Canada/Ontario
Eastern Ontario Subsidiary
Agreement

SOUTH NATION RIVER BASIN WATER MANAGEMENT STUDY

- MAIN REPORT -

SOUTH NATION RIVER
CONSERVATION AUTHORITY,
BERWICK, ONTARIO.

February 1983.

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BACKGROUND STUDIES

1 Preliminary Optimization Study, Marshall, Macklin, Monaghan

2 Interim Flood Plain Mapping, DeLCan

3 Heritage Resource Study, Historical Planning and Research Branch, Ministry of Culture and Recreation

4 Agricultural Component, Weston Graham and Associates

5 Residential, Commercial, Industrial Component, Municipal Planning Consultants

6 Geotechnical Background Study, Ministry of Natural Resources

7 Forestry Component, Arbex Forest Development Company

8 Fisheries and Wildlife Component, MacLaren Plansearch

9 Amenity System Study, Hough, Stansbury and Michalski

10 Idle Lands Study, Weston Graham and Associates

11 Erosion and Sedimentation Study, Water and Earth Science Associates

12 Wetlands Study, Water and Earth Science Associates

13 Water Resources Study Component, MacLaren Plansearch

14 Master Drainage Planning, Methodology and Case Study for Augusta Township, A.J. Robinson & Associates

15 Floodline Mapping, Proctor and Redfern Group

16 Technical Analysis of Alternatives, MacLaren Plansearch, Proctor and Redfern Group, and DeLCan

CONVERSION FACTORS*

Length

1 foot	= 0.305 metres	1 m	= 3.281 ft.
1 mile	= 1.609 kilometres	1 km	= 0.625 miles

Area

1 square foot	= 0.09 sq. metre	1 m^2	= 10.76 $ft.^2$
1 acre	= 0.404686 hectare	1 ha	= 2.47105 acres
1 square mile	= 2.590 sq. km.	1 km^2	= 0.386 mi^2

Volume

1 cubic foot	= 0.03 cubic metres	1 m^3	= 35.315 ft^3
1 gallon	= 4.546 litres	1 L	= 0.21997 gal.
1 gallon	= 0.0045 cubic metres	1 m^3	= 220 gal.

Flow

1 gallon/sec	= 0.0045 cubic metres/sec	1 m^3/sec	= 220 gal/sec
		1 m^3/sec	= 19 million gal/day

Weight

1 pound	= 0.453592 kilogram	1 kg	= 2.20462 lb.
1 ton	= 0.907185 tonne	1 tonne	= 1.10231 tons
1 tonne	= 1000 kilograms	1000 kg.	= 1 tonne
1 pound	= 0.440513 litres (for raw milk)	1 L	= 2.27008 lb.

* Note: Most calculations in this report and the background studies were done in English units and later converted, therefore direct metric calculations may give slightly different results.

1.1 INTRODUCTION

The South Nation River Basin Development Program (SNRBD) is composed of interim flood control works and a three year study of the water and land resources that will provide for improved economic conditions within the Watershed. The program was jointly funded by the Government of Ontario and Canada - each contributing 45% - with 10% contributed by the thirty member municipalities of the South Nation River Conservation Authority. The federal/provincial funding was provided under the Canada/Ontario Eastern Ontario Subsidiary Agreement (EOSA), which was signed December 20, 1979.

The South Nation River Basin Development Program of the Canada/Ontario Agreement has the following two goals:

a. Provision of interim flood control projects upstream of Chesterville and Plantagenet;

b. The development of a plan for further enhancement of the economic conditions of the area according to the objectives of the Agreement by the integrated management of water and land resources within the South Nation River Basin through the identification of the necessary and effective measures to achieve protection against flooding and erosion, effective removal of excess water for the optimization of agricultural production and marketing, acceptable disposal and transport of waste effluents; the provision of adequate supplies of good quality water to meet water supply, agriculture, fish, wildlife, and recreation desires and needs.

The Province of Ontario is responsible for carrying out the program and the South Nation River Conservation Authority was appointed as the implementing agency for both the study and the interim flood control works.

Conservation Authorities in Ontario have a long history of close working relationships with provincial and federal agencies. This stems from the Authorities' role in water and land resource management at the local level. They represent an essential continuing mechanism for local coordination and close contact with municipalities concerning public input for resource management.

1.2 WATER MANAGEMENT ISSUES

The South Nation River is one of Eastern Ontario's largest rivers with a drainage basin of approximately 3900 km^2 (see Figure 1.2.1). It has unique physical characteristics which cause continuing problems for natural resource management in general and water management in particular.

Water management-related issues are an integral part of the history of the South Nation River Basin. Problems of spring and summer floods, availability of good drinking water, and the need for land drainage have been experienced in varying degrees since the mid 19th century. As the population has grown in the Basin, with new needs for water and conflicting uses for it, the issues have persisted and become more clearly defined.

The main branches of the South Nation River do not have sufficient grade nor channels large enough to accommodate peak flows. Extensive flooding is virtually an annual occurrence along certain stretches of the South Nation River, particularly in the Brinston and Plantagenet areas. Also spring flooding causes damage in villages such as Crysler. Late spring flooding often inundates extensive areas of prime agricultural land at critical times, delaying planting operations, or causing serious damage to young crops. Summer and fall flooding occur as well in these agricultural areas, resulting in damage to crops and severely restricting field operations such as cultivation and harvesting.

The water in the South Nation River and its tributaries is of poor quality year round. There are several contributing factors. Extremely low flows occur during the summer and fall months - even under normal weather conditions. Erosion along streams and ditch banks contributes a great deal of sediment, particularly north of Crysler.

Run-off from agricultural crop land and livestock operations contribute phosphorus and bacteria that impair water quality. Fall discharges of effluent from municipal and industrial lagoons, as well as sanitary and storm sewage outfalls, also contribute to impaired water quality in the main river and its tributaries.

While only two communities draw their water from the South Nation River, the river does supply water for industry, livestock, and irrigation, as well as providing

FIG. I.2.I

South Nation River Basin
Location

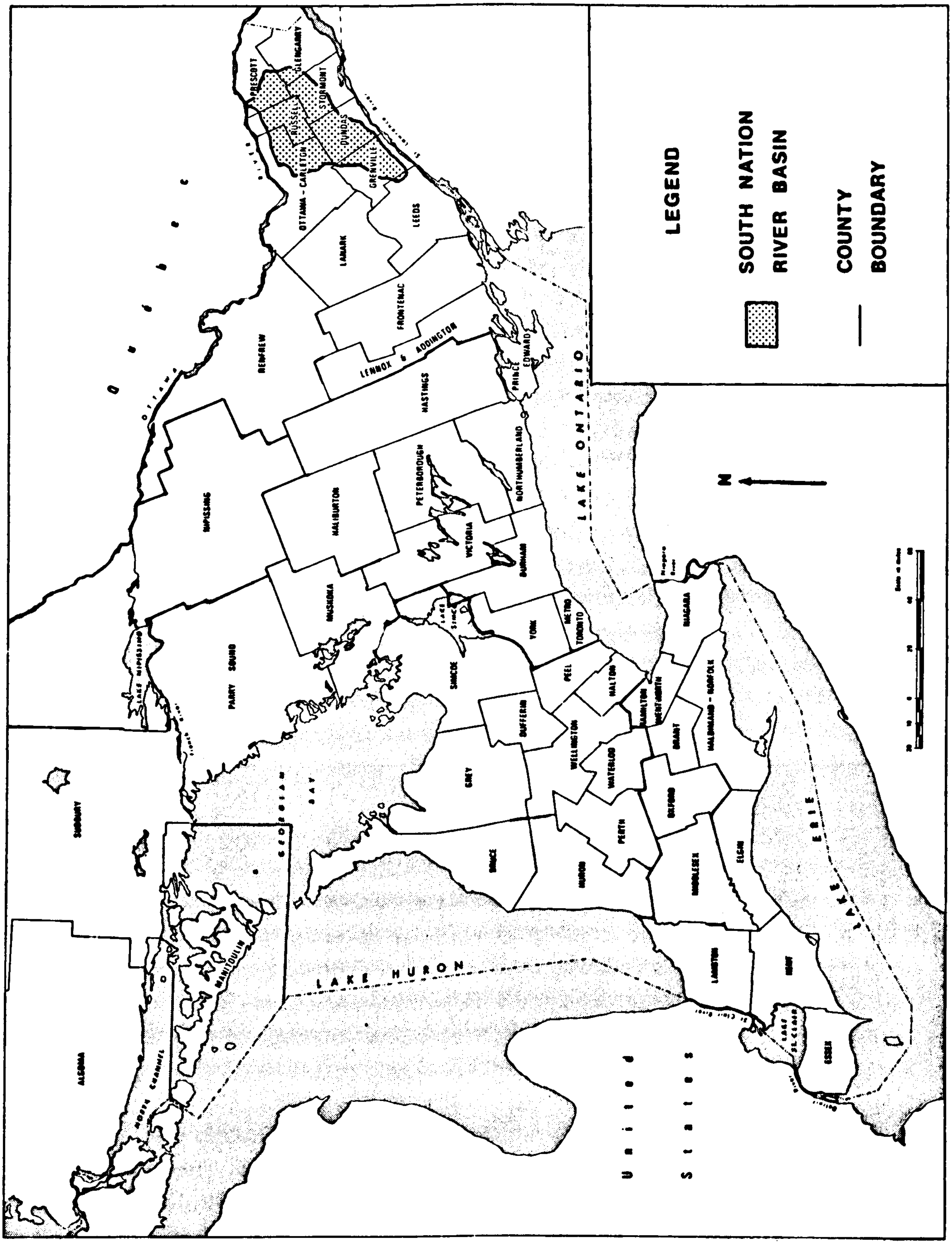


PHOTO 1.2.1 SPRING FLOODING IN PLANTAGENET FLOOD ZONE

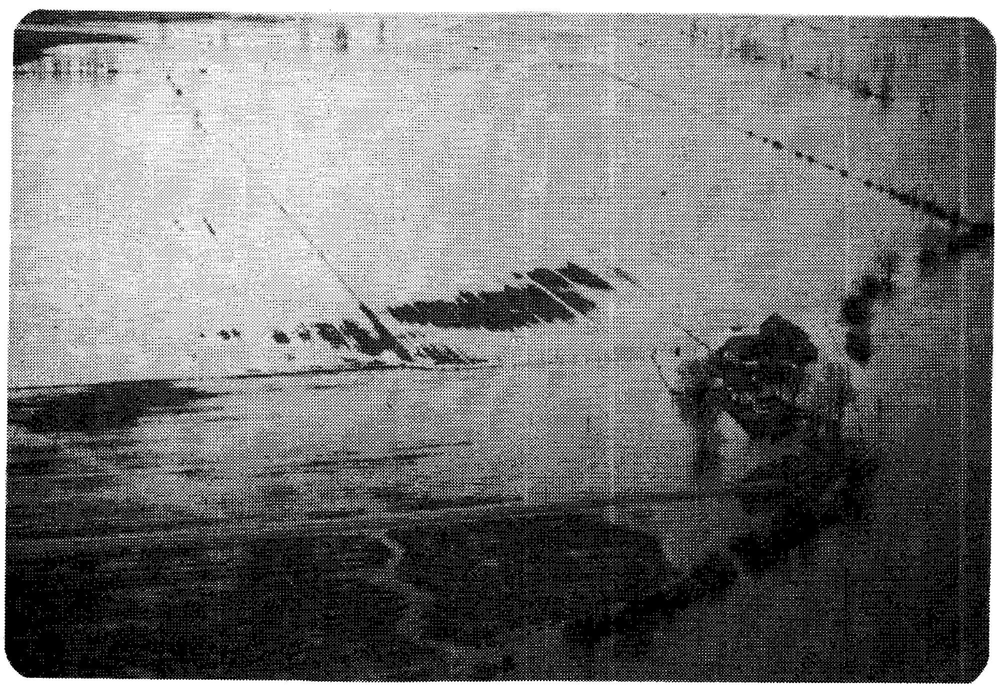


PHOTO 1.2.2 SPRING FLOODING IN BRINSTON FLOOD ZONE

PHOTO 1.2.3 VILLAGE FLOODING

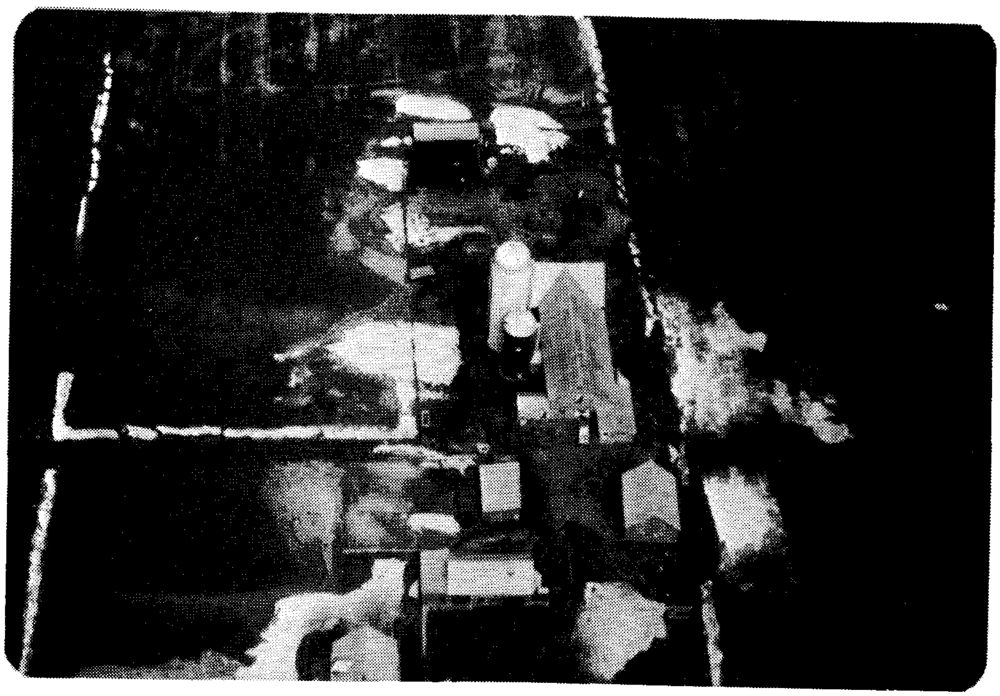


PHOTO 1.2.4 FLOODING OF AGRICULTURAL AREA

fish and wildlife habitat and recreational opportunities. Both low flows and poor water quality affect these uses. Groundwater is the main source of domestic water supply in the communities; however, the supply and quality have not always been adequate to meet the needs in many parts of the river Basin.

Slopes and riverbanks composed of marine (leda) clays, especially in the northern part of the Watershed, are prone to landsliding. Considerable damage and property loss has occurred over the years. These landslides and slumping are caused by a combination of erosion at the base of the slopes, excess groundwater and low inherent strength of that type of soil.

Land drainage has been a prerequisite for crop production in many parts of the Basin since agricultural settlement began. Municipal outlet drains that were originally designed for removal of excess surface water have been more recently improved to also serve as outlets for tile drains. Other related works such as channelization have been undertaken to reduce spring and summer floods on productive agricultural lands. However, there is still over 100,000 ha of land that may become tile drained in the future.

1.3 STUDY BACKGROUND

Several aspects of resource management took on new dimensions in Eastern Ontario during the '70's and underlie the evolution of this study for the South Nation River Basin. Technological change in agriculture, such as the rapid expansion of corn acreage, created a pressure for improved water control both in terms of land drainage and flood control. Housing development in the some municipalities along the river and its major tributaries gave rise to increased concern for the protection of life and property from flooding and slope failures, as well as for the provision of adequate municipal water supplies and the safe disposal of sewage effluent from lagoon systems. While these questions arose with respect to the river system, concern was also being expressed about the quantity and quality of groundwater available in the Basin.

In the 35 years that the South Nation River Conservation Authority has been in existence, numerous site specific studies and projects have been undertaken which relate directly to water management. The lack of detail and the site specific

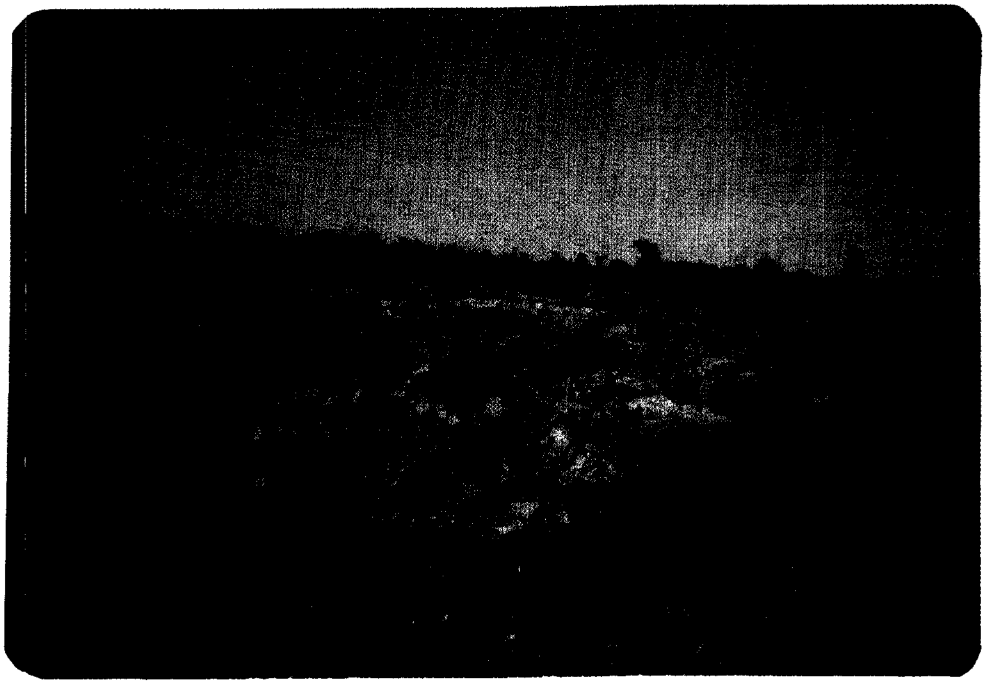


PHOTO 1.2.5 LEMIEUX LANDSLIDE

PHOTO 1.2.6 AERIAL VIEW OF LEMIEUX LANDSLIDE AND RIVER

nature of these studies gave rise to the need for a comprehensive water management study.

As a result of these findings, the damaging spring flood in 1976 and the fact that a number of major drains were being initiated in the area, Ontario set up an Inter-Ministerial Committee to prepare a discussion paper on the South Nation River Basin. This led to the announcement in the 1978 Speech from the Throne that new measures and projects would be undertaken in the Basin.

The Ministry of Natural Resources was named as the lead ministry for planning in the South Nation River Basin. An Advisory Committee was formed on this basis. The ministries of Agriculture and Food, and Environment were also included on the Committee. The Advisory Committee prepared "A Report on Pre-Planning", South Nation River Basin, September, 1978, which became the basis for Canada/Ontario negotiations under the General Development Agreement on the South Nation component of the Canada-Ontario Eastern Ontario Subsidiary Agreement.

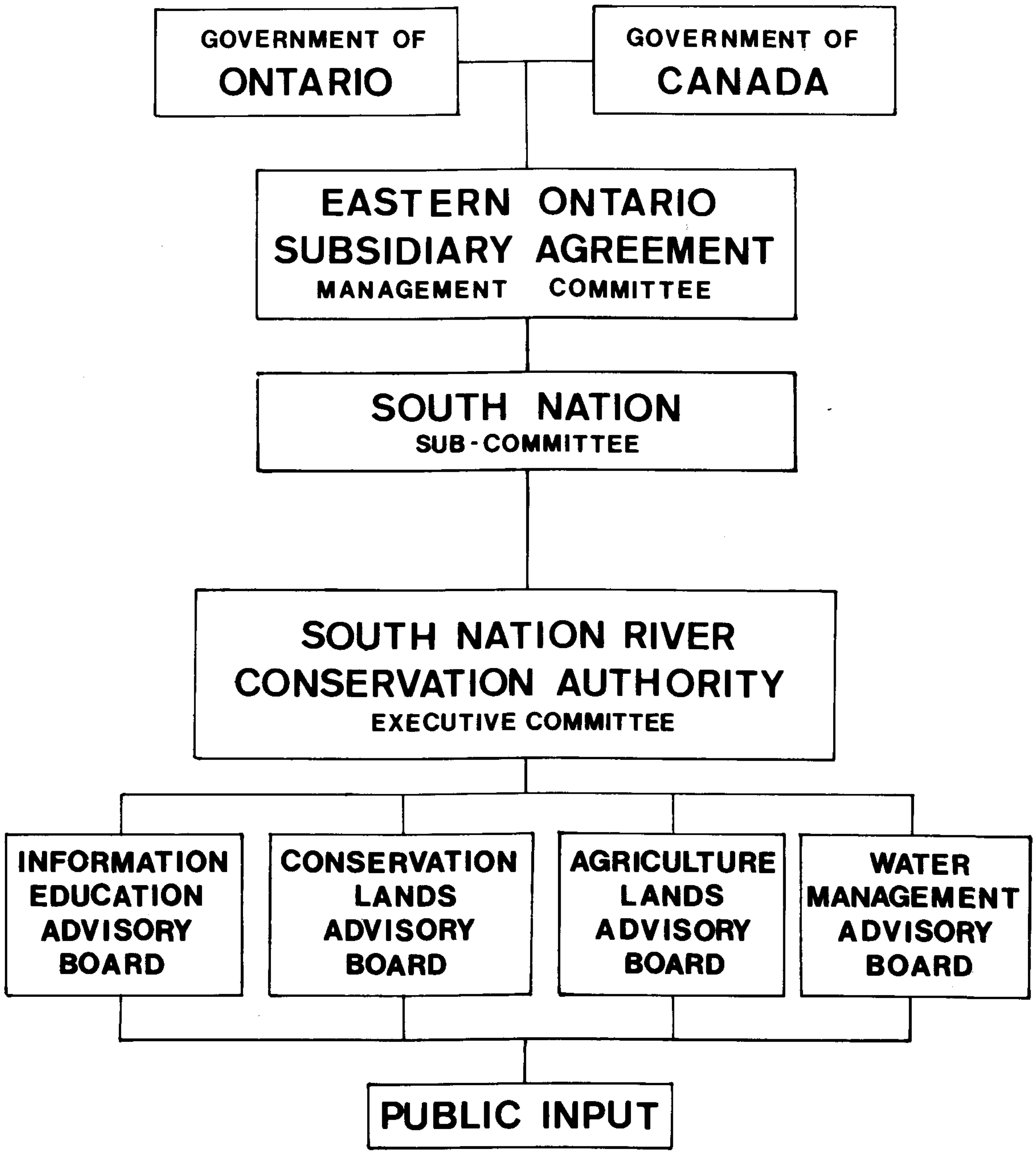
The Subsidiary Agreement consists of seven programs amounting to $50,350,000. over five years, to be cost-shared 50/50. Agriculture is the major program, valued at $23 million. South Nation River Basin Development is a major component of this program, valued at $9 million, and it is summarized in the Subsidiary Agreement as:

> Provision for interim flood control projects upstream of Chesterville and Plantagenet, and a river basin water management study to determine the viability of measures for flood control, water quality improvement, land drainage, erosion control and other means of improved economic conditions in the watershed.

As a result of the Subsidiary Agreement, a new joint committee structure was put in place (See Figure 1.3.1). Responsibility for Subsidiary Agreement programs rests with the Federal-Provincial Management Committee, jointly chaired by the Department of Regional Economic Expansion and the Ministry of Treasury and Economics. The South Nation River Basin Development Subcommittee is responsible for overseeing the Basin planning and the interim flood control projects.

Fig. 1.3.1

Committee Structure



The Subcommittee reports to the Management Committee. The Subcommit-tee consists of three provincial and three federal agencies. The provincial agencies are Natural Resources (chairman), Agriculture and Food and Environment. The federal agencies are Regional Economic Expansion, Agriculture and Environment. Thus, the South Nation River Basin Development program has enabled the work on the interim flood control projects to proceed while the preparation of this comprehensive water and land management study has been underway.

1.4 STUDY FRAMEWORK

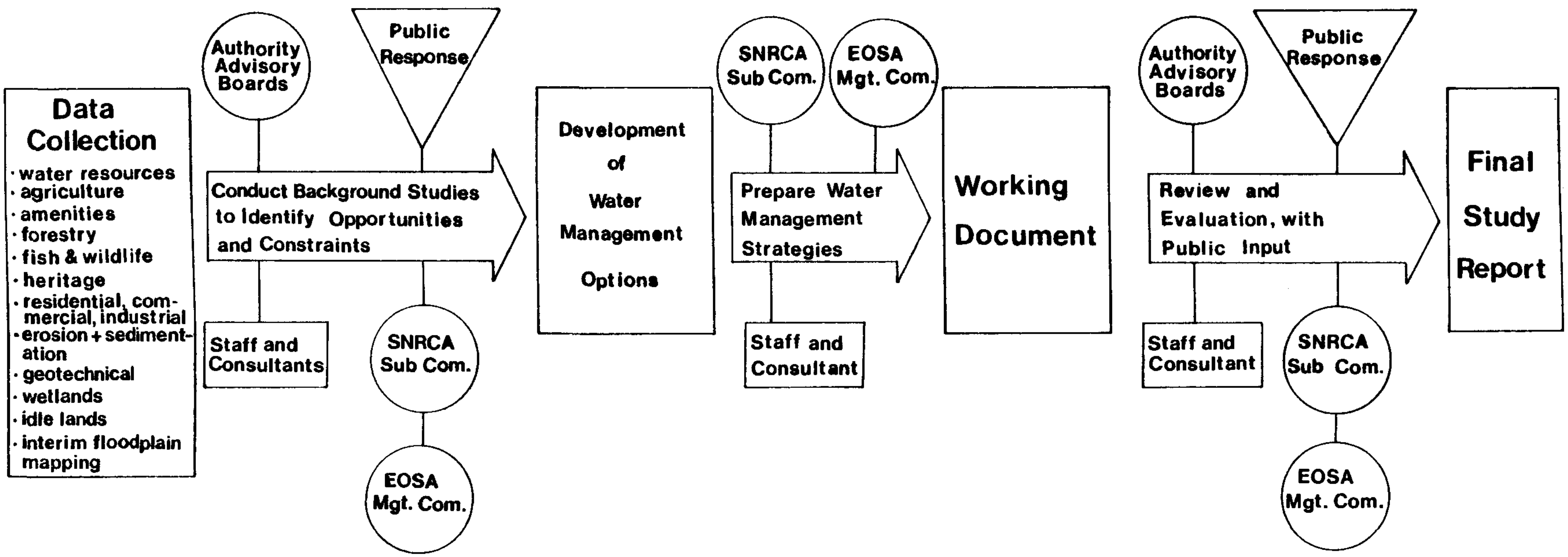
The Conservation Authority was designated as the implementing agency for the study and the interim flood control works. Authority staff was expanded to form a team of specialists to organize and carry out the project. They worked in close cooperation with officials of many different government agencies and consultants in this process to have sixteen different background studies prepared, as listed in the table of contents; Background Studies.

These background studies provided essential technical information, identified specific problems and remedial practices, and planned ways of analyzing and managing resource issues to develop an integrated approach to water management problems (Refer to Figure 1.4.1 for graphic representation of the study process).

Agriculture, amenities, fish and wildlife, forestry, heritage, idle land, residential, commercial, industrial and wetlands background studies dealt with resource inventory, land use, and economic development, as well as future opportunities and constraints. The erosion and geotechnical studies addressed the problems of existing and potential sediment, erosion and landslides. The interim flood plain mapping and water resources studies utilized the information generated from the other components and combined it with information on the physical characteristics of the river basin and its hydrology to develop and test a series of water management options. This was accomplished with the use of computer modelling (The models used are explained in the Water Resources Background Study).

Public involvement in the study process was initiated through the Conservation Authority by the publication of special information tabloids that were circulated to every home in the Basin. Public meetings were organized with Conservation

Fig. 1.4.1 BASIN STUDY PROCESS



Authority Advisory Committees and special interest groups to discuss technical results of the different study components. Also, Citizen Advisory Committees were involved during various stages throughout the process.

The findings of the background documents were assimilated by the Authority Staff and a study consultant into a series of working documents. These working documents were reviewed by members of technical working groups that included participating government agencies and the specialist consultants who prepared the background studies. The result of this part of the process was a draft study report which was submitted to the South Nation River Basin Development Subcommittee. This draft report was then presented at various public meetings to residents of the Basin, to ensure that their comments and concerns were addressed. The culmination of the study process was the preparation of this final South Nation River Basin Water Management Study report.

This document outlines long term directions for major forms of land and water use, reflecting current economic needs and future opportunities for economic development and resource management. It identifies feasible measures to achieve protection against flooding, to provide for agricultural drainage and to secure adequate supplies of good quality water to meet the projected water supply needs of the major sectors of the Basin, including agriculture, forestry, fish, wildlife, residential, commercial, industrial and outdoor recreation. It provides a means of establishing water management priorities and practices that may be used on a continuing basis for funding and implementation.

1.5 PHYSIOGRAPHY

The South Nation River Basin lies in the Central Division of the St. Lawrence Lowland physiographic region of Canada. It comprises Paleozoic sedimentary rocks deposited onto the Canadian Shield from the Appalachian Mountain System and the overlying Quaternary (surficial) deposits resulting from the retreat of the Late Wisconsin ice sheet, the inundation of the Champlain Sea and the erosion and deposition of early phases of the Ottawa River.

1.5.1 Bedrock Geology*

Exposures of bedrock are not common in the Watershed, and do not impose any definite control on the topography of the area. It should be noted however, that the South Nation River in some places upstream of Lemieux, and in the vicinity of Plantagenet, is flowing on bedrock.

The oldest sedimentary rock unit is the Lower Ordovician, Beekmantown Group (dolostones and sandstones) which underlies the southwestern part of the Basin. It is overlain to the east by the Chazy Group (Middle Ordovician; limestone and shale) which occurs in a narrow north-south belt under the Little Castor, South Branch and South Nation rivers. The younger (Middle Ordovician) Trenton and Black River Groups (limestone, dolostone and shale) occur in the south-eastern part of the area.

The Gloucester Fault separates the older rocks in the southern part of the area from the younger rocks to the north. This fault is located along a northwest-southeast trending line across the Basin. A second fault, from Russell northeast through Casselman to St. Isidore de Prescott, separates these younger rocks from the Trenton and Black River Groups to the east.

The younger rocks comprise the Upper Ordovician Meaford-Dundas Formations, grey to black shales with some limestones and the younger Queenston Formation, a red shale that outcrops in a small area between Russell and Vars.

1.5.2 Surficial Geology*

The Watershed was last glaciated by the southward flowing Late Wisconsin Laurentide ice sheet. The retreat of the ice sheet was followed immediately by submergence by the Champlain Sea about 12,800 years ago, and the ensuing formation of the Ottawa River. The river cut various channels before eventually stabilizing in its present channel.

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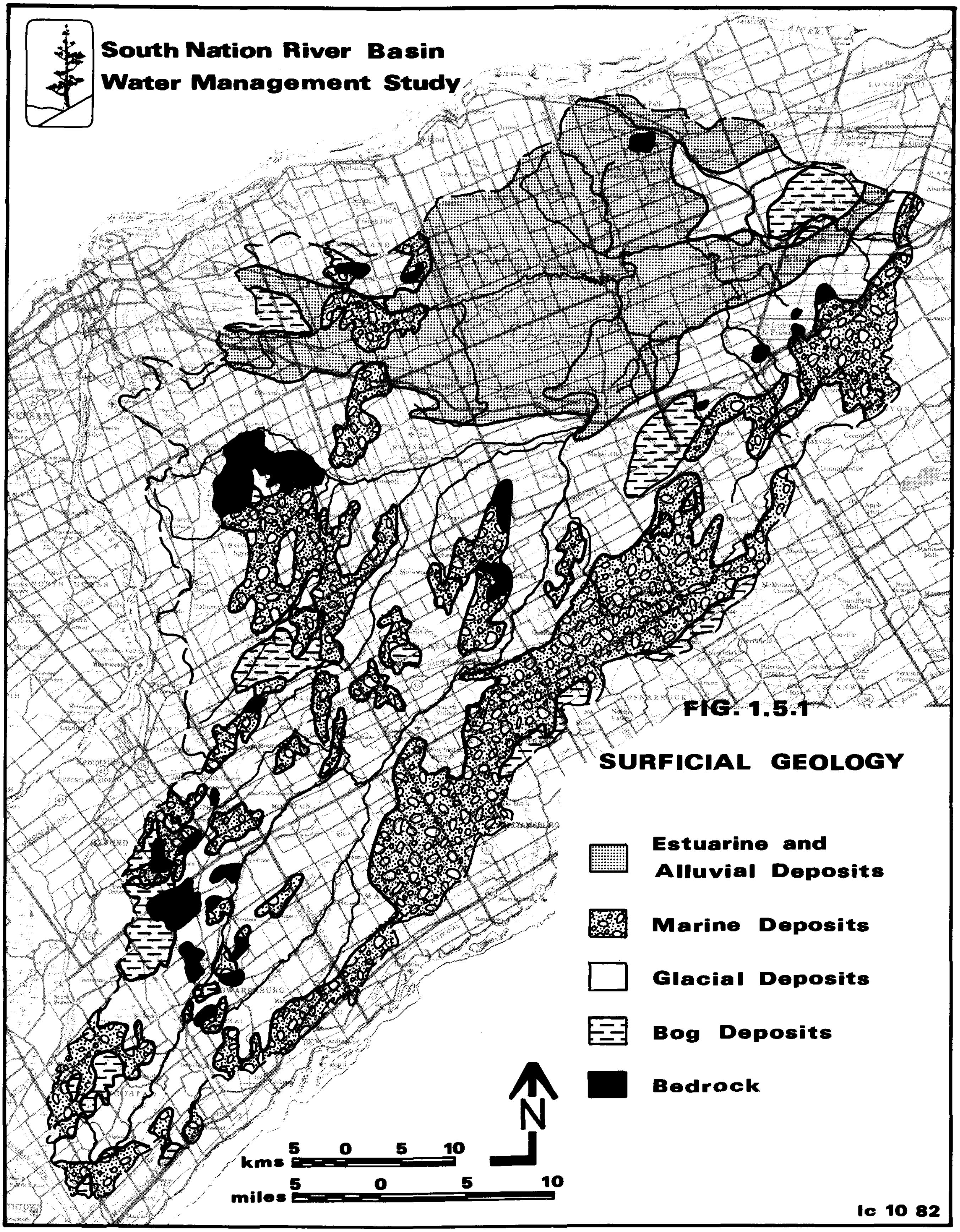
* (Source: Erosion & Sedimentation Background Study)



(Source; Erosion - Sedimentation Study)

The glacial deposits comprise till, sand and gravel. These materials underlie all younger materials and occur at the surface throughout the area but are also most prominent south of Highway 417.

The till is hard and compact, with a calcareous sandy silt matrix. The surface of the till is undulating to moderately rolling, and drumlinized in places in the southern half of the Basin. The sand and gravel is distributed sporadically throughout the Basin in the form of eskers and kames.

The marine deposits of clay and silt, sand and gravel occur throughout the Watershed. Thick clay and silt units underlie most of the northern part, but are also common in the southern part of the Basin. Sand and gravel occur mainly in the southern part. South of Crysler, the clay is grey to bluish grey, massive, sticky, sensitive and calcareous. North of Crysler the clay deposits are grey and red in colour, geotechnically sensitive and involved in all of the large landslides in the area.

Wave action during the regression of the Champlain Sea reworked the till exposed in knobs through marine clays and deposited a layer of medium to fine grained, well sorted sand over the marine clays. This sand cover is most common in the southern part of the area. In places wind action has reformed the sand into large areas of dunes. At the margins of the sea, wave action reworked the till knobs into gravel and sand beaches, bars and spits; these features are common only in the southern part of the Watershed. Also during the regression of the Champlain Sea, water flowing down the Ottawa River valley deposited deltaic and fluvial sand, clay and silt across the northern part of the area. This unit has been dissected by channels of the early Ottawa River which flowed across the northern part of the area after the regression of the Champlain Sea.

Bog deposits, of peat, organic silts, organic clays and muck up to three metres thick, occur in low lying areas, particularly on clays and in the abandoned channels, and along the drainage divides.

1.5.3 Soils*

The Basin is endowed with a variety of soil conditions which occur in a wide range of complex and intermixed patterns. These soil patterns control the agricultural capability and agricultural land use in the Basin.

Twenty-eight different soils have been recognized. In addition, some of these soils are further subdivided into textural, stony and depth phases, as well as grouped into complexes because they are so intricately mixed. The soils are associated with different physiographic units, an outcome of the glacial and postglacial activity. Figure 1.5.1 provides a very generalized distribution of the surficial geology. The soils developed on the surficial geology units are subdivided into 8 geomorphic or parent material groups.

1. Soils developed on Glacial Till
   The soils in this group are either medium or fine-textured and calcareous depending on the origin of the parent material. They are generally gravelly loam or clay loam.

2. Soils developed on Gravel Outwash
   Soils in this group have developed on coarse textured calcareous gravels. These are gravelly loams.

3. Soils developed on Sandy Outwash or Sandy Deltaic Deposits
   Soils in this group have developed on acid or non-calcareous gravels. These are gravelly or sandy loams.

4. Soils developed on Sandy Deltaic Overlying Clay Deposits
   This group of soils have developed in fine sandy deposits which overlie fine-textured lacustrine sediments and are generally classified as fine sandy loams.

5. Soils developed on Medium-Textured Deltaic Overlying Clay Deposits
   The deltaic deposits comprise layered silts and fine sands over clay and include sandy loams and silt loams.

---

* (Source: Agriculture Background Study)

6. Soils developed on Lacustrine Clay

   These soils are associated with non-calcareous red clay, calcareous grey clay and lacustrine silt. They are the clay and clay loam silts.

7. Soils developed on Limestone Bedrock

   A small area of loam silts has developed on the exposed limestone bedrock plain.

8. Soils developed on Organic Material

   Bogs formed in undulating till plains or depressions in clay or sand plains lead to the development of peat and muck soils.

The Basin soils and soil conditions occur in patterns which control the agricultural capability and land use in the Basin. The soils range from light, acid sands to muck soils, with large areas of highly productive clays and clay loams. A high proportion of these soils are suitable for agricultural production. Most of these high capability soils correspond to the Ottawa Valley and the Winchester Clay Plains.

Nearly 78% of the Basin area or 300,000 hectares is in agricultural soils capability classes 1-4. Table 1.5.1 summarizes the distribution of agricultural soils capability classes in the Basin, and Figure 1.5.2 geographically presents this information.

The nature of the soils under the forested areas is variable with all soil series supporting some of the forest. The distribution of the forest tends to be more closely related to surficial geology groups than to particular soil groups. Most of the high capability forest land occurs on upland sites, have originated from glacial activity and are comprised of till plains, sand and gravelly outwash deposits. Only a small proportion of the forest is on bottomland sites composed of lacustrine, marine and organic deposits. A very small area of forest occurs on shallow sites where bedrock occurs close to the ground surface.

Upland sites are comprised of the following physiographic regions, as recognized by the Canada Land Inventory: the Prescott and Russell Sand Plain; the Edwardsburgh Sand Plain; the North Gower Drumlin Field. Generally, these sites extend along the perimeter of the Basin, with the exception of the Prescott and Russell Sand Plain which extends east from Russell to St. Isidore de Prescott.

TABLE 1.5.1

Land Capability Summary

Land Class & SubClass	Total Area ha	% in Basin	% in Agriculture
1 Land has no significant limitations for a wide range of crops. The soils are deep, well drained and occur on level or nearly level topography.	35,966	9.2	85.0
2 Land has moderate limitations that may restrict the range of crops. The limitations could include imperfect drainage, rolling topography, moderate erosion and stoniness.	93,812	24.0	82.5
3 Land has moderately severe limitations that restrict the range of crops or the land may require special management practices to sustain productivity.	108,812	28.0	73.5
4 Land is subject to severe limitations. The soil is too susceptible to erosion, too stony or too poorly drained to be cultivated on a regular basis.	64,206	16.4	37.3
5 The limitations are severe. Class 5 land is unsuitable for cultivation but could be developed as grazing areas.	36,386	9.3	18.7
6 Land is capable of producing perennial forage crops and should be kept in a permanent vegetative cover. The limitations include steep slopes, severe erosion, and shallow soil over bedrock.	13,689	3.5	36.8
7 Land is not considered suitable for agriculture and includes rockland, quarries and areas virtually devoid of soil.	111	-	50.0
Organic Soils	36,894	9.4	30.0
Water	550	0.1	-
Totals	390,426	100.0	60.2

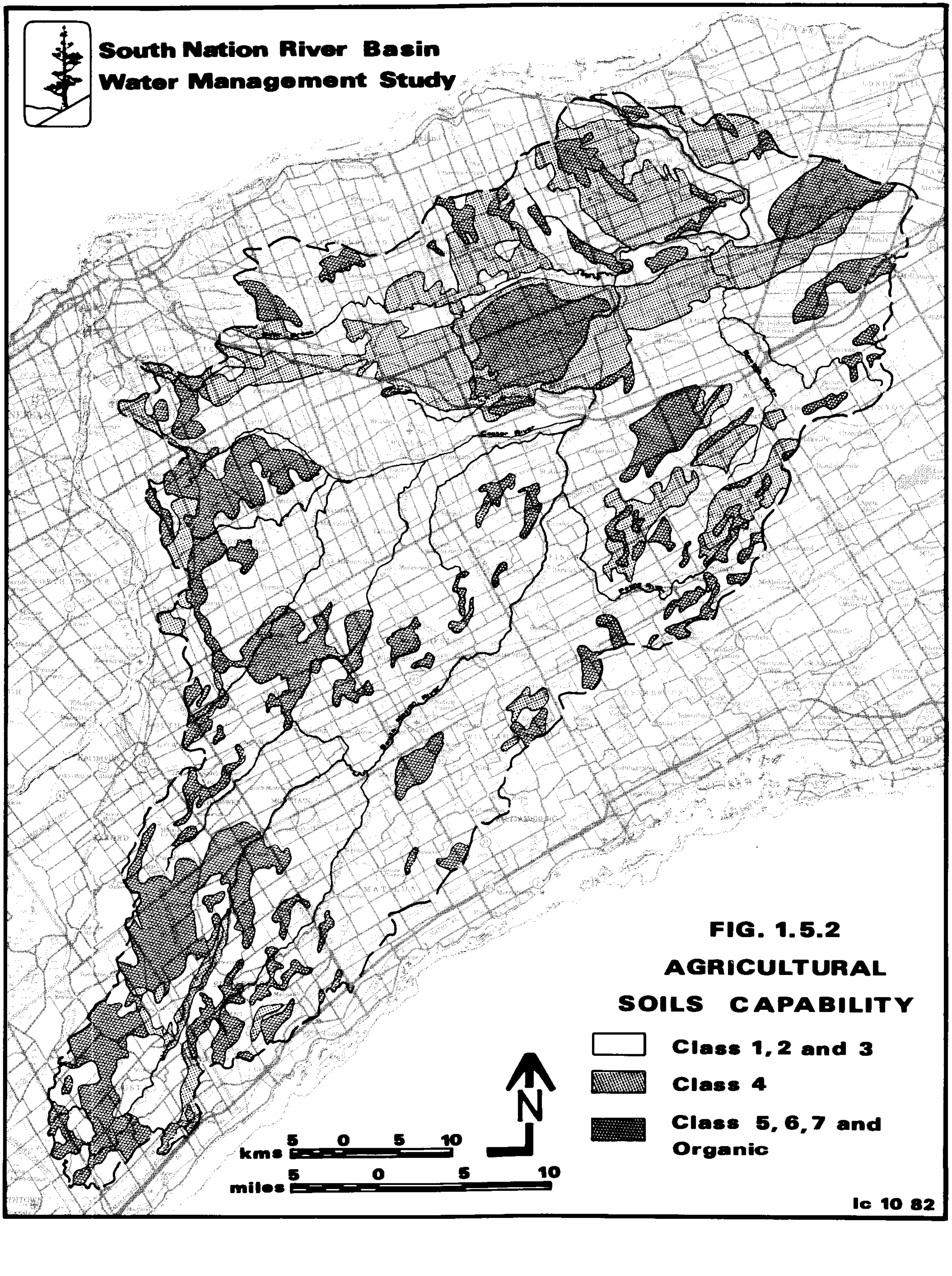


FIG. 1.5.2
AGRICULTURAL SOILS CAPABILITY

Bottomland sites occur adjacent to river corridors in the Basin, along all branches of the South Nation River, and along the Castor River. The Canada Land Inventory recognizes these areas as the Ottawa Valley Clay Plain, Winchester Clay Plain, and the bogs and marshes.

Portions of the Smiths Falls Limestone Plain extend into the Basin and are referred to as shallow sites. Shallow sites are located in the vicinity of Metcalfe and in the upper portions of the Basin near Brockville.

1.5.4 Climate

The South Nation River Basin lies within the Eastern Counties Climatic Region and is characterized by a continental type climate with warm summers and cold winters.

The meteorological station at Kemptville has generated the following statistics which are considered applicable to the Basin. Seasonality statistics are taken from the Agriculture Component Report. Refer to Figure 1.5.3 for climatic trends.

a) Precipitation

• Mean annual precipitation (range)	810 - 890	mm
snowfall (range)	2030 - 2440	mm
• Mean annual evapotranspiration (range)	530 - 560	mm
• Mean annual water deficiency (summer)	50	mm
• Mean annual water surplus	300	mm

b) Temperature

• Mean annual temperature		6°C
• Mean daily max.	January	-4°C
	July	27°C
• Mean daily min.	January	-15°C
	July	14°C

c) Seasonability

• Frost-Free period	south	140 days
	north	130 days

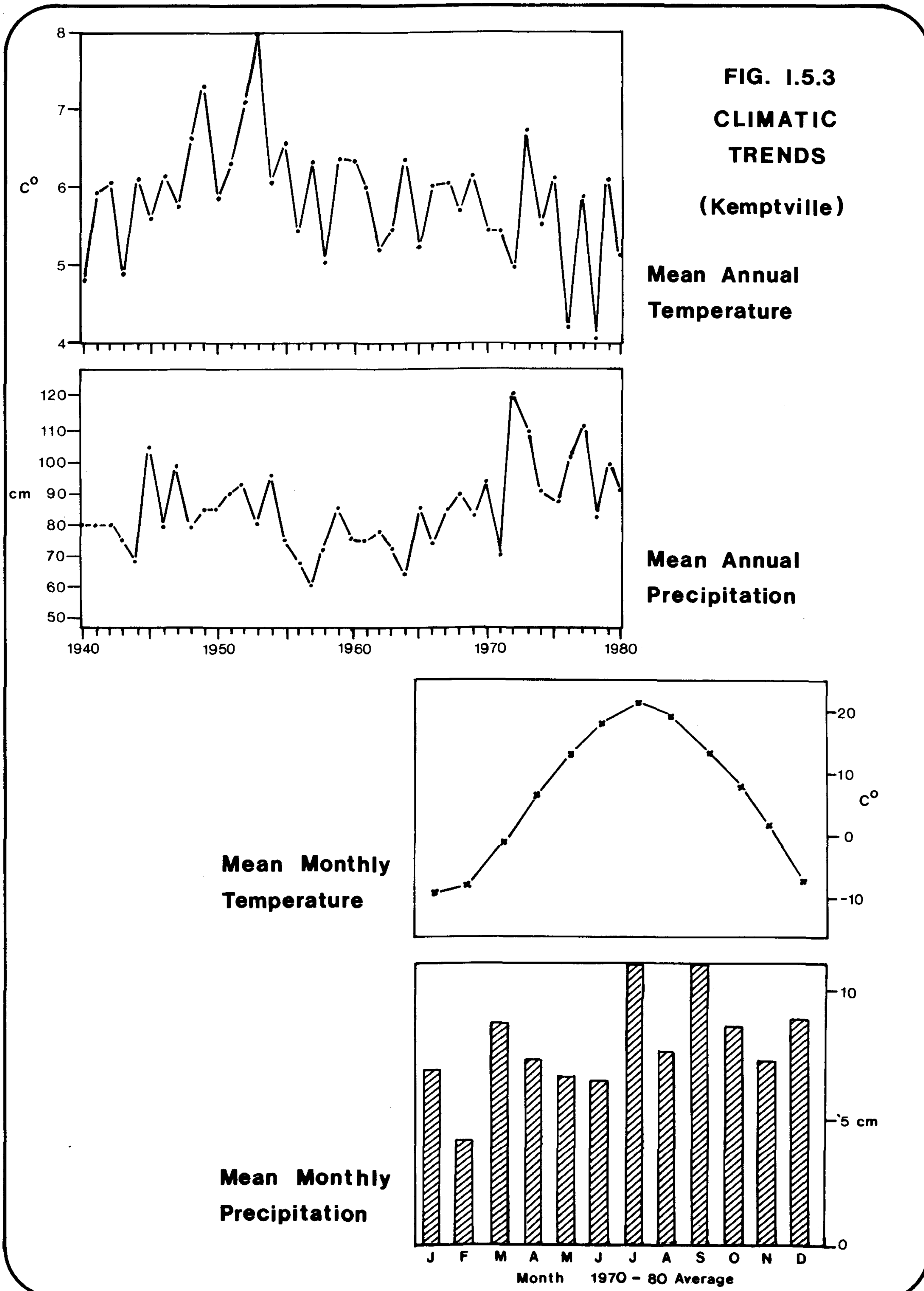


FIG. 1.5.3 CLIMATIC TRENDS (Kemptville)

•	Mean last frost in spring May 15	± 15 days
•	Mean first frost in fall- south - Sept.30	± 15 days
	- north - Sept. 15	
•	Growing period- south	200 days
	- north	190 days
•	Growing degree days	3,400 days
•	Corn heat units - south	2,700
	- north	2,500

In general, the South Nation River Basin has a favourable climate for most perennial and cereal crops. A drier fall period would be more favourable to the maturing and harvesting of crops such as corn and soybeans. It has been found that climatic constraints can be overcome to some extent with new plant varieties and improved cultural practices. Other areas such as forestry, recreation and commercial/industrial development are less sensitive to climatic factors than agriculture.

1.5.5 River System

The South Nation River rises near Brockville and flows in a general northeasterly direction until it joins the Ottawa River at a point 38 km east of Ottawa. The total area of the drainage basin is 3900 km^2. The average slope of the main stream is 0.0005 which corresponds to a fall of 85 m in a river length of 175 km.

Although the river drains an almost flat plain, there are regional differences. The source area is located on a limestone plain which has little overburden apart from peat bogs, and the small streams wander from one swampy depression to another without entrenching themselves. In the first 11 km the average mainstream slope is 0.0027. For the next 37 km the slope is uniform at 0.0006 and the river has cut a shallow valley through a region of slightly deeper drift which is dominantly composed of water-laid sands overlying clay. Near South Mountain, however, the river enters the Winchester clay plain and in the next 27 km to beyond Chesterville, the slope is only 0.0003. Between Chesterville and Crysler there is a slope of 0.0004 and more of an actual valley which deepens below Crysler until the solid rock is exposed at Casselman. Below Casselman, the river swings west and north again at a slope of 0.0006 to cut a canyon, 25 m deep, through a broad sand plain.

