INVENTORY OF LAND USE AND LAND USE PRACTICES IN THE CANADIAN GREAT LAKES BASIN

REPORT OF THE INTERNATIONAL REFERENCE GROUP ON GREAT LANES POLLUTION FROM LAND USE ACTIVITIES

Volume V: Canadian Lake Ontario Basin

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INVENTORY OF LAND USE AND LAND USE PRACTICES IN THE CANADIAN GREAT LAKES BASIN

with Emphasis on Certain Trends and Projections to 1980, and Where Appropriate, to 2020.

To be used as portion of the Canadian Task B Report on GREAT LAKES POLLUTION FROM LAND USE ACTIVITIES BY the International Joint Commission.

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This report was assembled by many people working on the Canadian portion of the Task B Study planned through the Pollution From Land Use Activities Reference Group (PLUARG) of the International Joint Commission.

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The material for these reports was assembled from existing census and other data available in 1972 - 1975.

Five volumes were prepared, one each for Lakes Superior, Huron, Erie and Ontario, and a summary volume for the Canadian portion of the Great Lakes Basin.

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PREFACE

As its title suggests, this volume presents an Inventory of Land Use and Land Use Practices in the Canadian Great Lakes Basin, with emphasis on certain trends and projections to 1980 (and to 2020 where appropriate). The report integrates several studies by contractors and sub-contractors. These studies were part of the Canadian Task B effort for the Great Lakes Pollution from Land Use Activities Reference Group, International Joint Commission.

The Task B report for the Canadian part of the Gr. eat Lakes Basin is contained in five volumes:

Volume I	Canadian Great Lakes Basin Summary
Volume II	Lake Superior Basin
Volume III	Lake Huron Basin
Volume IV	Lake Erie Basin
Volume V	Lake Ontario Basin

Knowledge of present and future land use and land use practices are important as background for evaluating and controlling non-point sources of water pollution. This report describes and quantifies, as appropriate, the Canadian Great Lakes Basin's geology, soils, minerals, climate, surface and ground water, vegetation, wildlife, and economic and demographic characteristics. It inventories available -information on waste disposal operations, lakeshore and riverbank erosion, high-density non-sewered residential areas and recreational land uses, as well as materials application of agricultural chemicals, fertilizers, animal wastes and salts on highways. Finally, future trends and projections are shown for the above categories.

This Canadian Great Lakes Basin Summary and each of the four Canadian lake basin volumes have been reviewed by Joint Task Group B, whose comments were considered before approval for final report development. This study forms a Canadian contribution to the Task B effort of the Study on Great Lakes Pollution from Land Use Activities.

The study discussed in this report was carried out as part of the efforts of the Pollution from Land Use Activities Reference Group, an organization of the International Joint Commission, established under the Canada-U.S. Great Lakes Water Quality Agreement of 1972. Findings and conclusions are those of the author(s) and do not necessarily reflect the views of the Reference Group or its recommendations to the Commission.

SUMMARY

PHYSICAL FABRIC

The Canadian portion of the Lake Ontario Basin occupies a land area of approximately 2,950,000 ha (7.3 million acres), comprised of two major sub-basins: Sub-Basin 10, Western Lake Ontario; and Sub-Basin 11, Trent-Moira Rivers. The northern portion of the basin is underlain by the Canadian Shield, and the remainder is underlain by sedimentary bedrock of the Paleozoic era. The climate varies with latitude and proximity to the lake, with the Niagara Fruit Belt having a climate mild enough for the production of tender fruits. The southern part of the basin lies in the Deciduous Forest Region and the northern part in the Great Lakes - St. Lawrence Forest Region. The Lake Ontario Basin is the most populous and economically active of the four other Canadian Great Lakes basins.

MAJOR LAND USES

Agriculture is the dominant land use in the Canadian Lake Ontario Basin, covering 49 percent of the land area. Forestry is second, with 43 percent, while urban uses constitute 5 percent of the land area.

SPECIALIZED LAND USES

There are thirteen mine tailings disposal sites in the Trent-Moira Sub-Basin, one of which is associated with an active mine.

There are 303 waste disposal sites in the Canadian portion of the Lake Ontario Basin, covering a land area of 2,885 ha (7130 acres) and receiving 17,000 t/d (37 million lb/d) of waste.

Lakeshore erosion problems occur along 111 km (69 miles) of the shoreline.

There are 60 intensive poultry operations, 132 intensive cattle operations, and 177 intensive swine operations in the Canadian portion of the Lake Ontario Basin.

About 6 percent of the population lives in high-density, non- sewered residential areas.

MATERIALS USAGE

Agricultural pesticides usage in the Canadian portion of the Lake Ontario Basin amounts to approximately 241.7 t/a (531,750 lb/a) of insecticides, 234.5 t/a (514,840 lb/a) of fungicides and 326.6 t/a (718,620 lb/a) of herbicides.

The estimated annual nutrient contributions from combined commercial fertilizer and agricultural manure usage are 36,450 t (80.2 million lb) nitrogen; 20,480 t (45 million lb) phosphorus (P_2O_5) and 33,400 t (73 million lb) of potassium (K_2O).

Road salt usage amounts to about 741,620 t/a (1.6 billion lb/a).

FUTURE TRENDS

The population in the Canadian portion of the Lake Ontario Basin may double over the next fifty years and economic output may increase by a factor of eight. Major land use projections for the Canadian portion of the basin indicate that agricultural land area will decline faster than urban land area will increase, resulting in small increases in forest and 'other' land uses. The future predicted pattern and extent of specialized land uses in the Canadian portion of the Lake Ontario Basin will be more a function of interacting social, technological, and legislative factors than of population and economics. Pesticide forecasts predict a decline in usage under an optimistic yield scenario and an increase in usage under a pessimistic scenario. Fertilizer forecasts predict a continued rapid increase until the year 2000, followed by a decline in usage. The use of road salt is predicted to increase from 741,620 t (1.6 billion lb) in 1972 to 1,207,789 t (2.7 billion lb) in 2020.

INTRODUCTION

INTRODUCTION

The Boundary Waters Treaty (1909) states, in part, that the boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health and property on the other side. In accordance with this treaty and the Water Quality Agreement of 1972, the governments of Canada and the United States requested that the International Joint Commission conduct a study on pollution of the boundary waters of the Great Lakes System by agriculture, forestry, and other land use practices.

Studies completed during 1969 demonstrated that diffuse land drainage sources were not only significant, but also were difficult to measure.

As a result of those findings, the International Joint Commission called upon the International Reference Group on Great Lakes Pollution from Land Use Activities to provide a better definition of the impact of land use activities, practices, and programs on water quality in the Great Lakes, and to propose appropriate practical remedial measures.

DETAILED STUDY PLAN

The February 1974 Detailed Study Plan emphasizes four main tasks:

TASK A - assessment of problems, management of programs and research, and the attempt to set priorities in relation to the best information now available on the effects of land use activities on water quality in boundary waters of the Great Lakes.

TASK B - inventory of land use and land use practices, with emphasis on certain trends and projections to 1980 and, if possible, to 2020.

TASK C - intensive studies of a small number of representative watersheds, selected and conducted to permit some extrapolation of data to the entire Great Lakes Basin and to relate contamination of water quality, which may be found at river mouths on the Great Lakes, to specific land uses and practices.

TASK D - diagnosis of the degree of impairment of water quality in the Great Lakes, including assessment of concentrations of contaminants of concern in sediment, fish, and other aquatic resources.

PURPOSE

The objectives of TASK B were:

1) to provide information on the physical fabric of the Great Lakes Basin, including soils and their capability, hydrology, geomorphology, climate, mineral and gas resources, and broad vegetation zones;

2) to provide a general land use inventory of the Great Lakes Basin; 3) to provide specific information concerning the nature and location of defined specialized land use categories in the Great Lakes Basin;

4) to provide an inventory of various materials applied to land which may influence the quality of drainage waters; and

5) to provide a consistent and comprehensive set of forecasts for 1980 and 2020 relating to land uses and land use activities based upon socioeconomic, technological, and political development.

1 PHYSICAL FABRIC

CANADIAN PORTION OF LAKE ONTARIO BASIN

The Lake Ontario Basin is the most populated and most urbanized of the Canadian Great Lake basins. It has a land area of 2,950,000 ha (7.3 million acres). For purposes of this report, the Lake Ontario Basin has been divided into two major sub-basins: 1) Sub-Basin 10 - Western Lake Ontario; and 2) Sub-Basin 11 - Trent-Moira Rivers. The boundaries of these sub-basins are illustrated in Figure 1.

LAND RESOURCES

GEOLOGY

The northern portion of the Lake 0ntario Basin is underlain by the geologic formation commonly referred to as the Canadian or Precambrian Shield (over 500 million years in age). At one stage in its development, the shield was extremely mountainous, but after millions of years of erosion by ice and water it has been reduced to a relatively flat surface. Through uplifting and faulting, the original igneous and sedimentary rock was altered to metamorphic rock.

The rest of the Lake Ontario Basin is underlain by the relatively flat lying sedimentary bedrock of the Paleozoic era. The Niagara Escarpment runs from Niagara Falls to Hamilton, and then north along the edge of the Western Lake Ontario Sub-Basin. The bedrock above the Escarpment is dolomite, whereas below the Escarpment it is shale. The eastern part of the basin has bedrock composed mainly of limestone.

TOPOGRAPHY AND SOILS

The distribution of soils in the Lake Ontario Basin is related to the bedrock and the glacial landform on which they are formed, as well as to climatic and vegetative regimes. In general, the soils can be described as being deep fertile clays, loams and sands on varying topography south of the Precambrian Shield. The Shield area is generally infertile, with shallow to deep sandy soils over relatively infertile bedrock.

The Niagara Peninsula has deep clay soils, whereas the rest of the Western Lake Ontario Sub-Basin has deep clay loam and sand. The Trent- Moira River Sub-Basin has deep sandy loam and organics, and deep clay to shallow loam in its southern portion. The northern area underlain by the Canadian Shield has shallow sandy soils.

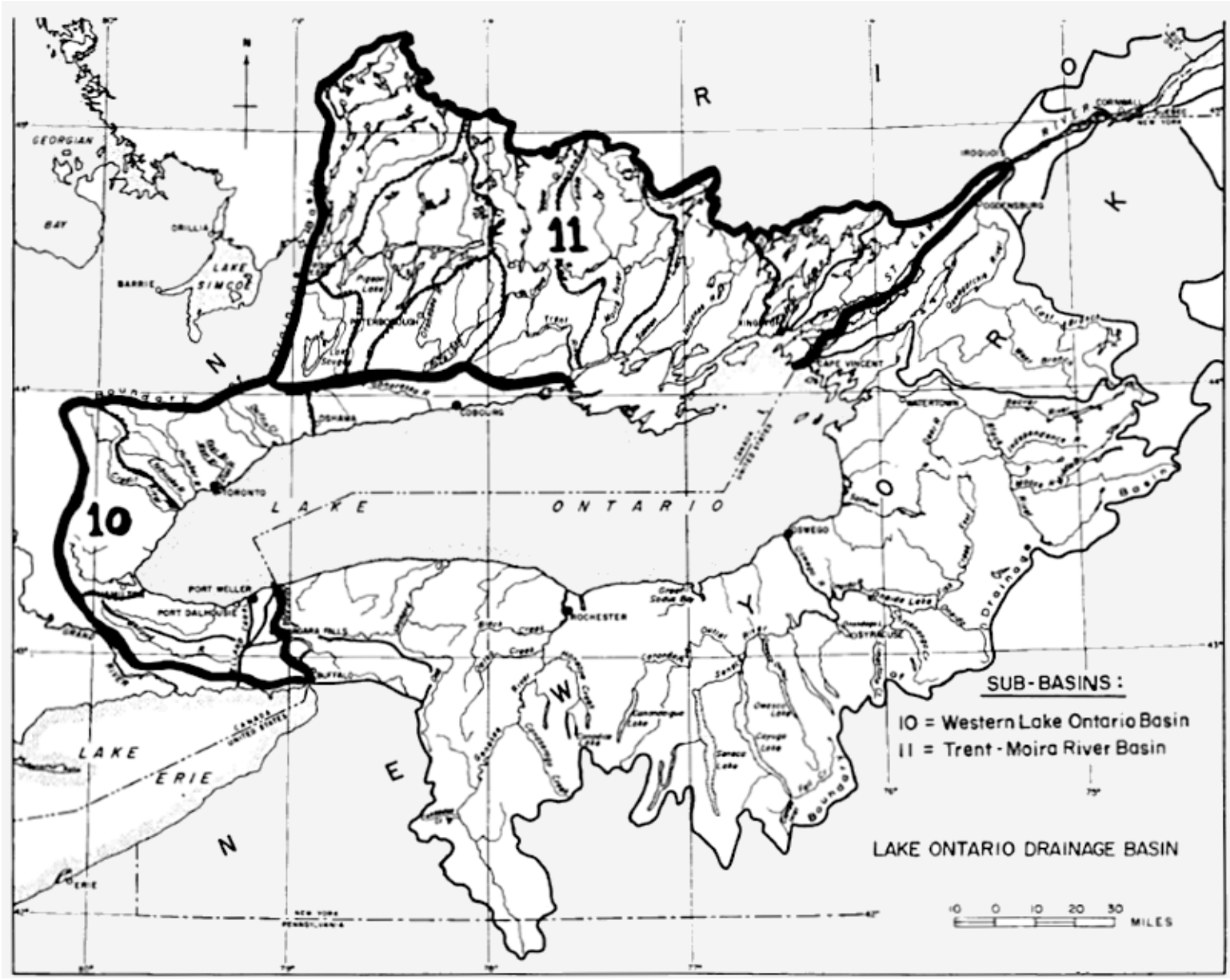

FIGURE I: Canadian Portion Of The Lake Ontario Drainage Basin

In the west, the topography is dominated by the Niagara Escarpment, which traverses the counties of Niagara, Wentworth, Halton, and Peel. The area north of Lake 0ntario from Toronto to Kingston is largely a drumlinized plain with many inclusions. The soil in the drumlins is well-drained, with imperfectly-drained soil lying between them. Around Peterborough, the drumlins are large and steep, but they tend to become flattened, elongated hills near Lindsay. Inclusions include imperfectly- drained lacustrine deposits around Lake Simcoe, Lindsay, Trent River and near the Lake Ontario shore. A large strip of hilly, sandy soils cut across the plain in York, Ontario, Northumberland, and Durham Counties.

North of the drumlinized plain lies a small area of till moraines, and eventually the Canadian Shield.

CLIMATE

Rapid and marked weather changes are common during all seasons, and are major features of the climate of the Lake Ontario Basin.

Mean annual precipitation ranges from 78 to 85 cm (31-33 in) in the Lake Ontario Basin, and mean annual snowfall varies from 112 cm (44 in) in the Niagara Fruit Belt to 200 cm (79 in) in the Haliburton Slopes. The growing season is longest in the Niagara Peninsula. The mean annual temperature for the Lake Ontario Basin is 7°C. The Niagara fruit belt has a unique combination of climate and soils which enables tender fruits, such as cherries and peaches, to be grown.

HYDROLOGY

SURFACE WATER

The watershed divisions of the Lake Ontario Basin are presented in Table 1. The Western Lake Ontario Sub-Basin is composed of numerous coastal creeks and rivers. In contrast, the Trent River system is the second largest watershed tributary to the Great Lakes. Best known for its canal system, linking the head of the Bay of Quinte with Georgian Bay, the Trent River itself represents only the most downstream portion of the watershed, draining Rice Lake to Lake Ontario. Above Rice Lake, in the northcentral and northwestern area of the watershed, the lakes of the Haliburton Highlands drain south to the Kawartha Lakes system via the Gull, Burnt, and Mississauga Rivers and Eels Creek. The Crowe River carries water from several northeastern lakes past the Kawarthas and directly into the Trent River at Crowe Bridge, below Rice Lake. Connecting the Kawartha Lakes and Rice Lake are the Otonabee and Indian Rivers. Discharge through the Trent system is regulated by a series of dams on the navigable lakes and waterways of the Trent Canal System, and by dams on many of the northern lakes which serve as reservoirs for the canal system.

The Moira River system, like the Trent, Salmon, Napanee and Wilton systems, flows into the Bay of Quinte.

TABLE 1: WATERSHED DIVISIONS IN THE CANADIAN PORTION OF THE LAKE ONTARIO BASIN

	CODE
Sub-Basin 10: Western Lake Ontario	
Niagara Peninsula-Ontario Drainage	2HA01 to 8
Credit and Bronte Rivers	2HB
Humber, Don, and Rouge Rivers	2HC
Bowmanville Creek and Ganaraska River	2HD
Sub-Basin 11: Trent-Moira	
Prince Edward County	2HE
Trent River	2HF, 2HG, 2HH, 2HJ, 2HK
Moira River	2HL
Salmon and Napanee Rivers	2HM
Gananoque and Cataraqui Rivers	2MA

VEGETATION ZONES AND WILDLIFE

The Western Lake Ontario Sub-Basin lies almost entirely within the Deciduous Forest Region, while the Trent-Moira River basin group is located in the Great Lakes-St. Lawrence Forest region.

In the Deciduous Forest Region, broad-leaved trees, such as sugar maple, beech, white elm, basswood, red ash, white oak and butternut, are common. A number of other trees have their northern limits in this locality and are scattered throughout the region. Among these are the tulip tree, cucumber tree, pawpaw, red mulberry, Kentucky coffee-tree, black gum, blue ash, sassafras, mockernut and pignut hickories, and the black and pin oaks. In addition, black walnut, sycamore and swamp white oak are largely confined to this region. There are only a few conifers, with a scattered distribution of eastern white pine, tamarack, eastern red cedar and eastern hemlock.

