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 IV CANADIAN LAKE ERIE BASIN

DECEMBER, 1977

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.

ACKNOWLEDGEMENTS

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 Great 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 Erie Basin has a land area of 2,318,000 ha (5.7 million acres) and consists of two major river basin groups: Sub-Basin 8, the Thames River; and Sub-Basin 9, the Grand River. These two sub-basins lie entirely within the Great Lakes Lowlands physiographic area. The soils generally have a high capability for agriculture, and the climate is the most temperate in the Canadian Great Lakes basins. The most extensive form of vegetation in the Canadian portion of the Lake Erie Basin, by a large margin, is agricultural crops.

MAJOR LAND USES

The dominant land use in the Canadian portion of the Lake Erie Basin is agriculture, which occupies about 80 percent of the total land area of the basin. About 15 percent is forest land, and the remainder is taken up by urban, recreation, extractive industries and other uses.

SPECIALIZED LAND USES

There are 158 active waste disposal sites in the Canadian portion of the Lake Erie Basin which receive about 6,500 t/d (14.3 million lb/d) of waste and cover a land area of 1,944 ha (4,804 acres). Dredge spoil disposal amounts to about 34,000 m^3/a (44,470 yd^3/a). The total net lakeshore erosion on Lake Erie was 17,577,252 m^3 (23 million yd^3) during the period from November 1972 to November 1973. This is 88 percent of the total net erosion on the Canadian Great Lakes. The Lake Erie Basin has more intensive livestock operations than any other Canadian Great Lakes basin. About 13 percent of the population lives in high density, non-sewered residential areas.

MATERIALS USAGE

The Canadian portion of the Lake Erie Basin has a higher level of materials usage than any other Canadian Great Lakes basin. Approximately 3,700 t/a (8.14 million lb/a) of pesticides are applied to agricultural lands. The combined nutrients from commercial fertilizers and agricultural manures amount to 275,000 t/a (605 million lb/a), about 70 percent of which are located in the Thames River Sub-Basin. It is estimated that a total of 207,000 t (455 million lb) of salt are used on roads in the Canadian portion of the Lake Erie Basin in an average winter.

FUTURE TRENDS

The population of the Canadian portion of the Lake Erie Basin is projected to increase from 1,515,445 in 1971 to 2,841,455 in 2020. Total economic output is projected to increase from 4,625.86 (millions of 1961 dollars) in 1972 to 36,057.50 in 2020. The contribution of the land-based industries will continue its past decline, while manufacturing will increase its share of total output. No major changes in land uses are forecast. There will be more urban, agricultural and recreational land, and less forest. The future pattern and extent of specialized land uses in the Canadian portion of the Lake Erie Basin will be more a function of interacting social, technological and legislative factors than of population and economics. The mass of materials applied to the land, to increase its productivity or to facilitate rapid transportation, will continue to grow.

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 of pollutants were not only significant, but also 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.

DETAILED STUDY PLAN

The February 1974 Detailed Study Plan emphasized 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 Great Lakes boundary waters.

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 relating 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 water quality impairment in the Great Lakes, including assessment of concentrations of specific contaminants in sediment, fish and other aquatic components.

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 ERIE DRAINAGE BASIN

The Lake Erie Basin is the southernmost of the Canadian Great Lakes basins. It has a land area of 2,318,000 ha (5.7 million acres). For purposes of this report, the Lake Erie Basin has been divided into two major river basin groups: 1) Sub-Basin 8, the Thames River: and 2) Sub- Basin 9, the Grand River. The boundaries of these two river sub-basins are illustrated in Figure 1.

LAND RESOURCES

GEOLOGY

The Canadian portion of the Lake Erie Basin lies entirely within the Great Lakes Lowlands geologic area. The Grand River Sub-Basin is underlain by bedrock composed mainly of dolomite. The bedrock of the Thames River Sub-Basin is predominantly limestone, except for Kent and Lambton counties, which have shale bedrock.

SOILS AND TOPOGRAPHY

The soils of the upper Grand River Sub-Basin are deep loams; in the lower reaches, they change to deep clay. In the Thames River Sub-Basin, the soils from east to west are deep sand and loam, deep loam and clay, and deep clay.

Essex, Kent and Lambton counties are made up of nearly level plains, with a very gentle slope towards Lake St. Clair. The soils are predominantly clay loams and clays which were deposited in glacial lakes. Much of the land is poorly drained, resulting in extensive tile drainage works.

The strip of land from Guelph to London, encompassing parts of Middlesex, Oxford, Perth, Waterloo, Elgin and Wentworth counties, is made up of undulating to rolling loam soils formed from coarse and medium-textured tills. The topography of the area is varied, consisting of drumlin areas near Woodstock and Guelph, sandy moraines around Kitchener, and undulating sands and sandy loams elsewhere in the basin. In Norfolk, the topography is one of smooth long gentle slopes which have been dissected and eroded adjacent to stream courses.

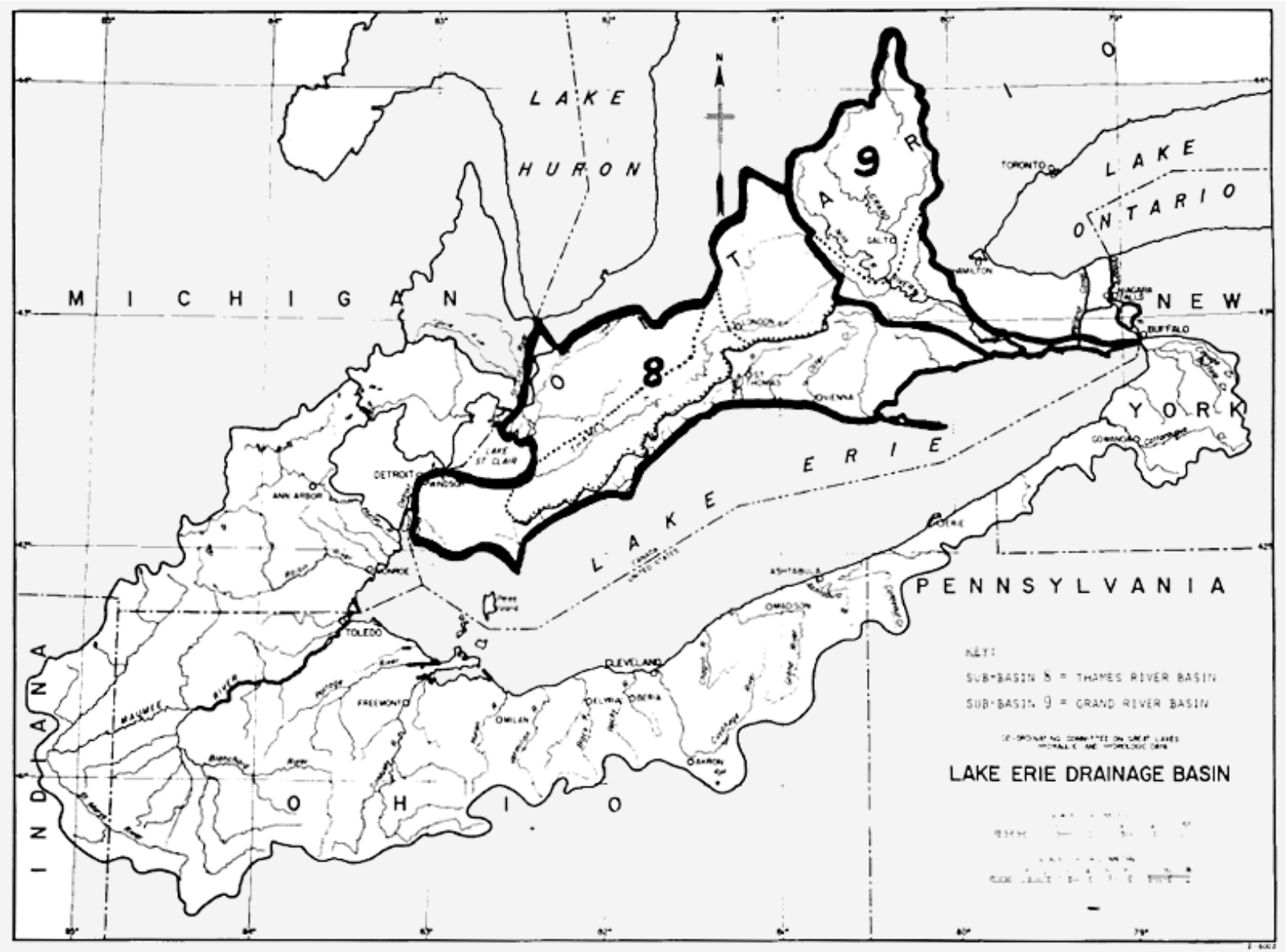

FIGURE 1: CANADIAN PORTION OF LAKE ERIE BASIN

CLIMATE

The Lake Erie Basin has a continental climate, modified by the open water of Lake Erie and the other Great Lakes. The Canadian portion of the Lake Basin experiences the warmest climate in the Canadian Great Lakes Basin, with a growing season of up to 220 days. This relatively mild climate and favourable soils makes the Canadian Lake Erie Basin most suitable for intensive agriculture and, therefore, most likely to receive large amounts of pesticides and fertilizers. The mean annual precipitation for the basin is 82 cm (32 in).

HYDROLOGY

SURFACE WATER

The watershed divisions of the Canadian portion of the Lake Erie Basin are presented in Table 1. The Grand River Sub-Basin is the largest drainage system in southwestern Ontario. It originates less than 20 mi (32 km) south of Nottawasaga Bay, in an area of poorly-defined drainage forming the head-water area not only of the Grand, but also of the Saugeen, the Beaver and Nottawasaga River systems. From its headwaters, the eastern boundary of the Grand River System parallels the Niagara Escarpment to a point immediately west of Hamilton, where the boundary extends southward to Lake Erie. The western portion of the watershed shares a common boundary with Saugeen and Maitland drainage to Lake Huron, with the Thames system draining to Lake St. Clair.

The southern part of the Canadian Lake Erie Basin is drained by numerous coastal creeks, while the Thames and Sydenham Rivers drain the remainder of the basin (Figure 1).

TABLE 1: Watershed Divisions of the Canadian Portion of the Lake Erie Basin

	CODE
Sub-Basin 8: Thames River	
St. Clair and Sydenham Rivers	2GG
Thames River	2GD, 2GE
W. Lake Erie and S. Lake St. Clair	2GH, 2GF
Central Lake Erie shore	2GC
Sub-Basin 9: Grand River	
Grand River	2GA, 2GB
Niagara Peninsula - Erie shore	2HA09

GROUND WATER

The quality and quantity of the ground water of the Lake Erie Basin is variable, depending on the soils and underlying geologic formations.

VEGETATION ZONES

The climax vegetative community of most of the Lake Erie Basin is the deciduous forest, but the upper reaches of the Thames and Grand River watersheds lie in the Great Lakes - St. Lawrence Forest Region. In the Deciduous Forest Region, broadleaved trees, such as sugar maple, beech, white elm, basswood, red ash, white oak and butternut are common. A number of other broadleaved trees have their northern limits in this locality and are scattered throughout the region, including the tulip tree, cucumber tree, paw paw, 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 confined largely to this region. There are only a few conifers, with a scattered distribution of eastern white pine, tamarack, eastern red cedar and eastern hemlock.