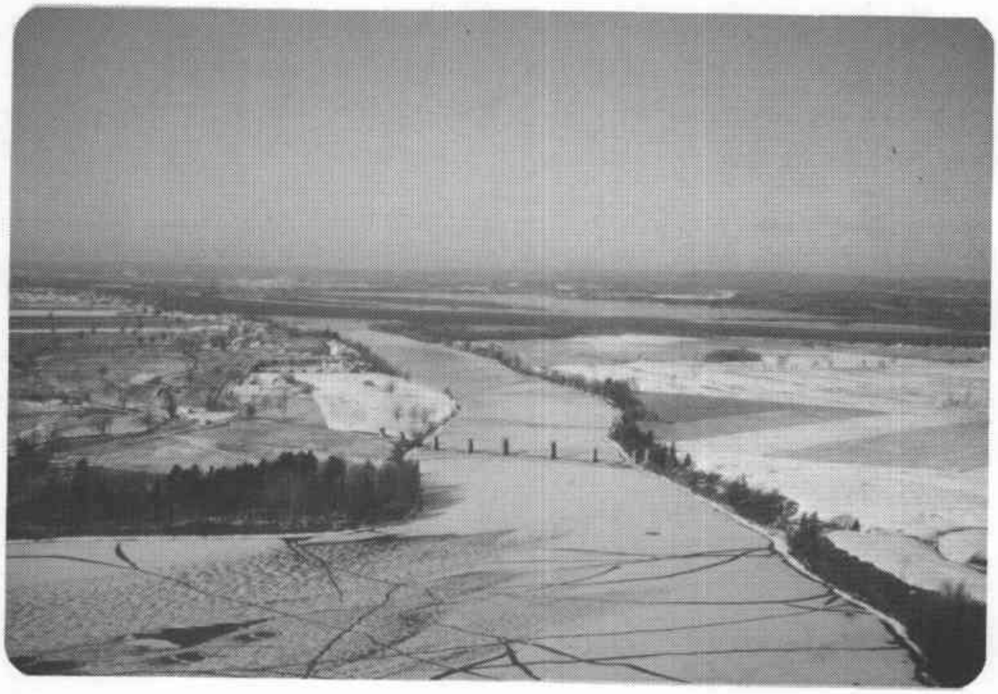


PHOTO 1.5.1

SOUTH NATION RIVER
AT OTTAWA RIVER

PHOTO 1.5.2

PAYNE RIVER

Near Lemieux, the river enters upon a broad clay plain and for the next 25 km has hardly any gradient and only a very shallow valley, held up by the rock sill at Plantagenet Springs.

The South Nation River has several important branches, the largest being Bear Brook and the Castor River. Both of these have shallow channels and drain very flat areas. Others include the South Branch, the Scotch River and the Payne River. The river system has not yet been able to establish drainage on its whole territory, and there are numerous peat bogs including the Alfred, Mer Bleue, Winchester, Moose Creek and others.

Photos 1.5.1 to 1.5.6 show typical river scenes in various parts of the watershed. Figure 1.5.4 is a map of the river system.

In order to understand the hydrologic processes of the South Nation River, the characteristics of the Basin terrain and its rivers were analyzed. Detailed analyses (from Water Resources Background Study) of the problem areas are presented in the water management sections of Part II, however a general overview of river flows here provides an introduction to the understanding of the river hydrology.

There are 16 hydrometric stations located in the various river sub-basins (See Figure 1.5.4). Table 1.5.2 presents a summary of the discharge flow data which have been gathered over many years. The length of record varies from 3 years at 4 stations to 66 years at Plantagenet Springs. As can be seen from Table 1.5.2, by comparing the mean annual flow and the mean flood flows, considerable seasonal variations in flow magnitudes exist. Flow rates per area also vary from tributary to tributary. The high flows in the spring coupled with a lack of channel capacity contributes to significant flooding in rural areas, on an annual basis. In the summers, during periods of high evaporation and low precipitation, the flow in some branches of the rivers can virtually dry up.

Chapman and Putnam (1966) have summarized the physiography of the river as follows:

"Physiographically, the South Nation is an inadequate river, a boy trying to do a man's job. It is a stream which is prevented from reaching maturity by its lack of

PHOTO 1.5.3 WEST BRANCH OF SCOTCH RIVER

PHOTO 1.5.4 CASTOR RIVER JOINS SOUTH NATION

PHOTO 1.5.5 BEAR BROOK

PHOTO 1.5.6 SOURCE AREA: MER BLEUE

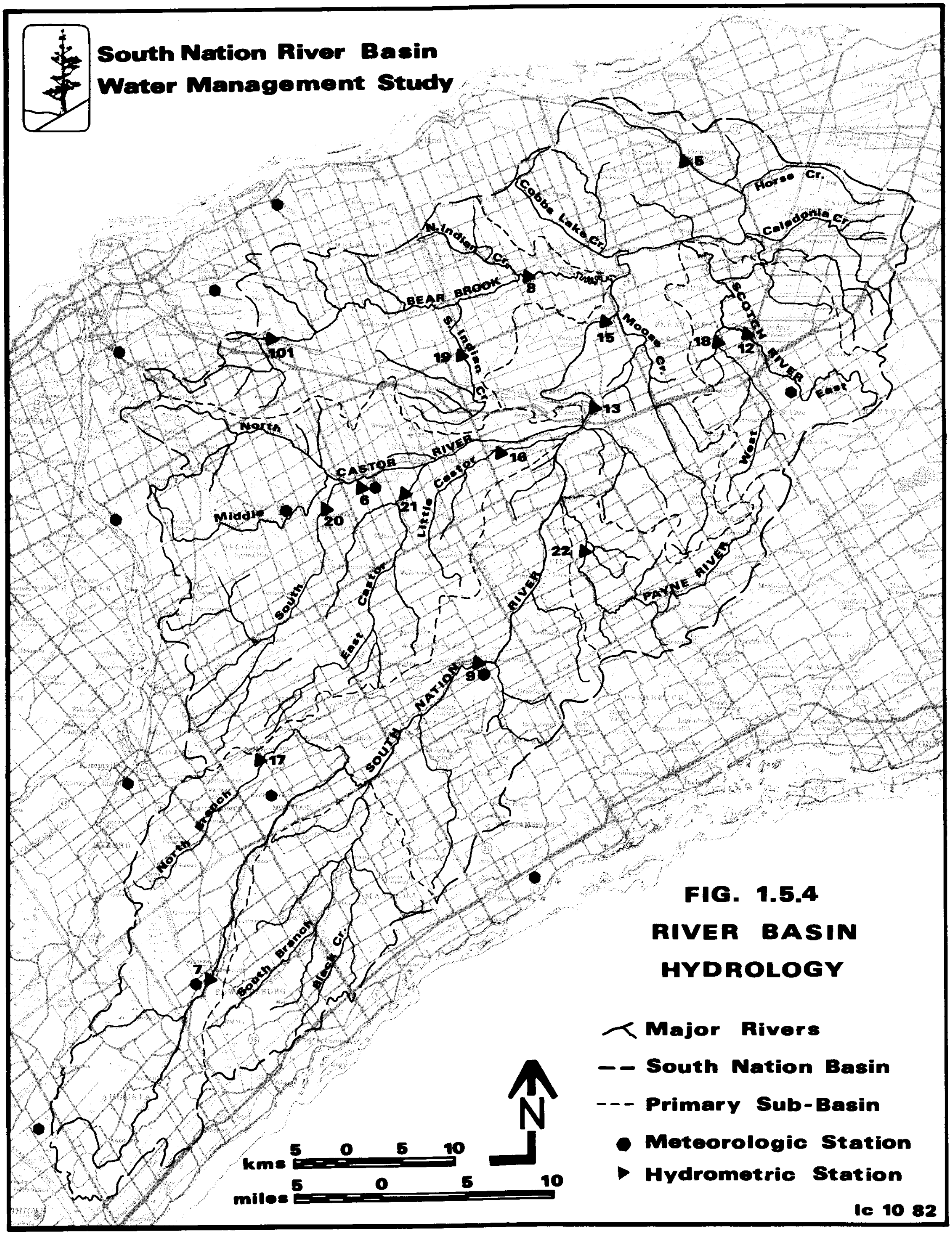


FIG. 1.5.4
RIVER BASIN HYDROLOGY

gradient, which even now is less than that of many a senile river. It therefore presents a difficult problem of drainage and flood control."

1.6 HISTORY OF DEVELOPMENT*

The South Nation River Basin holds a variety of cultural and heritage resources including archaeological resources, cultural landscapes and historical structures. These resources relate to a long history of settlement from the Archaic period of 5000 B.C. to the farming landscape of today.

The first period of Indian occupation identified in the South Nation River Basin is the Archaic (5000 to 1000 B.C.). The Archaic culture had primarily a hunting, fishing, and gathering subsistence economy. Archaic cultural remains or artifacts have been found in the Basin and further survey may reveal Archaic campsites or quarry workshops.

The next two periods of Indian pre-history in the Basin are the Initial and Terminal Woodland which lasted from 1000 B.C. until contact with European cultures. These periods are marked by the development of agricultural practices, first by the organized harvesting of wild crops such as rice and finally by full-scale exploitation of such crops as corn, beans, and squash. Archaeological sites from the Initial Woodland period include camp sites, quarry sites, and cemeteries, while the Terminal period includes the sites of former villages and hamlets as well.

The most active indigenous settlement, the St. Lawrence Iroquois in the Basin area, appears to have existed from 1300 to 1500 A.D. and continued until the "mysterious" disappearance of the Iroquois people from the Basin sometime after Cartier's visit to Hochelaga (Montreal) in 1535. Several St. Lawrence Iroquois sites have been identified in the Basin area south of Spencerville. The most noteworthy is the famous Roebuck site, a former Indian village that was excavated by archaeologists in 1912. A provincial plaque marks the location of this site just east of Roebuck in Augusta Township. Figure 2.6.1 in the cultural and natural heritage section, shows representative archaeological sites in the Basin.

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* (Source: Historical Background Study)

In 1783, most of Eastern Ontario was purchased from the Indians by the British, and the first settlers were disbanded soldiers and their families that had served in the British Forces during the American Revolution. The eight townships along the St. Lawrence River were the first to be settled by groups according to religious affiliation. The inland townships were later gradually filled in by British settlers.

Prior to European settlement the Basin was heavily timbered. Logging was relatively small scale until the 1830's when a few larger operations were initiated in the square timber industry. Later, interest was turned to the saw log industry for local building needs. More recently the pulp and paper industry has become dominant.

In the 1850's and 60's, large numbers of French settlers moved into the northeastern part of the basin from Quebec due to population pressure in Quebec, and vacant land in the Basin. This led to an increased French Canadian population in Prescott and Russell Counties. The trend has continued to the present time and the area is now predominantly French. Glengarry and Stormont were settled by the French after 1900 as the English vacated farms to move west.

The Watershed has remained predominantly rural and non-industrial. Early farming was at a subsistence level and the major activity was in dairy enterprises. This resulted in dairy processing becoming the major industry of the region; a characteristic which has persisted to the present. The agricultural nature of settlement has given the Basin many unique heritage resources. Examples of which are the mills and heritage farmsteads. One farmstead of particular importance is the McIntosh Farm from which the McIntosh apple originated (see Photo 1.6.1).

Many river-oriented heritage resources are included in the Heritage Resource Study including the following:

1. Jessups Falls where a turning basin was used by Ottawa River steamers, where logs were gathered to be floated downstream to Quebec, and where the old Canadian Northern railway bridge abutments cross the South Nation River;
2. High Falls - Coupal Dam, where a hydro electric power plant was erected in 1909-10 and the upstream terminus for steamboats that travelled the South Nation River from the "Pitch-off" or limestone ridge at Plantagenet Springs was located; and

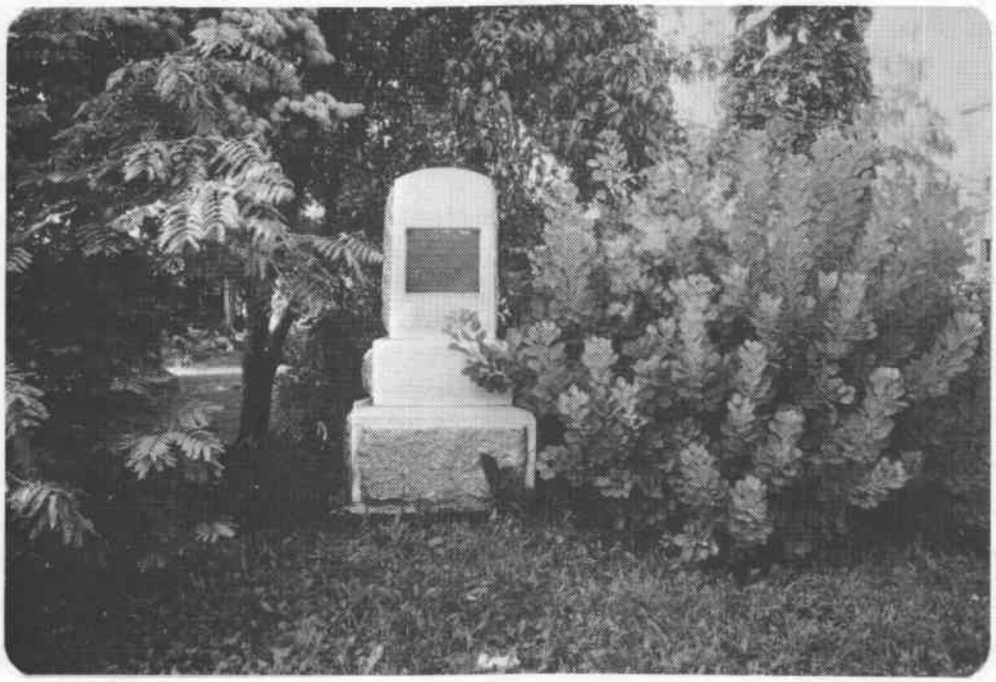


PHOTO 1.6.1 MCINTOSH APPLE MEMORIAL PLAQUE

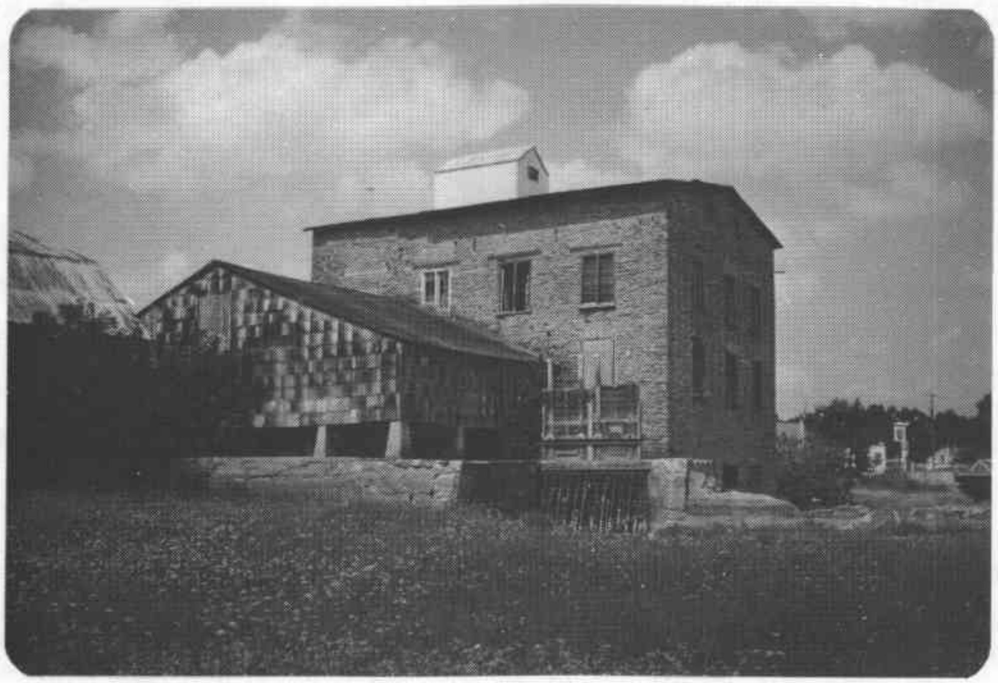


PHOTO 1.6.2 SPENCERVILLE MILL, SPENCERVILLE

3. Spencerville Mill, which is one of the two remaining mill structures in the Basin.

Representative historic sites which relate to water management are shown in Figure 2.6.1.

1.7 DEMOGRAPHIC PROFILE*

The South Nation River Basin lies within 3 political county units; Prescott -Russell, Stormont - Dundas - Glengarry, Leeds - Grenville, and one Regional Municipality, Ottawa-Carleton. Its area is further divided by 25 townships. The townships and county boundaries are outlined on Figure 1.7.1. Within the Basin townships, 7 villages and 32 unincorporated settlements have developed over the years, based on the needs of farm and rural non-farm families in the surrounding area.

The growth rate of the population within the Basin remained significantly below that of Eastern Ontario, generally, up until 1971, when the trend began to reverse itself to effect a Basin growth rate significantly above the Eastern Ontario and Ontario averages (see Table 1.7.1).

This post-1971 growth in the Basin reflects the outward expansion of the Ottawa commuting area and the increasing popularity of an alternative rural lifestyle. The rural area within easy driving distance of Ottawa or the commutershed, composed of less than one-third of all Basin municipalities, increased its share of Basin population from 44% in 1961 to 50.4% in 1979. Information regarding the population structure, as reflected by the settlement patterns of the Basin residents, revealed a recent trend towards populating small urban centres.

During the same period, the population of the rural area (everything outside of the defined incorporated and unincorporated urban centres) was shifting substantially from a farm population base to a non-farm base. In 1966, the farm population of Basin municipalities constituted 63% of the rural population total, but by 1976, this figure had dropped to only 25% (Agricultural Background Study).

* (Source: Residential, Commercial, Industrial Background Study)

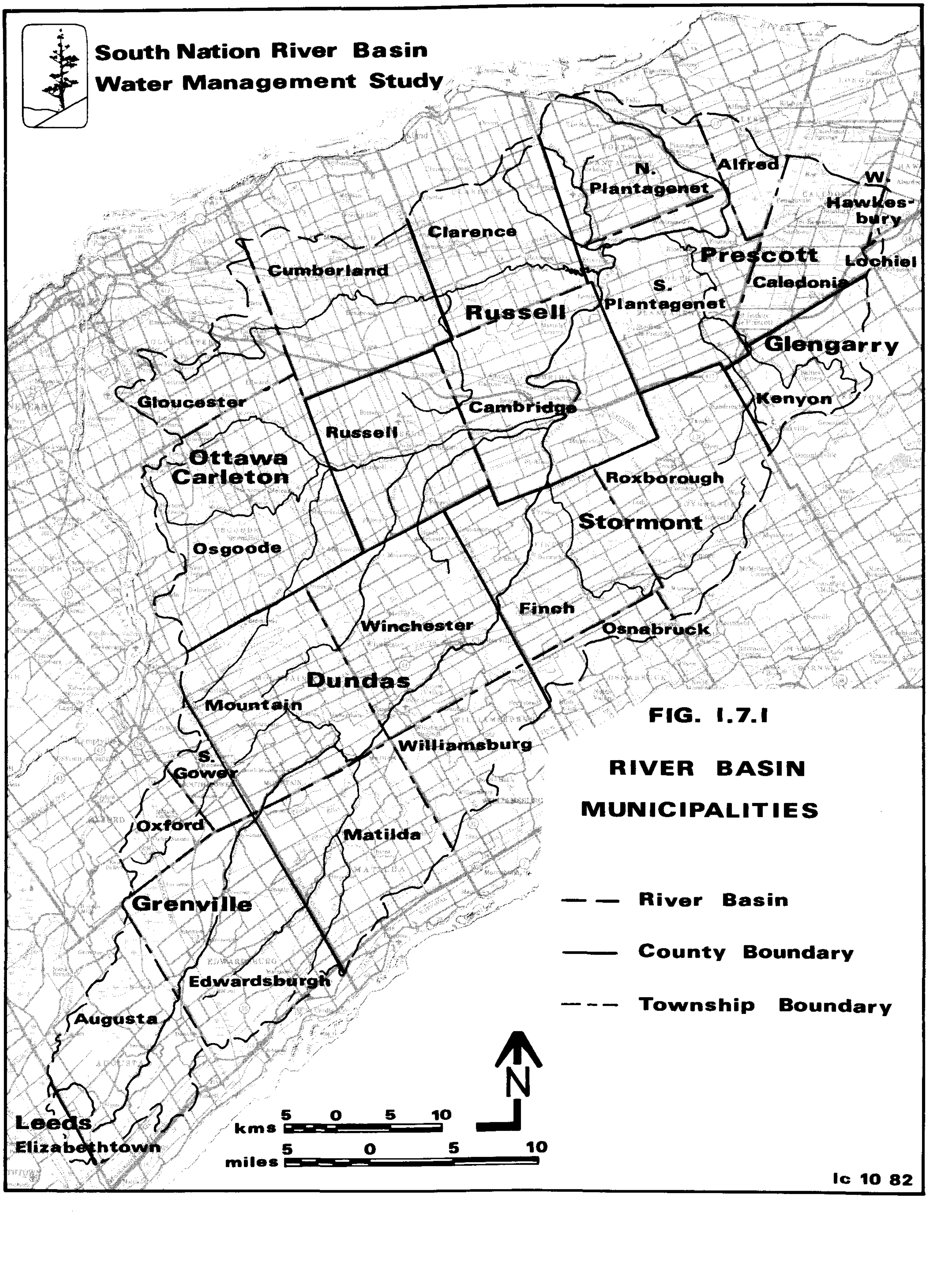


FIG. 1.7.1

RIVER BASIN MUNICIPALITIES

TABLE 1.7.1

Basin Population

Basin Population			Percentage Increase in Population		
			Basin	Eastern Ontario	Ontario
1961	58,403				
1966	59,303	1961-66	1.5%	7.7%	11.6%
1971	62,426	1966-71	5.2%	8.0%	10.7%
1976	68,579	1971-76	9.8%	4.6%	5.6%
1979	74,120	1976-79	8.0%	2.8%	2.5%

(Source: Residential, Commercial, Industrial Background Study)

At the same time that the farm population was declining, non-farm population was growing sharply to effect an annual 3.3% population increase. This significant growth was experienced by all municipalities within the Basin, but occurred most dramatically for areas within the Ottawa commutershed.

These trends of growth are expected to continue in the future at a slower rate, so that in time the farm vs. non-farm population ratio will stabilize at a level which will ensure the continuation of farm enterprises (see Figure 1.7.2).

The overall projected population increases indicate that the Basin population is expected to increase at a declining rate but still be ahead in growth as compared to Eastern Ontario and the province (Table 1.7.2).

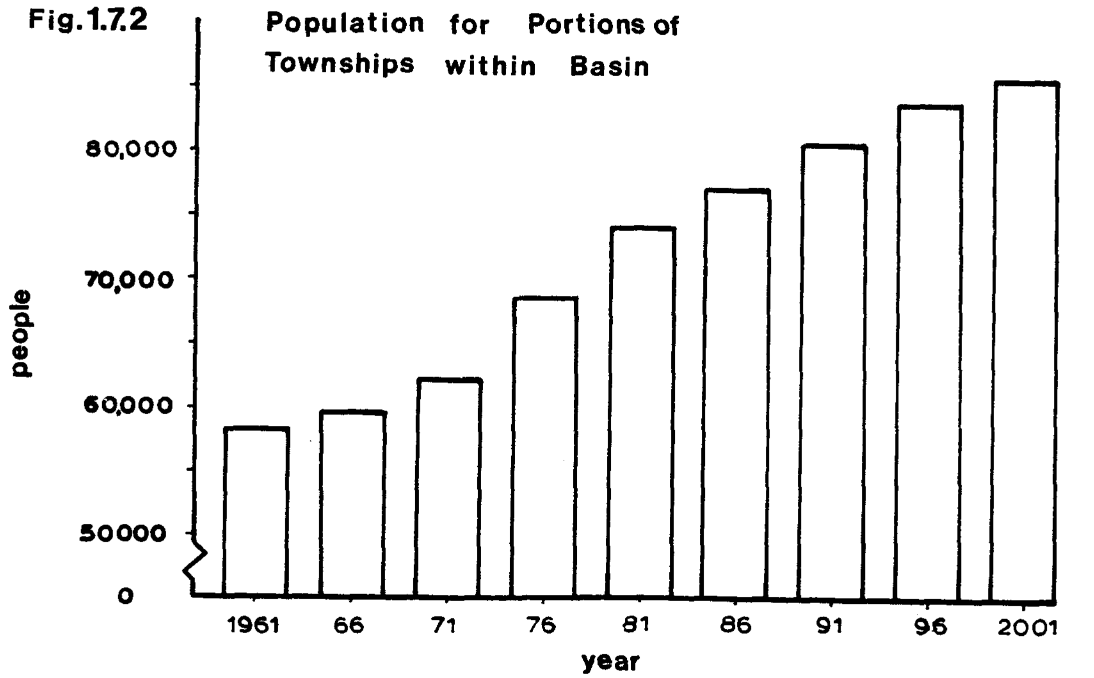
TABLE 1.7.2

Projected Basin Population

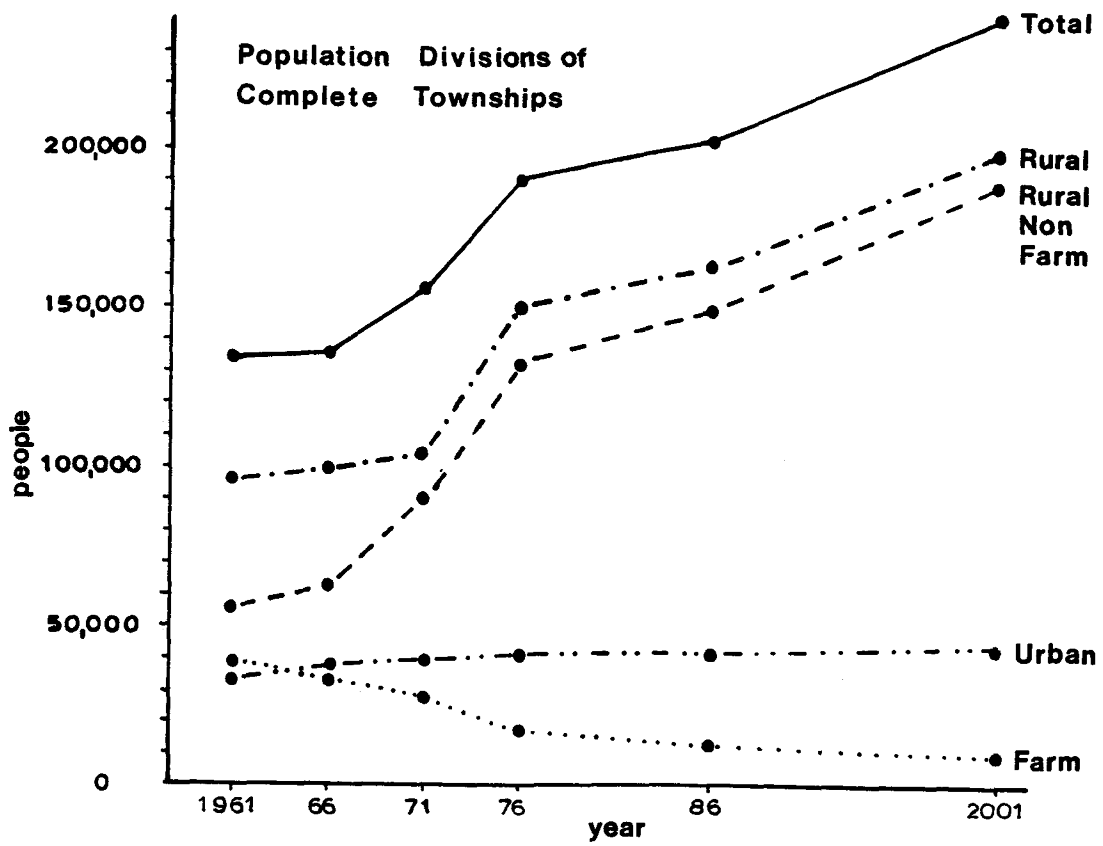
Projected Basin Population			Percentage Increase in Population		
			Basin	Eastern Ontario	Ontario
1986	77,035	1981-86	5.3%	4.0%	5.1%
1991	80,675	1986-91	4.7%	3.1%	4.2%
1996	83,628	1991-96	3.7%	1.9%	3.2%
2001	85,883	1996-2001	2.7%	1.0%	2.3%

(Source: Residential, Commercial, Industrial Background Study)

Fig.1.7.2



(Source: Residential, Commercial, Industrial Study)



(Source: Agriculture Study)

2.1 LAND USE IN THE SOUTH NATION WATERSHED

Sixty per cent of the land base is devoted to agriculture. This represents about 236,600 ha as is identified with 6 different major systems, ranging from the monoculture and corn system through the mixed, the hay and the hay-grazing and grazing systems. The minor system included under the non-agricultural section comprise specialty agriculture (market gardens, nurseries and orchards) and sod farms. The other 40 per cent of the Basin is utilized by non-agricultural uses such as towns, woodlots and treed areas, forest plantations, swamps, extractive areas, recreational lands, and those lands which are mapped as being idle land.

The distribution of the land among major uses is as shown in Table 2.1.1 and on Figure 2.1.1.

TABLE 2.1.1

Land Use in the South Nation River Watershed

Land Use	Hectares	Proportion
Agriculture	237,000	60%
Woodlands	90,000	23%
Wetlands	9,000	2%
Forest Plantation	2,000	1%
Idle Land	34,000	9%
Urban & Other	19,000	5%
Total	391,000	100%

2.2 AGRICULTURE*

2.2.1 Agricultural Land Resource

The Forestry and Agriculture Resources Inventory of Eastern Ontario (FARINEO) has indicated that the monoculture land use system occupies some 10,800 ha or 3%

* (Source: Agriculture Background Study)

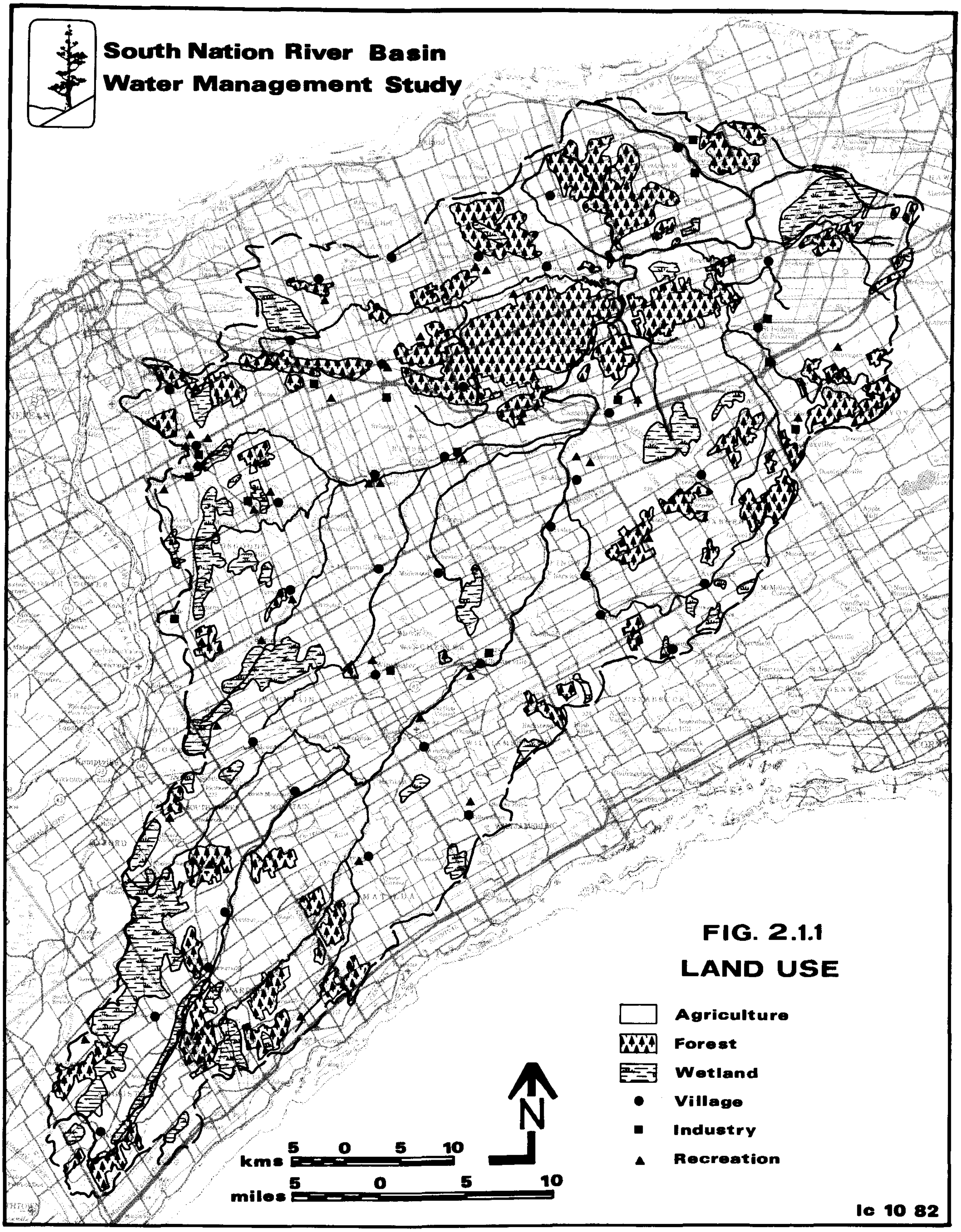


FIG. 2.1.1
LAND USE

of the Basin area. This monoculture system is essentially a non-rotational cropping system and reflects a continuous system of the same crop year after year. In the Basin, it is predominantly corn. The corn land use system occurs over approximately 42,420 ha or about 11 per cent of the Basin. This system, while predominantly corn, reflects a rotational pattern with hay and pasture and some grains. In the Basin, indications are that about 60 per cent of this system would be in corn, either for silage or grain. The corn system appears to be an integral part of the dairy-livestock operations. The areas under the monoculture and corn systems reflect some of the more intensively managed lands in the Basin, as well as those which are extensively under "clean" cultivation practices.

The mixed agricultural land use system can be found over approximately 77,700 ha, or 20 per cent of the Basin. This system reflects the rotational pattern with less extensive areas of corn and more area in grain and hay. It reflects the more traditional agricultural pattern that is normally associated with livestock operations in the Basin. Indications are that about 20 per cent of the system is in corn with the remainder in grain and hay.

The hay system, on some 77,300 ha or 19% includes lands that are predominantly in hay with some cereals and corn. This system reflects a less intensive agricultural land use associated with extensive types of livestock operations.

The monoculture, corn, mixed and hay systems represent, in general, the "improved" area of the Basin, while the hay/grazing, grazing and idle agricultural land systems constitute, in general, the "unimproved" area of the Basin.

The hay/grazing system can be found over 20,300 ha or 5 per cent of the Basin. This system appears to be associated with extensive type livestock operations and often with marginal type lands. The grazing system has been found over 6,100 ha or 1.6 per cent of the Basin. Lands in this category comprise the rough pasture and grazing lands that are normally associated with marginal agricultural land resource.

Almost 9 per cent of the land is idle land, representing close to 34,000 hectares of land currently not being used. A study of the idle land was carried out to identify the future use potential of these lands and the reasons for idleness. Of the 34,000 ha about 2,200 ha have been returned to agricultural use and are no longer idle, and another 4,300 ha have some agricultural potential. The remaining 27,500 ha are generally not suitable for agricultural use and most of this acreage is currently sustaining a variety of tree cover.

2.2.2 Agricultural Economic Profile

The South Nation River Basin is one of the most highly productive and rapidly growing agricultural areas of Eastern Ontario. The value of farm production in the Basin increased between 1961 and 1976 from $53.7 million to $170.2 million or 212%. Milk is the single most important farm commodity in the Basin counties. Production rose from just over 88.1 million litres in 1961 to 484.6 million litres in 1971. The level of production has remained relatively constant at about 484.6 million litres since. This level of production has been maintained recently in spite of a decline in the number of dairy farms. The farms have become larger, with larger cow herds, and higher production per cow.

Equally dramatic have been production increases achieved in grain corn. In 1961, the grain corn production in the Basin counties was 4,812 tonnes; ten years later, in 1971, it had exceeded 144,828 tonnes and by 1979, it had reached 210,889 tonnes.

In 1971 there were 3,008 farms with sales of $2,500 or more in the area, and four-fifths of them were dairy farms. By 1976, the total number had decreased by 8.3% to 2,747 farms - of which two-thirds were dairy enterprises. The number of dairy farms decreased by 23% over that period, while the number of beef cattle, hog and other livestock enterprises increased from 389 to 505 (about 30%). Poultry farms decreased from 87 to 63 over the 1971-76 period. The number of field crop enterprises increased sharply from 70 to 200 farms, and enterprises with a main source of income from fruit and vegetables increased from 35 to 51 farms.

Farm size has been increasing. The percentage of farms that were 97 hectares or more increased from about 26% of the total in 1961, to more than 31% in 1976. Capital investment also increased substantially between 1971 and 1976. In 1971, about 11% of the farms had a capital investment of more than $100,000. By 1976, about 63% of the farms had more than that invested. Some of these increases were due to inflation.

Livestock numbers generally decreased in the Basin from 1971 to 1976 (see table below). The pattern continued through 1980, with the exception of fowl and sheep numbers which increased during that period.

TABLE 2.2.1

Livestock Population

Livestock	Total Number 1971[1]	1976[1]	1980[2]
Cattle	151,154	146,815	138,000
Milk Cows	79,638	71,790	56,500
Pigs	35,842	24,026	60,000
Sheep	2,171	4,646	7,500
Hens & Chickens	995,836	870,232	2,225,000
Laying Hens	708,675	596,409	n.a.
Turkeys	65	312	350
Geese	566	1,323	n.a.
Ducks	508	1,494	n.a.

1 Based on special run of Census of Agriculture, Basin enumeration areas.
2 Estimulated from Ontario Ministry of Agriculture and Food Statistics.

Areas of selected field crops are shown in Table 2.2.2 for 1971, 1976 and 1980. Area increases in the future are expected to occur with cash crops, including soybeans and canola (not shown). Expansion of cash crops is predicated on extensive new tile drainage.

There were 35 growers whose main source of income was from fruit and vegetable production in 1971. By 1976, the number had risen to 51 growers. Area of the main commodity groups are shown in Table 2.2.3.

Fruit and vegetable growers in the Basin have a long history of commercial production and marketing of their products. The development of the McIntosh apple is one example. Vegetable production in Cumberland Township is another. More recently the interest of consumers in obtaining farm-fresh produce has led to the development of a new group of producers with pick-your-own operations. At the other extreme is a small number of growers that have successfully tailored their operations to commercial production of potatoes, mushrooms, and turnips for the Ottawa wholesale trade.

TABLE 2.2.2

Area of Selected Field Crops In The Basin, 1971, 1976 and 1980

Crop	Hectares 1971[1]	1976[1]	1980[2]
Tame Hay	63,468	71,015	69,605
Corn Silage	17,023	23,791	15,783
Grain Corn	15,408	14,595	18,818
Grain Oats	17,385	14,199	10,117
Barley	2,449	2,197	4,247
Mixed Grains	7,788	7,022	8,984
Wheat	420	983	283
Total	123,941	133,802	127,641

1 Based on special run of Census of Agriculture Basin enumeration areas.

2 Estimated from Ontario Ministry of Agriculture and Food statistics. Assumes crops are evenly distributed within each county.

TABLE 2.2.3

Fruit and Vegetable Crop Area in the Basin, 1971 and 1976

Crop	Hectares 1971	1976
Potatoes	650	511
Vegetables	214	243
Tree Fruits	165	228
Small Fruits	9	13
Total	1,046	995

Photos 2.2.1 to 2.2.4 illustrate typical agricultural activities in the Basin.

AGRICULTURAL DEVELOPMENT

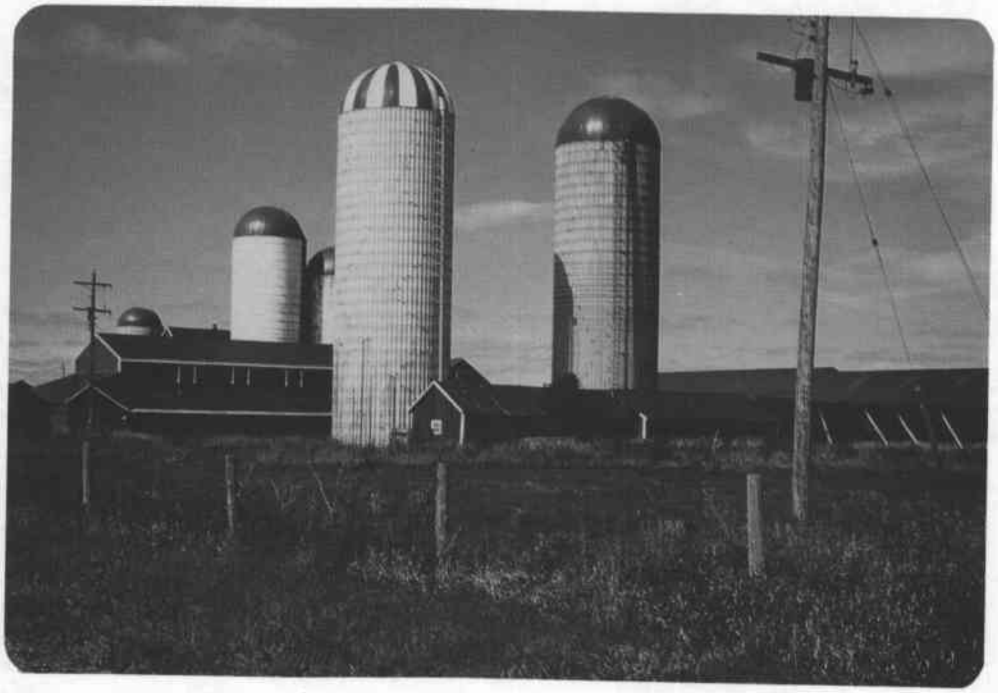


PHOTO 2.2.1 DAIRY AND OTHER LIVESTOCK - THE MAINSTAY

PHOTO 2.2.2 TRADITIONAL CASH CROPS - HARVESTING BARLEY

AGRICULTURAL GROWTH

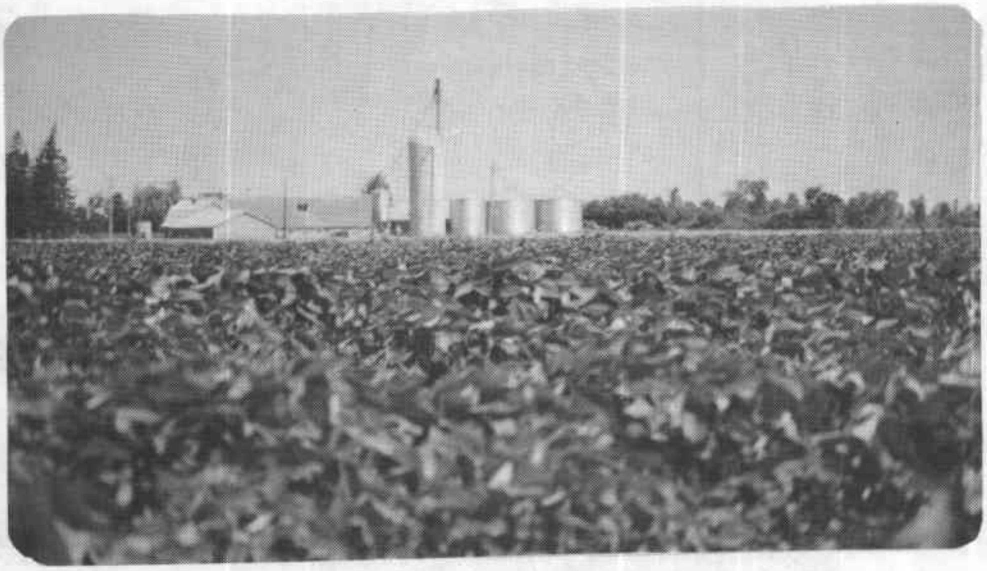


PHOTO 2.2.3 EXPANSION OF NEW CASH CROPS - SOYBEANS

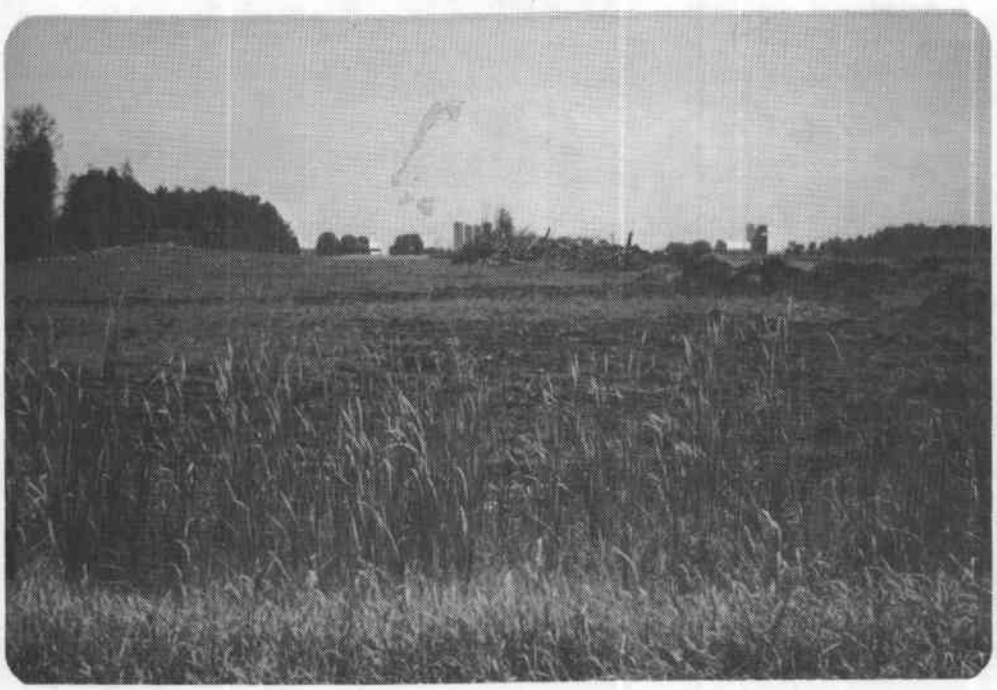


PHOTO 2.2.4 RECLAIMING LAND FOR AGRICULTURE

2.2.3 Agriculture Opportunities and Constraints

The potential for agricultural development and growth lies mainly in the expansion and diversification of farm enterprises to produce cash crops such as corn, soybeans, canola and a range of horticultural crops. The production of milk is the single most important agricultural activity in the Basin and it will continue to be for the foreseeable future.

The major constraints on agricultural development are the lack of drainage and climate which restrict the land base in terms of its ability to produce crops for food and feed. The opportunities, constraints and trends are outlined in discussions below, and are shown in Tables 2.2.4 and 2.2.5.

Livestock

The trend to fewer and larger dairy farms is expected to continue as those with smaller herds retire or leave the industry. Expansion of the industry will depend on the farmers' ability to buy additional milk quota. Other opportunities for additional income may include veal production and expansion into cash crops.

Meat production will continue to be an important part of the agricultural industry in the Basin. In the long term, beef cattle will be kept mainly as scavengers on cash crop farms or on farms operated by part-time farmers. Dairy beef and veal production appears to have potential as a secondary profit centre on existing farms or as small scale independent operations. One of the major constraints identified for the beef industry was the lack of a slaughtering facility. If such a facility were available larger scale beef feedlots could be encouraged to develop in the Basin.

The characteristics of hog production suggest that they are a secondary enterprise on many farms in the Basin, and that numbers will continue to fluctuate with pork prices and feed supplies. The opportunity for development appears to lie with being able to feed out the weaner pigs currently being shipped to Quebec and elsewhere in Ontario. This development may require a slaughtering facility so that more local pork can enter the Ottawa market.

TABLE 2.2.4

SUMMARY OF AGRICULTURAL CONSTRAINTS

	CONSTRAINTS: RESOURCE BASE			MANAGEMENT			FINANCIAL				MARKETING			FACILITIES			INSTITUTIONAL			
COMMODITIES	weather/climatic limitations	drainage problems, poor soil conditions	water quantity/quality	high degree of specialization req'd	poor quality control	availability of farm labour	high capital cost	high interest rates, operating costs	high risk	low farm income	limited local market	access to external markets	market structure	handling/packing	processing/manufact.	storage/delivery	quotas	government policies	competion for land	other
Livestock			X																	
Dairy				X		X	X	X									X			
Beef							X	X	X	X					X					
Veal				X					X						X					
Hogs						X	X	X	X						X					
Sheep/lambs										X					X					
Eggs & Poultry				X		X	X	X							X		X			
Field Crops																			X	
Corn		X		X			X	X												
Soybeans		X												X		X				
Other oilseeds		X												X		X				
Barley		X								X										
Wheat		X																		X
Alfalfa		X								X										
Fruit & Vegetables	X			X	X	X	X	X	X		X	X	X	X	X	X				
Other Specialty Crops	X	X		X	X	X	X	X	X		X			X		X				X

TABLE 2.2.5

SUMMARY OF AGRICULTURAL OPPORTUNITIES

COMMODITIES	OPPORTUNITIES	TYPE OF NEED TO REALIZE OPPORTUNITY
Livestock		
Dairy	. more industrial milk to larger processors	
Beef	. dairy beef, backgrounding steers & heifers	
Veal	. heavy red veal to Québec market, white veal for Ontario market	. local slaughtering & processing facility
Hogs	. feeding out weaners	
Sheep/lambs	. increased lamb production for growing market	
Eggs & Poultry	. opportunities limited	. local slaughtering & processing facility
Field Crops	. rehabilitate unused agricultural land, improve lower quality soils	. increased tile drainage
Corn	. industrial processing for starch, oil, fructose, alcohol, foods, and feed	. collection, handling & grading systems
Soybeans	. oil & meal production for local & export markets	. collection, handling, storage & delivery system, and crushing facility
Other oilseeds	. oil & meal production for local & export markets	
Barley	. opportunities limited	
Wheat	. opportunities limited	
Alfalfa	. alfalfa pellets & meal, export of high quality hay	. dehydrating plant, new crop varieties
Fruit & Vegetables	. Ottawa fresh wholesale market, fresh exports	. market development, new facilities & equipment
Other Specialty Crops	. local & export markets	. market development, new facilities & equipment

The feasibility of establishing a larger slaughtering facility for beef and hogs for increased local marketing should be examined.

Sheep and lamb production is increasing in the Basin and this trend is expected to continue. Sheep and lamb production is well suited for part-time and hobby farms, as well as a secondary operation on larger farms.