Most of this deciduous forest has been cleared for agriculture and subsequent urbanization. Only 14 percent of the Western Lake Ontario Sub-Basin remains forested. Nearly 70 percent is farmland. The Great Lakes- St. Lawrence forest of the Trent-Moira River Sub-Basin is characterized by a mixed forest consisting of eastern white and the red pines, eastern hemlock and yellow birch. Common to this region are species such as sugar maple, red maple, red oak, basswood and white elm. Other wide- ranging species are the eastern white cedar and large-tooth aspen, and to a lesser extent beech, white oak, butternut and white ash. Boreal species, such as the white and black spruces, balsam fir, jack pine, trembling aspen, balsam poplar and white birch, are intermixed. More

than half (55 percent) of the Trent-Moira Sub-Basin remains covered by this Great Lakes-St. Lawrence forest.

About 40 percent of the Trent-Moira Sub-Basin has been cleared for agriculture. However, the majority of this land is used as pasture, rather than as cropland.

POPULATION

The Lake Ontario Basin is the most densely populated of the Canadian Great Lakes basins. It contained 4,035,064 persons in 1971, or 61 percent of the total Canadian Great Lakes Basin population. The largest proportion of this population (91 percent) lives in the Western Lake Ontario Sub-Basin.

Figure 2 presents the growth of the Canadian Lake Ontario Basin population over the period 1901 - 1971. Growth has been especially rapid from 1951 to 1971.

RESOURCE USE AND DEVELOPMENT

Economic activity in the Canadian portion of the Lake Ontario Basin for 1972 is presented in Table 2. As in the other Great Lakes, the land-based industries (i.e., agriculture, forestry, fisheries and mining) contribute a relatively small proportion to the total economic output.

AGRICULTURE

The western part of the Canadian Lake Ontario Basin is involved principally in the dairy industry, with such crops as corn, winter wheat, spring grains, hay and pasture. Many orchards and vineyards are cultivated near the Niagara Escarpment in the Hamilton-Wentworth and Niagara Regions.

The Niagara Fruit Belt is bounded on the north by Lake Ontario, on the south by the Niagara Escarpment, and on the east and west by the Niagara River and Hamilton. It is the principal production area in Ontario for peaches, cherries, pears, plums and grapes. These crops all require heavy pesticide applications to insure unblemished fruit.

The area north of Lake Ontario from Toronto to Kingston has a mixed agriculture, with dairy herds, orchards and canning crops being raised on the well-drained soils bordering Lake Ontario. Crop production is limited farther north by steep slopes, susceptibility to erosion, drought and low fertility. A large proportion of the area is reforested (with trees harvested for the Christmas season), or else is in low quality pasture.

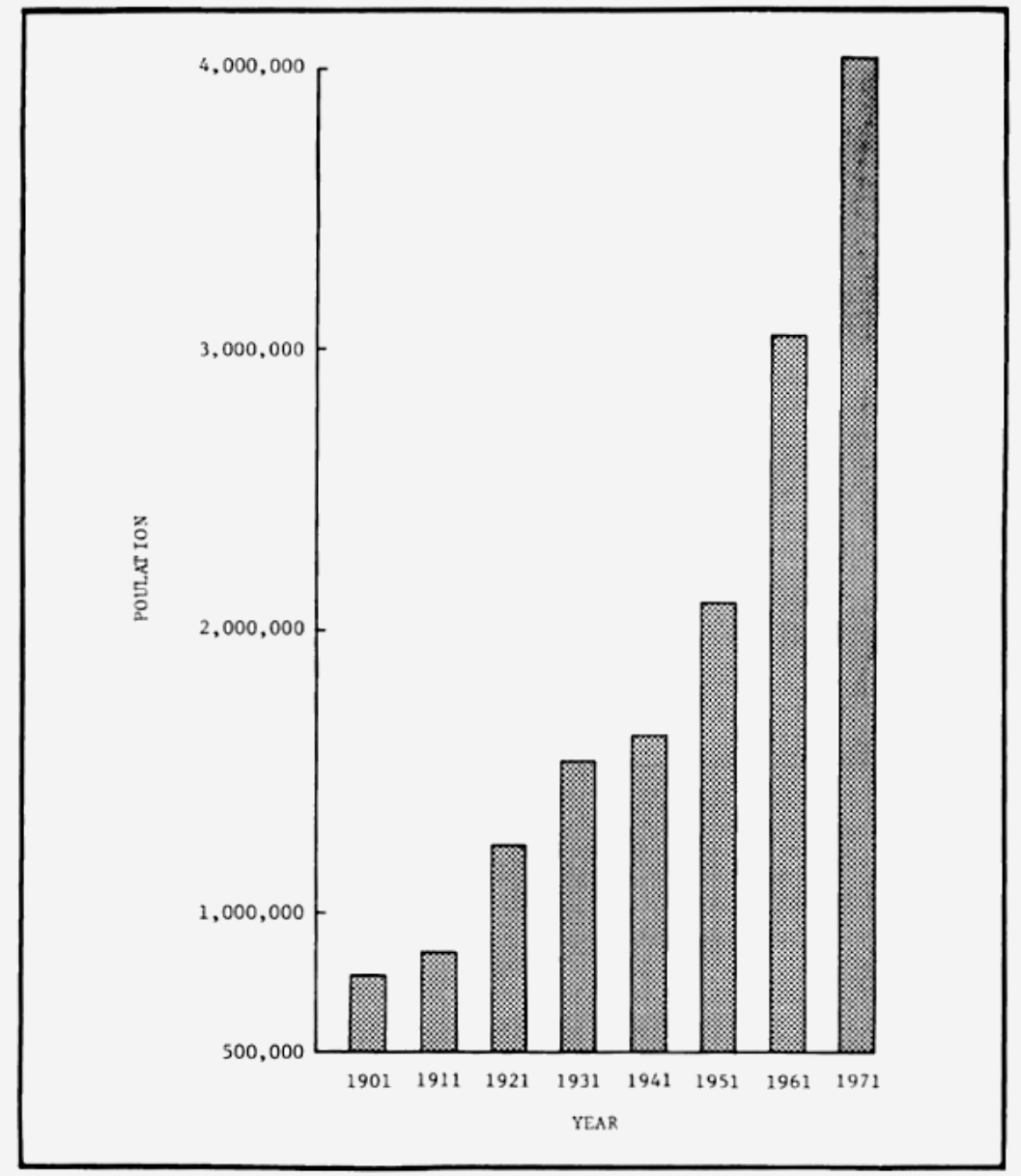

FIGURE 2: Population In The Canadian Portion Of The Lake Ontario Basin 1901-1971

TABLE 2: ECONOMIC ACTIVITY IN THE CANADIAN PORTION OF THE LAKE ONTARIO BASIN, 1972

Real Domestic Product by Major Industrial Group
(millions of 1961 dollars)

	Western Lake Ontario Sub-Basin	Trent-Moira Sub-Basin	Total Canadian Lake Ontario Basin
Agriculture	84.31	44.07	128.38
Forestry	2.48	2.63	5.11
Fisheries	0.74	0.22	0.96
Mining	76.65	12.51	89.16
Manufacturing	4911.56	323.60	5235.16
Construction	660.98	66.42	727.40
Transportation, Utilities, Trade & Other	6534.67	594.46	7129.13
Total Output, All Sectors	12271.39	1043.91	13315.30

FORESTRY

The Western Lake Ontario Sub-Basin has a high capability for forestry, while in the majority of the Trent-Moira Sub-Basin, forestry capability is only moderate. To a large extent, the sites with high timber capability actually have a low level of forest cover. This is because they also have a high agricultural use capability, with the result that in most cases the land is farmed. Productive forest in the Western Lake Ontario Sub-Basin is largely confined to farm woodlots, river valleys, swamps and areas of shallow or infertile soil. The largest major forest concentration is in the Precambrian Shield portion of the Trent-Moira Sub-Basin.

MINING

The Lake Ontario Basin lacks the valuable metallic ore deposits which characterize the upper Great Lakes Basins, but it does have a significant extraction potential of its own, particularly in sand, gravel and other raw materials for the construction industry.

Cement production is concentrated along the north shore of Lake Ontario in Bowmanville, Colbourne, Picton and Bath. In 1974, production rose to 3.6 million t (8 billion lb), and was valued at 82 million dollars. High purity nepheline syenite, used in glass and ceramics, is mined in Peterborough County and was valued at 7.4 million dollars in 1973. Uranium deposits existing around Bancroft may be developed in the future. However, mineral extraction for the construction industry is the most important mining activity in the Canadian portion of the Lake Ontario Basin. Presently, about 6,400 ha (15,800 acres) of land are being used for extractive purposes, including 4,740 ha (11,700 acres) in the Western Ontario Sub-Basin and 1660 ha (4100 acres) in the Trent-Moira Sub-Basin.

RECREATION

An evaluation of recreation in the Canadian portion of the Lake Ontario Basin was done on the basis of land capability. Capability for intensive recreation was derived from the Canada Land Inventory. Capability for extensive or dispersed recreation was determined by relating water patterns and topography.

The Niagara Falls area has an outstanding concentration of high capability sites for intensive recreation.

The Hamilton-Dundas area has a very high capability for extensive recreation, as do the Haliburton Highlands and the Bay of Quinte area. The Canadian portion of the Lake Ontario shoreline is rated from high to moderate for extensive recreational use.

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2 MAJOR LAND USES

INTRODUCTION

The land use classification scheme used in this report is described below, followed by presentation of the results. A discussion of methodology is presented in Appendix A of Volume I in this report series.

LAND USE CLASSIFICATION SYSTEM

INTRODUCTION

The factors taken into consideration during the development of the classification system are as follows: 1) nature of the data required; 2) data collection methodologies available; 3) cost of data acquisition; 4) comparability of the data from both countries; and 5) timeliness of information.

The fact that the land use data were to be used in studies related to water quality dictated that classes should be different with respect to water runoff, types of pollution, degree of pollution, etc. The land use categories used in the inventory of land use in the Canadian Lake Ontario Basin are defined in Table 3.

TABLE 3: LAND USE CLASSIFICATION DEFINITIONS

URBAN - Land used for residential, commercial, industrial or institutional purposes.

Residential - Land used for residential purposes. Single and multiple dwelling units in the built-up portions of cities and towns were included in this category. Areas of urban sprawl, such as country estates and strip residential developments, were also included.

Low density residential - Land used for residential purposes which had 10 percent or less man-made surface ground cover. This category included, for example, strip residential and country estates.

Medium density residential - Land used for residential purposes which had 10 to 25 percent man-made surface ground cover. This category included, for example, urban fringe subdivision-type developments.

High density residential - Land used for residential purposes which had greater than

25 percent man-made surface ground cover. Included in this category were downtown housing and apartment buildings. Note: although some apartment buildings may have had less than 25 percent man-made surface ground cover, they were included in the high density category due to the high population density within the building.

Commercial - Industrial - Land used for commercial, industrial or institutional purposes. The entire area occupied by the establishment was included, such as surrounding grounds, storage sheds, parking lots, etc.

Low density commercial - industrial - Land used for commercial, industrial or institutional purposes which had 10 percent or less man-made surface ground cover.

Medium density commercial - industrial - Land used for commercial, industrial or institutional purposes which had 10 to 25 percent man-made surface ground cover.

High density commercial - industrial - Land used for commercial, industrial or institutional purposes which had greater than 25 percent man-made surface ground cover.

Transportation - Land used for transportation facilities such as rail yards, highway interchanges, airports and airstrips.

EXTRACTIVE - Land used for the extraction of earth materials, including open pit mines, strip coal mines, commercial mineral excavations, commercial topsoil removal operations, etc. Idle land held in reserve was included.

SLAG HEAPS - Land used for commercial dumping of mine tailings, chemicals, and slag. This category was of particular significance in the Sudbury area.

OUTDOOR RECREATION - Land used for private or public outdoor recreation. This category included such things as developed national, provincial, municipal, city and private parks, wildlife sanctuaries, historical sites, race tracks, golf courses, drive-in theatres, marinas and cemeteries.

AGRICULTURE -

Orchards, Vineyards, Horticulture, Fur and Poultry Operations - Land used for the production of tree fruits and grapes, vegetables and small fruits, and large scale fur farms and poultry operations.

Cropland - Land used for the production of annual crops such as grain, tobacco, or sugar beets.

Improved Pasture - Land used for pasture or for the production of hay and other fodder crops. To qualify as improved, a pasture had to exhibit some evidence of cultivation.

Unimproved Pasture - Included grasslands, such as natural range, and areas of sedges and herbaceous plants. Brush scrub and mature trees up to a maximum cover of 25 percent of the total land area was included in this category.

Forest - Land bearing forest, short trees or bushes in which the tree cover exceeded 25 percent of the total area, was included in this category.

March & Swamp - Open wetlands of all types were included in this category.

Barren - Land which did not support vegetation. Examples include sand flats, barren rock, alkali flats, etc.

RESULTS

SUB-BASIN 10: WESTERN LAKE ONTARIO

There are four major watersheds in the Western Lake Ontario Sub-Basin: 1) Niagara Peninsula (Ontario Drainage); 2) Credit and Bronte Rivers; 3) Humber, Don and Rouge Rivers; and 4) the Bowmanville and Ganaraska Rivers. The major land uses of these watersheds and the Western Lake Ontario Sub-Basin are presented in Table 4.

The majority of the land area in the Western Lake Ontario Sub-Basin is used for agriculture. Of the 605,507 ha (1.5 million acres) of farmland, 30,161 ha (74,530 acres) are orchards and horticulture, 225,942 ha (550,300 acres) are cropland, and 349,504 ha (863,600 acres) are pasture. The orchards are concentrated in the Niagara Peninsula watershed.

The second largest land use in the Western Lake Ontario Sub-Basin, in terms of area, is urban. It incorporates 135,055 ha (333,720 acres), 15 percent of the total land area in this sub-basin. About half of this urban land is located in the Humber, Don and Rouge Rivers watershed, which includes Metropolitan Toronto. A large proportion (89 percent) of the urban land in this sub-basin is located in large cities with populations greater than 25,000.

Forest covers 14 percent of the Western Lake Ontario Sub-Basin. The largest amount of outdoor recreation land is found in the most highly urbanized watershed, the Humber, Don and Rouge Rivers.

SUB-BASIN 11: TRENT-MOIRA RIVERS

Five major watersheds comprise the Trent-Moira Sub-Basin: 1) Prince Edward County; 2) Trent River; 3) Moira River; 4) Salmon and Napanee Rivers; and 5) the Ganonoque and Cataraqui Rivers. The major land uses in these watersheds are presented in Table 5.

TABLE 4: MAJOR LAND USES IN THE WESTERN LAKE ONTARIO SUB-BASIN (SUB-BASIN 10)

(ha)

BASIN CODE	Niagara Peninsula Ontario Drainage	Credit & Bronte R.	Humber, Don & Rouge R	Bowmanville & Ganaraska R	Total Sub-Basin
Urban Areas > 25,000 Pop.					
Commercial-Industrial					
Low Density	0	0	0	0	0
Medium Density	690	655	1,857	78	3,280
High Density	4,439	6,002	21,276	1,100	32,817
Total Comm.-Indust.	5,129	6,657	23,133	1,178	36,097
Residential					
Low Density	2,451	675	2,929	371	6,426
Medium Density	8,363	9,390	15,154	1,350	34,257
High Density	4,599	3,913	23,796	1,567	33,875
Total Residential	15,413	13,978	41,879	3,288	74,558
Transportation	2,922	1,248	4,930	188	9,288
Total Urban > 25,000	23,464	21,883	69,942	4,654	119,943
Urban Areas < 25,000 Pop.	2,262	4,359	4,443	4,048	15,112
Total Urban Areas	25,726	26,242	74,385	8,702	135,055
Extractive					
Extractive	1,079	1,551	1,548	238	4,416
Slag Heaps	297	28	0	0	325
Total Extractive	1,376	1,579	1,548	238	4,741
Outdoor Recreation	2,560	2,326	7,368	1,337	13,591
Agriculture					
Orchards, Hort., etc.	22,768	2,730	2,225	2,438	30,161
Cropland	73,644	47,652	68,286	36,360	225,942
Improved Pasture	65,238	69,789	67,229	53,844	256,100
Unimproved Pasture	24,988	18,424	27,624	22,368	93,404
Total Agriculture	186,638	138,595	165,364	115,010	605,607
Forest	24,011	45,951	21,987	34,699	126,648
Marsh and Swamp	1,388	176	555	713	2,832
Barren	0	0	0	0	0
Total Watershed Land Area	241,699	214,869	271,207	160,699	888,474

Taken from Land Management Information Systems/Lands Directorate Environment Canada/Data Source C.L.I. and C.C.R.S. Maps.

TABLE 5: MAJOR LAND USES IN THE TRENT-MOIRA SUB-BASIN (SUB-BASIN 11)

(ha)

Basin Code	Prince Edward County	Trent River	Moira River	Salmon & Napanee R.	Gananoque & Cataraqui R.	Total Sub-Basin
Urban Areas > 25,000 Pop.						
Commercial-Industrial						
Low Density	0	0	0	174	0	174
Medium Density	0	311	54	176	0	541
High Density	0	1,059	457	1,687	486	3,689
Total Comm.-Indust.	0	1,370	511	2,037	486	4,404
Residential						
Low Density	0	609	310	576	50	1,545
Medium Density	0	1,288	589	1,882	226	3,985
High Density	0	258	83	22	178	541
Total Residential	0	2,155	982	2,480	454	6,071
Transportation	0	63	0	160	0	223
Total Urban > 25,000	0	3,588	1,493	4,677	940	10,698
Urban Areas < 25,000 Pop.	1,093	7,551	1,378	2,219	2,194	14,435
Total Urban Areas	1,093	11,139	2,871	6,896	3,134	25,133
Extractive						
Extractive	48	715	359	474	70	1,666
Slag Heaps	0	0	0	0	0	0
Total Extractive	48	715	359	474	70	1,666
Outdoor Recreation	113	15,410	360	530	978	17,391
Agriculture						
Orchards, Hort.,etc.	701	658	0	0	0	1,359
Cropland	28,048	80,553	9,207	11,926	533	130,267
Improved Pasture	40,417	239,913	47,353	103,966	69,574	501,223
Unimproved Pasture	7,499	114,326	22,427	38,227	23,362	205,841
Total Agriculture	76,665	435,450	78,987	154,119	93,469	838,690
Forest	24,844	702,893	187,274	131,605	81,361	1,127,977
Marsh and Swamp	4,406	21,763	7,797	6,462	5,419	45,847
Barren	513	324	990	1,713	1,630	5,170
Total Watershed Land Area	107,682	1,187,694	278,638	301,799	186,061	2,061,874

Taken from Land Management Information Systems/Lands Directorate Environment Canada/Data Source C.L.I. and C.C.R.S. Maps.

