single most important change was the conversion of the Fraser Companies Ltd. pulp mill at Edmundston which allowed recovery of pulping chemicals and effective treatment of the reduced pollution load.

Municipal waste treatment has proceeded to the point that only Edmundston and some areas of the City of Saint John discharge significant volumes of untreated sewage. Edmundston is presently in the process of installing waste treatment (Brian Barnes, personal communication, 1985).

With the installation of treatment systems at food processing plants in Maine, the waste loading to the Aroostook and Presque Isle rivers has been greatly reduced thereby reducing the loading on the Saint John River. A number of starch plants in New Brunswick have ceased operation thereby removing high BOD waste streams from the system.

In 1976, the International Technical Advisory Sub-Committee (ITAS) on water quality in the Saint John River was established. This sub-committee investigated the existing water quality in the international section of the Saint John River and compared those conditions to water quality objectives (ITAS, 1979, 1980a, 1980b and 1983). In addition to this, Water Quality Branch (WQB) of Environment Canada has submitted several reports on water quality in the international section of the Saint John River to the sub-committee (WQB, 1983a, 1983b, 1984a, 1984b and 1984c).

Problem parameters and possible problem parameters have been identified (ITAS, 1979). Problem parameters include fecal coliforms, iron, manganese, phosphate and mercury (in the Madawaska River at Edmunston, the Saint John River at Ste. Basile and the Green River). Those parameters which have not been identified as problems, but which could be when more information is gathered include copper, mercury, pH, phosphate, dissolved oxygen and suspended solids. (ITAS op. cit.). ITAS (1980a) recommends safe level objectives (long term water quality management goal) and accute level objectives (an alert level which may indicate a potential problem) for these parameters.

Dissolved oxygen levels must be maintained for the protection of aquatic life. In 1980-81 data, no sample exceeded the acute level of 5 mg/L and all means were within the safe range for oxygen saturation (between 80% and 100%)(ITAS, 1983). However, between Trois Isles and Grand Falls less than 6.5 mg/L at 68-75% saturation was common. Oxygen depletion near Grand Falls was noted in other data reports (ITAS, 1980b, and WQB, 1984a). In September, 1983 oxygen concentration at Grand Falls was less than 5.0 mg/L (WQB, 1984a).

Fish species can tolerate a pH range from 5.0 to 9.5 for long duration. The pH of the Saint John is generally between 6.2 and 8.0, well within the recommended level of 6.0 to 9.0 (WQB, 1984a), pH is also important because of its relation to the solubilities of gases, salts and metals.

Aluminum has a recommended safe level of 0.1 mg/L at pH 7.0 and greater (ITAS, 1980). In 1982-83 data, a high aluminum value was found. This was attributed to high sediment loading and it was suggested that all sites complied with the recommended levels (WQB op. cit.).

Increased phosphate can cause eutrophication of freshwater. Eutrophication yields increased numbers of noxious algae and may result in oxygen depletion. In 1980-81 phosphate levels were within the recommended safe levels (ITAS 1983), however in a more recent study WQB(1984a) reported three streams which were likely being eutrophied as a result of high phosphate levels.

Fecal coloforms objectives are set for drinking water and wimming. The recommended average level is 200/100 ml and with no sample with a concentration greater than 1000/100 ml. In the Saint John River an average of 630/100 ml for Clair and 900/100 ml for St. Basil exceeded the recommended level (WQB 1984c).

2.2.3 Changes in Groundwater Quality

The contamination of groundwater is usually a localized event and therefore does not receive the attention that a major point source of surface water does. Once contamination does occur, however, remedial measures are difficult and costly to put in place. Because a contaminated aquifer may have its use impaired for many years, the cumulative effect of a number of events can be important.

Several sources of groundwater contamination have been noted including:

1) Petroleum spills and leaks from buried tanks.
2) Leachate from road salt storage.
3) Bacterial and nitrate contamination from manure storage.

Although there has been increasing concern with groundwater contamination in agricultural areas, the resource in general has maintained its "natural" level of water quality.

2.3 Industrial and Municipal Discharges

2.3.1 Industrial Discharges

Two trends have dominated the influence of industrial discharges on the waters of the Saint John River Basin since World War II. With the development of the forest products and food processing industries, industrial discharges had increased to the point where serious water quality problems occured. The second trend has been the recognition of these problems, resulting in a move to clean up industrial pollution problems through process modifications and waste treatment facilities.

The two main industrial sources at the beginning of the period covered by the present paper were a pulp and paper facility at Edmundston/Madawaska Me. consisting of a 400 ton/day (360 tonne/day) sulphite pulp mill, an 85 ton/day (76 tonne/day) paper board mill and 135 ton/day (120 tonne/day) paper mill, and 200 ton/day (180 tonne/day) sulphite pulp mill at the mouth of the river at Saint John. Montreal Engineering Company Limited (1969) estimated an effluent loading of 302,000 lb/day (137,000 kg/day) BOD and 100,000 lb/day (45,000 kg/day) suspended solids from the Edmundston mills. The same report also estimated an industrial waste loading of 100,000 lb/day (45,000 kg/day) BOD from Madawaska Me. which was likely from the paper mill. In 1972, partial treatment (neutralization, followed by sedimentation and aeration ponds, for about one-third the effluent) was installed. The organic loading to the river was still estimated to be 100,000 kg/day (Montreal Engineering Company Limited, 1975). In 1979 the mill was converted to a bisulphate pulping process which allowed pulping liquor recovery and substantially reduced treated effluent loadings to those values shown in Table 2-10.

The Irving Pulp & Paper Limited mill at the mouth of the river in Saint John has been a major source of pollution to Saint John Harbour (as well as the immediate up-river environment due to the action of incoming tides). Montreal Engineering Company Limited, op. cit., cite N.B. Department of Fisheries and Environment data giving effluent discharges of 150,000 to 158,700 kg/day BOD and 41,000 to 45,350 kg/day suspended solids. A kraft mill was added and the sulphite mill was closed in 1977. With chemical recovery, the discharges to the river have been substantially reduced (see Table 2-7). In 1970, a 625 tonne/day bleached hardwood kraft mill was constructed at Nackawic by St. Anne-Nackawic Pulp & Paper Co. Ltd. Although this plant was sited on the Mactaquac headpond, a modern treatment system was installed at the time of mill construction and effluents have not produced water quality problems.

TABLE 2-10

INDUSTRIAL DISCHARGES TO SAINT JOHN RIVER - MAY 1984

	Waste Water Treatment Method	#BOD_5/day	#SS/day	Flow MGD
Nadeau Poultry	Solid & grease separator	709	381	0.21
Fraser Edmundston	Clarifier & aerated lagoon	36808	11741	23.99
McCain Foods, Grand Falls	Clarifier & packed tower biofilter	5044	1274	0.685
McCain Foods, Florenceville	Clarifier	15266	6620	2.10
Humpty-Dumpty, Hartland	Inplant treatment & aerated lagoons	10	0	0.03
Ste. Anne, Nackawic	Settling ponds & aerated lagoons	1650	8908	17.34
Irving Pulp & Paper	Inplant system	40975	13991	28.5

Source: Environment New Brunswick, 1984.