Eggs and Poultry

Egg production is not expected to show much change in the foreseeable future. Some internal consolidation is expected but there is likely to be little opportunity for growth because of the industry structure under the quota system. The poultry meat industry in the Basin is very small because there is no slaughtering facility. Currently birds have to be trucked to Aurora or Kitchener. There is not likely to be such a facility established in Eastern Ontario under the current system. Other poultry such as ducks and geese will continue to be raised as a hobby or small sideline operation.

Field Crops

Grain corn has an excellent potential for expansion as a cash crop, as well as for on-farm feed. Market opportunities include the feed trade in Eastern Ontario and Quebec, and a number of industrial users. Specialized markets exist for grain corn that will become increasingly attractive to growers because of the premium prices that are paid. These markets include corn oil and starch, breakfast foods, and beverage alcohol. Production for these markets requires a commitment to the specific market in terms of growing a suitable high quality product and installation of appropriate handling facilities, or have access to properly equipped collection stations.

Soybeans are a promising new cash crop in the Basin. A system of handling and marketing should be organized specifically for soybeans, with emphasis on the production and marketing of a top quality crushing bean. Other oil seeds such as canola, sunflower, yellow and brown mustard have potential as cash crops. Marketing arrangements are needed, as well as technical assistance for production, and proper handling and storage capability.

Cereal grains will continue to be produced as a major source of livestock feed in the Basin. Barley will continue to replace oats for the near future. Winter wheat acreage is likely to expand in the rotation with soybeans.

Alfalfa has the potential to provide a larger portion of the protein for livestock, as well as a commodity for processing and export. There are two possibilities in this regard. Alfalfa is already being exported in baled form for hay and the opportunities for expansion in this area need to be explored further, as well as local and export markets for dehydrated alfalfa pellets for feed. One of the needs in the Basin and adjacent areas is for new alfalfa cultivars that are better adapted to local conditions.

Fruit and Vegetables

The future for expanded horticultural crop production lies initially in being able to supply a larger portion of the Ottawa wholesale trade, and later to process or export some commodities. This will require new marketing arrangements between buyer and seller, as well as extensive investment in production, handling, storage and other facilities. Eleven fruit and vegetable crops were examined in the Ottawa market.

All have some potential for expansion - as do others; however, a grower has to identify a specific market and gear his/her production to meet the requirements of that particular situation, including quantity, quality, handling, pack, storage, and delivery. Any large scale development of fruit and vegetable production in the Basin and adjacent areas would have to be preceeded by a thorough analysis of area export opportunities for large volumes of quality produce, as well as the potential for establishing processing facilities in Eastern Ontario.

There can be substantial new economic and development impacts at the farm level and at the industry level if agriculture in the Basin responds to the market opportunities that are available. Expansion of new and existing crops could have the greatest impact over the next five to ten years. For example, with the Eastern Ontario population expected to grow from 1.2 million in 1981 to more than 1.3 million by 1996, and with serious effort toward import substitution, there is some potential to expand fruit and vegetable production. The size and value of this potential could be in the order of 1,092 ha worth $3.8 million annually. This is made up of 587 ha of seven vegetables and 506 ha of the four fruits (mainly apples).

An additional 20,230 ha grain corn and 11,330 ha of soybeans together with the 1,092 ha of fruits and vegetables could generate $26.2 million of new gross farm income annually. Additional drainage is the key to this scale of development. These kinds of production increases would require much new farm investment, related industry expansion, new skills, as well as a variety of government services, especially in the area of financing.

Tile Drainage

Tile drainage has become increasingly important for agriculture in the South Nation River Basin. An inventory of tile drainage in the Basin, indicates that approximately 31,600 ha, or about 13% of the agricultural land has already been tile drained. Current trends also indicate that about 4,000 ha are being tiled each year. It is estimated that there are approximately 111,000 ha of agricultural land in the Basin that would benefit greatly from tile drainage.

The benefits of tile drainage include:

- earlier planting dates (7-10 days)
- later harvesting
- more efficient use of machinery
- increased root aeration
- higher soil temperatures for root growth
- wider selection of high value crops can be grown
- improved crop yields
- reduction of risk.

Because tile drainage can provide some of these benefits to land that theoretically should not require drainage, and because farm units are drained as opposed to just those sections of a farm that do require drainage, it is expected that 75% of the agricultural land in the Basin, or about 180,000 hectares will ultimately be tile drained.

Table 2.2.6 provides an inventory of the extent of existing tile drainage by township. Figure 2.2.1 is a map outlining where existing tile drainage is located and showing the distribution of nearly 111,000 ha of agricultural soils which require drainage. The main drainage system of the river, the improved municipal drains and ditches are necessary for the adequate removal of surface water from the agricultural lands, as well as to provide outlets for sub surface drainage systems.

The installation of tile drains increases the productivity capacity of the land substantially. Indications were that Class 2 and 3 lands that are tile drained now have production capacities equal to Class 1 land. Similarly, lands that are Class 4 and 5 because of excess moisture, are elevated to at least the capability of Class 2 lands, and may even attain outputs of Class 1.

Tile drainage is considered to be essential for growers to produce high value cash crops such as corn and soybeans in Eastern Ontario. Only those farmers on Class 1 land can expect to have continuously optimal cropping results without drainage.

Photos 2.2.5 and 2.2.6 show cropland that requires tile drainage and installation of tile drains.

Improved crop yields effectively demonstrate the economic importance of tile drainage to farmers. Comparing average grain corn production on three different soil capability classes, the difference in net income per ha is $143 on Class 2 land and $341 on Class 3 land, and $366 on Class 4 land, in favour of tile drainage (Table 2.2.7). Crop values are taken from the Agricultural Background Study, and reflect the relatively high commodity prices in 1980.

TABLE 2.2.7

Effect of Tile Drainage on Grain Corn Income

Soil Class	Value of Crop/Ha		Cost of Production/Ha	Net Income/Ha	
	Undrained	Drained		Undrained	Drained*
2	$ 830	$1,077	$ 541	$ 289	$ 432
3	$ 632	$1,077	$ 541	$ 91	$ 432
4	$ 464	$ 830	$ 541	$ -77	$ 289

* Annual cost of tile drainage at $104/ha, subtracted from gross income.

(See: "Agriculture Background Study")

TABLE 2.2.6

Area of Tile Drainage

Township	Area of Township In Basin (hectares)	Area Tile[1] Drained (hectares)	% of Township Tiled	Area of Township In Basin Under Agricultural Use (hectares)	% of Agricultural Used Area In Basin Tiled
Gloucester	11,415	458	4.0	3,575	12.8
Osgoode	32,934	2,496	7.6	20,430	12.2
Cumberland	20,791	2,235	10.7	12,404	18.0
Russell	19,954	2,204	11.0	15,490	14.2
Clarence	20,164	386	1.9	10,118	3.8
Cambridge	26,886	1,617	6.0	14,257	11.3
North Plantagenet	17,230	99	0.6	9,640	1.0
South Plantagenet	20,759	1,580	7.6	14,598	10.8
Alfred	5,801	71	1.2	3,432	2.1
Caledonia	15,010	1,071	7.1	10,281	10.4
West Hawkesbury	457	-	-	204	-
Elizabethtown	941	-	-	311	-
Oxford	5,415	-	-	1,487	-
Augusta	19,351	454	2.3	6,549	6.9
Edwardsburgh	26,196	748	2.8	9,555	7.8
South Gower	4,856	46	0.9	2,246	2.0
Mountain	24,703	3,582	14.5	17,631	20.3
Winchester	25,352	4,704	18.6	22,171	21.2
Matilda	21,182	2,618	12.4	15,281	17.1
Williamsburg	9,893	1,281	12.9	7,399	17.3
Finch	21,668	3,547	16.4	17,019	20.8
Onsabruck	4,705	123	2.6	2,285	5.4
Roxborough	22,944	1,311	5.7	13,089	10.0
Kenyon	12,202	930	7.6	6,773	13.7
Lochiel	291	9	3.0	142	6.3
Total ha	391,100	31,570	8.1	236,367	13.3

1 Area tile drained to August 1980.

n.d. No data.

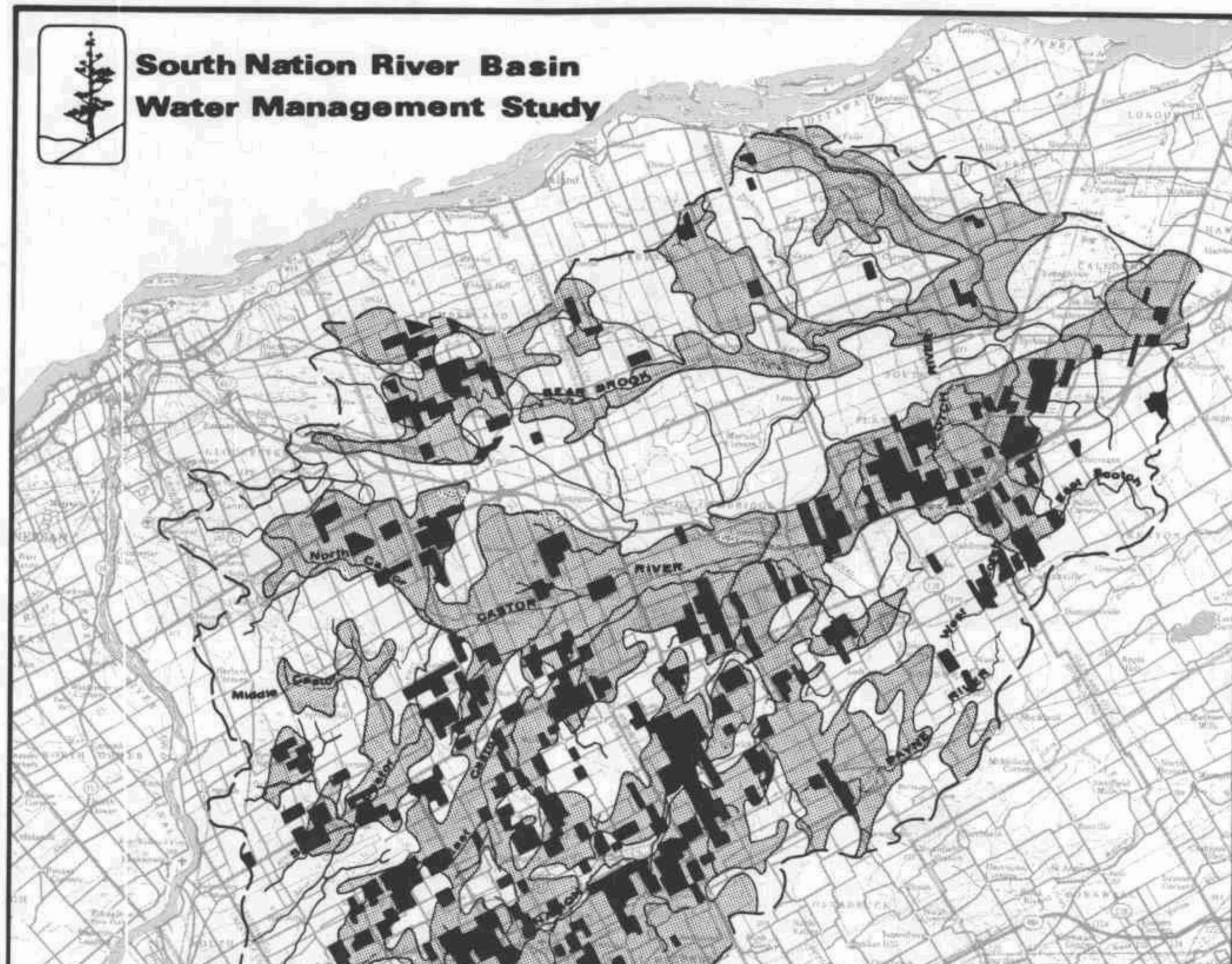


FIG. 2.2.1
AGRICULTURAL LAND DRAINAGE

PHOTO 2.2.5 CORN LAND REQUIRING TILE DRAINAGE

PHOTO 2.2.6 INSTALLATION OF TILE DRAINS

Similarly with soybeans, a comparison of net income per acre to the producer on undrained and drained land shows that drainage raises the net income per ha on Class 2 land by $69, and by $220 Class 3 land, and $260 on Class 4 land (Table 2.2.8).

TABLE 2.2.8

Effect of Tile Drainage on Soybean Income

Soil Class	Value of Crop/Ha		Cost of Production/Ha	Net Income/Ha	
	Undrained	Drained		Undrained	Drained*
2	$ 692	$ 865	$ 403	$ 289	$ 358
3	$ 541	$ 865	$ 403	$ 138	$ 358
4	$ 432	$ 692	$ 403	$ 29	$ 289

* Annual cost of tile drainage at $104/ha, subtracted from gross income.

In each of the above situations there is a net income benefit from tile drainage because of increased yields. The same is true for grains. With hay and pasture, the gains in yield are not sufficient to justify drainage costs at this level. While there is a small net gain in income with hay on drained land versus undrained land, net returns are greater for pasture on Class 1-4 land that is undrained.

What does not show in the above analysis is that these crops are often grown in rotation on the same land so that the grower obtains the higher net incomes from corn or soybeans and in turn benefits from the increased yields of lower value crops as well. For example, if a farmer operated on a 6 year rotation of 2 years corn, 2 years grain, and 2 years hay on Class 2 land, the average annual income would be $242/ha if the land was undrained and $302.00/ha if it was tile drained. The average annual net income per ha is $60.00 more on the drained land, as shown below.

If this example is expanded, the economic benefits of drainage across the Basin can be illustrated. Using this 6 year rotation on class 3 land, the increase in average annual net income is $80.33/ha and on Class 4 the increase is $43.67/ha.

If the 111,000 hectares that would benefit greatly from tile drainage was all cropped in the 6 year rotation outlined above in the undrained condition, then in the drained condition the results summarized in Tables 2.2.9 and 2.2.10 would be expected.

TABLE 2.2.9

Net Income for Rotation per Hectare

6 yr. rotation	Net Income/Ha Undrained	Drained	Difference
	$	$	$
2 yrs. grain corn	578	865	287
2 yrs. grain	751	810	59
2 yrs. hay	124	138	14
	1,453	1,813	360
Average annual net income per hectare	242.00	302.00	34.46

TABLE 2.2.10

Increase in Net Income with Tile Drainage

Agricultural Soil Class	Area Requiring Drainage ha	Increase in Average Annual Income/ha with Tile Drainage $/ha	Increase in Average Annual Income for Basin $
Class 2	61,000	$ 60.00	$ 3,660,000
3	43,000	$198.41	$ 8,531,000
4&5	7,000	$107.86	$ 755,000
Total	111,000	--	$ 12,946,000

The net income generated annually on 111,000 ha requiring tile drainage would therefore be approximately $13,000,000. This benefit will be achieved only after outlet drains and main channels have been constructed.

The cost of outlet drain construction has been estimated at $185/ha ($75/acre), based on average engineering estimates for approximately 200 drains assessed in 1980 and 1981. According to the Erosion Sedimentation Study maintenance costs are an additional 25% of the construction cost. Therefore the cost of outlet drainage works is approximately $250/ha, or $25/ha.yr. On a basin scale the cost for outlet drains would be approximately $2,800,000. Main channels may also be necessary to achieve maximum drainage potential. Costs for main channels have also been estimated at $2,800,000 annually. (These are average figures from drains assessed by the Drainage Petition Review Committee). When the cost for outlet drains and main channels are subtracted from the tile drainage benefit, it can be seen that proper drainage could generate an additional $7.4 million in annual net income on potentially good land that is now poorly drained. This figure does not include environmental or other potentially adverse effects. These are discussed in Part III of this report.

2.3 FORESTRY*

2.3.1 Forest Land Resource

Woodlands and wetlands that have remained after two centuries of land clearing and timber cutting, account for approximately 100,000 hectares or about 25 per cent of the land base. New forests, consisting of coniferous plantations, cover about 2,000 hectares, which is approximately one half of one per cent of the land area.

Woodlands include productive as well as non-productive forest land. Included also are small patches of forest which have an aesthetic value, but which, from the commercial point of view, have very little or no value. A considerable portion of the Larose Forest consists of plantation grown conifers, and is apparently not recognized in the recent Forestry and Agriculture Resources Inventory (FARINEO). If it were, the acreage of plantation forests would be three times higher and exceed 6,000 hectares.

Although there is considerable woodland area, approximately 100,000 ha throughout the Basin, there is in fact only about 78% of this which is commercially viable forestry land. Table 2.3.1 shows the total volumes of timber on publicly and privately owned forest lands. According to data collected by the Forestry and

* (Source: Forestry Background Study)

TABLE 2.3.1

Total Timber Volume by Ownership
(Millions of cubic meters)

Ownership	Deciduous	Coniferous	All Species
Publicly Owned	.91	.68	1.59
Privately Owned	4.68	.49	5.17
All Owners	5.59	1.17	6.76

Agricultural Resources Inventory, 101,185 ha are forested, however close examination of aerial photos shows that only 78,194 ha are, in fact, carrying timber of commercial value. All subsequent timber volumes are based on these 78,194 ha of stocked forest land. The difference of 22,991 ha presumably consists of forests with low stocking or small patches of treed land.
Of the total amount of timber growing stock, 76.5 per cent or more than 5.1 million m^3 are on private lands. Less than 1.7 million m^3 are on Crown lands. Because of the planting program started by Larose in 1928, the ratio of coniferous to deciduous timber growing stock is much more favourable on the publicly owned lands than on the privately owned lands. Of the timber growing stock on public lands, 44.9 per cent consists of the valuable, and more readily marketable, coniferous species. Not much high quality veneer or sawlog material, however, can be found among the privately owned hardwood timber.

Red pine is the most important species planted on the publicly owned lands. Almost 48 per cent of the 66 million m^3 of the timber in coniferous working groups consists of red pine plantation wood, followed by white spruce (27.9%) and white pine (12.5%), with the balance made up of other species.

2.3.2 Forestry Economic Profile

Although the C.I.P. mill in Hawkesbury has announced closure of its operation, the markets do not appear to be a constraint to future forest development in the Basin. The pulp and paper industry appears to be an assured market because of the proximity to the Domtar mill, whose procurement area covers the watershed.

The Hawkesbury CIP mill, when operating, consumes about 290,000 m^3 of hardwood fibre annually. About 75 per cent originated from the private sector, 20 per cent from company controlled timberland, and the remainder is chips or sawdust. About 30 per cent of supply came from Eastern Ontario.

The consumption of roundwood by Domtar in Cornwall is approximately 200,000 cunits of wood and 100,000 tonnes of chips. The species consumption by percentage is: poplar - 25%; hard and soft maple - 35%; birch - 15%; cherry - 8%; balsam - 5%; oak - 3%; and other - 9%.

Fifty per cent of the wood in the past few years has been purchased from New York State. However, this has recently dropped considerably to less than 25 per cent due to the Canadian dollar's loss of value.

Domtar purchases most of its Canadian wood within 120 km of the mill. Wood procurement has reached as far as Maniwaki, Granby and Kingston but these are definitely the outer limits. With the high cost of gasoline, Domtar reiterates that anything over 120 km would be difficult to justify for a long term supply.

There is every expectation that the demand for the products of the Domtar mill will continue to grow and the mill looks favourably upon increasing wood procurement in Eastern Ontario as opposed to placing a heavier reliance upon imports from New York State and Quebec.

The sawmill industry within the Watershed and its immediate vicinity is completely overshadowed by the pulp and paper mills. The causes are the current lack of high-grade sawlog material and the industry's inability to adapt itself technologically to the current quality of raw material. Improving the sawmill sector will require efforts in forest management as well as technological modernization.

At the same time, new and competing uses for primary wood products can be expected to come from continuously increasing oil prices. Old technologies capable of converting bulky and difficult to transport fuelwood into more convenient to handle and easier, more efficient to burn fuel, are currently under intensive review and are being refined and modernized. While many people have been buying wood stoves, it appears that the use of fuelwood will only be economic to the rural residents who have an accessible wood supply within not more than 16 km from home.

The main thrust of a forest development strategy should be to increase the production of primary forest products. This will be, because of past neglect of the forest resource, a long, arduous and costly task. This task is further complicated by the fact that the bulk of the resource is owned by numerous small private owners, representing a large cross-section of occupations, with a correspondingly wide range of levels of income and management objectives.

2.3.3 Forestry Opportunities and Constraints

The development potential of forestry can be realized by strengthening the role of the Watershed's forests as a provider of wood raw material for industrial or domestic use. The increased production of marketable primary forest products should be carried out within the constraints of sound forest management which takes into account the realities of today's society. One of these realities is the dominant position occupied by the pulp and paper industry within the forest industry sector. The Domtar Mill at Cornwall draws a significant proportion of their wood requirements from the Watershed.

The sawmill industry is in desperate need for quality timber. This industry will have great difficulty in the future in competing with the pulp and paper industry. The technology for the sawmill industry to use smaller diameter material does exist - i.e., the chipper-headrig for softwood lumber and the short-log bolter for hardwoods. To make use of the currently available raw material, the sawmill industry will have to resort to using more of this technology. This will bring the sawmill industry more in direct conflict with the pulp and paper industry. The expected competition for the timber resources of the Watershed should benefit the woodlot owner in the Basin.

The largely unknown factor in future demands is the fuelwood market. The fuelwood market is believed to be rather limited in comparison to the potential for conversion of forest biomass into several forms of energy. It is, however, at this point in time, too early to tell how intensive the use of biomass for energy will be and at what rate it will grow.

On the basis of the analysis of markets, the following general conditions appear to apply to forestry in the Basin.

1) The pulp and paper industry can be expected to absorb all the pulpwood that can be grown;
2) Similarly, the sawmill industry can be expected to purchase all the sawlog material that can be grown;
3) Competition for the wood raw material in the Basin can be expected to increase as a consequence of:
   - the sawmilling industry adapting itself to shorter and smaller logs by adopting new technologies,
   - more and more rural residents and institutions changing over to wood heating as a result of government programs to convert from oil, and,
   - the introduction of technologies and systems to convert forest biomass into more readily transportable and combustible fuel.

Based on the timber use capability ratings prevailing in the Watershed, it appears that under levels of management which aim to maintain fully stocked stands with species well suited to the particular sites, the existing privately owned forests can produce 0.3 million m^3. Under present levels of management approximately 0.1 million m^3 of primary forest products could be cut without further inroads on the timber capital. In other words, through better forest management the cut per year could be increased at least 2.7 times the current allowable cut.

Further increases in production can be achieved by adding currently idle land to the forest land. Assuming that the available idle land 27,500 ha is reforested within a time span of 60 years, the annual cut can be increased to 0.39 million m^3 or 3.7 times the current permissable cut. This assumes that ownership, land capability and parcel size problems can be overcome.

Higher levels of annual production can be achieved than indicated by the timber use capability ratings alone. It should be remembered that timber use capability ratings merely indicate the annual production per acre that can be achieved under levels of management that maintain stands fully stocked with native species well suited to the particular sites. These ratings do not take into account the growing of hybrid poplar according to the recent prescriptions developed by the Ontario Ministry of Natural Resources; nor do they take into account a regime of thinnings, intermediate fellings and final fellings of softwood plantations, and finally; no account is taken of the production resulting from thinnings and/or improvement cuts from hardwood stands. A forest development program is proposed that imposes the foregoing high levels of forest management on all private lands available. A level of production of more than 8 times current levels of allowable cut can be achieved over the next 60 - 80 years.

There are essentially two types of forest land in the Basin. The largest and most important block of forest land is that part of the Basin that is currently supporting commercial or potentially commercial timber crops. The production on these lands can be increased by measures to improve species composition, and the quality of the individual trees by introducing cutting practices which aim to achieve a balanced diameter distribution among the favoured species.

The other block of land which has the potential to produce timber crops is the "idle land". Commercial timber production on some of these lands may be achieved by reforestation.

Two types of reforestation can be recognized. They are:

1) The establishment of short-rotation hybrid poplar plantations to produce a single product (i.e., poplar pulpwood).
2) The establishment of traditional softwood plantations to produce a range of products over a longer rotation period (i.e., softwood sawlogs, poles and pulpwood).

The traditional softwood species can be planted throughout the Watershed wherever suitable sites can be found. Hybrid poplar, under present market conditions, should be restricted to the southern part within 30 - 50 km of the Cornwall mill. Only a rapid development in biomass utilization would warrant extensive poplar planting in other parts of the Watershed.

The proposed forest development program consists of three components. The first two components deal with reforestation of idle agricultural land with hybrid poplar and traditional softwood species. The third component is the improvement of the existing timber.

PHOTO 2.3.1 IDLE LAND WHICH MAY BE SUITABLE FOR FORESTRY

PHOTO 2.3.2 IDLE LAND UNDERGOING NATURAL REGENERATION

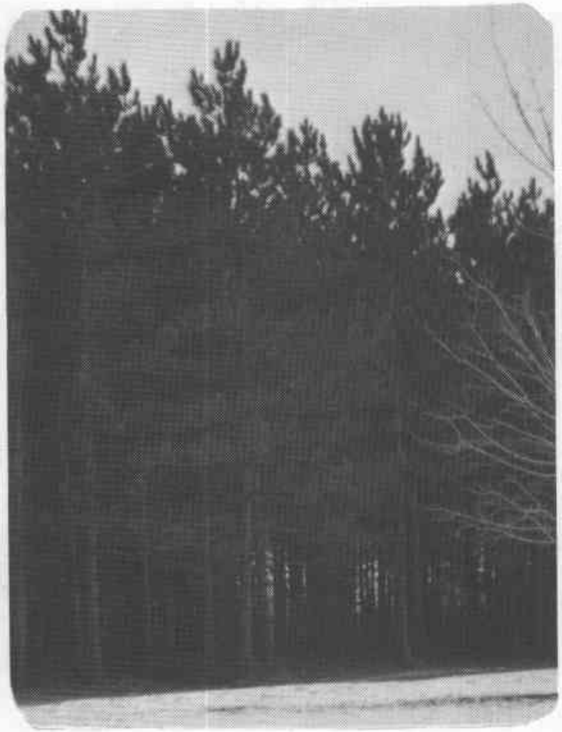


PHOTO 2.3.3

RED PINE FOREST
PLANTATION

PHOTO 2.3.4

HYBRID POPLAR
PLANTATION

As crop production increases in the Basin, additional areas of low capability agricultural land are likely to become available for reforestation, so that over a 20 year period, the net effect could be the same as that attained below in the first two components.

1) Reforestation of that proportion of idle land which is suitable for the growing of hybrid poplar on a short rotation basis (i.e., 10 years). It is estimated that about 40 per cent of the available idle land (or 11,000 ha) will be suited to the production of wood fibre from hybrid poplar plantations.

2) Reforestation of the remaining 60 per cent of the available idle agricultural land (or 16,500 ha) with the more traditional softwood species - mainly pine and spruce at a 60 year rotation.

3) Improvement of the existing timber concentrated in the tolerant hardwood through silvicultural operations at 10 year cycles over a period of 60 years.

2.4 RESIDENTIAL, COMMERCIAL, INDUSTRIAL*

2.4.1 Urban Land Resource

As uses of land, these three categories, residential, commercial, and industrial, represent a relatively small area. In total, there are 39 urban areas with residential and commercial concentrations. As well, in many areas, there is roadside strip residential development. In total, the Basin has 4,240 ha of built-up urban areas. The area of industrial development within this designation is almost negligible. In August 1981, there were 198 ha of industrial parks, most of which are in Osgoode and Russell Townships, of which approximately 40 ha were immediately available. The major urban areas and industrial sites are indicated on the Land Use Map (Figure 2.2.1).

* (Source: Residential, Commercial, Industrial Background Study)

URBAN DEVELOPMENT

PHOTO 2.4.1 CHESTERVILLE

PHOTO 2.4.2 PLANTAGENET

2.4.2 Industrial and Commercial Economic Profile

The economic base of the South Nation River Basin is not diversified. Only a few sizeable employers have operations in the Basin and generally there is a lack of employment opportunities.

During the last ten years, agriculture has continued to be the basic economic activity in the Basin. Dairy farming and dairy processing constitute the primary agricultural and industrial activities in the area. The largest cheese producer in Ontario is Ault Foods Ltd., located in Winchester. It employs about 175 people and produces cheese, butter, skim milk powder, whey powder and ice cream mix. Possibilities for large scale expansion of the dairy processing industry are limited due to the institutional constraint of the market-sharing quota system for users of industrial milk. The Nestlé plant at Chesterville is the other major industry in the Basin. It employs 200 people and produces instant coffee and drinks. Other large employers in the Basin include Seaway Chemicals, Winchester Cheese, Winchester General Hospital, Ontario Hydro and Bell Canada. The labour force in the Basin is characterized by a high participation rate, low levels of unemployment, and a healthy labour relations climate that is attractive to new industries.

Industrial

There were 590 manufacturing and processing establishments in the 8 Basin counties* in 1976, which generated a manufacturing value of about $2.4 billion. The food and beverage sector was the largest with 86 establishments with a value of manufactured production in 1976 of $504 million.

The food and beverage sector includes slaughtering and meat processing, dairy products, feed industry, bakeries, confectioneries, food processors and soft drinks. From 1966 to 1976, the number of establishments in this sector fell from 120 to 81, and the value of manufactured products rose from about $122 million to more than $500 million. The greatest change occurred in dairy products where the number of

*Industrial data is on a county basis that takes 8 complete countries of which the Basin is a part.

INDUSTRIAL DEVELOPMENT

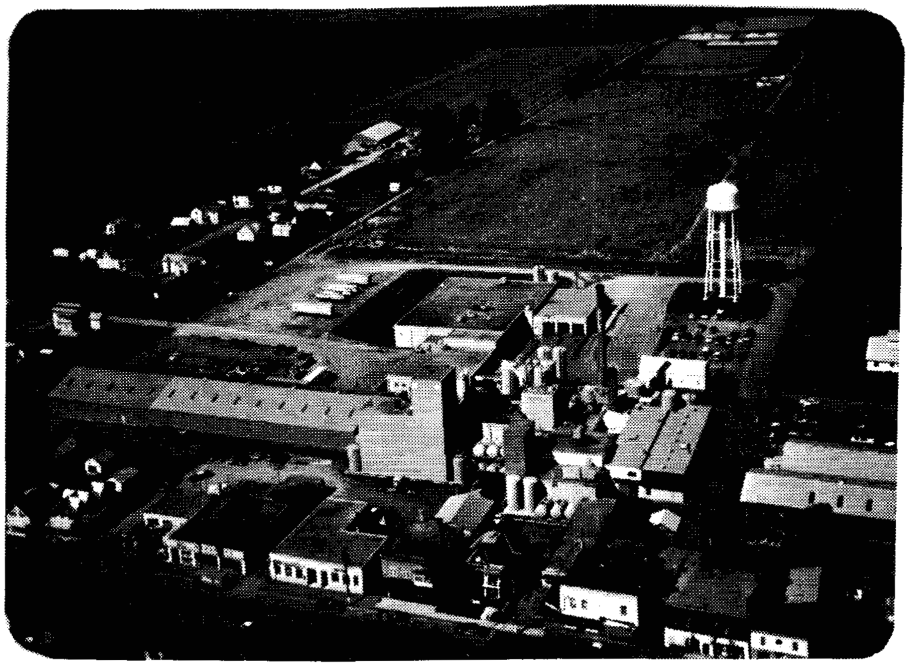


PHOTO 2.4.3 AULT FOODS PLANT, WINCHESTER

PHOTO 2.4.4 NESTLÉ PLANT, CHESTERVILLE

establishments dropped from 59 in 1966 to 17 in 1976 as many small butter and cheese factories were closed down.

The value of manufactured products in the food and beverage sector in the Basin counties increased by 312% between 1966 to 1976, while during the same period, the value of products from all other sectors increased by 152%. Although the value of manufactured products per firm increased substantially in the processing and maufacturing industries from 1966 to 1976, the increase was much more dramatic in the food and beverage industries after 1971. At least part of the change that has occurred in the food and beverage sector is due to the growth of the large firms in the dairy products industry, compared to those in other sectors.

In three counties - Dundas, Glengarry, and Leeds - the food and beverage sector was larger than all other sectors combined in 1976. Even in the Ottawa area, food and beverages accounted for about 23% of the total value of manufacturing. Compared with the other counties, the proportion of the total value was lowest in Prescott (4%) and Stormont (9%). No data were available on the value of manufactured products in the food and beverage sector in Grenville County.

In addition to food and beverages, several firms in other sectors were active in manufacturing directly related to agriculture. Four firms manufacture agriculture implements and three manufacture mixed fertilizers.

Although the agricultural manufacturing firms dominate throughout the Basin, there are many other manufacturers. In the eight counties which contain the Basin, in 1976 there were 76 printing and publishing firms, 64 metal fabrication businesses, 22 textile firms, 22 electrical firms, 21 wood businesses, 21 furniture and fixture manufacturers, 20 mineral products firms and 182 other manufacturing firms. Within the Basin itself, there are generally fewer of these types of firms than there are agriculturally-related firms.

Commercial

There is a range of commercial facilities and services within the Basin to serve both the urban and rural communities. The level of service provided can be categorized as "basic" or "general" with little specialization. This is due to the small, dispersed market that is being served and the high level of competition from easily accessible, larger service centres outside of the Basin.

The following is a listing of the main types of retail and community services present in one or more of the 39 urban centres in the Basin.

Retail Services	Community Services
general store	church
gas station	public school
bank	community centre
restaurant	post office
hardware	arena
food store	municipal office
hotel-tavern	library
building supplies	nursing home
automobile dealer	high school
clothing	hospital
furniture	
drug store	

The services are listed in descending order as to the number of such establishments within the Basin. For example, most urban centres have a general store and church, but only a few drug stores exist and the only hospital is in Winchester.

The size of the individual establishment varies, but generally most establishments are of a small, local size serving the immediate area. The more centralized services, such as high schools, hospitals and furniture stores, are larger due to their functional requirements and due to the extent of the area being served by the few establishments.

In addition to the general list, there are many small establishments throughout the Basin that cater to special needs or result from local skills; such as, antique shops, pottery shops, and upholstery shops.

There are also administrative centres and establishments providing local services; such as, Ministry of Agriculture and Food offices in Winchester, Embrun and Plantagenet, Ontario Milk Marketing Board in Winchester, S.N.R.C.A. offices in Berwick, Ontario Provincial Police detachments and local real estate, medical and dental offices. Other services for the farming community, include farm machinery sales and service shops, welding shops, trucking firms, and local contractors for drainage construction.

Resource Extraction

Resource extraction of gravel and topsoil is a small land user but is found in all but two townships. The majority of gravel extraction is in Gloucester, Osgoode, Cumberland, Mountain, Augusta, and Roxborough townships, and most topsoil is extracted in Cumberland township. Resource extraction accounts for approximately 2,200 ha of Basin lands.

The mineral potential for the Basin has been rated high for limestone in areas of the Ottawa limestone formation. The limestone is used as crushed rock. There are very limited occurrences of other minerals and, therefore, mineral industries are constrained in the Basin. Continuing demands for horticultural peat and the potential for peat as a fuel have recently generated some new interest in area peat bogs, particularly at Alfred.

Sand and gravel aggregate is found in numerous small ancient beach deposits. There are numerous small extraction operations at present and future opportunities will similarly be constrained by size of deposits. There are, however, opportunities in the crushed stone extraction industry within the Basin.

2.4.3 Industrial and Commercial Opportunities and Constraints

Industrial

The industrial development potential in the South Nation River Watershed is closely tied to the resource base industries, agriculture, forestry, and aggregate processing. The food and beverage sector dominates processing and manufacturing and this trend is likely to continue as new crops and handling facilities are added in the area. One of the apparent needs in agriculture is for additional meat packing and processing capability. If cash crop acreage in the Basin continues to expand, it could generate manufacturing requirements in production, handling and storage equipment. Similarly, in forestry, a long term development program would have a series of small scale industrial benefits such as equipment manufacturing, maintenance and trucking.

Other industrial priority areas appear to be small scale electronics, and insulation materials.

One of the major constraints for industrial developments is water supply. There is simply not enough water available in the Basin for large scale industrial development. Also, with increasing competition elsewhere, it will take an aggressive effort to attract new industries to the Basin, as well as to retain existing ones.

Commercial

Commercial development is, for the most part, dependent on the growth of population and other industries. From this point of view, the potential for commercial development is limited to the extent that it must wait for the impetus to come from elsewhere.

However, several options are available to enhance the existing commercial centres and improve their economic viability. Local planning documents should be revised to include appropriate policies and standards. Commercial areas could be improved by providing better parking facilities, pedestrian access or relocating conflicting uses elsewhere. The commercial centres represent the historic cores of the communities and their maintenance and improvement is an important goal.

Residential opportunities in the urban areas are limited by existing water supply. Table 2.4.1 summarizes the development and growth characteristics for several of the large communities in the Watershed. Section 3.4 Water Supply provides further information concerning water supply opportunities and constraints.

TABLE 2.4.1

MAIN URBAN CENTRES
DEVELOPMENT AND GROWTH CHARACTERISTICS
S.N.R. BASIN

URBAN CENTRE	1976[(1)] POPULATION	2001[(2)] POPULATION	SERVICING CAPACITY (CURRENT CONSUMPTION) PIPED WATER	PIPED SEWER	ACCESS TO MAJOR HIGHWAY	INDUSTRIAL LAND POTENTIAL	HOUSING SUPPLY
Casselman	1,425	2,207	36.83 l/s ($3,182\ m^3$/day) (6.63 l/s) (572.8)	15.97 l/s (1,364) (4.3 l/s) (371.5)	Highway 417	18.8 ha.	Adequate residential land, adequate units.
Chesterville	1,325	1,735	9.47 l/s (982) (Data not available but capacity adequate in short-term.)	11.89 l/s (1,029) (Data not available but recently expanded capacity.)	Highway 43	8.5 ha.	Limited residential land available, adequate number of units.
Finch	405	379	8.42 l/s (691) (Data not available but new water system adequate.)	none.	Highway 43	-	Limited residential lots available.
Maxville	850	835	none.	none.	Between Highway 43 and 417	5.0 ha.	Limited residential lots, shortage of housing units.
Plantagenet	920	1,131	18.42 l/s (1,700) (Data not available - system new.)	6.84 l/s (591) (5.68 l/s) (490.8)	Highway 17	20.0 ha.	Adequate residential land and housing unit.
St. Isidore de Prescott	690	903	none.	7.58 l/s (655) (2.42 l/s) (209)	Close to Highway 417	9.0 ha.	Limited residential land available.

URBAN CENTRE	1976(1) POPULATION	2001(2) POPULATION	SERVICING CAPACITY (CURRENT CONSUMPTION) PIPED WATER	PIPED SEWER	ACCESS TO MAJOR HIGHWAY	INDUSTRIAL LAND POTENTIAL	HOUSING SUPPLY
Winchester	1,745	2,746	18.57 l/s (1,866) (Data not available - marginal capacity.)	(909) Demand often exceeds capacity.	Highway 43 and 31	6.0 ha.	Abundant residential land. Limited rental and moderate priced units available.
Bourget	949	1,437	Communal water system at capacity.	none.	-	-	Limited residential land available.
Embrun	1,763	2,666	Proposed: 37.04 l/s (3,200)	Proposed: 20.83 l/s (1,800)	Close to Highway 417	4.0 ha.	Adequate residential land; limited rental units available.
Osgoode	984	1,186	none.	none. (1,000)	Highway 417	-	Abundant residential land.
Russell	857	1,275	none.	11.58 l/s (low usage)	Close to Highway 417	-	Abundant residential land; limited rental units available.
Metcalfe	681	820	none.	none.	Close to Highway 31		Adequate residential land.

(1) 1976 population from Census data.

(2) 2001 population as projected Industrial Commercial Residential Report.

2.5 FISH AND WILDLIFE*

2.5.1 Fish and Wildlife Resources

A total of 49 fish species have been identified in Basin waters. Of these 12 are valued for sport fishing. The present state of the South Nation River for sport fisheries, as reflected by the variety of fish, is relatively good, however there are water quality problems in some areas, particularly high turbidity and phosphorous levels.

In addition, there are habitat problems throughout the Basin. For example, many areas are plagued by low water flows, shortage of deep water, and shoreline vegetation damage. The South Nation River below Casselman contains the best fish habitat in the Watershed, followed by the section between Casselman and South Mountain and the Castor River. Other parts of the drainage Basin, however, are limited in their capability to support sport fishing.

Fish habitat is very sensitive to alterations in the hydrologic regime of the river. For this reason, great care must be taken where works such as channelization or dam construction are undertaken. Destroyed or damaged habitat should be restored as an integral part of each project.

The wildlife resource of the Basin is not highly significant, there are, however, some opportunities for viewing and hunting. Defined areas for these activities are presently limited and new areas are needed for passive use and/or for future preservation.

Resident moose populations are found only in the Larose Forest and in the Alfred Bog. The Watershed as a whole has limited capacity to support resident moose populations. Deer populations appear to be limited by a lack of suitable wintering habitat. Small game populations are robust, and habitat is abundant and of good quality.

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* (Source: Fisheries and Wildlife Background Study)

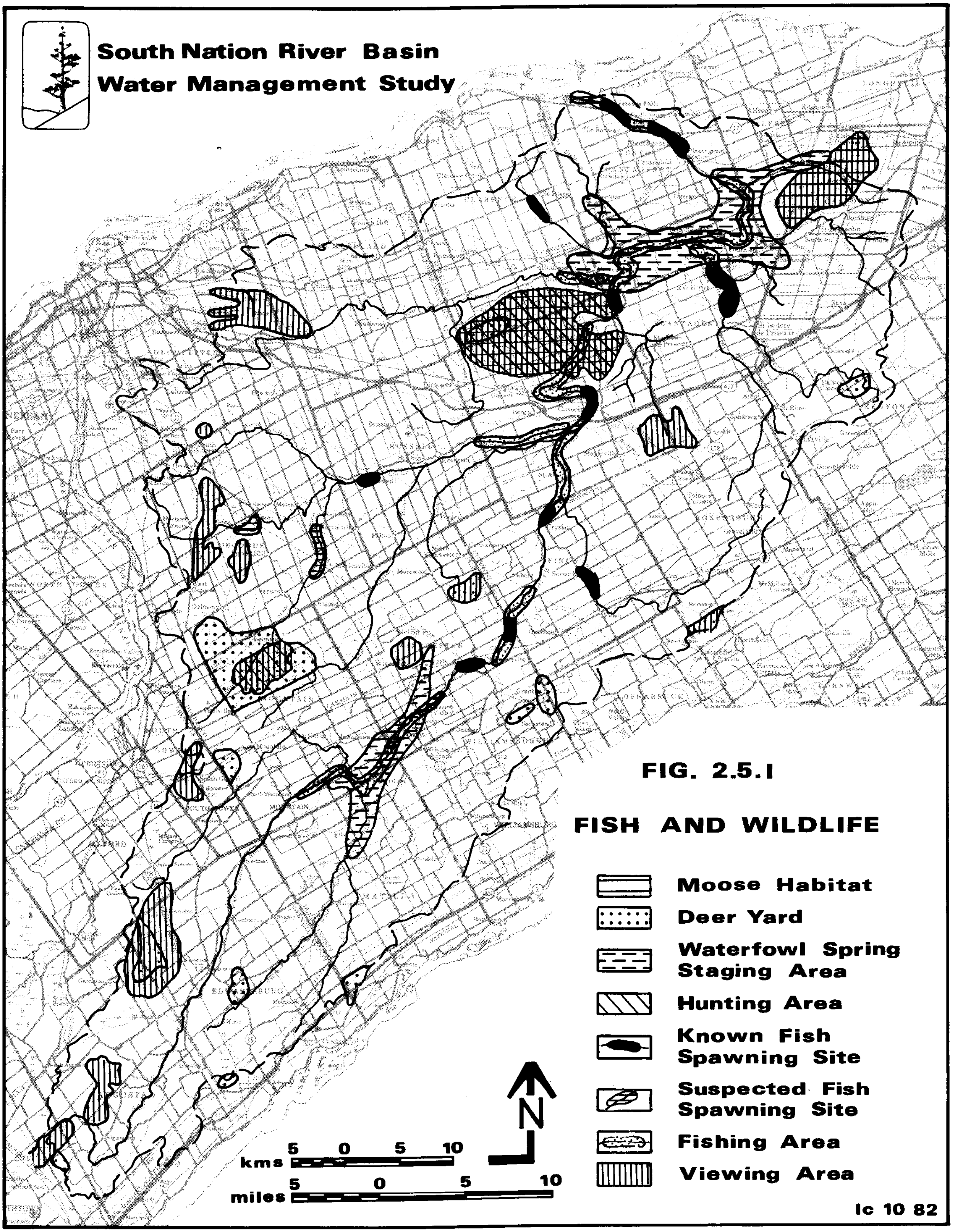


FIG. 2.5.1

FISH AND WILDLIFE

(Source; Amenity Study)

Fish and wildlife sites have been categorized into three levels of significance as follows:

Level 1	High
Level 2	Moderate
Level 3	Basic

Level 1 sites are particularly important and include:

1. Larose Forest
2. Alfred Bog
3. Winchester Deer Yard
4. Fish spawning sites on South Nation River (seven), Cobbs Lake Creek (one), Scotch River (one), Payne River (one) and Castor River (one).

Level 2 sites have interpretive potential

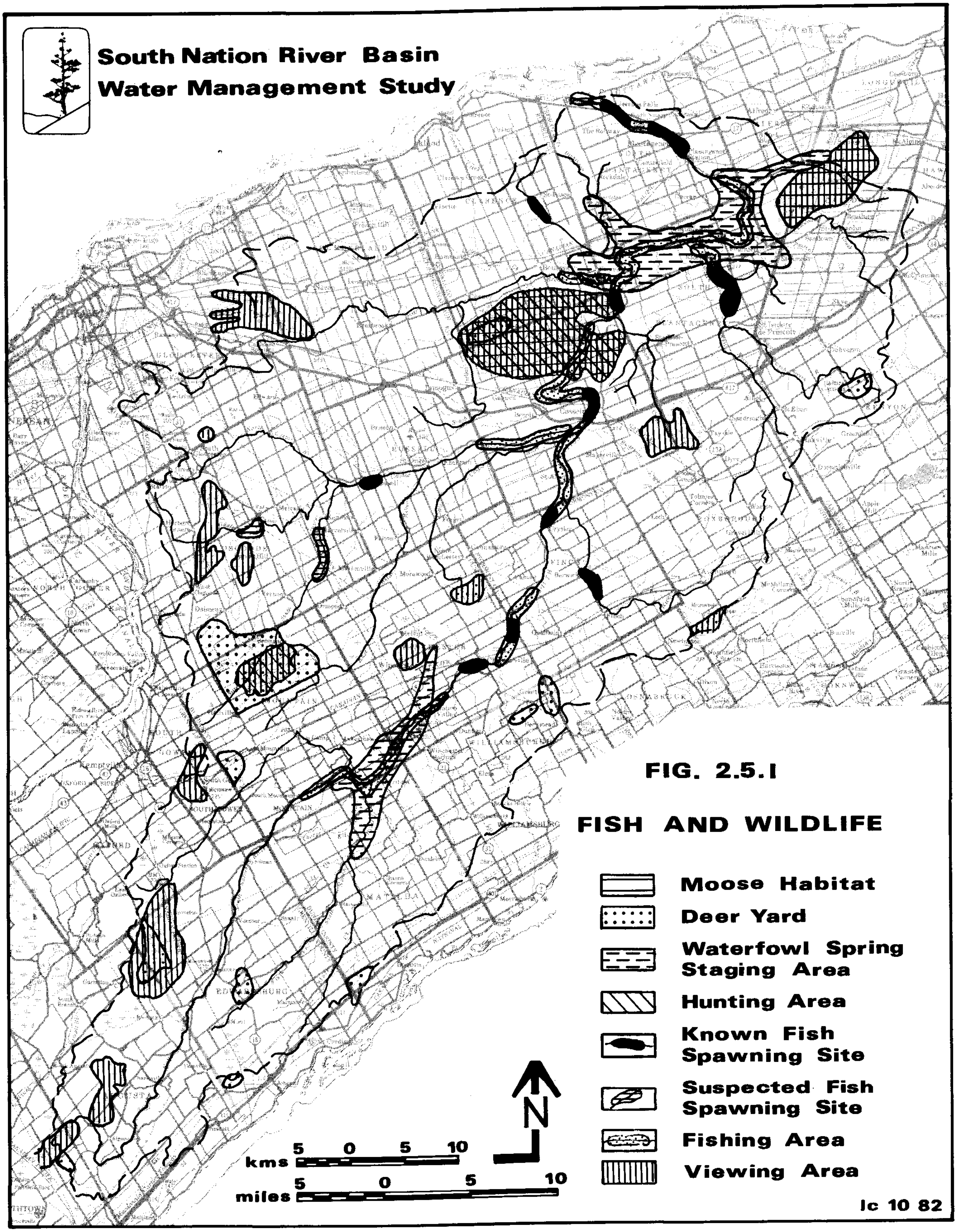
1. 12 secondary deer yards
2. Mer Bleue
3. Waterfowl spring staging areas.

There are also 12 Level 3 sites.

The Mountain Provincial Wildlife Area and the Larose Forest are readily identifiable as important areas for hunting and non-consumptive use but many other suitable public and private lands are also used for these activities (see Fisheries and Wildlife Report for details).

Hunting is a popular recreational activity, as seen in the following table of user days devoted to hunting, and non-consumptive uses such as nature walks and photography.

		User Days
Hunting	Deer	5,800
	Ruffed Grouse	23,500
	Partridge	19,000
	Pheasant	4,600
	Hare	35,000
	Raccoon	10,000
	Fox	28,500
	Coyote	19,000
	Geese	36,000
	Ducks	37,600
	Moose	controlled hunts
Non-Consumptive Uses		187,000



(Source; Amenity Study)

2.5.2 Fish and Wildlife Economic Profile

The economic value of fish and wildlife activities within the Watershed is extremely difficult to determine. In general, it is unknown what the average daily user cost is for hunting, fishing, trapping and passive wildlife-oriented recreation. Although several estimated values are presented, these cannot be taken as definitive nor can they be directly applicable, without refinement, in a management strategy.

The estimated annual value of fish and wildlife use in the area is based on estimates of purchase prices and costs for commodities related to the activity.

Sport Fishing	$ 322,000
Commercial Fisheries (Bait fish)	$ 6,000
Hunting	$ 1.96 million
Trapping	$ 346,000

(Source: Fisheries and Wildlife Background Study)

Under present conditions the fishery resources have expansion potential and with better water quality and habitat improvement work, total production could be further enhanced. The potential for increased wildlife populations varies greatly from area to area and by species as indicated below:

Species	Capabilities
Moose	limited
Deer	low to good
Waterfowl	low
Beaver, Muskrat	good (nuisance levels)
Mink, Fox, Racoon	high

(See Fisheries and Wildlife Background Study for complete listing and capability area maps.)

2.5.3 Fish and Wildlife Opportunities and Constraints

There are currently two recreational uses by Basin residents of fish and wildlife resource. These are consumptive uses such as sport fishing, hunting and trapping, and non-consumptive uses such as wildlife viewing and bird watching.