The dominant land use in the Trent-Moira Sub-Basin is forest, which occupies 1,127,977 ha (2.8 million acres), or about 55 percent of the total land area.

Agriculture is the second predominant land use type, with 838,690 ha (2.1 million acres), 84 percent of which is pasture. Most of the cropland is located in Prince Edward County and the Trent River watershed.

Urban centres with populations greater than 25,000 are present in every watershed except Prince Edward County. These larger centres represent 10,694 ha (26,400 acres), 43 percent of the 25,125 ha (62,080 acres) of urban land in the Trent-Moira Sub-Basin.

The Trent River watershed contains 89 percent of the outdoor recreational land in the Trent-Moira Sub-Basin (15,410 ha or 38,080 acres).

Marsh and swamp occupy more land than urban or recreation, 45,847 ha (113,290 acres).

SOURCE MATERIALS

Thie, J., R.A. Ryerson, and T.T. Alfoldi. Mapping Land Use in the Great Lakes Basin: an Evaluation of Conventional and Remote Sensing Techniques, Report to Technical Committee B, International Reference Group on Great Lakes Pollution from Land Use Activities. International Joint Commission, Toronto, August, 1973.

Gierman, D. and R.A. Ryerson. Land Use Information for the Great Lakes Basin, Report to Technical Committee B, International Reference Group on Great Lakes Pollution from Land Use Activities. International Joint Commission, Ottawa, 1974.

3 SPECIALIZED LAND USES

INTRODUCTION

Six specialized land use categories are inventoried in this report. They are as follows: 1) mine tailings disposal sites; 2) waste disposal sites; 3) shoreline erosion; 4) riverbank erosion; 5) intensive livestock operations; and 6) high density, non-sewered residential areas. These specialized land uses are discussed individually below.

DISPOSAL OPERATIONS

MINE TAILINGS DISPOSAL SITES

There are thirteen mines in the Canadian portion of the Lake Ontario Basin which extract minerals requiring tailings disposal areas (Table 6). All these mines are located in the Trent-Moira Sub-Basin. Only one of the thirteen is presently active, with iron being the mineral mined there (methodology is presented in Appendix A of Volume I in this report series).

TABLE 6: MINE TAILINGS DISPOSAL SITES IN THE CANADIAN PORTION OF THE LAKE ONTARIO BASIN

Sub-basin	Watershed	Description	Minerals
11	2HH	Canadian Dyno Mines Ltd.	Uranium
11	2HK	Belmont Mine	Iron
11	2HK	Blairton Mine	Iron
11	2HK	Cordova Mine	Gold
11	2HK	Coehill Mine	Iron
11	2HK	Atlas Mine (Deloro, Smelting & Refining)	Gold, Arsenic
11	2HK	Deloro Mine (Deloro, Smelting and Refining)	Gold, Arsenic
11	2HK	*Marmoraton Mining Co. Ltd.	Iron
11	2HL	Hollandia Mine	Lead
11	2HM	Long Lake Mine	Zinc
11	2MA	Chaffey Mine (New Myla-Maque Mining)	Iron
11	2MA	Matthews Mine (New Myla-Maque Mining)	Iron
11	2MA	Quartz Crystal Mines Ltd.	

* Still Active

WASTE DISPOSAL SITES [1]

INTRODUCTION

The waste disposal sites in the Western Lake Ontario and Trent- Moira Sub-Basins are listed in Tables 7 and 8 respectively. The table includes liquids, solids, hazardous materials and deep well disposal sites which were licenced by the Waste Management Branch of the Ontario Ministry of the Environment as of January 31, 1974. The methodology used in the data collection is described in Appendix A of Volume I in this report series. The column headings in Tables 7 and 8 are defined as follows:

No. -	An arbitrary code assigned for mapping purposes.
MOE No. -	Permit number in Ontario Ministry of the Environment (Waste Management Branch) records.
Municipality -	Municipality in which the disposal area is situated.
Opened -	Date on which the site was opened. If no figure is entered, the site was opened prior to 1971.
Closed -	Date of closure.
Area -	Site area (hectares).
Population Served -	Operator's estimate of the population served.
Waste Type -	S - Solid, L - Liquid, H - Hazard.
Volume -	Listed in tons/day, unless otherwise noted.
Proj. Life -	Life, as estimated in 1971 when the licence was first issued, or on the opening date.
Watershed -	This identifies the sub-drainage basin in which the site is located, in accordance with the Canada Water Survey classification.

SUB-BASIN 10: WESTERN LAKE ONTARIO

Solid waste is the most common form of waste and is handled at 89 sites. Liquid wastes are disposed of at 18 sites, and hazardous wastes at six sites. Five of the six hazardous waste disposal sites are located in Peel and Halton counties.

The large volume of waste, 16,600 t (36.5 million lb), disposed of daily in the Western Lake Ontario Sub-Basin is a direct consequence of the high population density in that area.

TABLE 7: WASTE DISPOSAL SITES IN THE WESTERN LAKE ONTARIO SUB-BASIN (SUB-BASIN 10)

NO.	MOE No.	Municipality	Opened	Closed	Area (ha)	Population Served	Waste Type	Volume	1971 Project Life	Watershed
		Northumberland & Durham County								
724	SS311607	Darlington Twp.		30/9/72	16.8	8,700	L			2HD
725	L311702	Haldimand Twp.			4.0	11,562	S, L	70	10	2HD
726	L311703	Haldimand Twp.			6.0	200	S	½ /wk.	10	2HD
728	L311705	Haldimand Twp.			2.0	200	S	1/wk.	25	2HD
729	1311706	Haldimand Twp.								2HD
730	L311801	Hamilton Twp.		Fall/73		3,500	S, L		5	2HD
751	L310101	Seymour Twp.			4.0	8,700	S		10	2HD
733	L3311901	Hope Twp.			0.04	2,778	S		10	2HD
734	L311902	Hope Twp.		23/5/73		9,000	L	1		2HD
735	L311903	Hope Twp.			2.0	9,000	S		5	2HD
736	L311904	Hope Twp.		15/5/72		9,000	L	1		2HD
737	L311905	Hope Twp.								2HD
718	L311502	Cramahe Twp.	11/2/72		20.0		S	4	20	2HD
721	L311601	Darlington Twp.		28/2/73	1.0	9,500	S	20	*2*	2HD
722	L311605	Darlington Twp.				8,800	S	10.5	10	2HD
723	L311606	Darlington Twp.			2.8	13,000	S	9.25		2HD
713	L311401	Clarke Twp.			4.4	1,550	S	1	30	2HD
714	L311402	Clarke Twp.		15/9/71	4.0	2,500	S			2HD
715	L311403	Clarke Twp.			1.2	1,688	S	1-4	9-10	2HD
716	L311404	Clarke Twp.								2HD
700	L310302	Town of Cobourg					L	10 gal/wk		2HD
701	OTH310402	Port Hope		15/1/72	2.8	9,000	L	1		2HD
702	L310403	Port Hope			4.0	9,000	S	20	10	2HD
703	1310501	Brighton			2.8	2,900	S	3	5	2HD
		Dufferin County								
169	L180101	Orangeville		Fall/73	5.6	7,703	S	16		2HB
170	L180102	Orangeville	30/9/73		1.2	-	S	¼	3	2HB
173	L180502	E. Garafraxa Twp.	13/4/72		24.0	8,030	S	16		2HB

TABLE 7 (cont'd): WASTE DISPOSAL SITES IN THE WESTERN LAKE ONTARIO SUB-BASIN (SUB-BASIN 10)

NO.	MOE No.	Municipality	Opened	Closed	Area (ha)	Population Served	Waste Type	Volume	1971 Project Life	Watershed
		Wentworth County								
68	L130102	Hamilton	24/5/72		14.8	297,000	S	170	3	2HA
69	L130103	Hamilton	24/5/72		66.8	297,000	S	438	2-3	2HA
70	L130104	Hamilton	24/5/72		9.2	297,000	S	959	1	2HB
71	L130201	Dundas			10.0	16,835	S	28	2	2HB
74	L130701	Binbrook Twp.			0.4	3,648	S	5	1-2	2HA
75	L130802	E. Flamboro Twp.			12.0	-	S	8	10	2HB
76	L130901	W. Flamboro Twp.			2.0	8,549	S	10	5	2HB
77	L131001	Glanford Twp.	29/3/72		0.8	6,137	S	2-3	-	2HB
78	L131101	Saltfleet Twp.			3.2	19,000	S	45	2-3	2HA
		Haldimand County								
11	110601	Canborough Twp.			7.2	1,230	S	1-2	20-40	2HA
20	111301	Seneca Twp.			2.0	-	S	10	20	2HA
21	111302	Seneca Twp.			0.8	2,400	S	2	25	2HA
		Toronto								
677	L280302	Etobicoke			45.2	550,000	S	805	3	2HC
678	L280401	Scarboro			77.6	550,000	S		5	2HC
679	L280601	East York								2HC
		Niagara Region								
33	L120101	St. Catharines			17.6	110,000	S	300	5	2HA
34	L120102	St. Catharines			2.8	105,000		100	1	2HA
35	L120103	St. Catharines	12/7/72		4.0			100	2	2HA
36	L120201	Niagara Falls			26.2	64,000	S, L	300	6-7	2HA
37	L120202	Niagara Falls	12/7/72		6.4	-	S	93	2-5	2HA
38	L120203	Niagara Falls	6/10/72		3.0	-	S	1	100	2HA
39	L120204	Niagara Falls			-	-	-	-	-	2HA
40	L120301	Port Colborne			41.2	-	S	100-300	12	2HA
41	L120401	Welland			37.8	45,000	S	85	20	2HA
42	L120501	Fort Erie			16.0	9,600	S, H	30	25	2HA
43	L120502	Fort Erie			20.0	14,000	S	40	5	2HA
44	L120601	Grimsby			11.4	14,000	S	25	10	2HA
45	L120701	Lincoln			6.0	14,000	S	-	15	2HA
46.	L120702	Lincoln			3.2	14,000	S	-	3	2HA

TABLE 7 (cont'd): WASTE DISPOSAL SITES TN THE WESTERN LAKE ONTARIO SUB-BASIN (SUB-BASIN 10)

NO.	MOE No.	Municipality	Opened	Closed	Area (ha)	Population Served	Waste Type	Volume	1971 Project Life	Watershed
47	L120801	Niagara-on-the-Lake	12/4/72		8.0	-	S	5,000	5-10	2HA
48	L120802	Niagara-on-the-Lake			4.2	13,000	S	3	10	2HA
49	L120803	Niagara-on-the-Lake			4.0		S	114.3	10	2HA
50	L120804	Niagara-on-the-Lake	11/9/72		16.0		S	300	2	2HA
51	L120901	Pelham			2.0	6,000	S	10	-	2HA
52	L121001	Thorold			12.8		S	600	10	2HA
53	L121002	Thorold	28/11/72		4.7	15,800	S	45	7½	2HA
54	L121101	Wainfleet Twp.			7.2	3,600	S	3	25	2HA
55	L121102	Wainfleet Twp.			2.4	1,800	S	1	15	2HA
56	L121201	West Lincoln Twp.	25/7/72		4.0	2,000	S	3	5	2HA
57	L121202	West Lincoln Twp.	25/7/72		2.0	3,000	S	3	3-4	2HA
58	L120704	Lincoln		15/12/72	0.4		L	300		2HA
		Ontario County								
512	L240402	Whitby			10.0	23,000	S	70	5	2HC
517	L241101	Pickering Twp.			2.2		S	4		2HC
518	L241102	Pickering Twp.	28/8/73		92.0	1,000,000	S	2,000		2HC
519	L241103	Pickering Twp.			8.0	18,000	L	1		2HC
520	L241104	Pickering Twp.								2HC
521	L241105	Pickering Twp.								2HC
535	L241801	Twp. of Whitby East			40.0	88,000	S	180	7	2HD
536	L241802	Twp. of Whitby East	5/1/73		28.0		L	50	5-10	2HD
		York Region								
482	L230302	Markham			27.6	2,000,000	S	500	2	2HC
483	L230601	Vaughan			24.4	18,000	S, L	150	20	2HC
484	L230602	Vaughan			40.8		S, L		10-15	2HC
485	L230603	Vaughan	1/6/73		38.4	Toronto	S	1,200	2	2HC
491	L231001	King Twp.			2.0	4,500	S	-	5	2HC
		Wellington County								
204	L175501	Morriston	4/3/73		0.4	200	S	-	20-30	2HB
205	L171002	Erin		30/11/71	20.0	1,365	S	5		2HB
195	L171301	Erin Twp.	25/5/72		2.8	4,000	S	2	5	2HB
193	L171001	Erin			1.2	1,365	S	12-15	5-10	2HB
		Halton County								
420	L210501	Oakville			24.0	55,000	S	115		2HB
421	L210502	Oakville			8.0		S,H	.01	20	2HB

TABLE 7 (cont'd): WASTE DISPOSAL SITES IN THE WESTERN LAKE ONTARIO SUB-BASIN (SUB-BASIN 10)

NO.	MOE No.	Municipality	Opened	Closed	Area (ha)	Population Served	Waste Type	Volume	1971 Project Life	Watershed
422	210503	Oakville			36.0		L			2HB
423	L210504	Oakville			180.0		S	4-5	20	2HB
424	L210505	Oakville			16.0		S	25-50/yr	50	2HB
425	L210506	Oakville			0.4		S	0-30/yr	50	2HB
426	L210507	Oakville			242.0		S	1/10	20	2HB
427	L210508	Oakville					S	20	5	2HB
428	L210601	Twp. of Esquesing			1.6	900	S	1½	15	2HB
429	L210602	Twp. of Esquesing			37.6		L	14-15	60	2HB
431	L210509	Oakville	15/1/74		5.1		S	1000 yd^3	1	2HB
415	L210101	Acton			2.0	4,800	S	20	5	2HB
416	L210201	Burlington			19.6	84,000	S, L	130	5	2HB
417	L210205	Burlington	11/10/73		14.0	84,000	S, H	130	1	2HB
418	L210301	Georgetown	20/12/73		6.0	17,000	S	60	10	2HB
419	L210401	Milton			2.0	7,500	S	20	2	2HB
		Peel								
451	L220201	Mississauga			32.0		S	2500/yr	20	2HB
452	L220202	Mississauga					H	5/yr		2HB
453	L220204	Mississauga	24/4/72		38.0		S	3000	10	2HC
454	L220205	Mississauga	6/7/72		7.2		S		2	2HB
455	L220302	Port Credit			12.8		H			2HC
456	L220303	Port Credit			19.6		L, H	1.7		2HB
457	L220701	Albion Twp.			4.0	8,800	S		10	2HC
458	L220702	Albion Twp.			0.8	250	S	2/wk	50	2HC
459	L220802	Caledon Twp.			20.0	4,829	S	8	50	2HB
460	L220903	Twp. of Chinguacousy			40.0	27,655	S	50	6	2HC
461	L220203	Mississauga	29/11/72		38.8	150,000	L	823	7	2HB

No information presented indicates data not available, unless otherwise noted.

acres = hectares (ha) x 2.471

TABLE 8: WASTE DISPOSAL SITES IN THE TRENT-MOIRA SUB-BASIN (SUB-BASIN 11)

NO.	MOE No.	Municipality	Opened	Closed	Area (ha)	Population Served	Waste Type	Volume	1971 Project Life	Watershed
		Leeds & Grenville								
1042	L440201	Ganonoque								2MA
1043	L440202	Ganonoque								2MA
1046	L441101	S.Burgess & Bastard Twp.	28/11/72		1.2	1,100	S	¼		2MA
1047	L442101	Leeds & Lansdowne		31/12/72	0.4	2,100	S	1/10		2MA
1048	D441102	S.Burgess & Bastard Twp.	8/8/72		1.2	1,000	S	2½	25	2MA
1049	L441301	S. Crosby Twp.			0.8	300	S	2		2MA
1050	L441303	S. Crosby Twp.			1.2	1,312	S	¼		2MA
1055	L442002	Leeds & Lansdowne			0.8		S	6	15	2MA
1057	L442102	Leeds & Lansdowne			1.2	2,100	S	¼		2MA
1058	L442103	Leeds & Lansdowne	4/1/72		0.4	1,000	S	1	10	2MA
1059	L442501	Rear of Yonge Twp.				1,036	S	¼		2MA
1060	L442503	Rear of Yonge Twp.			0.4	1,000	S	¼		2MA
		Frontenac County								
1007	L380101	Kingston			6.0		S	½	25	2MA
1008	L380102	Kingston			0.4		L	6000 gal.	20	2HM
1009	D380307	Bedford Twp.	29/5/73		6.0		S	½	20	2MA
1010	D380308	Bedford Twp.			0.2	125(summer)	S	400 lb.	40	2MA
1011	D380305	Bedford Twp.			0.4	300 (summer)	S	1	99	2MA
1012	D380702	Kennebec Twp.			2.0	700	S	¼ - ½	50	2HM
1013	L380803	Kingston Twp.			0.05		S	¼	10	2HM
1014	L380802	Kingston Twp.			8.0		S	10	10	2HM
1016	L380805	Kingston Twp.								2HM
1018	L380808	Kingston Twp.	25/2/72		0.2		S	1	30	2HM
1019	L380809	Kingston Twp.								2HM
1020	L380902	Loughborough Twp.		31/7/72	2.0	300	S			2MA
1021	L380903	Loughborough Twp.			1.6	1,000 (summer)	S	½ - 1½	20-30	2HM
1022	L380904	Loughborough Twp.		17/10/73	0.4	60-100	S	1/5-	10-30	2MA
1023	L381001	Olden Twp.		Fall/73	0.2	1,000	S	1¼		2HM
1024	D381002	Olden Twp.	21/7/72		0.4	500	S	¼	100	2HM
1025	L381301	Pittsburch Twp.			2.0	4,500	S	11	15	2MA
1026	L381302	Pittsburch Twp.			6.5	4,500	S	11	15	2MA

