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Ontario Region

A REVIEW OF WATERSHED MANAGEMENT PLANS RELATIVE TO THE CONTROL OF RURAL NON-POINT SOURCE POLLUTION IN THE CANADIAN GREAT LAKES BASIN

Direction générale des eaux intérieures

Région de l'Ontario

Canada

Under the Direction of:

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Burlington, Ontario

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Ontario Ministry of Natural
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JULY, 1981

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EXECUTIVE SUMMARY AND RECOMMENDATIONS

Introduction

In recent years, the Province of Ontario has undertaken three major water management studies. The drainage basins studied were the Thames River, the Lake Simcoe-Couchiching and the Grand River; all watersheds that drain into the Great Lakes. These investigations were comprehensive, both in terms of technical scope and agency participation.

Although the Thames River, Simcoe-Couchiching and Grand River water management studies all identified and dealt with similar problems (e.g., water quality impairment, flooding, water supply, etc.) each of the studies were unique in that they were undertaken in different watersheds, at different times and for different reasons. Moreover, they involved different organizations and varying amounts of funding. Implementation of the watershed plans, developed from the studies, also varied significantly from basin to basin.

One of the issues investigated by the water management studies was pollution from rural non-point sources. The main pollutants of concern were nutrients (in particular phosphorus) and sediments. Each study determined the significance, causes and extent of rural diffuse source loadings to their watershed and made specific recommendations for its reduction[1]. The recommendations were outlined in the water management plans. Various provincial agencies are currently in the process of implementing these recommendations.

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1 The Grand River Basin plan has yet to be finalized. Although extensive preliminary information is available, specific recommendations to reduce rural non-point source pollution have not yet been developed.

This study was undertaken on behalf of Environment Canada (Inland Waters Directorate - Ontario Region) and the Ontario Ministry of Natural Resources (Conservation Authorities and Water Management Branch). Its purpose was to review the Thames River, Simcoe-Couchiching and Grand River watershed management studies and their implementation relative to the control of rural non-point source pollution in the Canadian Great Lakes Basin. The studies and their implementation were to be evaluated from a Great Lakes perspective and within the context of the studies, conclusions and recommendations of the Pollution from Land Use Activities Reference Group (PLUARG) of the International Joint Commission, in accordance with the attached Terms of Reference (Appendix A).

The report is based on information obtained and interviews conducted during the summer of 1980. While this document has been reviewed by the Inland Waters Directorate and the Conservation Authorities and Water Management Branch, as well as the staff of the Thames River Implementation Committee, the Grand River Implementation Committee and the Simcoe-Couchiching Report Committee, it is not an official publication of either Environment Canada or the Ministry of Natural Resources.

Water Management Studies

(a) Thames River Basin Water Management Study:

The Thames River Basin Water Management Study, established in 1972, was undertaken jointly by the Ministry of the Environment (MOE) and the Ministry of Natural Resources (MNR). The investigation took 3 years to complete and cost approximately $600,000 (McFadden, pers.comm.). The study was initiated in response to growing concern over existing problems related to water quality, flooding and erosion in the watershed, and potential problems anticipated as a result of future population growth and economic development.

The two main water management problems identified in the Thames River Basin by the Water Management Study were water quality impairment and flooding.

The impairment of surface water quality was attributed to excessive inputs of nutrients, from both point and non-point sources. Although diffuse sources were identified as the major contributors to water quality impairment

in the basin (diffuse sources were found to contribute 74 percent of the total phosphorus and 95 percent of the total nitrogen load), the Study primarily concerned itself with point sources of pollution.

The major diffuse nutrient sources identified by the Study were surface runoff from fertilized fields, municipal drains, field tile systems and drainage from intensive feedlots. Sediment was the other major diffuse source pollutant named. However, no estimates were made as to its severity in the watershed nor were problem areas singled out. Erosion of soil from cultivated land; elimination of soil stabilizing vegetation along water courses to maximize acreage in production; unrestricted cattle access to streams; and construction activities such as installation of drains; were recognized as the major contributors of sediment loading to the river.

Overall, the Thames River Study was too general in regard to rural non-point source pollution (McFadden, pers. comm.). The problems identified and their specific locations were very vague. Information was found lacking on such inherent factors as surficial geology, land use practices and vegetation cover; all of which have a considerable bearing on the contribution of diffuse sources. As a result, the Study was not very helpful to the various government agencies when they began the implementation of non-point pollution control programs.

Remedial measures recommended by the study for management of rural oriented problems included restricting cattle access to streams, limiting fertilizer application rates and controlling farm waste discharges. To reduce soil erosion the following options were suggested: strip cropping, crop rotation, diversion terraces, grassed waterways, vegetative buffer zones and reforestation. Other conservation measures recommended included: sound agricultural tillage practices; preservation of water retaining areas; and use of appropriate ground cover.

The recommended land treatment measures were merely listed in the report. There was no mention of their cost-effectiveness nor was there any discussion of where they were applicable. Moreover, there was very little explanation of where implementation of the recommendations should be

undertaken. A breakdown of the effect on water quality of each land use and each activity would have been useful in identifying the basis of the recommendations. The potential benefits and costs to the agricultural community with respect to alternative remedial programs would also have been useful. The specific recommendations were, unfortunately, not integrated into the rest of the report so that cause-effect linkages were not readily identifiable.

(b) Lake Simcoe-Couchiching Environmental Strategy

The Lake Simcoe-Couchiching Environmental Strategy was significantly different from the other basin investigations. Besides being unique in terms of studying a lake system versus a river system, the Lake Simcoe-Couchiching Report Committee (LSCRC)[2], which was established to prepare an Environmental Development strategy for the Lake Simcoe Watershed, used primarily existing studies. Unlike the other water management studies, no funds were allocated for the study and, as a result, no new research was undertaken by the study team.

The Study was undertaken by the Province in response to noticeable changes in Lake Simcoe water quality, public pressure and the possibilities of further environmental degradation resulting from future population growth. The major overall problem identified by the Report Committee was the release of excess nutrients to the lakes, in particular phosphorus. Periodic algae scums, localized weed problems, localized turbidity problems and the decline of the fishery were all the result of increased loadings of nutrients to the lakes.

The total annual phosphorus load to Lake Simcoe was estimated at 103 metric tonnes per year of which agricultural sources were determined to contribute 21 percent. The Holland Marsh was identified as the major rural

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2 The Lake Simcoe-Couchiching Report Committee consisted of technical staff representation from MOE, MNR, OMAF, The Ministries of Industry and Tourism, Treasury and Intergovernmental Affairs and representatives from the Canada-Ontario-Rideau-Trent-Severn Secretariat (CORTS) and the South Lake Simcoe Conservation Authority (SLSCA).

diffuse source of phosphorus. Agricultural practices identified as contributing to water quality problems included: fertilizer use, manure storage and application, continuous corn cropping, watering cattle in streams, and drain construction. No specific information on the water quality effects nor the extent of these practices within the Lake Simcoe Basin were outlined.

To reduce the negative effects of agricultural activities on water quality, the report recommended that remedial measures be introduced in two main areas: the cultivated portion of the Holland Marsh and the agricultural area in the remainder of the basin. Alternatives suggested for the Holland Marsh included: fertilization only to soil-test needs; minimizing pumpage from the Marsh during and shortly after ice cover; additional fall pumpage of drainage water; and establishing an aeration lagoon or a treatment tank at the foot of the marsh (LSCRC, 1979). The following remedial measures were recommended for the remainder of the basin: fertilization only to soil test needs; manure management (greater implementation of the Agricultural Code of Practice); reduction of soil erosion (by crop rotation strip cropping, contour cultivation, sod buffer strips along watercourses, grassed waterways, and reforestation of shoreline areas); restriction of livestock access to watercourses; and better education and communication (LSCRC, 1979).

All these remedial measures were presented with no discussion as to their costs, effectiveness or applicability to the Lake Simcoe-Couchiching area. In fact, planning staff stated that the measures were simply taken directly from PLUARG and other reports (Salbach, pers. comm. and Gallagher, pers. comm.). No new studies were undertaken and no technical reports were cited in the report. The basic approach taken for all the recommendations was to stress implementation of remedial measures and then to monitor the water quality afterwards to determine the effectiveness of the measures introduced.

(c) Grand River Basin Water Management Study

The Grand River Basin Water Management Study (GRBWMS) was scheduled

to be completed in September 1980[3]. With a budget of 1.663 million dollars, a vast network of monitoring stations, and data and results from PLUARG, MOE and Grand River Conservation Authority (GRCA) studies, it is by far the most intensive study of the three discussed herein.

The Grand River Study was initiated in response to growing concern over existing and potential water quality and flooding problems in the Grand River Basin. Unlike the other water management studies, the Grand River Study did place heavy emphasis on rural non-point source pollution. In fact, the Study established a separate subcommittee dealing solely with diffuse sources. In addition, four related technical reports were published by GRBWMS. Throughout all the reports, considerable use was made of the PLUARG Grand River Pilot Watershed Study.

The PLUARG Study identified excessive inputs of sediments, phosphorus and nitrogen as major causes of water quality problems in the Grand River Basin. PLUARG determined that a large portion of the loading - 84 percent of the sediment, 67 percent of the total phosphorus, 47 percent of total kjeldahl nitrogen and 81 percent of nitrite and nitrate - came from rural diffuse sources (Hore and Ostry, 1978). Areas identified as contributing the largest amount of sediment and nutrients were the Middle Grand, the Nith River and the Conestoga River.

Agricultural watershed information from the PLUARG Study indicated that the nature and type of agricultural activity was reflected in the water quality of the receiving streams (Hore and Ostry, 1978). Simple correlations between ten sub-basin characteristics and the unit-area loads and various water quality parameters were calculated. Relatively strong correlations were found between the unit area loads and the following parameters: percent farmland, percent cropland, percent small grains, percent hay, intensity of livestock operations and percent clay (GRBWMS, 1980). A number of these correlations suggested that the unit area loads of phosphorus and nitrogen

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3 The study has been delayed and the release date of the final report is not definite at this time.

would depend greatly on the amount of fertilizers used and manure produced in the sub-basin; soil characteristics; and agricultural practices. Surface runoff from cropland, municipal drains and field tile systems and drainage from intensive livestock operations were recognized as the major causes of rural diffuse source pollutant loading to the basin (GRBWMS, 1979).

In order to assess the extent, location and severity of these problems in the problem areas identified; two field surveys, as well as a study of aerial photographs, were undertaken by the Grand River Implementation Committee[4] (GRIC). Five regression models were also developed by GRIC to relate measured unit area loads to the sub basin characteristics. These models were then used to project pollutant loads to the years 2001 and 2031 for each sub-basin.

Overall, rural non-point source pollution was given considerable attention in the Grand River Water Management Study. The fact that the Grand River Basin was chosen as a pilot watershed study by PLUARG made data and results from an extensive stream quality monitoring network available. This led to much more accurate estimates of pollutant loadings and allowed the study to identify problem areas with improved precision.

At the writing of this report, the Grand River Basin Water Management Study has not yet outlined specific recommendations to reduce rural non-point source pollution inputs to the Grand River watershed. However, several technical reports, published by GRBWMS, do recommend specific remedial measures that should be undertaken (see section 4.3). In addition, a few of the reports have determined the cost-effectiveness of the recommended measures. The PLUARG study was the source of most of the information contained in these reports.

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4 GRIC is a Joint Committee of Government Agencies and other bodies assigned to direct the Grand River Basin Water Management Study, the Committee consists of representatives from MOE, MNR, GRCA, OMAF and the Ministries of Housing, Treasury and Intergovernmental Affairs.

(d) Comparison of the Water Management Studies

The Thames River, Simcoe-Couchiching and Grand River Water Management Studies, all identified rural non-point source pollution as a major problem in their respective watersheds. Each study also recommended specific remedial measures to reduce rural diffuse source loadings.