The fisheries resource is severely constrained by low flows in the upper half of the South Nation River and in most tributaries. Augmenting low flows and creating areas of deeper water would increase the quantity of habitat available to sport fish species. Fish production may also be increased by an improvement in water quality, especially by reducing nutrient inputs from agricultural land and restricting access of livestock to the watercourses. Increases in shoreline and instream vegetation and instream cover would also tend to improve fish production.

The potential for increased small game and furbearer populations appears to be good. The major constraints to realizing this potential are current and possibly future agricultural and forestry land utilization and management practices (discussed in detail in the Fisheries and Wildlife Background Study). Waterfowl production is constrained by a scarcity of good breeding habitat but some opportunities do exist for improvement, such as by encouraging shoreline vegetation in agricultural areas. There appears to be little potential for enlarging existing moose herds, but deer populations might be increased if more suitable wintering habitat was available. The draining of wetlands is detrimental to most wildlife species.

There is much publicly owned land in the Watershed available to non-consumptive users. Opportunities for these users, however, are restricted by the scarcity of identified activity areas and facilities, such as interpretive trails. Potential for development is therefore fairly high. The potential for enhancement of the quality of organized and individual outdoor activities, by improving the land for fish and wildlife, is also good.

Fish and Wildlife Conservation

The fisheries resource is by far the most sensitive of the natural resources to changes in the hydrologic regime. It is therefore very important that the concerns of this aquatic resource be accounted for in the water management schemes. In order to achieve this objective it is recommended that an environmental assessment of major works be conducted prior to commencement of design and construction. Works for the enhancement of the fishery resource should be combined with major water management activities.

Water management practices that improve water quality will have the added benefit of enhancing fish habitat. Riffle areas and deep pools provided in combination with control structures such as weirs will also encourage growth in fish populations. In channelized areas, re-establishment of shoreline vegetation and the creation of artificial reefs are potential means of increasing fish production.

Sensitive fish spawning sites and habitat in general are often damaged or destroyed as a result of adjacent land use activities, or channelization works. Livestock access to the spawning areas, improper use or handling of chemicals or manure, and landuse activities or conditions that generate heavy sediment loads immediately upstream, jeopardize these sensitive sites.

The water quality recommendations which are applicable to the protection of aquatic resources include the establishment of vegetative buffer strips, exclusion of livestock from waterways, field erosion control practices, ditch and river bank stabilization to control sedimentation and proper management of agricultural and municipal nutrient from chemicals, manures and sewage effluents.

The wildlife resources are not as greatly affected by water management activities; however, they are strongly influenced by land use activities. From a natural heritage point of view, wildlife habitat should be protected and enhanced wherever possible. The Fisheries and Wildlife Background Study has outlined several recommendations which include various land use practices that will serve to help protect and enhance habitat (i.e. maintenance of hedge rows, instream cover, regulated tree cuttings, as well as interpretive, education and demonstration programs).

2.6 NATURAL AND CULTURAL HERITAGE*

2.6.1 Heritage Resources

There are no particularly outstanding archaeological or historic sites in the Basin, with the possible exception of the Roebuck Iroquoian village in Augusta Township.

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* (Source: Amenity System Background Study)

There are many features, however, that are unique to the Basin and that reflect the general historic development of the province and country. Among the more significant:

Archaeological Sites

1. Casselman site (possible Middle Woodland site)
2. Spencerville site (possible Archaic and Iroquoian site)
3. Roebuck site - known Iroquoian site

Historic Sites

Level 1 sites are important and represent heritage themes and have interpretive potential

1. Jessups Falls
2. Pitch-off; South Nation River
3. Riceville Dam
4. Coupal Dam
5. Spencerville Mill

Level 2 sites are unusual or unique and may be marked with a historic plaque

1. Hop kiln, South Plantagenet
2. Carlsbad Spring hotel and spa
3. Dr. Mahlon W. Locke home
4. John McIntosh monument
5. Rev. Charles Gordon plaque, Presbyterian Church, St. Elmo
6. Glengarry Congregational Church plaque, St. Elmo
7. Osgoode Township Historical Society Museum, Vernon
8. Glengarry Museum, Dunvegan

Figure 2.6.1 shows the location at these and other sites.

Natural heritage sites that have significant scientific and interpretive interest, or are regionally unique are relatively few. The sites of note which are discussed in detail in the Amenity System Report include:

Natural Heritage Sites

Level 1 sites are particularly important and are identified as primary candidate nature reserves

1. Alfred Bog*
2. Mer Bleue*
3. Long Swamp Bog*
4. South Gloucester Forest*
5. Lemieux Landslide*

Level 2 sites are moderately important from scientific and interpretive view points

1. Champlain Sea radiocarbon date location
2. Plantagenet Caves*
3. Perrins Corners Swamp

Figure 2.6.2 shows the locations of Level 1, Level 2 and other sites.

Wetlands**

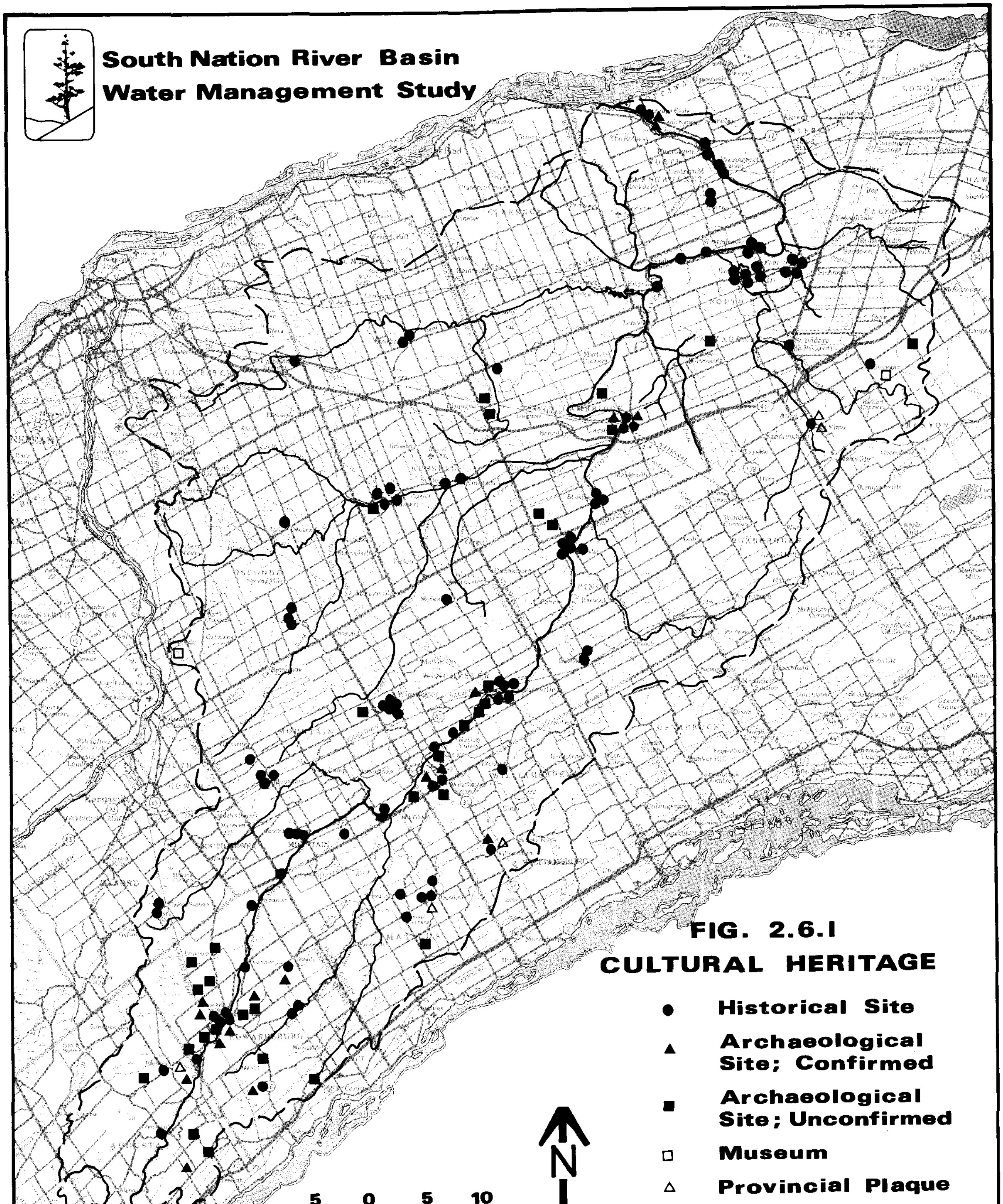
Wetlands and areas of organic soils comprise a significant 9% of the total South Nation River Basin area.

There are 38 wetlands in the watershed with an area greater than 0.5 square kilometers. Their distribution is shown on Figure 2.1.1. Of this total, 19 are bogs and 19 are swamps. Marsh floodplain wetlands are present as part of 2 swamps. There are no true fens in the Watershed. The 8 largest wetlands in the Basin are listed in Table 2.6.1 and shown on Figure 2.6.2.

A description and classification of each wetland has been prepared for the Basin. The geographic, geological, hydrogeological and hydrological characteristics of each wetland are described in detail in the Wetlands Study report.

Several ways of using wetlands have been considered in the background studies. The potential for wetlands to be dammed to increase water storage has been considered in a preliminary way. This would reduce flood peaks and augment flows in late

* Areas of natural and scientific interest identified in MNR Land Use Strategies
** (Source: Wetlands Background Study)



(Source; Amenity Study)

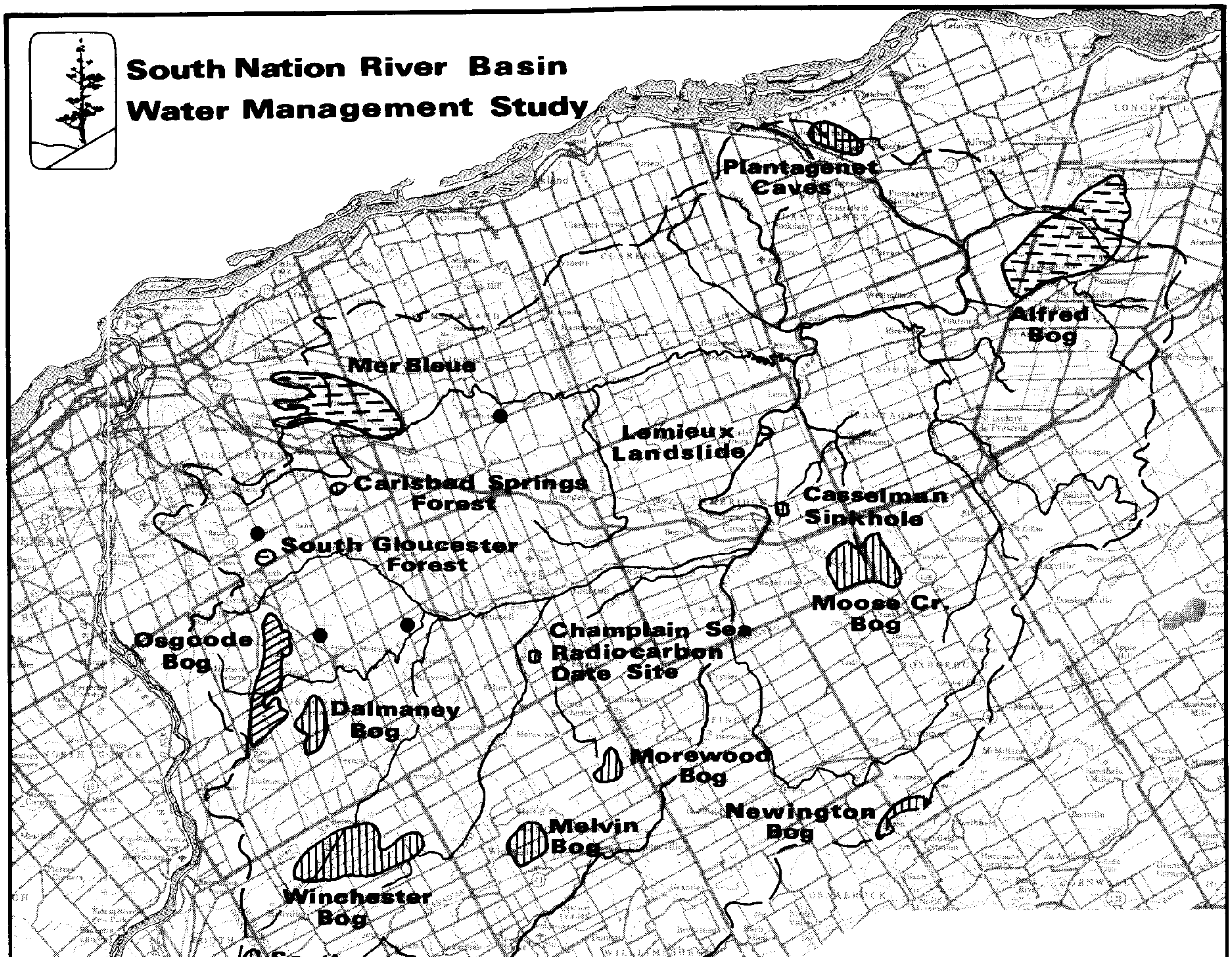


FIG. 2.6.2
NATURAL HERITAGE

(Source; Amenity Study)

PHOTO 2.6.1 DR. LOCKE HOUSE, WILLIAMSBURG

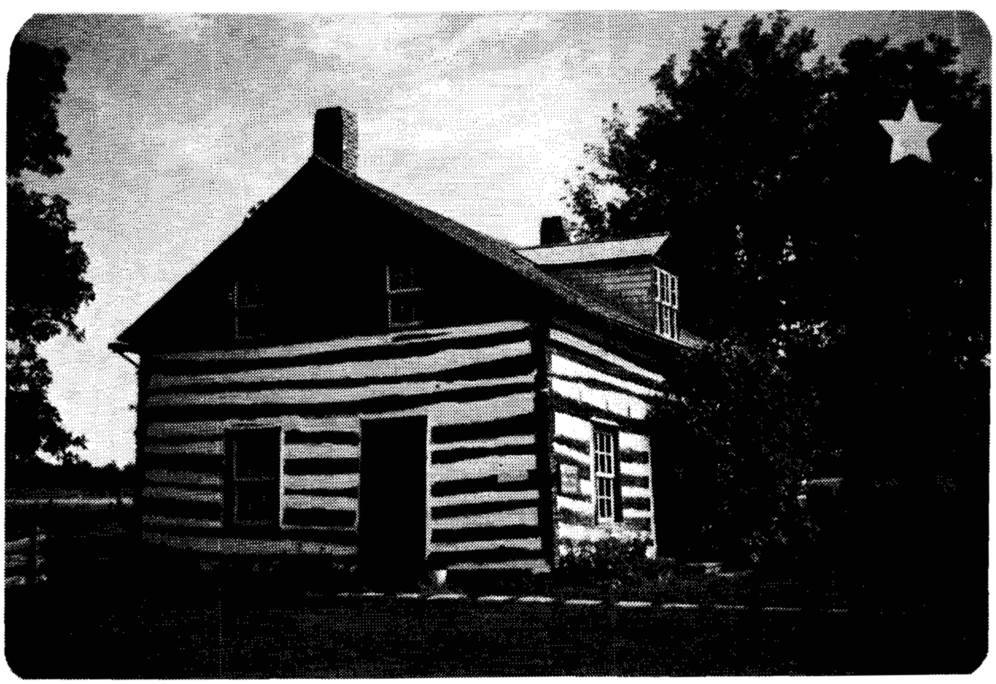


PHOTO 2.6.2 GLENGARRY MUSEUM, DUNVEGAN

summer months. The location of the wetland in the Basin, its size and catchment area, surrounding slopes, and number of outlets are the critical criteria in this evaluation. A total of 6 wetlands in the upper area of the Watershed were found that could make suitable water storage reservoirs. These include the Groveton Bog (area 31 km^2) which has the potential to increase low flows at Chesterville by as much as 10.5% and by 71.5% at Spencerville.

Table 2.6.1

Largest Wetlands in South Nation Basin

Wetland	Classification	Area (km^2)
Bear Brook Swamp	flat	10.7
Osgoode Swamp	flat, hardwood	12.2
Newington Bog	basin, flat	16.7
Moose Creek Bog	basin, flat	18.1
Winchester Bog	basin, hardwood	23.5
Mer Bleue Bog	flat, basin	26.0
Groveton Bog	basin (some swamp, floodplain)	31.0
Alfred Bog	flat	42.5

(Source: Wetlands Background Study)

Some bogs (i.e. Melvin Bog) have a potential to be used to receive and polish sewage effluents from lagoon discharges. Field testing is required to assess the economic feasibility and environmental impact of this process.

The Fisheries and Wildlife Study identified the Mer Bleue, Winchester Bog and Long Swamp Bog, Osgoode Bog and Center Augusta Bogs as important wildlife and nature study areas. The Alfred Bog includes an important moose population and part of it is used for small scale peat and timber harvesting. The interpretive and scientific value of these wetlands is supported in the Amenity System Study.

2.6.2 Opportunities and Constraints

The above sites are representative of the cultural resources and natural heritage of the Basin, and it is important that they be protected for information, and education purposes and for the general appreciation of Basin residents. Large scale restoration or land purchase schemes are not likely to be undertaken, and for this reason, these resources should be identified and incorporated into an interpretive program on scenic routes, or managed and developed through cooperative agreements between various agencies and private interests.

Cultural and Natural Heritage Conservation

The cultural heritage of the Basin and the archaeological and historic resources which represent it should be protected for future generations to enjoy and understand.

Archaeological and historic sites can be damaged or destroyed while undertaking water management projects. Archaeological sites, in particular, can be accidentally destroyed since they are often not recognized. Damage to heritage features can be minimized by undertaking surveys of areas to be affected before work begins. Identified sites can then be protected by avoiding the site if possible, recording all information from the site before destruction, or if practical preserving and developing the site as a tourist attraction.

In addition to protecting water related resources, other cultural sites throughout the Basin should be identified, ranked and suitably incorporated into a comprehensive signage and education program. It is recommended that sites which are ranked as highly significant be protected in the municipal planning process, and that cooperation between public and private agencies be encouraged to preserve and restore unique sites.

Similarly natural heritage sites, listed in a previous section, should be protected and managed to ensure that they are properly maintained into the future. It is recommended that where possible unique natural sites be purchased and managed by a public agency. Two sites of significance in this regard are the Long Swamp Bog and the Alfred Bog.

2.7 OUTDOOR RECREATION AND TOURISM

2.7.1 Land Resource

The outdoor recreation and tourism sector provides a considerable range of opportunities and facilities for local people. The role of the sector is primarily one

PHOTO 2.6.3 ALFRED BOG

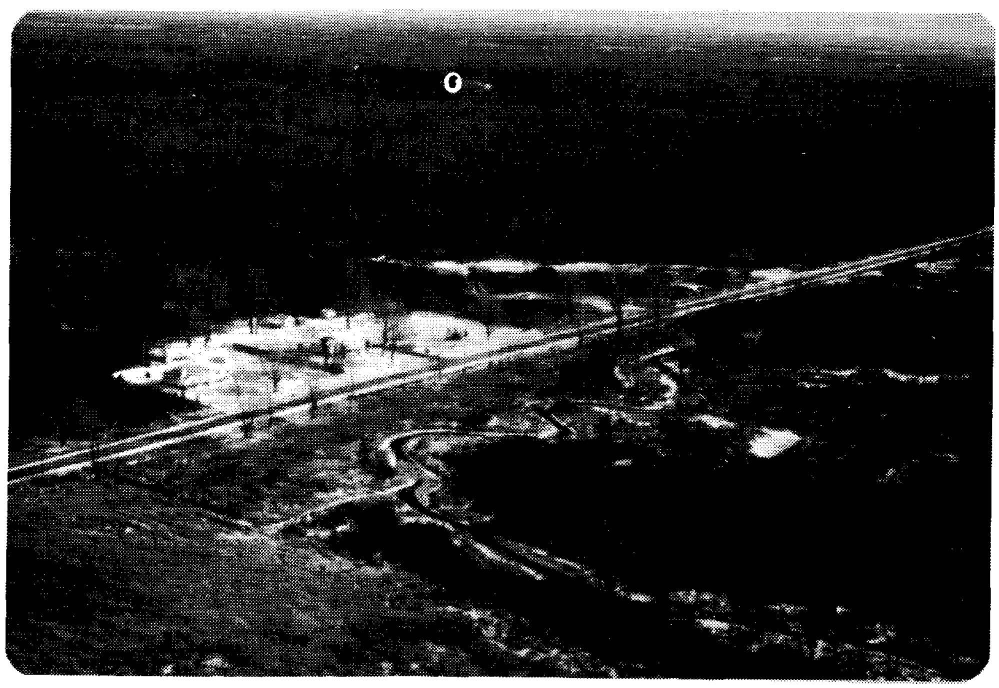


PHOTO 2.6.4 LAROSE FOREST

of meeting local day-use needs. Major recreational opportunities exist outside the Basin on the Ottawa, St. Lawrence and Rideau Rivers, providing weekend and vacation facilities.

Facilities in the Basin, which account for 440 ha of the Basin land, include:

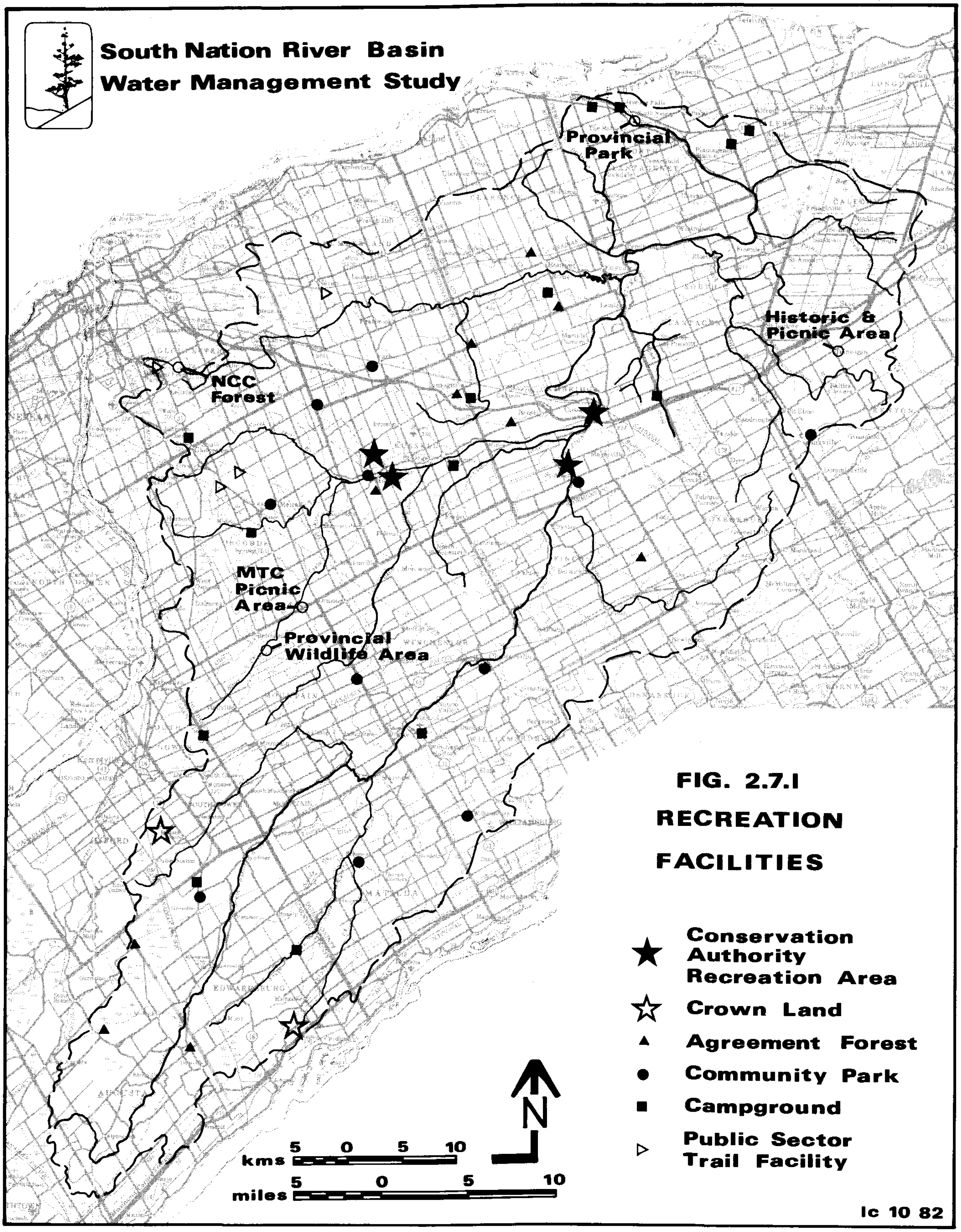
Type	No. of Locations	
Campgrounds	13	(1,162 sites)
Picnic Areas	30	(283 sites)
Boat Launch Sites	2	
Swimming Beaches	0	
Trails:	17	(967 km snowmobiles, 27 km cross country skiing)

Figure 2.7.1 shows location of existing recreation facilities.

2.7.2 Outdoor Recreation Opportunities and Constraints

The South Nation River Watershed has a relatively low recreational attractiveness in comparison with neighbouring areas. Residents of the Watershed have access to extensive, high quality recreational facilities just outside the watershed; for example, the Ottawa River, St. Lawrence River, Rideau River, Gatineau Hills, National Capital Commission facilities, and St. Lawrence Parks Commission facilities, are all within 2 hours drive of any part of the Basin.

Existing recreational facilities are well spaced across the Watershed. There are no high intensity concentrations anywhere, although there is a slight increase in the number of camping and picnicking sites nearer Ottawa. Camping opportunities available in the Watershed are more than adequate to meet demand; however, there is a need for more picnic areas along major travel routes and in association with water management demonstration areas, as recommended in the Amenity Study. Although good boating opportunities exist in the Ottawa, Rideau and St. Lawrence river systems, there is need for launching ramps within the Watershed for local use. Site selection criteria should consider erosion potential from access and wave action.



(Source; Amenity Study)

The Watershed does not contain any significantly scenic travel corridors of considerable driving distance. There are, however several discontinuous scenic road links dispersed throughout the Watershed. The majority are in the southwest and south-central portions. Since the scenic quality of the travel corridors is not optimal, it is necessary to combine scenic corridors with points of interest so that travel routes are established to utilize scenic travel, demonstration areas, and specific points of interest.

At present there are relatively few large recreational areas with established facilities. The Larose Forest is by far the largest and most important tract of public open space in the Basin. It has development potential, which is underutilized, in terms of passive recreational opportunities.

Even though the Basin's flat topography is generally not attractive to hikers or skiers, the supply of such facilities at present is not adequate to meet resident needs and demand for ski trails may increase. Most existing opportunities are concentrated in Augusta Township.

The increased fuel costs may tend to encourage residents to increase their demand for recreational opportunities near home, and thus increase the need for resident user oriented recreation facilities of various kinds.

There is the need to develop two or three day-use picnic facilities for travellers passing along major routes through the Watershed, probably along Highway 31 and 417.

Recreational facilities can be developed as ancillary uses to water control structures. Suitable facilities include, where appropriate, boat launching, picnicking and cross country skiing. A detailed recreational development program identifying specific types and locations of sites is recommended based on information present in the Amenity Systems Report and on Figure 2.7.2.

Low-key, non-labour intensive interpretation of the Basin's amenity resources can be provided for local residents through the establishment of conservation corridors or routes. These routes provide convenient day trips, specific terms, and resource access, involving a cross-section of Watershed terrain. By travelling these corridors, residents and visitors can pass through many of the scenic and historical

PHOTO 2.7.1 SOUTH NATION PARK NEAR PLANTAGENET

communities, and see the major natural and cultural resources within the Basin. Water management practices can also be pointed out and explained. Route maps and accompanying explanations of features in the form of pamphlets could be distributed.

There is a vital need to recognize the importance of agriculture to the Basin's economy and heritage. Agricultural practices are rarely interpreted to either the farming or non-farming public. Examples of Best Management Practices and their beneficial impacts should be highlighted for all to see and appreciate. Such sites can be located, where possible, along the conservation corridors.

It is, therefore, recommended that an education program be initiated. Some recommended sites include the following:

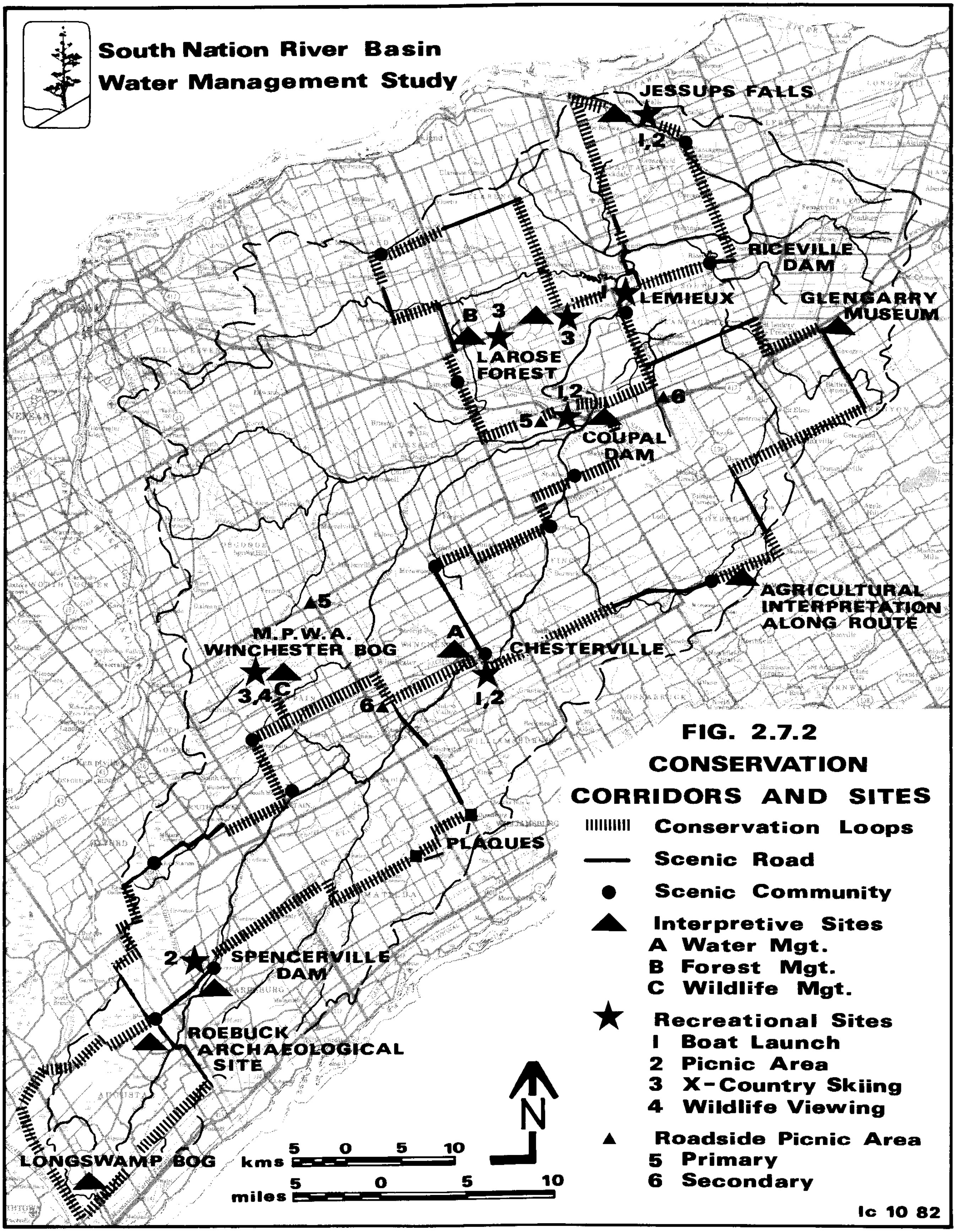
a) Forest management - Larose Forest,
b) Wildlife management - Winchester Bog,
c) Natural Heritage - Lemieux Landslide,
d) Water management - Chesterville Dam and channelization,
   - Plantagenet Rock Cut
e) Agricultural and conservation interpretive routes and/or demonstrations throughout the Basin, and
f) Recreation Areas - boat launch ramps, picnic sites.

Figure 2.7.2 shows the recommended locations of the above sites and conservation corridors.

2.8 FUTURE LAND USE PATTERNS

The development potentials outlined above contain a number of implications for future land use patterns in the South Nation River Watershed. The most important overall feature in this regard is that there are not likely to be any dramatic shifts in land use between sectors. Agriculture will continue to be the dominant land use form, followed by forestry. Industrial, commercial, and residential land use is not expected to change, or expand significantly, in the foreseeable future.

The major changes in land use will be within the agriculture and forestry sectors. They will reflect a growing emphasis on better management and more intensive use



(Source; Amenity Study)

of each land parcel. In agriculture, there is a strong trend to producing more cash crops. Areas of grain, corn, and barley have increased over the last ten years while oats have decreased substantially. Present indications are that soybean acreage will increase dramatically and it will become second to grain corn as a cash crop. Canola has considerable potential for expansion as a new cash crop in the very near future as well.

The implication from these changes in agricultural land use is that the area under intensive cultivation will increase sharply and, conversely, the area under hay and pasture will decrease to some extent. These kinds of changes will require new emphasis on wise agronomic practices to ensure that the best soil management and conservation methods are used. In addition, more emphasis must be placed on providing adequate processing and manufacturing within the Basin to handle their increases in production.

Similarly, in forestry, intensive forest management on private and public lands may not significantly change the total area under forest cover. However, it will change the type of cover through planting, thinning, and harvesting practices. The application of sound forest management practices should have generally beneficial impacts on land use from the point of view of water management considerations.

3.1 FLOODING

Historically, flooding has presented a problem for rural and urban residents of the Basin. There are four major rural flood areas. These are the Plantagenet, Brinston, South Castor and Bear Brook flood areas as indicated on Figure 3.1.1. Spring flooding caused by snowmelt is an annual occurrence in these areas. Although approximately 8,000 hectares flood each year, residents in these areas have adjusted somewhat to the problem by building structures above flood levels and flood proofing. Current problems associated with spring flooding in these areas are mainly those of inconvenience including access problems on certain main roads and several farm roads, increased risk of fire damage and health hazards, and major clean-up requirements after the flood.

Spring flooding can also be a concern in villages along the South Nation River and its main tributaries. Normal spring run-off does not usually cause significant urban flooding. However, the occurrence of either significantly higher than normal peak flows, due to rapidly rising temperatures or large rainfall amounts during the snowmelt period, or artificially high water levels due to ice jams can create significant flooding as was the case in Crysler during 1982.

Summer flooding is normally caused by one or more major rainfall events occurring on wet or saturated soils. It has not been a problem in urban areas. However, in the four rural flood areas (noted above) serious flooding resulting in significant crop damages does occur. From an economic point of view, summer floods are much more damaging than spring floods. Flooding can cause total crop loss under certain conditions of timing and duration. The average annual area affected by summer flooding in the four major flood areas is approximately 1,000 hectares on average.

In addition to flooding of the land surface, there is also a fringe area adjacent to the flooded area where the water table rises into the root zone of the crop. A prolonged high water table in the crop root zone within the fringe areas can be equally as devastating to the crops as surface flooding. According to the Water Resources Background Study, the total fringe area affected during the summer growing season for the four major flood areas is approximately 2,750 hectares on average.

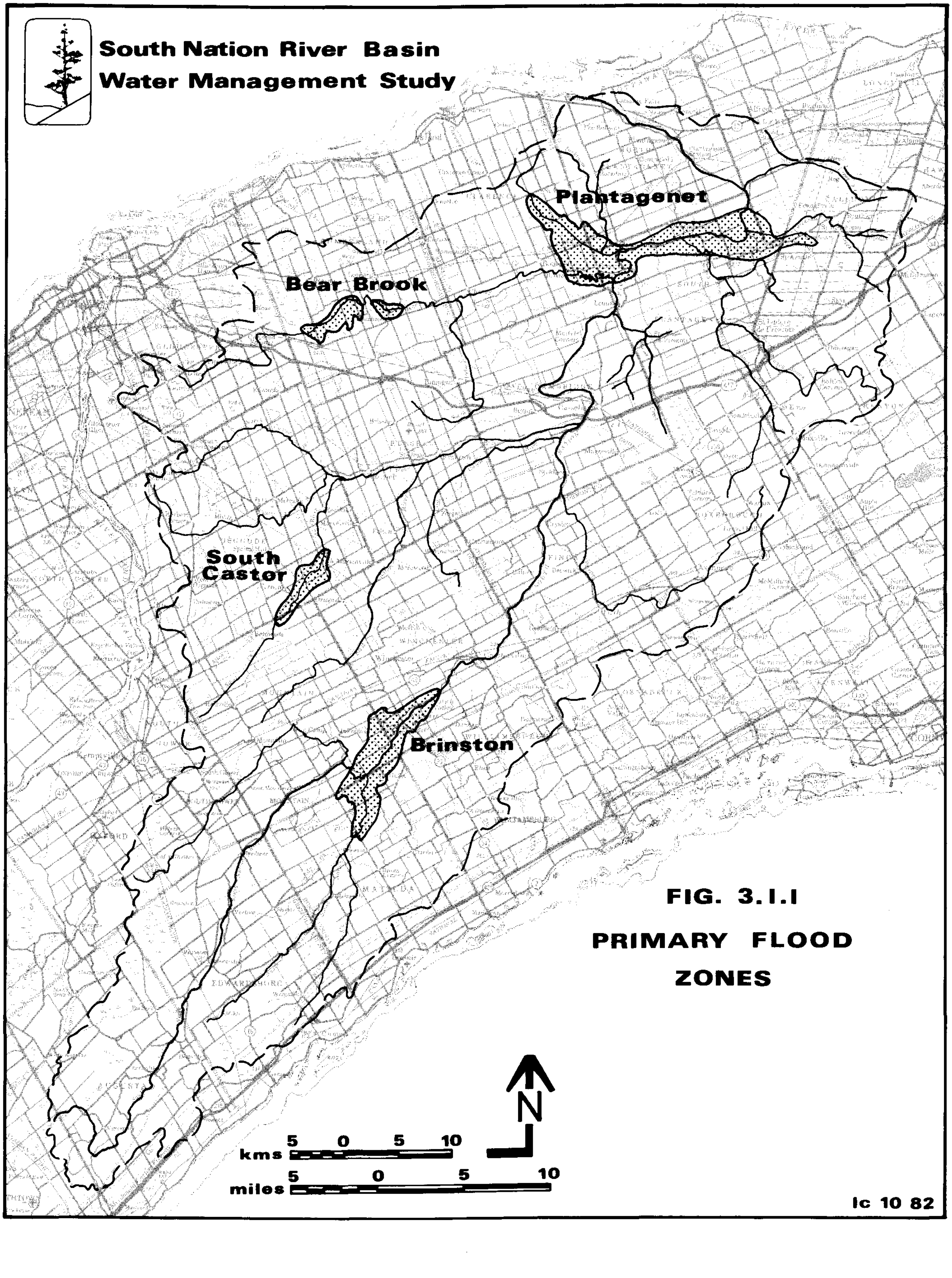


FIG. 3.1.1

PRIMARY FLOOD ZONES

3.1.1 Problem Analysis

3.1.1.1 Spring Floods

Spring floods in the South Nation River Basin are associated with the spring snowmelt and at times the flooding is increased by concurrent rainfall. The spring flood has in the past been the largest flood event each year on the South Nation River and its major tributaries according to the flow records at 15 stations located throughout the Watershed. The spring flood generally lasts for a week to ten days and occurs during February, March and April.

Table 1.5.1 shows the mean annual flood discharge for the 15 gauging stations while Table 3.1.1 illustrates peak flows at the four major flood areas for a number of recurrence levels. Basically floods are an annual occurrence at the four major flood areas since flows generated in the spring significantly exceed channel capacities.

In the Plantagenet area the channel capacity averages about 255 m^3/s. From Table 1.5.1, it can be seen that the mean annual flood flow is 735 m^3/s which indicates that spring flood flows regularly exceed the channel capacity. These excess flows spread over large areas of the adjacent flat lands. For the average annual flood flow 3,697 ha of land in the Township of South Plantagenet becomes inundated. Approximately 5,700 ha of land was flooded as a result of the highest recorded flow of 1082 m^3/s which occurred in the Plantagenet area during 1978.

Annual spring flooding occurs elsewhere throughout the Basin to varying degrees. Prior to channelization upstream from Chesterville the channel capacity was approximately 14-17 m^3/s and flood flows normally range between 170 and 255 m^3/s in the spring. The resulting flooding inundated 2966 ha of land annually on average. The highest recorded flood flow rate at Chesterville was 278 m^3/s and it resulted in an estimated 4856 ha of land being flooded in the Brinston area. The new channel capacity is approximately 100 m^3/s, and the flood area will be substantially reduced in future years. Table 3.1.2 summarizes average annual flood areas for the four major flood areas pertaining to the snowmelt run-off period.

TABLE 3.1.1

Flows for the 2, 5, 10, 20, 50 and 100 Year Return Periods at the Four Major Flood Areas

Location	Season	Flows at Specified Period m^3/s					
		2 Year	5 Year	10 Year	20 Year	50 Year	100 Year
Plantagenet[3]	Annual[1]	589.	762.	850.	918.	989.	1030.
	Growing[2] Season	122.	234.	312.	386.	478.	544.
Bear Brook	Annual	70.	91.	104.	116.	131.	142.
	Growing Season	12.	24.	31.	38.	45.	49.
South Castor	Annual	34.	45.	51.	56.	61.	64.
	Growing Season	7.	17.	26.	36.	51.	64.
Chesterville[3]	Annual	203.	263.	292.	314.	340.	354.
	Growing Season	30.	69.	104.	144.	207.	263.

1 Annual refers to the calendar year
2 Growing season refers to May to October
3 Pre Chesterville Channel

TABLE 3.1.2

Average Annual Spring Flood Area

Flood Zone	Flooded Area
Chesterville/Brinston	2966 ha
Plantagenet	3697 ha
Bear Brook	446 ha
South Castor	362 ha

For the most part, flooding in the Basin has been concentrated in predominantly agricultural areas. According to previous studies (Agricultural Background Study), the land use in each of the flood areas is more than 80% agricultural, and more than 30% of that is intensively cropped as indicated by the following table.

TABLE 3.1.3

Land Use in Flood Zones

	% of Total Land Use			
Flood Zone	Cropland	Hay/Pasture	Agr. Total	Other
Chesterville/Brinston	41.4	41.8	89.9	10.1
Plantagenet	39.3	48.7	88.0	12.0
Bear Brook	54.3	29.1	83.4	16.6
South Castor	59.8	29.8	89.6	10.4

While the spring floods do impact on agricultural operations, they have, in general, little impact on crops. In fact, the spring flood is viewed as being beneficial in some respects. Nutrients are added in the layer of silt which is deposited and the frost is melted earlier.

Although many of the farmers within the flood zones perceive the spring flood as a normal annual event that precedes the planting season, a few are more directly affected in terms of interruptions in the farming operations. Depending on the seriousness of the flood and the depth of water, entry into the farm area is often impeded and milk cannot be shipped out. In the past, this was not as much a problem when milk was shipped in cans and could be transported in boats.

FLOODING

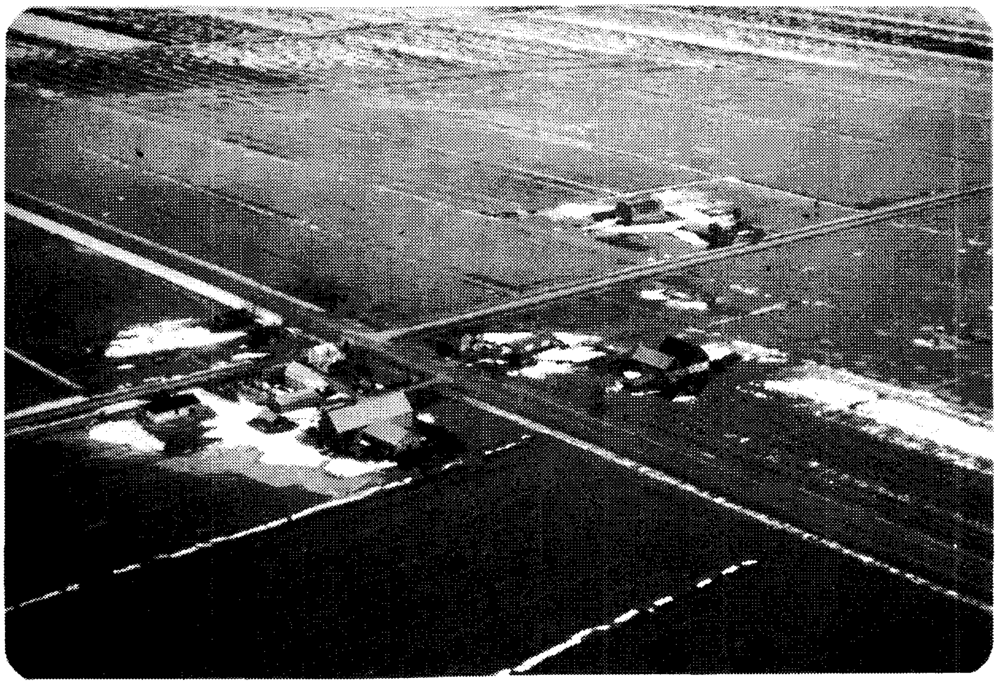


PHOTO 3.1.1 SPRING FLOODING AT PLANTAGENET FLOOD ZONE

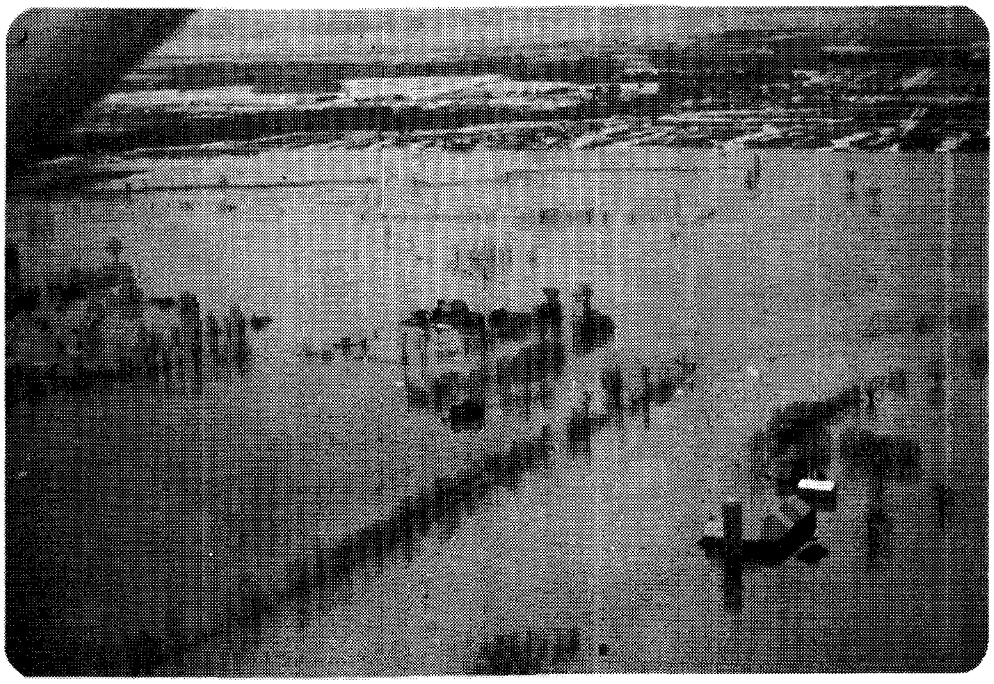


PHOTO 3.1.2 SPRING FLOODING AT BRINSTON FLOOD ZONE

However, with the present day methods of bulk handling of milk, the problem becomes considerably more criticial. While this problem is real to a few farmers, efforts are being made to raise roads in critical areas in order to improve access. An example of this is County Road 5 in Dundas, where approximately 2 km was raised at a cost of $200,000 in 1980.

A serious problem caused by the spring flood is the damage to fencing, the extent of which varies depending on the severity of the flow and the amount of ice.

Another is the large amount of debris left in fence rows and on fields which must be cleaned up before spring operations can begin. Discussions with local farmers have suggested that $2,000.00 per farm unit approximates the cost incurred annually for clean-up and fence and structure repair and replacement. Based on average farm sizes of 81 ha the cost per hectare of the annual flood is $24.70.

Based on this damage estimate and above noted average area flooding estimates the average annual damage for each of the flood areas is as follows:

TABLE 3.1.4

Average Annual Spring Flood Damage

Flood Zone	Average Annual Spring Flood Damage
Plantagenet	$ 91,340
Brinston	73,280
Bear Brook	11,020
South Castor	8,940

Costs such as road and ditch maintenance, alternate transportation and emergency expenses are not included, therefore, damage figures may be slightly higher.

Indications are that most of the building in rural areas are above normal flooding levels and there is no apparent concern with respect to structural problems. It appears that residents in the flood zone area have adjusted to the environment and view it as a discomfort and a nuisance. This is notwithstanding that most residents would like the flood problem ameliorated and brought under control.

Although the urban areas along the rivers and in the flood zone are few and relatively small, they can be significantly affected by large scale floods. In most instances where a town is located within or partially within a flood plain there are serious threats to property and even to life, during a severe spring flood.

One example is the Village of Crysler where high water levels due to a combination of high flows and ice jams on the main branch of the South Nation River, on April 1, 1982, caused flooding of about a dozen structures including residences and businesses. Damages to buildings and contents were estimated at $30,000.00, based on discussions with residents shortly after the flood. Actual long term damages may be higher. Flooding in Plantagenet due to ice jamming at the bridge very nearly occurred during the 1980 snowmelt run-off but was fortunately prevented when the ice jam broke. Some flooding has occurred in Hammond and the possibility of flooding within Spencerville, Limoges and Kenmore has been acknowledged in the Water Resources Background Study.