TABLE 8 (cont'd): WASTE DISPOSAL SITES IN THE TRENT-MOIRA SUB-BASIN (SUB-BASIN 11)

NO.	MOE No.	Municipality	Opened	Closed	Area (ha)	Population Served	Waste Type	Volume	1971 Project Life	Watershed
1027	L381303	Pittsburch Twp.								2MA
1028	L381304	Pittsburch Twp.	25/2/72		0.4		S	6¼	30	2MA
1029	L381401	Portland Twp.	16/10/73		18.0	2,630	S	25	25	2HM
1030	L381501	Storrongton Twp.		30/9/72	0.8	2,300	S	1		2MA
1031	L381502	Storrongton Twp.	18/2/72				S			2MA
1032	L381601	Wolfe Is.Twp.			0.4	1,000	S	¼	25	2MA
		Hastings County								
954	D361901	Limerick Twp.			0.2		S		10	2HK
955	D361904	Limerick Twp.			0.8		S			2HK
956	D362001	Madoc Twp.		Fall/73	1.6	1,500	S	2	10	2HL
957	L362002	Madoc Twp.					S			2HL
958	L362101	Marmora Lake Twp.			10.0	1,200	S	7	25	2HK
959	L362103	Marmora Lake Twp.	12/4/72		15.2	2,700	S	7	30	2HK
960	D362104	Marmora Lake Twp.	24/5/72		2.4	450	S	⅛	10	2HK
961	L362502	Thurlow Twp.								2HM
962	L362401	Sidney Twp.			1.6	1,500	S	½	7	2HK
963	L362503	Thurlow Twp.			20.0	1,900	S	1½	40	2HL
964	362504	Thurlow Twp.	Application Refused							
965	D362505	Thurlow Twp.			2.4	2640 Airbase 3,540	S,L	30	2-4	2HL
966	L362601	Thurlow Twp.		Fall/73	19.2	5,743	S		20	2HL
967	L362602	Thurlow Twp.			20.0	5,743	S	5 lb.	50	2HL
968	L362701	Tudor & Cashel Twp.				40	S			2HL
969	D362702	Tudor & Cashel Twp.		1/10/71		488	S	½		2HL
970	D362703	Tudor & Cashel Twp.			0.4	40	S		20	2HL
971	L362801	Tyendinaga Twp.			1.0	1,800	S	2	30	2HM
972	L362802	Tyendinaga Twp.								2HM
973	D362901	Wollaston Twp.			4.0	600	S			2HK
		Lennox & Addington County								
983	L370402	Adolphustown Twp.			0.4	500	S	3	6	2HM
984	L370501	Amherst Is. Twp.			0.4	400	S		10	2HM
985	L370601	East Camden Twp.			2.8	1,200	S		25	2HM
986	L370602	East Camden Twp.								2HM

TABLE 8 (cont'd): WASTE DISPOSAL SITES IN THE TRENT-MOIRA SUB-BASIN (SUB-BASIN 11)

NO.	MOE No.	Municipality	Opened	Closed	Area (ha)	Population Served	Waste Type	Volume	1971 Project Life	Watershed
987	L370603	East Camden Twp.			7.2	2,000	S		50	2HM
988	1370604	East Camden Twp.			1.5		S		15	2HM
989	1370801	Ernestown Twp.			0.02		L	1.25		
990	L370802	Ernestown Twp.			14.0	9,000	S			2HM
991	LA370803	Ernestown Twp.								2HM
992	L370901	Fredericksburgh N.			1.0	2,057	S		10	2HM
993	D371001	Fredericksburgh S.					S			2HM
994	L371002	Fredericksburgh S.			0.7		S		7	2HM
995	L371101	Kaladar, Anglesea, Effingham								2HM
996	L371103	Kaladar, Anglesea, Effingham		Fall/73	0.4		S	1/20	25	2HL
997	L371104	Kaladar, Anglesea, Effingham			0.4	150	S			2HL
998	L371106	Kaladar, Anglesea, Effingham			0.4	250	S			2HM
999	L371107	Kaladar, Anglesea, Effingham			0.4	200	S			2HL
1000	D371108	Kaladar, Anglesea, Effingham					S			2HM
1002	L371202	Richmond Twp.			4.0	300	S	¼	20	2HM
1003	L371203	Richmond Twp.			10.0	6,500	S	15	30	2HM
1004	D371204	Richmond Twp.				1,830	S			2HM
1005	L371302	Sheffield Twp.			2.0	1,180	S	2	20	2HM
1006	L371301	Sheffield Twp.		15/6/72	0.2	1,189	S	1	1	2HM
		Peterborough County								
846	D340501	Asphodel Twp.			0.8	1,450	S		15	2HJ
847	L340502	Asphodel Twp.			4.0	1,100	S	15-20	15	2HJ
848	L340601	Belmont Methuen			1.2	500	S		10	2HK
849	L340602	Belmont Methuen								2HK
850	L340603	Belmont Methuen		15/7/71						2HK
851	L340604	Belmont Methuen	Application	Cancelled						2HH
852	L340605	Belmont Methuen				500	S			2HK
853	L340606	Belmont Methuen	Application	Cancelled						2HK
854	L340607	Belmont Methuen		Fall/73	1.2	500	S		5	2HK
855	L340608	Belmont Methuen			1.6	500	S		10	2HK

TABLE 8 (cont'd): WASTE DISPOSAL SITES IN THE TRENT-MOIRA SUB-BASIN (SUB-BASIN 11)

NO.	MOE No.	Municipality	Opened	Closed	Area (ha)	Population Served	Waste Type	Volume	1971 Project Life	Watershed
856	L340609	Belmont Methuen			1.2		S		20	2HK
857	D340609	Belmont Methuen	Application	Cancelled						2HK
858	L340610	Belmont Methuen	7/7/72		6.0		S		10	2HK
859	D340611	Belmont Methuen								2HK
860	L340701	Burleigh Anstruther			4.0	100	S	1/5	50	2HH
861	L340702	Burleigh Anstruther				300(summer)	S	¼	50	2HH
862	L340703	Burleigh Anstruther			6.0	500	S	¼	25	2HH
863	L340704	Burleigh Anstruther			2.3	1,000(summer) 300	S	1	20	2HH
864	L340705	Burleigh Anstruther			1.2	100	S	1/10	3	2HH
865	L340706	Burleigh Anstruther				250 (summer)	S	1/10	50	2HH
866	D340802	Chandos Twp.			0.5	700	S		30	2HK
867	D340803	Chandos Twp.			0.3	500	S		3	2HH
868	D340804	Chandos Twp.			2.0	500	S		30	2HK
869	D340806	Chandos Twp.			2.8	500	S		30	2HK
870	D340807	Chandos Twp.			0.3	300	S		3	2HK
871	L340901	Douro Twp.			0.8	3,100	S	½	15	2HJ
872	L340902	Douro Twp.			2.0	3,100	S	½	5	2HJ
873	L340902	Douro Twp.								2HJ
874	L341002	bummer Twp.		31/7/72			S			2HJ
875	L341004	Dummer Twp.			10.0		S			2HJ
876	L341005	Dummer Twp.		31/7/72	2.0	700(summer) 100	S			2HJ
877	L341101	Ennismore Twp.			155.6	1,200	S			2HH
878	D341201	Galway Cavendish Twp.			0.6		S			2HH
879	L341202	Galway Cavendish Twp.	6/9/73		8.0	150(summer) 75	S	3-4/wk	10	2HF
880	L341203	Galway Cavendish Twp.			2.0	12	S			2HF
881	D341204	Galway Cavendish Twp.		30/9/72	0.4	3,000	S			2HH
882	D341205	Galway Cavendish Twp.			1.6	125(summer) 5	S			2HH
883	D341206	Galway Cevendish Twp.	21/2/72				S			2HH
884	341207	Galway Cavendish Twp.			2.8	25-45	S	2½/wk	10	2HH
885	D341301	Harvey Twp.				1,200	S	¼		2HH
886	L341302	Harvey Twp.		15/6/72	1.2	350	S	1/wk	3	2HH
887	D341304	Harvey Twp.			1.6	1,200	S	¼	20	2HH

TABLE 8 (cont'd): WASTE DISPPOSAL SITES IN THE TRENT-MOIRA SUB-BASIN (SUB-BASIN 11)

NO.	MOE No.	Municipality	Opened	Closed	Area (ha)	Population Served	Waste Type	Volume	1971 Project Life	Watershed
888	L341501	Otonabee Twp.			40.0	57,000	S	225	25	2HJ
889	L341601	Smith Twp.			18.0	7,600	S	9	20	2HH
890	OTH341603	Smith Twp.			16.0	7,600	S, L		20	2HH
		Prince Edward County								
900	L350101	Picton Twp.				4,760	S	4		2HE
901	L350102	Picton Twp.			0.3	4,760	S			2HE
902	L350301	Wellington			4.2	1,000	S	2	30	2HE
903	1350401	Ameliasburgh Twp.	1/12/73		2.4	4,200	S	4-5	10	2HE
904	LA35O401	Ameliasburgh Twp.	24/4/72		5.2		L	2	5	2HE
905	L350501	AtholTwp.			0.8	1,000	S			2HE
906	L350601	Hallowell Twp.				3,800	S	1.3		2HE
907	L350602	Hallowell Twp.			2.4	480(Camp.)	S		10	2HE
908	L350603	Hallowell Twp.	23/8/72		2.0		S	0-20		2HE
909	L350701	Hillier Twp.					S			2HE
910	L350802	N. Marysborough Twp.			0.4	1,000	S		20	2HE
911	L350905	N. Marysborough Twp.			1.6	900	S			2HE
912	L350906	N. Marysborough Twp.	7/7/72		8.0		L	7		2HE
913	L351001	Sophiasburgh Twp.			2.0	1,650	S			2HE
914	L351002	Sophiasburgh Twp.		31/8/72		60	S	600 lb/wk		2HE
		Hastings County								
924	1360101	Belleville			0.8		S			2HL
925	L360102	Belleville								2HL
926	L360103	Belleville					S			2HL
927	L360104	Belleville			0.4		S		4	2HL
928	L360201	Trenton		1/6/71		14,000	S	30-35		2HK
929	L360203	Trenton			1.2		S	10		2HK
930	L360501	Deloro			0.1	200	S		15	2HL
931	L360901	Stirling			1.2	1,472	S	2	30	2HK
933	D361401	Elzevir Grimsthorpe		Jan./74	0.2	200	S	.15	5	2HL
934	D361402	Elzevir Grimsthorpe			1.2	150	S			2HL
935	L361403	Elzevir Grimsthorpe			0.8	100	S	1/10	10	2HL
940	L361701	Hungerford Twp.	7/7/72		4.0		S	1	25	2HL
941	L361702	Hungerford Twp.			6.4	1,800	S	8	10	2HL
942	L361703	Hungerford Twp.								2HL
943	L361704	Hungerford Twp.		31/5/72	0.4	200	S		¼	2HL

TABLE 8 (cont'd): WASTE DISPOSAL SITES IN THE TRENT-MOIRA SUB-BASIN (SUB-BASIN 11)

NO.	MOE No.	Municipality	Opened	Closed	Area (ha)	Population Served	Waste Type	Volume	1971 Project Life	Watershed
944	L361705	Hungerford Twp.		31/5/72		900	S		¼	2HL
945	L361706	Hungerford Twp.			3.2	2,300	S	5		2HL
946	L361801	Huntingdon Twp.		9/1/73	0.8	1,350	S	3	1	2HL
947	L361802	Huntingdon Twp.		15/6/72	0.8	500	S	200 lb	1	2HK
948	L361803	Huntingdon Twp.		15/6/72	0.4	500	S	200 lb	5	2HK
949	D361804	Huntingdon Twp.			0.04	200(Camp)	S		10-15	2HL
950	L361805	Huntingdon Twp.	19/4/72		8.0	1,500	S		15	2HK
951	L361806	Huntingdon Twp.			20.0		L	5,000 gal/yr.	100	2HL
952	D361902	Limerick Twp.		30/9/73	0.2		S		10	2HK
953	D361903	Limerick Twp.			0.2		S		15	2HK
		Haliburton County								
800	D330104	Anson, Hindon, Minden			0.4	200	S	1/10	30	2HF
801	D330201	Cardiff Twp.		Fall/73	0.4		S			2HH
803	D3302O3	Cardiff Twp.			1.6		S		10	2HK
804	D330204	Cardiff Twp.			1.2		S		10	2HF
805	D330205	Cardiff Twp.			1.2		S		10	2HH
806	D330301	Dysart Et Al Twp.			0.8	150	S	¼	10	2HF
807	D330302	Dysart Et Al Twp.			3.8	2,000	S		10	2HF
808	D330303	Dysart Et Al Twp.			1.0	400	S		10	2HF
809	D330304	Dysart Et Al Twp.			1.6	400	S			2HF
810	D330305	Dysart Et Al Twp.	Application Refused							2HF
811	D330306	Dysart Et Al Twp.		15/11/71	0.6	250	S	½	10	2HF
812	D330307	Dysart Et Al Twp.		15/11/71	0.4	250	S	½	10	2HF
813	D330308	Dysart Et Al Twp.		Fall/73	1.1	325	S	¾	10	2HF
814	D330309	Dysart Et Al Twp.			0.8	400	S	½	10	2HF
815	D330310	Dysart Et Al Twp.			0.8	300	S	½	10	2HF
816	D330312	Dysart Et Al Twp.			2.0	400	S		10	2HF
817	D330313	Dysart Et Al Twp.			2.0	325	S		10	2HF
818	D330314	Dysart Et Al Twp.			0.1	175	S		20	2HF
819	D330315	Dysart Et Al Twp.			0.05	700	S	1/20	99	2HF
820	D330316	Dysart Et Al Twp.			0.01	160(summer)	S			2HF
822	D330401	Glamorgan Twp.			0.4	409	S	⅛	5	2HF
823	D330503	Lutterworth Twp.			2.0		S	1/wk	25	2HF
824	D330504	Lutterworth Twp.	10/2/72	Fall/73	0.4		S			2HF
825	D330505	Lutterworth Twp.				500	S		20	2HF
826	LD330506	Lutterworth Twp.				100	S		5	2HF
827	DL330507	Lutterworth Twp.			0.4	100	S		15	2HF

TABLE 8 (cont'd): WASTE DISPOSAL SITES IN THE TRENT-MOIRA SUB-BASIN (SUB-BASIN II)

NO.	MOE No.	Municipality	Opened	Closed	Area (ha)	Population Served	Waste Type	Volume	1971 Project Life	Watershed
828	L330602	Monmouth Twp.			8.0	700	S		30	2HF
832	D330801	Snowdon Twp.			1.6		S		10-15	2HF
833	D330802	Snowdon Twp.				150(summer)	S	5		2HF
834	D330803	Snowdon Twp.	30/11/72		8.0	400(summer)	S	200 lb.	50	
835	D330901	Stanhope Twp.			2.0	250	S	⅓	20	2HF
836	D330902	Stanhope Twp.			4.0	250	S	⅓	40	2HF
798	D330102	Anson, Hindon, Minden			0.8	400	S	3	10	2HF
		Ontario County								
531	L241501	Scugog Twp.			1.6	3,000(summer) 500	S	1		2HG
525	L241302	Reach Twp.			10.0	2,900	S	1	20	2HG
526	L241303	Reach Twp.					S			2HG
529	L241306	Reach Twp.			40.0	7,000	S	14	40	2HG
		Northumberland & Durham County								
699	L310202	Campbellford			20.0	3,600	S, L	2	10	2HK
717	L311501	Cramahe Twp.				2,000	S	5	25	2HK
704	L311001	Alnwick Twp.			1.8	696	S		10	2HJ
705	L311002	Alnwick Twp.		31/8/72	0.2	696	S			2HJ
706	L311101	Brighton Twp.			0.04	800	S	2	7	2HK
707	L311102	Brighton Twp.			0.6	2,000	S	6	5	2HK
708	L311103	Brighton Twp.	Application Cancelled		20.0	11,800	S	30	15	2HK
709	L311201	Cartwright Twp.			20.0	2,000	S	3	10	2HK
710	L311202	Cartwright Twp.			8.0		S, L	40 t	3	2HK
711	L311302	Cavan Twp.		30/4/72	10.0	2,400	S		5	2HJ
712	L311303	Cavan Twp.			1.2	950	S	2/ wk		2HJ
719	L311503	Cramahe Twp.			4.8	1,560	S	4	40	2HK
720	L311504	Cramahe Twp.			1.2	2,000	S	5	25	2HK
727	L311704	Haldimand Twp,			0.1	200	S	1/wk	5	2HK
731	L311802	Hamilton Twp.			3.6	2,500	S		5-10	2HJ
732	L311803	Hamilton Twp.			0.8	1,500	S		3-5	2HJ
738	L312001	Manvers Twp.			0.6	750	S	¼	10	2HH
739	L312002	Manvers Twp.			0.8	750	S	¼	10	2HH
740	L312003	Manvers Twp.			1.6	700	S	¼	10	2HH

TABLE 8 (cont'd): WASTE DISPOSAL SITES IN THE TRENT-MOIRA SUB-BASIN (SUB-BASIN 11)

NO.	MOE No.	Municipality	Opened	Closed	Area (ha)	Population Served	Waste Type	Volume	1971 Project Life	Watershed
741	312004	Manvers Twp.	10/8/71	Never had Licence		100	L	5		2HH
742	L312101	Twp. of S. Monaghan		30/6/71						2HJ
743	L312102	Twp. of S. Monaghan			4.5	800	S	1	25	2HJ
744	L312201	Murray Twp.	31/7/72		0.4	3,500	S	2	1	2HK
745	L312202	Murray Twp.			5.2	2,000	S	1	15	2HK
746	L3],2204	Murray Twp.	10/4/72		40.0	900(factory)	S	10-12	20	2HK
747	L312301	Percy Twp.			20.0	900	S	1	50	2HK
748	312302	Percy Twp.			0.6	2,000	S	15	5	2HK
749	L312401	Seymour Twp.			13.2	2,758	S	½	25	2HK
750	L312402	Seymour Twp.		15/8/71	0.8	800 (summer) 130	S	4	15	2HK
		Victoria County								
761	L320101	Lindsay			12.0	12,000	S	30	2	2HH
762	L320201	Bobcaygeon								2HH
766	L321003	Eldon Twp.		Fall/73	2.0	1,000	S	2	10	2HF
768	L321102	Emily Twp.			40.0	3,004	S	5	30	2HH
769	L321203	Fenelon Twp.		31/5/72	0.8	2,273	S			2HF
770	L321204	Fenelon Twp.								2HF
771	L321205	Fenelon Twp.			0.4	300 (summer) 50	S	⅛ - ¼		2HH
772	L321206	Fenelon Twp.	24/2/72		20.0	2,509	S		20	2HF
773	L321207	Fenelon Twp.	21/12/72		0.1	200	S		10	2HH
777	L321401	Mariposa Twp.			20.0	3,000				2HG
778	L321402	Mariposa Twp.			8.0	3,000	S			2HG
779	L321501	Ops Twp.		15/10/71						2HH
780	L321601	Somerville Twp.		Fall/73	2.0	210	S,L,H	½	2	2HF
781	L321602	Somerville Twp.			2.8	400	S		20	2HF
782	L321603	Somerville Twp.		15/7/72	3.6	1,000	S	2½	2	2HF
783	L321604	Somerville Twp.		2/5/72	16.0	7,000(summer) 2,000	S	3	30	2HF
784	L321605	Somerville Twp.					S			2HF
785	L321701	Verulam Twp.		31/5/73	57.2	1,400	S	50-60	10	2HH
786	L321703	Verulam Twp.			40.0	10,000 (summer) 400	S			2HH

Information not presented indicates data not available, unless otherwise indicated.
acres = hectares (ha) x 2.471

SUB-BASIN 11: TRENT-MOIRA

Waste disposal sites in the Trent-Moira Sub-Basin are listed in Table 8. In comparison to the Western Lake Ontario Sub-Basin, the sites in the Trent-Moira Sub-Basin are greater in number, but smaller in size and in the amount of waste handled. The column headings in Table 8 were described above.