Next to the forest products industry, the largest industrial waste loads on the river come from the food processing industry. McCain Foods Ltd. opened a food processing plant at Florenceville in 1957 and one at Grand Falls in 1971. Up to 1969, untreated effluent was discharged to the river. -Although they do not present effluent loading values, Department of National Health and Welfare (1960) comment on the waste as follows:

> "The river received the untreated process waste water from the factory. These waste waters were loaded with peas, stalks, pods and other coarse vegetable debris associated with this type of operation. Some of this waste settled quickly and putrified on the river bottom giving off offensive odours, while other parts floated for some distance and spread over a long stretch of the river before becomming waterlogged and eventually settling to the bottom to undergo further decomposition"

A primary treatment plant was installed at the Florenceville plant in 1969 with subsequent effluent loading being reported as 35,000 lb/day (16,000 kg/day) BOD and 6,400 lb/day (2,900 kg/day) suspended solids (Montreal Engineering Company, 1969). Similar BOD loadings but higher suspended solids loadings were found in the New Brunswick Water Authority Surveys of May 1971 and January 1972 as reported by The New Brunswick Department of Agriculture and Montreal Engineering Company Limited (1974). These authors reported that in-plant waste recovery systems had been installed since the New Brunswick Water Authority surveys. These included a system for removing mud and sprouts from potato fluming water, a starch recovery system and a fat skimming process. An estimate of the present effluent loadings from the Florenceville plant is given in Table 2-10.

The McCain Foods Ltd. Grand Falls processing plant has a modern waste treatment system (clarifier plus two trickling filters in series). At times this system has been overloaded resulting in high waste discharges. The estimated effluents for 1984 are given in Table 2-10. For various times throughout the period covered by this paper, starch plants have operated and produced high strength wastes. Montreal Engineering Company Limited (1969), for example, give an effluent loading of 10,900 lb/day (4,900 kg/day) BOD and 5,450 lb/day (2,500 kg/day) suspended solids for Pirie Potato Company and loading of 5,350 lb/day (2,400 kg/day) BOD and 5,950 lb/day (2,700 kg/day) suspended solids for Valley Co-op Limited. Both of these companies operated in Grand Falls but neither is in production at the present time.

Other food production facilities in the New Brunswick portion of the Basin include the Humpty-Dumpty potato chip plant at Hartland, the McCready's Foods Limited and Barbour Foods Limited complex at Sussex, as well as a number of dairies and meat packing plants. While some of these facilities have caused local environmental problems, most have treatment systems or discharge to municipal systems and none have influenced water quality to the extent which pulp and paper mills or large food processing plants have.

In 1977 a neutral sulphite, semi-chemical pulp mill was constructed at Cabano, Quebec. From start-up this mill has had a modern efficient waste treatment system and has not caused downstream water quality problems.

Both the Aroostook and Presque Isle tributaries receive the effluent from a number of food processing plants in Maine. Montreal Engineering Company Limited (1975) give figures of organic pollutants as measured by TOC (Total Organic Carbon) in the Saint John River in 1972 of 457,000 kg/day immediately upstream of the confluence with the Aroostook and 627,000 kg/day immediately downstream. The Aroostook at that time contributed a major source of pollution to the main stem of the Saint John. While the Presque Isle river exhibited low dissolved oxygen levels and dense algae growths, the estimated loading on the Saint John was only 7.9 percent of the loading at Woodstock (Montreal Engineering Company Limited, op. cit.).

Since 1972, pollution abatement programs have eliminated much of this organic loading to the system. The International Saint John River Water Quality Committee (1984), for example, has estimated that organic loading (in terms of BOD) from point sources has been reduced by 88 percent between 1972 and 1982. They present a list of specific improvements including a number of industrial sources in Maine.

2.3.2 Municipal Discharges

Compared to industrial discharges, municipal effluents have had a minor and localized effect on water quality. Sewage contamination has however restricted recreational uses (swimming and boating) in some areas and untreated municipal effluents when added to industrial loadings have contributed to the gross pollution problems which the river has experienced. At present nearly all municipalities in the New Brunswick Portion of the Basin have satisfactory treatment systems (Environment New Brunswick, 1984).

Most of the sewage from the City of Edmundston does not presently have treatment, however, plans are underway to have a treatment system installed (Brian Barnes, Environment New Brunswick, personal communication, 1985). Saint John still discharges a portion of its sewage directly to the harbour.

2.4 Dams and Impoundments

2.4.1 Large Hydro-electric Dams

In the period covered by this paper, large dams (Beechwood and Mactaquac) were constructed on the main stem and the Tobique dam was built at the mouth of a major tributary. These dams have changed the character of the main stem of the river upstream of Fredericton from a fast-flowing river to a number of headponds, thus affecting its ability to assimilate waste. It has been estimated (Barnes, 1979) that 175 kilometres of the 265 kilometres between Edmundston and the Mactaquac dam comprises headponds.

The retention of polluted waters and the ensuing oxygen depletion and fish habitat degradation was one of the concerns of the Saint John River Basin Board Study. Experience had shown that the Grand Falls headpond had suffered severe water quality degradation and that problems extended downstream into the Beechwood headpond. Since Mactaquac was a larger headpond and was shown to have a more stable thermal stratification, concern was expressed that severe problems (e.g., oxygen depletion and algal blooms) would occur (Watt, 1973).

Although depressed oxygen levels have been measured below the thermocline, no serious algal blooms have been reported and the Mactaquac headpond continues to be a prime recreational area (boating, swimming and fishing).

Both the Mactaquac and Beechwood dams are equipped with fish passage facilities. At Mactaquac, the fish are collected and trucked around the dam. (Some are trucked as far as the Tobique River.) At Beechwood, there is a hoist to assist in fish passage. The hydro-electric dam at Tobique Narrows (at the mouth of the Tobique River) has a ladder-step fishway. Grand Falls has always provided a natural barrier to upstream fish migration. There are no fish passage facilities at Grand Falls at present. In order to compensate for losses in Atlantic salmon production upstream of Mactaquac, a hatchery was built in conjuunction with the Mactaquac dam. This facility was constructed by the New Brunswick Electric Power Commission and is an example of government industry co-operation to mitigate resource losses.

2.4.2 Small Dams

As was indicated in Section 1.3.3, there were 88 dams in the New Brunswick portion of the Saint John River system in 1969. Approximately half of these were built since 1946. Some of the older dams which were used as part of stream driving operations may no longer be in existence. New developments require approval as a water course alteration and therefore receive careful consideration for fish passage and fish habitat concerns.