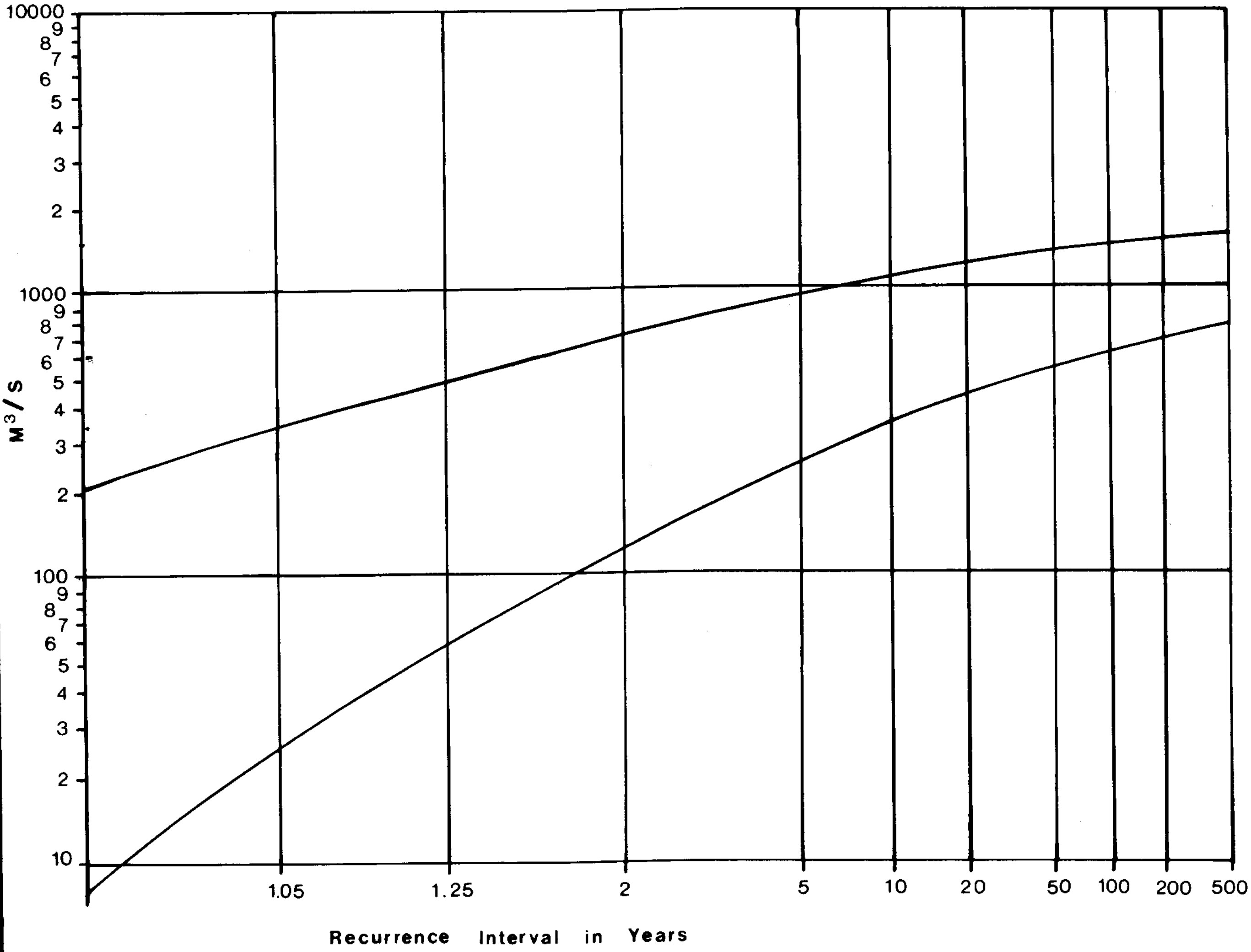
3.1.1.2 Summer Floods

In addition to spring snowmelt flooding, the four major flood areas are subject to periodic flooding during the months of May to October. While the magnitude of flooding during the May to October period is less than that of the spring flood, the impact is often more severe because it occurs during the growing season and damage can occur to agricultural crops.

A comparison between growing season flows and annual flows is shown in Table 3.1.1 and illustrated by the flow frequency curves, for the Plantagenet case, shown in Figure 3.1.2. Flood areas corresponding to these flows were utilized to generate estimates of the average area flooded annually in each of the four flood areas (Table 3.1.5):

Fig. 3.1.2

PEAK FLOW FREQUENCY CURVES AT PLANTAGENET



1 ANNUAL

2 GROWING SEASON

Log Pearson Type III Distribution

TABLE 3.1.5

Average Annual Growing Season Flood Area

Flood Zone	Area Flooded
Plantagenet	312 ha
Brinston	492 ha
Bear Brook	115 ha
South Castor	85 ha

In most years the highest summer flows occur in the month of May, when crops are at a sensitive stage of growth. If flooded for a short period of time (2 days) total crop loss occurs. Often it is too late to replant, so that the farmer must buy the feed equivalent to replace the lost crop.

In order to establish costs of total crop loss the Ontario Ministry of Agriculture and Food crop budgeting aid and 1981 prices were used. The figures shown in Table 3.1.6 resulted.

TABLE 3.1.6

Cost of Total Crop Loss

Crop	Total Crop Loss $/ha
Corn	$ 1,150
Grain	$ 672
Alfalfa Hay	$ 635

These figures reflect crop replacement costs as well as a portion of the production costs.

For each of the four major flood zones, the proportion in various crops was determined in the Agricultural Background Study (Table 3.1.7).

TABLE 3.1.7

Average Crop Loss per Hactare

Flood Zone	Corn	Grain	Hay	Other	Average Crop Loss ($/ha)
Plantagenet	14%	25%	36%	25%	558
Brinston	23%	26%	41%	10%	702
Bear Brook	34%	20%	17%	29%	638
South Castor	39%	20%	25%	16%	746

The above calculation assumed "other" lands to be idle, woodland or pasture where economic losses from temporary flooding would not be significant. Based on the foregoing it was possible to determine the average annual direct damages for each flood damage area which are as follows:

TABLE 3.1.8

Average Annual Growing Season Flood Damage

Flood Zone	Growing Season Flood
Plantagenet	$ 174,250
Brinston	$ 345,340
Bear Brook	$ 73,270
South Castor	$ 63,120

In addition to the primary flood area there is also a fringe area which is affected by flooding and crop damage results. Since the requirement for tile drainage is approximately 1 metre below ground level, the fringe area is defined as that area which would experience a backup of water from the flood into the top metre of soil. Although water is not at the surface it is within the root zone (top metre) and can severely limit crop growth. The average annual fringe areas have been calculated for the four major flood zones (Table 3.1.9):

FLOODING

PHOTO 3.1.3 FALL FLOODING ALONG THE SOUTH NATION

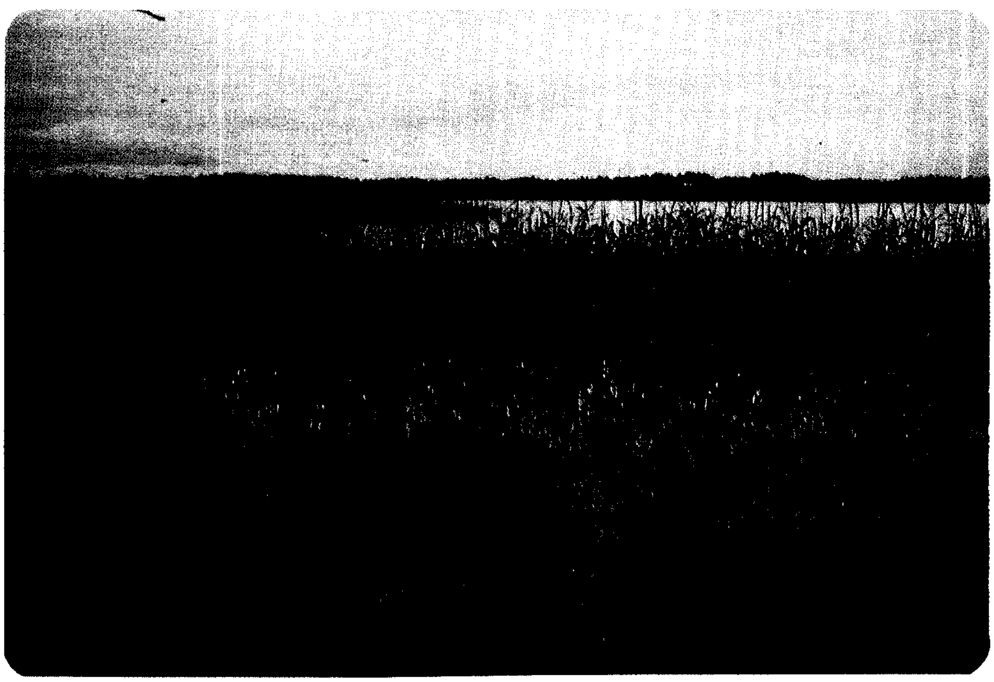


PHOTO 3.1.4 CROP FLOODING DURING GROWING SEASON ALONG SOUTH CASTOR RIVER

TABLE 3.1.9

Average Annual Fringe Area

Flood Zone	Fringe Area (Hectares)
Plantagenet	492 ha
Brinston	1792 ha
Bear Brook	79 ha
South Castor	388 ha

Crop yield reduction in the fringe areas varies with the distance from the river for the flooded area. At the limit of the flood area, crop loss is close to 100%, however, at the outer limit of the flood fringe area the crop loss is 0%.

The amount of damage in both the flooded area and the fringe area is dependent on the type of crop, stage of crop growth, duration of flooding or root zone saturation and weather conditions following flooding. There is no research record or information on this kind of crop damage in Eastern Ontario.

Literature from Southwestern Ontario indicates that saturation of the root zone between May and September will reflect in crop losses varying from 10% to 23% for corn, 2% to 60% for soybeans and 15% to 23% for grains. These figures can be considered to be low for Eastern Ontario because the growing season is shorter and number of degree days lower.

By adjusting the Southwestern Ontario figures proportionately by the five year production averages estimates of O.M.A.F. or the difference in heat units, figures for the South Nation River area would be 15% to 28% for corn and 21% to 29% for grains. Therefore, a figure of 25% would appear to be a reasonable estimate. Damages per acre and total damages in fringe areas have been calculated and are shown in Table 3.1.10.

The total average annual damage associated with the four flood areas can now be calculated. There are several indirect costs which have not been included in this damage assessment such as inconvenience, limited access, road repair and inability to tile drain. Based on previous similar cases the Water Resource Background Study has suggested a figure of 20% be used to cover these indirect costs. The total damage estimates are shown in Table 3.1.11.

TABLE 3.1.10

Average Annual Fringe Area Damages

Flood Zone	Damage Per Hectare	Total Fringe Area Damage
Plantagenet	$ 140	$ 69,260
Brinston	$ 176	$ 314,400
Bear Brook	$ 160	$ 12,700
South Castor	$ 187	$ 72,900

TABLE 3.1.11

Total Average Annual Damages

Flood Zone	Spring Flood Damage	Growing Season Damage	Fringe Area Damage	Indirect Damage (20%)	Total Average Annual Damage
Plantagenet	$ 91,340	$ 174,250	$ 69,360	$ 66,970	$ 401,820
Brinston	73,280	345,340	314,400	146,610	879,630
Bear Brook	11,020	73,270	12,700	19,400	116,390
South Castor	8,940	63,120	72,900	28,990	173,950

Table 3.1.12 shows the present value of this damage for various discount rates:

TABLE 3.1.12

Present Value of Damages

Flood Zone	Discount Rate (50 Year Period) 5%	7%	10%
Plantagnet	$ 7,336,000	$ 5,546,000	$4,984,000
Brinston	16,059,000	12,140,000	8,722,000
Bear Brook	2,125,000	1,606,000	1,154,000
South Castor	3,176,000	2,401,000	1,725,000

The discount rate is a measure of the effective long term interest rate (i.e. difference between interest and inflation rates) over the anticipated lifetime of a structural project which would solve the flooding problem. The purpose of returning annual crop damages to present value is to permit comparison to (present value) cost estimates of structural solutions. Basically, the structural solution cost estimate should not exceed the present value of benefits to be obtained.

In addition to the four major flood areas there are a number of locations along the South Nation River and its major tributaries where summer flooding of cropland occurs. There is some local overbank flooding and tributary back-up in certain areas. Also, when streams are running bank full there is an adjacent fringe area effect with high water tables in the crop root zone because sub-surface water cannot drain away. The secondary flood areas have been identified through air photo interpretation and are described in the Water Resources Background Study. The fringe area close to the secondary flood areas has not been assessed.

3.1.2 Management Options and Recommendations

There are a number of structural and non-structural measures that can be employed in different areas of the Watershed to help reduce the flooding problem and its impacts on local residents. These measures include diversions, reservoirs, channels, dykes and flood proofing, as well as flood plan regulations, special insurance and land acquisition. These have been assessed, for the most part in the Water Resources Background Study, and are discussed in detail below. Locations of structural schemes are illustrated on Figure 3.1.3.

A summary of the measures considered to reduce flooding is provided in Table 3.1.21. To account for linkages between flooding and other water management issues impacts on water supply, water quality, and damage from erosion are considered. A discussion of major constraints and a final recommendation regarding project feasibility are also provided. Further discussion regarding these and other impacts, where required, has been included within the section dealing with the issue in question.

3.1.2.1 Diversions

Diversion structures are built to take water out of an area or to bring it in by way of a new channel. Two such diversions to reduce flooding at Brinston and Plantagenet have been assessed.

The Spencerville diversion was proposed in combination with reservoirs located upstream of Spencerville, to relieve flooding in the Brinston area by directing a maximum flow of 84.9 m^3/s out of the Basin into the St. Lawrence River. However, the location of the diversion limits its flood reduction potential because less than 20% of the flow affecting the Brinston flood area comes from upstream of the diversion site. Furthermore, both Spencerville reservoir alternatives (see Table 3.1.13) appear to have adequate live storage capacities to hold runoff volumes from most growing season storm events, with the larger 1966 reservoir proposal providing well in excess of the capacity required, thereby eliminating the need to divert flows to the St. Lawrence River for critical summer events. It was therefore concluded that the estimated expenditure of $14,000,000.00 (in 1979 dollars) for the Spencerville diversion was not warranted.

A diversion to reduce flooding in the Plantagenet area, the Cobb's Lake Creek Diversion, would follow Cobb's Lake Creek starting at a point approximately one mile downstream of the junction of Bear Brook with the South Nation River and cross the drainage divide to Clarence Creek and into the Ottawa River at Rockland. While its location is excellent, being immediately upstream of the flood area, recent investigations have indicated that the capital cost of the scheme would be in excess of $120 million. Based on available hydraulic head between the South Nation River and the Ottawa River, diversion of 200 m^3/s would require 13.0 km of grassed lined channel with a water depth of 3.7 m and bottom width 28.7 m as well as 8.0 km of tunnel at the drainage divide consisting of four 4.9 m x 6.1 m box culverts. Theoretically, this diversion channel would solve flooding problems at Plantagenet, for events between the 1:5 year "growing season" event where summer flooding begins at present and approximately the 1:50 year summer event. The costs, estimated at $120 million, however, far outweigh potential maximum benefits which approximate $5.5 million (7% discount rate), according to estimates provided in the previous section. The benefit/cost of this project would be less than 0.05.

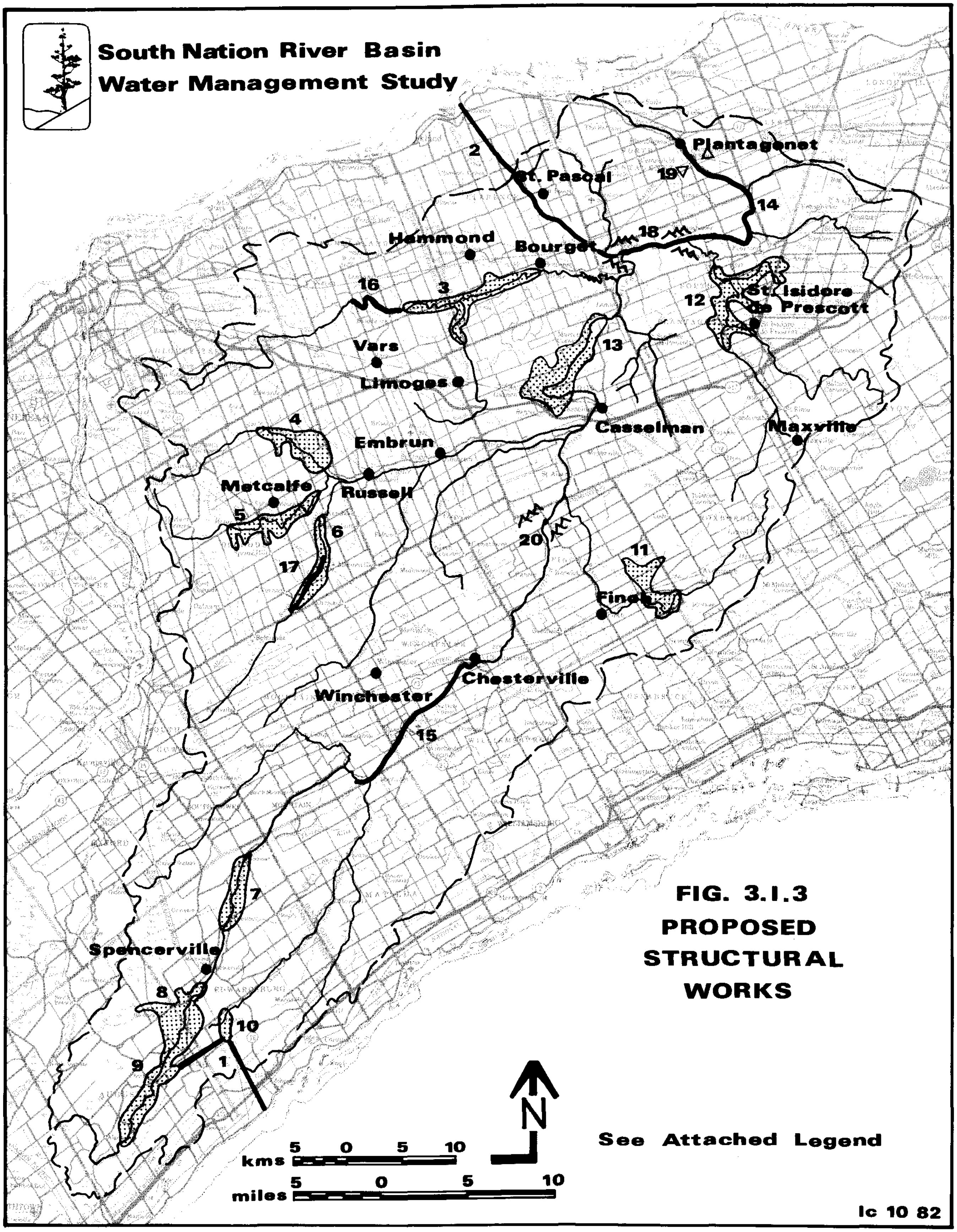


FIG. 3.1.3
PROPOSED STRUCTURAL WORKS

PROPOSED STRUCTURAL WORK

LEGEND

Symbol	Name
	Diversion
1	Spencerville
2	Cobbs Lake
	Reservoirs
3	Bear Brook
4	North Castor
5	Middle Castor
6	South Castor
7	Hyndman
8	Spencerville Mill
9	Spencerville
10	Domville
11	Payne
12	Scotch
13	Lemieux
	Channels & Dykes
14	Plantagenet
15	Chesterville
16	Bear Brook
17	Castor River
18	Plantagenet Dyking
19	Plantagenet Rock Cut
20	Crysler Dyking

No further consideration should be given to diversion channels in view of the high capital costs involved and the existence of other more suitable alternatives.

3.1.2.2 Reservoirs

As indicated in Table 3.1.13 two versions of relatively large reservoirs (1948 and 1966 reservoirs), located in the vicinity of Spencerville, have been considered to reduce flooding in the Brinston flood area. However, because of location the reservoir would control only about 23% of the drainage area above Chesterville and, according to the hydraulic analysis, less than 20% of the run-off volume observed at Chesterville.

The larger 1966 version of the Spencerville Reservoir cannot be fully utilized because of the large storage capacity relative to the small upstream catchment areas. This is demonstrated by the fact that during the peak flow for the 1:10, 1:20 and 1:50 year growing season events, the live storage in the reservoir would be 3%, 16% and 20%, respectively. The reduction in area flooded for both reservoirs would be approximately 200 ha or 16% for the 1:50 year event, 40 ha for the 1:20 year event and nil for the 1:10 year event as the flow will be contained in the new channel being constructed. Based on Table 3.1.13 reduction in flood area, compared to farmland inundated at the reservoir sites, is at least 1,082 ha and 2,830 ha for the 1948 and 1966 reservoirs, respectively.

Costs for the 1948 Spencerville Reservoir were estimated at $2,750,000.00 in 1979 and current estimated costs for the larger 1966 reservoir are in the order of $30 million, including dams, dykes and land acquisition. Based on these estimated construction costs, and the fact that land areas inundated at the reservoir sites significantly exceed land areas removed from flooding, these structural alternatives are not recommended for flood control purposes.

Three other smaller reservoirs have been proposed in the past to help reduce flooding in the Brinston area, namely the Spencerville Mill (73 ha), Domville (233 ha) and the Hyndman reservoirs. The size and storage volume available in the reservoirs when compared to the magnitude of the flood at Brinston, are insignificant and therefore these reservoirs should not be considered further as viable options to solve the flooding in the Brinston area.

Several reservoirs have been considered to reduce flooding in the Plantagenet flood area. They include the following:

- Payne reservoir
- South Castor reservoir
- Middle Castor reservoir
- North Castor reservoir
- Bear Brook reservoir
- Scotch reservoir
- Lemieux reservoir

All reservoirs are located on Figure 3.1.3. Figure 3.1.4 shows the flow reduction in the Plantagenet area due to the reservoirs taken in various combinations. The effectiveness of the reservoirs in reducing the area flooded as a measure of the surface area of the reservoirs are summarized in Table 3.1.13. Where available, cost estimates for the reservoirs have been included. Detailed estimates were not considered to be necessary since most reservoirs are not very effective in reducing flood areas and can be eliminated from further consideration in the Basin.

The Payne reservoir would be located on the Payne River, upstream of the village of Finch. Live storage in the reservoir is in the order of 1560 ha-m. The reservoir would be 1360 ha in size. However, the area of flood reduction at Plantagenet would be 14 ha for the 1:10 year flood event and about 203 ha for only less frequent events such as the 1:20 and 1:50 year events. Since the Payne reservoir would inundate much more agricultural land than it would protect in the Plantagenet flood area, it should not be considered further for flood control purposes.

The South Castor reservoir is located on the South Castor River, approximately 7 km upstream of Russell. Live storage in the reservoir is approximately 1164 ha-m and the reservoir surface is 2125 ha. However, the area of flood reduction would only be in the order of 64 ha for the 1:10 year flood event and about 106 ha for the 1:50 year flood. From this it can be seen that the South Castor reservoir would inundate much more agricultural land than it would protect downstream in the Plantagenet flood area. The South Castor reservoir should not be considered for flood control.

TABLE 3.1.13

Pertinent Data For Proposed Reservoirs

River	Name of Reservoir	Drainage Area mi. km^2	Flooded Area at Max. WS Elevation Hectares	Gross Reservoir Storage $10^6 m^3$	Area of Flood Reduction (ha) Area of Reservoir (ha) 1:10 Year	1:20 Year	1:50 Year	Reservoir Live Storage $10^6 m^3$
South Nation River above Spencerville	Spencerville (ODPD 1948)	238	1082	15.8	-	-	-	-
South Nation River at Spencerville	Spencerville (Acres 1966)	246	2830*	88.8	No Flooding	0.006	0.036	74.0
South Nation River near Spencerville	Spencerville Mill	246	-	2.2	-	-	-	-
South Branch of South Nation River near Domville	Domville	18	-	3.0	-	-	-	-
South Nation River near the Village of Hyndman	Hyndman	297	-	2.2	-	-	-	-
North Branch of Castor River above Russell	North Castor River	135	1546*	21.7	0.08	0.10	0.21	21.7
Middle Branch of Castor River above Russell	Upper Middle Castor River	85	809*	15.1	0.10	0.12	0.24	15.1
Middle Branch of Castor River above Russell	Lower Middle Castor River	96	318	2.9	-	-	-	-
South Branch of Castor River above Russell	South Castor River	176	2125*	11.6	0.03	0.04	0.05	11.6
Castor River above Russell	Castor River Combined (excluding Lower Middle Castor River)	N/A	4480	48.4	-	-	-	-
Payne River above Finch	Payne River	119	1360*	16.5	0.01	0.06	0.06	15.6
Bear Brook near Bourget	Bear Brook	430	332	11.1	0.48	0.30	0.30	9.9
Scotch River at Riceville	Scotch River	285	2400*	45.6	0.08	0.10	0.13	44.7
South Nation River above Lemeiux	Lemeiux	7500	462	25.5	.44	-	1.14	25.5

N/A Not Applicable
\- No Information
* Figures derived by MacLaren from 1:500 000 scale topographic mapping

Two reservoirs, the Upper Middle Castor and the Lower Middle Castor with dams located 13 and 7 km above Russell, respectively, have been considered. The larger of the two, the Upper Middle Castor reservoir floods about 809 ha at maximum water level and has a live storage of about 1510 ha-m. Flood reductions would range from 81 ha for the 1:10 year event to 194 ha for the 1:50 year event. Since reductions in the Plantagenet flood area are far less than the agricultural area flooded by the reservoir itself, construction of this reservoir is not recommended for flood control in the Plantagenet flood area. Similarly the somewhat smaller Lower Middle Castor reservoir is not recommended.

The dam for the North Castor reservoir would be located about 6 km upstream of Russell. The reservoir would flood about 1546 ha and would provide a live storage of approximately 2171 ha-m. Flood reduction in the Plantagenet flood area would range from 124 ha for the 1:10 year event to 325 ha for the 1:50 year event which are significantly less than the area flooded by the reservoir itself. This reservoir which is estimated to cost $11,900,000.00 (1979 dollars) is therefore not recommended for flood control in the Plantagenet area.

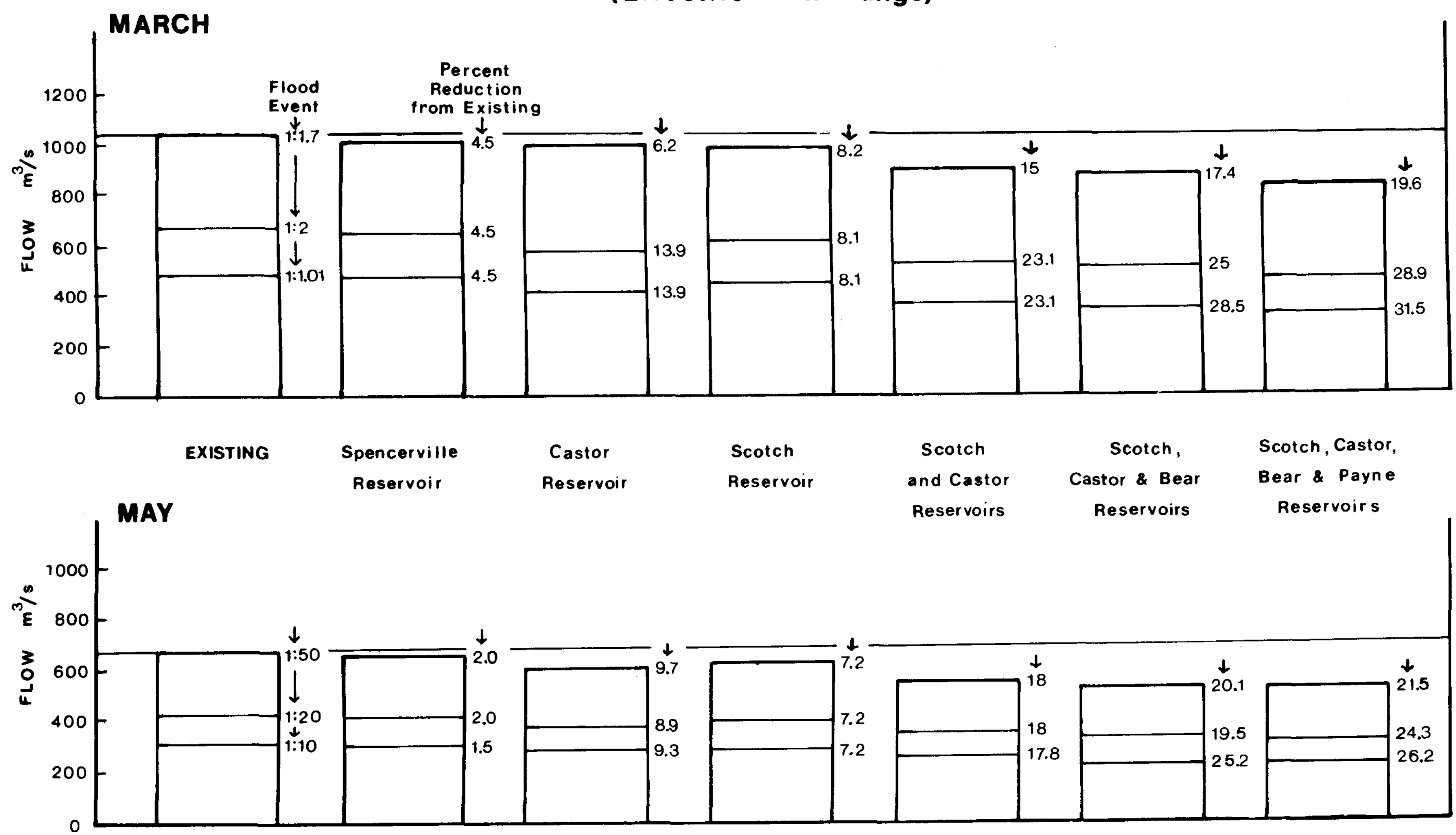
The dam forming the Bear Brook reservoir would be located near Bourget about 1006 m downstream of the Bourget bridge. The reservoir would flood 332 ha and would provide a live storage of about 988 ha-m. Flood reductions in the Plantagenet area range from 161 ha for the 1:10 year event to 101 ha for the 1:50 year event which are significantly less than the area flooded by the reservoir itself. This reservoir is therefore not recommended.

The dam forming the Scotch River reservoir would be located at Riceville. The reservoir would flood 2400 ha at maximum water level and would provide a live storage of 4473 ha-m. Flood reductions at the Plantagenet flood area range from 192 ha for the 1:10 year event and 312 ha for the 1:50 year event which are significantly less than the area flooded by the reservoir itself. The Scotch River reservoir which is estimated to cost $13,100,000.00 (1979 dollars) is therefore not recommended.

The Lemieux reservoir would be located on the South Nation River, above the village of Lemieux. The reservoir live storage would be 2553 ha-m and its size, 462 ha. The area of flood reduction for the 10 year and 50 year flood flows would

Fig. 3.1.4

Flow Reduction in the Plantagenet Area due to Proposed Reservoirs (Effective Flow Range)



be approximately 203 and 527 ha respectively. The reservoir would appear to be beneficial in terms of flood reduction at the higher recurrence intervals. It is further noted that the flood would be transferred from an agricultural area to unused river valley and in association with the Larose forest the recreation potential of the reservoir is substantial. A very detailed geotechnical assessment of the marine (Leda) clay soil is required to determine foundation conditions and water retention capability. Also the recreational and social benefits of this reservoir must be established, prior to consideration for construction.

Since combined effects of reservoirs might improve overall performance, several combinations of reservoirs were analyzed in terms of their flood reduction potential. Figure 3.1.4 and Table 3.1.14 illustrate the effectiveness of various combinations of reservoirs such as:

- Scotch and Castor
- Scotch, Castor and Bear Brook
- Scotch, Castor, Bear Brook and Lemieux
- Scotch, Castor, Bear Brook and Payne

It can be concluded from interpretation of Figure 3.1.4 and Table 3.1.14 that areas inundated at the combined reservoirs exceed areas of flood reduction that would result. Further when structure costs are also considered total costs far outweigh the benefits for all combinations of reservoirs. Therefore, the reservoir combinations should not be considered further for flood control purposes alone.

3.1.2.3 Channelization and Dyking

Channelization generally involves widening, straightening and deepening watercourses to improve the flow capacity within the channel. Dyking involves raising of channel banks to reduce spillage from the channel. This improved flow capacity reduces the volume of flood plain storage along the channel reach and upstream. However, channels commonly increase flood peaks and area flooded at downstream locations. Channelization is a flood control option at the four major flood prone areas.

The Chesterville Interim Flood Reduction Project is a channel scheme from Chesterville upstream to the confluence with the South Branch, a distance of 17

TABLE 3.1.14

Comparison of Total Surface Area Flooded by the Reservoirs and Total Reduction in Area Flooded in the Plantagenet Area as a Result of the Operation of the Proposed Reservoirs

Recurrence Interval (years)	Total Surface Area Flooded by North Castor, Scotch, Bear Brook and Lemieux Reservoirs (hectares)	Total Reduction in Area Flooded in the Plantagenet Area with the Reservoirs in Operation (hectares)
1:12	1651	1052
1:23	2267	1457
1:50	2678	1437
1:100	2769	769

km, that was started in 1978 and will be completed in 1983. The project involves construction of a channel with 3:1 side slopes and 24 metre bottom width. The channel capacity through the flood area corresponds to a 10 year summer flow.

The channel as it is presently designed will reduce the average annual area flooded (spring) in the Brinston flood area from 2966 ha to 1831 ha, the average area flooded during the growing season from 492 ha to 199 ha and the average annual fringe area affected during the growing season from 1792 ha to 802 ha. The reduction in spring and growing season areas flooded and fringe area affected are 1134, 293 and 990 hectares respectively. However, the average annual spring and growing season flooded areas in Plantagenet are increased by 174 and 23 hectares, respectively. The fringe area increase at Plantagenet is estimated to be 29 hectares.

Based on damage evaluation procedures developed in Sections 3.1.1 and 3.1.2 the total average annual flood reduction benefit in the Brinston area is summarized in Table 3.1.15.

TABLE 3.1.15

Total Benefit of Chesterville Channel

Annual Flood Reduction Benefit	Growing Season Flood Reduction Benefit	Fringe Area Benefit	Indirect Benefit (20%)	Total Average Annual Benefit
$28,030	$205,900	$173,737	$81,533	$489,200

The total average annual flood damage that has been transferred down to Plantagenet is summarized in Table 3.1.16.

TABLE 3.1.16

Damage Transferred Downstream

Annual Flood Damages	Growing Season Flood Damages	Fringe Area Damages	Indirect Damages (20%)	Total Average Annual Damages
$4,290	$12,882	$4,050	$4,240	$25,460

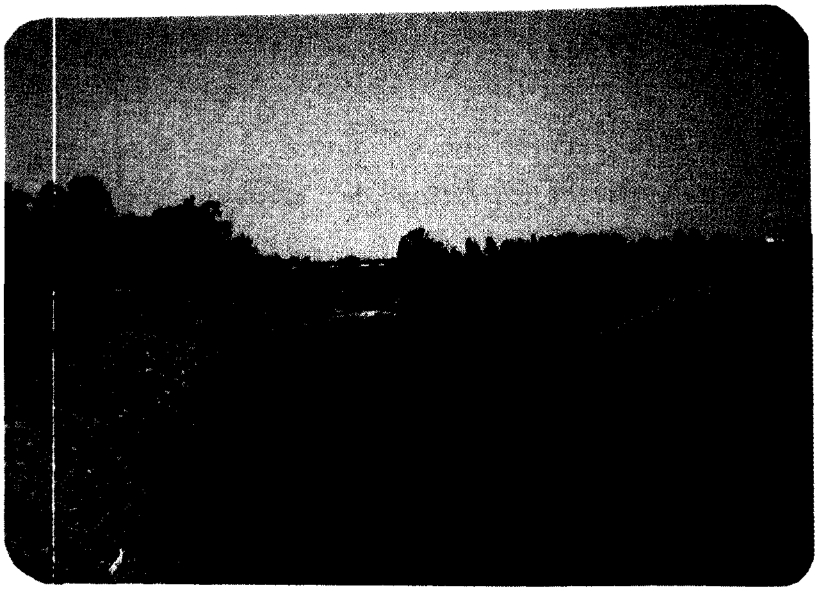
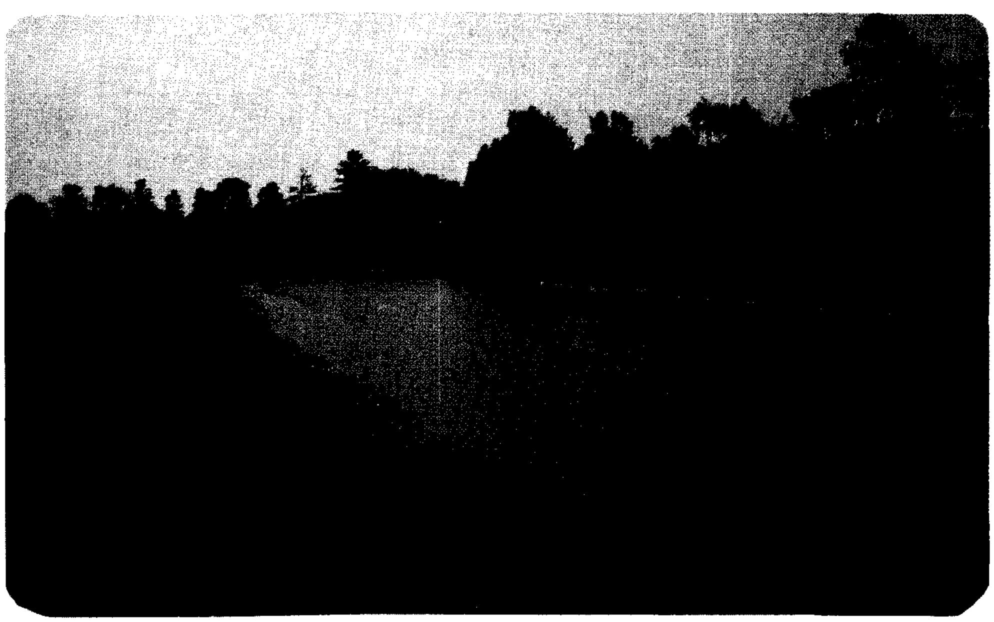


PHOTO 3.1.5

CHANNELIZATION
NEAR
CHESTERVILLE

PHOTO 3.1.6

PHOTO 3.1.7



Therefore for flood reduction, the total average annual benefit of the Chesterville channel is $463,740. In present value terms for various discount rates the benefit is approximately $8,466,000 (5%), $6,400,000 (7%) and $4,598,000 (10%). The total estimated cost of the Chesterville Channelization Project is $8,000,000. Therefore, the Chesterville Channelization is a favourable flood reduction project at real discount rates of less than approximately 6%.

An improved channel through the South Castor flood area will reduce the agricultural flood damages in the South Castor flood area and will not adversely affect the Plantagenet flood area. A similar benefit evaluation was carried out to assess the economic viability of this channel. The flood reduction benefits for a 10 year design channel are summarized below:

TABLE 3.1.17

Total Benefit of South Castor Channel

South Castor Channel Design	Average Annual Flood Reduction (ha)	Average Annual Flood Reduction ($)	Average Growing Season Flood Reduction (ha)	Average Growing Season Flood Reduction ($)	Fringe Area Benefit (ha)	Fringe Area Benefit ($)	Indirect Benefit (20%)	Total Average Annual Benefit ($)
10 year	149	3,680	53	39,864	96	17,969	12,303	73,816

In present value terms for discount rates of 5, 7 and 10% the benefits are $1,348,000, $903,000 and $732,000, respectively. The cost estimate for this channel is approximately $900,000 indicating the project to be favourable with regard to flooding considerations at a discount rate of less than 7%. It should be noted, however, that although flooding at Plantagenet will not be significantly affected by this channel, flooding within Kenmore may be, according to the results of the assessment on the South Castor Drain summarized in Section 3.3. The cost requirements to provide downstream remedial measures or drain modifications to eliminate such concerns should therefore be considered during the design stage. The South Castor Channel described above should not be confused with the South Castor Drain which is currently being considered for construction. The benefits of the South Castor drain are not only for flood reduction but also for improved upstream drainage potential. If the South Castor Drain is constructed the South Castor channel assessed in this report should not be considered.

Two channelization alternatives have been considered in the Bear Brook flood area. While both channel alternatives will reduce flooding along the Bear Brook, they will not adversely affect the Plantagenet flood area.

One alternative involves the construction of a 10 year design channel through the Bear Brook flood area and the other involves the excavation of several constrictions below the flood area. An analysis to assess the economic viability of these channelization alternatives has been undertaken and is summarized in Table 3.1.18.

TABLE 3.1.18

Total Benefit of Bear Brook Channels

Bear Brook Channel	Average Annual Flood Reduction (ha)	Average Annual Flood Reduction ($)	Average Growing Season Flood Reduction (ha)	Average Growing Season Flood Reduction ($)	Fringe Area Benefit (ha)	Fringe Area Benefit ($)	Indirect Benefit (20%)	Total Average Annual Benefit ($)
10 yr design	76	1,870	52	33,282	0	0	7,030	42,182
Constriction excavation	191	4,870	65	41,860	0	0	9,346	56,076

(Note: Area figures are approximate)

Present value estimates of benefits for the 10 year channel at discount rates of 5, 7 and 10% are $770,000, $582,000 and $418,000 respectively. The cost estimate is in the order of $1,000,000.

Present value estimates of benefits for the excavation of constrictions at discount rates of 5, 7 and 10% are $1,024,000, $774,000 and $556,000 respectively, indicating the project to be favorable with regard to flooding considerations at discount rates of 5%. Although this economic analysis appears favourable, a more detailed field assessment should be carried out due to difficulties encountered in the accurate assessment of areas flooded. At the design stage the benefits of

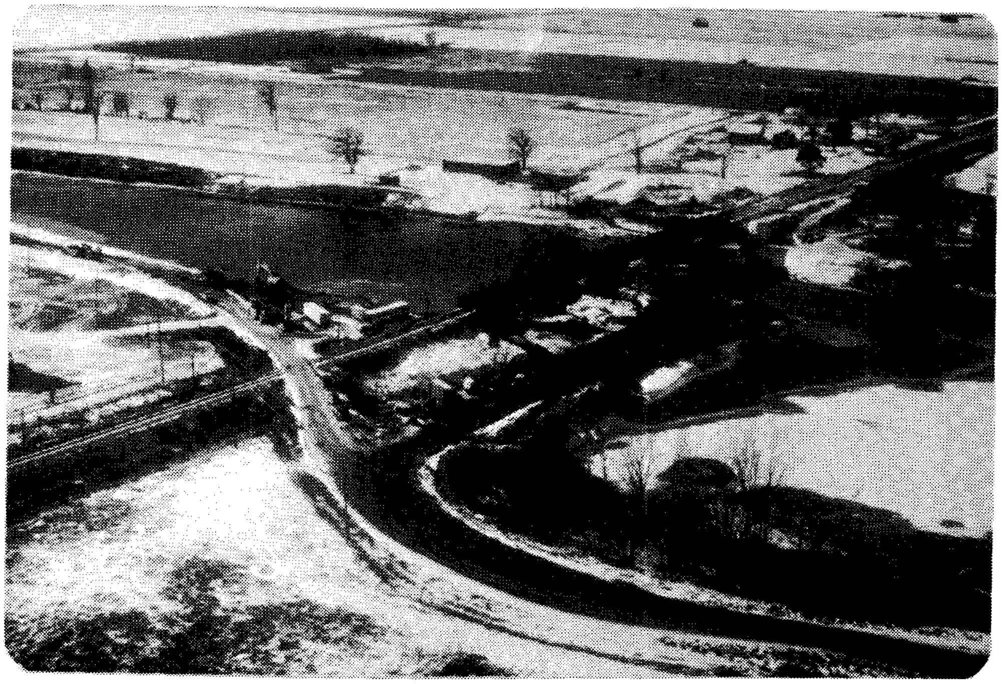


PHOTO 3.1.8 PLANTAGENET INTERIM FLOOD CONTROL PROJECT

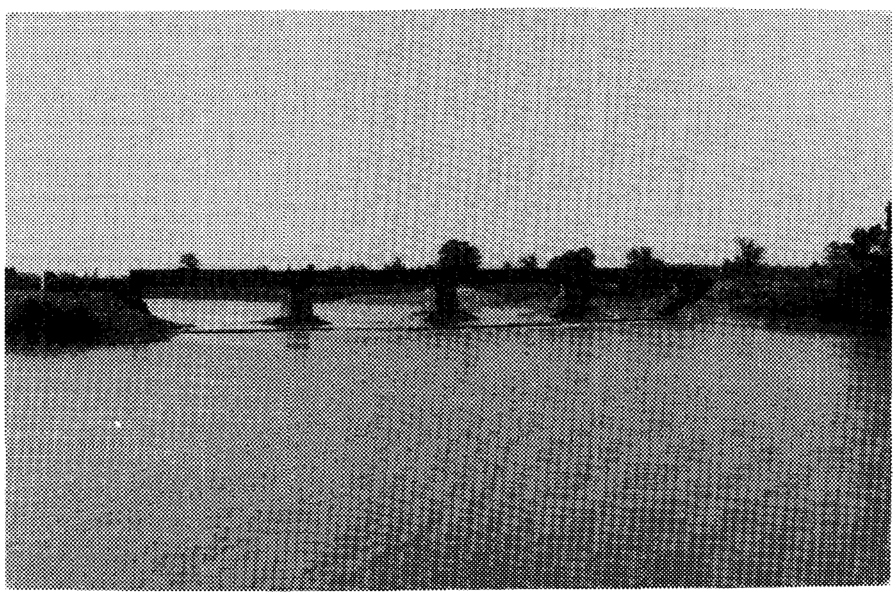


PHOTO 3.1.9 PLANTAGENET PROJECT COMPLETED IN 1981

upstream drainage should be considered as well as possible downstream remedial measures to overcome the impact of increased flow or erosion. The cost estimate is $950,000.

Historically, the rock sill at Plantagenet Springs has contributed to upstream flooding in the South Plantagenet flood area. The Plantagenet Interim Flood Control Project (shown in Photos 3.1.8 and 3.1.9) was completed in the summer of 1981, and has improved the hydraulic capacity through the rock sill. Approximately 21,000 m^3 of rock was excavated and a low flow weir constructed at a cost of approximately $400,000. With the excavation complete, the main constrictions to flow have been transferred from the rock sill to the river sections through the flood area and downstream of the rock sill.

Nine different channelization and dyking alternatives have been assessed in terms of their flood reduction potential in the Plantagenet flood area. Those included channel widening, channel deepening and tributary channel dyking. Alternative descriptions, flood reduction benefits, estimated costs and benefit-cost ratios are shown in Tables 3.1.19 and 3.1.20. Detailed benefit estimates were developed for alternatives No. 4 to 9 only, as these appeared during the initial stage to be the more promising alternatives.

ALTERNATIVE NO. 1 involves a 100% increase in the channel size from Plantagenet Springs to Caledonia Creek. Although water levels would be lowered locally along the channel the effect of the flood area is minimal. Approximately 5.3 million m^3 would be excavated at a cost of $26.5 million. This alternative should not be considered further for flood control.

ALTERNATIVE NO. 2 involves a 100% increase in the channel size from Plantagenet Springs to Cobb Lake Creek. Although flood levels through the flood area would be reduced by approximately 1 metre for both low and high flows the cost estimate of $57 million was considered too high to warrant further investigation of this alternative.

ALTERNATIVE NO. 3 involves a 50% increase in the channel size from Plantagenet Springs to Cobbs Lake Creek. Although flood levels through the flood area would be reduced by approximately 0.7 metre for both low and high flows the cost estimate

TABLE 3.1.19

AVERAGE ANNUAL BENEFIT FOR

FLOOD REDUCTION ALTERNATIVES AT PLANTAGENET

Alternative	Average Annual Benefit (ha)	Average Annual Benefit ($)	Growing Season Benefit (ha)	Growing Season Benefit ($)	Fringe Area Benefit (ha)	Fringe Area Benefit ($)	Indirect Benefit (20%) ($)	Total Average Annual Benefit ($)
No. 4	662	16,358	102	59,961	62	8,732	16,410	98,461
No. 5	453	11,193	24	13,738	0	0	4,986	29,917
No. 6	707	17,480	141	78,851	46	6,406	20,547	123,284
No. 7	2,550	63,018	231	129,184	240	33,868	45,214	271,284
No. 8	2,188	54,077	216	120,600	224	31,590	41,253	247,520
No. 9	58	1,438	39	21,701	63	8,840	6,396	38,375

TABLE 3.1.20

BENEFIT/COST SUMMARY OF FLOOD REDUCTION ALTERNATIVES AT PLANTAGENET

Alternative Number	Description	Cost Estimate	5% Present Value Benefit	Benefit Cost	10% Present Value Benefit	Benefit Cost
1	100% increase in channel size from Plantagenet Springs to Caledonia Creek	26,500,000	± 5,000,000*	0.2	± 3,000,000*	0.11
2	100% increase in channel size from Plantagenet Springs to Cobbs Lake Creek	57,000,000	± 5,000,000*	0.1	± 3,000,000*	0.05
3	50% increase in channel size from Plantagenet Springs to Cobbs Lake Creek	27,000,000	± 5,000,000*	0.2	± 3,000,000*	0.11
4	Deepening a section from Caledonia Creek to between Seguin Bridge and the Scotch River	3,600,000	1,800,000	0.5	980,000	0.27
5	Deepening the section between Plantagenet and the rock outcrop	2,700,000	550,000	0.2	300,000	0.11
6	Alternatives Nos. 4 and 5 (above)	6,300,000	2,250,000	0.36	1,220,000	0.19
7	Alternatives Nos. 4 and 5 and widening to 75m from Plantagenet to Cobbs Lake Creek	40,000,000	4,950,000	0.12	2,790,000	0.07
8	As No. 7 w/o rock removal from Plantagenet to rock outcrop	35,500,000	4,520,000	0.13	2,450,000	0.07
9	Low level dyking along 4 tributaries	300,000	700,000	2.34	380,000	1.27

* Approximate Estimates Based on Comparison with Other Alternatives

for this alternative is approximately $27,000,000. This alternative should not be considered further since there are less costly alternatives that are equally as effective and other alternatives, although more costly, that are more effective for flood control.

ALTERNATIVES NO. 4 to 6 involve deepening the river profile. There are two substantial rises in the bed of the river, one located just downstream of the rock cut and the other upstream of Seguin Bridge in the South Plantagenet flood area. Only minimal widening to accommodate improved side slopes were considered for these alternatives.

ALTERNATIVE NO. 4 involves deepening a section of the South Nation River from Caledonia Creek to a location between Seguin Bridge and the Scotch River. It is estimated 717,000 m^3 of material would be excavated at a cost of approximately $3.6 million dollars. The benefits of this alternative in terms of area of flood reduction and average annual dollar benefit are shown in Table 3.1.19. Table 3.1.20 presents dollar benefit in present value terms and benefit/cost rates.

ALTERNATIVE NO. 5 involves the deepening of the river from Plantagenet to the rock outings. As can be seen from the figures in Table 3.1.20, this alternative is not very effective in reducing the flood area, however the material excavated would only be 244,520 m^3 of earth and 59,270 of rock for an estimated cost of $2.7 million.

ALTERNATIVE NO. 6 is a combination of No. 4 and 5. The cost estimate is $6.3 million. Since social effects to the flood have not been incorporated into this design and the benefit cost is reasonable, Alternatives No. 4 and 6 should be considered at a more detailed pre-engineering phase.

ALTERNATIVE NO. 7 and 8 involve deepening and widening. A base width of 75 metres was assumed for Alternative No. 7 for Plantagenet and Cobbs Lake Creek and the channel deepened through the two rises of Alternatives No. 4 and 5. Alternative No. 8 is the same as No. 7 except that the rock cut work from Plantagenet to Plantagenet Springs is eliminated. The volumes of earth excavation is 7,100,000 m^3 and rock excavation is 164,000 m^3. The cost estimates are $40 million and $35.5 million for Alternatives No. 7 and 8 respectively. With very low benefit/cost ratios these alternatives should not be considered further.