Essentially all three studies identified the same problems, and recommended the same remedial measures to correct them. Erosion of agricultural land was found to be a major contributor of sediment loading to streams. Associated with the sediment contamination, were excessive inputs of nutrients (i.e., phosphorus and nitrogen) due to poor management of manure and/or commercial fertilizers. Among the techniques suggested for reducing soil erosion rates were: crop rotation, strip cropping, contour cultivation, sod buffer strips bordering watercourses, use of mulch or cover crops, grassed waterways, diversion terraces, and restriction of cattle access to streams. Remedial measures specifically aimed at reducing nutrient inputs included: fertilization at rates recommended by soil tests; incorporation of manure into the soil as soon as possible after application; restriction of manure application within stream floodplains or during the winter; and greater implementation of the Agricultural Code of Practice with respect to livestock operations, manure storage, runoff from barnyards, manure spreading, etc.

The recommended measures were not new. In fact, virtually the same remedial measures were outlined in detail in the Conservation Reports of the Upper Thames Valley (Department of Planning and Development, 1952), the Grand Valley (Department of Planning and Development, 1954), the Lower Thames Valley (Department of Energy and Resources Management 1965), and the South Lake Simcoe Basin (MNR, 1973). These Conservation Reports were extensive documents that summarized the findings of major surveys of land use, forestry, water, wildlife, and recreation in the respective watershed. The Reports outlined conservation measures the Authority should implement in each field; and gave numerous references supporting the recommendations made. Actually, description

of the need and value of conservation practices, as well as their basis and implementation was much more detailed in the Conservation Reports than in the Water Management Studies. Moreover, the Reports covered areas not necessarily addressed by the Studies (i.e., natural water storage areas, reforestation, farm planning and conservation practices). Although somewhat dated, the Conservation Reports were generally overlooked by the Water Management Studies.

One problem with the generalized recommendations made in the Water Management Studies was that no mention was made of their applicability. Localized variations in pollutant source, soil properties and landscapes, cropping systems and active pollutant contributing areas were not considered. PLUARG studies have shown that the erosion and transport of pollutants from rural land is a site-specific problem requiring the implementation of site-specific remedial measures on the active contributing areas. The relative magnitude of a pollutant source varies from area to area, thereby governing the implementation of remedial programs. Soil properties, such as texture, can affect the suitability of a remedial practice at a given location. Clay soils such as those located in the Lower Thames River basin are not suited to spring plowing or minimum tillage remedial practices since the corresponding yield reductions make corn or soybean production uneconomical (Heard, pers. comm.). However, spring plowing or minimum tillage are viable remedial programs in areas with medium to coarse textured soils. The shape of the landscape can also affect the selection of remedial measures. For example, strip or contour cropping are most applicable on simple, uniform slopes rather than hummocky, complex topography (Agric. Can., OMAF and MOE, 1978). The existing range of crops grown in a region can also determine the choice of remedial measures. The use of hay crops in rotations is not economically feasible in areas where there is no local market for the hay and higher yields of row crops are possible (Agric. Can., OMAF and MOE, 1978).

Another basic criticism of the Water Management Studies was the fact that very little research was undertaken or cited by the studies to determine the cost-effectiveness of the remedial measures they outlined. In fact, the

Thames River and Simcoe-Couchiching studies did not conduct any research at all. The PLUARG Grand River Pilot Watershed Study determined that the most effective measures for the reduction of rural non-point pollution were, in decreasing order of importance: i) reduction of sediment from soil erosion; ii) control of runoff from manure storage and livestock feeding areas; iii) incorporation of manure into the soil immediately after spreading; iv) application of fertilizer according to "soil test recommendations"; and v) control of drainage from silos and barn yards (Agric. Can., OMAF and MOE, 1978).

This information, together with other PLUARG Studies was used by the Grand River Study, which did investigate the cost-effectiveness of implementing certain remedial measures in key contributing areas (see section 4.3). Streambank stabilization, no cropping in the floodplain and widening buffer strips were found to be more cost-effective than crop rotation and winter crop cover in the Grand River Basin (GRBWMS, 1980).

Still the results obtained by the Grand River Study were limited at best. All three studies failed to document the cost-effectiveness or applicability of the recommendations they made to reduce rural non-point source pollution.

Implementation of the Water Management Studies

Although many management methods currently exist to reduce rural diffuse source pollution, studies have shown that the remedial measures are not being widely used (TRIC, 1978; Neilson, 1978). To implement the remedial measures various alternatives were adopted (see section 2.4, 3.4 and 4.4).

(a) Thames River Basin

Implementation of the recommendations pertaining to the control of non-point source pollution in the Thames River Basin was assigned to the Agriculture and Land Use Subcommittee of the Thames River Implementation

Committee (TRIC)[5]. Despite the original study's shortcomings, TRIC has done an admirable job in coordination, promotion and implementation of the Water Management Study's Recommendations (see section 2.4.1). As recommended in the "PLUARG" report, TRIC has identified the key contributing areas (hydrologically active areas) and is concentrating its efforts in these areas. Two field surveys and a farmer questionnaire survey have also been completed by TRIC. These studies will serve as the basis for selecting demonstration sites to illustrate the benefits of good land management practices. Once selected, remedial measures will be undertaken at the sites and their cost-effectiveness will be monitored. The demonstration sites will serve primarily as informational/educational projects promoting conservation measures among farmers in the basin by providing visual evidence of the nature and value of erosion control measures and effective land use practices. TRIC also has plans for examining drain construction techniques and the effects of current drain construction practices with a view toward developing a guideline booklet for use by contractors and individual farmers. In addition, TRIC is offering increased assistance to farmers in the assessment and application of sound conservation practices. The expertise of an agricultural engineer, an agronomist and an agricultural technician have been secured to aid these activities.

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5 TRIC is a joint committee of Government Agencies and other bodies assigned to "Overcome communication and coordination problems related to Water Management in the Basin and to implement planning on a watershed basis." Established in October 1976, TRIC includes representatives from the MOE, MNR, the Ontario Ministry of Agriculture and Food (OMAF), the Upper Thames River Conservation Authority (UTRCA), the Lower Thames Valley Conservation Authority (LTVCA), the Ministry of Housing, the Municipal Engineers Association and the Ontario Federation of Agriculture. Funding for TRIC is split equally (on a monthly basis), between MOE and MNR. The budget for the 1980-81 fiscal year is $188,000.

Throughout all its efforts, TRIC has maintained close liaison with OMAF, Soil and Crop Improvement Associations, Conservation Authorities and the basin farmers. They have also stayed abreast of the Stratford/Avon Study, Reynold's Creek, PLUARG Studies, OMAF and Agriculture Canada research investigations and studies undertaken in the United States (particularly the Honey Creek Study in Ohio).

The UTRCA, through its various programs, has also contributed significantly to implementing the recommendations of the Thames River Study pertaining to non-point source pollution (see section 2.4.2). Besides its reforestation and erosion control programs, the UTRCA has completed an intensive site-specific demonstration project - Reynolds Creek. The Reynolds Creek Project provides readily accessible examples of erosion control methods that private landowners can employ to reduce agricultural runoff, erosion and siltation. Hopefully other land owners will be encouraged to undertake similar improvements on their own properties. Reynolds Creek is being monitored to determine the cost-effectiveness of the various control measures introduced.

The Reynold's Creek Project illustrates a new approach being adopted by UTRCA (i.e., site-specific). This approach is based on the fact that some sub-basins contribute more significantly to non-point source pollution than other sub-basins within the watershed. By locating problem erosion areas[6], approaching landowners and encouraging them to take advantage of the assistance programs available, UTRCA believes significant water quality improvements in the Thames River will be effectively achieved. UTRCA staff feels that this site-specific approach will be further utilized in implementing its other programs (Prout, pers. comm.).

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6 Strictly speaking, UTRCA did not undertake the Reynold's Creek Project as a result of it being identified as a problem erosion area. The Reynold's Creek project was undertaken more as a demonstration project. Reynolds Creek originally came to the attention of the authority as a result of landowners on the Creek petitioning the township under the Drainage Act to improve and repair the Creek.

The Stratford/Avon River Environmental Management Project, undertaken primarily by MOE and UTRCA, is another example of the site-specific sub-watershed approach being adopted in the Thames River basin. This study is considerably larger and more intensive than the Reynold's Creek Project (see section 2.4.2). At the present time, demonstration sites are being located and key contributing areas are being identified. Once selected, remedial measures will be undertaken at the sites and their cost-effectiveness will be monitored and evaluated.

The Lower Thames Valley Conservation Authority (LTVCA) and OMAF have not come close to matching the implementation of non-point source pollution control measures demonstrated by TRIC, MOE and UTRCA (see sections 2.4.4 and 2.4.5). LTVCA has a conservation services program, offering reforestation and erosion control assistance. However, its budget is comparatively small and the programs are not promoted. OMAF, while it has various program designed to assist farmers by increasing soil productivity and reducing soil losses, has done very little on its own to reduce rural non-point source pollution inputs to the Thames River basin. Results of OMAF's Farm Productivity Incentives Program show little implementation of erosion control, alternate livestock watering or demonstration projects. What implementation there is, is haphazard.

(b) Lake Simcoe-Couchiching Basin

Implementation of recommendations of the Lake Simcoe-Couchiching Environmental Strategy was left to existing government agencies and mechanisms, with the Cabinet Committee for Resources Development (CCRD) acting as coordinator. SLSCA and OMAF were thus assigned chief responsibility for reducing rural non-point source pollution inputs to the basin.

The SLSCA has several programs, currently in operation, which contribute to erosion control and the reduction of sedimentation and nutrient loading (see section 3.4.1). Many of these programs and studies are in their early stages. Response to the programs has been limited (Peterkin, pers. comm.). At the present time, the programs require that landowners apply to the Authority for assistance. In this manner, many sites where clearly visible erosion problems exist are overlooked. The staff at SLSCA is of the opinion that the Authority should become actively involved in locating problem erosion areas, approaching landowners and encouraging them to take advantage of the assistance programs available (Peterkin, 1980). Furthermore, the Authority staff believes they should priorize areas for stream stabilization and reforestation.

The Authority staff would also like to expand and promote their extension services, but do not have sufficient funds to do so. In fact, currently the programs are not promoted at all since the SLSCA is receiving as much of a response as they are willing to fund. They fear that their public image will suffer if they get too many more applications than they can handle (Peterkin, pers. comm.). If the Authority is to play a major contributing role in implementing the Environmental Strategy, it is essential that financial commitments from local, regional and provincial governments be made in order to ensure the continuing development and expansion of existing Authority programs and to encourage the development of new programs (Peterkin, 1980).

The SLSCA should also be expanded itself to include the entire watershed area. As it now stands, the Authority covers approximately 75 percent of the basin. Implementation of its programs is therefore limited. The rest of the watershed does not have a Conservation Authority.

OMAF, the other principal agency responsible for reducing rural non-point source pollution to the Simcoe-Couchiching basin, has done very little. Results of OMAF's Farm Productivity Incentives Program for the

watershed show hardly any implementation (see section 3.4.2). A cooperative erosion control demonstration site, with SLSCA has not yet been selected.

The two basic problems in the Simcoe-Couchiching basin are money and coordination. The SLSCA and OMAF both have the programs necessary for reducing rural diffuse source pollution. What they don't have is the financial support required to hire more technical staff and promote and help subsidize their programs. Without the financial backing it is impossible to properly implement the recommendations of the Environmental Strategy. Moreover, without coordinated implementation, the results are haphazard. OMAF does not seem committed to reducing rural non-point source pollution in the Simcoe-Couchiching basin.

(c) Grand River Basin

Since the Grand River Basin Water Management Study has not yet been completed - a discussion of the implementation of its recommendations is not possible. However, the Grand River Conservation Authority (GRCA) and OMAF both offer programs which could be directed towards reducing rural diffuse source pollution loading to the Grand River basin (see sections 4.4.1 and 4.4.2). Implementation of these programs however, is haphazard.