The Great Lakes - St. Lawrence Forest Region is characterized by a mixed forest consisting of eastern white and red pines, eastern hemlock and yellow birch. Common to this region are such species 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.

In the course of human settlement of the Canadian portion of the Lake Erie Basin, the natural forest vegetation has been reduced mostly to farm woodlots, hedge-rows and remnant stands on soils which are too poor to farm. Forests now occupy only 348,000 ha (860,000 acres), which is 15 percent of the Canadian portion of the Lake Erie Basin area.

By far, the most extensive form of vegetation in the Canadian Lake Erie Basin area is agricultural crops, which are grown on 50 percent of the land. Another 30 percent is covered by pasture.

ECONOMIC AND DEMOGRAPHIC CHARACTERISTICS

POPULATION

Population growth in the Canadian portion of the Lake Erie Basin from 1901-1971 is presented graphically in Figure 2. The rate of growth was relatively slow until the period 1941-1951, after which it increased rapidly. In 1971, the Canadian Lake Erie Basin had a population of 1,504,559 persons. Approximately 67 percent of this population lived in the Thames Sub-Basin, with the remaining 33 percent in the Grand Sub-Basin.

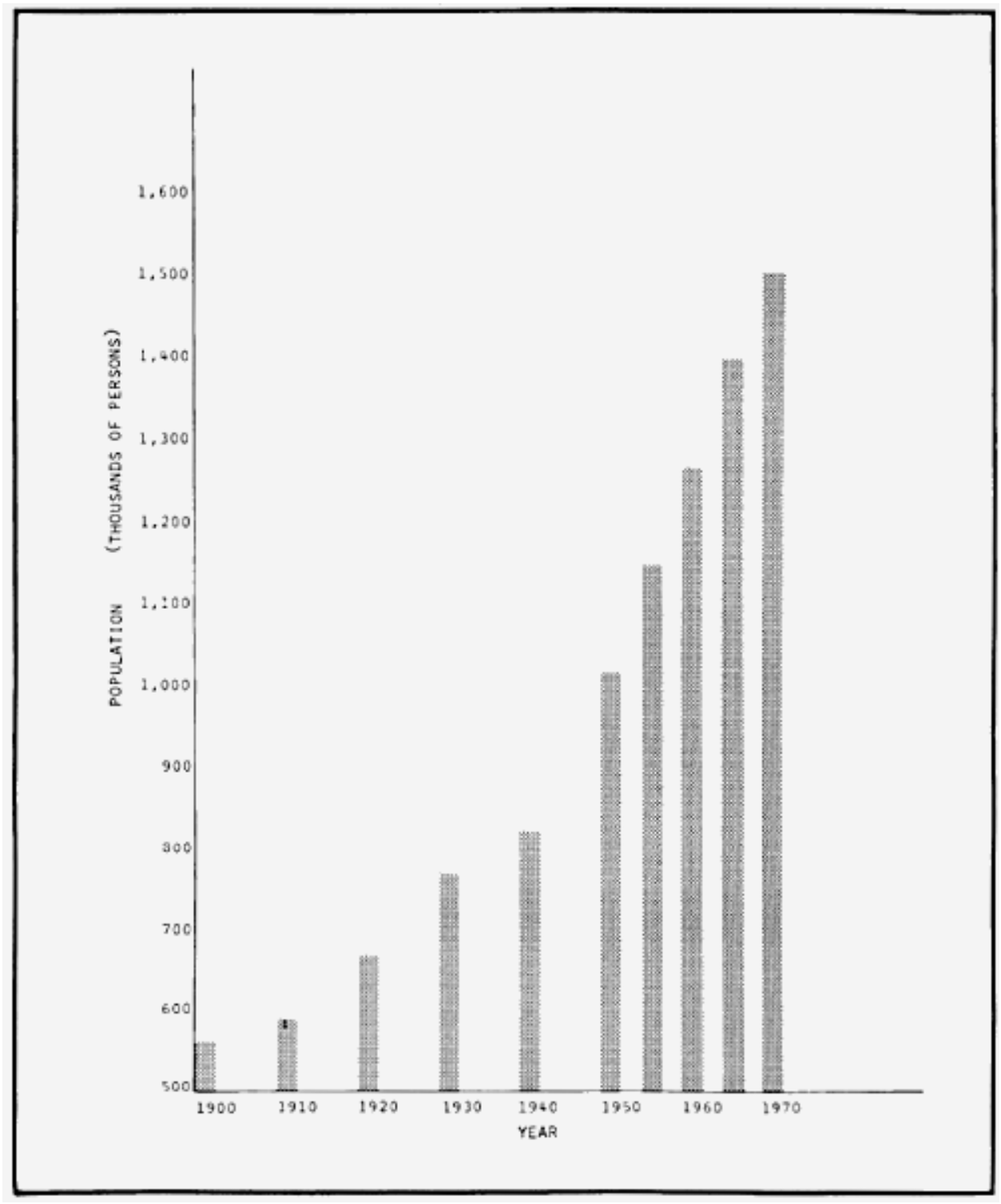

FIGURE 2: POPULATION GROWTH IN THE CANADIAN PORTION OF THE LAKE ERIE BASIN, 1901-1971

RESOURCE USE AND DEVELOPMENT

Table 2 presents 1972 economic statistics for the Canadian portion of the Lake Erie Basin. The land-based industries (i.e., agriculture, forestry, fisheries and mining) all together contribute only about 6 percent of the total economic output, with nearly all of this output from agriculture.

AGRICULTURE

Almost all of the Canadian portion of the Lake Erie Basin ranks high in agricultural capability, meaning it is Land Class 1, 2, or 3, according to the Canada Land Inventory. Its soils are the most acceptable for sustained production of cultivated field crops under good management.

The Lake Erie Basin contains some of the most intensively farmed land in Canada. An intensive cash-cropping type of agriculture is carried out in Essex and Kent counties, the most important crops being corn, soybeans, soft winter wheat, oats and alfalfa hay. Potatoes, white beans, tobacco, barley, tomatoes, cucumbers, melons and many other vegetables and canning crops are also found.

A more general type of farming is common to the part of the basin from Guelph to London. Large increases of land devoted to corn production have occurred in recent years. Hog, poultry and beef operations are scattered throughout the area.

A large section of Brant, Norfolk and Oxford counties constitute the principal tobacco growing area in Ontario. The sandy soils require high rates of irrigation and fertilization to maintain high productivity. Tree fruits, vegetables, grain corn, and canning crops are also grown extensively in this area.

FORESTRY

Nearly all of the Canadian portion of the Lake Erie Basin has a high potential for forest production. However, the level of forest cover is low because the land also has a high agricultural capability, and is extensively farmed as a result. Productive forests are largely confined to farm woodlots, river valleys, swamps and areas of shallow or infertile soil.

MINING

The Canadian portion of the Lake Erie Basin lacks the valuable metallic ore deposits characteristic of the northern Great Lakes basins. However, it does have a significant extraction potential in sand and gravel and other raw materials for the construction industry. The area of highest mineral potential is around Windsor.

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

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

	THAMES RIVER (Sub-Basin 8)	GRAND RIVER (Sub-Basin 9)	TOTAL
Agriculture	166.65	62.89	229.54
Forestry	1.19	0.88	2.07
Fisheries	1.56	0.24	1.80
Mining	17.07	5.49	22.56
Manufacturing	1271.52	733.01	2004.53
Construction	158.21	85.93	244.14
Transportation, Utilities Trade and other	1453.16	668.05	2121.21
Total Output, All Sectors	3069.37	1556.49	4625.86

RECREATION

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

Areas of high capability for intensive recreation occur along the Lake Erie shoreline in Essex County, at Point Pelee and Rondeau in the Niagara region, and in the Elora Gorge north of Kitchener. Areas of high capability for extensive recreation exist along the Lake St. Clair shoreline and at Point Pelee.

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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 1 in this report series.

LAND USE CLASSIFICATION SYSTEM

INTRODUCTION

The factors were 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 land use categories should be different with respect to water runoff, types of pollution, degree of pollution, etc. The categories used in the inventory of the Canadian portion of the Lake Erie 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 10 to 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 in this category.

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

OUTDOOR RECREATIONS - Land used for private or public outdoor recreation. This category included such land use types 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.

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

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

RESULTS

SUB-BASIN 8: THAMES RIVER

Sub-Basin 8 (Table 1) is composed of four major sub-watersheds: 1) St. Clair and Sydenham Rivers; 2) Thames River; 3) Western Lake Erie and Lake St. Clair shore; and 4) the Central Lake Erie shore. The major land uses in these sub-watersheds and the total sub-basin are presented in Table 4.

Approximately 1,300,512 ha (3,213,565 acres) of land in the Thames River Sub-Basin is used for agriculture, approximately 81 percent of its total area. In contrast to agricultural land in the Lake Huron and Lake Ontario Basins, the farmland of the Thames River Sub-Basin is 72 percent cropland, orchards and horticultural land, and only 28 percent pasture.

Forest in the Thames River Sub-Basin has dwindled to 222,770 ha (550,464 acres), or 14 percent of its total land area.

Urban centres with populations greater than 25,000 are present in each of the four sub-watersheds. The total urban land in Sub-Basin 8 is 56,190 ha (138,845 acres), or about 3.5 percent of its total land area.

Another 21,973 ha (54,295 acres; 1.4 percent of total land area) are classified as marsh and swamp, which is excellent habitat for waterfowl wildlife. The land used for outdoor recreation amounts to 5,922 ha (14,633 acres), 0.4 percent of the total land area of the sub-basin.

TABLE 4: MAJOR LAND USES IN THAMES RIVER SUB-BASIN (SUB-BASIN 8)

	Sydenham St. Clair & River	Thames River	Western Lake Erie & Lake St. Clair Shore	Central Lake Erie Shore	Total Sub-Basin 8
Urban Areas > 25,000 pop.					
Commercial-Industrial			Hectares(ha)		
Low Density	31	305	270	74	680
Medium Density	162	1356	454	0	1972
High Density	1701	3483	2280	428	7892
Total Com.-Indust.	1894	5144	3004	502	10544
Residential					
Low Density	607	963	2226	240	4036
Medium Density	863	7303	3936	584	12686
High Density	566	1753	1631	269	4219
Total Residential	2036	10019	7793	1093	20941
Transportation	28	689	474	93	1284
Total Urban > 25,000	3958	15852	11271	1688	32769
Urban Areas < 25,000 pop.	2708	5933	7799	6981	23421
Total Urban Areas	6666	21785	19070	8669	56190
Extractive					
Extractive	442	1371	434	352	2599
Slag Heaps	0	0	0	0	
Total Extractive	442	1371	434	352	2599
Outdoor Recreation	573	1720	2714	915	5922
Agriculture					
Orchards, Hort.,etc.	572	2708	8345	6148	17773
Cropland	196168	314315	184571	225134	920188
Improved Pasture	68760	131032	8150	49149	257091
Unimproved Pasture	27566	47937	9512	20445	105460
Total Agriculture	293066	495992	210578	300876	1300512
Forest	58923	65826	17625	80396	222770
Marsh and Swamp	9421	1538	3259	7755	21973
Barren	239	0	514	1828	2581
total Watershed Land Area	369330	588232	254194	400791	1612547

acres = hectares (ha) x 2.471

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

SUB-BASIN 9: GRAND RIVER

The Grand River Sub-Basin contains the Grand River watershed itself, plus a small strip of land in the Niagara Peninsula which drains into Lake Erie. Major land uses in these two sub-watersheds are presented in Table 5.