3.0 THE ROLE OF INTERGOVERNMENTAL ACTION IN THE RESOLUTION OF WATER RESOURCE ISSUES

The resolution of water resource issues in a major river system is a complicated process extending over many years. The Saint John River provides an example of the many factors which have influenced the progress toward the restoration of the water resource. These include:

1. An identification of the problem and an understanding of its complexity. It is not sufficient to identify the sources of industrial pollution. The relative importance of discharges from outfalls and non-point source pollution should be understood as should the importance of impoundments in interacting with waste loading.

2. Public awareness of water resource problems and an assessment of public priorities. This is obviously helpful where the support of political leaders is necessary in taking action. It is also important that managers in other resource sectors appreciate the complexity of the water resource problem so that protection measures can be incorporated in their resource management decisions.

3. Mechanisms for influencing decisions on water resource issues from outside jurisdictions. In the case of the Saint John River, it was important to the clean-up efforts on both sides of the international border to show that progress was being made both in Canada and the United States.

4. Regulatory controls are an important factor in the clean-up of pollution problems. A strong regulatory position is necessary to negotiate meaningful compliance schedules. A recent court ruling against McCain Foods Limited did not result in large fines, however, it probably was a contributing factor in the company taking steps to provide waste treatment.

5. Provision of adequate financial support was a critical factor in reduction of municipal waste discharges to the river. Although industry might be expected to pay for its own pollution control, funds for modernization often allow an obsolete plant to be replaced and thereby provide substantial pollution control benefits.

3.1 Planning Studies

The Governments of Canada and the Province of New Brunswick have co-operated either informally or through formal agreements from the time of initial awareness and reaction to pollution control problems in the basin. The Maritime Water Resource Study, with joint federal and provincial funding, provided a comprehensive assessment of the water resource and identified development opportunities and some problems. In the Saint John River the disposal of industrial and municipal water was cited as a major problem.

By 1970 the Saint John River was being subjected to a number of pressures which threatened to further aggravate its water quality problems. In addition to the industrial pollution loads cited in the Maritime Water Resource Study, the Mactaquac dam had recently been constructed and others (Green River and Dickey Lincoln) were under consideration. It was known that these might affect the assimulative capacity of the river in a complex way, (i.e., water releases at low flows would assist in assimilating waste, however, headponds might trap pollutants and reduce natural re-aeration). Furthermore, forestry and agricultural practices were changing with a trend toward different land use practices (clear-cutting) and more use of pesticides.

It was with this background of uncertainty that the Saint John River Basin Board was established jointly by the governments of Canada and New Brunswick to undertake a comprehensive river basin planning study. An important aspect of the board's activities was a public participation program with field workers throughout the New Brunswick portion of the Basin.

The Saint John River Basin study was a high profile program extending over four years and involving the expenditure of $1,600,000. There were expectations that this effort would provide clear direction for the solution to the basins water management problems and provide an impetus for comprehensive water management. The fact that no implementation agreement was signed leaves the impression that the plan did not meet these expectations. In the absence of such a formal agreement by which implementation can be measured an analysis of the effectiveness of the Saint John River Basin Board efforts becomes subjective judgement. That being said, several observations can be made concerning the effect the Saint John River Basin study had on the restoration of the river.

Cardy (1983) has reviewed the Saint John River Basin Board Study and discussed some of the reasons for the lack of response to the plan. Most of these have also been mentioned in discussions with other resource managers.

> 1. Comprehensive planning study was not necessary to solve point source pollution problems. Industrial pollution was the most important water management issue.

2. The recommendations were presented in a complicated format which tended to diffuse their impact.

3. Many recommendations required the reassignment of responsibilities among government departments, as well as the creation of new agencies.

Many of the recommendations of the Saint John River Basin Board have been implemented. Two examples are an agreement between the governments of Canada and New Brunswick to undertake a flood damage reduction program and the establishment of a co-operative program to regulate alterations of water courses. The fact that the report identified the need for these programs and that the study provided a forum for water planners and managers to discuss common interests provided a basis for the development of these programs.

In the preparation and review of reports the Basin Board activity provided a mechanism for heightened awareness of water management problems for managers in all resource sectors in the region. This undoubtedly contributed to improved environmental practices in other resource sectors such as forestry and agriculture. In conclusion, despite a number of short comings the Basin Board study undoubtedly influenced progress toward the solution of water management problems in many positive ways.

3.2 Monitoring Programs

An important aspect of water resource management is on-going monitoring programs. Water quality monitoring programs provide a measure of the success of pollution control programs as well as a warning system of key parameters whose build-up may lead to serious environmental problems. Monitoring programs related to river hydrology provide the basic data used for a wide range of management concerns including flood forecasting, the availability of electrical energy and the assimilation of pollutants.

The Inland Waters Directorate of Environment Canada has continuing programs to monitor both water quality and water quantity. Several water quality programs have extended back to 1965 (Belliveau and Lockerbie, 1981). These programs have emphasized major ions, nutrients and metals. Several special studies have also been undertaken to monitor the fate of pesticides, and other toic substances. The recent focus of federal water quality programs in the basin has been on international waters.

Federal water quality programs are complemented by those undertaken by Environment New Brunswick. The provincial program has concentrated on gathering baseline data on lakes and impoundments or providing baseline information where future developm nts may impact the water course (e.g., the development of potash mines on the Kennebecasis watershed).

A comprehensive federal stream gauging program began in New Brunswick in 1918. This program became a joint federal provincial program in 1974 and is continuing on that basis.

3.3 Regulatory Efforts

At present protection of the water resource is effected through a number of federal and provincial acts and regulations. The Saint John River Basin Board (1975) listed 25 federal acts and 39 Provincial acts relevant to water resource administration. The Water Quality Regulation under the Clean Environment Act provide the basis for provincial pollution control action. Each industrial facility is required to obtain a permit which specifies the conditions for discharge of a waste. The Fisheries Act (Subsection 33) provides the regulatory authority for the federal government to prevent the discharge of substances at levels harmful to fish. Levels of contaminants for each industry are specified under the act.

The lead agencies in regulating point sources pollution are the Pollution Control Branch of Environment New Brunswick and the Environmental Protection Service of Environment Canada. These agencies usually work co-operatively in negotiating regulatory controls with an industry. By informal agreement the province usually takes the lead in the negotiations but any course of action is approved by their federal counterparts to ensure that federal effluent standards are met. Both jurisdictions set effluent limits to limit the entry of pollutants to watercourses.

The various statutes provide a legal base for regulatory agencies to act. The use of court action is usually the last resort. Court actions which have been undertaken are listed in Tables 3-1 and 3-2. Although fines are usually small, the actions signify the serious intent of government regulatory actions as well as give adverse publicity to the company and often bring some progress toward pollution control.