Very heavy emphasis (perhaps too much) is placed on reforestation by the GRCA. Almost the whole of the relatively large "Conservation Services Program" budget goes toward planting trees. Implementation of other programs is limited. Implementation of OMAF's Farm Productivity Incentives Program in the Grand River basin also does not show any marked concern for projects to reduce rural non-point pollution except for manure storage projects which received 93 percent of the OMAF grants. Only a few erosion control projects were undertaken.

Again, there seems to be no evidence of coordination between the agencies. The various programs offered by GRCA and OMAF are administered on a

first-come, first-served basis; and remedial measures are not necessarily undertaken where they are most needed. (i.e., the "Key Contributing Areas").

(d) Comparison of Implementation Within the Basin

Table 1 provides a summary of all the relevant implementation initiatives undertaken within each basin by the agencies. It is of interest to compare the total expenditures in the Thames and Grand River Basins. More money is evidently being spent on activities related to implementation within the Grand River, despite the fact that the management study is incomplete, than in the larger Thames Basin. However, the variety of projects and emphasis in the Thames Basin on demonstration-type projects is noteworthy.

OMAF's activities are conspicuous by the emphasis placed upon manure storage. There seems to be little concern for erosion control practices either directly or through education and demonstration projects.

The figures provided in Table 1 for MOE's activities are misleading to some extent because the funding in the Grand River is for studies associated with the management plan as opposed to implementation. It is clear from Table 1 that MOE's emphasis with respect to implementation is within the Thames Basin, at this time.

Recommendations

1. ALL THE PROVINCIAL AGENCIES INVOLVED IN THE CONTROL OF RURAL NON-POINT SOURCE POLLUTION SHOULD PLACE GREATER EMPHASIS ON EDUCATION AND EXTENSION EFFORTS.

The Provincial Agencies should concentrate on informing, educating and demonstrating to rural landowners that good land management is an essential and very practical activity. Since PLUARG has already determined many of the best remedial measures for control of soil loss and water quality

TABLE 1

SUMMARY OF IMPLEMENTATION OF WATER MANAGEMENT PLANS RELATIVE TO THE CONTROL OF NON-POINT SOURCE POLLUTION IN THE CANADIAN GREAT LAKES BASIN (1980)

AGENCY	THAMES RIVER BASIN (5,827 km²) Prog.	Budget	Implem.	LAKE SIMCOE-COUCHICHING BASIN (2,425 km²) Prog.	Budget	Implem.	GRAND RIVER BASIN (6,500 km²) Prog.	Budget	Implem.
Conservation Authorities	UTRCA			SLSCA			GRCA		
	Reforestation	8,200	150,000 Trees	Reforestation	NA	49 Projects	Reforestation	50,000	100 Projects
	Farm Tree Replacement	16,500	4,000 Trees	Farm Tree Replacement	NA	13 Projects	Farm Tree Replacement	18,000	100 Projects
	Erosion	5,000	2 Projects	Erosion	NA	1 Project	Erosion	5,000	10 Projects
	Reynolds Cr. Ploughing	20,000	Demonstrations	TOTAL Conser. Services	22,000		Water Quality Improvement	1,500	1 Project
	Match	8,000	Displays	Water Quality (SPOF)	15,000	Uxbridge	TOTAL Conser. Services	96,500	
	General	13,000	Supplies &	Ecological Sensitive Area Study	NA	Ecologistics			
	TOTAL Conser. Services	59,000							
	Wetlands Study	NA							
	LTVCA								
	Reforestation	NA	20,000 Trees						
	Farm Tree Replacement	NA	NA						
	TOTAL Conser. Services	12,000							
Ontario Min. of Agric. & Food									
	Erosion Control	7,480	15 Projects	Erosion Control	3,700	5	Erosion Control	9,580	11
	Manure Storage	684,520	262 Projects	Manure Storage	79,130	37	Manure Storage	758,820	296
	Alternate Livestock Wat.	0	0	Alternate Livestock Wat.	0	0	Alternate Livestock Wat.	730	1
	Education/ Demonstration	0	0	Education/ Demonstration	0	0	Education/ Demonstration	0	0
	TOTAL	692,000	277	TOTAL	82,830	42	TOTAL	769,130	318
Ministry of the Environment	TRIC	188,000*		Aeration Study	15,000	Holland Marsh	GRIC	(TOTAL) ($1.663M)	
	Stratford/ Avon	220,000							
	TOTAL	408,000		TOTAL	15,000		TOTAL	($1.663M)	

NA = information not readily available.
* TRIC's funding is actually split equally between MOE and MNR.

impairment, the agencies should promote these better practices, evaluate their cost-efficiency and particularly, show that they can be effective in the Ontario farm situation.

OMAF has been particularly lax in this regard. Although the senior administrators in OMAF seem committed to erosion control and good land management practices, this commitment has not reached the "grass roots" level. TRIC, when they approached farmers to promote their programs, found that a large portion of them were unaware of the grants and subsidies available from OMAF (McFadden, pers. comm.). Specifically, the Ontario Farm Productivity Incentive Program has been poorly advertised and promoted. Very few farmers have taken advantage of the program. Of the 12.8 million dollars allocated for soil management, erosion control and production facility projects by OMAF in 1979-80, only 4.9 million dollars has been used (OMAF, 1980). Furthermore, of that amount only $73,380 has been utilized for erosion control projects. No money at all was spent on education/demonstration projects. The effectiveness of the local agricultural representative has to be questioned given these statistics. Most local agricultural representatives seem unconvinced that farm activities contribute to water pollution. To ensure that the local agricultural representatives are aware of the detrimental effects the agricultural community can have on water quality, a coordinated educational program should be undertaken by OMAF, MOE, MNR and the Conservation Authorities.

2. KEY CONTRIBUTING AREAS SHOULD BE IDENTIFIED AND SHOULD RECEIVE FIRST PRIORITY IN THE IMPLEMENTATION OF REMEDIAL MEASURE PROGRAMS.

The identification of key contributing areas is the first step in implementing a cost-effective program of non-point source remedial measures. Because of the higher probability of eroded soil particles being delivered from these areas to surface water, these areas should receive first priority in the implementaton of remedial programs.

The main problem with the programs available from OMAF to reduce rural non-point source pollution is that they are broad area programs. That is, they are the same right across the province. PLUARG Studies have shown, however, that the erosion and transport of pollutants from rural land is a site-specific problem, requiring the implementation of site-specific remedial measures on active contributing areas. Since implementation of OMAF's programs is left to the local county OMAF representatives, implementation has been sketchy, varying from county to county.

The same is true for implementation of Conservation Authority (CA) programs. As it now stands, most of OMAF's and CA's programs require that landowners apply to them for assistance. In this way, many sites are overlooked where clearly visible problems exist. The agencies should become actively involved in locating the "Key Contributing Areas", approaching landowners and encouraging them to take advantage of the assistance programs available.

3. EFFORTS SHOULD BE UNDERTAKEN TO IMPROVE COMMUNICATION AND COORDINATION BOTH BETWEEN DIFFERENT GOVERNMENT AGENCIES AND WITHIN INDIVIDUAL MINISTRIES.

There seems to be a basic communication - coordination problem in all three basins. The different government agencies are not kept informed of each others activities. Not only is this situation present between Ministries; it is also common within individual Ministries. The head offices are not aware of what the regional or county offices are doing. There is also very little communication between the basins. This stuation leads to duplication of results, wasted efforts and inadequate or inappropriate management strategies. Remedial measures to control rural non-point source pollution are not new. All three studies identified essentially the same problems and recommended the same measures to correct them. With greater communication - coordination, many problems could have been avoided and implementation would have been more effective.

4. THE CONSERVATION AUTHORITIES AND OMAF SHOULD BETTER COORDINATE THEIR PROGRAMS TO CONTROL RURAL NON-POINT SOURCE POLLUTION.

One problem is a clause in the "Ontario Farm Productivity Incentives Program" which does not allow farmers applying for the OMAF grant to receive subsidies from any other government source. This makes it difficult for the Conservation Authorities and the implementation agencies to set up demonstration sites.

In addition there appears to be some controversy over the roles and mandates of these two agencies that should be resolved.

5. A GREAT LAKES PERSPECTIVE NEEDS TO BE ADOPTED FOR THESE WATER MANAGEMENT STUDIES IN LIGHT OF THE FACT THAT CONTROL OF THE EUTROPHICATION PROBLEM OF THE GREAT LAKES DEPENDS TO A CONSIDERABLE EXTENT UPON THE EFFECTIVE MANAGEMENT OF NON-POINT SOURCES, AS IS BEING ATTEMPTED IN THESE WATER MANAGEMENT STUDIES.

PLUARG identified the need for further reduction of phosphorus loads to the Great Lakes through the control of both point and non-point sources. As noted above PLUARG indicated that the effective control of non-point sources requires implementation on a priority area basis and site-specific evaluation and implementation of alternatives. These watershed management studies have been undertaken for the purpose of resolving local (i.e., within the river basin) problems and have not given consideration to the broader Great Lakes Basin perspective. Management of the Great Lakes will be frustrated without greater cooperation among the parties involved and particularly without Federal government involvement in the watershed management studies.

Further, management studies for other basins need to develop within a province wide plan which incorporates a Great Lakes Basin perspective. This will help to avoid excessive expenditures in areas of low regional priority

but perhaps of considerable local concern. It should also be recognized that problems resulting from agricultural activities are not always clearly manifested within the local basin. Therefore, recognition of the broader perspective may assist in the justification of remedial programs.

6. FINANCIAL SUPPORT FOR THE CONTROL OF RURAL NON-POINT SOURCE POLLUTION SHOULD BE INCREASED.

Perhaps the greatest problem facing implementation of remedial measures is financial. The need for financial support from the province cannot be overly stressed, particularly, in promoting a greater appreciation of the potential for water quality impairment as a result of agricultural and other land use activities; and the implementation of effective soil conservation measures. With very limited funding the UTRCA and TRIC both demonstrated that much could be accomplished. With more money, a lot more can be done. Emphasis should be placed on implementation. The remedial measures are well known; once in place their cost effectiveness can be determined. If the lakes and rivers are to be preserved, the achievements made thus far in the treatment of point sources will have to be continued and matched by parallel improvements in the control of contaminants from non-point sources. In light of recommendation 5 it is also apparent that Federal support for both the planning and implementation aspects would be desirable.

7. A MULTI AGENCY JOINT FEDERAL, PROVINCIAL AND CONSERVATION AUTHORITY TASK FORCE SHOULD BE ESTABLISHED TO REVIEW THE PLUARG REPORT, THE SUBSEQUENT REPORT OF THE INTERNATIONAL JOINT COMMISSION, THE PHOSPHORUS MANAGEMENT STRATEGIES TASK FORCE REPORT AND THE STATUS OF THE WATERSHED MANAGEMENT PLANS.

The purpose of the Task Force would include the identification of the best alternatives for coordinating all relevant activities among the agencies. Cost sharing agreements, and the establishment of a joint planning and coordination group should also be considered. Other requirements of the Task Force could be defined as appropriate but it is essential that the "communication channels" be established as soon as possible to avoid further fragmentation and loss of initiative.

CHAPTER 1

INTRODUCTION

1.1 Background Information

In response to growing concern over existing and potential environmental problems, the Province of Ontario has undertaken water management studies in a few watersheds. These investigations were comprehensive both in terms of technical scope and agency participation. The studies examined the environmental scientific, engineering, economic and social aspects of water planning and involved water management organizations with diverse, often conflicting objectives.

Three of the water basins studied were the Thames River, the Lake Simcoe-Couchiching and the Grand River. For each of these watersheds the agencies involved:

(a) assessed the availability and quality of both surface and ground water;

(b) inventoried all water uses and related land uses;

(c) assessed the type and extent of existing and potential water resource problems;

(d) identified the causes of these problems; and

(e) proposed various water management alternatives to deal with them.

The alternatives were then evaluated and comprehensive watershed management plans were developed.