The dominant land use in the Grand River Sub-Basin is agriculture, which occupies 551,747 ha (1,363,372 acres), or 78 percent of its total land area. The agricultural land is broken down into sub-classes as follows: orchards and horticulture - 1,214 ha (3000 acres; 0.2 percent of agricultural land) cropland - 243,053 ha (600,584 acres: 44 percent of agricultural land) and pasture - 307,480 ha (759,783 acres; 56 percent of agricultural land). Sub-Basin 9 has a higher percentage of farmland in pasture than does Sub-Basin 8 (44 versus 28 percent respectively), although the absolute numbers are relatively similar.

About 17 percent of the Grand River Sub-Basin (119,417 ha or 295,079 acres) is forest land. Urban uses cover 28,757 ha (71,063 acres) or 4 percent of the total land area. Only 2,107 ha (5206 acres; 0.3 percent of the total land area) are used for outdoor recreation, and 1,665 ha (4114 acres; 0.2 percent of the total land area) for extractive purposes.

TABLE 5: MAJOR LAND USES IN THE GRAND RIVER SUB-BASIN (SUB-BASIN 9)

	Grand River	Niagara Pen. Erie shore	Total Sub-Basin 9
Urban Areas > 25,000 pop.		Hectares (ha)	
Commercial - Industrial			
Low Density	620	0	620
Medium Density	1168	102	1270
High Density	4523	289	4812
Total Com.-Indust.	6311	392	6703
Residential			
Low Density	1342	1619	2961
Medium Density	7417	498	7915
High Density	2193	1305	3498
Total Residential	10952	3422	14374
Transportation	442	48	490
Total Urban > 25,000	17705	3862	2157
Urban Areas < 25,000 pop.	6510	680	7190
Total Urban Areas	24215	4542	28757
Extractive			
Extractive	1632	33	1665
Slag Heaps	0	0	0
Total Extractive	1632	33	1665
Outdoor Recreation	1836	271	2107
Agriculture			
Orchards, Hort. etc.	1179	35	1214
Cropland	240551	2502	243053
Improved Pasture	241842	3240	245082
Unimproved Pasture	58772	3626	62398
Total Agriculture	542344	9403	551747
Forest	118035	1382	119417
Marsh and Swamp	1465	0	1465
Barren	303	0	303
Total Watershed Land Area	689830	15631	705461

acres = hectares (ha) x 2.471

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

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3 SPECIALIZED LAND USES

INTRODUCTION

Seven specialized land use categories are inventoried in this report. They are as follows: 1) mine tailings disposal sites; 2) waste disposal sites: 3) dredge spoil disposal; 4) shoreline erosion; 5) river bank erosion; 6) intensive livestock operations and 7) high density, non-sewered residential areas. These specialized land uses are discussed individually below.

DISPOSAL OPERATIONS

MINE TAILINGS DISPOSAL SITES

The Canadian portion of the Lake Erie Basin contains no mine tailings disposal sites.

WASTE DISPOSAL SITES (1)

INTRODUCTION

The tabulated data on waste disposal sites in the Thames River and Grand River Sub-Basins are presented in Tables 6 and 7, respectively. The tables include liquids, solids, hazardous materials and deep well disposal sites which were licensed 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 presented in Appendix A of Volume I in this report series.

The column headings in Tables 6 and 7 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 (acres).
Population Served -	Operator's estimate of the population served.
Waste Type -	S - Solid, L - Liquid, H - Hazard
Volume -	Listed in tons/day, unless otherwise indicated.

TABLE 6: WASTE DISPOSAL SITES IN THAMES RIVER SUB-BASIN (SUB-BASIN 8)

No.	MOE No.	Municipality	Opened	Closed	Area	Population Served	Waste Type	Volume	1971 Proj. Life	Water Sheds
		KENT COUNTY:								
237	020101	Chatham			.013		S	20/wk		2GE
238	L020601	Tilbury				3,501	S	6		2GE
239	L020701	Wallaceburg	11/10/73		0.3	3,800				2GG
240	L021202	Wheatley	11/1/74		0.8	1,600	S	8/wk	5	2GF
241	021302	Camden Twp.			1.8			50/wk		2GE
242	L021303	Camden Twp.	28/7/72		20.0	2,490	S	2/wk		2GG
243	L021304	Camden Twp.				2,465	S	6		2GG
244	L021306	Camden Twp.			2.0	2,375	S	6		2GG
245	L021401	Chatham Twp.			2.0	7,061	S	8-10	10	2GE
246	L021501	Dover Twp.		Fall/73	3.0					2GG
247	L021601	Harwich Twp.			40.0	41,000	S, L	245	20	2GF
248	L021603	Harwich Twp.			40.0	3,000	S	6	50	2GE
249	L021701	Howard Twp.			2.8	3,000	S	-	5	2GE
250	L021702	Howard Twp.	19/7/72		1.6	1,500	S	-	25	2GF
251	L021801	0rford Twp.			22.8	2,000	5	1	50	2GE
252	L021901	Raleigh Twp.	15/5/72		6.0	32,500	S	10	5	2GE
253	L021902	Raleigh Twp.			2.0	5,496	S	5	10	2GE
254	L022002	Romney Twp.			2.0	1,800	S	2½	40	2GF
255	L022102	Tilbury East	Twp.		0.8	2,886	5	5	10	2GE
256	L022103	Tilbury East	Twp.		24.0		S		50	2GE
257	L022201	Zone Twp.			20.8	1,100	S	20-3	100	2GE
258	L020102	Chatham	19/10/72		0.2		L		20	2GE

TABLE 6 (continued): WASTE DISPOSAL SITES IN THAMES RIVER SUB-BASIN (SUB-BASIN 8)

No.	MOE No.	Municipality	Opened	Closed	Area	Population Served	Waste Type	Volume	1971 Proj. Life	Water Sheds
		MIDDLESEX COUNTY:								
310	L040102	London		10/15/73	12.0	215,000	S			2GE
311	L040103	London		Fall/73	6.0	215,000	S			2GD
312	L040104	London		Fall/73	38.8	215,000	S			2GE
313	L040105	London			72.0	215,870	S, L	520	4	2GD
331	L041801	Metcalfe Twp.			1.6	800	S	½ /wk	40	2GG
332	L041902	Mosa Twp.								2GG
333	L042004	Nissouri West Twp.			0.8	3,060	S	4	2	2GD
334	L042101	Westminster Twp.			3.2	6,500	S	4	3	2GE
319	L041101	Caradoc Twp.			13.6	2,000	S	3	-	2GE
320	L041103	Caradoc Twp.			4.0	500	S	½	10	2GG
321	L041202	Delaware Twp.			1.6	2,200	S	3	10	2GE
322	L041301	Dorchester N.Twp,	21/3/72		-	-	-	-	-	2GD
323	L041302	Dorchester N. Twp.		15/12/71	2.2	6,123	S			2GD
324	L041401	Ekfrid Twp.								2GE
325	D041402	Ekfrid Twp.								2GE
326	L041403	Ekfrid Twp.			20.0	3,200	S	4-5	25	2GE
327	L041501	Lobo Twp.			10.8	4,000	S	20/wk		2GE
328	L041502	Lobo Twp.	23/7/73		10.8					2GE
329	L041601	London Twp.			2.4	6,018	S	5	7	2GE
315	L040301	Strathroy			4.0	6,500	S	15		2GG
337	L041904	Mosa Twp.			6.0	200	S			2GG

TABLE 6 (continued): WASTE DISPOSAL SITES IN THAMES RIVER SUB-BASIN (SUB-BASIN 8)

No.	MOE No.	Municipality	Opened	Closed	Area	Population Served	Waste Type	Volume	1971 Proj. Life	Water Sheds
		ESSEX COUNTY:								
215	L010101	Windsor			86.0	75,000	S,L	275-300		2GH
216	L010102	Windsor			6.9	80,000	S,L	275-300		2GH
217	L010103	Windsor			72.0	13,000	S,L	400-500		2GH
218	L011101	Colchester North			40.7	38,985	S	28	20	2GH
219	L011401	Gosfield South								2GH
220	L011501	Maidstone Twp.			40.0	24,080	S	24	25	2GH
221	L011801	Pelee Twp.	21/3/72		8.4	300	S	½	40	2GH
222	L012001	Sandwich South Twp	2/4/73		1.0		L	50		2GH
223	L012102	Sandwich West Twp			4.8	10,000	S	20	10	2GH
		HURON COUNTY:								
156	L162401	Usborne Twp.	26/3/73				S			2GD
		PERTH COUNTY:								
110	L150101	Stratford			40.0	22,995	S	90	20	2GD
111	L150201	St.Mary's	30/3/72		8.0	4,740	S	8.6	20	2GD
113	L150401	Mitchell	21/4/72		38.8	2,500	S	1½	100	2GD
115	L150701	Downie Twp			1.2	2,400	S	-	50	2GD
119	L151201	Fullarton Twp			0.4	1,500	S	-	30	2GD
120	L151202	Fullarton Twp	20/12/72		4.0	-	S	1½	20	2GD
122	L151401	Logan Twp	4/7/72		10.0	2,259	S	2	50	2GD
		HALDIMAND COUNTY:								
10	L10501	Jarvis			3.2	1,000	S	10	15	2GC
13	L10702	N. Cayuga Twp			0.1	1,000	S	1	1	2GC
19	L11201	Rainham Twp	29/3/72		1.6	1,900	S	1	10	2GC
23	L11502	Walpole Twp			2.4	2,000	S	3	20	2GC

TABLE 6 (continued): WASTE DISPOSAL SITES IN THAMES RIVER SUB-BASIN (SUB-BASIN 8)

No.	MOE No.	Municipality	Opened	Closed	Area	Population Served	Waste Type	Volume	19/1 Proj. Life	Water Sheds
		ELGIN COUNTY:								
347	L051101	St.Thomas				1,090	S	2		2GC
348	L051102	Aldborough Twp.			26.0	1,000	S	2.1		2GF
349	L051103	Aldborough Twp.		15/6/73	20.0	1,000	S			2GF
350	L051401	Dunwich Twp.			24.8	3,000	S	1.1		2GF
351	051502	Malahide Twp.		1971						2GC
352	L051601	Southwold Twp.	4/1/74		40.0	60,000	S	100	10	2GF
353	L051702	Yarmouth Twp.		15/10/71	0.8	6,000				2GC
354	L051704	Yarmouth Twp.		Fall/73		1,560		15		2GC
355	L051705	Yarmouth Twp.			50.0	30,000	S, L	80		2GC
356	L051706	Yarmouth Twp.	24/ 4/72		20.0		S	6 loads/wk		2GC
		LAMBTON COUNTY:								
299	L031804	Moore Twp.	26/10/73		80.0		L	40,000 gal/d		2GG
270	L030104	Sarnia			3.8		S	120	20	2GG
295	L032103	Sombra Twp			4.4	4,000	S	3	8	2GG
296	L032201	Warwick Twp.			0.5	2,300	S	3		2GG
297	L032202	Warwick Twp.			2.0	1,400	S	1	15	2GG
298	L032203	Warwick Twp.	5/10/72		40.0	45,000	S,L	20	15	2GG
272	L030106	Sarnia	4/7/73		0.03			250 yd^3		2GG
273	L030107	Sarnia			24.0	3,000	L	160 yd^3	125	2GG
274	L030303	Petrolia			5.2	7,000	S	35	5	2GG
275	L030401	Alvinston			1.2	680	S			2GG
276	L030801	Oil Springs			0.4	565	5	5-6	10	2GG
279	L031402	Brooke Twp.			3.6	2,081	S	6/wk	20	2GG
280	L031501	Dawn Twp.			0.8	2,100	S	1-2/wk		2GG
281	L031502	Dawn Twp.	7/4/72		14.0	2,100	S	1-2/wk		2GG
283	L031801	Moore Twp.			20.0		L	380	10	2GG
284	L031802	Moore Twp.			56.0		S	1,000	40	2GG
285	L031803	Moore Twp.			1.6		S	1.5	40	2GG
286	L031806	Moore Twp.			40.0		S,L	150	40	2GG
287	L031808	Moore Twp.			17.6	7,200		4	40	2GG
288	L031809	Moore Twp.			2.8		S, H	200-1300 ft^3/a	10	2GG
289	L031810	Moore Twp.	17/5/73		32.0		S	30	10	2GG