TABLE 3-1

FEDERAL COURT ACTIONS FOR WATER POLLUTION RELATED CHARGES

DEFENDANT AND LOCATION	DETAILS OF CHARGE	DISPOSITION
Nadeau Poultry Farm St. Francois, N.B.	April 27, 1973 Discharge of poultry wastes.	Found guilty on July, 17, 1973, of violating Subsection 33(2). Fined $100.
Irving Pulp and Paper Ltd. Saint John, N. B.	From April 5 to 9, 1976, defendant allowed discharge of pulp with effluent (toxic wastes) into Saint John River.	On October 1, 1976, case dismissed.
Irving Pulp and Paper Ltd. Saint John, N. B.	On January 7, 1977, defendant allowed discharge of pulp with effluent (toxic wastes) into Saint John River.	Found guilty on April 16, 1977, of violating Subsection 33(2). Fined $3,500.00.
McCain Foods Limited Florenceville, N. B.	Between May 10-14, 1982, defendant allowed deposit of deleterious substance to the Saint John River, contrary to Subsection 33(2) and 33(5)(b) of the Fisheries Act.	Found guilty on all four counts February 27, 1984. Fined $1.00 for each count.
McCain Foods Limited Grand Falls, N. B.	Between May 17-21, 1982, defendant allowed deposit of deleterious substance to the Saint John River, contrary to Subsection 33(2) and 33(5)(b) of the Fisheries Act.	Found guilty on all four counts February 27, 1984. Fined $1.00 for each count.

TABLE 3-2

PROVINCIAL COURT ACTIONS FOR WATER POLLUTION RELATED CHARGES

DEFENDANT AND LOCATION	DETAILS OF CHARGE	DISPOSITION
McCain Foods Ltd.	Section 3(1) Clean Environment Act-Discharge of a contaminant.	Pleaded guilty. Fined $1,000.00.
Ronald Nadeau, Collin, Madawaska Co. N.B.	Section 3(1) Clean Environment Act-Discharge of a contaminant	Case dismissed. Revised copy of Certificate of Analysis not shown to defendant's counsel.
McCain Foods Ltd. Florenceville, N.B.	Section 3(1) of Reg. 82-126-Discharge of contaminant.	Pleaded guilty. Fined $3500.00
Ouellette and Freres St. Hilaire, N.B.	Section 3(2) of Reg. 82-126-Deposit of a contaminant upon the environment.	Found guilty. Fined $400.00.
Herve Hebert Saint Joseph, Mad. Co.	Section 11(2) of Reg. 82-126-Failure to report a discharge.	Found not guilty. "Acted in the spirit of the law although not to the letter".

The regulation of other actions which may degrade the water resource also involve co-operation between the two levels of government. Any proposed stream alterations are reviewed and approved by a committee comprised of representatives of Fisheries and Oceans Canada, Environment New Brunswick and the New Brunswick Department of Natural Resources. Environment New Brunswick regulates the sale and application of pesticides, while the chemicals themselves must be registered by Agriculture Canada.

The public usually becomes aware of regulating actions only when a court action takes place or the construction of a major pollution abatement facility is undertaken. What is not obvious is the continuing negotiations between regulatory agencies and industries or municipalities. These may extend over several years and involve many meetings and extensive monitoring programs. Regulatory actions themselves may involve a combination of methods including compliance schedules, control orders, the withholding of government financial assistance or court action. In addition to these regulatory efforts financial assistance is often provided to assist in plant modernizations or directly to construct waste treatment facilities. All of these instruments have been used to restore water quality in the Saint John River system to acceptable levels. Section 3.5 gives a brief outline of the efforts to bring several large industrial pollution facilities into compliance and provides examples of the use of the above strategies.

3.4 Financial Assistance

The provision of financial assistance by governments has made an important contribution to the restoration of the Saint John River. In New Brunswick municipalities receive grants from the province to finance capital projects. Many of these have been for sewage treatment facilities.

In the 1960's and 1970's joint federal provincial funding (40% federal/60% provincial) was provided to construct public water and sewer systems. Most municipalities have taken advantage of this funding and municipal waste discharges are no longer a serious problem (with the exception of the City of Edmundston which is in the process of installing treatment).

In 1965, the Canada Department of Fisheries and Forestry made available a pollution control fund to assist industries in eliminating organic pollution loading to the Saint John River upstream of the Mactaquac dam. Over three million dollars was made available for the construction of waste treatment facilities. The amount received by each industry was proportional to the amount of waste loading which was to be removed by the treatment system (as measured by Biochemical Oxygen Demand).

Three industries took advantage of this fund, Fraser Companies Ltd., McCain Foods Limited and Carleton Co-operative Ltd. A description of how the use of these funds assisted government regulatory action is given in the following section.

3.5 Progress in the Elimination of Major Sources of Industrial Pollution

3.5.1 Fraser Inc. Pulp Mill at Edmundston

Earlier sections of this report document that water quality survey in the 1960's clearly demonstrated the serious pollution problem posed by the discharge of untreated effluents from the Fraser Companies Limited (later Fraser Inc.) pulp and paper mill complex at Edmundston. Problems with the excessive pollution loading (300,000 lbs./day) were aggravated by downstream impoundments which trapped pollutants and often exhibited severe water quality degradation.

Pollution control efforts were seriously constrained by the fact that the facility was an old mill of the type and size which made it impractical to continue operations and treat the liquid wastes to a desired level.

The first substantial progress in waste treatment was made about 1970 when the company took advantage of the Canada Department of Fisheries and Forestry's pollution control fund. Fraser built a waste treatment system capable of handling the effluent from a mill with chemical recovery in place and had to agree to rebuild the mill and install chemical recovery as soon as the financial position of the company would permit.

After a much larger corporation assumed ownership of the mill the rebuild took place and the mill then "matched" the treatment system. The treatment system is now operating effectively but is occasionally overloaded by upset conditions. Regulating efforts are now focused on pressuring the company to make in-plant improvements to eliminate spills and upset conditions.

3.5.2 Irving Pulp and Paper Ltd. Mill in Saint John

Another example of an old pulp mill which became a problem "inherited" by the new regulatory agencies in the 1970's is the Irving Pulp and Paper Ltd. mill at the mouth of the river in Saint John. The facility consisted of a very old sulphite mill and a kraft mill. As was the case with the Fraser Inc. mill early negotiations produced very little in the way of progress in the reduction of waste loadings to the river.

In April 1976 and January 1977 charges were laid against the Irving Pulp and Paper Ltd. under the federal Fisheries Act. The first charge was dismissed but the defendant was found guilty in the second one and was fined $3500.

The important result of these court actions was the impasse between the regulatory agencies and the company was broken. Irving Pulp and Paper Ltd. undertook to close the sulphite mill and institute a pollution control program at the kraft mill. In this case the program was entirely funded by the company who chose to reduce discharges by in plant measures rather than by constructing an external treatment plant.

Although there are aesthetic problems with releases of foam to the Reversing Falls (a local tourist attraction) and Saint John harbour, the mill presently meets liquid effluent requirements of both the provincial and federal government. There remains a serious odor problem and regulatory efforts are being directed toward the reduction of air pollution.