Solid waste is handled at 95 percent of the sites. Eleven sites dispose of liquid waste. One liquid disposal site is listed as a hazardous waste disposal area, but was closed in 1973. Most of the sites serve small communities with populations less than 5,000, and many serve populations less than 1,000.

SUMMARY

Table 9 presents a summary of waste disposal sites for the Canadian portion of the Lake Ontario Basin. There are 303 active waste disposal sites in the basin which cover a land area of about 2,900 ha (7166 acres). Approximately 17,000 t (37.4 million lb) of waste are applied to these sites daily. In addition, there are 58 closed sites which occupy about 200 ha (494 acres) of land.

The Western Lake Ontario Sub-Basin has half as many active waste disposal sites as the Trent-Moira Sub-Basin. However, they occupy more land and handle 28 times as much as the sites in the Trent-Moira Sub-Basin.

TABLE 9: WASTE DISPOSAL SUMMARY FOR THE CANADIAN PORTION OF THE LAKE ONTARIO BASIN

	No. Active Sites	Approx. Area (ha)	Volume (t/d)	No Closed Sites	Approx. Area (ha)
Western Ontario Sub-Basin	102	1,700	16,600	10	50
Trent-Moira Sub-Basin	201	1,200	600	48	150
Total Canadian Lake Ontario Basin	303	2,900	17,200	58	200

acres = hectares (ha) x 2.471

pounds/day (lb/d) = tonnes/day (t/d) x 2200

EROSION

LAKESHORE EROSION

The following information on lakeshore erosion on Lake Ontario was excerpted from the Canada-Ontario Great Lakes Shore Damage Survey Technical Report (2).

Short-term rates of erosion were calculated by comparing profiles established as early as 1971 to those re-surveyed in 1973. The resultant data reflect the volume of material change which occurred during a peak water level stage on the Great Lakes shoreline.

There are 111 km (69 mi) of measured shoreline on the Canadian portion of the Lake Ontario Basin which have erosion rates greater than 0.5 $m^3/m/m/yr$.* Table 10 lists the areas with their reach lengths and average erosion rates.

TABLE 10: REACHES IN THE CANADIAN PORTION OF THE LAKE ONTARIO BASIN WITH EROSION RATES GREATER THAN 0.5 $m^3/m/m/yr$

County or Regional Municipality	Town, City Township	Location	Length (km)	Annual Rate ($m^3/m/m$)	Net Volume (m^3)
Niagara	Niagara-on-the Lake to Grimsby	bluffs	36.61	3.77	963,700
		beach	3.76	31.78	
Halton	Burlington	beach strip	2.41	1.06	3,130
Northumberland	Cramahe	Brighton	10.14	3.48	79,152
		remainder north shore	58.23	1.23	604,358

miles (mi) = kilometers (km) x 0.62
cubic yards (yd^3) = cubic meters (m^3) x 1.308

The heaviest erosion occurred between the towns of Niagara-on-the-Lake and Grimsby, where the bluffs eroded at a rate of 3.77 $m^3/m/m/yr$. Beach material in these areas also eroded at a relatively high rate of 31.78 $m^3/m/m/yr$.

* Cubic meters of eroded material per 'linear meter of shoreline per vertical meter of bluff height per year.

Erosion is minimal along the north shore of Lake Ontario, although some areas in the Regional Municipality of Durham and the village of Brighton suffered significant erosion losses. The weighted average for these areas on the north shore was 1.23 m^3/m/m/yr, constituting an eroded volume of 604,358 m^3 (790,500 yd^3).

The total volume eroded from the Canadian Lake Ontario shoreline during the period November 1972 to November 1973, was 1,698,986 m^3 (2.22 million yd^3). Assuming an average density of 2.6, this means that 4.4 million t (9.7 billion lb) of material was eroded during this period.

RIVERBANK EROSION

A riverbank erosion study is being conducted as part of the Canadian PLUARG Task C effort. The objective of this study was to gain a better understanding of bank recession mechanisms and to determine the qualities and quantities of materials eroded on a representative number of sites, such that actual contributions of sediment to streams may be estimated.

The results of the riverbank erosion study were not available for inclusion in this report. However, the analysis of data collected during the preliminary phase suggested that average erosion on streambanks in southern Ontario involved relatively small quantities, probably in the neighbourhood of 1 to 2 cm (0.4-0.8 in) laterally per year.

INTENSIVE LIVESTOCK OPERATIONS

The following information on intensive livestock operations in the Canadian portion of the Lake Ontario Basin was obtained from a study carried out by Agriculture Canada (3). Details concerning methodology appear in Appendix A of Volume I in this report series.

Intensive livestock operations are defined as follows: 75 or more dairy cattle; 150 or more beef cattle; 300 or more swine; and 30,000 or more poultry. Based on these criteria, there are 60 intensive poultry operations, 132 intensive cattle operations, and 177 intensive swine operations in the Canadian portion of the Lake Ontario Basin (Table 11). The poultry operations are concentrated in the Niagara Peninsula.

TABLE 11: INTENSIVE LIVESTOCK OPERATIONS IN THE CANADIAN PORTION OF THE LAKE ONTARIO BASIN

	Poultry	Cattle	Swine
Lake Ontario	60	132	177
Total Great Lakes	165	1,002	834

HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS

INTRODUCTION

The information on non-sewered residential areas was taken from a study conducted for Environment Canada (1). Details of the methodology are presented in Appendix A of Volume I in this report series.

Since this study was to include both permanent and seasonal residences, compact groupings of cottages or chalets were included. In the case of seasonal residences, the number of units was tabulated. This was translated to an equivalent population, using a factor of 3.5 persons per unit. This same practice was followed for permanent residences in some municipalities. These estimated populations are included under the heading "total population" in the Tables.

SUB-BASIN 10: WESTERN LAKE ONTARIO

High density, non-sewered residential areas in the Western Lake Ontario Sub-Basin are listed in Table 12. A total population of 132,400 resides in these areas. The average population per non-sewered residential area is 752. However, some areas have populations as large as 10,000.

SUB-BASIN 11: TRENT-MOIRA

Table 13 presents a listing of the high density non-sewered residential areas in the Trent-Moira Sub-Basin. There are 249 such areas, with a total non-sewered population of 120,300. The average population per area is 483, considerably less than the average of 752 in the Western Lake Ontario Sub-Basin. The largest non-sewered residential area is located in Frontenac County on Highway 33, west of Kingston, where 14,000 persons reside.

SUMMARY

Approximately 252,600 persons live in high density, non-sewered residential areas in the Canadian portion of the Lake Ontario Basin. This represents 6 percent of the total Lake Ontario Basin population. About 52 percent of the non-sewered residential area population is located in the Western Lake Ontario Sub-Basin, with the remainder in the Trent-Moira Basin.

TABLE 12: HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS IN THE WESTERN LAKE ONTARIO SUB-BASIN (SUB-BASIN 10)

TOWNSHIP	BASIN	LOCATION	UNITS	KNOWN POPULATION	TOTAL POPULATION
Niagara County					
Port Colborne	2HA	Hwy 3 @ Rd 5		175	175
"	"	Con. II, Lot 11-12		645	645
"	"	II, Lot 17-18		441	441
"	"	Rd.5, E. of City		50	50
"	"	Hwy.3, E. of City		200	200
"	"	Rd.140, E. of City		200	200
"		Nickel Beach Area		80	80
"	"	Poll. Sub.38, N.W. Corner		834	834
Niagara-on-the-	2HA	Niagara		1,000	1,000
Lake	"	Poll. Sub. 10, Lakeshore Rd.		500	500
"	"	Poll. Sub.16		532	532
"	"	St. David's Area		533	533
"	"	Queenston Area		540	540
"	"	Virgil Area		1,000	1,000
Niagara Falls	2HA	City of Niagara Falls		4,300	4,300
Thorold	2HA	Port Robinson		400	400
"	"	Allanburg		200	200
"	"	S.& E. of Thorold		1,700	1,700
"	"	Thorold South area		600	600
Fort Erie	2HA	Douglastown		200	200
"	"	Stevensville		350	350
"	"	W. of Crystal Beach		302	302
"	"	N. of Crystal Beach		1,900	1,900
"	"	Poll. Subs. 2-18 & Wildwood		387	387
"	"	Thunderbay - Wavecrest		550	550
"	"	N. of Wavecrest		800	800
"	"	Wavecrest - Bertie Bay		590	590
"	"	Poll. Subs.2-26		468	468
"	"	N. of Erie Beach		274	274
"	"	Poll. Subs.2-8 & 2-20		300	300

TABLE 12 (cont'd): HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS IN THE WESTERN LAKE ONTARIO SUB-BASIN

(SUB-BASIN 10)

TOWNSHIP	BASIN	LOCATION	UNITS	KNOWN POPULATION	TOTAL POPULATION
Pelham	2HA	Fenwick Area		694	694
"	"	W. of Fonthill		527	527
"	”	E. of Fenwick		640	640
Wainfleet	2HA	Camelot Beach	300	100	1,150
"	“	Burnaby & Morgan's Point	300	75	1,125
"	“	Burnaby Rd. & Hwy. 3		75	75
"	"	Long Beach	400	75	1,475
"	“	Wainfleet		175	175
"	"	Winger		40	40
Lincoln	2HA	Jordan		124	124
"	"	Jordan Station		353	353
"	“	Vineland		1,200	1,200
"	"	Campden		184	184
"	"	Beamsville Area		4,297	4,297
West Lincoln	2HA	Near Smithville		293	293
"	“	Rd. 12, Con. VIII	20		70
"	"	Rds. 6 & 65		50	50
"	"	Attercliff		75	75
"	“	Bismark		40	40
"	“	St. Anns		200	200
"	"	Boyle Rd.& Rd. 63		45	45
"	“	Wellandport		250	250
"	“	Caistorville		150	150
"	“	Rd. 23 & Con. VII		75	75
Grimsby	2HA	E. of Grimsby		2,677	2,677
"	"	W. of Grimsby		1,900	1,900
St. Catharines	2HA	Perimeter of City		2,700	2,700
Port Colbourne	2HA	Humberstone		50	50
"	“	Yager Rd, Fords Rd, Babion Rd.		666	666
"	"	Troop Rd, Neef Rd, Fords Rd.		394	394

TABLE 12 (cont'd): HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS IN THE WESTERN LAKE ONTARIO SUB-BASIN

(SUB-BASIN 10)

TOWNSHIP	BASIN	LOCATION	UNITS	KNOWN POPULATION	TOTAL POPULATION
Port Colbourne	2HA	Sharkston, Michael & Need Rds.		75	75
"	"	Empire, Garrison, Beath Rds.		538	538
Durham County					
Clarke	2HD	Orono		1,137	1,137
"	"	Newtonville		110	110
"	"	Kendall		75	75
Hope	2HD	Garden Hill		74	74
"	"	Campbellcroft		40	40
"	"	Welcome		186	186
"	"	Dale		34	34
Darlington	2HD	Courtice		150	150
"	"	Hampton		200	200
"	"	Enniskillen		60	60
"	"	Mitchell Corners		150	150
Dufferin County					
Mono	2HB	N. of Orangeville		75	75
"	"	E. of Orangeville		235	235
York County					
King	2HC	King City		2,269	2,269
"	"	Laskay		164	164
"	"	Nobleton		1,356	1,356
Whitchurch-Stouffville	2HC	Bloomington		89	89
"	"	Preston Lake		274	274
"	"	Stouffville		500	500
"	"	Gormley		242	242
"	"	Ringwood		258	258
Town of Markham	2HC	Dixon's Hill		160	160
	"	Victoria Square		199	199

TABLE 12 (cont'd): HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS IN THE WESTERN LAKE ONTARIO SUB-BASIN

(SUB-BASIN 10)

TOWNSHIP	BASIN	LOCATION	UNITS	KNOWN POPULATION	TOTAL POPULATION
Town of	2HC	Buttonville		228	228
Markham	"	Cachet Country Club		706	706
"	"	Unionville		520	520
City	2HC	Toronto Islands	246		861
Etobicoke	2HC		68		238
North York	2HC	Bridle Path	100		350
"	"	Yonge	75		262
King	2HC	Eversley		60	60
"		King Cross Estate		275	275
Vaughan	2HC	Elder Mills		100	100
"	"	Kleinburg		950	950
"	"	Teston		117	117
"	"	Maple		1,984	1,984
"	"	Nashville		199	199
Wentworth County					
W. Flamborough	2HB	Freelton	150		525
"	"	Strabane	35		122
"	"	Rd. 4 Con. VI-VII	18		63
"	"	Rd. 4 Con. V-VI	29		102
"	"	Milgrave Area	125		438
"	"	Rd. 5 Con. III-IV	31		108
"	"	Rd.4 Con.II	40		140
"	"	Bullock's Corner	380		1,330
"	"	W. Flamborough	22		77
"	"	Christie's Corner	12		42
Binbrook	2HA	Binbrook Area	160		560
"	"	Sinclairville Area	30		105
"	"	Woodburn Area	25		88
"	"	N.E. Corner Twp.	120		420

TABLE 12 (cont'd): HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS IN THE WESTERN LAKE ONTARIO SUB-BASIN

(SUB-BASIN 10)

TOWNSHIP	BASIN	LOCATION	UNITS	KNOWN POPULATION	TOTAL POPULATION
Saltfleet	2HA	Shoreline	620		2,170
"	"	N. of Hwy. 8	820		2,870
"	"	S. of Mount Albion	100		350
"	"	Tayleyton	15		52
"	"	S. of Stoney Creek	25		88
Glanford	2HB	North 2 Concessions	330		1,155
"	2HA	Mount Hope Area	230		805
"	"	M. Glanford Area	37		130
"	"	North 2 Concessions	512		1,792
E. Flamborough	2HB	E. of Waterdown	320		1,120
"	"	W. of Waterdown	200		700
"	"	Rds. 5 & 42	50		175
"	"	Flamborough Centre	60		210
"	"	Rd. 8 Con. IV-V	53		186
"	"	Rd. 5 & Hwy. 6	37		129
"	"	Mountsburg	15		52
"	"	Carlisle & Flamborough	250		875
"	"	Harper's Corners	29		102
Beverly	2HB	Con. VIII	50		175
Ancaster	2HB	Con. I - III Lots 31-50	2,109		7,381
"	"	Mineral Springs	30		105
"	"	Southcote	10		35
Northumberland County					
Hamilton	2HD	Baltimore		250	250
"	"	Bewdley		365	365
"	"	Camborne		100	100
"	"	Cold Springs		189	189
"	"	Coverdale		900	900
"	"	W. of Colborne		75	75
"	"	Creighton Heights		175	175

TABLE 12 (cont'd): HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS IN THE WESTERN LAKE ONTARIO SUB-BASIN

(SUB-BASIN 10)

TOWNSHIP	BASIN	LOCATION	UNITS	KNOWN POPULATION	TOTAL POPULATION
Saltfleet	2HA	Shoreline	620		2,170
"	"	N. of Hwy. 8	820		2,870
"	"	S. of Mount Albion	100		350
"	"	Tayleyton	-15		52
"	"	S. of Stoney Creek	25		88
Glanford	2HB	North 2 Concessions	330		1,155
"	"	Mount Hope Area	230		805
"	"	M. Glanford Area	37		130
"	"	North 2 Concessions	512		1,792
E. Flamborough	2HB	E. of Waterdown	320		1,120
"	"	W. of Waterdown	200		700
"	"	Rds. 5 & 42	50		175
"	"	Flamborough Centre	60		210
"	"	Rd. 8 Con. IV-V	53		186
"	"	Rd. 5 & Hwy. 6	37		129
"	"	Mountsburg	15		52
"	"	Carlisle & Flamborough	250		875
"	"	Harper's Corners	29		102
Beverly	2HB	Con. VIII	50		175
Ancaster	2HB	Con. I - III Lots 31-50	2,109		7,381
"	"	Mineral Springs	30		105
"	"	Southcote	10		35
Northumberland County					
Hamilton	2HD	Baltimore		250	250
"	"	Bewdley		365	365
"	"	Camborne		100	100
"	"	Cold Springs		189	189
"	"	Coverdale		900	900
"	"	W. of Colborne		75	75
"	"	Creighton Heights		175	175

TABLE 12 (cont'd): HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS IN THE WESTERN LAKE ONTARIO SUB-BASIN

(SUB-BASIN 10)

TOWNSHIP	BASIN	LOCATION	UNITS	KNOWN POPULATION	TOTAL POPULATION
Murray	2HD	12 O'Clock Point		500	500
Brighton	2HD	W. Emd. Murray Canal	170		595
"	"	"		350	350
Cramahe	2HD	Colborne		1,000	1,000
Halton County					
Oakville	2HB	Part of Town.		445	445
"	"	Part of Town.		2,400	2,400
Esquesing	2HB	Part of Town.		9,600	9,600
Burlington	2HB	Part of Town.		1,025	1,025
Nassagaweya	2HB	Part of Town.		3,409	3,409
Haldimand County					
Camborough	2HA	Camborough	20		70
"	"	Attercliffe Station	30		105
Moulton	2HA	Lowbanks	14		49
Seneca	2HA	Blackheath	10		35
Wellington County					
Erin	2HB	Hillsburg		893	893
"	"	South of Erin		35	35
Puslinch	2HB	Morriston		214	214
Peel County					
Caledon	2HB	Alton		491	491
"	"	Caledon		373	373
"	"	Inglewood		365	365
Mississauga	2HB	Streetsville		106	106
Albion	2HC	Palgrave		189	189

TABLE 12 (cont'd): HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS IN THE WESTERN LAKE ONTARIO SUB-BASIN

(SUB-BASIN 10)

TOWNSHIP	BASIN	LOCATION	UNITS	KNOWN POPULATION	TOTAL POPULATION
Albion	2HC	Caledon East		944	944
Toronto Gore	2HC			1,274	1,274
Chinguacousy	2HC			7,700	7,700
Ontario County					
Pickering	2HC	Claremont	100		350
"	"	Greenwood	10		35
"	"	Brougham	20		70
"	"	Green River	30		105
"	"	Brock Road	50		175
"	"			10,000	10,000
"	"			5,000	5,000
Whitby	2HD	Taunton	15		52
"	"	Columbus	55		192
"	"	Raglan	40		140
Sub-Basin 10 Total					132,362

Information not presented indicates data not available, unless otherwise indicated.