ALTERNATIVE NO. 9 is a lower level of protection designed to protect against the 1:10 year summer flood. It includes low level dykes (one metre high) along 4 small tributaries of the South Nation River and Cobbs Lake Creek. The total length of the dyking is estimated at 2300 m. Flap gates would also be required on culverts installed through the dykes. The cost estimate for this work is $300,000. Further work including detailed ground surveys should be done to optimize the final design for each dyke prior to construction.

Alternative No. 9 with benefit cost ratios of 2.34 and 1.27 for discount rates of 5 and 10 per cent respectively is a feasible alternative for implementation. It is further noted that total average flood reduction benefits provided by the dyking, equal to $38,375, more than offsets the computed average annual increases in damages in the Plantagenet flood area, due to the upstream Chesterville channelization of $254,468.

It is noted, from Table 3.1.20, that benefit/cost ratios for all alternatives except No. 9 are equal to or less than 0.5 and less than 0.3 for discount rates of 5 and 10 per cent respectively. Alternatives No. 4 and 6 are the best channelization schemes. They protect against a much greater flood event than the dyking and merit further consideration to determine accurate cost estimates and reduction of social impacts, if implemented. It is recommended that a preliminary engineering study be undertaken for Alternatives No. 4 and 6, and it should include a social impact assessment.

In summary for Plantagenet, the low level dykes should be constructed, a preliminary engineering assessment is recommended for the two best channelization schemes (No. 4 and No. 6) and a detailed geotechnical study should be undertaken for the Lemieux Reservoir.

3.1.2.4 Other Remedial Measures

As mentioned previously the spring snowmelt flood in the rural area is primarily an inconvenience and has limited economical damage. Since major reductions in the average annual flood areas are not possible, except at high costs, it is recommended that roadways be raised where possible to eliminate some of the inconvenience factor. This type of remedial measure has been undertaken in the past. Examples are the Cobbs Lake Creek Road east of Bourget in the Plantagenet flood area and Dundas County Road No. 5 in the Brinston flood area.

Also, flood proofing of structures is a low cost alternative to protect against the impacts of the spring flood. Flood proofing is particularly applicable in the South Nation River Basin. Flooding along the main channel upstream of Chesterville and Plantagenet will always occur since there are no cost effective measures that will completely eliminate the flooding.

It is recommended that steps be taken to flood proof existing structures that are susceptible to damage in the flood areas. Any new structures should be constructed at elevations higher than the 100 year flood.

A part of this program is to undertake detailed flood plain mapping. The Conservation Authority, under the E.O.S.A., are presently completing flood plain mapping through several communities within the Watershed. The 100 year flood line will be plotted so that future development in the flood plain can be regulated. Also a preliminary engineering assessment is included that identifies feasible remedial measures to protect existing structures located within the flood plain. A feasible alternative for flood reduction in the village of Crysler is the construction of a dyke. The dyke varies in height from one to three metres and would cost approximately $140,000.

Crop flood insurance and flood plain acquisition have been practised elsewhere in an attempt to reduce the impact of damages resulting from flood events. Noting that approximately 40 million dollars would be required to purchase all lands subject to flooding under the 1:100 year annual peak flood, acquisition of this land does not appear to be reasonable. Further, the cost of acquisition of lands flooded during an average annual growing season would be approximately 3 million dollars, not including the loss of potential crops during productive years. Since it appears more reasonable to attempt to reduce summer flooding in such areas where cost effective projects can be initiated, this course of action is also not recommended for the present. Crop flood insurance is not presently available in Canada.

TABLE 3.1.21 FLOOD CONTROL RECOMMENDATION ASSESSMENT

RECOMMENDATION	FLOODING	WATER SUPPLY	WATER QUALITY	LAND DRAINAGE	EROSION	OTHER BENEFITS, OPPORTUNITIES	MAJOR CONSTRAINT	STATUS OF RECOMMENDATION
Diversions								
Spencerville	(+)reduces Brinston flood	(0)	(+)low flow assimiliation of wastes	(-)develops backwater effect	(0)	(0)	(-)costs far exceed benefits	not recommended
Cobbs Lake	(+)reduces Plantagenet flood	(0)	(0)	(+)provides new drain outlets	(0)	(0)	(-)costs far exceed benefits	not recommended
Reservoirs								
Payne	(+)reduces Plantagenet flood	(0)	(0)	(-)develops backwater effect	(0)	(0)	(-)costs far exceed benefits	not recommended
Castor River	(+)reduces Plantagenet flood	(-)Russell, Embrun, Casselman	(+)low flow assimilation of wastes	(-)develops backwater effect	(0)	(0)	(-)costs far exceed benefits	not recommended
Scotch River	(+)reduces Plantagenet flood	(+)St. Isidore	(+)low flow assimilation of wastes	(-)develops backwater effect	(0)	(0)	(-)costs far exceed benefits	not recommended
Spencerville	(+)reduces Brinston flood	(+)augments Chesterville Winchester	(+)low flow assimilation of waste	(-)develops backwater effect	(0)	(0)	(-)costs far exceed benefits	not recommended
Bear Brook	(+)reduces Bear Brook flood	(+)Hammond, Bourget	(+)low flow assimilation of wastes	(-)develops backwater effect	(-)site in sensitive clay area	(0)	(-)costs far exceed benefits	not recommended
Lemieux	(+)reduces Plantagenet flooding	(0)	(+)low flow assimilation of wastes	(0)upstream area non-agricultural	(-)site in sensitive clay area	(+)recreation	(-)high costs	detailed geotechnical investigation recommended
Chesterville	(+)reduces Brinston flood (-)Plantagenet flood increased slightly	(-)short term interruption	(-)short term damage	(+)improves upstream drainage	(0)	(+)recreation boating	(-)fish and wildlife and archaeological sites destroyed	under construction
South Castor	(+)reduces South Castor flood	(-)short term interruption	(-)short term damage	(+)improves upstream drainage	(0)	(0)	(-)high cost possible fish, wildlife, and archaeological impacts	recommended if South Castor Drain not constructed
Plantagenet	(+)reduces Plantagenet flood	(-)short term interruption	(-)short term damage	(+)improves upstream drainage	(-)disturbs sensitive clay slopes	(+)social benefit	(-)costs exceed flood reduction benefit	preliminary engineering and social impact assessment recommended
Bear Brook	(+)reduces Bear Brook flood	(-)short term interruption	(-)short term damage	(+)improves upstream drainage	(0)	(0)	(-)high cost possible fish wild-life and archaeological impacts	recommended
Dykes at Plantagenet	(+)reduces impacts at channels	(0)	(0)	(0)	(-)may require special works on clay base	(0)	(-)only low level production	recommended
Dykes at Crysler	(+)reduces village flooding	(0)	(0)	(0)	(-)stabilization required	(0)	(0)	recommended
Other Measures								
Flood Proofing	(+)reduces structure damage	(0)	(0)	(0)	(0)	(+)low cost	(-)cost to owner	recommended
Flood Plain Regulations	(+)eliminates new structure from flood areas	(0)	(0)	(0)	(0)	(0)	(0)	recommended
Flood crop Insurance	(+)spreads out damage cost	(0)	(0)	(0)	(0)	(0)	(-)not available in Canada	not recommended
Flood Plain Acquisition	(+)crop losses from flooding eliminated	(0)	(0)	(0)	(+)includes sensitive clay sites	(0)	(-)very expensive and agricultural production lost	not recommended

3.2 SURFACE WATER QUALITY

Surface water quality in the South Nation River Basin does not satisfy Provincial Water Quality Objectives for phosphorus and bacteria. The high phosphorus and bacterial concentrations are directly related to agricultural activities. In fact, according to the Water Resources Study, ninety-five percent of the phosphorus in the system is attributable to diffuse (non-point) sources located throughout the Watershed.

Although much of the phosphorus and bacterial loading occurs in association with flooding, poor water quality conditions in general are exaggerated by extended periods of low flow during the summer months.

Sediment from erosional losses reaches relatively high concentrations during the peak run-off period, and in some parts of the Basin during the entire year. The sediment problem is of concern, both with regard to aesthetics (turbidity) and phosphorus levels.

Dissolved oxygen problems occur at some of the lagoon discharge locations or in impoundments downstream from the lagoons.

3.2.1 Problem Analysis

3.2.1.1 Sediment

Sediment loads are high in the South Nation River and are mainly associated with the spring snowmelt flood and high flows. Sediment is important for several reasons. Firstly, it is in itself a significant cause of poor water quality. The highly turbid water is undesirable from aesthetic and recreational points of view. Also, phosphorus often occurs in association with or adheres to the sediment so that high phosphorus concentrations result from high sediment loads. Further high sediment loading is an indication of erosion upstream which could be reflecting landslide activity endangering life and property, or agricultural drain deterioration, which results in high maintenance costs.

As identified in the Erosion and Sedimentation Background Study, most of the sediment is produced in the northern half of the Basin, with the Bear Brook and Castor River systems being the largest contributors. The sources of sediment are closely related to the distribution of red and grey banded sensitive marine clays in the northern half of the Basin. The three major sediment producing sources were ranked as follows:

i) mass wasting;
ii) open channel drains; and
iii) sheet erosion of fields.

The sources of sediment are shown of Figure 3.2.1. Total annual sediment loads are summarized in Table 3.2.1. Approximately 80% of this total load is transported out of the Watershed during the months of March, April and May. Table 3.2.1 also shows that the sediment loading as measured at Plantagenet Springs decreased during the period 1972 to 1977, with the exception of 1976. During this year approximately 2/3 of the total annual load occurred during a four day period in May. During the peak day (20 May) more sediment passed the station than was discharged over the entire year for either 1975 or 1977. No marked increase in sediment discharge at Casselman or Lemieux was reported during this same May event suggesting the source of this sediment to be a major bank failure somewhere downstream of Lemieux.

Once mass wasting has been accounted for, total annual Basin sediment losses are comparable to mean sheet erosion losses reported for permanent pastures in Southern Ontario. The sediment production rate for the Basin is consistent with the fact that over 50% of the Watershed area is associated with either pasture, woodland or idle land, land uses which typically produce little sediment.

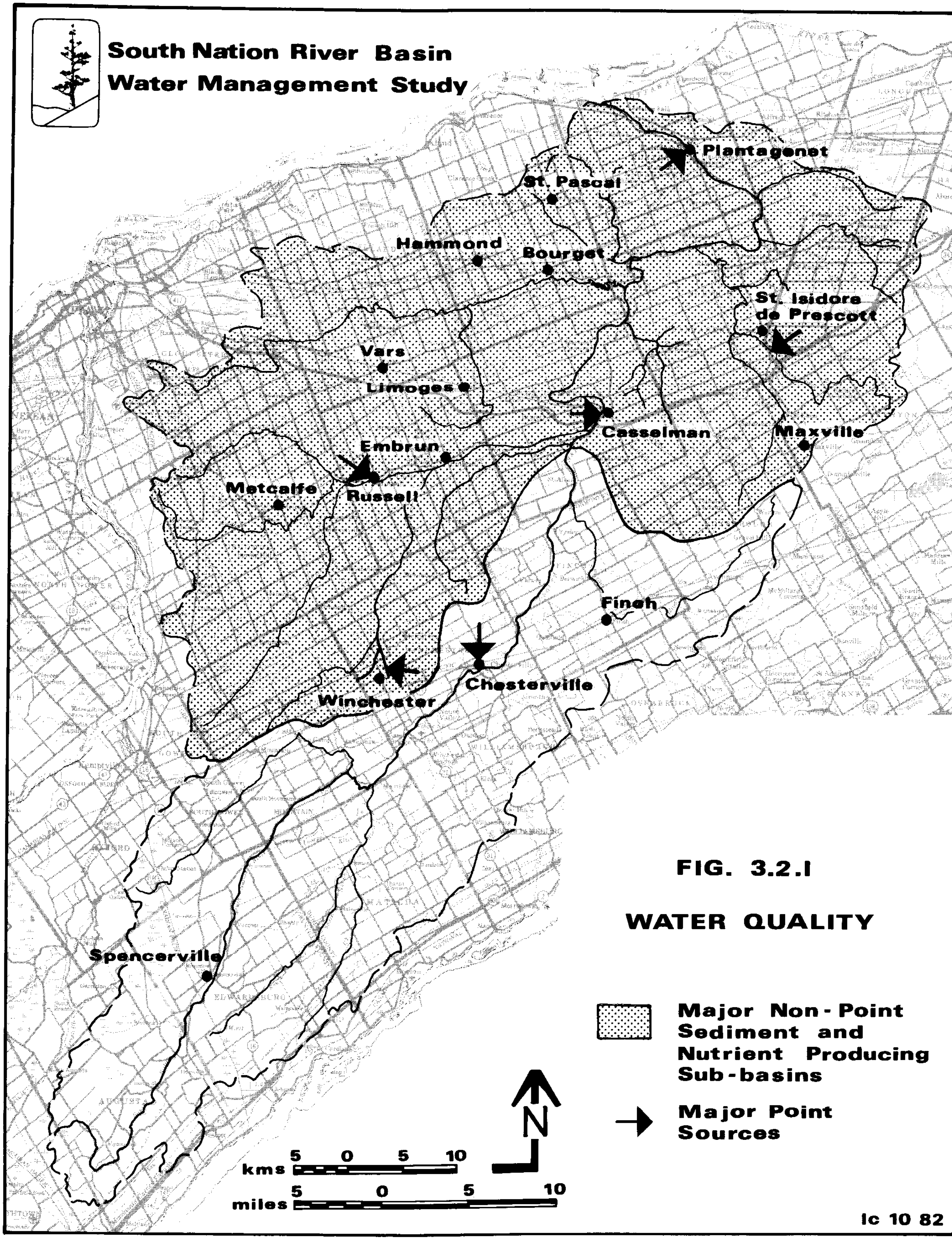


FIG. 3.2.1

WATER QUALITY

lc 10 82

TABLE 3.2.1

Suspended Sediment Load at Plantagenet Springs

	Flow Discharge		Suspended Sediment Load		
Year	Max. Daily m^3/s	Total ha.m	Max. Daily tonnes/day	Total tonne	Areal Loading tonnes/ha
1972	923	222,000	38,000	516,140	1.34
1973	852	212,160	23,857	309,320	0.81
1974	676	181,300	35,650	292,990	0.76
1975	844	155,400	9,250	108,852	0.29
1976	1050	180,100	157,835	548,800	1.43
1977	761	162,800	9,615	99,780	0.27

Source: Drennan & Stichling, 1979

3.2.1.2 Phosphorus and Nitrogen

Total phosphorus concentrations throughout the Basin have frequently been measured at more than twice the Provincial Objectives, of 0.03 mg/L and are sometimes ten times higher. As illustrated in the Water Resources Background Study approximately 95% of the phosphorus losses to the stream originate from non-point sources. The point sources in the Basin, which include 2 industrial and 6 municipal discharges, contribute to the remainder of the annual Basin phosphorus export.

High phosphorus levels in the river contribute to the growth of algae which reduces the aesthetic and recreational appeal of the water. Also, algae can reduce the dissolved oxygen supply in the water which can limit fish resources. Furthermore, high phosphorus levels indicate that phosphorus is being lost by the farmer. This translates to higher costs for fertilization and should encourage the use of agricultural best management practices to retain more of the phosphorus on the land.

Based on findings from the Water Resources Background Study, 70% of the annual total phosphorus losses in the South Nation Basin of 0.34 kg/ha.yr. are exported during the months of March, April and May. The majority of the phosphorus emanates from the northern half of the Basin, which includes the Bear Brook and Castor River systems where the unit area losses are about twice that of the southern half of the Basin. Higher phosphorus losses in the northern half of the South Nation River Basin can be attributed to the higher sediment yield and an apparently greater livestock concentration. Table 3.2.2 illustrates the spatial distribution of phosphorus losses.

Phosphorus losses associated with eroded bank material may range from 30-50% of the total annual Basin phosphorus export based on the findings of the Water Resources Background Study and PLUARG studies. By comparison, sub-surface drainage, which includes tile drain effluent, interflow and active groundwater recharge, is estimated to contribute approximately 20% of the phosphorus export. Phosphorus losses associated with agricultural activity are also estimated to be in the range of 30-50% of the annual phosphorus export. The distribution of phosphorus losses attributable to these sources represent Basin averages. The actual proportion of phosphorus losses in a particular area may vary depending on local soil conditions and management practices.

The contribution of phosphorus from livestock-related activities is estimated to be between 7% and 34% of the total Basin phosphorus export attributable to non-point sources. This range is based on estimated livestock contributions per unit area and rates per animal unit, taken from agricultural watershed studies in Southern Ontario. While these studies demonstrate that management of livestock activities is more important in determining nutrient loss rates than animal densities per se, the larger animal inventories in the northern half of the Basin may account for some of the higher phosphorus levels found there.

The available data base is insufficient to determine the exact mechanism by which nutrients attributable to livestock activities reach the streams. However, cattle access to the streams, feed-lot run-off and poor manure handling practices are likely sources.

TABLE 3.2.2

Spatial Distribution of Phosphorus Losses for 1976

Drainage Basin	Square Km^2	Incremental Phosphorus Losses tonnes	Phosphorus Export Coefficients kg/ha.yr.
Lower Basin (includes Bear Brook and Scotch Rivers)	541	89	0.64
Middle Basin (includes Castor River System)	525	86	0.64
Upper Basin (includes headwaters)	404	33	0.31

For the major land uses in the Basin other than livestock activities, the following ranges of average annual unit area phosphorus losses were developed in the Water Resources Background Study.

TABLE 3.2.3

Phosphorus Losses

Row Crops	0.90 - 1.70 kg/ha
Grains	0.45 - 0.81 kg/ha
Pasture/Hay	0.34 - 0.59 kg/ha
Woodland/Idle	0.05 - 0.09 kg/ha

Nitrate nitrogen is generally less than 2 mg/L throughout the Basin. On occasion, non-point sources can contribute significant amounts during storm events or during snowmelt run-off. This rarely, however, exceeds the 10 mg/L Objective. As illustrated in Table 3.2.4 which is based on findings of the Water Resources Background Study, 99.5% of the total nitrogen load is attributable to non-point sources. About 60% of the annual nitrogen loading in the South Nation River and its tributaries was found to originate during the spring months from non-point sources (4.56 kg/ha.yr). In general the nitrogen appears to be assimulated into the water courses without harm.

TABLE 3.2.4

Relative Contribution of Point and Non-Point Nutrient Sources

Source	Total Phosphorus		Total Nitrogen	
	Estimated Load tonnes/yr	% of Total	Estimated tonnes/yr	% of Total
Point Source	9	4	14	0.5
Non-Point	209	96	2671	99.5
Total (1976)	218	100	2685	100.0

At several test sites it was found that the run-off from sub-surface (tile) drains was of better quality than surface runoff with respect to most parameters, except nitrate nitrogen. Increased sub-surface drainage would decrease surface run-off and thereby reduce phosphorus concentrations in the receiving streams. The effects of tile drainage on water quality is discussed in more detail in Section 3.3 Land Drainage.

3.2.1.3 Bacteria

As indicated by several sampling programs undertaken over the past few years, instream bacterial quality generally exceeds Provincial Objectives of 1000/100 ml and 100/100 ml for total and fecal coliforms, respectively. The Objectives are exceeded throughout much of the Basin and notably in the northern areas.

Coliform bacteria concentrations indicate the possible presence of disease causing organisms. Treatment of surface water for drinking is required, such as at Plantagenet and Casselman. Recreational activities such as swimming are also restricted. Furthermore, fecal coliform is an indication that animal waste is reaching the river. This is important to the farmer because of the fertilizer value of manure.

Analyses of instream baseflow quality during periods of little or no surface runoff reveal high total and fecal coliform levels. As these are periods of low flow, direct access of animals to the stream could be a mechanism of fecal contamination. Cattle access to surface water courses occurs throughout the Watershed and scenes such as shown on Photo 3.2.1 are common. Concentrated feedlot runoff could also contribute to these high levels since little dilution would be available.

In PLUARG studies on selected test watersheds in Southwestern Ontario, livestock operations appeared to be the major source of bacterial pollution. However, there were no consistent data obtained in any of the detailed watershed studies which related indicator bacteria to the presence of livestock. In some watersheds bacterial quality was extremely poor even though the livestock density was very low. It would follow that the way in which livestock operations are managed and not just their size, is also an important consideration.

There are several consequences of water pollution by animal manure. There are the health risks associated with drinking the polluted water or coming in contact with disease causing organisms present in the manures. Also, as the organic matter in the manure is decomposed by aerobic micro-organisms, oxygen levels in the water may become depressed. If the demand for oxygen created by this decomposition is high, the oxygen concentrations in the water may become seriously depleted and may no longer support desirable aquatic life forms such as fish. Further, the addition of the nutrient constituents of the manures to the water may cause or contribute to eutrophication and the resultant excessive growth of algae.

3.2.1.4 Dissolved Oxygen

Dissolved oxygen is necessary for all aquatic life. For the protection of water biota in the South Nation River Basin during the summer the dissolved oxygen concentration must not be less than 4 mg/L at any time. A continuous monitoring program undertaken in July, 1981 indicated that the dissolved oxygen in the South Nation River is generally above 4 mg/L. but that some local and periodic problems do exist.

Dissolved oxygen modelling results from the Water Resources Background Study corresponding to the seven day low flow condition that occurs once every 20 years

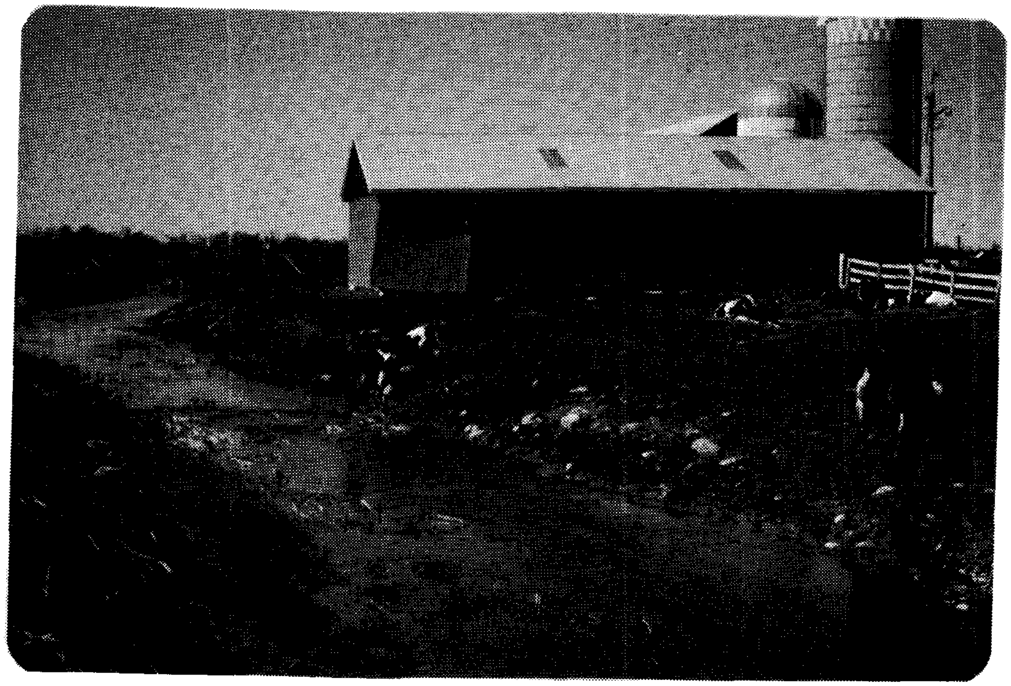


PHOTO 3.2.1 EXAMPLE OF NON-POINT LIVESTOCK POLLUTION RESULTING FROM CATTLE ACCESS TO WATERWAYS

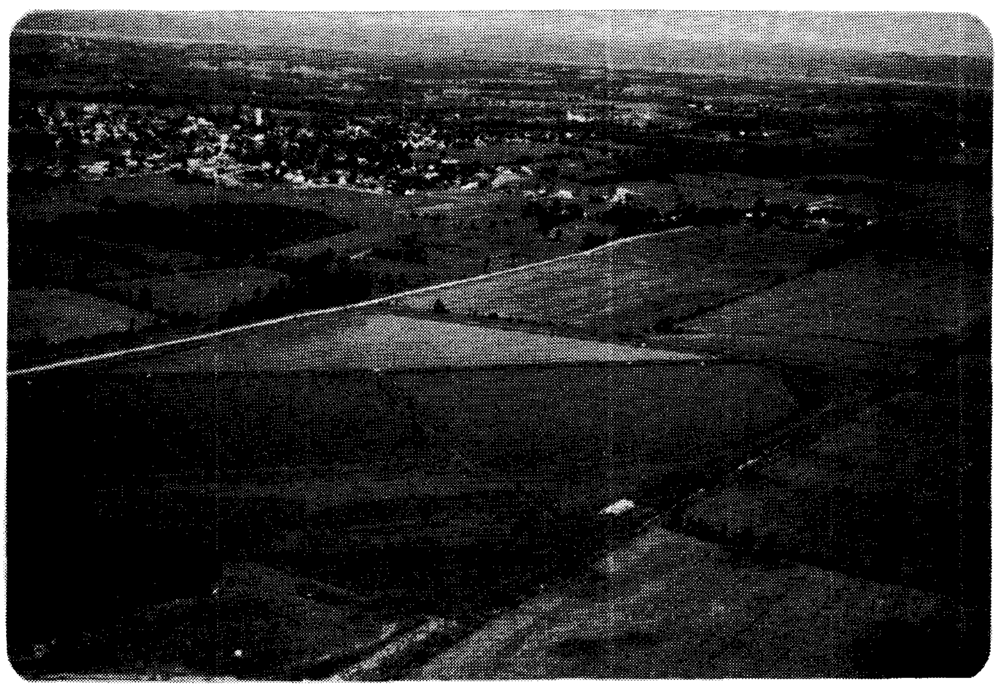


PHOTO 3.2.2 EXAMPLE OF SEWAGE HANDLING FACILITY - CASSELMAN LAGOON

($7Q_{20}$) suggest that potentially unacceptable dissolved oxygen concentrations downstream of point sources may result in the East Castor River during late summer and fall due to industrial and village lagoon discharges in Winchester. It has also been suggested in the Water Resources Background Study that dissolved oxygen problems may occur in the Casselman impoundment during fall because of the cumulative effect of emptying upstream lagoons simultaneously and in the Crysler impoundment due to continuous summer discharges from the industrial source in Chesterville.

The waste assimilative capacity of the South Nation River and its tributaries downstream of certain municipal and industrial discharges is potentially stressed with respect to dissolved oxygen levels during low flow conditions. Therefore, new or expanded lagoon facilities should be designed for once a year (spring) discharge, when waste volumes can be properly proportioned to the higher flows in the river.

3.2.2 Management Options and Recommendations

There is no single answer for improving and managing surface water quality in the South Nation River Basin. There are several options for dealing with non-point source pollution that, taken together, will lead to improved water quality. The options for dealing with point source pollution are more limited in number and more costly to implement.

3.2.2.1 Non-Point Source Pollution

More than 100 remedial measures for the control of non-point source pollution have been identified in the PLUARG studies. Some of these measures have direct application in the South Nation River Basin and are shown in Table 3.2.5. Several of the other remedial measures may be applicable in some areas within the Watershed, however, widescale application is not warranted due to the site specific and limited nature of the problem to be corrected.

PHOTO 3.2.3 HEAVY SEDIMENT LOAD IN RIVER

PHOTO 3.2.4 MANURE PILE ADJACENT TO CREEK

TABLE 3.2.5

Management Options for Control of Non-Point Source Pollution Problems

Management Options	Pollution Problems: Sediment	Nutrients	Bacteria	Dissolved O_2
Manure Management	X	X	X	-
Cattle Access	X	X	X	-
Crop Rotation	X	X	-	-
Conservation Tillage	X	X	-	-
Critical Area Planting	X	X	-	-
Permanent Vegetation	X	X	-	-
Field Borders	X	X	-	-

All of these options will improve water quality in the agricultural drains and rivers within the Watershed. Associated with this improvement will be a corresponding improvement in fish and wildlife habitat, recreational opportunity and aesthetics along the water courses.

Manure management includes controlling feedlot run-off as well as proper handling, storage and field application of manure. Good manure management will reduce the nutrient and bacterial loading in the surface water. Proper handling, storage and spreading practices enable the farmer to maintain the valuable nutrients in the manure on his land. It has been suggested by members of the agricultural community that the potential fertilizer saving is in the order of $50/ha/yr.

Several different techniques are used for manure management. These include minimizing surface drainage from feedlots, diverting external drainage around feedlots, locating manure piles within the internal feedlot drainage area. Selection should be on a case-by-case basis.

Farmers should be advised of the available techniques, the need for proper manure management practices and benefits to them including available financial and technical assistance. Demonstration and education programs to inform farmers of good practices and new approaches should be pursued. This can be accomplished with field demonstration days, demonstration sites incorporated in demonstration/education travel loops, and/or road side plaques to recognize existing good manure management systems. In addition, it is recommended that existing environmental legislation be enforced wherever necessary to overcome cases where manure or its leachate is being deposited directly into a river.

Exclusion of livestock from watercourses will reduce the nutrient and bacterial loading to surface waters. Also, sediment loads will be reduced and streambanks will be stabilized thereby reducing maintenance costs along agricultural drains. Fencing along watercourses and providing alternate sources of water supply are the best methods to reduce the problem of cattle access. Where this is not feasible due to water supply limitations, the use of gravel ramps in controlled areas will reduce the problems of sediment loading and high drain maintenance costs. However, regular cleaning around the access ramps will be necessary.

An education/demonstration program should be initiated to inform farmers of the benefits of excluding livestock from watercourses. Existing bylaws for the exclusion of livestock from drains should be enforced. Manure management and exclusion of livestock from watercourses are recommended throughout the Watershed.

Crop rotation is a widely used practice in the Basin and is one important reason why sheet erosion from fields may not be as serious as it is in some parts of Southwestern Ontario where monoculture cropping is practised much more extensively. Crop rotation helps to improve soil structure, soil organic matter and soil porosity. Continued crop rotation should be encouraged within the Watershed with an education/demonstration program.

In addition, special practices such as winter cover crops may be needed on soils susceptible to sheet erosion. Where severe sheet, rill and gully erosion occurs, permanent vegetation should be established. Areas where sheet erosion occurs in the Basin have been described in the Erosion and Sedimentation Background Study.

Conservation tillage is an option that utilizes a range of tillage practices such as conservation, minimum or no-till on soils with excessive sediment loss from sheet erosion. It maintains crop residues, improves infiltration and reduces nutrient loading in the rivers that is associated with sheet erosion. Conservation tillage has been used in areas of Southwestern Ontario where there has been a trend away from crop rotation to monoculture operations. It has been found that soil loss has been reduced to less than 1/10th of that on fields without crop residues. Conservation tillage is only applicable in light well-drained soil. It is not applicable in fine textured, shallow or poorly drained soils. Conservation tillage is a beneficial best management practice that should be promoted for farmer use through demonstration projects throughout the Basin.

Critical area planting is an option to help stabilize gully and ditch banks which are susceptible to mass wasting (landslides). It will reduce the sediment loadings in the rivers and improve aesthetics and wildlife habitat. Areas identified in the Erosion and Sedimentation and Geotechnical Background Studies to be susceptible to landslides should be stabilized with suitable vegetation in critical areas.

Field borders, buffer strips, grassed waterways or channels are options which utilize sod, wild grasses or small shrubs planted around fields and along small streams and ditches, to buffer them from surrounding cultivated areas. This reduces sheet and gully erosion on the buffer area, maintains slopes along drains and traps some of the water and wind eroded sediment from the cultivated areas thereby encouraging deposition of sediment before it enters waterways. This option should be considered as an integral part of improved drain design and construction techniques which are discussed in detail in Section 3.3 Land Drainage.

3.2.2.2 Point Source Pollution

Options to control point source pollution include reservoirs to augment low flows, controlled discharge from waste lagoons, industrial treatment, wetland polishing and spray irrigation. Table 3.2.6 summarizes the available options.

The North Castor, Spencerville and Bear Brook reservoirs were considered to have significant low flow augmentation potential in the Water Resources Background Study. The North Castor Reservoir would augment flows at Russell, Embrun, Casselman and Plantagenet, the Spencerville at Spencerville, Chesterville, Crysler, Casselman and Plantagenet and the Bear Brook at Bourget and Plantagenet.

TABLE 3.2.6

Management Options to Control Point Source Pollution Problems

Management Options	Pollution Problems: Sediment	Nutrients	Bacteria	Dissolved O_2	Constraint
Reservoirs	-	X	X	X	Very high cost
Controlled Lagoon Discharge	-	X	X	X	Large area required
Industrial Tertiary Treatment	-	X	X	X	High cost
Effluent Polishing	-	X	X	X	Lack of research
Spray Irrigation	-	X	X	X	Lack of research

All three reservoirs would be very expensive to construct, ranging between $12,000,000 and $30,000,000. Further, substantial areas of good agricultural land would be inundated and lost to crop production. These were considered to be prohibitive costs for pollution control alone recognizing that point source pollution problems within the Basin, although significant locally at times, are not severe. It should be noted, however, that there are other possible benefits to low flow reservoir construction such as water supply, recreation and fish and wildlife enhancement. These aspects are discussed in other sections of this Report and summarized in Part IV.

There are some substantially less expensive alternatives for the control of point source pollution than the reservoirs noted above.

Controlled lagoon discharge is recommended. There must be enough storage in the lagoon to allow for effluent discharge at such times that river flow is able to assimilate and dilute effluent, to maintain acceptable nutrient bacteria and oxygen levels in the river water. In most cases, for the South Nation River Basin this means sizing lagoon storage to permit once a year (spring) discharge. Costs for lagoon expansion varies based on population but would be in the order of \$200,000 to \$500,000 for villages located in the South Nation River Basin.

As discussed, a particular problem exists along the East Castor River downstream of Winchester. To improve water quality in the East Castor River it is recommended that both Ault Foods and the Village of Winchester lagoons be sized for spring discharge.

Tertiary treatment of industrial wastes is an option where effluent standards are currently being exceeded. This option, however, is generally more expensive than providing adequate lagoon storage. Other alternatives exist but are not widely accepted in Canada, such as effluent polishing by wetlands and spray irrigation of lagoon effluent.

Effluent polishing by wetlands is being tested in Southwestern Ontario by the Ontario Ministry of the Environment. Properly designed wetland systems have the potential to remove suspended and colloidal solids, BOD, nitrogen, phosphorus, heavy metal, organics, bacteria and viruses, thus protecting water quality in the receiving streams. Present concerns include the requirement for further research and tests prior to widespread implementation and possible impairment of fish and wildlife and aesthetic values within wetlands.

Spray irrigation of lagoon wastes is also not widely accepted in Canada. It has however, been practised successfully in other parts of the world and has been developed extensively in the United States. MOE operates a spray irrigation project on crop land at Landsdowne. This system can provide the equivalent of tertiary treatment, supply nutrients for crop production, provide irrigation water and reduce the problem of waste assimilation in waterways. Concerns include contamination of surface or groundwater with improper application, and concentration of harmful wastes in the soil if hazardous wastes are disposed of with this method. Detailed analysis of waste water should be carried out and site specific assessment of the receiving area be undertaken prior to spray irrigation of effluent. Field testing of spray irrigation is recommended on agricultural and forested land in the Basin, to evaluate the cost and effectiveness of this method of treatment.

3.3 LAND DRAINAGE

A high proportion of agricultural land in the Basin is flat and low lying. This represents a major problem to farmers for the removal of excess surface and subsurface water so that the most productive, high value crops such as corn and soybeans can be grown. Undrained, wet agricultural land can support only a narrow range of relatively low value crops. Undrained, wet soils delay planting time and farmers have to wait until the land has dried out sufficiently to work in the spring. Cold, wet soils slow seed germination and plant growth. Crop production risk is high in wet, undrained land. Under favourable growing conditions a normal crop can be produced. However, a cold, late spring or above-average rainfall during the growing season, or at harvest time, can result in serious crop damage or crop loss.

Since agricultural settlement began in the Basin, an extensive network of surface outlet drains have been developed. Originally, these drains served to remove excess surface water from fields. With the advent of tile drainage, they assumed a second function of removing excess subsurface water from the tile outlets. For tile drains to function properly, many of the municipal outlet drains have had to be deepened, as well as extended.

It is generally true that the effect of improving (i.e. straightening, widening or deepening) stream channels is to induce a more rapid response to runoff events. This often results in higher peak flows and shorter peak flow durations, although there appears to be no significant increase in total volume of runoff. In a large watershed with many tributaries, the net effect on the peak flows in the main channel may be less significant due to routing effects and the time-offset of peak flows arriving from the tributaries. The inclusion of subsurface tiles in the scheme of drainage improvements further alters the runoff process. Tile drainage creates a drier antecedent moisture condition with more soil storage and induces more infiltration which, based on preliminary modelling results, appears to reduce peak surface runoff rates from most runoff events.

Understanding the impact of land drainage is particularly important for water resource management in the South Nation River Basin. The four most important considerations in this regard are:

LAND DRAINAGE

PHOTO 3.3.1 NEW TILE DRAINAGE

PHOTO 3.3.2 WELL CONSTRUCTED OUTLET DRAIN

- high flows, and whether or not outlet and tile drains increase high flows;
- low flows, and whether or not drainage further reduces low flows;
- water quality, and whether or not additional drainage in the Basin will cause a further impairment in water quality;
- groundwater, and whether or not drainage lowers the groundwater table, reducing recharge and well yields.

Because of the importance of tile drainage in enabling farmers to successfully grow more high value crops, much more emphasis should be placed on organizing and co-ordinating the overall system. For example, municipalities need more predictable arrangements for obtaining drainage construction and maintenance funding for sound financial planning and management; farmers need more efficient ways of dealing with the problems associated with the building and maintenance of outlet drains across their farms; and the Conservation Authority needs comparable information so that it can effectively carry out its water management role in the Basin.

3.3.1 Problem Analysis

3.3.1.1 Major Outlet Drains

Concern over downstream effects of major drainage works prompted analyses of five proposed major outlet drains in the Water Resources Study, which are shown on Figure 3.3.1. These include the Payne, South Caster, Van Camp, Ferguson and Mullen drainage schemes. Table 3.3.1 summarizes the percentage increase in peak flows with drain improvement for various return periods for each drain at both the drain outlet and selected downstream locations including the two major flood areas on the South Nation River.

With regard to peak flows at the drain outlets, the Payne, Mullen and South Castor schemes produce the greatest increases, ranging between 35 and 56 percent, while the Van Camp and Ferguson produced significantly smaller increases of between 12 and 15 percent.

Downstream effects of the drain improvements are noteworthy on the Payne River. The percentage increase in peak flows at the confluence with the South Nation River is reduced to about one-half the magnitude at the drain outlet but remains significant ranging from 22 to 30%.

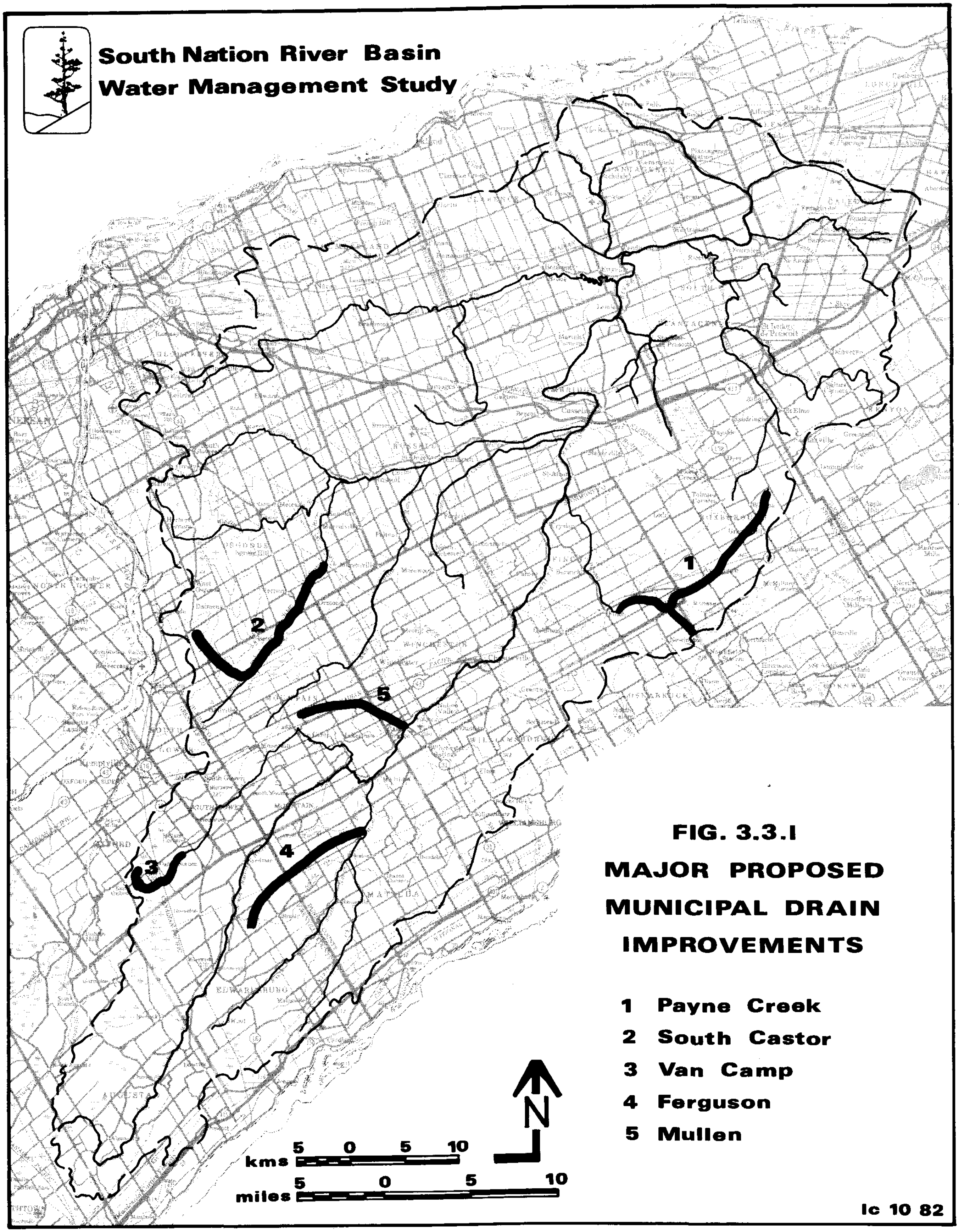


FIG. 3.3.1
MAJOR PROPOSED MUNICIPAL DRAIN IMPROVEMENTS

TABLE 3.3.1
Increase in Mean 2-Hour Peak Flows With Drain Improvement*

DRAIN/REACH	% INCREASE FOR RETURN PERIOD				
	5 YR	10 YR	20 YR	50 YR	100 YR
Van Camp	13	13	14	15	15
Ferguson	15	13	13	12	12
Mullen	54	52	47	45	44
Chesterville	1	1	1	1	1
Payne	50	54	55	55	55
Mouth of Payne R.	30	27	27	24	22
South Castor	56	51	46	39	35
Mouth of Castor R.	10	9	9	8	8
Plantagenet	2	2	2	1	1

(* based on original design)

Flow impacts on the Castor River due to the South Castor drain are less noticeable due to the relative magnitude of tributary runoff from other portions of the Watershed. While peak flow increases are large locally, at the confluence with the South Nation River the percentage increase in peak flows diminishes to about 9%.

Flood prone lands adjacent to the South Nation River upstream of Chesterville and Plantagenet will not be significantly affected by the combined flow impact of the five drains which were studied. In both cases, annual flood frequency analyses reveal that peak flows will be increased by no more than 2%.

Regarding flow rates occurring between storm events, since peak flows will be increased by the proposed drainage improvements, as indicated above, flow rates after the peak storm event will decrease more quickly than before the improvements. Nevertheless, the flow duration curves resulting from the hydrologic (HSP-F) modelling are identical for both the existing and improved drain conditions. It appears to indicate that low flows occurring between runoff events remain unchanged. This analysis did not, however, account for local water tables and subsurface flows before and after municipal drain construction. To adequately resolve this question regarding municipal drain effects on low flows a comprehensive evaluation including measurement and modelling of flows, under existing and improved drainage conditions would be required.

3.3.1.2 Outlet Drain Improvements

In addition to the above major drainage schemes, evaluation of impacts of drain development for the entire Basin was undertaken. This was based on evaluation of typical 90 km^2 test basins using anticipated levels of drainage improvement. Tile drain effects were then superimposed and the results were extrapolated to the entire Basin. Since the data base is limited, caution must be taken when interpreting the results. Also, it is recommended that data collection continue and further calculations be done in order to improve the level of confidence with the results in future years.

As a basis for determining levels of drainage improvements, different drainage situations were classified into five types:

1. Natural, unimproved streams that may be deepened, straightened and widened;
2. Drains that have been improved in the past but require deepening to permit tile drainage;
3. Improved drains that have to be deepened to permit tile connections and enlarged for increase capacity (major outlet works);
4. Improved drains that need maintenance to restore the original design capacity;
5. Improved drainage channels which are currently adequate.

The analysis of future improvements was carried out on a township basis. The percentage of the area in each township that is adequately served by outlet drains was estimated, as well as the percentage of the area in each township that is likely to become drained. The type of drains required in each township were then estimated. The results of the analysis are shown in Table 3.3.2. Many townships have a well established drainage network and most drains fall into the Type 4 and 5 categories.

TABLE 3.3.2

Estimated Potential Extent of Future Outlet Drain Improvements*

Township	% of Township Area Adequately Served	% of Township Area To Become Drained	Type of Drained Required	
Augusta	5	25	No. 2 75%;	No. 3 25%
Edwardsburgh	20	30	No. 2 100%;	
South Gower	35	60	No. 2 100%;	
Oxford	0	15	No. 2 50%;	No. 3 50%
Matilda	50	95	No. 2 50%;	No. 3 50%
Winchester	75	85	No. 2 100%	
Williamsburg	75	85	No. 2 100%;	
Mountain	40	75	No. 2 75%	No. 3 25%
Finch	50	80	No. 2 75%;	No. 3 35%
Osnabruck	25	35	No. 2 100%;	
Roxborough	25	60	No. 2 75%;	No. 3 25%
Kenyon	30	45	No. 2 100%	
Cambridge	20	45	No. 2 100%	
Russell	75	90	No. 2 100%;	
North Plantagenet	20	30	No. 2 100%;	
South Plantagenet	40	60	No. 2 100%;	
Clarence	20	45	No. 2 100%;	
Cumberland	25	50	No. 2 75%;	No. 3 25%
Caledonia	30	60	No. 2 100%;	
Alfred	20	45	No. 2 75%;	No. 3 25%
Osgoode	15	30	No. 2 50%;	No. 3 50%
Gloucester	15	30	No. 2 100%;	

(* based on review of drains by Ontario Ministry of Agriculture and Food and South Nation River Conservation Authority Staff)

PHOTO 3.3.3 POORLY CONSTRUCTED DRAIN

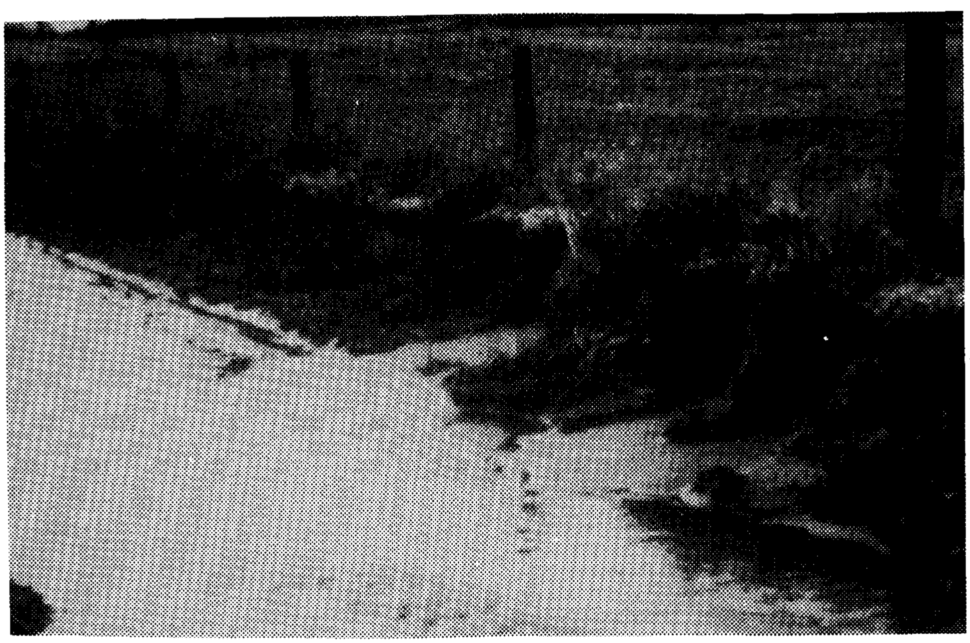


PHOTO 3.3.4 DRAIN SHOWING EROSIONAL DAMAGE

Utilizing data from Table 3.3.2 concerning levels of drainage improvement likely to be required, peak flow increases for the 90 km^2 test areas ranged between 0 and 7 percent and averaged about 3.5 percent. These increases are much lower than those determined above for the major drainage schemes due to the relatively small percentages of the total Basin area where improvements are needed. The increases are indicative of what can be expected on a local scale.

The next analysis was carried out to assess the combined effects on flows of improving outlet drains and installing subsurface drainage on a watershed basis. It was assumed that ultimately about 75% of the agricultural land in the Basin will be tile drained (44% of the total land area). The current area tile drained is about 8% of the total land area within the Basin.

TABLE 3.3.3
Changes in Peak Flows Due to Agricultural Drainage Improvement Scenario
% Change for Return Periods

Period	Location	2 Yr	5 Yr	10 Yr	20 Yr	50 Yr	100 Yr
Annual	Plantagenet	-7	-8	-9	-11	-12	-14
	Chesterville	-9	-8	-7	-5	-4	-3
	Bear Brook	-12	-12	-12	-12	-13	-13
	Vernon	-14	-12	-10	-9	-7	-5
May - October	Plantagenet	-11	-13	-13	-12	-11	-10
	Chesterville	-6	-12	-14	15	-16	-17
	Bear Brook	-16	-25	-28	-31	-33	35
	Vernon	-14	-24	-28	-32	-35	-38

The analysis was carried out for the same 23 year period of record from 1957 to 1979 which was previously completed for existing drainage conditions. In all locations, and for all frequencies and seasons, the simulation of agricultural drainage improvements resulted in significantly lower peak flows as noted in Table

3.3.3. With respect to annual peak flows, the Plantagenet location near the outlet of the Wshows a tendency for larger flow reductions with lower frequency events, ranging from a reduction of 7% for a 2 year event to 14% for a 100 year event. The Vernon and Chesterville locations, with much smaller tributary areas, displayed the opposite tendency, while the Bear Brook site gave a nearly constant 12 to 13% reduction at all frequencies.