3.5.3 St. Anne Nackawic Pulp and Paper Co. Ltd. Mill at Nackawic

The St. Anne Nackawic pulp mill is an example of the effectiveness of having a regulating system in place when a plant is constructed. A waste treatment system was constructed when the plant was built and the facility has not caused serious water pollution problems. Even a "problem free" case such as this has required surveillance and on-going negotiations to ensure the waste management practices have kept up with changes in mill production and have made use of the best up-to-date technology. The New Brunswick Department of Fisheries and Environment was able to use the leverage of the provincial loan guarantees to require changes to the waste treatment system during one of the plant modernizations. The focus of regulatory concern with the St. Anne Nackawic Mill is presently odor problem from air emissions.

3.5.4 McCain Foods Limited Plants at East Florenceville and Grand Falls

Both the McCain Foods Limited plants on the Saint John River (East Florenceville and Grand Falls) have had waste management problems and are still the cause of regulatory concern. When initially constructed in 1957, the East Florenceville plant had no waste treatment facilities. Negotiations with the company were unsuccessful, until the money made available from the pollution control fund was used by the company to assist in the construction of a primary treatment plant. Subsequently a number of in plant changes were made to reduce pollution loadings and correct malfunctions in the treatment system.

A secondary treatment plant was not constructed and high pollution loadings to the river have continued. Negotiations with the company continued with pressure being applied to the company through the use of court actions and the withholding of part of the grants from the Department of Regional and Economic Expansion.

McCain Foods Limited pleaded guilty to two pollution related charges laid by the province (February 1982 and January 1984) and was found guilty on four counts of a charge laid by the federal government in February 1984. Although the fines have been small ($1000 and $3500 in the provincial case and $1.00 on each charge in the federal case), the actions appear to have had the desired effect since the company has hired a consultant to finalize the design for a secondary treatment system.

When the McCain Foods Limited plant at Grand Falls was constructed in 1971, an adequate waste treatment system was also built. The difficulty with the Grand Falls plant is that it has been expanded over the years without adequate expansion of the waste treatment facility. Federal and provincial regulatory agencies have not to date been able to resolve the situation although charges were successfully laid in February 1984 under the Fisheries Act (again with a $1.00 fine on each of four counts). Some of the money provided by the Department of Economic Expansion for plant expansion has been held back.

Until adequate waste treatment or waste reduction programs are put in place at East Florenceville and Grand Falls, effluents from these plants will probably continue to exceed federal and provincial standards, and require strong regulatory pressure.

3.6 Flood Damage Reduction

When a major flood occurs people look to government for emergency assistance during the event and later for compensation for damages incurred. Flood damages are also incurred directly by governments when government property or property into which the government has put funds is damaged. In the 1973 flood of the Saint John River economic costs were estimated to be $10,780,000 with $6,630,000 being paid out by the federal and provincial government as compensation (Environment Canada, Inland Waters Directorate, 1974).

In 1976 the two governments signed an agreement to undertake a joint program aimed at reducing flood damages (see Appendix 1). While the program was province wide in scope, much of the emphasis was in the Saint John River Basin, particularly in the Fredericton area and the areas downriver of Fredericton to the Jemseg River. The agreement provided for three areas of action; flood forecasting, flood risk mapping and special studies.

A flood forecasting center was set up in Fredericton and provides river flow forecasts throughout the year. At times of spring freshet forecasting activity is stepped-up and water level information and one-day forecasts are provided to the local news media.

The flood forecasting effort requires extensive data collection of both the federal and provincial governments. Weather data as well as water levels throughout the Basin and snow and ice conditions are all used in preparing flood forecast information. Assistance has been obtained from the government of the United States through the Saint John River Basin Hydrology Committee (see Appendix 1).

The flood risk mapping program involves a detailed mapping of flood risk areas and a designation of flood prone areas. The designation provides for "floodways" where the governments will not provide financial support for projects other than for recreational or agricultural purposes. In risk areas outside of "floodways" (termed the floodway fringe) support would be contingent upon flood proofing measures. Table 3-3 shows the areas of the basin which have been mapped and designated.

TABLE 3-3

FLOOD RISK MAPS

AREA	DESIGNATED WORKING MAPS			PUBLIC INFO. MAPS	
	NO.	SCALE	DESIGNATION DATE	NO.	SCALE
Fredericton	75	1:1000	Feb. 15, 1980	1	1:10,000
Lower Fredericton-Lincoln	14 18	1:1000 1:2000	Feb. 25, 1982	1	1:10,000
Oromocto-Lower Jemseg	8	1:10,000	Mar. 31, 1981	1	1:50,000
Perth-Andover	4	1:2000	Feb. 15, 1980	1	1:5,000
Sussex	14 21	1:2000 1:5000	Sept. 13, 1982	1	1:25,000
Keswick River	7	1:5000	Mar. 3, 1983	1	1:25,000
	161			6	

Source: Annual Report Steering Committee, Canada-New Brunswick Flood Damage Reduction Agreement for the Fiscal Year 1983-84.

Although no special studies have been carried out in the Basin, the March Creek area on the fringe of the Basin in the City of Saint John was the subject of a special study and a separate agreement whereby extensive capital works were undertaken to alleviate flooding.

The flood damage reduction program appears to be having the desired effect in that people are much more informed of water levels each spring, therefore, better prepared should a major flood occur.

4.0 PRESENT WATER MANAGEMENT CONSIDERATIONS AND FUTURE DIRECTIONS

4.1 Water Quality Issues

4.1.2 Water Quality Surveys

The focus of recent monitoring efforts has been on the international portion of the Saint John River. This work is now co-ordinated under the International Technical Advisor Sub-committee on Water Quality in the Saint John River Basin (see Appendix 1).

A recent report of this committee (International Technical Advisory Sub-Committee, 1983) indicates the substantial progress whicn has been made the quality of the Saint John River waters. Their data shows that for most parameters the water meet a "fishable-swimmable" objective. Parameters reported to meet these objectives were metals (arsenic, copper, lead and zinc), phosphorus, dissolved oxygen, ionized ammonia and suspended solids. The objective for aluminum was exceeded on two tributaries and both pH and temperature objectives were exceeded on one tributary.

The objective related to bacterial contamination was exceeded on the main river from the Madawaska River to 3 km below St. Basile as well as below St. Leonard and in the St. Francois River. Areas where this objective was exceeded would impair the use of the water for swimming.

While similar reports for the entire river are not available, it can be inferred that uses for most of the river are not impaired by water quality. Some areas still have problems with bacterial contamination and organic loadings may still be a problem immediately below industrial out falls not in compliance with regulations (particularly in times of low flow).

4.1.3 Industrial and Municipal Pollution

. When the sewage treatment plant at Edmundston becomes operative all the major municipalities on the river will have treatment in place. There remains a continuing effort to maintain and modernize the large investment in infrastructure which has been built up. Many of the sewage plants have reached the stage where replacements or modernization and required. Therefore adequate commitment to finance municipal waste treatment will be required if the progress attained to date is not to be lost.

The two McCain Foods Ltd. plants remain the outstanding problems in industrial pollution. If these plants were brought into compliance and all new industrial facilities on the river were to be constructed with adequate waste treatment systems, water quality should continue to improve.