TABLE 6 (continued): WASTE DISPOSAL SITES IN THAMES RIVER SUB-BASIN (SUB-BASIN 8)

No.	MOE No.	Municipality	Opened	Closed	Area	Population Served	Waste Type	Volume	1971 Proj. Life	Water Sheds
		NORFOLK COUNTY:								
366	L060101	Delhi			2.8	4,000	S	7	16	2GC
367	L060603	Charlotteville Twp.			20.0	6,200	S	6		2GC
368	L060604	Charlotteville Twp.	26/4/72		10.0	1,600	S	1	50	2GC
369	L060701	Houghton Twp.		15/9/71	0.8	2,300	S			2GC
370	L060702	Houghton Twp.		15/9/71	6.0	2,300	S			2GC
371	L060801	Middleton Tap.	11/5/72		46.0	6,475	S	30	20	2GC
372	L060802	Middleton Twp.	30/9/73		20.0	3,000	S			2GC
373	L060803	Middleton Twp.								2GC
374	L060901	Townsend Twp.		15/7/71	16.0	7,500				2GC
375	L061001	N. Walsingham Twp.			5.3	2,883	S	2 ½	20	2GC
376	L061101	S. Walsingham Twp.			9.0	2,000 7,000-sum.	S	16	3	2GC
377	L061202	Windham Twp.		15/5/71	0.9	2,500				2GC
378	L061203	Windham Twp.		15/5/71	7.0	2,500	S			2GC
379	L061204	Windham Twp.	16/3/72		13.2	10,400	S	22	20	2GC
380	L061301	Woodhouse Tap.			10.0	6,000	S	8	50	2GC
		OXFORD COUNTY:								
390	L070101	Woodstock			3.0	25,000	S	50	1½	2GD
391	L070102	Woodstock	6/11/72							2GD
392	L070201	Ingersoll		15/5/71	2.0	7,400	S			2GD
393	L070301	Tillsonburg	12/7/73		1.6		S	200 yd^3	50	2GC
394	L070502	Embro	4/1/74		7.3	692	S	10		2GD
395	L070601	Norwich			22.0	1,760	S	5	10	2GC
397	L071001	Dereham Tap.			2.8	6,500	S	10	2	2GC
398	L071101	E. Nissouri Tap.			39.6	3,350	S	8	100	2GD
399	L071202	N. Norwich Twp.			40.0	4,500	S	16	50	2GC
400	L071301	S. Norwich Tap.			1.2	3,200	S	1	15	2GC
401	L071402	E. Oxford Tap.			4.0	2,200	S	1	30	2GC
402	L071501	N. OxfordTwp.			1.2	1,000	S	Z	8	2GD
403	L071601	W. Oxford Tap.			4.0	3,000	S	60	10	2GD
404	L071801	W. Zorra Tap.	12/6/72		1.6	2,165	S	4	8	2GD
405	L071502	N. Oxford	8/11/73		1.2		S	60	7-10	2GD

TABLE 7: WASTE DISPOSAL SITES IN GRAND RIVER SUB-BASIN (SUB-BASIN 9)

No.	MOE No.	Municipality	Opened	Closed	Area	Population Served	Waste Type	Volume	1971 Proj. Life	Water Sheds
		WENTWORTH COUNTY:								
72	L130501	Ancaster Twp.			3.2	14,000	S	7-10	1	2GB
73	L130601	Beverly Twp.			1.6	6,059	S	10	10	2GB
		WATERLOO REGION:								
89	1140101	Cambridge	25/5/72		2.8	38,000	S & L	90	1	2GA
90	1140102	Cambridge	25/5/72		1.0	6,101	S	10-15	1	2GA
91	L140103	Cambridge			10.8	15,600	S	30	10	2GA
92	L140104	Cambridge	16/8/72		40.0	40,000	S & L	220	30	2GA
93	L140202	Kitchener			38.0	153,000	5 & L	2,000	5	2GA
94	L140301	Waterloo	12/5/72		69.2	50,000	S	150	50	2GA
95	L140401	N. Dumfries Twp.			3.6	2,200	S	-	3	2GA
96	L140403	N. Dumfries Twp.			4.0	3,000	S	-	4	2GA
97	L140502	Wellesley Twp.			1.6	8,000	S	5.7	10	2GA
98	L140601	Wilmot Twp.			0.6	6,858	S	1.4	12	2GA
99	L140701	Woolwich Twp.			5.2	6,300	S	8-1.0	12	2GA
100	L140702	Woolwich Twp.			2.0	4,610	S	22	-	2GA
		BRANT COUNTY:								
1	100101	Brantford			72.0	70,000	S, L, H		50	2GB
2	100102	Brantford	11/5/72		8.0	70.000	S	15-100	5	2GB
3	100103	Brantford	30/3/73		4.2		S, L	90	4	2GB
4	100201	Paris			8.4	10,100	S, L	15	20	2GA
5	100301	Brantford Twp.			6.0	1,100	S	8	20	2GB
6	100402	Burford Twp.			13.6	5,874	S	5	10	2GB
7	100601	Oakland Twp.			1.6	1300-1500	S	½	3	2GB

TABLE 7 (cont'd): WASTE DISPOSAL SITES IN GRAND RIVER SUB-BASIN (SUB-BASIN 9)

No.	MOE No.	Municipality	Opened	Closed	Area	Population Served	Waste Type	Volume	1971 Proj.Life	Water Sheds
		HALTON REGION:								
430	L210701	Twp. of Nassagaweya			5.2	3,200	S	1	10	2GA
		OXFORD COUNTY:								
396	L070903	Blenheim Twp.			5.4	6,000	S	9		2GA
		WELLINGTON COUNTY:								
190	L170101	Guelph			60.0	58,000	S	70	20	2GA
192	L170601	Arthur		Closed	4.0	2,500	S	1½	-	2GA
201	L171901	Nichol Twp.			20.0	13,000	S	15	20	2GA
202	L172001	Peel Twp.			18.8	700	S	1½/wk	25	2GA
203	L172201	Puslinch Twp.	4/7/72		1.2	3,400	S		10	2GA
194	L171101	Arthur Twp.			32.0	7,300	S	3	20	2GA
196	L171401	W. Garafraxa Twp.			6.0	1,661	S	3	15	2GA
198	L171702	Maryborough Twp.			1.6	900	S	7		2GA
		DUFFERIN COUNTY:								
180	L180501	E. Garafraxa Twp.		30/6/72	1.2	1,200	S	1-2		2GA
174	L180601	E. Luther Twp.			4.0	850	S	1/wk	2G	2GA
175	L180701	Melancthon Twp.			0.8	2,114	S	2/wk	10	2GA
171	L180401	Amaranth Twp.	24/5/72				S			2GA
172	L180402	Amaranth Twp.			6.0	2,000	S	1	25	2GA
		PERTH COUNTY:								
116	L150801	N. Easthope Twp.	4/7/72		2.0	2,093	S	2/month	13	2GA
117	L151001	Ellice Twp.	4/7/72		0.8	2,784	S	1	10	2GA
123	L151501	Mornington Twp.	4/7/72		1.0	1,179	S	-	25	2GA

TABLE 7 (cont'd): WASTE DISPOSAL SITES IN GRAND RIVER SUB-BASIN (SUB-BASIN 9)

No.	MOE No.	Municipality	Opened	Closed	Area	Population Served	Waste Type	Volume	1971 Proj. Life	Water Sheds
		HALDIMAND COUNTY:								
8	110101	Caledonia			2.0	3,000	S	2	20	2GB
9	110201	Dunnville			2.8	5,400	S	18	4-5	2GB
24	111503	Walpole Twp.			32.8	5,000	S	1-2	100	2GB
22	111401	Sherbrooke Twp.			0.8	400	-	-	10	2GB
14	110801	S. Cayuga Twp.			0.8	637	S	100 b.	10	2GB
15	110901	Dunn Twp.			0.4	1,200	S	1-2	5	2GB
16	111001	Moulton Twp.			1.2	2,700	S		10-15	2GB
17	111101	Oneida Twp.			2.9	1,700	S	3.6	15	2GB
18	111102	Oneida Twp.	9/6/72		2.0	-	S	50		2GB
12	110701	N. Cayuga Twp.			6.0	4,500	S,L	10	-	2GB

Proj. Life - Life, as estimated in 1971 when the licence was first issued, or on the opening date.

Watershed - Identifies the sub-drainage basin in which the site is located, in accordance with the Canada Water Survey classification.

SUB-BASIN 8: THAMES RIVER

Table 6 presented a detailed list of the waste disposal sites in the Thames River Sub-Basin. There are a total of 110 disposal sites, as follows: 5 liquid; 7 solid and liquid; 1 solid and hazardous materials; and 97 solid waste disposal sites. The single hazardous material disposal site is located in Moore Township, Lambton County.

SUB-BASIN 9: GRAND RIVER

The waste disposal sites in the Grand River Sub-Basin were presented in Table 7. Six of the 48 sites handle solid and liquid wastes; one in Brantford handles solid, liquid, and hazardous materials; and the remainder are for solid waste disposal only.

SUMMARY

Table 8 presents a summary of the waste disposal sites in the Canadian portion of the Lake Erie Basin. There are 158 active sites in the basin, covering 1,944 ha (4804 acres) of land. Approximately 6,500 t (14.3 million lb) of waste are disposed of daily.

The Thames River Sub-Basin has about twice as many waste disposal sites (110) as the Grand River Sub-Basin (48), and they occupy nearly three times as much land (1,429 ha (3,531 acres) compared to 515 ha (1,273 acres)).

TABLE 8: WASTE DISPOSAL SITE SUMMARY FOR THE CANADIAN PORTION OF THE LAKE ERIE BASIN

	No. Active Sites	Area (ha)	Volume (t/d)	No. Closed Sites	Area (ha)
Thames R. Sub-Basin	110	1,429	3,891	15	108
Grand R. Sub-Basin	48	515	2,629	2	5
Canadian Lake Erie Basin	158	1,944	6,520	17	113

acres = hectares (ha) x 2.471
pounds (lb) = tonnes (t) x 2200

DREDGE SPOIL DISPOSAL

Due to the importance of shipping and fisheries in the Lake Erie Basin, maintenance dredging of ship channels is often necessary for preserving ship draft requirements. In Lake Erie harbours, large volumes of sand and gravel are removed, and in most cases dumped outside the littoral zone. An estimated 34,000 m^3/a (44,472 yd^3/a) of material is dredged from the 18 Canadian harbours on Lake Erie (2).