The results for the growing season from May to October generally show similar results at Plantagenet although there is no evident trend between frequent and longer return period events. Much larger peak flow reductions are evident at the other 3 locations. These locations also show a strong trend towards greater flow reductions with both longer return periods and smaller drainage areas. The degree of agricultural drainage improvement is very similar in each case.

In summary, the relatively small degree of improvement in outlet drains expected in the Basin does not appear to have a large effect on peak flows. In fact, since tile drains are put in concurrently or shortly following outlet drain construction, peak flows at downstream flood areas may be reduced, as indicated by Table 3.3.3. It should be cautioned, however, that the tile and drain model used in this evaluation has received very limited calibration to date in terms of actual recorded events and values shown in this table could be altered when the calibration is complete. It should also be emphasized that local downstream effects of major drainage works can be significant and these should be taken into consideration with regard to downstream urban or rural flood prone areas prior to implementation of such works.

3.3.1.3 Impacts of Drains on Water Quality

Outlet drains were identified in background studies as significant contributors of sediment to the South Nation River and its tributaries. Particularly in the northern part of the Watershed where drains are dug through unstable marine clays, the sediment contribution is very high. While outlet drains will always yield large volumes of sediment during construction and maintenance, recent research in the area indicates that improved drain design and construction practices will lead to a major reduction in bank erosion and associated sediment and phosphorus levels in the water following the construction period. Also, annual costs for drain maintenance will be reduced.

Tile drain effluent quality in the South Nation River Basin has been monitored as part of the Tile/Drain Study project. This project commenced in the summer of 1980 and was designed to gather the appropriate quality and quantity data on which the impacts of increased subsurface drainage in the Basin could be gauged. Two representative outlet surface drains were selected and monitored in each of the three major physiographic regions in the Basin - Winchester Clay Plain, Russell Sand Plan and the Ottawa Clay Plain. In each region, one outlet drain represents a sub-basin with a low level of tile drainage improvement and the other a high level of tile drainage improvement. In each region, a representative tile drain was also selected and monitored for water quality. The results of the 1981 field programme are shown in Table 3.3.4.

In general, it can be seen that tile drain quality is better than that of the outlet (surface) drains with respect to most measured parameters, including phosphorous, B.O.D., turbity and suspended solids. Nitrate nitrogen does not appear to improve with tile drainage since nitrate is water soluble and readily transported through the soil profile to be discharged through the tile drains while the remaining pollutants, which are not as soluble, would be filtered by the soil. It follows that future anticipated increases in tile drained areas, within the Basin, should improve the quality of water reaching the river system with respect to all parameters but nitrate nitrogen.

TABLE 3.3.4

Tile and Outlet Drain Quality - 1981 Field Programme

		Russell Sand Plain							Ottawa Clay Plain							Winchester Clay Plain						
	Date	TKN	TN	TP	DRP	BOD	TURB	SS	TKN	TN	TP	DRP	BOD	TURB	SS	TKN	TN	TP	DRP	BOD	TURB	SS
Outlet	May 27	1.55	1.58	0.3	.096	3	6.7	-	-	-	-	-	-	-	-	.68	.90	.018	.002	2	2.1	-
Drain	May 29	1.25	2.75	0.21	.098	3	5.0	-	2.8	3.6	.72	.54	5	170	-	.66	1.90	.024	.002	1	2.1	-
Quality-	Jun 24	1.20	4.63	0.18	.122	-	-	-	2.0	2.3	.70	.48	-	-	-	.78	11.8	.018	.002	-	-	-
Low Level of of Drainage Improvement	Aug 5	2.10	4.62	0.36	.164	2	-	90	1.4	2.3	.76	.74	2	-	98	2.55	5.3	.32	.156	2	-	27
	Mean	1.5	3.4	0.26	0.12	2.3	5.9	90	2.1	2.7	.73	.59	3.5	170	98	1.2	5.0	.10	.04	1.7	2.1	27
Outlet	May 27	3.3	3.4	0.4	.054	46	1.6	-	2.0	4.2	.74	.06	4	26	-	1.1	1.16	.088	.036	1	1.5	-
Drain	May 29	2.0	3.1	0.22	.104	3	7.8	-	1.55	5.2	.32	.24	3	15	-	1.0	2.83	.135	.102	1	1.7	-
Quality-	Jun 24	1.55	2.6	0.16	.048	-	-	-	0.6	9.0	.094	.68	-	-	-	8.6	8.46	.11	.09	-	-	-
High Level of Drainage Improvement	Aug 5	1.2	2.1	0.52	.360	3	-	96	2.0	10.4	1.12	.06	8	-	58	2.0	4.8	.72	.68	5	-	-
	Mean	2.0	2.8	0.32	0.14	4	4.7	96	1.5	7.2	0.57	.33	5	21	58	1.2	4.3	.26	.23	2.3	1.6	13
Tile	May 27	.26	.96	.012	.010	0.1	.57	-	.33	6.5	.02	.002	0.3	0.49	-	-	-	-	-	-	-	-
Drain	Mau 29	.35	1.97	.028	.016	0.1	1.1	-	.50	7.7	.04	.018	1	3.1	-	.73	17.8	.076	.062	4	92	-
Quality	Jun 24	.26	6.5	.008	.002	-	-	-	.29	13.3	.004	.002	-	-	-	1.65	34.7	.110	.092	-	-	-
	Aug 5	.10	.54	.03	.008	1	-	1	.52	14.6	.04	.002	1	-	10	25*	25.2*	6.8*	.44*	26*	-	249*
	Mean	.24	2.5	.02	.01	0.7	.84	1	0.41	10.5	.03	.011	0.8	1.8	10	9.1	18.2	2.3	.20	13.5	92	249

TKN = Total Kgeldahl Nitrogen
TN = Total Nitrogen
TP = Total Phosphorus
DRP = Dissolved Reactive Phosphorus
BOD = Biochemical Oxygen Demand (5 day)
TURB = Turbidity
SS = Suspended Solids
All units mg/L, except Turbidity which are in Formazin Trubidity Units.

*Tile drain quality of Winchester Clay Plain is not representative of subsurface drainage due to manure storage construction.

3.3.2 Management Options and Recommendations

3.3.2.1 Drainage Master Planning

This option is based on the fact that drains will continue to be constructed to satisfy agricultural drainage requirements. It is necessary to plan implementation of drainage schemes to maximize this effectiveness and to optimize available financial resources, as well as to minimize potential adverse environmental impacts.

A drainage master plan should be prepared for surface and subsurface drainage development within the Basin. It will incorporate available information from the current water management studies as well as research work on proper ditch design. The planning process should include examination of the existing drainage network and future requirements, based on land use and soil capability, the assessment of environmental and water management implications, and the identification and evaluation of alternative schemes to come up with a priorized implementation plan. A review of the effectiveness of the current township level priorization system for meeting farm and water management needs, as well as the current drainage assistance process in relation to this proposed (master planning) system should also be completed.

To further support this planning process, policies should be developed to prevent drainage of unique or sensitive lands such as significant recharge and wetland areas.

To demonstrate the merits of forward planning and to further establish the methodology, Augusta township with relatively extensive drainage requirements has been selected for a pilot project. Upon successful completion of this project and application of drainage master planning elsewhere in the Basin, the use of the interim drainage criteria established by the Drainage Petition Review Committee will be superceded. Other high priority areas for drainage master planned would be the South Branch, South Castor, Bear Brook and Plantagenet areas, which will have channel improvements or other works planned that affect drainage.

3.3.2.2 Drain Design, Construction, and Maintenance

This option promotes the design and construction of outlet drains in accordance with prescribed guidelines and recent research on the Basin, as well as regular maintenance of the drains to maximize drain lifetime and minimize any adverse environmental effects. Although initial construction costs might be higher and "catch up" maintenance costs may be significant, benefits in terms of reduced long term construction costs (i.e. fewer reconstructions) reduced loss of cropland, reduced river sedimentation (from bank erosion) and improved water quality should outweigh the higher initial costs.

It is therefore recommended that new drains or existing drain reconstruction be evaluated and designed in accordance with the O.M.A.F. Guidelines for Construction and Design of Municipal Drains as well as design guidelines being developed from drain studies currently being undertaken by Agriculture Canada in the South Nation River Basin as soon as these are available.

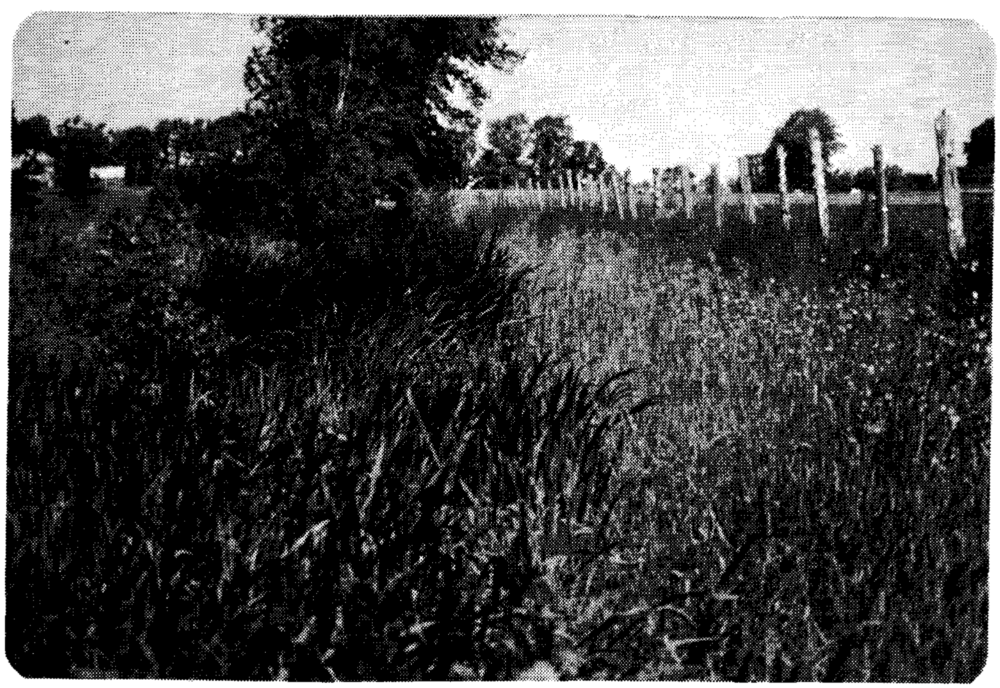
3.3.2.3 Drainage Monitoring Program

This option concerns continuation of the program begun in 1980 of monitoring selected outlet and tile drains within the Watershed. The program which involves the monitoring of both quantity and quality of surface and subsurface (tile) runoff from drains in different physiographic regions will provide the basic information for continued and improved modelling of drain effects. This accurate prediction of drain effects is required for analysis, and long term planning and management of the drains. The tile and drain model which is the basic tool for predicting drain effects on peak and low flows requires significantly more calibration. Sound information on the effects of drains (tile and outlet) on water quality is a fundamental requirement for establishing better land management practices, as well as better drain design, construction and maintenance practices.

It is therefore recommended that the tile/drain monitoring program established by the Conservation Authority be reviewed and upgraded to meet the essential long term water and land management considerations that have been identified with drain construction and maintenance, installation of tile drainage, agricultural practices and water quality, as well as the preservation of unique or important wetlands.

PHOTO 3.3.5 DRAIN MAINTENANCE - BANK STABILIZATION WORKS

PHOTO 3.3.6 OUTLET DRAIN REQUIRING UPGRADING



3.4 WATER SUPPLY

Groundwater is the most important source of water supply in the South Nation River Basin. Most municipalities and rural residents, as well as several industries, obtain their water supplies from groundwater sources. Ten major communities have communal water supply systems. Plantagenet and Casselman rely on the South Nation River for supply and the other eight use groundwater. Many of the communities have shortfalls in their water supplies at present, while others will not be able to supply future demands for village expansion. Water supplies limit residential development and industrial growth in several communities. In rural areas groundwater sources are adequate for individual domestic and agricultural uses.

In a number of locations, groundwater is naturally of poor quality, with high levels of chloride (Cl), iron (Fe) and hydrogen sulphide (H_2S). Although poor quality water occurs sporadically throughout the Watershed, groundwater is of poor quality especially in the northeastern portion of the Watershed. Furthermore in several communities where concentrated development has occurred, individual wells have become polluted with bacteria and nitrate from septic system effluent.

3.4.1 Problem Analysis

The groundwater in the Basin is obtained from both carbonate bedrock and overburden aquifers. In the northern part of the Basin most of the water is from sand and gravel deposits, while in the southern portion, the carbonate bedrock formations provide the bulk of the groundwater supply.

Bedrock yields are highly variable but generally quite low because of low intrinsic porosities and permeabilities. Of the bedrock deposits, limestones and dolomites of the Ottawa and Oxford Formations, which together occupy some 80% of the Basin, are the primary sources of groundwater. Localized occurrences of shale are common, and though sandstone aquifers occur in the western portion of the Watershed they are of limited extent.

The overburden aquifers constituting the major source of groundwater supply in the northern part of the Basin, consist of sands and gravels of varying origins laid down in various depositional environments. Fine grained surficial sands constitute the most extensive overburden aquifers but do not exhibit the potential to yield large supplies. Glaciofluvial and beach deposits generally constitute much better aquifers.

The distribution of bedrock and overburden aquifers within the Basin are shown in Figures 3.4.1 and 3.4.2 respectively. Table 3.4.1 summarizes groundwater quantity and quality for the various aquifers which are discussed below in greater detail.

3.4.1.1 Bedrock Aquifers

The Nepean Sandstone Formation overlies the precambrian basement rocks and subcrops in only some 130 km^2 of the Basin. It is located close to Maynard, Winchester and Leitrim. Although restricted by its limited extent this formation appears to have the best potential for groundwater development of all the bedrock aquifer systems in the Basin. Generally the aquifer yields fresh water except when it is encountered at great depths, underlying other formations where it may often yield groundwater of questionable quality.

The Oxford and March Formations occupy some 1075 km^2 in the southern part of the Basin. Although wells extend into the bedrock to varying depths most are reported to have encountered water within 15 metres of penetration of the bedrock surface. Well records show that the Oxford limestone-dolomite aquifer readily yields adequate supplies for domestic purposes with some potential for small municipal supplies of up to .25 m^3/min. Generally waters from these aquifers are fresh and of good quality but poor quality waters may be found in areas of ground water discharge or under thick marine clays.

The limestone-shale aquifer complex consists of the Ottawa, St. Martin and Eastview Formations. It occupies an area of some 2110 km^2 in the northern and eastern areas of the Basin. The aquifer is mostly confined and well log data indicates that yields are generally low though domestic supplies can be obtained throughout the aquifer at the depths of 12m. Indications are that the aquifer has little potential to yield supplies that are adequate for municipal uses. Yields appear to increase with depth of well penetration but are usually accompanied by a deterioration in groundwater quality. In fact water obtained from this aquifer is often sulphurous, saline and/or mineralized.

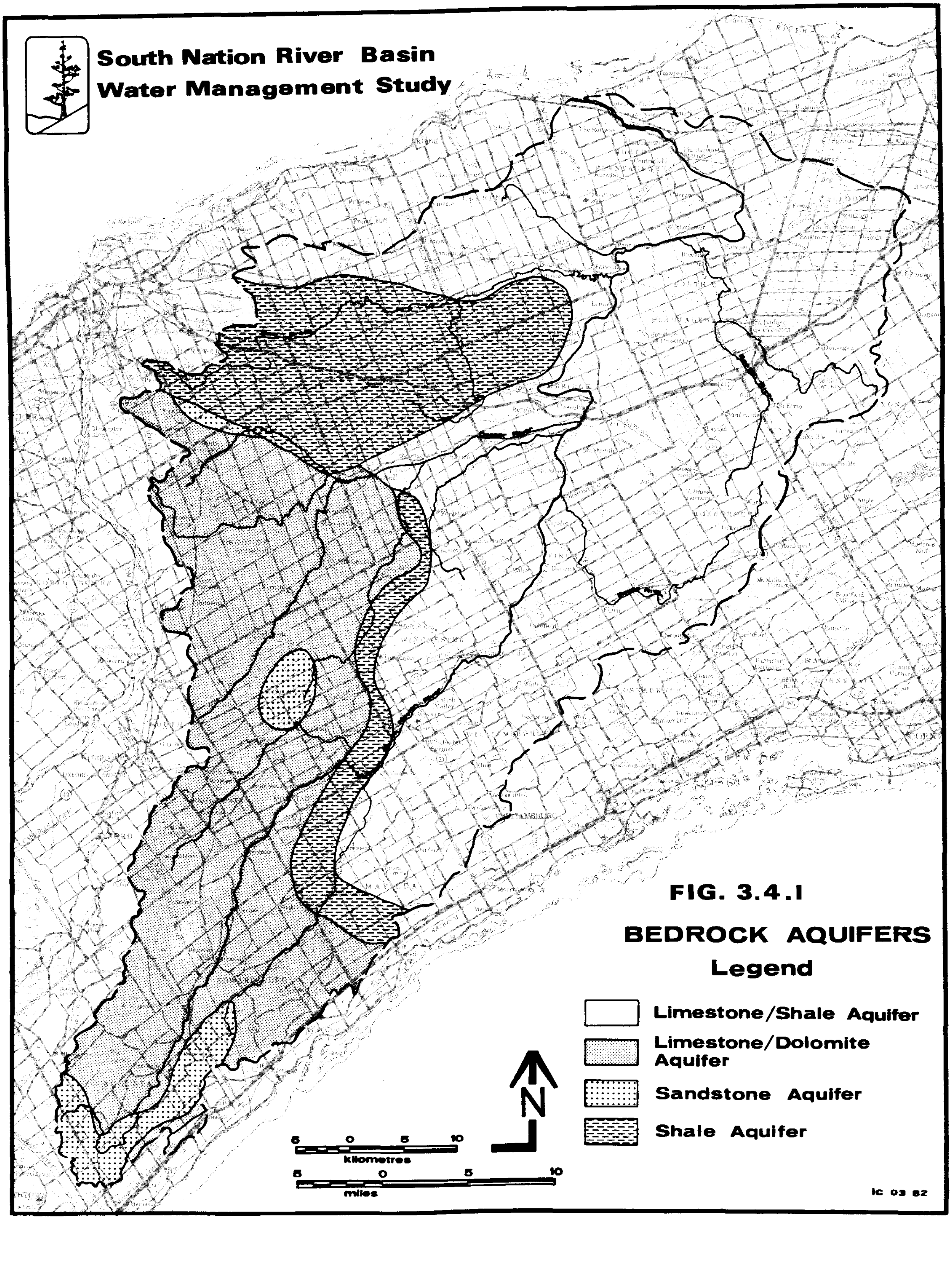


FIG. 3.4.1

BEDROCK AQUIFERS

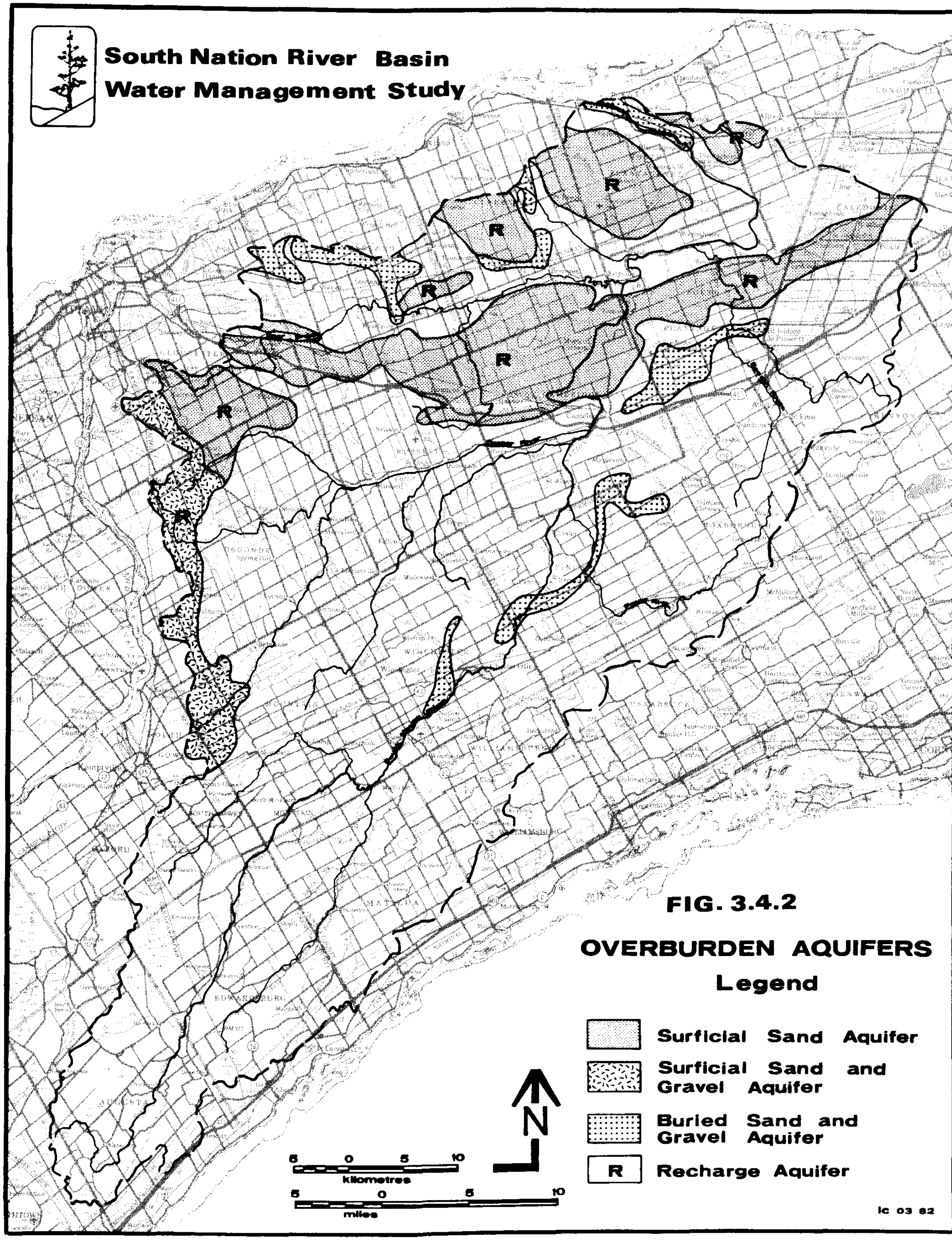


FIG. 3.4.2

OVERBURDEN AQUIFERS

TABLE 3.4.1

Groundwater Quantity and Quality

Aquifer	Transmissivities Range	Transmissivities Average	Specific Capacities Range	Specific Capacities Average	Well Yields	Quality
	(m^3/day/m depth)		(m^3/min/m drawdown)		(m^3/min)	
Nepean Formation (Sandstone)	1.3-350	37	.0015-.3	.027	.09 (normally) .45 (occasionally)	Generally fresh, occurrences of sulphur
Oxford & March Formation (limestone and dolomite and sandstone)	.3-340	18	.0015-.27	.01	.045 (normally) .45 (theoretically)	Generally fresh, occurences of sulphur. Poor quality occasionally encountered at depth
Ottawa, St. Martin & Eastview Formation (Limestone-shale)	.3-350	16	.0015-.72	.009	.113 (normally) .022 (often)	Frequently sulphuric water may be encountered in groundwater discharge areas.
Billings, Carlsbad & Russell Formations (Shale)	.1-33	3-4	.0015-.07	.0045	Low	Frequently salty
Surficial Sand (Champlain Aquifer)			.0015		.01	Generally fresh
Surficial Sands and Gravel (Rideau Front Aquifer)			.0015-.5		up to .5	Fresh
Buried Sands and Gravel			.0015-.05		up to 175	Fresh

The bedrock subcrops of the Billings, Carlsbad, Queenston and Russell formations delineate the extent of the shale aquifer complex which occupies some 590 km^2 of the Basin area. These shale aquifers generally have low yields and are seldom capable of supplying potable water to wells other than for domestic purposes. The water is frequently of inferior quality being both saline and highly mineralized.

3.4.1.2 Overburden Aquifers

The Champlain aquifer complex is the most extensive overburden aquifer encompassing some 570 km^2 within the northern part of the Basin. The sands are essentially fine grained and only moderately permeable. The deposits are of limited thickness, with saturated thickness varying between .3 and 3m and in some cases, wells constructed in this shallow aquifer have been reported to dry up as a result of low water tables during the summer months. Normally, the aquifer supplies adequate yields of good quality water to domestic wells but does not have the potential to yield municipal requirements. At the few locations where the aquifer is exploited for small communal water supplies, extensive spring and well collector systems are utilized.

The Rideau Front Aquifer occupies some 100 km^2 along the western boundary of the Basin. These surficial sands and gravels are highly permeable and are generally over 15m thick. The aquifer has the potential for high well yields but has not been actively exploited for municipal supplies due to location. Industrial wells with pumping capacities in excess of .5m^3/min have been developed in the aquifer.

Sand and gravel deposits of essentially limited extent occur in the subsurface at varying locations in the Basin, as indicated on Figure 3.4.2. The buried aquifers are typically comprised of essentially thin and discontinuous sand and gravel deposits which are generally less than 3m in thickness but which have been recorded up to 12m in thickness. Yields are always adequate for domestic requirements and some of the thicker occurrences have good potential for development of large supplies. The buried esker located south of the village of Embrun is capable of producing 25 m^3/min. Others located near Plantagenet, Sarsfield, Notre Dame and St. Isidore de Prescott also have potential for development of large supplies.

3.4.1.3 Groundwater Recharge

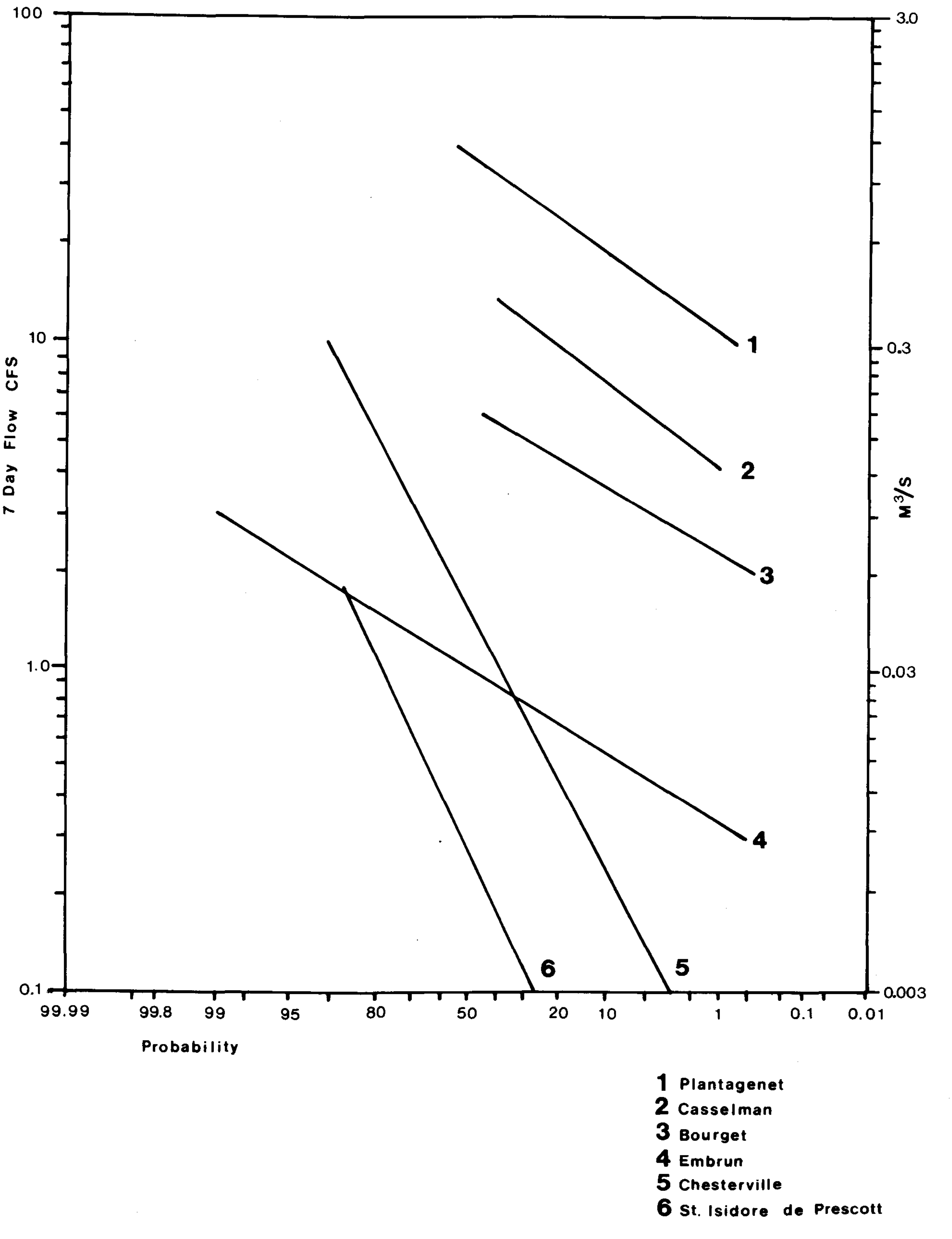
Groundwater recharge is that portion of total precipitation that infiltrates the soil to the water table and enters groundwater flow systems. It is difficult to determine because of a large number of variables which, among other factors, include geology and climate. The Ontario Ministry of the Environment, in their study (1980) of the South Nation River Watershed, estimated annual groundwater recharge rates varied between 1.5 and 10.5 m^3pd/km^2 for the bedrock aquifers, and 8.8 and 88 m^3pd/km^2 for overburden aquifers. Total annual groundwater recharge to aquifers in the South Nation River Watershed has been estimated at 289,000 m^3/d, of which some 274,000 m^3/d constitutes baseflow or groundwater run-off (Chin et al, 1980). All groundwater recharge is not recoverable from wells and hydrogeologic studies have indicated that only some 60 percent of groundwater recharge can be recovered practically by properly spaced and managed wells.

Indications are that recharge areas for aquifers are predominately in the southwest and southeast, outside of the South Nation River Basin. Both the Rideau Front and Champlain aquifers are, however, significant recharge areas in the Basin. Both are exposed at the surface and are susceptible to contamination, and should therefore be protected.

3.4.1.4 Surface Water Supplies

The alternative to groundwater for supply in the South Nation River Basin is surface water. When surface water is available it can be an attractive, easily obtained source of water. In the Basin, however, there are problems associated with both quantity and quality of surface water supplies. With regard to quantity, there is generally only enough flow during the summer at the downstream end of the Watershed (i.e., Plantagenet). In many places the rivers literally dry up in the summer and contain no flow as illustrated by Figure 3.4.3 which shows seven day low flow duration curves at several locations in the Watershed. Therefore, in order to ensure a surface water supply storage impoundments would be required in most places. Furthermore, surface water quality does not meet Provincial Objectives for human consumption so that more sophisticated treatment facilities, than for groundwater supplies are normally required.

SEVEN-DAY MINIMUM FLOW FREQUENCY CURVES FIG. 3.4.3



3.4.1.5 Major Water Users

Limited withdrawals of groundwater are used for irrigation purposes. Of an authorized total of approximately 4,450 m^3/d, withdrawals in 1975 averaged 1,800 m^3/d; 1,500 m^3/d for golf course operations and 320 m^3/d for crops. Irrigation is practised during the summer months from May to October when it is essential to maintain soil moisture levels for the growth of grass and some crops. It has been estimated that some 95% of total withdrawals for irrigation are from surface water sources (Chin et al, 1980).

Ault Foods in Winchester and Nestlé Canada Ltd. in Chesterville are the 2 major consumers of water in the Basin. Ault Foods is dependent on groundwater for its processing requirements. Nestlé Canada Limited utilizes 14 wells but yields are inadequate and must be supplemented by supplies from the South Nation River for process cooling requirements. Because of the general lack of high capacity wells and low flows in the summer it is recommended that future industries requiring large volumes of water for their processes be located elsewhere.

As illustrated by Table 3.4.3 there are a number of deficiencies with regard to availability of current groundwater for municipal water supplies within the Basin. These are much more pronounced during peak consumption periods and according to the table will increase in future. The table also indicates a number of quality restrictions pertaining mainly to sulphur, sediment and total dissolved solids. Further detail on a village by village basis is provided in the following section.

3.4.2 Management Options and Recommendations

Water supplies in sixteen of the major villages have been assessed and are discussed below. Figure 3.4.4 and Table 3.4.2 summarize the municipal supplies and projected future demands while Table 3.4.3 summarizes the community water supply recommendations. Further detail is provided in the Water Resources Background Study.

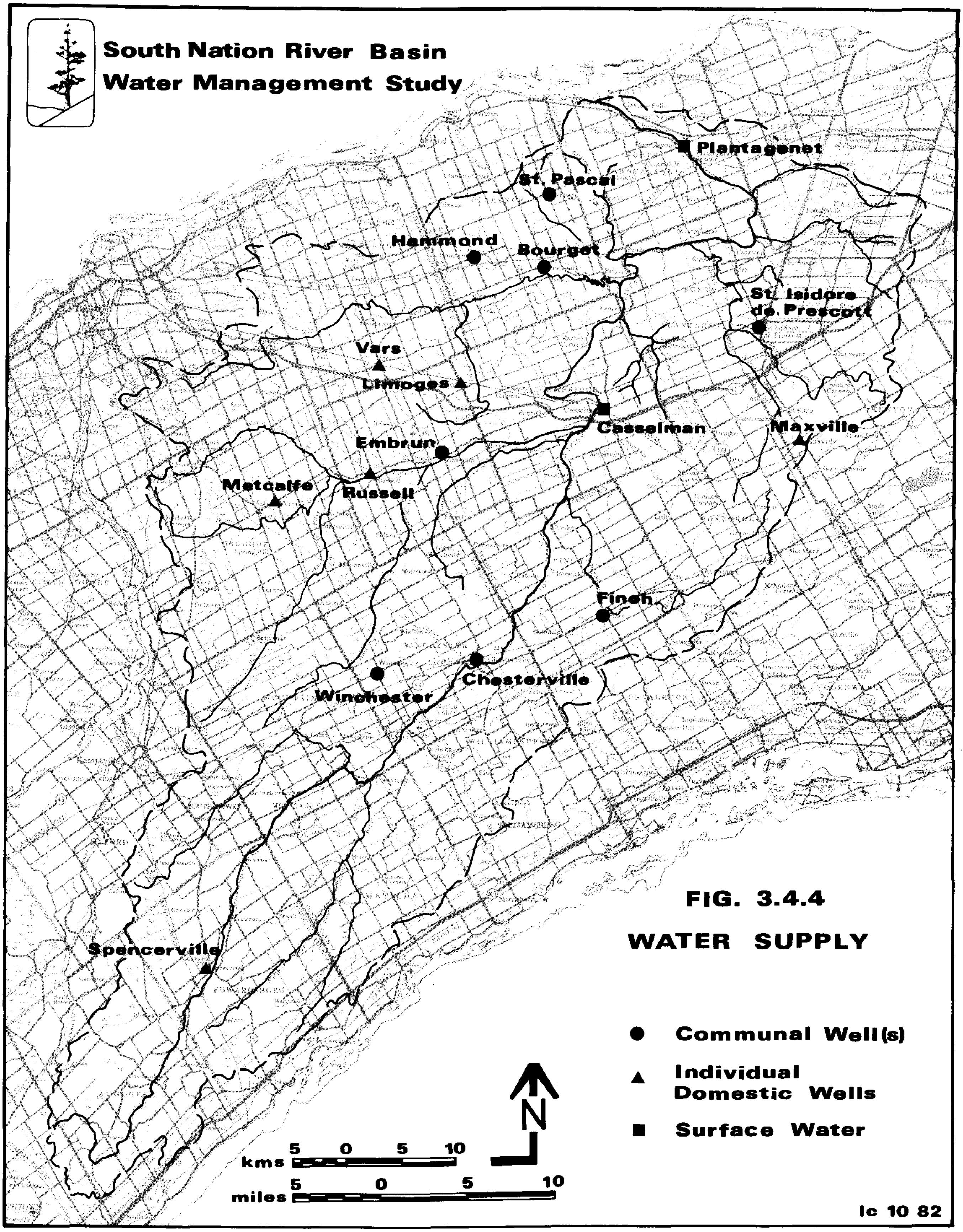


FIG. 3.4.4
WATER SUPPLY

TABLE 3.4.2

Summary of Municipal Supplies and Projected Future Demands to the Year 2001

Community	1975 Average Daily Consumption m^3pd	1981 System Capacity m^3pd	2001 Projected Population	Requirements m^3pd				Deficiencies m^3pd				Groundwater Potential for Development		Potential Quality Restrictions	Potential Source of Additional Communal Supplies	Possible Additional Supplies Available m^3pd
				1981		2001		1981		2001						
				Avg. Day	Max. Day	Avg. Day	Max. Day	Avg. Day	Max. Day	Avg. Day	Max. Day	Wells	Springs			
Winchester[1]	777	1,591	2,444	909	2274	1137	2500	None	682	None	909	Fair	Poor	H_2S	Nepean Sandstone West of Winchester Maple Ridge Aquifer	300-600
	Industrial Requirements Ault Foods & Winchester Cheese			591	1091	728	1364	591	1091	728	1364					
Chesterville[2]	564	818	1635	637	1591	773	1910	None	773	None	1091	Fair	Poor	H_2S	Bedrock Valley S.W. of Village	300-600
St. Isidore	91	637	903	364	1000	546	1319	None	364	None	682	Poor	Poor	Chloride & TDS	None	Individual domestic wells in northern part of village
Bourget	273	637	1437	500	1137	637	1591	None	500	None	955	Poor	Limited	Chloride & TDS & Iron	Spring Collectors Basal Sand & gravel	300
Hammond	45	136	600	182	546	273	773	45	409	136	637	Poor	Limited	Chloride & TDS & Iron	Spring Collectors Basal Sand & gravel	300
St. Pascal	91	91	400	91	318	182	546	None	227	91	455	Poor	Limited	Iron	Spring Collectors N.E. of Village	300
Embrun[3]	No System	No System	266	1000	2274	1591	3183	N/A	N/A	N/A	N/A	Good	Poor	Chloride & Iron	Esker Deposit 5 miles south of the village	from wells in esker 3300 m^3/d

TABLE 3.4.2 (cont'd)

Summary of Municipal Supplies and Projected Future Demands to the Year 2001

Community	1975 Average Daily Consumption m^3pd	1981 System Capacity m^3pd	2001 Projected Population	Requirements m^3pd 1981 Avg. Day	Requirements 1981 Max. Day	Requirements 2001 Avg. Day	Requirements 2001 Max. Day	Deficiencies m^3pd 1981 Avg. Day	Deficiencies 1981 Max. Day	Deficiencies 2001 Avg. Day	Deficiencies 2001 Max. Day	Groundwater Potential for Development Wells	Groundwater Potential for Development Springs	Potential Quality Restrictions	Potential Source of Additional Communal Supplies	Possible Additional Supplies Available m^3pd
Finch	No System	-	379	182	500	182	500	None	None	None	None	N/A	N/A	N/A	N/A	N/A
Maxville	No System	No System	835	364	1046	364	1046	N/A	N/A	N/A	N/A	Poor	Poor	Chloride & H_2S	None None	Individual domestic wells completed in upper bedrock
Russell	No System	No System	1667	546	1364	728	1910	N/A	N/A	N/A	N/A	Poor	Poor	Chloride & TDS	None	Individual domestic wells
Limoges	No System	No System	950	364	1000	409	1182	N/A	N/A	N/A	N/A	Good	Limi-ted	None	Surficial sand & gravel acquifer	300-450 Individual domestic wells
Metcalfe	No System	No System	800	318	909	364	1000.3	N/A	N/A	N/A	N/A	Fair	Poor	H_2S	Bedrock aquifer in the Oxford Nepean Formations	300-900 Individual domestic wells
Spencerville	No System	No System	500	182	500	227	682	N/A	N/A	N/A	N/A	Good	Poor	None	Top 20m of Oxford limestone bordering South Nation River	700 Individual domestic wells

Note:

1. Present and projected water requirements for Ault Foods and Winchester Cheese have been tabulated separately in order to identify potential additional municipal requirements.
2. Requirements and deficiencies at Chesterville assumes that Nestles will continue to be serviced by its own wells and will make no demands on the municipal system.
3. The design requirements for Embrun calls for a 1,591 m^3pd system which will meet average-day requirements. No deficiency in the system is anticipated, however, as the vast storage in the aquifer will apply satisfy the shortage.

TABLE 3.4.3

Summary of Community Water Supply Recommendations

Village	Individual Domestic	Communal Groundwater	Communal Surface Water
Winchester		1	2 - South Nation with Chesterville
Chesterville		1	2 - South Nation existing dam
St. Isidore	1		
Bourget	2	1	3 - dam on Bear Brook
Hammond	*2	1	3- dam on Bear Brook
St. Pascal	*2	1	
Embrun	*	1	
Finch		1	
Maxville	*1		
Russell	*1	2	
Vars	*1	2	
Limoges	*1	2	
Metcalfe	1		
Spencerville	1	2	
Plantagenet			1
Casselman			1

1 - 1st Priority for additional Water Supply
2 - 2nd Priority if 1 fails
3 - 3rd Priority if 1 & 2 fail
* - Low Cost Alternative Program (carried out by M.O.E.)

3.4.2.1 Winchester

The existing municipal water supply consisting of three wells, and a fourth for standby purposes is adequate to meet current average daily requirements but deficient in terms of maximum daily requirements. Based on population projections future domestic requirements will be increasing. Further current industrial users, (i.e. Ault Foods and Winchester Cheese), could require additional supplies for expansion of their operations. At present treatment is by chlorination only but problems associated with hydrogen sulphide and iron have been reported.

It would appear that the area west of Winchester holds the best potential for developing aquifers capable of yielding adequate supplies to municipal wells. Since the Maple Ridge Sand and Gravel aquifer located midway between Winchester and Chesterville is unlikely to provide high water volumes it is recommended that further testing in the area of the Big O Drain and March Formation subcrop be carried out. Further evaluation of the feasibility of piping surface water from the Chesterville impoundment, on the South Nation River, possibly in conjunction with supplies to Chesterville, could also be investigated.

3.4.2.2 Chesterville

The existing water supply system is serviced by two wells, with the second or standby well of very low capacity. The second well will be decommissioned soon due to severe quality problems associated with H_2S, bacteria and turbidity. The main well is adequate to meet current and projected average daily requirements but not adequate to satisfy maximum daily requirements. Nestlé Canada Ltd. utilizes their own groundwater and surface water supplies. Treatment of the municipal supply is by chlorination only and, with the exception of the standby well, problems associated with iron and hydrogen sulphide have not been severe.

To provide additional supplies to satisfy maximum daily requirements further drilling in the bedrock channel southwest of the village is recommended. Particular attention would have to be given to proper location of any new wells because of the potential for aquifer degradation from river borne contaminants. If groundwater supplies prove inadequate then consideration should be given to the Chesterville impoundment which provides sufficient storage for municipal use.

3.4.2.3 St. Isidore de Prescott

The southern part of the village is serviced by a syndicate-operated communal well system consisting of 2 wells with chlorination facilities while remaining residences obtain water from individually drilled and dug wells. The communal well system is sufficient to satisfy average daily demands of the section of the community served, both now and (20 years) in the future but is not sufficient to satisfy the entire village even at the present time. Maximum daily requirements are not satisfied.

Since supplies of fresh water from the bedrock located under the village are not extensive it is recommended that development proceed on the basis of individual wells. Experience has shown that due to the stratigraphy the wells are uncontaminated. If all other supplies fail and demand rises significantly then consideration could be given to obtaining surface water from the Scotch River. This alternative would, however, require a reservoir to augment low flows or provide storage and would be expensive.

3.4.2.4 Bourget

The existing water supply system consists of two wells and a spring collection system with one of the wells being used for standby purposes. Treatment is by chlorination only, although the water from the collector system is high in iron and the standby well produces water high in sodium. The existing system is adequate to meet average daily requirements but is deficient in terms of maximum daily requirements.

To supply the additional requirement for maximum days groundwater exploration of a basal gravel aquifer and Champlain sand aquifer, which are located in the Bourget area is recommended. Recent drilling has indicated that supplies in the order of $.23 m^3/min$ are available. If required, water supply from Bear Brook could be considered once groundwater alternatives have been exhausted. This surface water alternative would be expensive, however, due to the relatively high concentrations of sediment, phosophorus and bacteria in the water as well as (possibly) objectionable levels of temperature and odour during the summer months.

3.4.2.5 Hammond

The existing community water supply system consists of a spring collector system and one deep well which is being utilized for standby purposes. Some households not connected to the community system obtain supplies from individually dug and drilled wells. Water from the deep well is hard with a high chloride content and H_2S odour while the spring water is of good quality and soft. Treatment is by chlorination. In terms of quantity the existing system is deficient in terms of both average day and maximum day requirements.

Hammond is located in a similar geological environment as Bourget and some potential exists for additional communal supplies in the basal gravel and Champlain sand aquifers. Properly constructed individual wells and upgraded existing wells can be expected to yield supplies of adequate quantity and quality for domestic use. Also, similar to Bourget, a communal surface water supply could be obtained from the Bear Brook, if still required, after groundwater supplies have been exhausted.

3.4.2.6 St. Pascal Baylon

The existing communal water supply system utilizes both spring water and surface drainage collected in two reservoirs. Treatment is by filtration and chlorination. The current system is adequate with regard to current average day requirements but deficient with regard to current maximum day requirements and projected average and maximum day requirements.

Further groundwater exploration of two nearby aquifers; namely the Champlain aquifer and a basal sand and gravel aquifer associated with fractured bedrock is recommended. Either an expanded municipal supply or properly constructed individual wells can be expected to yield supplies of adequate quantity and quality for domestic use.

3.4.2.7 Embrun

A private communal well presently services a small section of the community. The remaining ground water users obtain water from individual drilled wells.

Test drilling has located a water source in a partially exposed esker deposit about 8km south of Embrun. Two production wells rated at 2.23m^3/min have been constructed in this aquifer. According to projected population figures this will satisfy maximum daily requirements at least for the next 20 years. Implementation of this system for Embrun currently requires construction of the distrubution system. If required this aquifer could be utilized to service Russell and Vars in future.

3.4.2.8 Finch

The village of Finch has only recently commissioned a new water system with a capacity of .40 m^3/min which is sufficient to satisfy present and projected future average and maximum daily requirements. The water from the two wells in the system is treated and filtered prior to distribution because of the high concentrations of hydrogen sulphide gas.

3.4.2.9 Maxville

The village of Maxville and its surroundings obtain their water supplies from individually drilled and dug wells. There are no communal piped services. Based on estimates of capacity requirements for a communal system and known geologic conditions it appears that neither the overburden nor the bedrock in the Maxville area demonstrate the potential to yield large supplies of good quality water such as would be required to serve the village. It is therefore recommended that individual wells continue to be utilized in the area.

3.4.2.10 Russell

The village of Russell is serviced in its entirety by individually owned private wells. Hydrogeologic conditions in the area indicate that yields from underlying bedrock would be of poor quality and of insufficient quantity to satisfy municipal requirements. On the other hand individually owned private domestic wells provide adequate supplies of good quality water and would seem to be the logical choice to accommodate future growth of the municipality. In future a communal supply may be obtained from the aforementioned esker, located 8 km south of Embrun, if required.

3.4.2.11 Vars

Most households in the Vars area obtain their water supplies from individually owned, dug and drilled wells. There are no communal piped services. Recent investigations have shown that a sand aquifer located northwest of the village has the potential to yield adequate supplies to cover average day requirements but not maximum day requirements. It is recommended that individual wells be utilized for the time being to accommodate future growth of the municipality.

3.4.2.12 Limoges

Households in the Limoges area obtain their water supplies from individually owned dug and drilled wells and sand points. Test drilling programs in 1976 indicated that the surficial sand in the Limoges area is too fine grained to provide adequate supplies of good quality water to satisfy the needs of the village. It is recommended based on geological conditions that future development require shallow screened wells on large lots.

3.4.2.13 Metcalfe

Most of the residents in the Metcalfe area obtain water supplies from individually owned drilled wells. There are no communal piped services. Investigations to date indicate that the bedrock offers the best potential for obtaining the required quantities of water to constitute a municipal supply for the village. However, indications are that the wells which would be required to penetrate deeply into the Oxford Formation and preferably into the underlying Nepean Sandstone to obtain sufficient supplies would be sulphurous. Wells completed in the shallow limestone would not demonstrate the required yield. Noting that individual domestic wells adequately service the community at present it is recommended that these continue to be utilized for future expansions.

3.4.2.14 Spencerville

Water supplies in the Spencerville area are obtained from individually owned private wells. Indications are that the Oxford Formulation constitutes a good aquifer in the Spencerville area. Wells developed in the upper 20 metres of the bedrock in close proximity to the South Nation River can be expected to produce required quantities of adequate quality water. On the basis of existing groundwater quality and quantity in individual wells and costs of a communal system, continued servicing by individual wells for future development is recommended.

3.4.2.15 Plantagenet and Casselman

Plantagenet and Casselman are the only two communities in the basin that have a communal surface water system, drawing from the South Nation River. There is adequate flow in the river in the summer to maintain an adequate water supply in Plantagenet for the foreseeable future. In Casselman, with the storage available behind the dam, there is enough water to supply the community even in years of low flow.

3.5 EROSION & LANDSLIDES

Erosion and landslides are of significant concern in certain areas of the Watershed. Large sections of land have been lost to erosion and landslides at several locations in the northern portion of the Watershed. The most serious problems arise when landslides occur in populated centres where lives, homes and property are threatened. Erosion is also occurring on a number of poorly constructed open channel drains which results in high maintenance costs. Sheet erosion of fields is gradually depleting valuable topsoil in some areas thus degrading crop productivity. All types of erosion contribute to poor water quality in the form of high sediment loads and associated nutrients.

3.5.1 Problem Analysis

In general, most sediment is derived from sources in the northern part of the Basin. Little sediment is contributed upstream of Crysler. The areas producing the most sediment are the Bear Brook (including the North and South Indian Rivers) and the Castor River sub-basins. Horse Creek, Calendonia Creek and Scotch River sub-basins also contribute significantly according to the Erosion and Sedimentation Background Study.

Approximately 80% of the total sediment load is normally transported from the Basin during the months of March, April and May. Although significant summer/fall storms can cause erosion, the magnitude and duration of peak discharges during these period are such, that the quantity of sediment removed from the Basin is normally much lower than during the spring period.

Sediment from erosion losses impairs water quality both in terms of turbidity and associated phosphorus. Water quality aspects of erosion and sedimentation are disussed fully in Section 3.2 Surface Water Quality.