4.1.4. Non-Point Source Pollution

As with point source pollutants much progress has been made in the elimination of land-use related pollutants to water courses. The regulation of pesticides includes testing for damage to aquatic systems. Through education and improved regulations the careless handling of pesticides (e.g., washing of spraying equipment in streams) appears to be much less prevalent.

Despite favourable trends the difficulty with non-point source or land use related pollutants is that their dispersed nature makes it difficult to pinpoint the cause and effect of environmental problems. Many of these type of contaminants (e.g., mercury or polychlorinated biphenyls) must accumulate in the food chain before it is realized that a problem exists. This being the case it is difficult to predict where the next problem will arise or which of man's activities may be the cause.

Groundwaters are particularly vulnerable to contaminants by land use related pollutants. Because of the relatively slow movement of groundwaters the cause and effect could be separated by many years in time. Concern for the contamination of groundwaters in agricultural areas by nitrates and pesticides has, for example, initiated recent investigations by the New Brunswick Department of Health. The extent of this problem will be known when they report their findings.

4.2 Flooding and Erosion

As was indicated in the previous chapter, the most flood prone areas in the basin have been mapped and designated as flood risk areas. The flood forecasting program continues to provide information to alert people to the potential of damages from floods.

Erosion continues to be a problem, both from the point of view of loss of productive soils and the deposition of sediments in streams. The recent report of the Standing Senate Committee on Agriculture, Fisheries and Forestry (1984) estimates that 75 percent of land used for agriculture in New Brunswick needs some form of protection from erosion. Habitat loss due to erosion during forest harvesting operations is also of serious concern which requires attention.

4.3 Habitat Protection

Through the stream alteration permitting process a system is in place to regulate actions which might disrupt fish habitat. In practice, however, the success of the system requires a strong surveillance effort to ensure that changes to watercourses are actually completed according to the provisions of the permits. Better habitat mapping would assist the regulatory effort in establishing areas of priority.

The Canada Department of Fisheries and Oceans is currently reviewing its habitat management policy. This review will hopefully result in programs to gather more habitat information, as well as an increased field surveillance effort.

4.4 Recommendations for Future Measures to Improve Water Management Which Bear Upon Federal Responsibility and Control

Any recommendations for future directions in water management must be made with regard to the present situation. Substantial progress has been made and the trends of the early 1970's of deteriorating water quality have been reversed. Programs to prevent flood damage and protect fish habitat are in place. Rather than a dramatic shift in emphasis, the present situation calls for a consolidation and fine-tuning of the water management systems.

The greatest danger in the present situation is complacency. Faced with the need to reduce expenditures, governments may feel the job is done and withdraw from active participation in water management in the basin. Without active government involvement at both the federal and provincial levels, it is likely that industrial treatment programs will not keep pace with process changes and municipal systems will not be maintained. The consequences would be a return to the conditions which prevailed fifteen years ago when uses of the river were in danger of becoming seriously impaired.

The following recommendations do not call for actions to combat a crisis situation. It is nonetheless important that the remaining problems be solved and the systems be maintained to ensure that the progress to date not be lost.

Pollution Control Considerations

1. An effective program to regulate industrial pollution must be maintained. The present system of co-operation between Environment New Brunswick and Environment Canada appears to be working well. There are indications that the last large industrial pollution source (the McCains East Florenceville Plant) may be reduced by the construction of a secondary treatment system. An ongoing regulatory effort is required to ensure pollution control efforts keep up with plant expansions and that new facilities are build with adequate waste treatment. The federal role in surveillance, research, and where necessary, legal action is required to support the provincial effort to protect the aquatic system.

2. The investment in infrastructure to collect and treat municipal sewage must be protected. The present level of funding, which comes entirely from the province is not adequate to maintain the systems and ensure their modernization. It is, therefore, recommended that the federal government and province undertake to jointly provide a level of funding so that the progress gained in municipal waste treatment will not be lost.

3. The problem of combatting non-point source pollution requires a varied approach. More research is needed on the effects of land use practices in forestry and agriculture on the water resource. The use and disposal of hazardous materials clearly require a continuing effort.

The deposit of airborne pollutants including anions which contribute to acidity must be monitored and research on cause and effect relationships continued.

Monitoring

4. The monitoring efforts on the international section of the Saint John River should be brought under the terms of reference of the International Joint Commission, so that a mechanism exists for formally implementing an agreed upon action.

5. Monitoring programs in the rest of the basin (outside international waters) should be maintained, or reinstated where special situations require. Two areas for which more water quality information would be useful are the Mactaquac headpond and the lower estuary. Both areas could act as indicators of the long term "health" of the basin's aquatic system.

Habitat Protection

6. An increased effort in fish habitat protection is required. The required actions include habitat mapping, research into cause and effect (e.g., of forestry operations on habitat) and mitigative measures and an increased surveillance effort.

Flood Control Issues

7. People should continue to be made aware of potential problems of development on flood planes. Flood forecasting is an effective tool of public awareness. Other information programs should be supported by both federal and provincial governments.

5.0 REFERENCES

Anonymous. 1970. New Brunswick canoeable waterways study. Research and Planning Branch, New Brunswick Department of Tourism.

Anonymous. 1982. A tourist sector strategy for New Brunswick, New Brunswick Department of Tourism.

Barnes, B.B. 1979. International co-operative activities in the Saint John River Basin. Canadian Water Resources Journal,4(3), 92-101.

Belliveau, P.E. and D.M. Lockerbie. 1981. Water Quality Branch activities in New Brunswick 1965-1980. IWD-AR-WQB-81-11 Water Quality Branch, Inland Waters Directorate, Environment Canada, Atlantic Region.

Bruley, A.J. 1974. Training Manual on the basic technology of the pulp and paper industry and its waste reduction practices. EPS 6-WD-74-3 Water Pollution Control Directorate, Environment Canada.

Cardy, W.F.G. 1983. River basins and water management in New Brunswick. In: River basin management: Canadian experience. Edited by B. Mitchell and J. S. Gardner. Faculty of Environmental Studies, Department of Geography, University of Waterloo, Ontario. Publication Series No. 20. pp. 61-70.

Dadswell, M.J., R. Bradford, A.N. Leim, G.D. Melvin, R.G. Appy and D.J. Scarratt. A review of fish and fisheries research in the Bay of Fundy between 1976 and 1983. In: An update on marine environmental consequences of tidal power development in the upper reaches of the Bay of Fundy. Edited by D.C. Gordon Jr. and M.J. Dadswell. Can. Tech. Rep. Fish. Aquat. Sci. (in press).

Department of National Health and Welfare Canada. 1961. Survey report: effects of pollution-Saint John River, New Brunswick and Maine. Public Health Engineering Division.

Englert, J., J.W.A. Grant and B.F. Bietz. 1982. Impact of logging and associated practices on salmonid standing crop in the Maritimes. Atlantic Region Environmental Protection Service, Environment Canada Surveillance Report EPS-5-AR-82-4.