EROSION

LAKESHORE EROSION

The following information on Lake Erie and Lake St. Clair lakeshore erosion 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 reflects the change in volume of material which occurs during a peak water level stage on the Great Lakes shoreline.

Although the shore zone of Lake St. Clair is low-lying and subject to intensive flooding, erosion is significant along the coasts of Tilbury North and Rochester townships in Essex County. This reach is 19 km (12 mi) in length, and bounded by the Thames River on the east and the Belle River on the west. The annual erosion rate was calculated to be 4.85 m^3/m/ m/yr*, most of which is beach material fronting very low exposed banks less than one meter high.

Lake Erie accounts for a large proportion of Great Lakes shoreline erosion, with maximum values reaching 35 m^3/m/m/yr. Table 9 lists specific Canadian reaches on Lake Erie where the erosion rate exceeded 0.5 m^3/m/m/yr for the period of survey (November 1972 to November 1973).

Notable reaches include the east side of Point Pelee and the Port Burwell reach as far as Clear Creek. Some of the bluff recession in the latter area resulted from massive rotational arc slides. This type of landslide is unique throughout the Great Lakes and is caused by an underlying hard clay layer. As ground water accumulates along the less permeable clay layer, a slip-surface can form at the sand-clay interface. The weight of the glacial sand overburden can then overcome the reduced friction between the layers and result in massive slumping. The heavy erosion on the east side of Point Pelee resulted in a considerable loss of beach material, emphasizing the instability of this cuspate spit.

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* m^3 of eroded material per linear m of shoreline per vertical m of bluff height per year.

Another area with relatively high erosion rates was Long Point, where the low-lying beaches eroded at rates as high as 35 m^3/m/m/yr.

TABLE 9: REACHES IN THE CANADIAN PORTION OF THE LAKE ERIE 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)	Volume (m^3)
Essex	Colchester S.	Colchester- Oxley	4.22	5.62	259,960
Essex	Mersea	Point Pelee- West side	9.77	2.12	50,570
		Point Pelee- East side	2.22	26.26	160,015
		Point Pelee- East side	14.13	2.37	91,790
Kent	Romney- Raleigh	Wheatley- Ouvry	22.50	1.62	679,830
Elgin		Pt. Talbot- Pt. Burwell	39.13	5.65	7,963,180
Elgin & Haldimand-Norfolk	Bayham & Norfolk	Pt. Burwell Clear Creek	16.58	13.20	5,736,510
Haldimand-Norfolk	Norfolk	Long Point	18.50	35.00	2,156,251
Haldimand-Norfolk	Nanticoke-Dunnville	Pt. Dover Mohawk Pt.	4.41	8.28 0.62	49,900
Niagara	Pt. Colborne	Pt. Albino	1.19	2.14	19,870

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

The total net erosion for Lakes St. Clair and Erie from November 1972 to November 1973 was 17,577,252 m^3 (22,991,045 yd^3). This figure represents 88 percent of the total net erosion in all the Great Lakes, as measured in the Canada-Ontario Great Lakes Shore Damage Survey.

RIVERBANK EROSION

A riverbank erosion study is currently underway as part of the PLUARG Study. The objective of this study is 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 so that actual sediment contributions to streams can 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 Erie Basin was obtained from a study done by Agriculture Canada (3). Details concerning methodology appear in Appendix A of Volume I in this report series.

Intensive livestock operations were 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, the Canadian portion of the Lake Erie Basin contains 78 intensive poultry operations, 711 intensive cattle operations, and 546 intensive swine operations (Table 10). The Lake Erie Basin has more intensive livestock operations than any of the other Canadian basins of the Great Lakes. The Grand River Sub-Basin, in particular, has the highest overall concentration of large livestock operations.

TABLE 10: INTENSIVE LIVESTOCK OPERATIONS IN THE CANADIAN PORTION OF THE LAKE ERIE BASIN

	Poultry	Cattle	Swine
Canadian Lake Erie Basin	78	711	546
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 concerning methodology are presented in Appendix A of Volume I in this report series.

Since this study included both permanent and seasonal residences, compact groupings of cottages or chalets were considered. 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. The resulting estimated populations are presented under the heading "total population" in Tables 11 and 12.

SUB-BASIN 8: THAMES RIVER

Table 11 presents the non-sewered residential areas located in the Thames River Sub-Basin. There are 236 such areas, with a total population of 153,281. The average population per area is 650, but one non-sewered area in the City of Windsor has a population of 30,000.

SUB-BASIN 9: GRAND RIVER

Non-sewered residential areas in the Grand River Sub-Basin are presented in Table 12. This sub-basin contains 128 non-sewered residential areas, about half the number of the Thames River Sub-Basin. The average population is 303 persons per area. Thus, the Grand River Sub-Basin contains both fewer and smaller non-sewered residential areas than the Thames River Sub-Basin.

SUMMARY

There are approximately 192,000 people in the Canadian portion of the Lake Erie Basin living in 364 high density non-sewered residential areas. This represents 13 percent of the total Lake Erie Basin population. The Thames River Sub-Basin contains 80 percent of the total non-sewered residential area population, with the remaining 20 percent being in the Grand River Sub-Basin.

TABLE 11: NON-SEWERED RESIDENTIAL AREAS IN THE THAMES RIVER SUB-BASIN (SUB-BASIN 8)

COUNTY	TOWNSHIP	BASIN	LOCATION	SEASONAL UNITS	KNOWN POPULATION	TOTAL POPULATION
ELGIN	Aldborough	2GF	New Glasgow		75	75
	"	"	Eagle		75	75
	Dunwick	2GF	Tyrconnell		40	40
	"	"	Wallacetown		221	221
	Southwold	2GF	Iona - N. of Talbot Rd.		75	75
	"		Iona - S. of Talbot Rd.		125	125
	"	"	Shedden		240	240
	"	"	Fingal		350	350
	"	"	Frome		50	50
	"	2GC	Talbotville Royal		55	55
	Yarmouth	2GC	N. of St. Thomas		250	250
	"	"	S. of St. Thomas		1000	1000
	"	"	Union		226	226
	"	"	Port Stanley		25	25
	"	"	Sparta		320	320
	Malahide	2GC	Aylmer		25	25
	"	"	Springfield		530	530
	Bayham	2GC	Bayham		132	132
	"	"	Straffordville		614	614
	"	"	Vienna		400	400
	"	"	Port Burwell		684	684
	S. Dorchester	2GC	Lyons		100	100
	"	"	Avon		150	150
ESSEX	Gosfield North	2GH	Cottam		657	657
	"	"	Rds. 14 & 27		60	60
	"	"	Con. 11, Lot 18		60	60
	"	"	Talbot Rd.& Hwy. 29		45	45
	Maidstone	2GH	Hwy. 39 & Hwy. 21		1476	1476
	"	"	Hwy. 25 & Hwy. 2		862	862
	"	"	E. of Puce River		933	933
	"	"	Rd. 27 & Hwy. 2		825	825
	"	"	Rd. 27& Rd. 39		700	700

TABLE 11 (Cont'd.): NON-SEWERED RESIDENTIAL AREAS IN THE THAMES RIVER SUB-BASIN (SUB-BASIN 8)

COUNTY	TOWNSHIP	BASIN	LOCATION	SEASONAL	KNOWN POPULATION	TOTAL POPULATION
ESSEX	Orford	2GE	Highgate		382	382
	"	"	Muirkirk		70	70
	"	"	Clachan		10	10
	"	"	Moraviantown I.E.		300	300
	"	"	Palmyra		60	60
	"	"	Duart		100	100
	Zone	"	Con IX, Lots 8-10		150	150
	Camden	"	Thamesville		1022	1022
	Chatham	"	Hwy #2 @ Hwy 30		350	350
	Dover	"	Paincourt		300	300
	Tilbury East	"	Tilbury		2000	2000
	"	"	Jeannettes Creek		300	300
	"	"	Fletcher		150	150
	Raleigh	"	Hwy 3 @ Rd 27		150	150
	"	2GE	Prairie Siding		50	50
	"	"	North Buxton		250	250
	"	"	Merlin		725	725
	"	"	South Buxton		50	50
	"	"	Charing Cross		450	450
	"	"	Con III, Lots 23,24		400	400
	Harwick	2GE	Con I, II, III, Lots	1-6	1000	1000
	"		Vosburg		50	50
	"	"	Louisville		125	125
	"	"	Northwood		100	100
	"	"	Harwick		60	60
	"	"	Springs		200	200
	"	"	Mull	150	50	50
	"	"	Shrewsbury	150	100	100
	"	"	Troy		25	25
	"	"	Guilds		75	75

TABLE 11 (Cont'd.): NON-SEWERED RESIDENTIAL AREAS IN THE THAMES RIVER SUB-BASIN (SUB-BASIN 8)

COUNTY	TOWNSHIP	BASIN	LOCATION	SEASONAL UNITS	KNOWN POPULATION	TOTAL POPULATION
ESSEX	Tilbury North	2GE	Point Aux Roches		571	571
	Tilbury West	2GE	Camber		319	319
	"	"	Staples		100	100
	City of Windsor	2GH	Windsor		30,000	30,000
	Sandwich West	2GH	Between Hwy 3 & 18		9,215	9,215
	Anderdon	2GH	Con. I, Lots 19-41		757	757
	"	"	" Lots 8-18		874	874
	"	"	Con. VIII, Lot 20		120	120
	Sandwich South	2GH	-		4,946	4,946
	Colchester N.	2GH	Paquette		80	80
	"	"	McGregor		220	220
	Rochester	2GH	Belle River		3,145	3,145
	"	"	Rd.31 & Hwy.2		1,258	1,258
	"	"	Rd.27 & Hwy.48		350	350
	"	"	Ruscom		300	300
	Mersea	2GH	Rd.18 & Rd.31		874	874
	"	"	Leamington		10,000	10,000
	"	"	Con.1, Lots 4 & 5		710	710
	"	"	" Lots 7 & 8		587	587
	Colchester S.	2GH	Harrow		1,970	1,970
	"	"	Comet		250	250
	"	"	Colchester		300	300
	Gosfield South	2GH	Ruthven		400	400
	"	"	Cedar Cr. at Lake Erie		800	800
	"	"	Con.1, Lots 6 & 6		400	400
	"	"	" Lots 4 & 5		250	250
BRANT	Oakland	2GC	Scotland	150		525
	Burford	2GC	Kelvin	12		42
	"	"	Harley	20		70

TABLE 11 (Cont'd.): NON-SEWERED RESIDENTIAL AREAS IN THE THAMES RIVER SUB-BASIN (SUB-BASIN 8)