The Erosion and Sedimentation Background Study has identified the three major sediment sources, for the South Nation Basin. These have been rated in order of sediment production as follows:

1. Landslides
2. Open channel drain erosion
3. Sheet erosion of fields

Figure 3.2.1 illustrates the general distribution of major sediment source areas within the Basin. The Erosion and Sedimentation Study includes detailed maps of sediment sources.

Landslides are natural, random and discrete events which are widespread along the banks of the natural channels (photo 3.5.1) and drains throughout the northern half of the Basin. Figure 3.5.1 shows the general distribution of landslide susceptible slopes in the Watershed. More detailed maps are included in the Geotechnical Background Study. The extremely large effects that the Lemieux slide has had and is still having after 10 years on total sediment production figures has been documented.

In addition to being major contributors to the sediment problems in the South Nation River Basin, landslides are considered to be a hazard to life and property and thus merit concern and special consideration for control measures. Although there has been no recorded loss of human life attributable to landslides, within the Basin to date, livestock have, on numerous occasions, been lost. Landslides can be destructive to property as well as hazardous to life. In several recorded in-

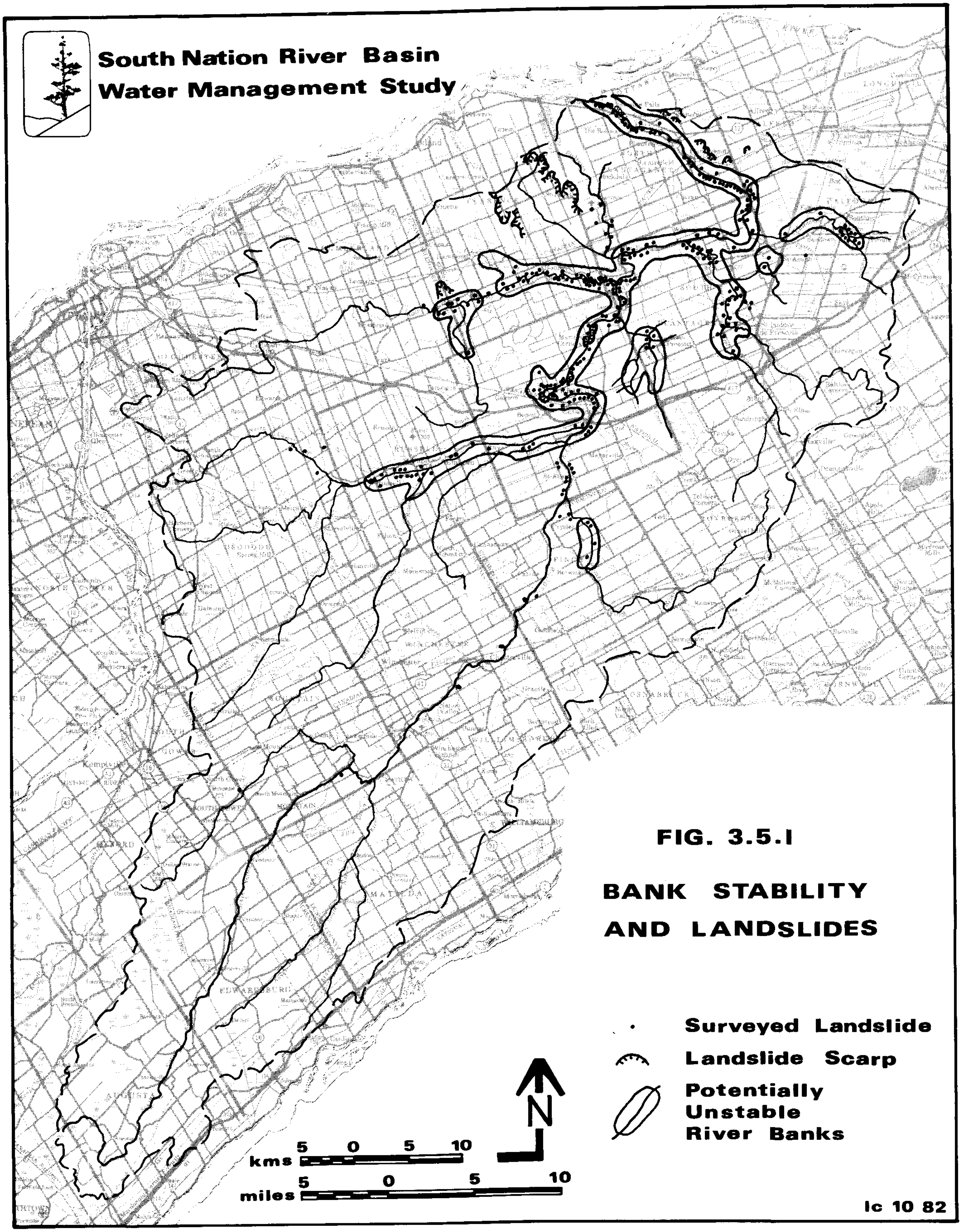


FIG. 3.5.1

BANK STABILITY AND LANDSLIDES

(Source; Geotechnical Study)

stances landslides have destroyed or damaged homes, summer cottages, farm buildings and private yards. Furthermore it has been estimated that approximately 400 homes and buildings are within sensitive landslide zones. Damages to public roads and utilities have also occurred, as shown in Photo 3.5.1.

The main causes of landslides are: erosion at the base (toe) of the slope; excess groundwater in the soil; varying strength values within the soil layers; and geometry of the slope. The most common type of landslide, rotational failure, is slumping of a mass of soil leaving a back scarp and resulting debris, as shown in Photo 3.5.2. Initial rotational failures are generally triggered by very high local groundwater conditions (high pore water pressures) and/or toe erosion. Hundreds of these landslides have occurred in the Basin. These frequent, smaller landslides encroach on residential areas causing damage to structures, transportation routes and communication lines. Recent rotational slides have occurred at: Plantagenet, where a roadway was cut off; St. Isidore, where municipal property was damaged; and Wendover and Clarence Creek, where private property and structures were damaged.

Retrogressive failures involve a series of rotational failures that extend into the slope. Immense land loss and loss of life or personal injury is possible as a result of retrogressive failures. For example, 31 lives and 40 homes were lost in the St. Jean-Vianney Slide on the Saguenay River in Quebec. The Lemieux landslide, which occurred in May, 1971, involving 36 hectares of land, was the largest landslide to take place recently on the South Nation River. (Photos 1.2.5 and 1.2.6 in Part 1 illustrate the Lemieux landslide). Many older retrogressive landslides can also be seen in the South Nation River Basin.

The Geotechnical Background Study gives further detail regarding the types and effects of landslides common to the South Nation Basin. As noted above erosion from poorly designed and constructed open channel drains can be a major source of sediment. Several open channel drains have been identified in the Erosion and Sedimentation Background Study as major sediment producers. Most of these drains are located in the northern portion of the Watershed. Five drains were studied in detail. It was found that drain cross-sections changed considerably during the study ranging between 1.0 to 4.0 m^3/metre length of drain in a 2 year period. Not only does this considerable sediment production affect water quality, but it also indi-

EROSION AND LANDSLIDES

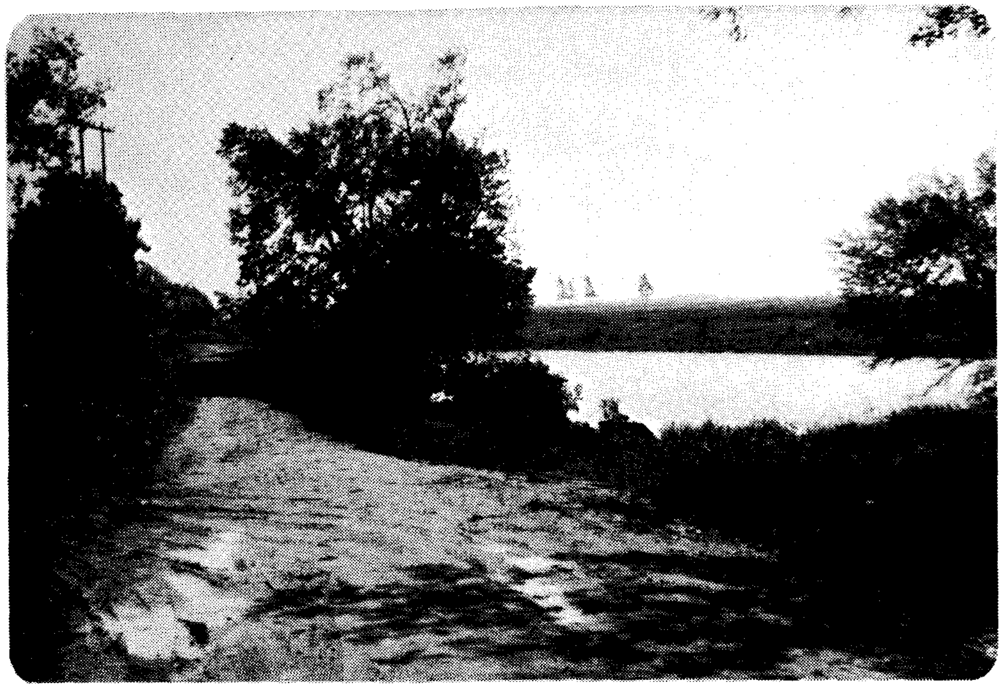


PHOTO 3.5.1 LANDSLIDE NEAR PLANTAGENET

PHOTO 3.5.2 RIVER BANK INSTABILITY - SOUTH NATION

cates substantial maintenance requirements noting that significant portions of the sediment are deposited in other parts of the same or downstream drains. Furthermore, with such drastic changes in cross-sections a considerable amount of agricultural land is being lost along the drains.

The Erosion and Sedimentation Background Study indicates that for a typical drain in the order of 2 km in length draining 500 hectares, under current maintenance practice, approximately $24,000 would be spent over a 10 to 12 year period. This could be substantially reduced with improved design and construction practices.

Erosion from fields is less significant than erosion from open channel drains in terms of sediment production. This is due to the relatively flat topography and diverse cropping pattern within the Watershed. Although not significant on a basin wide scale, field erosion is important locally. Forty sites were identified in the Erosion and Sedimentation Background Study as contributing sediment to the streams. Also, as monoculture farming operations increase in number, sheet erosion from fields could potentially become more serious.

As well as contributing sediment to the receiving waters, sheet erosion from fields can reduce the productivity of the land as valuable topsoil is lost. This is not perceived to be a significant problem within the Watershed at present and should not become a major problem providing suitable agricultural best management practices are employed.

3.5.2 Management Options and Recommendations

Recommendations for control of erosion are related to landslides, open channel drains and sheet erosion from fields.

3.5.2.1 Landslides

Several measures are available to reduce the impacts and the damages associated with landslides. These measures are both preventive and protective.

Preventive measures ensure that future impacts of landslides are minimized. The most important component of a preventive program is the establishment of construction setbacks from unstable slopes. The Geotechnical Background Study has identified construction setback distances within the unstable slope areas. These are shown on Figure 3.5.2. For the setback distances in each zone and how the information can be used, the reader should refer to the detailed maps in the Geotechnical Background Study. The setback distances should be enforced for all types of structures including houses, cottages, barns, outbuildings, septic drain tile fields, and wells, swimming pools, etc.

The setback zones can be implemented in the following ways. The Conservation Authority can adopt regulations to enforce the setback lines or the townships concerned can adopt a municipal bylaw suited to their area such as:

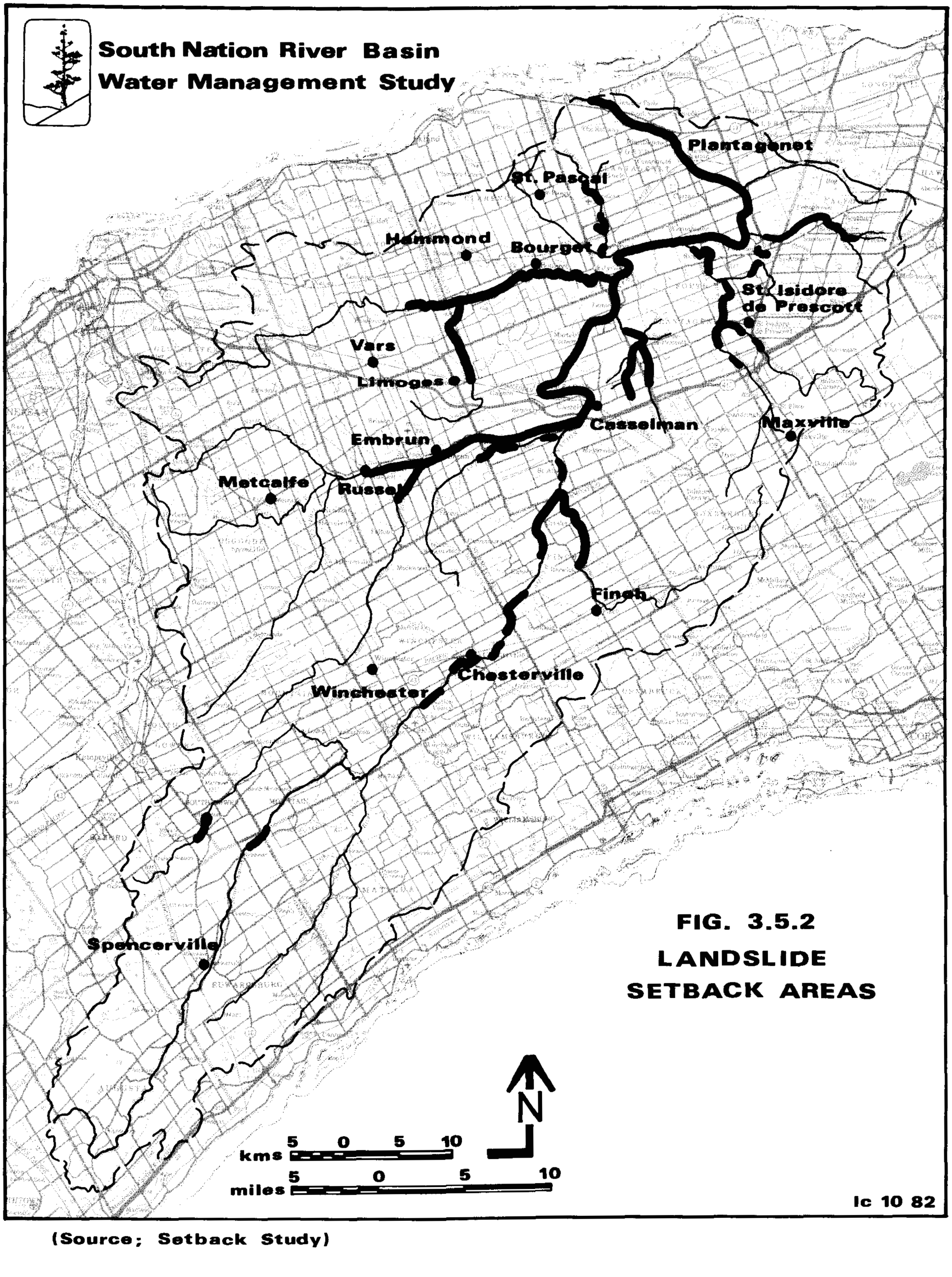
"The proponent may not construct a structure (house, barn, septic drain tile field, etc.) within the setback distance specified unless he first has the approval of the Township. The approval shall be based on the proponent adequately demonstrating that either his recommended safe setback distance is different than the specified setback limit because of site specific differences in conditions, or because protective measures will be taken to stabilize the slope on which he intends to build."

In both cases a slope stability investigation and suitable recommendations by a qualified geotechnical engineer would be required.

Benefits of the setback program would be substantial. Life is protected and structural damage is minimized by removing the impact of landslides on permanent dwellngs, and future man-induced landslides should be virtually eliminated.

Since many of the landslides occur in rural areas, prevention of landslides on a basin scale through the use of structural measures would be extremely expensive and not cost effective. However, the risk of failure can be substantially reduced through a low-key vegetation program. An established vegetative cover increases evapotranspiration, reduces groundwater pressures and strengthens the top layer of the slope by providing a root structure and cover to reduce surface erosion.

The protective program should concentrate on the potential impacts of landslides on existing structures. Several structures are presently located on slopes where the



(Source; Setback Study)

risk of failure is high. There are essentially two methods available to lessen the potential impacts of landslides on existing structures. One is to improve the stability of the slope by structural remedial measures. The other is to remove the structure from the unstable slope area.

Several structural remedial measures are applicable. These include slope regrading, rip-rap toe erosion protection, rock fill berms, gabions, slope drainage and vegetation. The selection of an appropriate method is site specific and depends on the probable cause of landslides, steepness and height of slope, groundwater conditions, type of structure being protected and location of structure.

To determine whether such works are justified the benefits of reducing the damage potential, should be compared to the cost of the required remedial works. Typical costs for works were determined in the Geotechnical Background Study for banks ranging in height from 5 to 10 metres and are shown in Table 3.5.1 below.

TABLE 3.5.1
TYPICAL COSTS FOR STRUCTURAL REMEDIAL MEASURES FOR EROSION CONTROL

Remedial Works	Approximate Cost
Slope regrading	\$500-800 per metre
Rip-rap toe protection	\$25-100 per metre
Rock fill bern	\$500-1000 per metre
Gabions	\$400-800 per metre
Drainage	Unknown

Benefits that could be considered would include value of structure protected, value of land protected, cost of clean-up after the landslide, inconvenience and fear.

The structure can be removed from the unstable slope area to eliminate the impacts of a landslide. This alternative should be considered when associated costs are less than costs for required structural remedial works and especially when the structural remedial works cannot be justified on a benefit/cost basis.

3.5.2.2 Open Channel Drainage Erosion

Recommendations for sediment control from open channel drainage sources involve the areas of field investigations, design and construction.

A very detailed "Design Manual for Open Channel Drainage" has been produced by Agriculture Canada. The implementation of this manual is considered to be of extreme importance if erosion in drains within the Basin is to be controlled. Drain design should follow the Design and Construction Guidelines put out by the Ontario Ministry of Agriculture and Food.

The benefits of improved drainage practices would be to reduce sediment loadings in receiving waters, maintenance costs and loss of agricultural land adjacent to the drains. Recommendations concerning open channel drain design are discussed in detail in Section 3.3, Land Drainage.

3.5.2.3 Field Erosion

Remedial measures to reduce sheet and rill erosion from fields is extremely well documented in published literature. As previously noted 40 areas were identified where sediment is reaching river and stream channels.

Each of these 40 areas should be investigated in the field to determine the most appropriate practices for alleviating the problem. Some methods which might be considered are as follows:

a) Install a three to five metre buffer strip along drains.
b) Change or rotate the crop planted from open types (i.e., corn) to covered types (i.e., hay).
c) Maintain good soil structure by not plowing sensitive clay fields when they are wet.
d) Strip cropping with crops which provide high soil coverage.

Further discussion of these control measures is included in Section 3.2 Surface Water Quality.

4.1 APPROACH

Problem solving and long-term management of water resources begins and ends with land-based activities. The use and management of surface and groundwater in the South Nation River Basin is contingent on the different forms of future land use and the corresponding needs of the resident population. Flood control is needed to reduce risk to life and property and to reduce agricultural crop damage. Surface and subsurface drainage is needed to make the best use of agricultural lands for crop production. Additional supplies of water are needed for resident use in homes and businesses. Better land and waste management practices are needed to improve water quality. These practices will enhance environmental quality and ensure that our land and water resources will be passed along to future generations in good condition.

Traditional approaches to solve water management problems have often been to build structures to fulfill certain needs, sometimes with very little examination of alternatives and related needs. The approach utilized here is to examine all the different alternatives that may realistically have application to solve water problems in the Basin. The different alternatives are also examined in terms of their impacts on other resource elements and land use activities. Opportunities and constraints for development, and wise management over the long term are identified and assessed. Strategy choices are based on the best combination of factors, including cost, that will enhance resource utilization and management in the Basin. In short, this approach attempts to recognize that action in one area should create beneficial impacts and new opportunities in related areas of activity.

Part I describes the background information necessary for the implementation of the Water Management Study. The land base, river system, history and demographic profile are highlighted in Part I.

Part II illustrates how the future land use pattern in the Basin is likely to evolve within the limits of the opportunities and constraints that condition the different activities. The analysis of economic activity and land use described in Part II indicates that it will remain much the same as it is now. Agriculture and forestry will continue to be the major land uses however, these lands will be more intensively managed in future. Industrial, commercial, and residential development will build slowly on the present economic base with the Ault and Nestlé plants continuing as the major manufacturing and processing facilities. A large number of the residents of the Basin will continue to work elsewhere, especially in Ottawa. There will be a greater awareness of the need to work toward improved environmental quality and this awarenesss will help to ensure long term benefits for fish, and wildlife, natural and cultural resources.

In Part III, the water management problems of flooding, water quality, land drainage, water supply and erosion were analyzed. A range of alternative measures to deal with these problems were also assessed. The best recommended measures for problem solving and resource management from Part II and Part III have been assembled in Part IV.

The interactions between different economic activities, land uses, and water uses are of major interest and concern in Part IV. Recommendations dealing with problems in some resource areas are mutually exclusive and can be implemented with virtually no impact on other resources. Some of the recommendations affect other resource areas only slightly, either adversely or by providing added potential or improvement. Many of the recommendations, however, substantially affect other resource areas or economic activities, and it is critical to consider the widespread effects that these recommendations have during planning and implementation phases.

Analysis and assessment of alternatives to deal with water resource management problems and issues in the South Nation River Basin provides the basis for a long-term planning strategy. Each recommendation has its own framework and process that are inherent in the nature of the measure. Different kinds of work need to be done by different specialists over time frames that vary from a few weeks to several years, in one or two specific sites, or across the entire Basin. This requires a concerted planning and scheduling exercise during the pre-implementation phase, with specific responsibilities assigned for the implementation of each measure. A concerted effort in co-ordination is needed due to the complexities inherent in implementing a multidisciplinary program, and the number of various interested private sector groups and government agencies that are involved.

Table 4.1.1 summarizes each recommendation and its primary benefit, the important secondary benefits or opportunities, and the major constraints or adverse impacts. The table illustrates the relationship of each recommendation to other elements of the study.

A simple rating system is used in the matrix to show the interactions or linkages:

(+) The recommendation has a positive or beneficial effect on an issue.
(0) The recommendation has little or no effect on an issue.
(-) The recommendation has a negative effect on an issue.

4.2 PLANNING STRATEGY

The planning strategy has three parts:

1. Carry out certain immediate corrective and protective measures to overcome major natural constraints;

2. Initiate programs for continuing long term corrective, protective and preventive measures concerning natural resource use and conservation;

3. Within this framework for resource management, develop programs and projects in the economic sectors, particularly agriculture and forestry.

The first part of the three part strategy deals with corrective and protective measures that are required immediately in the Basin. The problem of flooding is a perennial one which will continue to cause damage to property and crops, risk to life, and considerable inconvenience to residents and businesses. Many of these problems can be alleviated with appropriate remedial measures.

An example is the Chesterville channelization project which is currently underway. This is an effective flood control project which has considerable interaction with other resource sectors and management issues.

Flood reduction benefits in the Brinston area will allow for more intensive agriculture in the flood area and allow for drainage improvements upstream of the flood area, as a result of lower water levels and better outlet for tile drainage. Erosion along the channel will be minimized due to stabilization at 3:1 side slopes. The increased water volume in storage at Chesterville is available for residential, commercial and industrial use in Chesterville and Winchester should it be required by those communities in the future, and boating and associated recreation potential has been enhanced.

There are short term adverse impacts to water quality with increased sediment loads. This is counteracted somewhat by providing a sedimentation basin at Nestlés water intake which maintains the integrity of the water supply. Also, private wells are sometimes affected, both in terms of quality and quantity, by construction methods. This is overcome by implementing a contingency plan to provide alternate short term water and to ensure that future long term supply is maintained.

A negative fish and wildlife impact is experienced by removal of near shore and underwater habitat. To reduce the impact of improving hydraulic capacity by removing an oxbow, the old river channel is left in its natural state to provide for fish nursery areas. If major spawning beds are removed, steps should be taken to replace them. In terms of heritage conservation, archaeology sites may be destroyed and it is recommended that prior to construction archaeological investigations must be undertaken, so that important information is not lost. In fact, for large structural works of this nature that may affect many resources both positively and negatively, it is recommended that an environmental assessment be undertaken and remedial measures implemented where necessary.

Other appropriate flood control measures to be implemented include channels along the South Castor, Bear Brook and channels and dykes along the South Nation in South Plantagenet. Impacts and opportunities provided with these recommended works are similar to those discussed above for the Chesterville channel.

The recommendation to proceed with detailed geotechnical, recreational and social impact assessment may lead to the construction of the Lemieux Reservoir. If so, a complete environmental assessment will also be necessary since interactions with other resources and management issues are significant.

The second part of the strategy is to initiate a number of programs of continuing longterm corrective, protective and preventive measures.

The recommendations that deal with minimizing the impacts of floods include floodproofing - a protective measure, and floodplain mapping with regulations - a preventive measure. Floodproofing is local protection that reduces the damage to structures that are located in the floodplain by waterproofing, sandbagging, berming, etc. Since it is local in nature, floodproofing can be readily implemented without great concern to other resources or management issues. Floodplain mapping and regulations will control development within the flood area, thereby virtually eliminating impacts of flooding on future development.

This part of the strategy also lays the groundwork for a concerted effort to improve surface water quality over the long term. Several practices are recommended to reduce the non-point pollution problems of sediment, phosphorus and bacteria. Proper manure management and restricted cattle access to streams will improve water quality, keep valuable nutrients on the farm, reduce erosion and provide for long term fish and wildlife benefits. The major adverse effect is that alternate cattle watering facilities will be required.

Crop rotation and conservation tillage are recommended practices in areas where sheet erosion is or may become a problem. Valuable topsoil and corresponding crop productivity will be maintained and sediment loading will be reduced in local waterways.

Critical area planting and buffer strips have widespread application with the emphasis on the northern half of the watershed. Streambanks and drain sideslopes will be stabilized which will reduce long term maintenance work and sediment loads. Also, wildlife habitat improvements will result along streambanks.

The proper design, construction and maintenance of agricultural outlet drains is a basin wide recommendation that will reduce the sediment load in the river and drain maintenance costs. The implementation of existing OMAF guidelines is an important part of this recommendation.

All of these best management practices have substantial benefits and very few adverse effects. They can be implemented easily without lengthy consideration of other issues or recommendations.

Controlled (once a year) lagoon discharge is recommended for all new or expanded facilities within the Basin, since river flows in the autumn are not adequate for proper assimilation of wastes. A critical problem exists in the East Castor River downstream of Winchester and should therefore receive top priority. Once a year discharge will improve dissolved oxygen, phosphorus and bacteria levels and thereby improve the fishery and river aesthetics. Alternate methods such as effluent polishing in wetlands and spray irrigation appear to have application, however they are still in the early development stage in Ontario.

Continued flow gauging and water quality monitoring on the South Nation River system is recommended so that the success of the water quality improvement program can be assessed and any new problems that surface can be identified at the earliest possible time for immediate corrective action to be taken.

The provision of cost effective land drainage is a very important requirement within the Watershed. As well as improved design, construction and maintenance techniques discussed above, Drainage Master Plans are recommended for several sub-basins within the Basin. The drainage plans will include analysis of several drainage alternatives leading to the least cost, most effective and environmentally sensitive drainage scheme.

The issues of flood control and land drainage are closely linked. Because of this, planning for channelization and land drainage must go hand in hand. Therefore, the process of drainage master planning at the sub-basin and township level should accompany detailed channel design. This will ensure effective co-ordination of drainage development and flood control measures. Candidate sub-basins include the upper South Nation in Augusta Township, the lower South Nation and tributaries in South Plantagenet, Bear Brook, South Castor and South Branch.

Because of the limited data base and calibration of the drainage model (DRAIN-MOD) employed in this study, it is recommended that monitoring of flows and water quality in various outlet drains and tile drain fields be continued. With more data available the effects of the drainage can be determined in future with a higher level of confidence.

The recommendations for community water supply are contingent upon the location of bedrock and surficial aquifers, and readily available surface water storage.

Where potential aquifers exist, a communal groundwater system should be developed. In villages where aquifers do not exist, future development should take place with individual wells. Plantagenet and Casselman are supplied with surface water from the South Nation River. The supply is adequate for the expected expansion in these villages. The potential for a surface water supply exists for Winchester and Chesterville, however this should only be pursued if the search for additional groundwater fails. Apart from providing future residential, commercial and industrial development requirements, the interactions of water supply with other issues are limited.

Recommendations to deal with the effects of landslides are both preventive and protective. The preventive component involves the implementation of construction setback lines to control future development in landslide areas, especially in the northern half of the Watershed. The protective portion of the strategy is to stabilize slopes with remedial works such as toe protection and grading the slope in areas where structures are in imminent danger.

Thoughout the Study there is a recurring theme about the impact of different land and water use activities, as well as improvement measures, on the natural environment and cultural heritage. This concern should be reflected in all aspects of implementation. Special consideration is required in this regard to develop conservation and recreation programs as an integral part of the planning and works dealing with the other issues. Both conservation and recreation are essential features of the social fabric. Integrating their planning and development with other major activities will ensure continuing public involvement and understanding of the ongoing task of water resource management.

Several recommendations have been made in an attempt to conserve valuable fish and wildlife habitat, wetlands, natural and cultural heritage and provide opportunities for outdoor recreation. The key recommendation concerning the conservation of these resources is to develop three conservation corridors or travel routes and an accompanying education program. The travel routes will include locations where the values of particular resources are easily represented and interpreted. Increasing public awareness of the importance of these resources is a major component of the conservation program. The travel corridors also provide an opportunity to interpret many of the strategy recommendations for flood control, erosion protection, water quality improvement, forestry management, etc. In fact, an education/-demonstration program is a fundamental prerequisite for implementation of the second part of the strategy to help the Basin residents live and work within the natural constraints of their environment.

The recommendations discussed above which are site specific are graphically illustrated on Figure 4.2.1. The Conservation Corridors were previously presented on Figure 2.7.2. Some recommendations have not been included on the maps, but are referred to in Table 4.1.1, and they should be considered for application throughout the Basin. In addition to the general recommendations outlined here, there are several very detailed recommendations in the Background Studies, which should form a part of implementation strategies.

The third and final part of the strategy is to implement new developmental programs and projects in economic sectors of agriculture, forestry and residential, commercial and industrial. The basis of these programs is more intensive use of the land.

The recommendations dealing with agriculture centre around maintaining the resource base and improving production potential. Included are implementation of the foodland guidelines and agricultural code of practice, development of local slaughtering facilities, handling and storage facilities for field crops, fruit and vegetables, and emphasis on marketing as the basis for agricultural development.

Forestry recommendations will improve the future marketable resource and improve management efficiency by encouraging the planting of non-agricultural idle land to trees, providing incentives for forest management on private land and integrating accessible private woodlots into the OMNR forestry program.

An integrated planning effort through the municipal planning process and encouragement of residential, commercial and small scale industrial growth in various centres throughout the Watershed will ensure that the economic viability of major centres and support of the agricultural industry will be maintained in the long term.

The water resource management strategy sets the stage for implementing a series of problem solving recommendations and resource management practices. It serves to highlight three critically important considerations that are fundamental to the successful implementation of the strategy and its components. They are, firstly, the importance and need for continuing the process of forward planning to provide a flow of decision-making information for businesses, individuals and governments concerning wise use of natural resources in harmony with economic development needs; secondly, the complex interdependence of water resource management and land use activities; and finally, the need for effective coordination and close cooperation between government agencies and with private sector interests so that priorities can be agreed upon and problems resolved with dispatch - in the best interests of sound resource management, the tax payers and investors.

Table 4.1.1 Recommendation Assessment and Interaction Matrix

FLOODING

RECOMMENDATION	LOCATION	AGRICULTURE	FORESTRY	RESIDENTIAL COMMERCIAL INDUSTRIAL	FISH AND WILDLIFE	CULTURAL NATURAL HERITAGE	TOURISM AND RECREATION	FLOODING	WATER QUALITY	LAND DRAINAGE	WATER SUPPLY	EROSION AND LANDSLIDES	COMMENTS AND RECOMMENDATIONS
Chesterville Channelization	Chesterville Village upstream 17.4 km to Salters Bridge	(+)Flood reduction and land drainage benefits will allow for more intensive agriculture in flood area and upstream	(0)	(+)Potential water supply with storage for Chesterville and Winchester and industrial expansion	(-)Short term habitat destruction (+)Long term raising of water levels	(-)Possible archaeology sites destroyed and information lost.	(+)New boating opportunities provided	(+)Substantial reduction of Brinston flood and *fringe areas* (-)Increase in flows downstream with impacts at Crysler and South Plantagenet flood areas	(-)Short term increases in sediment load necessitates operation of sedimatation basin at Nestlés	(+)Improved outlet for upstream drainage *especially on the* South Branch	(+)With the Chesterville dam 3 meters high *there is substantial* storage for possible future water supply Chesterville and Winchester (-)Individual wells affected during construction	(+)Side slopes have been stabilized at 3:1	(+)Positive benefit/cost, presently under construction
South Castor Channelization	South Castor River floods area south of Vernon	(+)Flood reduction and land drainage benefit will allow for more intensive agriculture in flood area and upstream	(0)	(0)	(-)Short term habitat destruction, suspected fish spawning site (-)Long term impact on fish unless water control weir is built	(-)Possible archaeology sites destroyed and information lost. (-)Possible impact on Winchester Bog	(0)	(+)Substantial *reduction of South* Castor flood area and fringe areas (-)Possible increase of flow at *Kenmore, Russell* and Embrun.	(-)Short term *increases in* sediment load	(+)Improved *outlet for* upstream drainage	(-)Individual wells *may be affected during* construction	(+)Side slopes will be stabilized (-)Downstream impact possible, due to increased flow velocities	(+)Positive *benefit/cost* Final design should be implemented
Bearbrook Channelization	Bearbrook flood area Cumberland Township	(+)Flood reduction and land drainage benefit will allow for more intensive agriculture in flood area upstream	(0)	(0)	(-)Short term habitat destruction (-)Long term impact unless water control weir is built	(-)Possible archaeology sites destroyed and information lost.	(0)	(+)Substantial reduction of BearBrook flood area and fringe areas	(-)Short term increases in sediment load	(+)Improved outlet for upstream drainage	(-)Individual wells may be affects during construction	(+)Side slopes will be stabilized (-)Downstream impact possible due to increased velocities	(+)High benefit/cost justifies preliminary engineering
Plantagenet Channel and Dykes	Along 4 drains in Plantagenet flood area and main stem	(+)Flood reduction benefits will allow for more intensive agriculture in portions of flood areas	(0)	(0)	(-)Short term disruption along drains and main stem	(-)Possible archaeologic site destroyed and information lost	0)	(+)Flood reduction for low level flooding. Increases in summer flows caused by upstream channellization will be *ameliorated* with dykes.Channel will provide further protection	(-)Increased sediment load during construction	(0)	(0)	(-)Unstable slopes *on drains will be* affected unless special design consideration are implemented on leda clay soils	(+)Benefit/Cost justifies preliminary engineering and final design to be completed for dykes. High benefit/cost for channels justifies prelim. engineering to determine detailed costs and social impact assessment
Lemieux Reservoir	Rock outcrop upstream of Lemieux	(+)Flood reduction benefits will allow for more intensive agriculture in entire South Plantagenent flood area	(-)Minor inundation of forested land	(0)	(+)12 m. deep reservoir will enchance fishery	(-)Lemieux landslide viewing will be lost	()*Boating* oportunities ill be created ppular ishing rea will e improved	(+)*Substantial* flood reduction potential in South Plantagenet flood area. Area inundated will be river valley, not agricultural or forested	(+)*Sediment* loads decreased downstream	(+)*Since* flooding is decreased flood area upstream drainage potential is improved	(0)	(+)Unstable slopes may be stabilized if reservoir operated properly	Detailed geotechnical feasibility study is required to assess foundation conditions, effect *on unstable* slopes so that design costs and feasibility can be established.
Flood-proofing	For major flood areas and villages	(0)	(0)	(+)reduces impact of flood for structures already constructed in flood plain	(0)	(+)Preserves structures with cultural heritage in villages	(0)	(0)	(0)	(0)	(0)	(0)	Inexpensive method to protect existing structures in floodplain as compared to flood reduction alternative. Widespread application encouraged
Flood Plain Mapping/ Regulations	Major Flood areas, villages and secondary flood areas	(0)	(0)	(+) Controls future development in flood area	(0)	(0)	(0)	(+)Eliminates all possible impacts of flooding up to 100 years on future developments	(0)	(0)	(0)	(0)	Authority regulations or township bylaws are required for enforcement
Crysler Dykes	Village centre of Crysler	(0)	(0)	(+)reduces impact of flooding in village	(0)	(0)	(0)	(+)reduces flood area	(0)	(0)	(0)	(0)	final design necessary

WATER QUALITY

RECOMMENDATION	LOCATION	AGRICULTURE	FORESTRY	RESIDENTIAL COMMERCIAL INDUSTRIAL	FISH AND WILDLIFE	CULTURAL NATURAL HERITAGE	TOURISM AND RECREATION	FLOODING	WATER QUALITY	LAND DRAINAGE	WATER SUPPLY	EROSION AND LANDSLIDES	COMMENTS AND RECOMMENDATIONS
Proper Manure Management and Restricted Cattle Access To Streams	Basin wide	(+)Valuable nutrients are kept on the farm, costs of drain maintenance are reduced (-)Alternate livestock water facilities are required	(0)	(0)	(+)Long term improved fishing due to gradual improvement in water quality	(0)	(0)	(0)	(+)Nutrient, sediment plus bacteria loading will be decreased gradually over long term	(+)Ditchbanks will be stabilized where cattle were causing erosion	(0)	(+)Erosion caused by Cattle along streambanks will be reduced	Demonstration/ education programs should be developed and backed up by enforced regulations
Crop Rotation (Winter cover crops) and Conservation Tillage	In Areas where sheet erosion is or may be-come a problem	(+)Valuable topsoil and crop productivity will be maintained in long term	(0)	(0)	(0)	(0)	(0)	(0)	(+) Sediment loading will be reduced on a local scale in places	(+)Drain maintenance costs will be reduced in areas of high sheet erosion	(0)	(+)Sheet erosion is minimized	Demonstration/ education programs should be developed Implement measures on 40 sites identified in Erosion and Sedimentation study elsewhere as required in future
Critical Area Planting and Buffer Strips	Basin wide with emphasis on northern half	(+)Drain maintenance costs will be reduced	(0)	(0)	(+)Habitat improvements along streambanks	(0)	(0)	(0)	(+)Sediment loading will be reduced gradually over long term	(+)Drains will be stabilized	(0)	(+)Erosion and landslides will be reduced especially in northern half of basin	Priority site selection and development of works program are necessary
Controlled (once-a-year) Lagoon Discharge	Winchester and all other new or expanded facilities in other Basin Communities	(0)	(0)	(+)Development can occur with servicing in place	(+)Improvement of fishery through improved water quality especially in East Castor River	(0)	(0)	(0)	(+)Dissolved oxygen, nutrients and bacteria levels will be improved downstream of facility	(0)	(0)	(0)	High costs are involved with expansion of facilities. Winchester lagoons should be expanded to once a year discharge
Effluent Polishing in Wetlands and Spray Irrigation	Villages close to wetlands	(+)Spray irrigation can supply wastes deficiency and fertilizer value	(+)Spray irrigation and nutrients for improved tree growth if applied to forested land	(+)Alternative to larger lagoons which do not require usable agricultural land	(-)Wildlife may be adversely affected	(-)Effluent polishing will may have impact on wetland vegetation types	(-) Passive recreation (wildlife viewing value) may be affected in wetlands	(0)	(+)Reduced nutrient and bacteria load, improved dis-solved oxygen in receiving stream	(0)	(0)	(0)	Research and site specific testing is required prior to implementation (Melvin Bog)
Continued Gauging and Water Quality Monitoring	Basin wide	(+)Water quality will indicate success of best management practices such as manure management and cattle access to streams	(0)	(0)	(+)Harmful constituents such as mercury can be monitored and corrective action taken if necessary	(0)	(0)	(+)Flow data can be used to test model predict-ion in this study and used for future predictions	(+)Water quality data will be used for future planning for long term improvement in water quality	(0)	(0)	(0)	Authority, Env. Canada and M.O.E. programs should be extended and evaluated on a regular basis.

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DRAINAGE	Drainage Master Planning	Subbasins where tile drainage will be placed. Priorities -Augusta -South Plantagenet -BearBrook -South Castor -South Branch	(+)Drainage will occur considering all interest in subbasins Overall costs of drainage will be minimized	(0)	(0)	(+)Will ensure protection of sensitive fish and wildlife locations	(+)Will ensure water levels in sensitive wetlands will not be significantly altered	(0)	(+)W ensure tha wnstream impa of flo g is not subs tially incr ed	(+)Through proper design and construction sediment loading will be decreased	(+)Most cost effective drainage should result	(0)	(+)Erosion in drains will be minimized	Pilot study undertaken in Augusta to establish methodology. Should be done in combination with channel design for flood reduction. Set priorities for other areas.
	Proper Design Construction and Maintenance	Basin wide	(+)Long term cost will be minimized	(0)	(0)	(+)Sensitive areas will be protected	(+)Sensitive areas will be protected	(0)	(+)D stream incr es in flow an be mini ed	(+)Sediment loading will be decreased	(+)Most cost effective drainage should result	(0)	(+)Erosion in drains will be minimized	Design guidelines should be implemented
	Drainage Monitoring Program	Gauge locations already established in South Natic River Basin	(0)	(0)	(0)	(0)	(0)	(0)	(+)Re ts can used in fu e plann of flood ntrol measu	(+)Results can be used in future planning of water quality management	(+)Effects of tile plus outlet drains on highflows, lowflows and water quality can be further calibrated as data becomes available and used in future planning	(0)	(0)	Authority program should be continued, data should be incorporated into "Drainmod" model established
WATER SUPPLY	Individual Wells	St Isidore Maxville Russell Vars Limoges Metcalfe Spencerville	(0)	(0)	(+)Domestic and commercial supply for predicted expansion	(0)	(0)	(0)	(0)	(0)	(0)	(+)Lowest cost alternative	(0)	(0)
	Communal Ground Water Supply	Bourget Hammond St Paschal Embrun Finch Wincester Chesterville	(0)	(0)	(+)Domestic and commerical supply and industrial supply in Chesterville and Winchester for predicted expansion	(0)	(0)	(0)	(0)	(0)	(0)	(+)Potential exists for communal ground water expansion	(0)	Ground water evaluation is necessary to prove up supplies. If not found individual wells recommended except for Winchester and Chesterville
	Surface Water Supply	Plantagenet Casselman	(0)	(0)	(+)Domestic commercial and industrial supplies	(0)	(0)	(0)	(0)	(0)	(0)	(+)Adequate supplies available for predicted village expansion	(0)	Can be utilized elsewhere if ground water supplies prove to be inadequate

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DRAINAGE	Drainage Master Planning	Subbasins where tile drainage will be placed. Priorities -Augusta -South Plantagenet -BearBrook -South Castor -South Branch	(+)Drainage will occur considering all interest in subbasins Overall costs of drainage will be minimized	(0)	(0)	(+)Will ensure protection of sensitive fish and wildlife locations	(+)Will ensure water levels in sensitive wetlands will not be significantly altered	(0)	(+)W[illegible] ensure tha[illegible]wnstream impa[illegible] of floo[illegible]g is not subs[illegible]tially incr[illegible]ed	(+)Through proper design and construction sediment loading will be decreased	(+)Most cost effective drainage should result	(0)	(+)Erosion in drains will be minimized	Pilot study undertaken in Augusta to establish methodology. Should be done in combination with channel design for flood reduction. Set priorities for other areas.
	Proper Design Construction and Maintenance	Basin wide	(+)Long term cost will be minimized	(0)	(0)	(+)Sensitive areas will be protected	(+)Sensitive areas will be protected	(0)	(+)D[illegible]stream incr[illegible]es in flow[illegible]an be mini[illegible]ed	(+)Sediment loading will be decreased	(+)Most cost effective drainage should result	(0)	(+)Erosion in drains will be minimized	Design guidelines should be implemented
	Drainage Monitoring Program	Gauge locations already established in South Natic River Basin	(0)	(0)	(0)	(0)	(0)	(0)	(+)Re[illegible]ts can [illegible]used in fu[illegible]e plann[illegible] of flood[illegible]ntrol measu[illegible]	(+)Results can be used in future planning of water quality management	(+)Effects of tile plus outlet drains on highflows, lowflows and water quality can be further calibrated as data becomes available and used in future planning	(0)	(0)	Authority program should be continued, data should be incorporated into "Drainmod" model established
WATER SUPPLY	Individual Wells	St Isidore Maxville Russell Vars Limoges Metcalfe Spencerville	(0)	(0)	(+)Domestic and commercial supply for predicted expansion	(0)	(0)	(0)	(0)	(0)	(0)	(+)Lowest cost alternative	(0)	(0)
	Communal Ground Water Supply	Bourget Hammond St Paschal Embrun Finch Wincester Chesterville	(0)	(0)	(+)Domestic and commerical supply and industrial supply in Chesterville and Winchester for predicted expansion	(0)	(0)	(0)	(0)	(0)	(0)	(+)Potential exists for communal ground water expansion	(0)	Ground water evaluation is necessary to prove up supplies. If not found individual wells recommended except for Winchester and Chesterville
	Surface Water Supply	Plantagenet Casselman	(0)	(0)	(+)Domestic commercial and industrial supplies	(0)	(0)	(0)	(0)	(0)	(0)	(+)Adequate supplies available for predicted village expansion	(0)	Can be utilized elsewhere if ground water supplies prove to be inadequate

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EROSION AND LANDSLIDES	Landslide Prevention	Northern half of Watershed	(0)	(0)	(+)Setback lines will control future development in areas of unstable slopes	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(+)Impacts of landslides on future development will be minimized	Setbacks lines as calculated in geotechnical study should be incorporated into municipal bylaws or Conservation Authority Regulations (updated on 5 year basis)
	Landslide Protection	Northern half of Watershed	(0)	(0)	(+)Structures located in unstable slope area will be protected	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(+)Impacts of landslides on existing structures in unstable areas minimized	In townships that apply "setbacks", assistance should be offered to home owners to protect against landslides In the remedial works or removal of structures
NATURAL AND CULTURAL HERITAGE	Wetlands Conservation	8 major wetland sites in Basin	(0)	(0)	(0)	(+) Wildlife habitat value of wetlands is maintained	(+)Scientific and interpretive value of wetland is maintained	(+)Wildlife viewing opportunities are maintained	(+) ing flooding is increased bec e of wetland is ined. Some wet ds have pot ial to sto more spr water to uce flo (Gr eton Bog)	(+)Wetlands help regulate water quality in streams	(0)	(0)	(0)	Demonstration/education programs should be initiated to illustrate values of wetlands Acquisition considered for Alfred and Long Swamp Bogs
	Spawning Bed and Habitat Enhancement	Major known spawning beds (11)	(0)	(0)	(0)	(+)Fish resource will be improved	(0)	(+)Fishing potential improved	(0)	(0)	(0)	(0)	(0)	Authority and MNR should create instream cover near confluence points, provide small weirs especially in major drainage and channelization works
	Wildlife Habitat Maintenance and Improvement	Basin wide	(+)Hedge rows between fields create suitable habitat	(+)Forest management practices should consider wildlife habitat improvement features to create variety in habitat	(0)	(+)Wildlife improved through preservation of habitat	(0)	(+)Small game hunting opportunities increased	(0)	(0)	(0)	(0)	(0)	Education programs should incorporate fish and wildlife values, so that awareness of conflicts will be improved (i.e. snowmobiles and deeryards) and benefits of wildlife habitat enhancement programs will be known Management plans necessary on public lands
	Natural and Cultural Heritage Conservation	Basin wide	(0)	(0)	(0)	(0)	(+)Historical sites of significance and archaeologic information will be preserved	(+)Interpretive value of heritage will be improved	(0)	(0)	(0)	(0)	(+)Interpretive value of landslides	Archaeological surveys should be undertaken prior to major construction works along channels. Cultural sites should be incorporated into a signage and education program. Natural sites interpreted and Alfred and Long Swamp Bogs considered for acquisition.
	Conservation Corridors and Travel Routes	Basin wide	(+)Acquisition incorporated	(+)Forest interpretation incorporated	(+)Scenic communities	(+)Interpretation program and habitat areas included	(+)Interpretation incorporated	(+)Attract tourists as well as residents	(+)Fl d contr measu s	(+) **Best Management practices, etc. incorporated**	(+)Land Drainage practices incorp.	(0)	(+)Lemieux Landslide interpretation	Travel routes would include agriculture and forestry management, villages with major industries and scenic or heritage features, wildlife viewing, water access for boating and fishing, picnic facilities, major look-out areas, water quality improvement programs, land drainage practices, erosion and landslide problems, water management practices. Accompanying brochures and maps are necessary.

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AGRICULTURE	Implement agricultural code of practice and foodland guidelines	Basin wide	(t)Program will help maintain longterm agricultural resource base	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	Implemented through municipal planning process
	Develop local slaughtering and processing facility	Major agricultural support centre	(t)Improve local marketability	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	Feasibility study is required prior to implementation (watershed boundary is unimportant)
	Install appropriate handling facilities for field crops	Major agricultural support centre	(t)Increase production potential	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	Inventory of type & distribution of facility required (watershed boundary unimportant)
	Develop new alfalfa cultivars	Basin wide	(t)Provide capability for local production of low cost protein	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	Developmental research required
	Develop production, handling and storage for fruit and vegetables	Basin wide	(t)Increase production potential and displacement of imported goods	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	Market development planning required
RESIDENTIAL/COMMERCIAL INDUSTRIAL	Update official plans and prepare plans where they don't exist	Basin wide	(0)	(0)	(t)provides integrated planning of township resource base	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	Current update required
	Prepare updated mapping & policies for landuse	Basin wide	(0)	(0)	(t)Ensures that current information is available for official plans	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	Inventories (ie. FARINEO) are required for updates
	Encourage residential, commercial and industrial growth	Casselman, Chesterville, to lesser extent in Leitrim, Winchester, Plantagenet & Embrun	(0)	(0)	(t)Improve Res/Com/Ind viability of major centres & maintain support for agriculture	(0)	(0)	(0)	(0)	(0)	(0)	(-)Expanded facilities may be required	(0)	Longterm implementation and incentives necessary
	Encourage residential & commercial growth in several centres	Osgoode, Metcalfe, Maxville, St. Isidore, Finch.	(0)	(0)	(t)Continued stabilization and support of agricultural industry	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	Longterm implementation and incentives necessary
FORESTRY	Provide landowner with incentives for forest mgt.	Basin wide	(0)	(t)Improves marketable resources	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	Forestry education & demonstration program & extension service required
	Integrate accessible private woodlots to MNR Forestry Program	Basin wide	(0)	(t)Improves mgt. efficiency	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	Extensive application of WIA
	Encourage planting of softwoods and hybrid poplar on non-agricultural idle land	Softwoods, Basin wide. Poplar, within 50 km of Cornwall	(0)	(t)Improves marketable resources	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	Education, demonstration, applications of WIA or purchase required