TABLE 13: HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS IN THE TRENT-MOIRA RIVERS SUB-BASIN

(SUB-BASIN 11)

TOWNSHIP	BASIN	LOCATION	UNITS	KNOWN POPULATION	TOTAL POPULATION
Frontenac County					
Portland	2HM	Verona		300	300
Kennebac	2HM	Arden	50		175
"	"	Henderson	10		35
Olden	2HM	Mountain Grove	20		70
Pittsburgh	2MA	Joyceville	10		35
"	"	Barriefield	100		350
"	"	Brewers Mills	15		52
"	"	Eastview	30		105
Howe Island	2MA	Howe Island	200	168	700
Wolfe Island	2MA	Wolfe Island	623	1,172	2,180
Loughborough	2MA	Perth Road	25		88
"	2HM	Sydenham	200		700
"	"	Wilmer	10		35
Storrington	2MA	Battersea	75		262
"	"	Sunbury	30		105
"	"	Inverary	75		262
Kingston	2HM	Glenburnie	50		175
"	"	Elginburg	30		105
"	"	Glenvale	10		35
"	"	Hwy 33 E. of Collins Bay	50		175
"	"	Hwy. 33 W. of Kingston	4,000		14,000
"	"	Cataraqui	100		350
	"	Westbrooke	300		1,050
Portland	2HM	Harrowsmith		200	200

TABLE 13 (cont'd): HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS IN THE TRENT-MOIRA RIVERS SUB-BASIN

(SUB-BASIN 11)

TOWNSHIP	BASIN	LOCATION	UNITS	KNOWN POPULATION	TOTAL POPULATION
Durham County					
Manvers	2HG	Janetville	60		210
"	"	Pontypool		200	200
"	"	Bethany		300	300
Cartwright	2HG	Blackstock		350	350
"	"	Caesarea		200	200
"	"	Nestleton		100	100
Cavan	2HJ	Millbrook		873	873
Victoria County					
Fenelon	2HF	S. of Isaacs Glen	12		42
"	"	South Bay Area	105		467
"	"	Long Beach	120		420
"	"	Sturgeon Point	110		385
"	"	Daytona Beach	60		210
"	"	Ellery Beach	40		140
Somerville	2HF	Cococonk		459	459
"	"	Kinmount		250	250
"	"	Burnt River		100	100
Laxton	2HF	Norland		150	150
Bexley	2HF	Rosedair	75		262
OPS	2HG	Hwy. 7 & Rd. 4	10		35
Mariposa	2HG	Taylors Corner	12		42
"	"	Oakwood		250	250
"	"	Little Britain	100		350
Lindsay	2HH	S.E. Corner - E. of River	40		140
"	"	S.E. Corner - E. of River	30		105
"	"	S.E. Corner - E. of River	10		35
"	"	E. of Hwy. 36	12		42

TABLE 13 (cont'd): HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS IN THE TRENT-MOIRA RIVERS SUB-BASIN

(SUB-BASIN 11)

TOWNSHIP	BASIN	LOCATION	UNITS	KNOWN POPULATION	TOTAL POPULATION
Lindsay	2HH	S.E. of Lindsay	20		70
"	"	S.W. of Lindsay	10		35
Leeds County					
Bastard	2MA	Delta	204		714
"	"	Lower Beverly Lake	100		350
"	"	Phillipsville	15		52
Rear of Leeds	2MA	Seeley's Bay	160		566
Lansdowne	"	Lyndhurst	100		350
"	"	Red Horse & Charleston L.	200		700
South Crosby	2MA	South Crosby Township	540		1,890
"	"	Jones Falls	15		52
"	"	Newboro	141	269	494
"	"	Morton	25		87
"	"	Elgin	165	336	578
Rear of Yonge	2MA	Athens	486	968	1,701
& Escott	"	South of Charleston	158		553
Front of Leeds	2MA	Rd. 10 @ River	40		140
& Lansdowne	"	Admiralty Island	140		490
Haliburton County					
Harburn	2HF	Haliburton Lake	30		105
Havelock	2HF	Kennisis Lake	20		70
Stanhope	2HF	Hall's Lake	25		87
Cardiff	2HK	Cardiff	200		700
Minden	2HF	Minden		1,200	1,200
"	"	Carnarvon	20		70
Guilford	2HF	West Guilford	150		525
"	"	Eagle Lake	125		438
Dysart	2HF	Haliburton Area		1,800	1,800
"	"	Donald	10		35
Snowdon	2HF	Gelert	10		35

TABLE 13 (cont'd): HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS IN THE TRENT-MOIRA RIVERS SUB-BASIN

(SUB-BASIN 11)

TOWNSHIP	BASIN	LOCATION	UNITS	KNOWN POPULATION	TOTAL POPULATION
Glamorgan	2HF	Gooderham Arc		400	400
Monmouth	2HF	Wilberforce		700	700
"	"	Tory Hill	40		140
Hastings County					
Tyendinaga	2HM	Blessington		25	25
"	"	Read		75	75
"	"	Lonsdale		50	50
"	"	Kingsford		40	40
"	"	Shannonville		250	250
"	"	401 Interchange 94		40	40
Thurlow	2HM	Point Anne		350	350
"	2HL	Foxborough		850	850
"	"	Honeywell Corners		50	50
"	"	Thresher Corners		150	150
"	"	Plainfield		100	100
"	"	Lotta		60	60
"	"	Corbyville		600	600
"	"	East of Belleville		250	250
Sidney	2HL	Chatterton		375	375
"	"	Wallbridge		100	100
"	"	Rd. 5A		500	500
"	"	Cannifton Area		700	700
"	"	Bayside		350	350
"	"	Makatewis Area		1,800	1,800
Wollaston	2HK	Rose Island		25	25
"		Coe Hill		150	150
Cashel	2HK	Gunter		25	25

TABLE 13 (cont'd): HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS IN THE TRENT-MOIRA RIVERS SUB-BASIN

(SUB-BASIN 11)

TOWNSHIP	BASIN	LOCATION	UNITS	KNOWN POPULATION	TOTAL POPULATION
Tudor	2HL	Millbridge		30	30
Madoc	2HL	Bannockburn		75	75
"	"	Eldorado		35	35
Elzevir	2HL	Queensborough		100	100
"	"	Actinolite		80	80
Hungerford	2HL	Sulphide		75	75
"	"	Stoco		50	50
"	"	Marlbank		150	150
"	"	Thomasburg		75	75
Huntingdon	2HL	Moira		50	50
"		Crookston		20	20
Rawdon	2HK	H.W. Corner Township	20		70
"		Springbrook		350	350
"	"	Harold		25	25
"	"	Wellman		50	50
Lennox & Addington Counties					
N. Fredericksburgh	2HM	S. of Napanee	300		1,050
S. Fredericksburgh	2HM	Sundhurst	60		210
"		Long Beach	100		350
Adolphustown	2HM	Bass Cove	50		175
"	"	Trumper Pt.	30		105
"	"	West Marvin	40		140
"	"	Dorland	20		70
"	"	Adolphustown	10		35
Ernestown	2HM	Bath	300		1,050
"	"	Marvin	20		70
"	"	Millhaven	75		262
"	"	Amherstview	1,500		5,250
"	"	Odessa	250		875
"	"	Switzerville	15		52

TABLE 13 (cont'd): HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS IN THE TRENT-MOIRA RIVERS SUB-BASIN

(SUB-BASIN 11)

TOWNSHIP	BASIN	LOCATION	UNITS	KNOWN POPULATION	TOTAL POPULATION
Ernestown	2HM	Thorpe	10		35
"	"	Violet	50		175
"	"	Wilton	60		210
Sheffield	2HM	Erinsville	20		70
"	"	Tamworth	200		700
Camden East	2HM	Colebrook	35		122
"	"	Yarker	100		350
"	"	Newburg	250		875
"	"	Strathcona	50		175
"	"	Camden East	30		105
"	"	Moscow	20		70
"	"	Centreville	25		88
"	"	Enterprise	200		700
Richmond	2HM	Selby	25		88
"	"	Roblin	25		88
"	"	Parkview (Napanee)	200		700
Kaladar	2HM	Northbrook	100		350
"	"	Kaladar	100		350
"	"	Flinton	50		175
Anglesea	2HM	Cloyne	110		385
Ontario County					
Reach	2HG	Epsom		100	100
"	"	Utica		100	100
"	"	Prince Albert		400	400
Scugog	2HG	-		742	742
Reach	2HG	Seagrave		200	200

TABLE 13 (cont'd): HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS IN THE TRENT-MOIRA RIVERS SUB-BASIN

(SUB-BASIN 11)

TOWNSHIP	BASIN	LOCATION	UNITS	KNOWN POPULATION	TOTAL POPULATION
Reach	2HG	Greenbank		275	275
"	"	Manchester		200	200
Brock	2HG	Manilla		100	100
Northumberland County					
Hamilton	2HJ	Gores Landing		175	175
"	"	Harwood		200	200
Brighton	2HK	Orland		30	30
"	"	Codrington		30	30
Seymour	2HK	N.W. Corner Township	200	300	1,000
"	"	Myersburg		40	40
"	"	S.W. Corner Township	200		700
"	"	Willson Island		500	500
"	"	S.E. Corner Township	100		350
Percy	2HK	Hastings		845	845
"	"	Warkworth		600	600
Cramahe	2HK	Castleton		272	272
Alnwick	2HK	Roseneath		175	175
"	2HJ	S. Shore Rice Lake	3,000		10,500
Murray	2HK	Stockdale		65	65
"	"	Wooler		100	100
"	"	S. of Wooler		60	60
"	"	N.W. of Trenton		400	400
Prince Edward County					
Hallowell	2HE	N. of Picton		150	150
"	"	West Lake	222		777

TABLE 13 (cont'd): HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS IN THE TRENT-MOIRA RIVERS SUB-BASIN

(SUB-BASIN 11)

TOWNSHIP	BASIN	LOCATION	UNITS	KNOWN POPULATION	TOTAL POPULATION
Athol	2HE	Cherry Valley		200	200
"	"	Lake Ontario Shore	112		392
S. Marysburg	2HE	Lake Ontario Shore	76		266
N. Marysburg	2HE	Prince Edward Bay	144		504
Sophiasburg	2HE	Demoretsville		155	155
"	"	North Port		90	90
"	"	Bay of Quinte	183		640
Hillier	2HE	West Consecon		175	175
"	"	Hillier		75	75
"	"	Wellington		1,006	1,006
"	"	Lake Ontario Shoreline	164		574
Ameliasburgh	2HE	Ameliasburgh		175	175
"	"	Rednersville		175	175
"	"	Rossmore		350	350
"	"	Hwy. 14 @ Rd.28		120	120
"	"	Carrying Place		150	150
"	"	Consecon		300	300
"	"	Bay of Quinte	600		2,100
Peterborough County					
Galway	2HF	Crystal Lake	500		1,725
"	"	White Lake	25		87
"	2HH	DeGaulle Lake	25		88
"	"	Bass Lake	40		140
Cavendish	2HF	Salmon Lake	100		350
"	"	Fortescue Lake	60		210

TABLE 13 (cont'd): HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS IN THE TRENT-MOIRA RIVERS SUB-BASIN

(SUB-BASIN 11)

TOWNSHIP	BASIN	LOCATION	UNITS	KNOWN POPULATION	TOTAL POPULATION
Cavendish	2HH	Galloway Lake	20		70
"	"	Pencil Lake	70		245
"	"	Bottle Lake	4		14
"	"	Catchaloma & Mississauga	1,300		4,550
"	"	Lake	35		122
Ansthruther	2HH	Apsley		350	350
Smith	2HH	Bridgenorth		1,500	1,500
"	"	Youngs Point		200	200
"	"	Buckhorn		60	60
"	"	Fife Bay	400		1,400
"	"	Woodland Acres	248		868
"	"	Peterborough - Terview Hts.	100		350
"	"	Peterborough - Village Mead	40		140
"	"	Peterborough	60		210
Peterborough County					
Ennismore	2HH	Ennismore	20		70
"	"	Rd.16	25		87
"	"	End Rd. 16	175		612
"	"	N. of Fowlers Cor.	55		192
Douro	2HH	Youngs Point	100		350
"	"	Katchawano Lake	50		175
"	"	Douro	75		262
Dummer	2HH	S. Sode Stoney Lake	750		2,625
"	2HJ	Warsaw	100		350
Harvey	2HH	Buckhorn		125	125
"	"	Sandy Lake	70		245
"	"	Big Bald Lake	103		360

TABLE 13 (cont'd): HIGH DENSITY, NON-SEWERED RESIDENTIAL AREAS IN THE TRENT-MOIRA RIVERS SUB-BASIN

(SUB-BASIN 11)

TOWNSHIP	BASIN	LOCATION	UNITS	KNOWN POPULATION	TOTAL POPULATION
Harvey	2HH	Little Bald Lake	300		1,050
"	"	Little Bald Lake	30		105
"	"	Black Duck Bay	100		350
"	"	Burleigh Falls		100	100
"	"	Chief Island	30		105
"	"	N. Side Buckhorn Lake	300		1,050
"		Lakehurst		10	
Asphodel	2HJ	Norwood		1,190	1,190
"	"	Westwood	30		105
"	"	Birdsall	100		350
"	"	N. Side Trent River	300		1,050
"	"	E. of Hastings	25		87
"	"	Norwood Area	75		262
Belmont	2HK	Cordova Mines		100	100
"	"	Belmont Lake South	75	10	272
"	"	Belmont Lake South	300		1,050
"	"	Havelock		1,225	1,225
Methuen	2HK	Nephton		100	100
Sub-Basin 11 Total					120,281

Information not presented indicates data not available, unless otherwise indicated.

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3. Coote, D.R., E.M. MacDonald, and M.D. Rigby. A Selective Inventory of Large Livestock Operations, Southern Ontario, Agriculture Canada, Ottawa, 1974.

4 MATERIALS USAGE

INTRODUCTION

The materials initially identified in this inventory were chosen because they may influence the quality of drainage water in the Lake Ontario Basin. These materials included pesticides, fertilizers, agricultural manures, road salts and agricultural lime and liming materials. However, lime was subsequently deleted in the following discussion because of its limited use.

The methodology used in the materials usage inventory is described in Appendix A of Volume I in this report series.

AGRICULTURAL PESTICIDES

Information on the agricultural use of pesticides is presented in terms of kg of active chemical used. Pesticides were divided into five groups as follows: insecticides; fungicides; triazine herbicides; phenoxy herbicides; and herbicides other than triazine and phenoxy. The data are presented in Table 14.

INSECTICIDES

Statistics on the use of insecticides in the two major Canadian Lake Ontario Sub-Basins are presented in Table 14. Insecticides are used to a much greater extent in the Western Lake Ontario Sub-Basin than in the Trent-Moira Sub-Basin. The area of heaviest use is the Niagara Fruit Belt. About 75 percent of the total amount of insecticides used in the Canadian Lake Ontario Basin is used on fruits and vegetables in the Western Lake Ontario Sub-Basin. This sub-basin receives about 190,400 kg/a (419,780 lb/a) of insecticides, while the Trent-Moira Sub- Basin receives only about 50,800 kg/a (112,000 lb/a).

FUNGICIDES

The amounts of fungicides used in the Canadian Lake Ontario Basins are also listed in Table 14. Virtually all of the fungicide (> 99 percent) is applied to fruits and vegetables, as opposed to their application to field crops. Use of fungicides is about ten times greater in the Western Lake Ontario Sub-Basin than in the Trent-Moira Sub-Basin. Most of the fungicides are used in the Niagara Region.