Among the agencies participating in the studies were the Ministry of the Environment (MOE), the Ministry of Natural Resources (MNR), the Ministry of Agriculture and Food (OMAF) and Conservation Authorities. Since the mandates of these various agencies [1] are broad in nature and tend to overlap, a coordinated interdisciplinary approach was adopted in each case.

Issues investigated within the studies included: water quality impairment (from both point and non-point sources); flooding; water supply; loss of prime agricultural land; future population and economic trends; encroachment upon marsh and wildlife areas; diminishing of forests; threats to sensitive ecological regions; inadequacy of water-based recreational facilities to meet demands; decline in the fisheries; and erosion.

Although the Thames River, Simcoe-Couchiching and Grand River Water Management Studies all identified and dealt with similar problems, each of the studies were unique in that they were undertaken in different watersheds, at different times and for different reasons. Moreover, they involved different organizations and varying amounts of funding. Implementation of the watershed plans, developed from the studies, also varied significantly from basin to basin.

One of the principal issues investigated by the Water Management Studies was pollution from rural non-point sources. The main pollutants of concern were nutrients, in particular phosphorus, and sediments. Each study

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1 MOE is responsible for water quality, ground water, water supply and urban storm water management. Coastal zone management and provincial flood emergencies are concerns of MNR. OMAF has responsibility for agricultural land and water management. Flood and erosion control are primarily Conservation Authority concerns. Hydro-electric generation and a variety of other water and related activities are shared by several public and private agencies and corporations. In addition, local municipalities have a major interest in water management decisions (MNR, 1979).

attempted to determine the significance, causes and extent of rural diffuse source loadings to their watershed and made specific recommendations for its reduction. The recommendations were outlined in the water management plans. Various provincial agencies are currently in the process of implementing these recommendations.

1.2 Study Objectives

This study was undertaken on behalf of Environment Canada (Inland Waters Directorate, Ontario Region) and the Ontario Ministry of Natural Resources (Conservation Authorities and Water Management Branch). Its purpose was to review and assess the Thames River, Lake Simcoe-Couchiching and Grand River Watershed Management Studies and their implementation - relative to the control of rural non-point source pollution in the Canadian Great Lakes Basin.

Environment Canada's concern stemmed from its responsibility for Great Lakes Water Quality: which, according to comprehensive studies carried out by the Pollution from Land Use Activities Reference Group (PLUARG),[2] was being significantly impacted by pollution from land drainage. PLUARG found that diffuse sources contributed between 32 and 90 percent of the total phos-

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2 On April 15, 1972, the Governments of Canada and the United States signed the Great Lakes Water Quality Agreement. As an integral part of this Agreement, the International Joint Commission (IJC) was asked to establish a Reference Group to investigate pollution in the Great Lakes System from land use activities. In response to this request, PLUARG was formed. PLUARG reviewed and studied the pollution potential of: several land use activities, including agriculture, urban, forestry, transportation and waste disposal; as well as natural processes such as lakeshore and riverbank erosion and atmospheric deposition of material on land and water surfaces. Using pilot watersheds and monitoring programs, PLUARG examined the effects of diffuse loads on Great Lakes water quality and identified cost effective remedial measures.

phorus loads to individual Great Lakes, as well as significant loads of sediments and toxic substances (International Joint Commission, 1978). To reduce these loadings PLUARG strongly recommended that site-specific watershed management plans be prepared. Since the Provincial Government has developed watershed plans, independently, in a few of the watersheds draining into the Great Lakes (i.e., Thames River, the Simcoe-Couchiching and the Grand River), Environment Canada was interested in gaining a better understanding of how rural non-point source pollution was considered in these plans and of current provincial activities and programs directed towards the reduction of rural non-point source inputs.

The Ministry of Natural Resource, on the other hand, was involved in the provincial water management studies noted above. Due to the independent nature of these investigations however, MNR's Conservation Authorities and Water Management Branch[3] recognized the need for an impartial assessment of the studies and their implementation - with respect to controlling pollution from rural diffuse sources. Additionally, the studies were to be reviewed and evaluated relative to future activities, within other basins, and the Great Lakes basin as a whole.

While this document has been reviewed by the Inland Waters Directorate and the Conservation Authorities and Water Management Branch, as well as the staff of the Thames River Implementation Committee, Grand River Implementation Committee and Simcoe-Couchiching, this Report is not an official publication of either Environment Canada or the Ministry of Natural Resources.

1.3 Study Approach

This study compares and contrasts the treatment of rural non-point source pollution in the Thames River, Simcoe-Couchiching and Grand River Water

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3 The Conservation Authorities and Water Management Branch of MNR coordinates assistance and provides grants and technical advice to the Conservation Authorities which develop and manage renewable resources on a watershed basis.

Management Studies. The significance of rural non-point source pollution; the recommendations outlined for its reduction; and the implementation of remedial measures, in the three study areas, are examined. In addition, the recommendations of the Water Management studies are evaluated; and the problems encountered by the implementation agencies are discussed. Finally recommendations are made in an attempt to improve future water management studies and implementation of the recommendations of these three studies.

The watershed plans and their implementation are reviewed and assessed from a Great Lakes perspective and within the context of the studies, conclusions and recommendations of PLUARG. For the sake of clarity, each watershed is dealt with separately. The basins are discussed in chronological order as to when the studies were undertaken.

CHAPTER 2

THAMES RIVER BASIN WATER MANAGEMENT STUDY

2.1 Background Information

The Thames River basin was the first watershed in Ontario to be studied intensively. It took precedence over the Grand River basin by reason of its higher nutrient loading and severe flooding problems. As such, it was used as the "blueprint" for future studies (MOE and MNR, 1974). The following section briefly describes the basin and summarizes the background, objectives and problems identified by the Thames River Basin Water Management Study.

2.1.1 Basin Description

The Thames River basin is one of the prime agricultural areas in the province. With a total length of 202 km. (125 mi) it is the second largest river basin in southwestern Ontario, draining an area of approximately 5,827 sq. km. (2,250 sq. mi.). Major water uses in the basin include: water supply for agricultural, domestic, municipal, and industrial purposes; waste disposal and assimilation; recreation; and fish and wildlife habitat. Inherent conflicts among these uses are prevalent in the watershed. Moreover, proposed solutions to individual problems may themselves create additional problems.

Agriculture is the major land use, accounting for approximately 85% of the total land area of the watershed (MOE and MNR, 1975). Agricultural activity is diversified and varies from area to area depending on soil and climatic conditions. It includes livestock raising, dairying, selected fruits, vegetables and tobacco. In general, farming activity is more intensive in the Lower Thames, with a higher proportion of row crops. Throughout the basin, but particularly in the Lower Thames, the amount of arable acreage and crop yields have been expanded by the installation of artificial drainage works consisting of field tiles and open drains. It is

estimated that between 60 and 70% of the farmland is drained artificially (Prout, pers. comm.).

The agricultural base of the watershed is complemented by industry and commerce in several urban centres. Urban municipalities account for 5% of the total land area-the City of London being the largest. Other non-farm uses, such as roads, industries and hamlets, cover the remaining 10% (MOE and MNR, 1975).

In 1971, 80% of the total population of the watershed (415,000) lived in urban areas. Population projections estimate that by 1991, the total population will be 671,000 comprising 556,000 urban residents (83%) and 115,000 rural residents (17%). More and more of the growth in the watershed population is expected to occur in the urban centres, with the focus on expansion being London (MOE and MNR, 1975).

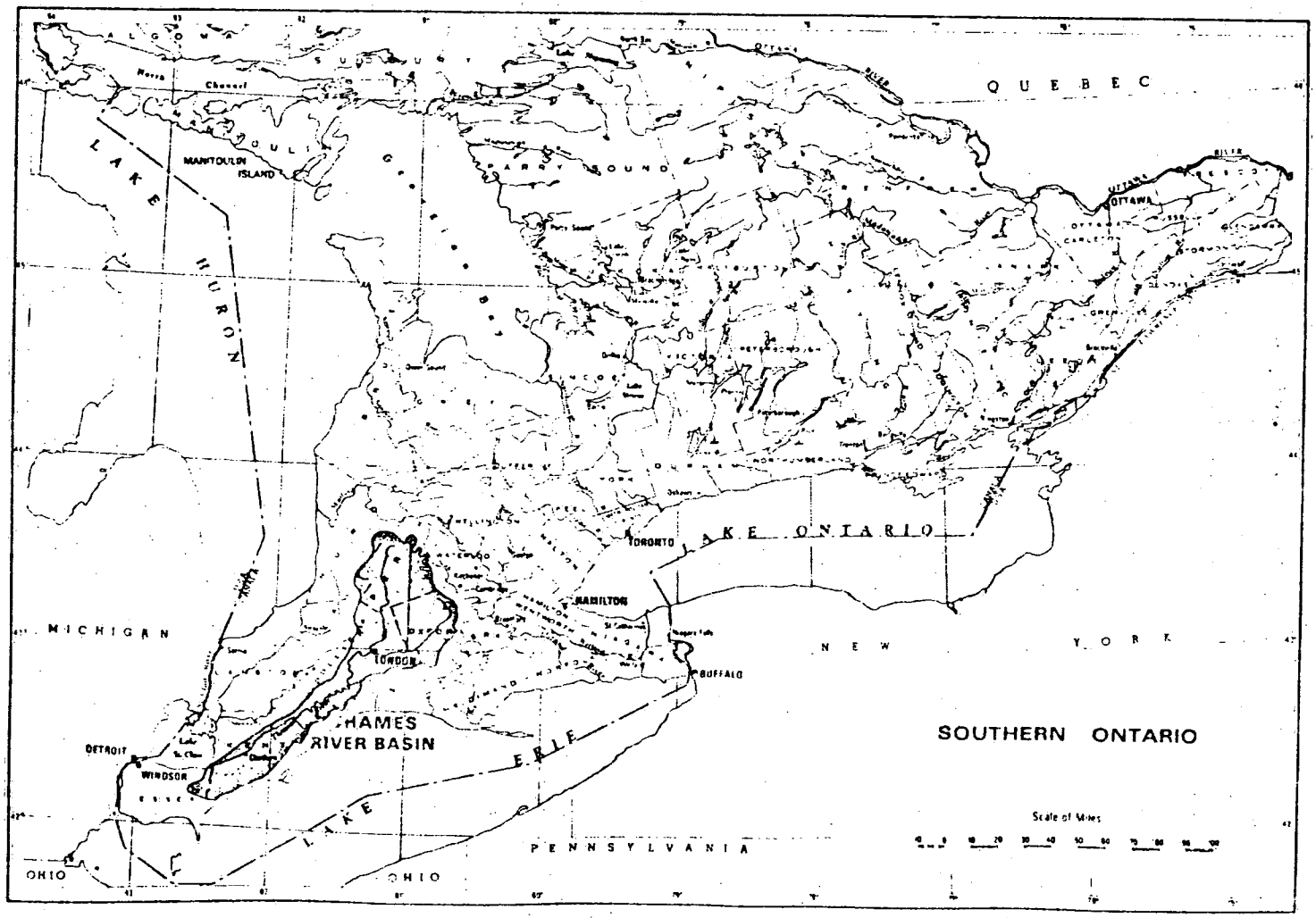
2.1.2 Objectives

The Thames River Basin Water Management Study, established in 1972, was undertaken jointly by MOE and MNR. The investigation took 3 years to complete and cost approximately $600,000 (McFadden, pers. comm.). The study was initiated in response to growing concern over existing problems related to water quality, flooding and erosion in the watershed, and potential problems anticipated as a result of future population growth and economic development.

The study team: assessed the availability and quality of both surface and ground water; inventoried water uses and related land uses; and evaluated existing and potential water resource problems in the basin. This information was then used to select and evaluate water management alternatives and develop water mangement guidelines.