Environment Canada. 1974. The New Brunswick flood April-May 1973. Technical Bulletin No. 81, Inland Waters Directorate.

Environment New Brunswick. 1984. Summary of operating conditions of wastewater treatment plants. Prepared by Pollution Control Branch, Department of the Environment. Province of New Brunswick Report T-8403.

Hartman, G.F., J.C. Scrivener, M.J. Brownlee, and D.C. Morrison. 1983. Fish habitat protection and planning for forest harvesting in coastal streams of B.C.; some research and management implications. Can. Ind. Rep. Fish Aquat. Sci. 143.

Hooper, W.C. 1974. The New Brunswick Atlantic salmon sport fishery 1969-1973. Fisheries Management Report No. 4. Fish and Wildlife Branch, Department of Natural Resources, New Brunswick.

Hooper, W.C. 1978. The New Brunswick Atlantic salmon sport fishery, 1972-1977. Fisheries Management Report No. 7. Fish and Wildlife Branch, Dept. of Natural Resources, New Brunswick.

Hooper, W.C. 1979. The 1975 New Brunswick sport fishery. Fisheries Management Report No. 9. Fish and Wildlife Branch Dept. Natural Resources, New Brunswick.

Hooper, W.C. and C. Ayer. 1984. Re-allocation of sea-run Atlantic salmon and potential of landlocked salmon in Canadian sport fisheries. Paper given at the 1984 Canadian sport fisheries conference, Vancouver, B.C. February, 1984.

Hustins, D.G. 1974. Tourism and outdoor recreation in the Saint John River Basin. A report prepared for the Saint John River Basin Board. Report No. 10.

Inland Waters Directorate. 1973. Hydrology of the Saint John River Basin. A report prepared for the Saint John River Basin Board. Report No. 2. Department of the Environment.

International Saint John Water Quality Committee. 1984. 12 years of progress. International Saint John Water Quality Committee 1972 - 1984.

International Technical Advisory Sub-committee, 1979. Water quality data analysis and sampling program for the international water of the Saint John River Basin. Report of the Water Quality and Sampling Sub-committee to the Canada-United States Committee on water quality in the Saint John River. January 1979. 39p plus figures and tables.

International Technical Advisory Sub-committee. 1980a. Review and update of water quality objectives for the international waters of the Saint John River Basin. ITAS report on water quality in the Saint John River. September, 1980. 51 p. plus appendices.

International Technical Advisory Sub-committee. 1980b. Interpretation of 1979/80 surveillance data for the international waters of the Saint River Basin. ITAS report on water quality in the Saint John River Basin. October, 1980. 27p.

International Technical Advisory Sub-committee. 1983. Interpretation of 1980/81 surveillance data for the international waters of the Saint John River Basin. ITAS report on water quality in the Saint John River Basin. February, 1983. 35p. plus figures.

MacNeill, J.W. 1971. Environmental management. A study prepared for the Privy Council office, Government of Canada.

Meth, F.F. 1973. Sports and commercial fisheries of the upper and middle Saint John River. A report prepared for the Saint John River Basin Board. Report No. 7d.

Meth, F.F. 1974. Sport and commercial fishery of the Saint John estuary. A report prepared for the Saint John River Basin Board. Report No. 7b.

Montreal Engineering Company Limited. 1969. Maritimes water resource study, stage 1. Vol. 3, New Brunswick: book 3. A report prepared for the Atlantic Development Board.

Montreal Engineering Company Limited. 1975. Water quality in the Saint John River Basin. A report prepared for the Saint John River Basin Board. Report No. 4.

New Brunswick Department of Agriculture and Montreal Engineering Company Limited. 1974. Agriculture and water management in the Saint John River Basin. A report prepared for the Saint John River Basin Board. Report No. 5.

Parks, A.C. 1977. Report of the agriculture resources study. Prepared for the Province of New Brunswick, Fredericton.

Powell, G.R. (ed.) 1983. Nashwaak experimental watershed project, annual report, 1981-82. A cooperative study of the environmental impacts of forestry practices. Published by Nashwaak Experimental Watershed Project Technical Committee of the New Brunswick Forest Research Advisory Committee.

Saint John River Basin Board. 1975. Water resources and water use. In: A plan for water management in the Saint John River Basin, Pt 1. Final report of the Saint John River Basin Board.

Sigvaldason, O.T. 1975. Electric power and water management in the Saint John River Basin. A report prepared for the Saint John River Basin Board. Report No. 14.

Standing Senate Committee on Agriculture, Fisheries and Forestry. 1984. Soil at risk. Canada's eroding future. Report on soil conservation by the Standing Committee on Agriculture, Fisheries and Forestry to the Senate of Canada. Hon. H.O. Sparrow, Chairman.

Water Quality Branch. 1983a. Report on the 1982 Saint John River automatic water quality monitor data at Grand Falls, N.B. Inland Waters Directorate, Environment Canada. Report IWD-AR-WQB-83-47, 13 p plus figures and appendix.

Water Quality Branch. 1983b. International Saint John River fecal coliform survey, August, 1982. Inland Waters Directorate, Environment Canada, Report IWD-AR-WQB-83-38. 17 p. plus appendix.

Water Quality Branch. 1984a. Compliance of selected water quality parameters to the objectives of the international waters of the Saint John River Basin during the years 1982 and 1983. Inland Waters Directorate, Environment Canada. Report IWD-AR-WQB-84-56. 30 p.

Water Quality Branch. 1984b. Report on the 1983 Saint John River automatic water quality monitor data at Grand Falls, N.B. Inland Waters Directorate, Environment Canada. Report IWD-AR-WQB-84-66. 18 p. plus appendix.

Water Quality Branch. 1984c. International Saint John River bacteriological survey, July, 1983. Inland Waters Directorate, Environment Canada. Report IWD-AR-WQB-84-70. 21 p. plus appendix.

Watson, R.S. 1983. New Brunswick forest industry and forest resources, an overview. A background paper prepared for the N.B. Private Woodlot Resources Study.

Watt, W.D. 1973. Aquatic ecology of the Saint John River. Volume I. Background, design, methods, nutrients, bacteria, phytoplankton and primary production. A report prepared for the Saint John River Basin Board.

Welsh, H.E., P.E.K. Symons, and D.W. Narver. 1977. Some effects of potato farms and forest clearcutting on small New Brunswick streams. Fish. Mar. Serv. Tech. Rep. 745.

Wilson, R.C.H., P.B. Eaton, S.E. Hall and H.H. Stone. 1980. Environmental quality in the Atlantic Provinces: 1979. Environment Protection Service, Environment Canada, Halifax, N.S.