COUNTY	TOWNSHIP	BASIN	LOCATION	SEASONAL UNITS	KNOWN POPULATION	TOTAL POPULATION
ESSEX	Tilbury North	2GE				
KENT	Harwick	2GF	Erie Beach		232	232
	"	"	Erieau		447	447
	"	"	Rondeau Bay	100		350
	"	"	Rd. 51 @ Lake	200		700
	"	"	Rondeau Prov. Park	200	40	700
	Romney	2Gf	Renwick		10	10
	"	"	Coatsworth		100	100
	"	"	Port Alma		75	75
	"	"	Port Crewe		20	20
	"	2GH	Wheatley		1657	1657
	"	"	Con. I, Lots 12 & 13		700	700
	Howard	wGF	Rd 17 @ Lake	150	100	625
		"			200	200
HALDIMAND	Walpole	2GC	Selkirk	80		280
	"	"	Hwy. 3 at Lake	40		140
	"	"	7 at Lake	150		525
	"	"	Peacock Point	200		700
	"	"	Woodlawn	60		210
	Rainham	2GC	Nell's Corners	15		52
	"	2GC	Fisherville	50	175	
	"	"	Rd. 37 at Lake	40		140
	"	"	Featherstone	250		875
	"	"	Evans Point	30		105
	N. Cayuga	2GH	Canfield	20		70
	Walpole	2GC	Garnet	13		45
	"	"	Nanticoke	30		105
	"	"	Cheapside	15	52	
	"	"	Balmoral	13		45

TABLE 11 (Cont'd.): NON-SEWERED RESIDENTIAL AREAS IN THE THAMES RIVER SUB-BASIN (SUB-BASIN 8)

COUNTY	TOWNSHIP	BASIN	LOCATION	SEASONAL UNITS	KNOWN POPULATION	TOTAL POPULATION
LAMBTON	Brooke	2GG	Alvinston		676	676
	"	"	Inwood		214	214
	Enniskillen	2GG	Oil City		161	161
	"	"	Oil Springs		547	547
	"	"	Marthaville		177	177
	Warwick	2GG	Warwick		198	198
	Moore	2GG	Froumfield		150	150
	"	"	Mooretown		336	336
	"	"	Bickford		100	100
	"	"			20	20
	"	"	Between Courtwright & Bickford	100		350
	"	"	Brigden		535	535
	"	"	Courtwright		656	656
	Sombra	2GG	Sombra		367	367
	"	"	Wilkesport		100	100
	"	"	Port Lambton		745	745
	"	"	Becker		15	15
	Dawn	2GG	Union Gas Houses		35	35
	"	"	Edys Mill		30	30
	"	"	Ruthford		35	35
	"	"	Oakdale		40	40
	"	"	Florence		188	188
	Euphemid	2GG	Shetland		30	30
	"	"	Cairo		15	15
	Plympton	2GG	Wanstead		36	36

TABLE 11 (Cont'd.): NON-SEWERED RESIDENTIAL AREAS IN THE THAMES RIVER SUB-BASIN (SUB-BASIN 8)

COUNTY	TOWNSHIP	BASIN	LOCATION	SEASONAL UNITS	KNOWN POPULATION	TOTAL POPULATION
MIDDLESEX	N. Dorchester	2GD	Crampton		60	60
	"	"	Crumlin		200	200
	"	"	Dorchester		2500	2500
	"	"	Milestown		50	50
	Westminster	2GC	Belmont		800	800
	"	2GE	Lambeth		2400	2400
	Delaware	2GE	Delaware		450	450
	London	2GD	Arva		200	200
	"	"	Ballymore		50	50
	"	"	Birr		30	30
	"	"	Elginfield		20	20
	"	"	Bryanston		165	165
	"	"	Fanshawe Lake	30		105
	"	"	Kilworth		150	150
	"	"	Hyde Park Corner		200	200
	"	"	London		10000	10000
	W. Nissouri	2GD	Belton		20	20
	"		Thorndale		434	434
	"	"	London Aerodrome		40	40
	"	"	McWilliams		30	30
	Caradoc	2GE	Melbourne		311	311
	"	"	Mt. Brydges		1184	1184
	Ekfrid	2GE	Glencoe		1392	900
	Lobo	2GE	Komoka		900	900
	"	2GG	Poplar Hill		190	190
	"	"	Coldstream		25	25
	Mosa	2GG	Newbury		300	300
	"	2GE	Wardsville		325	325
	Adelaide	2GG	Strathroy		1600	1600
	N. Dorchester	2GC	Harrietville		50	50
	Biddulph	2GD	Granton		350	350

TABLE 11 (Cont'd.): NON-SEWERED RESIDENTIAL AREAS IN THE THAMES RIVER SUB-BASIN (SUB-BASIN 8)

COUNTY	TOWNSHIP	BASIN	LOCATION	SEASONAL UNITS	KNOWN POPULATION	TOTAL POPULATION
NORFOLK	Woodhouse	2GC	Port Dover		1568	1568
	"	"	Port Ryerse	35		122
	"	"	E. of Port Dover	100		350
	Windham	2GC	Vanessa	40		140
	"	"	Teeterville	35		122
	"	"	Nixon	18		63
	"	"	Colbourne	50		175
	"	"	Windham Centre	26		91
	S. Walsingham	2GC	Port Rowan	352	757	1232
	"		Walsingham	45		158
	Charlotteville	2GC	Lyndoch	25		88
	"	"	Turkey Point	600		2100
	"	"	Green Corner	30		105
	"	"	Vittoria	80		280
	"	"	Walsh	20		70
	"	"	St. Williams	80		280
	"	"	Normandale	60		210
	"	"	Silverhill	15		52
	"	"	Long Point	750		2625
	Houghton	2GC	Frogmore	25		88
	"	"	Fairground	24		84
	"	"	Clear Creek	25		88
	Middleton	2GC	Courtland	100		350
	N. Walsingham	2GC	Langton	110		385
	"	"	Glen Meyer	18		63
	Townsend	2GC	Waterford		1154	1154
	"	"	Villa Nova	8		28
	"	"	Renton	12		42
	"	"	Bloomsburg	20		70

TABLE 11 (Cont'd.): NON-SEWERED RESIDENTIAL AREAS IN THE THAMES RIVER SUB-BASIN (SUB-BASIN 8)

COUNTY	TOWNSHIP	BASIN	LOCATION	SEASONAL UNITS	KNOWN POPULATION	TOTAL POPULATION
PERTH	Ellice	2GD	Gadshall		50	50
	"	"	"		90	90
	"	"	Kinkora		40	40
	"	"	Sebringville		250	250
	"	"	of Stratford		225	225
	Fullarton	2GD	Fullarton		50	50
	"	"	Russeldale		40	40
	Downie	"	Avonton		30	30
	"	"	Pauls		25	25
	S. Easthope	2GD	Shakespeare		300	300
	Ellice	2GD	Rostock		150	150
	Logan	2GD	Bornholm		40	40
	"		Broadhagen		100	100
OXFORD	Dereham	2GC	Mount Elgin		250	250
	"	"	Brownsville		350	350
	"	"	Culloden		30	30
	"	"	Ostrander		35	35
	"	"	S. of Ostrander		75	75
	"	"	Tillsonburg		130	130
	"	2GD	Salford		100	100
	"	"	Verschagle		25	25
	East Missouri	2GD	Wildwood		30	30
	" "	"	Wildwood River	23		81
	" "	"	Uniondale		40	40
	" "	"	Lakeside		90	90
	" "	"	Kintore		150	150
	West Zorra	2GD	Embro		700	700
	East Zorra	2GD	Innerkip		450	450
	"	2GD	Woodstock		1250	1250
	North Oxford	2GD	Thamseford		1500	1500
	" "	"	Ingersoll		700	700
THAMES RIVER SUB-BASIN TOTAL						153281

TABLE 12: NON-SEWERED RESIDENTIAL AREAS IN THE GRAND RIVER SUB-BASIN (SUB-BASIN 9)

COUNTY	TOWNSHIP	BASIN	LOCATION	SEASONAL UNITS	KNOWN POPULATION	TOTAL POPULATION
PERTH	Mornington	2GA	Newton		75	75
	"	"	Hesson		50	50
	"	"	Millbank		200	200
	"	"	Poole		40	40
	N. Easthope	2GA	Amulreg		20	20
	Ellice	2GA	Brunner		60	60
OXFORD	Blenheim	2GA	Plattsville		560	560
	"	"	Drumbo		460	460
	"	"	Princeton		368	368
NORFOLK	Townsend	2GB	Boston	15		52
HALDIMAND	Seneca	2GB	York	25		88
	Sherbrooke	2GB	Port Maitland	17		59
	Walpole	2GB	Springvale	45		147
DUFFERIN	Melancthon	2GA	Riverview		78	78
	"	"	Corbetton		150	150
	Amaranth	2GA	Laurel		85	85
	"	"	Waldemar		120	120
	E. Garafraxa	2GA	Marsville		45	45
	"	"	Orton		35	35

TABLE 12 (Cont'd.): NON-SEWERED RESIDENTIAL AREAS IN THE GRAND RIVER SUB-BASIN (SUB-BASIN 9)

COUNTY	TOWNSHIP	BASIN	LOCATION	SEASONAL UNITS	KNOWN POPULATION	TOTAL POPULATION
WATERLOO	Woolwich	2GA	Floradale		140	140
	"	"	Winterbourne		160	160
	"	"	Conestoga		450	450
	"	"	3 mi. E. of Conestoga		50	50
	"	"	Elmira		30	30
	"	"	West Montrose		55	55
	Waterloo	2GA	Erbsville		40	40
	"	"	Rd. 22 & Hwy. 85		850	850
	"	"	Freeport		150	150
	"	"	3 mi. N. of Bridgeport		600	600
	"	"	1 mi. N. of Doon		250	250
	"	"	Bridgeport		1750	1750
	"	"	Blair		282	282
	"	"	Bloomingdale		250	250
	"	"	Doon		200	200
	"	"	Maryhill		250	250
	"	"	2 mi. N. of Strasburg		120	120
	"	"	Breslau		540	540
	"	"	E. Side of Kitchener		420	420
	"	"	2 mi. W. of Hespeler		60	60
	"	"	2 mi. N. of Williamsburg		50	50
	"	"	N.W. Corner of Kitchener		100	100
	"	"	W. Corner of Kitchener		50	50
	"	"	Hespeler		170	170
	N. Dumfries	2GA	Orrs Lake		90	90
	"	"	Galt		800	800
	"	"	3 mi. N. of Galt		125	125
	"	"	Hwy. 8 & Rd. 17		170	170
	"	"	Ayr		1300	1300
	"	"	Roseville		85	85

TABLE 12 (Cont'd.): NON-SEWERED RESIDENTIAL AREAS IN THE GRAND RIVER SUB-BASIN (SUB-BASIN 9)