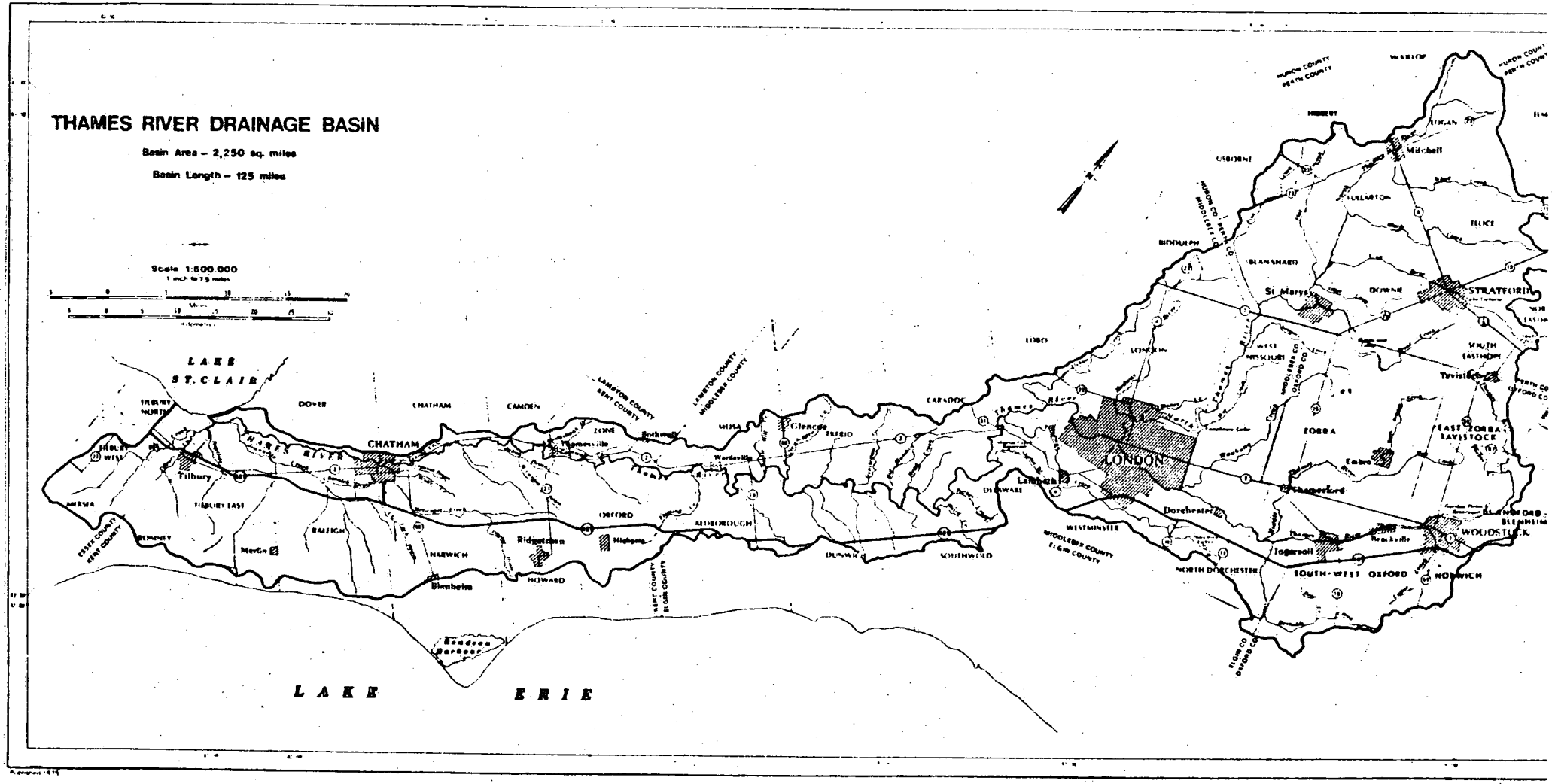
2.1.3 Problems Identified

The two main water management problems identified in the Thames River Basin by the Water Management Study were water quality impairment and flooding.



Map 1. Location and extent of the Thames River basin.

Source: (MOE and MNR, 1975)



Map 2. Thames River Basin

Source: (MOE and MNR, 1975)

The impairment of surface water quality was attributed to excessive inputs of nutrients, oxygen consuming materials, bacteria and suspended solids; from both point and non-point sources. This caused excessive aquatic plant growth, unpleasant aesthetic conditions, low dissolved oxygen levels and high bacteria counts, all of which contributed to the curtailment or restriction of water uses in the watershed. Most severely affected by this impairment were fish and aquatic life and recreational water uses.

Recurrent flooding was the other most significant problem identified. Average annual flood damages in the watershed were calculated to be over 1.5 million, 1975 dollars, of which 57% was in Chatham and 20% in the vicinity of London (MOE and MNR, 1975). Related in part to flooding was the erosion of stream banks and dikes, particularly in the lower basin.

The inadequacy of water-based recreational facilities to meet demands, erosion of topsoil, and the potential loss of prime agricultural land were also identified as problems common to the watershed. Other water management problems of local importance included negative effects of artificial land drainage, water supply interference and ground water quality impairment.

2.2 Rural Non-Point Source Pollution

Rural non-point source pollution was given very little quantitative consideration in the Thames River Basin Water Management Study (MOE and MNR, 1975). Although diffuse sources were identified as the major contributors to water quality impairment in the basin, the study was primarily concerned with point sources of pollution. Most of the water quality modelling undertaken by the study team stressed urban point sources. As a result, the management alternatives selected were, for the most part, directed at controlling municipal sewage treatment plant and industrial discharges.

To determine the relative significance of point and non-point source nutrient loadings to the basin, the Thames River Study made extensive use of

water quality studies carried out by MOE in 1972[1]. These studies monitored streamflow and nutrient levels at several locations in the river. In addition, a regular surveillance of point source inputs of phosphorus and nitrogen was maintained. To calculate the total loadings, the basin was divided into 31 sub-basins. For each sub-basin, channel inputs (i.e., main channel, tributaries and diffuse sources), sub-basin effects (i.e., point sources, storage) and main channel outputs were determined for both phosphorus and nitrogen. Non-point sources were found to contribute 74 percent of the total phosphorus and 95 percent of the total nitrogen loading to the Thames River basin (MOE and MNR, 1975).

The major diffuse nutrient sources identified by the Thames River Basin Water Management Study were: surface runoff from fertilized fields, municipal drains, field tile systems, and drainage from intensive feedlots. A comparison of fertilizer sales statistics with recommended rates, for different crops grown, showed the amount of fertilizer sold was twice that required to meet recommended rates, in four out of five counties in the Thames River basin (Bangay, 1976). This suggested that fertilization beyond recommended rates was a general practice in the basin. Furthermore, a series of samples from municipal drains in East Zorra Township indicated that levels of nutrients far exceeded the concentration known to support nuisance amounts of aquatic plants (MOE and MNR, 1975). Both these findings were considered to be fairly representative of conditions throughout the basin.

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1 It should be noted that these surveys were undertaken prior to the implementation of the phosphorus removal program at municipal sewage treatment plants.

Sediment was the other major diffuse source pollutant identified by the study. However, no estimates were made as to its severity in the watershed nor were problem areas singled out. Erosion of soil from cultivated land; elimination of soil stabilizing vegetation along water courses to maximize acreage in production; unrestricted cattle access to streams; and construction activities, such as the installation of drains; were recognized as the major contributors of sediment loading to the basin (MOE and MNR, 1975).

Other non-point source pollutants identified as problems in the watershed included: oxygen consuming materials, bacteria and toxic chemicals. Inputs of these pollutants, however, were localized in the watershed and led to isolated water quality impairment problems (MOE and MNR, 1975).

Based on studies of chemical, bacteriological and biological surveys conducted during the period 1970-1973, the Thames River Basin Water Management Study described and evaluated the existing water quality for four parameters in the Thames River and its major tributaries. The parameters were biological oxygen demand (BOD), coliforms, total nitrogen levels and total phosphorus levels. Two areas that were identified as being particularly enriched by phosphorus and nitrogen input from rural non-point sources were the Avon River upstream from Stratford and the Medway River above London (MOE and MNR, 1975).

Overall, the Thames River Basin Water Management Study was too general in regard to rural non-point source pollution (Jack McFadden, pers. comm.). The problems identified and their specific locations were very vague. Information was found lacking on such inherent factors as surficial geology, land-use practices and vegetation cover; all of which have a considerable bearing on the contribution of diffuse sources. As a result, the study was not very helpful to the various government agencies when they began the implementation of non-point pollution control programs. It should be noted however, that the Thames River Study was undertaken before the effects of land use activities on water quality were better understood, (i.e., pre-PLUARG).

2.3 Recommendations to Reduce Rural Non-Point Source Pollution

While the Thames River Basin Water Management Study did not deal with rural non-point source pollution in very much detail (see section 2.2), 7 of its 29 recommendations were directly concerned with rural diffuse sources. These recommendations were not based on any accurate technical studies; no research was carried out by the study team to determine the cost effectiveness of the various remedial measures suggested; nor was there any attempt made to ascertain their applicability to the basin (Salbach, pers. comm.).

One reason given for the emphasis placed on rural non-point sources of pollution, in spite of a lack of technical information, was the significance of non-point sources indicated by the nutrient budget. (see section 2.2). In addition, the Thames River Study was under considerable pressure from farmers and the farming industry. During the Public Consultation Program, many comments were received and much discussion was entertained concerning the effects of the agricultural industry and farming practices upon the water resources of the basin (Haussmann, 1975). The practices mentioned most frequently were land drainage, municipal drain management, erosion control, waste management of intensive livestock operations, cattle access to streams, farm pond management, and application of chemicals to soils and crops. The Thames River Study, in response to these concerns, acknowledged that these matters were not investigated in the course of the study to any great extent and recommended that further detailed study be undertaken (MOE and MNR, 1975).

Still, the Water Management Study did make several specific recommendations aimed at reducing rural non-point pollution in the Thames River Watershed.

Remedial measures recommended by the study for management of rural oriented problems included restricting cattle access to streams, limiting fertilizer application rates, controlling farm waste discharges and increasing environmental surveillance and enforcement. To reduce soil erosion the

following options were suggested: strip cropping, crop rotation, diversion terraces, grassed waterways, other vegetative buffer zones, and reforestation. Some of the other conservation measures recommended by the study were sound agricultural tillage practices, preservation of water retaining areas, use of appropriate ground cover and encouragement and enforcement of sound construction practices during drainage ditch installations and reconstruction.

The recommended land treatment measures were merely listed in the report. There was no mention of their cost-effectiveness, nor was there any discussion of where they were applicable. Moreover, there was very little explanation as to why or where the recommendations should be undertaken. A breakdown of the effect on water quality of each land use and each activity would have been useful in identifying the basis of the recommendations (McFadden, pers. comm.). As it stood, the recommendations for the reduction of rural non-point source pollution were entirely separate from the rest of the report.

2.4 Implementation of Recommendations

One of the main recommendations in the Thames River Basin Water Management Study, not directly related to control of rural non-point source pollutants, stressed the need for a joint committee of government agencies and other bodies to "overcome communication and coordination problems relating to water management in the basin, and to implement planning on a watershed basis". This recommendation resulted in the formation of the Thames River Implementation Committee (TRIC) in October, 1976. Presently the Committee includes representatives of the following agencies. Ministry of Natural Resources (MNR), Ministry of the Environment (MOE), Upper Thames River Conservation Authority (UTRCA), the Lower Thames Valley Conservation Authority (LTVCA), Ontario Ministry of Agriculture and Food (OMAF), Ministry of Housing (MOH), Municipal Engineers Association and the Ontario Federation of Agriculture.

Funding for TRIC is split equally between MNR and MOE. The budget for 1980 is $188,000. Currently on TRIC's staff are: an agronomist, an agricultural engineer, an agricultural technician, a community relations technician, four students under the Experience '80 program, plus a number of short term and temporary staff.