About 210,600 kg (464,290 lb) of fungicide are used annually in the Western Lake Ontario Sub-Basin, compared with 23,400 kg (51,600 lb) in the Trent-Moira Sub-Basin.

TABLE 14: USE OF PESTICIDES IN THE CANADIAN PORTION OF THE LAKE ONTARIO BASIN

(kg of active chemical)

Sub-Basin	PHENOXY			TRIAZINE		OTHER TYPES		FUNGICIDES	
	Field Crops	Road-Sides	Fruit & Veg.	Field Crops	Fruit & Veg.	Field Crops	Fruit & Veg.	Field Crops	Fruit & Veg.
Western Ontario	39,650	6,100	2,900	78,400	2,400	49,800	17,800	50	210,500
Trent-Moira	28,300	8,400	1,450	55,500	500	34,200	560	30	23,400
Total Canadian Lake Ontario Basin	67,950	14,500	4,350	133,900	2,900	84,000	18,360	80	233,900

pounds (lb) = kilograms (kg) x 2.2046

HERBICIDES

Herbicides were separated into three groups according to their chemical composition: phenoxy; triazine; and other types. A total of about 326,000 kg (718,700 lb) of herbicides are applied to agricultural lands in the Canadian Lake Ontario Basin annually (Table 14). The breakdown, according to chemical composition, is approximately as follows: phenoxy 86,800 kg (191,360 lb); triazine 136,800 kg (301,590 lb); and other types 102,400 kg (225,750 lb).

The use of herbicides in the Western Lake Ontario Sub-Basin is about 197,000 kg (434,310 lb), 60 percent of the total.

In contrast to fungicides and insecticides, which are used mainly on fruits and vegetables, 88 percent of the herbicides are used on field crops. Only about eight percent of the herbicides are used on fruits and vegetables, while four percent are used for weed control along road sides.

COMMERCIAL FERTILIZERS AND AGRICULTURAL MANURES

Information on the production and/or usage of agricultural manures and fertilizers in the Canadian portion of the Lake Ontario Basin is presented in terms of their nutrient content. The nutrient input from these materials is reported by weight and density (kg/ha of improved farmland and/or all land), and includes nutrients from fertilizer usage, animal manure production, and total nutrients from agricultural manures and fertilizers.

Tables 15 and 16 present information on farmland use and livestock numbers in the Canadian portion of the Lake Ontario Basin. The two major sub-basins have approximately equal amounts of improved farmland. However, in terms of total land area, the Trent-Moira Sub-Basin is more than twice as large as the Western Lake Ontario Sub-Basin.

The Trent-Moira Sub-Basin has more cattle than the Western Lake Ontario Sub-Basin, but less swine, poultry, and other livestock.

TABLE 15: FARM LAND USE IN THE CANADIAN PORTION OF THE LAKE ONTARIO BASIN

Sub-Basin	Total Land	Total Farmland	Improved Farmland	Crop-Land	Total Pasture	Wood-Land
Western Ontario	881,000	493,120	372,140	279,030	105,270	39,710
Trent-Moira	2,061,900	652,480	335,210	220,970	218,730	117,590
Total Canadian Lake Ontario Basin	2,942,900	1,145,600	707,350	500,000	324,000	157,300

acres = hectares (ha) x 2.471

TABLE 16: LIVESTOCK NUMBERS IN THE CANADIAN PORTION OF THE LAKE ONTARIO BASIN

Sub-Basin	Total Cattle	Dairy Cattle	Beef Cattle	Swine	Poultry	Others
Western Ontario	223,564	87,833	35,143	176,301	6,692,231	164,370
Trent-Moira	275,536	89,967	48,857	88,699	1,442,219	49,900
Total Canadian Lake Ontario Basin	499,100	177,800	84,000	265,000	9,134,219	214,270

COMMERCIAL FERTILIZERS

Table 17 lists the weight (kg) of fertilizer nutrients applied to land in the Canadian portion of the Lake Ontario Basin. The Western Lake Ontario Sub-Basin receives approximately twice as much nitrogen, phosphorus and potassium from fertilizer as does the Trent-Moira Sub-Basin.\

TABLE 17: TOTAL NUTRIENTS FROM COMMERCIAL FERTILIZER

	(kg)		
Sub-Basin	N	P_2O_5	K_2O
Western Ontario	9,033,900	6,476,300	6,884,700
Trent-Moira	4,739,500	3,395,500	3,606,100
Total Canadian Lake Ontario Basin	13,773,400	9,871,800	10,490,800

pounds (lb) = kilograms (kg) x 2.2046

The usage of fertilizer nutrients is expressed in terms of kg/ha of improved land and total land in Table 18. The density of fertilizer use is higher in the Western Lake Ontario Sub-Basin than in the Trent-Moira Sub-Basin. The average density of fertilizer nutrient usage for the Canadian Lake Ontario Basin is 19.5 kg nitrogen (43 lb), 14.0 kg phosphorus (P_2O_5) (31 lb), and 14.8 kg potassium (K_2O) (33 lb) per ha of improved farmland. The density of fertilizer nutrients per ha of total land is 4.7 kg nitrogen (10 lb); 3.4 kg phosphorus (P_2O_5)(7.5 lb) and 3.6 kg potassium (K_2O) (8 lb).

TABLE 18: ESTIMATED ANNUAL USAGE OF FERTILIZER NUTRIENTS

Sub-Basin	(kg/improved ha)			(kg/total ha)		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Western Ontario	24.3	17.4	18.5	10.3	7.4	7.8
Trent-Moira	14.1	10.1	10.8	2.3	1.7	1.8
Average of Canadian Lake Ontario Basin	19.5	14.0	14.8	4.7	3.4	3.6

pounds/acre (lb/acre) = kilograms /hectare (kg/ha) x 0.8922

AGRICULTURAL MANURES

The total nutrients from manure in the two major sub-basins in the Canadian portion of the Lake Ontario Basin are listed in Table 19. The amount of each nutrient is slightly higher in the Western Lake Ontario Sub-Basin than in the Trent-Moira Sub-Basin; however, the differential is much smaller for manure nutrients than it is for fertilizer nutrients (see Table 17).

Manure contributes about 23,700 t/a nitrogen (52.1 million lb/a), while fertilizers account for about 13,800 t/a (30.4 million lb/a). The pattern is similar for potassium (K_2O), with 23,000 t/a (50.6 million lb/a) coming from manure and 10,500 t/a (23.1 million lb) from fertilizers. Phosphorus (P_2O_5) is split more equally with 10,600 t/a (23.3 million lb/a) attributed to manure and 9,900 t/a (21.8 million lb/a) to fertilizers.

TABLE 19: ANNUAL TOTAL NUTRIENTS FROM AGRICULTURAL MANURE

Sub-Basin	(kg)		
	N	P_2O_5	K_2O
Western Lake Ontario	12,998,800	5,836,300	11,954,700
Trent-Moira	9,680,850	4,768,800	10,954,400
Total Canadian Lake Ontario Basin	22,679,700	10,605,100	22,909,100

pounds (lb) = kilograms (kg) x 2.2046

TABLE 20: ESTIMATED ANNUAL PRODUCTION OF MANURE NUTRIENTS

	(kg/improved hectare)			(kg/total ha)		
Sub-Basin	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Western Lake Ontario	34.9	15.7	32.1	14.8	6.6	13.6
Trent-Moira	28.9	14.2	32.7	4.7	2.3	5.3
Total Canadian Lake Ontario Basin	32.1	15.0	32.4	7.7	3.6	7.8

pound/acre (lb/acre) = kilogram/hectare (kg/ha) x 0.8922

COMBINED FERTILIZERS AND MANURES

The estimated annual total nutrients from commercial fertilizer usage and agricultural manure production are presented in Table 21. A total of 36,450 t nitrogen (80.2 million lb), 20,480 t phosphorus (P_2O_5) (45.0 million lb), and 33,400 t potassium (K_2O) (73.5 million lb) are received by the Lake Ontario Basin from both Canadian fertilizers and agricultural manure on an annual basis.

TABLE 21: ESTIMATED ANNUAL TOTAL NUTRIENTS FROM FERTILIZER USAGE AND MANURE PRODUCTION

	(t/a)		
Sub-Basin	N	P_2O_5	K_2O
Western Lake Ontario	22,030	12,310	18,840
Trent-Moira	14,420	8,110	14,560
Total Canadian Lake Ontario Basin	36,450	20,480	33,400

pounds (lb) = tonnes (t) x 2200

ROAD SALTS

The data presented in Table 22 is a comprehensive summary of salt use in the Canadian portion of the Lake Ontario Basin. The salt indicated is rock salt or sodium chloride, which is composed of 94 to 97 percent pure sodium chloride, plus small quantities of chlorides, carbonates and sulphates of calcium and magnesium.

Of the 741,620 t (1.6 billion lb) of salt used in the Canadian Lake Ontario Basin, 629,560 t (1.4 billion lb), 85 percent of the total salt used in the Western Lake Ontario Sub-Basin. This is due to the higher concentration of roads in the Western Lake Ontario Sub-Basin than in the Trent-Moira Sub-Basin.

The intensity of salt use (kg/ha of land) is 711 in the Western Lake Ontario Sub-Basin, 70

in the Trent-Moira Sub-Basin, and 298 in the entire Lake Ontario Basin.

TABLE 22: USE OF ROAD SALT IN THE CANADIAN PORTION OF THE LAKE ONTARIO BASIN

Sub-Basin	Total Salt Use (t/a)	Land Area (ha)	Intensity of Salt Use (kg/ha)
Western Lake Ontario	629,560	883,040	711
Trent-Moira	112,060	1,606,060	70
Total Canadian Lake	741,620	2,489,100	
		Average:	298

pounds (lb) = tonnes (t) x 2200
acres = hectares (ha) x 2.471
pounds/acre (lb/acre) = kilograms/hectare (kg/ha) x 0.8922

SUMMARY

The Canadian Lake Ontario Basin has a total land area of 2,942,872 ha (7.27 million acres), of which 707,350 ha (1.75 million acres) are improved farmland. The estimated annual total nutrients from fertilizer usage and manure production are: 36,450 t (80.2 million lb) nitrogen; 20,480 t phosphorus (P_2O_5) (45.0 million lb), and 33,400 t potassium (K_2O) (73.5 million lb). About 38 percent of the nitrogen, 48 percent of the phosphorus and 31 percent of the potassium come from commercial fertilizers. The remainder of the nutrients are attributable to agricultural manure.

The estimated annual usage of fertilizer nutrients, in terms of kg/ha of improved farmland, is as follows: nitrogen - 19.5; phosphorus (P_2O_5) - 14.0; and potassium K_2O) - 14.8. The estimated annual usage of manure nutrients, expressed in kg/ha of improved farmland, is nitrogen - 32.1; phosphorus (P_2O_5) - 15.0; and potassium (K_2O) - 32.4.

Approximately 326 t (717,200 lb) herbicides are applied annually in the Canadian Lake Ontario Basin; 234 t fungicides (514,800 lb); and 241 t insecticides (530,200 lb). Herbicides are used less in the Canadian Lake Ontario Basin than in the Canadian Lake Erie Basin. The majority of the herbicides, 286 t (88 percent of the total herbicides used in the Canadian Lake Ontario Basin), are applied to field crops, while almost all of the fungicides and insecticides are used on fruits and vegetables. The greatest use of fungicides, over 50 percent of the total amount, is in the Niagara region. Prince Edward, Northumberland, and Wentworth counties also have a high use of fungicides. As might be expected, the area of heaviest use of insecticides is also the Niagara Region.

It is estimated that a total of 741,620 t (1.6 billion lb) of salt are used on roads in the Canadian Lake Ontario Basin in an average winter. The salt indicated is rock salt, or sodium chloride, which is composed of 94 to 97 percent pure sodium chloride plus small quantities of chlorides, carbonates, and sulphates of calcium and magnesium.

In the Canadian Lake Ontario Basin, the amounts of road salt used are very high relative to the Canadian Lake Erie or Lake Huron basins. This is attributed to the greater number of roads concentrated in the southwest corner of the Canadian Lake Ontario Basin. Actual application rates have decreased in the last ten years because of more conservative de-icing practices. However, the total amount of road salt used has increased because the total mileage of roads has increased.

SOURCE MATERIALS

PRIMARY SOURCE

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SECONDARY SOURCES

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OTHER AGENCIES CONSULTED

Canadian Salt Company Ltd.

Crop Science Department, University of Guelph.

Domtar Chemicals Ltd., Sifto Salt Division.

Economics Branch, Ontario Ministry of Agriculture and Food.

Iroquois Salt Products Ltd.

Maintenance Branch, Ontario Ministry of Transportation and Communications.

Soils and Crops Branch, Ontario Ministry of Agriculture and Food.

Water Resources Branch, Ontario Ministry of the Environment.

5 FUTURE TRENDS

POPULATION

The population forecasts presented in Table 23 were compiled by the Regional Planning Branch of the Ontario Ministry of Treasury, Economics, and Intergovernmental Affairs (1). A basic assumption underlying these forecasts is that there will be no major intervention in current trends in the form of development projects or special government policies.

Table 23 contains population projections for the Canadian portion of the Lake Ontario Basin and its two major sub-basins, for the years 1980, 2001, and 2021. The general outcome of these projections is that the large urban complexes in the Western Ontario Sub-Basin, in particular the Toronto-Hamilton area, will have a much larger proportion of the Canadian Great Lakes Basin population in the future than they have now. The Canadian Lake Ontario Basin population is predicted to more than double over the forecast period, from 4,035,064 in 1971 to 8,118,689 in 2021. The Western Lake Ontario Sub-Basin proportion of this population will increase from 91 to 93 percent of the total Canadian Lake Ontario Basin population.

TABLE 23: POPULATION PROJECTIONS FOR THE CANADIAN PORTION OF THE LAKE ONTARIO BASIN

Sub-Basin	1971	1981	2001	2021
Western Lake Ontario	3,656,181	4,294,572	5,821,387	7,567,111
Trent-Moira	378,883	412,432	482,620	551,578
Total Canadian Lake Ontario Basin	4,035,064	4,707,004	6,304,007	8,118,689

ECONOMIC ACTIVITY

The economic activity projections presented here were produced by Informetrica Limited (2). Details concerning methodology were presented in Appendix A of Volume I in this report series.

Two sets of estimates were made, Series A and Series B.

Series A postulates a world economy in which basic resources are continually in short supply. This is reflected in two ways:

a) a rapid growth in world prices of several major commodity groups, mainly associated with metals, mining, and energy, will occur; and

b) the assumption that Canadian suppliers of these goods will respond by providing a rapid growth in the volume of these goods that are exported.

Over the long period under review in this study, the growth of economic output will be a function of the growth in the labour force, increases in productivity per worker, and the ability of policy makers to keep the economy continuously operating at or near "potential", with acceptable price increases. It is assumed that governments will operate the economy at close to the potential, accepting an average annual increase of about 4.1 percent in prices in the long term as measured by the implicit deflator of Gross National Product. This rate is somewhat higher than has been experienced in the post-World War period and reflects the general assumption of a continued world scarcity of basic resources.

Growth of the supply of labour is related to the growth of the population eligible to work and the willingness of that group to participate in the labour force. The past generation has seen a steady decline in the average hours worked per week. It is anticipated that this trend will continue, the average falling from a present 36 hours per week to about 27 in 2020. On the other hand, there has been a clear tendency for people to participate (albeit in the reduced work week) in the past. This is attributable primarily to the increased rate of women's participation. It is expected that this trend will also continue. The participation rate of women under the age of 35 is projected, for example, is projected to rise from a present 45 percent to almost 80 percent in 2020. Overall, it is projected that the participation rate will rise from its current 58 percent to almost 65 percent in 2020.

Consequently, the labour force can be expected to grow at an average annual rate of about 1.5 percent in 1974-2020. This factor together with a growth in output per labourer averaging about 2.7 percent annually, yields an expected average annual growth of 4.2 percent of the Gross National Product (in constant dollar terms). The pattern over time is interesting. The potential for rapid growth is almost certain to deteriorate over time, as the growth of the labour force slows. Thus, in 1974 -1990, the economy can potentially grow at an average annual rate of about 4.8 percent. However, from 1991 through 2020, this potential is restricted by the slow growth of the labour force to about 3.8 percent per year.

To support the rapid growth of government services, it is assumed that taxes will be such that disposable personal income per capita will grow slightly less rapidly than Gross National Product. Nevertheless, this indicator of economic well-being will continue to increase at an average annual rate of 3.0 per cent in 1974-2020. This rate is only slightly less than that which was maintained in the 1960's. In terms of 1961 prices, per capita disposable income will rise from $4,950 in 1974 to $9,410 in 2020.

The consumption of public goods and services, as measured by government current expenditures, is projected to provide an increasing share of total expenditures at the expense of private consumption. Under conditions of a slowly growing population, this is a reasonable projection if the economy is to operate at its full potential. Among private consumption items, expenditures for services and durable goods can he expected to grow most rapidly, as has been the case in the past decade.

Demand generated for investment is projected to provide 21-22 percent of total expenditures, of which the private sector is expected to provide an even greater amount. The one significant contrast between the experience of recent years and that expected in future years is in the projection for residential construction, which is projected to grow slowly and to decline as a proportion of total expenditures. This can be attributed to the projected pattern of population growth. The formation of new households, which has grown rapidly in the past decade, can be expected to increase at slower rates in the future. Domestic savings should be sufficient to finance investment throughout most of the period. Business and government can be expected to provide increasing shares of total savings, particularly after the mid-1980's. Until that time, low dependency ratios (i.e., the ratio of the number of persons not in the labour force to those employed) should cause personal savings to rise rapidly.

In Series B by the year 2020, exports (in current dollars) will he about 23 percent less than in the Series A simulation. This is accomplished by assuming that:

a) world prices for uranium, coal, iron ore and automobiles will grow less rapidly after 1985, and
b) the volume of exported uranium, coal and iron ore will grow more slowly, reflecting a diversion of investment interest from these sectors of the economy.