COUNTY	TOWNSHIP	BASIN	LOCATION	SEASONAL UNITS	KNOWN POPULATION	TOTAL POPULATION
BRANT	Town of Paris	2GA	Paris	2030	6438	7105
	S. Dumfries	2GA	Glen Morris	50		175
	"	"	W. of Glen Morris	12		42
	"	2GB	Harrisburg	35		122
	Burford	2GB	Burford	514	105	1799
	Brantford	2GB	Tranquility	500		1750
	"	"	S. of Brantford	100		350
	"	"	Mt. Pleasant Rd. at Hwy.2	150		525
	"	"	E. of Airfield	100		350
	"	"	Cainsville	75		262
	"	"	Hwy. 403 & 54	50		175
	Onondaga	2GB	Onondaga	30		105
	"		Middleport	25		88
	Oakland	2GB	Oakland	75		262
WENTWORTH	Beverly	2GB	Tory Area	20		70
	"	"	Hwy 8 & Con. III - VI	30		105
	"	"	Rds 3 & 39	16		54
	"	"	Lynden	180		630
	"	"	Orkney	19		67
	"	"	Copetown	65		228
	"	"	Con. I Lots 30-31	16		54
	"	"	Con. I Lot 36, Hwy 99	22		77
WENTWORTH	Beverly	2GB	Con.VII	54		189
	"	"	Kirkwall	12		42
	"	"	Hwy 8 & Con V-VI	35		122
	"	"	Rockton	50		175
	"	"	Sheffield	70		245
	Ancaster	2GB	Duffs Corners	30		105
	"	"	Alberton	20		70
	"	"	Jerseyville Area	50		175
	"	"	Summit	16	54	
	Glanford	2GB	North Seneca	20		70

TABLE 12 (Cont'd.): NON-SEWERED RESIDENTIAL AREAS IN THE GRAND RIVER SUB-BASIN (SUB-BASIN 9)

COUNTY	TOWNSHIP	BASIN	LOCATION	SEASONAL UNITS	KNOWN POPULATION	TOTAL POPULATION
WATERLOO	Wilmot	2GA	New Dundee		700	700
	"	"	Mannheim		80	80
	"	"	Petersburg		210	210
	"	"	3 mi. E. of Petersburg		55	55
	"	"	St. Agatha		20	200
	"	"	New Hamburg		55	55
	"	"	Sunfish Lake	20		70
	Wellesley	2GA	Linwood		485	485
	"	"	Hawkesville		190	190
	"	"	Heidelberg		185	185
	"	"	St. Clements		650	650
	"	"	Paradise Lake	55		192
WELLINGTON	Maryborough	2GA	Moorefield		324	324
	"	"	Rothsay		102	102
	Nichol	2GA	Salem		700	700
	"	"	West of Fergus		180	180
	"	"	South of Fergus		50	50
	"	"	Ennetville		45	45
	Pilkington	2GA	Central Pilkington	27		94
	"	"	East Pilkington		84	84
	Guelph	2GA	N.E. of Guelph		175	175
	"	"	N. of Guelph		180	180
	"	"	E. of Guelph		60	60
	"	"	s. of Guelph		35	35
	"	"	N.E. Corner of Twp.		35	35
	Eramosa	2GA	Everton		100	100
	"	"	Rockwood		945	945
	"	"	Eden Mills		190	190
	"	"	Crewson's Corners		75	75

TABLE 12 (Cont'd.): NON-SEWERED RESIDENTIAL AREAS IN THE GRAND RIVER SUB-BASIN (SUB-BASIN 9)

COUNTY	TOWNSHIP	BASIN	LOCATION	SEASONAL UNITS	KNOWN POPULATION	TOTAL POPULATION
WELLINGTON	Erin	2GA	Orton		30 30	30
	"	"	Ospring		30	30
	Puslinch	2GA	Arkell		60	60
	"	"	E. of Guelph		700	700
	"	"	Aberfoyle		60	60
	"	"	S. Puslinch Lake	35		122
	"	"	N. Puslinch Lake		400	400
	West Luther	2GA	Damascus		45	45
	Arthur	2GA	Kenilworth		102	102
	Peel	2GA	Drayton		743	743
	"	"	Glen Allen		54	54
	"	"	Wallenstein		60	60
	"	"	Alma		275	275
	W. Garafraxa	2GA	Belwood		165	165
	"	"	Irving Creek	25		88
	"	"	East Belwood		40	40
	"	"	N. of Fergus		240	240
	"	"	Belwood Lake	344		1204
GRAND RIVER SUB-BASIN TOTAL						38,785

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1. Crysler & Lathem. Land Drainage Reference Study Task B2: Mine Tailings Disposal Sites, Waste Disposal Sites, Non-Sewered Residential Areas, Land Fill Sites, prepared for Canada Department of the Environment.

2. Environment Canada and Ontario Ministry of Natural Resources. Canada- Ontario Great Lakes Shore Damage Survey Technical Report, October 1975.

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 Erie 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 in this section is presented 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 13.

INSECTICIDES

The 1,878,999 kg/a (4.14 million lb/a) of insecticides used in the Canadian portion of the Lake Erie Basin exceeds the levels of all other pesticide use categories. The Thames River Sub-Basin accounts for about 92 percent of the total insecticide use. The highest intensity of use is in Oxford, Elgin and Norfolk counties, which constitute the tobacco growing region of Canada.

FUNGICIDES

The use of fungicides in the Canadian portion of the Lake Erie Basin is restricted largely to fruits and vegetables, most of which are grown in the Thames River Sub-Basin, particularly in Kent, Essex and Norfolk counties. About 211,794 kg/a (467,380 lb/a) of fungicides are applied to agricultural lands in the Canadian portion of the Lake Erie Basin. Approximately 86 percent of this total is used on fruits and vegetables in the Thames River Sub-Basin.

HERBICIDES

The use of herbicides is common in the agriculture of the Canadian portion of the Lake Erie Basin, as reflected in Table 13. Altogether, 1,612,494 kg/a (3.55 million lb/a) of herbicides including 214,000 kg/a (472,759 lb/a) of phenoxy herbicides, 688,780 kg/a (1.51 million lb/a) of triazine

TABLE 13: USE OF PESTICIDES IN THE CANADIAN PORTION OF LAKE ERIE BASIN

(kg of active chemicals)

	Insecticides		Fungicides		Herbicides						
					Phenoxy			Triazine		Other Types	
	Field Crops	Fruits & Veg.	Field Crops	Fruits & Veg.	Field Crops	Road-Side	Fruit & Veg.	Field Crops	Fruits & Veg.	Field Crops	fruits & Veg.
Thames River Sub-basin:	1,613,075	111,913	4,705	181,676	90,928	20,450	20,878	512,320	2,439	602,201	15,833
Grand River Sub-basin:	133,828	20,183	541	24,872	66,732	12,175	3,277	173,444	577	85,943	5,297
Total Canadian Lake Erie Basin:	1,746,903	132,096	5,246	206,548	157,660	32,155	24,155	685,764	3,016	688,144	21,130

pounds (lb) = kilograms (kg) x 2.2046

herbicides, and 709,274 kg/a (1.56 million lb/a) of other types.

About 95 percent of the herbicides are used on field crops, three percent on fruits and vegetables, and two percent on roadsides for weed control. As with the insecticides and fungicides, the Thames River Sub- Basin receives the majority of the herbicides (78 percent).

COMMERCIAL FERTILIZERS AND AGRICULTURAL MANURES

Information on the production and/or usage of agricultural manures and fertilizers in the Canadian portion of the Lake Erie Basin is reported in terms of their nutrient content. The total nutrient input from these materials and the density per unit area of improved farmland and/or all land are presented in this section. Tables 14 and 15 contain background information on farmland use and livestock numbers in the Canadian Lake Erie Basin.

COMMERCIAL FERTILIZERS

Fertilizer use is much higher in the Lake Erie Basin than in any of the other Canadian Great Lakes basins because of the high level of agricultural activity in this basin. In absolute terms, nutrients applied to the Canadian portion of the Lake Erie Basin via fertilizers amount to 63,544 t nitrogen/a (140 million lb/a), 52,889 t phosphorus (P_2O_5)/a, (116 million lb/a), and 52,488 t potassium (K_2O)/a (115 million lb/a). The large majority of these nutrients are applied in the Thames River Sub-Basin (Table 16).

Table 17 shows the estimated annual usage of fertilizer nutrients in kg/ha of improved farmland and kg/ha of total land. Fertilizer nutrient densities are notably higher in the Thames River Sub-Basin than in the Grand River Sub-Basin.

AGRICULTURAL MANURES

The total nutrients deposited annually from manure in the Canadian portion of the Lake Erie Basin are listed in Table 18. The major source of the nutrients in the Thames River Sub-Basin is fertilizers, while in the Grand River Sub-Basin most of the nutrients come from manure. This reflects the types of farming which characterizes the two sub-basins; namely cash-cropping in the Thames, and livestock farming in the Grand.

Table 19 shows the density of manure nutrients in the Canadian portion of the Lake Erie Basin. The density per improved farmland ha and per total ha is higher in the Grand River Sub-Basin than in the Thames. However, for the basin as a whole, the density of manure nutrients is less than the density of fertilizer nutrients.

TABLE 14: FARMLAND USE IN THE CANADIAN PORTION OF THE LAKE ERIE BASIN

(ha)

	No. Of Farms	Total Farmland	Improved Farmland	Crop- Land	Pasture	Woodland
Thames River Sub-Basin	22,351	1,232,559	1,056,348	879,351	152,196	87,893
Grand River Sub-Basin	10,202	579,280	475,377	367,939	101,558	48,802
Total Canadian Lake Erie Basin	32,553	1,811,839	11,531,725	1,247,290	253,754	136,695

acres = hectares (ha) x 2.471

TABLE 15: LIVESTOCK NUMBERS IN THE CANADIAN PORTION OF THE LAKE ERIE BASIN

	Total Cattle	Dairy Cattle	Beef Cattle	Swine	Poultry	Others
Thames River Sub-Basin	467,196	135,452	227,898	645,163	4,472,216	234,343
Grand River Sub-Basin	367,276	122,663	95,771	511,073	5,196,391	214,167
Total Canadian Lake Erie Basin	834,472	258,115	323,669	1,156,236	9,668,607	448,510

TABLE 16: TOTAL NUTRIENTS FROM FERTILIZER

	(kg)		
	N	P_2O_5	K_2O
Thames River Sub-Basin	48,693,718	41,555,458	40,916
Grand River Sub-Basin	14,850,245	11,335,013	11,571,784
Total Canadian Lake Erie Basin	63,543,963	52,889,471	52,488,068

pounds (lb) = kilograms (kg) x 2.2046

TABLE 17: ESTIMATED ANNUAL FERTILIZER NUTRIENTS USAGE FROM RECOMMENDED APPLICATION RATES AND AREA FERTILIZED (1971)

	(kg/improved ha)			(kg/total ha)		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Thames River Sub-Basin	46.1	39.3	38.7	30.8	26.4	26.0
Grand River Sub-Basin	31.2	23.8	24.3	19.8	15.1	15.4
Average of Canadian Lake Erie Basin	41.5	34.5	34.3	27.3	22.7	22.6

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

TABLE 18: ANNUAL TOTAL NUTRIENTS FROM MANURE

(t/a)

	N	P_2O_5	K_2O
Thames River Sub-Basin	24,347	13,021	22,909
Grand River Sub-Basin	19,255	9,903	17,611
Total Canadian Lake Erie Basin	43,602	22,924	40,520

pounds (lb) = tonnes (t) x 2200

TABLE 19: ESTIMATED ANNUAL PRODUCTION OF MANURE NUTRIENTS (1971)

	(kg/improved ha/a)			(kg/total ha/a)		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Thames River Sub-Basin	23.1	12.3	21.7	15.4	8.3	14.5
Grand River Sub-Basin	40.5	20.8	37.1	25.7	13.2	23.5
Average of Canadian Lake Erie Basin	28.5	15.0	26.5	18.7	9.9	17.4

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

COMBINED FERTILIZERS AND MANURES

The combined nutrients from fertilizer usage and manure production are presented in Table 20. About 275,000 t (605 million lbs) of nutrients are applied to the basin annually; including 107,146 t (235 million lb) nitrogen; 75,813 t phosphorus (P_2O_5) (166 million lb); and 93,008 t potassium (K_2O) (204 million lb). About 70 percent of all these nutrients are applied in the Thames River Sub-Basin and 30 percent in the Grand River Sub-Basin.