From a preliminary assessment of the 29 recommendations contained in the Thames River Basin Water Management Study Report, the TRIC Committee decided that they fell into three separate categories and that the most efficient and manageable way to deal with the recommendations would be to develop a subcommittee to deal with each of the three separate groups. Accordingly, the following three subcommittees were formed: Dams, Reservoirs and Floodplain Management Subcommittee; Municipal Coordination Subcommittee; and Agricultural and Land Use Subcommittee.

Implementation of the recommendations pertaining to rural non-point source pollution in the Thames River Basin was assigned to the Agriculture and Land Use Subcommittee. The following summarizes the programs and studies carried out by the Agriculture and Land Use Subcommittee of TRIC, as well as its other member agencies (i.e., the Conservation Authorities and OMAF), to reduce rural diffuse source pollution. Where possible, implementation will be outlined within the context of the recommendations of the Water Management Study.

2.4.1 The Thames River Implementation Committee (TRIC) - Agricultural and Land Use Subcommittee

The Agricultural and Land Use Subcommittee of TRIC was assigned 10 of the 29 recommendations. However, only 7 of the recommendations, as noted in section 2.3 are relevant to this study. The other 3 recommendations pertain to groundwater. This section will outline these 7 pertinent recommendations and discuss their implementation by the Subcommittee.

Recommendation No. 11 - FERTILIZER USE

IT IS THEREFORE RECOMMENDED THAT FERTILIZER APPLICATION RATES BE LIMITED TO THOSE RECOMMENDED BY THE ONTARIO MINISTRY OF AGRICULTURE AND FOOD, USING SERVICES SUCH AS THOSE AT THE UNIVERSITY OF GUELPH FOR DETERMINING APPROPRIATE RATES. INDIVIDUAL AND GROUP ACTIVITY BY THE AGRICULTURAL COMMUNITY AND THE ACTIVE SUPPORT OF GOVERNMENT AGENCIES IS IMPORTANT TO IMPLEMENT THIS PRACTICE.

A detailed review of this recommendation by an ad hoc committee comprised of soil scientists from OMAF, Ridgetown College of Agricultural Technology, and the University of Guelph, substantiated that farmers tend to follow the recommended fertilizer rates for nitrogen, but that the phosphorus applications frequently exceed the recommended levels by 2 to 4 times. The ad hoc committee agreed with the intent of the recommendation to achieve the wise use of fertilizers but did not feel that this objective could be reached by legislative or regulatory means. It recommended that emphasis be placed instead on education and extension services (TRIC, 1978b).

A questionnaire survey undertaken by TRIC[2] incorporated questions to determine why farmers are over-fertilizing. This survey found that a majority of the farmers questioned, decide on their rate of fertilizer application from personal past experience. Only slightly more than one-quarter of the farmers based their decision on a soil test (TRIC, 1978c).

TRIC staff believe a credibility problem exists. The farmers do not trust the University of Guelph soil test (McFadden, pers. comm.). Therefore, TRIC submitted a request to OMAF that plans be initiated to convince farmers of the validity of the soil test and related recommendations. No further action on this recommendation is currently planned by TRIC.

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2 The Questionnaire Survey was undertaken to "Assess Existing Agricultural Practices and Farmers' Perceptions and Attitudes with Respect to Conservation Farming". The Survey involved approximately 3.5 percent of the farm operators in the Thames River Basin. Survey conclusions indicated a general lack of understanding among farm operators about the land processes which contribute to water pollution and the related remedial measures. A majority of farmers did however, indicate a willingness to participate in a Water Pollution Control Program on their own properties, if assistance was provided by government (TRIC, 1978c).

Recommendation No. 12 - CATTLE ACCESS

A PROGRAM OF RESTRICTING FREE ACCESS OF LIVESTOCK TO STREAMS SHOULD BE COMMENCED. IT IS RECOMMENDED THAT THE ONTARIO DEPARTMENT OF AGRICULTURE AND FOOD TAKE THE LEAD ROLE IN UNDERTAKING A DETAILED STUDY OF THE IMPLICATIONS OF SUCH A PROGRAM TO FARMERS, OF THE BEST METHODS SUCH AS FENCING OR VEGETATION BARRIERS, AND OF THE FEASIBILITY OF PROVINCIAL SUBSIDIES TO ENCOURAGE SUCH A PROGRAM

OMAF, although designated as a lead agency for implementing this recommendation, has, in the opinion of TRIC staff, done very little (McFadden, pers. comm.). Implementation has been left to TRIC.

The previously mentioned TRIC questionnaire survey also examined farmers' attitudes towards restricting cattle access to streams, and solicited reactions to alternative methods for accomplishing this objective. Two thirds of those farmers questioned, thought erosion problems may be caused by cattle movement along the edge of watercourses, while half the farmers reported that fencing was the best method for controlling this type of erosion (TRIC, 1978c).

Through an Experience '77 Program, carried out on behalf of TRIC by 15 students, the extent and location of points of cattle access to the main stream of the Thames and its tributaries were determined. Situations were also documented where cattle access had led to erosion problems (TRIC, 1978a).

Having identified the problem areas as well as the significance of the problem, TRIC, as part of the Experience '80 Program, had four students searching for possible demonstration sites during the summer of 1980. Using the '77 field survey as a guide, the students catalogued, by township, examples of both good and poor land management practices, (not just cattle access). To help them identify possible site locations, the students also contacted local OMAF agriculture representatives, township clerks, Soil and Crop Improvement Associations, and the Conservation Authorities.

Next year (1981), after screening potential farms, a few sites will be chosen by TRIC as demonstration sites. Remedial measures will be undertaken at these sites and their effectiveness will be monitored. The sites will be priorized on the basis of location (e.g., near a road), the magnitude of the problem, the costs involved and the degree of cooperation shown by the farmer. Once the sites have been selected, TRIC will return to the landowners with a written proposal. TRIC will offer technical advice, financial assistance, financial subsidies and physical assistance in return for the use of the farm as a demonstration site. Upon acceptance by the farmer, a contract will be drawn up identifying, in detail, the participating parties' responsiblities and obligations. TRIC will then oversee implementation of the remedial measures. The Committee will buy the materials, hire the contractor and a representative of TRIC will be available at the site at all times during construction. Effects will be monitored and any adjustments will be made as needed. Finally, a report will be written, documenting conditions before, during, and after construction.

The demonstration sites will serve primarily as informational/ educational projects promoting conservation measures among farmers in the basin.

Recommendation No. 13 - FARM WASTE DISCHARGES

IT IS RECOMMENDED THAT INCREASED ENVIRONMENTAL SURVEILLANCE AND ENFORCEMENT BE UNDERTAKEN BY APPROPRIATE GOVERNMENT AGENCIES TO CONTROL FARM WASTE DISCHARGES, PARTICULARLY FROM INTENSIVE FEEDLOT OPERATIONS, AND ILLEGAL SEPTIC TANK CONNECTIONS TO MUNICIPAL DRAINS.

Increased environmental surveillance and enforcement is seen as impractical by TRIC. Besides the number of staff needed and the costs involved, MOE appears to be very hesitant to prosecute offenders (McFadden, pers. comm.).

At the present time, preventing farm waste discharges from reaching watercourses is limited to the control provided by the livestock farming Certificate of Compliance program administered jointly by OMAF and MOE (based

on The Agricultural Code of Practice). However, submission of an application for a Certificate of Compliance is voluntary. Education and promotion of the program, have not worked. TRIC believes that the laws should be enforced and known offenders should be prosecuted.

Recommendation No. 20 - SOIL EROSION CONTROL PRACTICES

SOIL EROSION CONTROL PROGRAMS INCLUDING STRIP CROPPING, CROP ROTATION, DIVERSION TERRACES, GRASSED WATERWAYS AND VEGETATIVE BUFFER ZONES OR REFORESTATION SHOULD BE IMPLEMENTED THROUGHOUT THE WATERSHED, WITH INITIAL EMPHASIS ON AREAS THAT SHOULD BE IDENTIFIED BY STAFF OF THE MINISTERIES OF AGRICULTURE AND FOOD, NATURAL RESOURCES AND ENVIRONMENT.

The previously mentioned Experience '77 erosion and agriculture land use field survey included documentation of: erosion sites, the presence of existing vegetative buffer zones along stream margins, as well as any areas where soil erosion control practices are currently in place (TRIC, 1978a). The results of this survey were used in the summer of 1980 to aid in the selection of practical demonstration sites as outlined before. The demonstration sites will be developed and utilized to illustrate the various land use practices that can be implemented to assure water quality protection in the hope that widespread application of such practices will gradually materialize.

In addition, a major sub-watershed study is now underway in the Avon River basin. The Stratford-Avon Environmental Management Project is an intensive two-year water quality management and demonstration project. Details of this project are outlined in section 2.4.2.

Furthermore, the Conservation Authorities and OMAF have their own specific programs to deal with soil erosion (see sections 2.4.3, 2.4.4, and 2.4.5).

Recommendation No. 21 - ENVIRONMENTAL ASSESSMENT FOR LAND DRAINAGE PROJECTS

IT IS RECOMMENDED THAT ENVIRONMENTAL IMPACT ASSESSMENTS OF LAND DRAINAGE PROPOSALS BE UNDERTAKEN TO SCREEN OUT OR MODIFY PROPOSALS WHICH WOULD DAMAGE THE ENVIRONMENT AND THAT SELECTED WETLANDS OF ECOLOGICAL IMPORTANCE, SUCH AS THE ZORRA SWAMP, BE PROTECTED FROM FURTHER DAMAGE.

The Drainage Act is administered by the Food Land Development Branch of OMAF. Its primary objective is to facilitate the construction, operation and maintenance of drainage works in order to improve crops and soil conditions (OMAF, 1980a).

Currently, drainage proposals are circulated to MNR, MOE and the appropriate CA for review prior to the inception of a drainage project within any municipality. Any of these agencies may within thirty days, require an environmental appraisal for the drainage works in the subject area. The cost of the appraisal is paid for by the party requesting it (OMAF, 1980a).

TRIC's position is that individual environmental assessments of agricultural drainage projects in the Thames River watershed are unnecessary. Most of the agricultural land is drained already. Emphasis should be directed instead towards the design, construction and maintenance of drainage works to ensure protection of the aquatic environment. "Guidelines developed for the construction and maintenance of drainage works should identify the anticipated environmental effects and the measures required to prevent or mitigate such effects. These measures would for example, necessitate proper attention to slope and soil characteristics, proper stabilization and maintenance of ditch banks, satisfactory handling and disposition of extracted materials, fencing of cattle from ditches where necessary and proper construction of drainage outlets to meet erosion control objectives" (TRIC, 1978b).

Guidelines for the construction and maintenance of drainage works have just recently been completed by drainage engineers and OMAF (OMAF, 1980a). In TRIC's opinion the new "drainage manual" does not go far enough from an evironmental point of view (McFadden, pers. comm.).

As for the second part of the recommendation (i.e., draining of wetlands) the committee agrees that major wetland areas deserve protection and that drainage schemes affecting such areas should be scrutinized under the Environmental Assessment Act (TRIC, 1978b). TRIC, itself has not dealt with the wetlands to any extent. Some implementation has been recently initiated by UTRCA (see section 2.4.3).

Recommendation No. 27 - CONSERVATION MEASURES

FOR LONG TERM FLOOD CONTROL, FLOW AUGMENTATION AND EROSION CONTROL BENEFITS, IT IS RECOMMENDED THAT SOUND CONSERVATION MEASURES SUCH AS REFORESTATION, SOUND AGRICULTURAL TILLAGE, USE OF APPROPRIATE GROUND COVER, AND PRESERVATION OF WATER RETAINING AREAS BE ENCOURAGED AND IMPLEMENTED. REFORESTATION AND ESTABLISHMENT OF SHRUB COVER ALONG STREAMBANKS SHOULD BE DIRECTED TO AREAS WHERE THEY WOULD SPECIFICALLY AID IN EROSION CONTROL, STREAMBANKS STABILIZATION, AND THE IMPROVEMENT OF FISH HABITATS.