In constant dollar terms, exports in 2020 are 10 percent less than in Series A.

Such assumptions would lead to a much slower increase in economic activity and would yield a sustained high rate of unemployment. This will provide the rationale for governments to sufficiently increase transfers to persons, in order to generate domestic demand that will again lead (as in Series A) to an economy operating at "potential".

Given that policy is set to yield growth at "potential" in both simulations, the trace of economic activity in the alternative forecasts will be less broadly distinguished than would be the case if major structural differences in the economy were allowed. The changed external assumptions will have a major depressive effect, for example, on the output of the mining industry. But, because of the compensation for the slack foreign demand, this depressive effect will be partially offset. It is, of course, possible to perceive of alternative simulations that are radically differentiated. However, most of those would entail the articulation of major changes to the institutional and behavioural structure of the economic system. Such an articulation would be a major task.

Given the underlying policy assumption, the results of Series B, as measured by such major aggregates as Gross National Product, the Consumer Price Index, and Personal and Disposable Income, are very similar to those of Series A. In Series B, Disposable Personal Income per person in 2020 amounts to $9,710 (in 1961 dollars) as compared to $9,410 in Series A. Most of the major characterizations detailed above for Series A apply to this simulation as well.

The Series A economic activity projections for the Canadian portion of the Lake Ontario Basin are presented by major industrial group in Table 24. Total economic output is forecast to increase by a factor of eight, from 13,314.29 (millions of 1961 dollars) in 1972 to 103,831.5 in 2020. The contribution of the land based industries (i.e., agriculture, forestry, fisheries, and mining) to the total output is projected to remain constant at 2 percent. Manufacturing will increase its share of total output from 39 to 48 percent, and other sectors will experience a relative decline.

TABLE 24: ECONOMIC ACTIVITY PROJECTIONS FOR THE LAKE ONTARIO BASIN, SERIES A

Real Domestic Product by Major Industrial Group
(millions of 1961 dollars)

	1972	1980	2000	2020
Agriculture	128.38	176.88	362.04	782.45
Forestry	5.11	8.39	17.47	34.80
Fisheries	0.97	1.05	1.44	2.26
Mining	89.16	137.84	327.66	825.93
Manufacturing	5,235.16	8,657.24	19,763.07	50,126.22
Construction	727.40	1,110.21	2,144.08	4,330.80
Trans. Utilities Trade & Other	7,128.11	11,082.75	23,423.71	47,729.04
Total Output All Sectors	13,314.29	21,174.36	46,039.47	103,831.50

MAJOR LAND USES

AGRICULTURE

The following agricultural land use forecasts are based upon trend projections, upon alternative assumptions of technological advance, and upon the assumption that political or economic factors will force agricultural output to grow in step with population (3).

The transition of traditional, labour-intensive farming to its modern capital intensive form has been an essential part of the creation of the present structure of the economy. Rapid growth in agricultural productivity has resulted in the release of labour and land to other sectors of the economy, while permitting absolute growth in the volume of agricultural commodities produced. These changes have been brought about through intensified use of intermediate inputs, especially machinery, fertilizers and pesticides.

The last few years have been somewhat different from those experienced by the economy over the entire 1950 - 1974 period. In 1973, and again in 1974, real wages and salaries dropped from the previous year's levels. These were the only times that this has happened in recent years. Furthermore, only in the seventies has the agricultural sector improved its position relative to the rest of the economy. If these are not temporary phenomena, future trends in agriculture will see little resemblance to the past. The outflow of land and labour will cease, and perhaps even reverse. In the forecasting exercise, this is the most critical question.

In a pessimistic scenario, it is assumed that these aggregate events will signify a turning point. The area of land required to sustain the consumption standards of a fixed number of people cannot be expected to decline as dramatically as it has in the past. Therefore, through price-induced resources movements, or through government economic directives, the present decline in the land base of agriculture will be halted.

In an alternative optimistic scenario, it is assumed that the events of the recent past are a short run aberration and that agriculture will return to its typical pattern of rising yields and reduced acreages.

In both scenarios it is assumed that either market forces or government intervention will ensure basic food production. Specifically, it is assumed that the physical volume of agricultural production will grow over any period at a constant proportion of the growth rate of Ontario population*. For a detailed discussion of methodology, see Appendix A of Volume I in this report series.

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* A key omission in this study is the relationship between Ontario agriculture and the rest of the world. An implicit assumption of the present study is that Ontario will not increase its net reliance on outside agriculture at a faster rate than it has in the past.

TABLE 25: AGRICULTURAL LAND USE FORECAST FOR THE CANADIAN PORTION OF THE LAKE ONTARIO BASIN

(ha)

	1980		2000		2020	
Scenario:	OPTIMISTIC	PESSIMISTIC	OPTIMISTIC	PESSIMISTIC	OPTIMISTIC	PESSIMISTIC
Western Lake Ontario Sub-Basin	351,388	344,496	274,831	393,028	232,792	618,780
Trent-Moira Sub-Basin	447,194	440,116	321,983	432,958	249,686	595,326
Total Canadian Lake Ontario Basin	798,582	784,612	596,814	825,986	482,478	1,214,106

acres = hectares (ha) x 2.471

The agricultural land use forecasts are listed by sub-basin groups in Table 25. The alternative forecasts of agricultural land use predict radically different futures for the Canadian Lake Ontario landscape. In the optimistic scenario, which is based upon the assumption that agricultural yields will continue to improve over the forecast period, the total area used by agriculture is predicted to decline. The reasons for the decline vary between the two sub-basins. In the Western Lake Ontario Sub-Basin, urban expansion is important. In the Trent-Moira Sub-Basin it is the continued decline of farm incomes which induces farmers to abandon production on marginal agricultural land.

In the pessimistic scenario, which is based upon the assumption that an upper limit to yields is being approached, the decline of the area occupied by agriculture will be halted between 1980 and 2000. Subsequently, a significant area will be absorbed by agriculture.

Which scenario will best approximate the future? This depends on the nature of technological advance in agriculture. It depends also on the nature of the decision-making process in agriculture. Will broad trends in agriculture be set by the decisions of isolated producers, responding to the product prices, land prices, and factor prices that are established in the world of monopolies that surrounds them; or will the broad trends of agriculture be established by state intervention, based upon a normative evaluation of the cost of resource use and of the value of alternative categories of consumption? Finally, what is becoming more scarce: farmland; energy; or the ability of the environment to absorb larger doses of biocides and fertilizer? Many forces are acting upon agriculture and the resolution of these forces is not at all clear.

URBAN

The urban land use forecasts in this report are based upon a cross- sectional analysis of the relationship between urban population and urban area (4). They are basically unconstrained, assuming no more effective planning than exists now, and also that the economy will continue to be the major determinant of the urbanization process.

Two different methodologies were used. The first is the constant land consumption rate method, which is based on the assumption that any increments of urban population will occupy as much space per person as the current urban population. The second approach is the allometric method, which assumes that as population increases, urban area also increases, but at a slower rate, reflecting a higher density and more intense use of land in larger cities. Finally, a preferred forecast, called the declining land consumption rate forecast, which combines the best attributes of both methods, is also presented. A detailed description of the methodologies is presented in Appendix A of Volume I in this report series.

DEFINITIONS

Urban Population, as defined in the 1971 Census of Canada, includes the population living

in: (1) incorporated cities, towns, and villages with a population of 1,000 or over; (2) unincorporated places of 1,000 or over, having a population density of at least 1,000 per square mile; and (3) the built-up fringes of (1) and (2) having a minimum population of 1,000 and a density of at least 1,000 per square mile.

Urban Area refers to the land actually used for residential, commercial, industrial, institutional or transportation purposes.

Land Consumption Rate is an intensity measure describing the relationship between urban population and urban area, expressed in hectares per 1,000 persons.

Urban land forecasts for the Canadian portion of the Lake Ontario Basin are presented by sub-basin in Table 26. About 89,000 additional ha (219,900 acres) of urban land will be required to accommodate population growth to the year 2020. Most of this urban expansion (94 percent) will take place in the Western Lake Ontario Sub-Basin, which presently contains 40 percent of all the urban land in the Canadian Great Lakes Basin.

Since there is a fixed amount of land in the Canadian Lake Ontario Basin, the forecast urban expansion will necessitate the conversion of non- urban land to urban use. Recently, the Lands Directorate, Environment Canada (5), studied the former use of land converted from rural to urban, over the period 1966 - 1971, in 21 Ontario cities. The results of this study for the cities located in the Canadian portion of the Lake Ontario Basin are presented in Table 27. The figures indicate that during that time period, most of the conversion to urban land was agricultural to urban conversion. It is likely that this pattern will continue in the future, as urbanization continues to encroach upon more increasing quantities of land.

TABLE 26: URBAN LAND FORECASTS FOR THE CANADIAN PORTION OF THE LAKE ONTARIO BASIN

(ha)

Sub-Basin	1972	1980	2000	2020
Western Lake Ontario	135,055	147,871	182,280	218,359
Trent-Moira	25,125	25,003	28,632	30,409
Total Canadian Lake Ontario Basin	160,184	172,874	210,912	248,768

acres = hectares (ha) x 2.471

TABLE 27: CONVERSION OF OTHER LAND USES TO URBAN USE IN THE CANADIAN LAKE ONTARIO BASIN CITIES, 1966-1971

City	Percentage of Total Land Converted		
	Agriculture	Forest	Other
Belleville	88	7	5
Hamilton	87	8	5
Kingston	91	5	4
Oshawa	92	6	2
Peterborough	85	15	0
St. Catharines-Niagara	88	11	1
Toronto	92	7	1
Trenton	85	15	0

SUMMARY

Major land use projections for the Canadian Lake Ontario Basin are summarized in Table 28. Considering the Canadian basin as a whole, farmland will decline at a faster rate than urban expansion, and there will be small increases in forest and other land. In the year 2020, about eight percent of the land will be devoted to urban use, 16 percent will remain in agriculture, 68 percent will be forest, and the remainder in other categories.

TABLE 28: MAJOR LAND USE PROJECTIONS FOR THE CANADIAN PORTION OF THE LAKE ONTARIO BASIN, 1972-2020

(1000 ha)

Land Use	1972	1980	2000	2020
Urban	160.2	172.9	210.9	248.8
Agriculture	919.2	798.6	596.8	482.5
Forest	1,779.6	1,877.9	2,007.3	2,007.8
Other	9.12	100.8	135.2	211.1
Total Land Use	2,950.2	2,950.2	2,950.2	2,950.2

SPECIALIZED LAND USE FORECASTS

The five categories of specialized land uses, including waste disposal, erosion zones, intensive livestock operations, high density non-sewered residential areas and recreational lands, bear no simple relationship with the standard economic and demographic variables. The future pattern and extent of specialized land uses in the Canadian Lake Ontario Basin will be more a function of interacting social technological, and legislative factors than of population and economics. The forecasts in this section extend only to the year 1990 because of the great uncertainties involved in specialized land uses.

WASTE DISPOSAL

A major trend in waste disposal is toward fewer, but larger and better managed waste disposal sites. The numerous open dump sites in the Canadian portion of the Lake Ontario Basin are being closed as waste is being consolidated into large sanitary landfill operations.

The Province of Ontario has adopted a waste management program, called Resource Recovery, which uses every practical means available to recover all valuable resources from the waste produced in the Province, and at the same time to eliminate unnecessary waste (6). The program is designed to provide, in three five-year stages, all the facilities necessary for complete resource recovery to serve at least 90 percent of the population of Ontario, and all but eliminate the need for the landfill of waste.

If the above plan is implemented, and garbage is indeed transformed into a resource, waste disposal may not be a problem in the future.

EROSION

Lakeshore and riverbank erosion are basically natural processes caused by natural phenomena. It is likely that these processes will continue at their present long term rates in the future. However, natural erosion can be accelerated by the clearing of vegetation and construction on shorelands. In order to prevent property damage and possible loss of life, shoreline management programs will probably be implemented in the near future. Such programs would regulate development in erosion prone zones, and thereby prevent further man-caused erosion.

INTENSIVE LIVESTOCK OPERATIONS

Due to economics of scale and the escalating cost of land, the trend toward larger numbers of livestock confined to small areas will likely continue in the near future. However, if the animal waste is properly handled, it need not have a negative impact on water quality.

Beef cattle will constitute an increasing proportion of the total number of cattle, due to a relative decline in the numbers of dairy cattle.

HIGH DENSITY. NON-SEWERED RESIDENTIAL AREAS

The urban, high density, non-sewered residential areas will gradually be connected to municipal sewage systems. The rural component of the high density, non-sewered residential areas will likely increase along with increases in the rural, non-farm population.

Advances in private waste disposal system technology may contribute to improved efficiency, resulting in less pollution of ground and surface water.

RECREATIONAL LANDS

If the supply of recreational lands keeps up with the demand for recreation, it will likely increase in the future.

Not only will there be more people wanting recreation, but the possibility of shorter work weeks will give each person more time for recreational pursuits.

MATERIALS USAGE FORECASTS

PESTICIDES

There are formidable obstacles to making statements about the nature and level of pesticide use in the future. New products are continually being introduced to the market. Furthermore, the use of old products can decline, resulting in the withdrawal of some of these products from the market. In addition, legislation can radically alter the pest control choices available for use.

The projections presented are based on the following restrictive assumptions: 1) that there will be no radical changes in pest control practices or types of chemicals used; 2) that the intensity of chemical use will remain constant; and 3) that the proportion of each class of farmland subjected to pesticide use will remain constant. The only remaining variable is the area of farmland. Details of the methodology used in those forecasts are discussed in Appendix A of Volume I in this report series.

Agricultural pesticide forecasts for the Canadian portion of the Lake Ontario Basin are presented in Table 29 under both the pessimistic and optimistic yield scenarios (7). In the lower (optimistic forecast), the use of each type of pesticide is predicted to decline. By contrast, substantial increases in pesticide use are predicted in the upper (pessimistic) forecast.

It should be noted that these forecasts are based on very restrictive assumptions and should not be construed as balanced projections that incorporate estimates of the magnitude of all factors that will affect future pesticide use.

TABLE 29: FORECAST OF ANNUAL AGRICULTURAL PESTICIDE USE IN THE CANADIAN PORTION OF THE LAKE ONTARIO BASIN

(t/a)

		1971	1980	2000	2020
HERBICIDE -	LOWER FORECAST	311	274	218	175
	UPPER FORECAST	-	280	317	477
FUNGICIDE -	LOWER FORECAST	234	223	223	226
	UPPER FORECAST	-	228	324	589
INSECTICIDE -	LOWER FORECAST	241	228	223	224
	UPPER FORECAST	-	233	325	585

dash (-) indicates data not available

pounds (lb) = tonnes (t) x 2200

FERTILIZERS

The volume of fertilizer that will be used by agriculture in the Canadian portion of the Lake Ontario Basin in the future will depend, in a complex way, upon the area used by agriculture, prices of farm products, prices of fertilizers, environmental constraints, and technical limits. Because of the uncertainty of long-run projections, most of these factors have been excluded from the agricultural forecasting exercise. However, the environmental implications of continued rapid increase in the use of fertilizers make it important to consider the magnitude of their use in the future. A description of the methodology appears in Appendix A of Volume I in this report series.

The projected nutrient content of fertilizers used in Canadian Lake Ontario Basin agriculture is presented in Table 30 (7). The forecasts are very sensitive to the assumptions upon which they are based. They indicate that there will be a continued rapid increase in the use of each fertilizer nutrient between now and the year 2000. Subsequently, fertilizer usage is predicted to decline.

TABLE 30: FORECAST WEIGHT OF NUTRIENTS IN COMMERCIAL FERTILIZER USED BY AGRICULTURE IN THE CANADIAN PORTION OF THE LAKE ONTARIO BASIN

(t/a)

	1971	1980	2000	2020
NITROGEN	15,266	17,374	25,127	23,604
PHOSPHORUS (P_2O_5)	14,861	16,905	24,530	23,002
POTASSIUM (K_2O)	18,604	21,122	30,471	28,451
TOTAL NUTRIENTS	48,731	55,401	80,128	75,057

pounds (lb) = tonnes (t) x 2200

The factors behind this projection include the following:

1) an increasing proportion of the area under crops will be fertilized;

2) the total area under crops will continue to decline; and

3) there will be a shift to crops which require more intensive fertilization.

The results would be different if the forecast of agricultural land use consistent with future needs and a pessimistic outlook for yield improvement had been used. In that scenario, the area under crops would begin to increase after 1980.Furthermore, agriculture would be extended to marginal lands which would require more intensive doses of fertilizers than do the 'average acres' upon which the 'recommended application rates' are based.

ROAD SALT

The large volume of salt applied to roads is based upon the dominance of private motor vehicles. If private transportation is de-emphasized in the future, the need to keep roads free of snow and ice will be reduced. At the same time, however, emergency vehicles, i.e., fire engines, police cars, ambulances), buses and all forms of public surface transport will still be impeded by winter road conditions. Therefore, the extinction of the private vehicle would not mark the end of the environment transportation conflict over deicing agents.

The use of road sale in the Canadian portion of the Lake Ontario Basin is expected to increase at a steady rate, from 741,620 t (1.6 billion lb) in 1972 to 833,000 t (1.8 billion lb) in 1980, 1,017,200 t (2.2 billion lb) in 2000, and 1,207,800 t (2.6 billion lb) in 2020.

The projections presented in this section are extremely limited. They are not based upon a systematic scenario of social factors or transportation patterns in the future. Ultimately, it is these factors which will constrain or permit expansion in the use of road salts.

SUMMARY

The quantity of material applied to the land in the Canadian portion of the Lake Ontario Basin to increase its productivity or to remove obstacles to rapid transportation will continue to grow. In this report, quantitative forecasts of the use of the most important of these materials have been presented, with all the implicit assumptions stated.

The uncertainties of the future have been emphasized. There is little that can be said about the preference system of society in the future. In an era characterized by rapid technological change, predictions will inevitably be clouded by the inability to deal with the development of radically new substitutes.

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