TABLE 20: ESTIMATED ANNUAL TOTAL NUTRIENTS FROM FERTILIZER USAGE AND MANURE PRODUCTION

(t/a)

	N	P_2O_5	K_2O
Thames River Sub-Basin	73,041	54,576	63,825
Grand River Sub-Basin	34,105	21,237	29,183
Total Canadian Lake Erie Basin	107,146	75,183	93,008

pounds (lb) = tonnes (t) x 2200

ROAD SALTS

It is estimated that a total of about 207,000 t (455 million lb) of salt are used on roads in the Canadian portion of the Lake Erie Basin in an average winter (Table 21). The salt indicated is rock salt or sodium chloride, plus small quantities of chlorides, carbonates and sulphates of calcium and magnesium.

Calcium chloride is also used as a de-icing agent, even though its use amounts to less than one percent of the sodium chloride used. Although calcium chloride is also used in the summer as a dust control agent on gravel surfaces, quantitative estimates were unavailable due to its relatively low level of use.

Total salt use is greater in the Thames River Sub-Basin. However, the intensity of salt use (kg/ha of land) is substantially higher in the Grand River Sub-Basin.

TABLE 21: USE OF ROAD SALT IN THE CANADIAN PORTION OF THE LAKE ERIE BASIN

	Total Salt Use (t/a)	Land Area (ha)	Intensity of Salt Use (kg/ha)
Thames River Sub-Basin	127,377	1,612,547	79
Grand River Sub-Basin	79,443	705,467	113
Total	206,820	2,318,014	89 Canadian Lake Erie Basin Average

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

SOURCE MATERIALS

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5 FUTURE TRENDS

POPULATION

The population projections presented in Table 22 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.

The total population of the Canadian portion of the Lake Erie Basin is projected to increase from 1,515,445 in 1971 to 2,841,455 in 2021. The Grand River Sub-Basin will increase its share of the Canadian Lake Erie Basin population from 32 to 42 percent.

TABLE 22: POPULATION PROJECTIONS FOR THE CANADIAN PORTION OF THE LAKE ERIE BASIN

Watershed	1971	1981	2001	2021
Thames River Sub-Basin	1,021,639	1,157,109	1,411,939	1,649,313
Grand River Sub-Basin	493,806	596,506	862,758	1,192,141
Total Canadian Erie Basin	1,515,445	1,753,615	2,274,697	2,841,454

ECONOMIC ACTIVITY

The economic activity projections presented here were prepared 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) the assumption that 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 time 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 II 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 worker 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, 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 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 percent 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 be 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 the persons employed) should cause personal savings to rise rapidly.

In Series B by the year 2020, exports (in current dollars) will be about 2.3 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 ten 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 simulations 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 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 Erie Basin are presented by major industrial group in Table 23. Total output is projected to increase from 4,626 (millions of 1961 dollars) in 1972 to 36,058 in 2020. The contribution of the land-based industries (agriculture, forestry, fisheries, and mining) will continue its past decline from 6 percent to 4 percent over the forecast period. Manufacturing will increase its share of total output from 43 to 52 percent. This will be compensated for by a relative decline in the contributions of construction, transportation, utilities, trade and other industries to the total economic output.

TABLE 23: ECONOMIC ACTIVITY PROJECTIONS FOR THE LAKE ERIE BASIN, SERIES A

Real Domestic Product by Major Industrial Group
(Millions of 1961 Dollars)

	1972	1980	2000	2020
Agriculture	229.54	316.28	647.36	1,399.07
Forestry	2.07	3.39	7.06	14.08
Fisheries	1.80	1.96	2.70	4.23
Mining	22.56	33.79	76.67	177.56
Manufacturing	2,004.54	3,294.53	7,432.33	18,839.53
Construction	244.14	372.62	719.63	1,453.58
Trans., Utilities Trade & Other	2,121.21	3,296.01	6,976.31	14,169.45
Total Output All Sectors	4,625.86	7,318.58	15,862.06	36,057.50

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 what the economy experienced over the entire 1950 - 1975 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 occurred 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 bear 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 resource 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.

The agricultural land use forecasts are presented by river sub- basin group in Table 24. The alternative forecasts of agricultural land use predict different futures for the Canadian Lake Erie 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 increase slightly. However, this increase will be distributed unevenly. In the Thames River Sub-Basin, a significant area will be added to agriculture, while in the Grand River Sub-Basin the agricultural area will be relatively stable, according to the model predictions.

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, which of the following 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 on 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 in the urban land forecasts. The first approach 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.

TABLE 24: AGRICULTURAL LAND FORECAST FOR THE CANADIAN PORTION OF THE LAKE ERIE BASIN, 1980 - 2020

(ha)

	1980		2000		2020	
Scenario:	Optimistic	Pessimistic	Optimistic	Pessimistic	Optimistic	Pessimistic
Thames River Sub-Basin	1,222,785	1,203,702	1,281,925	1,372,969	1,322,793	1,376,435
Grand River Sub-Basin	339,070	325,879	339,203	511,963	342,923	543,030
Total Canadian Lake Erie Basin	1,561,855	1,529,609	1,621,128	1,884,932	1,665,716	1,919,465

acres = hectares (ha) x 2.471

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 Erie Basin are presented by sub-basin in Table 25. Approximately 50,000 ha (123,550 acres) of urban expansion land will be needed by the year 2020 to accommodate the projected population growth in the Canadian Lake Erie Basin. This increase in urban land will be divided fairly evenly between the Thames and Grand River Sub-Basins. However, in relative terms, urban land in the Grand River Sub-Basin will grow at a faster rate than in the Thames River Sub-Basin. The Grand River Sub-Basin will increase its share of urban land in the Lake Erie Basin from 34 percent in 1972 to 43 percent in 2020, while that in the Thames River Sub-Basin will decrease from 66 percent to 57 percent over the same time period.

TABLE 25: URBAN LAND FORECASTS FOR THE CANADIAN PORTION OF THE LAKE ERIE BASIN

(ha)

	1972	1980	2000	2020
Thames River Sub-Basin	56,190	62,033	70,746	75,496
Grand River Sub-Basin	28,759	32,601	43,783	55,852
Total Canadian Lake Erie Basin	84,949	94,634	114,529	131,348

acres = hectares (ha) x 2.471

Since there is a fixed amount of land in the Canadian Lake Erie Basin this urban expansion will necessitate the conversion of about 50,000 ha (123,550 acres) of non-urban land to urban use. The Lands Directorate, Environment Canada, recently did a study on rural conversion in Ontario cities (5), recording the former use of land converted to urban over the period 1966 to 1971. The results for the seven cities in the Canadian Lake Erie Basin with populations greater than 25,000 are presented in Table 26. It is noted that a very high percentage of the conversion to urban land use in the Canadian Lake Erie Basin was agricultural to urban conversion. It is likely that this pattern will continue in the future.

SUMMARY

Major land use projections for the Canadian portion of the Lake Erie Basin are summarized in Table 27. No major changes are forecast.

TABLE 26: CONVERSION OF OTHER LAND USES TO URBAN USE IN THE CANADIAN LAKE ERIE BASIN CITIES, 1966-1971

City*	Percentage Of Total Land Converted		
	Agriculture	Forest	Other
Brantford	85	13	2
Chatham	99	0	1
Guelph	88	10	2
Kitchener	85	14	1
London	89	10	1
Windsor	96	4	0
Woodstock	93	7	0

* populations > 25,000

TABLE 27: MAJOR LAND USE PROJECTIONS FOR THE CANADIAN PORTION OF THE LAKE ERIE BASIN, 1972-2020

(1000 ha)

	1972	1980	2000	2020
Urban	84.9	94.6	114.5	131.3
Agriculture	1533.2	1561.9	1621.1	1665.7
Forest	661.3	620.4	532.4	451.3
Other	38.6	41.1	50.0	69.7
Total Land Use	2318.0	2318.0	2318.0	2318.0

acres = hectares (ha) x 2.471

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 portion of the Lake Erie 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 Erie 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 should 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 demand for dairy products.

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 surely increase in the future.

Not only will there be more people wanting recreation, but 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 these forecasts are discussed in Appendix A of Volume I in this report series.

Table 28 presents a predicted increase in pesticide use in the Canadian portion of the Lake Erie Basin under both the pessimistic and optimistic yield forecasts (7). This increase will result from the consolidation of agriculture in the favoured region of southwestern Ontario, even if agricultural land is retired from production in the rest of the Province.

The forecasts imply the following percentage changes, relative to the base year, in annual pesticide use for the Canadian portion of the Lake Erie Basin:

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.

	Lower Forecast	Upper Forecast
	(percent)	
Herbicide	+ 12	+ 30
Fungicide	+ 97	+110
Insecticide	+ 16	+ 33

TABLE 28: FORECAST OF ANNUAL AGRICULTURAL PESTICIDE USE IN THE CANADIAN PORTION OF THE LAKE ERIE BASIN

	(t/a)			
Pesticide	1971	1980	2000	2020
Herbicides- Lower Forecast	1580	1600	1715	1776
Upper Forecast	-	1637	1996	2048
Fungicides- Lower Forecast	212	243	323	417
Upper Forecast	-	249	356	446
Insecticides- Lower Forecast	1879	1917	2075	2179
Upper Forecast	-	1959	2410	2500

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 Erie 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-range projections, most of these factors have been excluded from the agricultural forecasting exercise. However, the environmental implications of a 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 chemical content of fertilizers used in the Canadian portion of the Lake Erie Basin is presented in Table 29 (7). These 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, the rate of growth is predicted to become more gradual.

The factors behind this projection include the following: 1) that an increasing proportion of the area under crops will be fertilized; 2) that the total area under crops will increase; and 3) that there will be a shift to crops which require more intensive fertilization.

Specifically, fertilizer nutrients applied to the Canadian portion of the Lake Erie Basin will increase from 108,058 t (238 million lb) in 1971 to 313,835 t (690 million lb) in 2020.

TABLE 29: FORECAST WEIGHT OF NUTRIENTS IN COMMERCIAL FERTILIZER USED BY AGRICULTURE IN THE CANADIAN PORTION OF THE LAKE ERIE BASIN

(t/a)

	1971	1980	2000	2020
Nitrogen	36,490	47,818	92,423	106,146
Phosphorus (P_2O_5)	34,358	45,027	87,185	100,169
Potassium (K_2O)	37,210	48,608	93,777	107,520
Total Nutrients	108,058	141,453	273,385	313,835

pounds (lb) = tonnes (t) x 2200

ROAD SALTS

The use of road salt in the Canadian portion of the Lake Erie Basin is projected to increase at a steady rate over the next 50 years. The specific forecasts by year are as follows: 1980 - 228,400 t (502 million lb); 2000 - 278,505 t (613 million lb); and 2020 - 336,614 t (740 million lb) (7).

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 mass of materials that are applied to the land in the Canadian Lake Erie 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.

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