Implementation of this recommendation has already been outlined under recommendations 12 and 20. TRIC is presently in the process of locating suitable demonstration sites to exemplify the benefits of soil conservation measures. As specified, under the earlier recommendations, it is projected that the Upper and Lower Thames Conservation Authorities will play a lead role in dealing with farmers and other landowners to implement specific projects, with supportive assistance from the Ministries of Natural Resources, Environment, and Agriculture and Food, and through the ongoing coordination afforded by the Agriculture and Land Use Subcommittee of TRIC (TRIC, 1978b), (See Sections 2.4.3, 2.4.4, and 2.4.5).

Recommendation No. 28 - DRAINAGE CONSTRUCTION PRACTICES

IT IS RECOMMENDED THAT MUNICIPALITIES AND GOVERNMENT AGENCIES ENCOURAGE AND ENFORCE CAREFUL CONSTRUCTION PRACTICES DURING DRAINAGE DITCH INSTALLATIONS AND OTHER CONSTRUCTION ACTIVITIES IN AND ALONG WATERCOURSES.

Coupled with the development of appropriate guidelines to protect water quality as suggested in recommendation 21, improved supervision and management of drainage projects at the municipal level should lead to the utilization of satisfactory procedures for drainage ditch installations (TRIC, 1978b).

TRIC is presently considering a project that will examine drain construction techniques and the effects of current construction practices. The project will involve monitoring selected drains (water sampling and

physical measurements) before and after construction to see if the cost of improved construction techniques can be justified (i.e., see if there is a significant difference in water quality and reduced maintenance costs) (McFadden, pers. comm.).

The UTRCA has also just completed a site-specific drainage reconstruction demonstration project on Reynold's Creek (See Section 2.4.3).

2.4.2 Stratford/Avon River Environmental Management Project

The Stratford-Avon River Environmental Management Project is an intensive two-year Water Quality Management and Demonstration Project currently underway in the Avon River Basin. Funding of $220,000 a year is being provided by MOE, most of which will be dispersed through MOE, UTRCA and the City of Stratford. The Avon River was identified in the Thames River Management Study as having severe water quality problems as a result of both urban and rural inputs. Subsequent investigations carried out by MOE, determined the relative magnitude of these inputs and measured their effects on water quality and biota. These studies found that in addition to the presence of some compounds below Stratford that are toxic to fish, a major problem is the enriched nature of the river water caused by excessive inputs of nutrients, in particular phosphorus, that originate from both municipal and agricultural sources (MOE, 1979). These nutrients promote excessive growths of algae and aquatic plants that choke the waterway and upset the normal oxygen balance essential to the support of stream life. Of the total annual phosphorus load to the Avon River, the MOE Studies revealed that 45 percent could be attributed to agricultural runoff and 37 percent to the Stratford Sewage Treatment Plant (MOE, 1979). To reduce this load MOE recommended that: the Sewage Treatment Plant be upgraded and expanded; and remedial measures be introduced as soon as possible to control urban and rural runoff.

The current project, undertaken at the request of the City of Stratford, will attempt to provide a more detailed assessment of all waste

inputs to the Avon River and determine the most appropriate pollution control measures required for both urban and rural areas - to meet the recommendations of the 1975 Water Management Study and MOE Water Quality Objectives.

Ministry and Authority staff involved in the project will be working closely with the City of Stratford personnel in regard to the urban-oriented activities, as well as OMAF and local farm organizations in regard to agricultural concerns (McFadden, pers. comm.).

Three working subcommittees dealing with rural, urban and stream management issues have been set up to provide technical direction to project staff. A Management Committee consisting of representatives from the city, MOE and UTRCA has been formed to integrate the individual program components. In addition, an Advisory Committee of senior representatives from the provincial ministries, municipal governments and local interest groups has been established to ensure two-way communication and coordination of program implementation (McFadden, pers. comm.).

Year one of the study will concentrate on data collection, specific problem evaluation and remedial measure definition. The subsequent year will focus on demonstrations to visibly confirm the benefits of certain management practices, and to evaluate the cost-effectiveness of remedial measures (McFadden, pers. comm.).

Responsibility for rural non-point source pollution problems was assigned to the Rural Subcommittee of the Stratford-Avon River Environmental Management Project. The approach being adopted by the Subcommittee is basically the same as the one used by The Agriculture and Land Use Subcommittee of TRIC. However, it is much more intensive.

During the summer of 1980, students were in the field searching for possible demonstration sites (i.e., examples of good and poor land management practices). Emphasis was placed on locations adjacent to streams and road crossings. Using aerial photographs (1:10,000 scale) taken in the spring of 1978, they: catalogued information pertaining to land use, topography,

drainage and remedial measures; and noted the probable cause and extent of visible water quality, erosion and manure handling problems. This information will then be scanned, digitized and incorporated into the CLDS (Canada Land Data System) developed by the Lands Directorate of Environment Canada.

The Lands Directorate has been contracted to: identify the high risk erosion areas in the Avon River watershed through application of the Universal Soil Loss Equation; and to identify hydrologically active areas (HAA) with a view to providing a priority rating of contributing areas which would eventually contribute to the estimation of stream sediment loads. To accomplish these tasks extensive use of CLDS and the field surveys will be made.

The identification of HAAs and/or contributing areas will serve as the first step in implementing a cost-effective program of non-point remedial measures. Because of the much higher probability of eroded soil particles being delivered from these areas to surface water, these areas will receive first priority in the implementation of a remedial measure program (McFadden, pers. comm.).

A letter was also sent out, with OMAF's assistance, to all the farmers in the Avon River Basin outlining the objectives of the Stratford-Avon River Environmental Management Project and asking for their help by taking part in a task force. Thirty-two responses were received (8% return rate) from farmers who requested more information. Seventeen of these farmers were interested in participating on the task force (9 from the Upper Avon and 7 from the Lower Avon). The task forces (one for the Upper Avon and one for the Lower Avon) will act as contacts and also aid the Avon study group in selecting demonstration sites.

As many of the chosen demonstration sites as possible, utilizing all applicable soil erosion control practices, will be undertaken. Water quality, before and after implementation of remedial measures, will be assessed and the cost-effectiveness of the various management practices will be calculated. Emphasis will be placed on those areas identified as HAAs.

The only constraints on the number of demonstration sites will be the amount of staff time and money available. A request for increased funding for the Avon study ($620,000) is currently before the Ministry of the Environment (McFadden, pers. comm.).

2.4.3 Upper Thames River Conservation Authority

The Upper Thames River Conservation Authority (UTRCA), besides being actively involved in TRIC, has various programs and studies of its own which relate to TRIC objectives for reducing non-point source pollution. These include:

a) Private reforestion assistance program;
b) Windbreak and shelter belt program;
c) Erosion control program;
d) Reynolds Creek;
e) Ploughing match; and
f) Wetlands study.

A discussion of each of these programs follows.

a) Private Reforestation Assistance Program

Under this program, the UTRCA offers tree planting advice and assistance to private land owners. The applicant must own a minimum of two acres. Staff from the Authority (UTRCA has its own full time forester), inspect the site and advise the owner as to the species of tree stock which should be planted; taking into consideration terrain, soil type and drainage characteristics. The property owner is responsible for obtaining the plant stock from the Ministry of Natural Resources. Conservation Authority staff assume responsibility for planting the trees at no charge to the landowner.

The purpose of the private land re-forestation assistance program is to reduce the soil erosion and surface water runoff and aid retention of groundwater supplies. Demand for this program is not as great as for the windbreak and shelter belt program outlined below. Still, roughly 150,000 tree seedlings were planted by the Authority in 1980 (Prout, pers. comm.).

(b) Windbreak and Shelter Belt Program

This program is designed to assist rural land owners in the replacement of fence and hedgerows. Tree stock, consisting of 4 to 6 foot deciduous species, is available to private landowners at a cost of $2.00 per tree if the trees are picked up and self-planted and $4.00 per tree if the Authority delivers and plants the trees.

UTRCA cannot keep up with the demand for this service. Names are taken of people wishing to participate in the program all year round. Then as many trees as possible are planted in the early spring. Roughly 4,000 trees were planted in 1980 under this program (Prout, pers. comm.).

(c) Erosion Control Program

This program is being carried out by UTRCA on a pilot project basis. The program is designed to reduce erosion along and within the stream channel. It could involve stream bank stabilization through the use of rip-rap, gabion baskets, re-grading and sloping, and/or minor channelization works.

The authority provides technical advice, supervision and a subsidy for 55% of the cost of erosion control projects carried out under this program. Two projects were undertaken in 1980 (Prout, pers. comm.).

d) Reynolds Creek

Reynolds Creek is an intensive site-specific demonstration project just completed by the UTRCA. The Creek flows through an intensively farmed area upstream from London. It is used as a municipal outlet drain. The landowners of this sub-basin petitioned the township of South-West Oxford, under the Drainage Act (1975) to improve and repair the drain. An engineering firm (Spriet Associates London Limited) was appointed by the township to: make an examination of the area; report on the work that needed to be done; and determine the benefit-costs involved.

The engineers found that the drainage ditch had silted up considerably and did not provide a satisfactory outlet for tributary tile drains and surface water runoff (Spriet Associates London Limited, 1978). Therefore, they recommended that the ditch be deepened and improved, according to their plans and specifications. Cost of the proposed work was estimated at $115,600. This cost was assessed by the engineers against the lands and roads liable for benefit and outlet (Spriet Associates London Limited 1978).

UTRCA, upon receiving a copy of the engineer's report, decided that Reynold's Creek could serve as a useful demonstration project - illustrating the positive effects of improved erosion control, drainage construction and maintenance practices. The Authority therefore offered to help subsidize, with the assistance of MNR and OMAF, the cost of remedial measures over and above those recommended in the engineer's report.

A field investigation was conducted by the engineers and UTRCA prior to reconstruction of the drain. The entire length of the creek was walked, noting the most seriously eroded areas and critical sources of sedimentation. The location and extent of the additional work required was then detailed.

Generally, the ditch and banks were found to be in satisifactory condition with the exception of a few sections. From the field examination of the drain, it was determined that the noted points of erosion and the resultant sediment loading of the water were due to several factors. These were:

(1) "some sections of the banks had collapsed due to irregularities and blockages in the streambed. These irregularities had deflected the flow of the water which had caused scouring of the banks;

(2) overhanging limbs and scrub growth on the banks or in the bottom had also obstructed the flow of water during periods of low and high flow which further attributed to the erosion of some sections of the ditch banks;

(3) numerous tile drain outlets were in a state of disrepair causing erosion of the banks at their specific locations and the deposition of the silt downstream;

(4) in a few locations, the banks had been trampled by livestock which denuded the banks of growth and also pushed earth from the banks into the ditch bottom resulting in reduced velocity or diversion of the water flow; and

(5) also in a few locations, the existing buffer strips (grassed areas adjacent to the drain) had failed because either cultivation of the lands had been too close to the top edge of the ditch bank or the volume of runoff water collected in the various depressions and runways along the course of the drain was too high for the buffer strip to withstand." (Spriet Associates London Limited, 1980).

They also observed that the amount of erosion decreased where livestock access was restricted and buffer strips were maintained.

The engineer's report suggested that owners having a direct outlet to Reynolds Creek Drain maintain a minimum six foot grassed section on each side of the open ditch for its entire length. A larger area of grass was advised where large or concentrated volumes of surface water entered the drain. In the instances where serious erosion was occurring, the report advocated the installation of rip-rap protection to safely conduct the overflow water into the ditch. It also recommended that livestock should not be afforded direct access to the drain.

The estimated total cost of all the extras was calculated to be $54,900. Due to problems with timing and funding the extra work was not carried out when the creek was reconstructed in 1979.

The UTRCA, after receiving grants from MNR and OMAF went back in 1980 to complete the project. Contractors were requested to submit bids to the UTRCA for the "extras" identified in the engineer's report. These "extras" included: backfilling washouts; repairing existing tile outlet drains; regrading banks and/or bottoms; seeding and mulching of banks and major eroded areas; installing rip-rap protection; and ditch widening. Since this type of work is not usually included in a drain reconstruction, a wide range of bids were received. The contractor eventually selected by the Authority bid $54,000.