APPENDIX 1

INTERGOVERNMENTAL COMMITTEES RELATING TO THE SAINT JOHN RIVER BASIN

A.1 The Atlantic Provinces Water Resource Study

The Atlantic Development Board commissioned two studies in 1967: a study of the administration of water resources in the Atlantic Provinces and a study of the water resources in the Maritime Provinces. The terms of reference for the study of the administration of water resources called for a comprehensive description of the administrative structure, function and decision-making process for the planning, organization and management of the water resources in each of the Atlantic provinces. It also called for an identification of the implications for administration of future investment in water resource development programs.

When the study was completed, a series of recommendations were put forward, eight of which applied specifically to New Brunswick and were directed at the New Brunswick Water Authority. The first recommendation is particularly relevant to subsequent developments in the Saint John River Basin in that it called for the preparation of a comprehensive plan for water resource development in the basin.

The Maritime Provinces Water Resource Study analysed water supply and demand and identified problems, possibilities and priorities for the Maritime provinces. The study looked at river basins as well as selected study areas in each of the three provinces. Coverage of the Saint John

River Basin included a section on the Basin as well as special studies of Edmundston, Fredericton and Saint John.

Pollution from untreated or inadequately-treated industrial and municipal wastes was identified as the most serious problem in the Basin. Serious problems were identified as resulting from the disposal of pulp and paper mill wastes at Edmundston, food processing wastes at East Florenceville and from tributaries entering New Brunswick from Maine. Potential problems with the eutrophication of the Mactaquac headpond were also noted. Other problems identified included: sunken wood at Oromocto, industrial and municipal pollution of Saint John Harbour, erosion of farmland and the flooding of farmland below Fredericton.

A.2 The Saint John River Basin Board

The Saint John River Basin Board was established jointly by the governments of Canada and New Brunswick on June 30, 1970 as a comprehensive river basin planning study. The agreement, which pre-dated the Canada Water Act by a few months, did not extend to implementation. No implementation agreement was signed (as was the case with the Qu'Appelle and Okanagan studies).

The objective of the study was:

> "to provide for optimum management of the water resources of the river basin for the social betterment and economic improvement of the region with due consideration to the maintenance of a proper ecological balance" (Saint John River Basin Board, 1975).

A planning office and a public participation program were established. These functions reported to a board of three appointees by the Government of Canada and three appointees by the Province of New Brunswick. An advisory committee was appointed to facilitate liaison with interested federal and provincial government departments.

The board completed its work in 1975 and reported to the two governments. The plan was formulated in terms of a comprehensive framework for management which presented various levels of decisions, tasks, policies, and responsibilities. One hundred and fifteen recommendations were directed at water-users and water-resource managers. In addition to the plan, 16 resource or sector reports were published.

A.3 International Saint John Water Quality Committee

The International Saint John River Water Quality Committee was formed in 1972 under an agreement between the governments of Canada and the United States. The International Joint Commission was designated to oversee its operation. The goals of the committee, which were set when the committee was established, are:

1. Demonstrate ways in which countries could cooperate in reducing water pollution to their mutual benefit.
2. Develop improved techniques and concepts for water quality management.

3. Review periodically progress in the conduct of water quality planning on both sides of the Canada-United States boundary in the Saint John River Basin, with a view to facilitating progress toward enhancement of water quality.
4. Exchange appropriate information about plans, programs, and actions which could affect water quality in the Basin.
5. Assist in coordination and consultation amoung appropriate authorities on matters and actions affecting water quality.
6. Make appropiate recommendations to relevant authorities on both sides of the boundary and to the International Joint Commission regarding the improvement of water quality in the Basin.

The International Saint John River Water Quality Committee which consists of three members from Canada, three members from the United States and a secretary meets on a regular basis to exchange information and review programs. An International Technical Advisory Subcommittee carries out tasks as directed by the Committee. The sub-committee regularly publishes the results of water quality surveys on the river. An earlier publication reviewed some of the pollution problems studied by the committee and presented specific set of water quality objectives for the international waters of the Saint John River.

A.4 Saint John River Basin Hydrology Committee

This committee was formed in 1979 by an exchange of letters between various Canadian and United States government agencies. It was formed to ensure the continuation of the exchange of information and co-operation which had existed during the pilot project on the application of World Weather Watch to operational hydrology. The committee, whose members represent federal government agencies in Canada and the United States as well as agencies from the provinces of New Brunswick and Quebec, meets twice a year to exchange information and to discuss means of co-operating on programs of common interest. The co-operation on measurement of snow packs in the upper basin has been particularly useful to the flood forecasting effort in the basin.

A.5 Canada-New Brunswick Flood Damage Reduction Steering Committee

This committee was constituted under the Canada-New Brunswick General Agreement Respecting Flood Damage Reduction which was signed on March 31, 1976. The original agreement was for a ten-year period however it was amended on July 16, 1981 to extend the term for an additional five years. While this agreement covers the whole province, most of the effort has been placed on the Saint John River Basin where the most serious flooding problems have occurred.

The steering has two members from the Government of Canada and two from the Province of New Brunswick. Technical committees with representatives of both governments also exist for the flood risk mapping program, the flood forecasting program and for any current flood damage reduction studies.

The agreement provides for sub-agreements on flood risk mapping, flood forecasting and special studies. Flood risk maps have been completed for Fredericton, Lower Fredericton-Lincoln, Oromocto-Lower Jemseg, Perth-Andover, Sussex and the Keswick River areas. These areas have all been designated as flood risk areas so that no federal nor provincial funds will be made available for developments unless flood-proofing takes place.

A flood forecast for the Saint John River was established in June 1978, and has operated since that time. During the period of spring freshet the forecast centre commences daily operation and provides water level information and one-day forecasts to local media outlets. During periods of high water, three-day forecasts are also provided.

No special studies have been carried out within the Basin. A study of Marsh Creek in Saint John (technically outside the Basin but adjacent to it) led to a separate sub-agreement to construct flood protection measures.

APPENDIX 2

TERMS OF REFERENCE

The objectives of the assignment are:

To review stresses on the water environment created during postwar economic development of the Saint John Basin; and to assess progress of and remaining needs for intergovernmental co-operation in restoring a satisfactory balance among water uses.

The tasks included in this assignment are:

1. Review post-World War II developments in the Saint John Basin, with emphasis on forestry, agriculture, energy projects, resource-processing industry and growth of urban communities and their impacts on the basin's water resources, e.g. flow control, erosion and sedimentation, waste discharges, flooding, aquatic habitats;

2. Describe the major intergovernmental programs which have focussed on Saint John waters and water use issues over the past two decades, including those of the Atlantic Development Board, Saint John River Basin Board, International Saint John Water Quality Committee, Saint John River Basin Hydrology Committee, and Canada-New Brunswick Flood Damage Reduction Steering Committee, and assess generally what has been achieved and what issues remain outstanding;

3. Assess in particular the progress of clean-up resulting from government-industry negotiations, court actions and (community) assistance programs throughout the Canadian portion of the basin, not minimizing remaining difficulties, e.g., the recent case of $8 fine for conviction on 8 counts of pollution;

4. Recommend measures for improving water management or accelerating remedial programs in the Saint John Basin which bear upon federal responsibility and performance.