Grants to the landowners totalling $40,000 for the "extras" were provided by various agencies. MNR, through its SPOF Program[3] (Strategic Planning for Ontario Fisheries) contributed $20,000. Thirteen thousand dollars were supplied by OMAF, under the Drainage Act[4]. The Townships involved furnished $3,000, with the Conservation Authority providing the remaining $4,000.

The affected landowners were assessed the balance of the cost of the "extras" ($14,000) on the benefits they would receive. This amounted to between $150. and $200. per landowner (O'Grady, pers. comm.).

The contractor, aided and supervised by UTRCA staff, commenced work at the headwaters of Reynold's Creek and proceeded towards the outlet. Since the original survey was carried out 1-1/2 years before and the Creek was subsequently deepened and improved, another survey was undertaken by UTRCA in conjunction with the onset of the project. This time the stream was walked just ahead of the contractor. Extra stations were added and some stations were dropped or changed depending on the situations encountered. Tradeoffs were then made between the CA and the contractor (i.e., new stations for old stations where remedial measures were no longer needed). The project was completed by October 1980.

Reynolds Creek is intended to serve as a demonstration project - providing readily accessible examples of erosion control methods that private landowners can employ to reduce agricultural runoff, erosion and siltation. Other landowners will be encouraged to undertake similar improvements on their own properties.

Reynolds Creek will also be monitored to determine the

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3 The Ministry of Natural Resources' "SPOF" Program provides funding for stream rehabilitation to improve coldwater fisheries habitat.

4 Under the Drainage Act (1975) - maintenance, repair, and minor improvements of drainage work undertaken on agricultural land, that have been recommended by an engineer's report, are eligible for a 1/3 grant from OMAF.

cost-effectiveness of the various control methods. Water samples and flow rates have been taken, since May 1979, at three locations on the Creek. By surveying water quality and quantity before and after completion of the project, the UTRCA hopes to document a significant reduction of phosphorus and sediment loading to the Thames River.

(e) Ploughing Match

UTRCA participated in the International Ploughing Match held in Woodstock at the end of September 1980. At this event the Authority set up displays and demonstrations to illustrate and encourage desirable land treatment techniques on private land. By promoting the services and programs of the Authority, UTRCA hopes to make people more aware of the problems which exist in the watershed and the measures that can be taken to reduce them.

(f) Wetlands Study

The CA, recognizing the biological and hydrological value of wetlands, has recently undertaken a preliminary wetlands study. Using the 1952 Conservation Report as a guide, UTRCA's biologist is preparing a land assembly scheme. The fifteen areas identified in the original report as water recharge areas are being surveyed for species diversity and hydrological importance. Efforts are being concentrated near the Thames River and its headwaters. When the study is completed, UTRCA will priorize the recharge areas; which will then form the basis for future land purchases by the Authority (O'Grady, pers. comm.)[5]

As can be seen from Table 2, a large portion of the private land assistance program's 1980 budget was allocated to the Reynolds Creek Project.

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5 Before this Study was undertaken the Conservation Authority had no wetlands policy - an ad hoc approach was used in land acquisition.

Applicants to all the programs were handled on a first come first served basis, subject to the budgetary limits established for each program by the Authority. All technical advice and assistance was offered to the landowner free of charge. The forestry projects also received considerable support. In fact, a forester is employed full-time by UTRCA to keep up with the demand expressed by landowners for tree planting. Erosion control projects, were not allotted a substantial amount of money.

TABLE 2

SUMMARY OF PROGRAMS OFFERED BY UTRCA UNDER
THEIR PRIVATE LAND ASSISTANCE PROGRAM

PROGRAM	BUDGET*	IMPLEMENTATION (1980)
Private Reforestation Assistance Program	$8,200.00	150,000 Trees Planted by UTRCA staff
Windbreak and Shelter Belt Program	$16,500.00	4,000 Trees Planted
Erosion Control	$ 5,000.00	2 Projects Undertaken 55% Subsidy Provided
Reynolds Creek	$20,000.00**	Intensive Site-Specific Demonstration Site
Ploughing Match	$ 8,000.00	Scheduled For End of Sept Will Include Displays and Demonstrations Promoting Good Land Management Practices
General	$13,000.00	Supplies, Equipment
TOTAL	$59,000.00	

* Budget Includes Staff Time.

** Total Budget for project was $54,000 - other sources made up the difference.

SOURCE: (Prout, pers. comm.)

2.4.4 Lower Thames Valley Conservation Authority (LTVCA)

The Lower Thames Valley Conservation Authority (LTVCA), also a member of TRIC, has a few programs of its own which help reduce non-point source pollution in the Thames River Watershed. The programs however, are different from those offered by UTRCA. The principal program is a tree planting assistance program. The Authority will plant, at no charge, seedlings bought by the landowner from MNR. Roughly 20,000 trees were planted in 1980 under this program (Campbell, pers. comm.). LTVCA also has a shade tree program for municipalities. This program is limited to public land. Although a stream erosion control program has been allocated funds in the 1980 LTVCA budget, a definite program has not yet been set up. Authority staff maintain, however, that if a request was made, the program could be introduced (Campbell, pers. comm.). Grants for 55 percent of costs would likely be provided.

The entire Private Land Assistance Program for the LTVCA has a budget of $12,000. Response to the programs is very limited. The programs are poorly advertised (no money was spent on advertising in 1978 or 1979) and not promoted (Campbell, pers. comm.).

LTVCA places heavy emphasis on flooding. Since 1977, approximately $500,000 has been spent by the Provincial Government and the Authority on channel improvement and bank protection on the Lower Thames River. The Authority has been involved in erosion control measures relating to flooding for many years. Usually they are undertaken when a dwelling is threatened. The landowner approaches the municipality. The municipality then requests an engineer to study the area and submit a report. LTVCA prvides grants and oversees the implementation of remedial measures.

Currently the LTVCA is searching for possible demonstration sites to illustrate the beneficial effects of streambank erosion protection, grassed waterways and good drainage construction and maintenance practices. When a suitable site (or sites) is selected, it will be developed with the CA providing the funding and TRIC supplying the technical expertise.

2.4.5 Ontario Ministry of Agriculture and Food (OMAF)

The Ontario Ministry of Agriculture and Food has various programs of its own which although designed to assist farmers by increasing soil productivity and reducing soil losses also improve water quality. Programs currently available from OMAF include:

a) The Ontario Farm Productivity Incentive Program;
b) Extension Services and Education Programs;
c) Soil Testing Program;
d) The Agricultural Code of Practice; and
e) The Farm Pollution Advisory Committee.

Details of these various programs as well as a short summary of their implementation, where applicable, in the Thames River Basin are outlined below.

(a) The Ontario Farm Productivity Incentive Program

The overall objective of this program is to "improve soil management and erosion control by providing grants to Ontario farmers to undertake changes in farm practices which would improve land management in order to minimize soil erosion and loss" (OMAF, 1979a).

Under this program grants are provided to an individual farmer, partnership or corporation for 40% of costs up to a maximum of $1,500 for erosion control devices, $3,000 for manure storage and $1,500 for alternative livestock watering facilities. Eligible items include: grassed waterways, drop inlet spillways, catch basins, tile outlet protection, construction of terraces or contours, reclamation of a gulley, seeding or sodding of watercourses, control of buffer strips, manure storage facilities, and fencing materials to keep livestock from the watercourses (OMAF, 1979a).

Grants are also available for educational and demonstration programs connected with the above-noted projects. Coordination of this portion of the program is provided by the Ontario Soil and Crop Improvement Association.

The Ontario Farm Productivity Incentives Program is relatively new (beginning April 1, 1979 and ending March 31, 1984). With a total budget of 50 million dollars, the program is administered by the Extension Branch of OMAF. All eligible claims are processed and approved subject to the budgetary limit established for each year.. For the fiscal year 1979, 4.9 million dollars in grants were provided to farmers out of a total budget of 12.8 million dollars (OMAF, 1980b). The budget (reviewed annually) for 1980 is 10 million dollars.

The number and types of projects undertaken, as well as the grants allocated under The Farm Productivity Incentive Program in the Thames River watershed are summarized in Table 3.

As can be seen from Table 3, heavy use of the Ontario Farm Productivity Incentives Program was made for the construction of manure storage facilities in the Thames River Basin. Some erosion control projects were undertaken. However, no alternative livestock watering facilities or education/demonstration projects applied for or received OMAF assistance.

(b) Extension Service and Education Programs

OMAF also provides Extension/Education Programs. Using the team approach, the staff in each of the 54 county, district, or regional municipality offices provide farmers with information and advice with respect to good farm management practices. The agricultural representative in each office is responsible for directing the local day-to-day program. Other OMAF personnel that can be brought in to deal with specific problems, may include an associate or assistant agricultural representative, an agricultural engineer, a drainage engineer, with assistance provided from the Soils and Crops Branch, the Livestock Branch and other OMAF branches (OMAF, 1979b).

The main techniques used in conducting the programs are: individual counselling on the farm and in the office; group instruction at work shops;

TABLE 3

SUMMARY OF FARM PRODUCTIVITY INCENTIVES
PROGRAM FOR THE THAMES RIVER BASIN
(1979-80)

($ = Thousands of Dollars)
(# = Number of Projects)

	EROSION CONTROL		MANURE STORAGE		ALTERNATE LIVESTOCK WATERING		EDUCATION/ DEMONSTRATION	
COUNTY	#	$	#	$	#	$	#	$
Elgin	1	1.50	23	57.93	-	-	-	-
Kent	8	3.37	30	70.39	-	-	-	-
Middlesex	2	.87	65	174.98	-	-	-	-
Oxford	3	1.61	65	171.80	-	-	-	-
Perth	1	.13	79	209.42	-	-	-	-
TOTALS	15	7.48	262	684.52	-	-	-	-

Results compiled using political (i.e., county) rather than watershed boundaries, thus the data includes portions of counties outside the watershed.

SOURCE: (OMAF, 1980c)

in-depth courses and educational meetings; mass media-press[6], radio and television; publications, newsletters, films, factsheets[7] etc.; demonstrations and tours; and exhibits and displays.

Close liaison is maintained with, and assistance provided to, the Junior Farmers Association of Ontario, the Ontario Farm Machinery Board, and numerous other agricultural boards, associations and agencies (OMAF, 1980b).

A large proportion of these extension/education programs are designed to inform farmers of the need for, and results of, improved erosion control through the use of current, up-to-date agriculture practices (OMAF, 1980b).

Agricultural field staff of OMAF are advised of the recent developments in soil erosion control measures. Close contact is also maintained between the agricultural representatives and researchers at the University of Guelph and the agricultural colleges (whose research funding for erosion control and tillage methods has increased dramatically) (OMAF, 1979b).

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6 One of the newspapers OMAF makes use of is "Farm and Country". "Farm and Country" is an agricultural newspaper published 17 times per year in association with the Ontario Federation of Agriculture (OFA). It is distributed free of charge to all OFA member farms. OMAF uses and pays for a 4-page centre spread in the newspaper entitled "Farm Management" that appears once a month. In addition, agriculture representatives and OMAF personnel issue press releases, and write reports for county newspapers.

7 Literally hundreds of factsheets are available from OMAF on a wide variety of topics, including soil erosion, drainage law, minimum tillage, etc.

Due to the multi-disciplined and advisory nature of the Extension Services Programs, not to mention their variance across the province, it is difficult to determine farmer interest in, and use of, erosion control measures in particular watersheds. However, OMAF staff, in all three study basins, noted an increased awareness by farmers of conservation measures. More and more farmers expressed concern for soil loss and were receptive to improved soil erosion control programs (Heard, pers. comm.).

(c) Soil Testing Program

A voluntary Soil Testing Program is available free of charge to all farmers in Ontario. Through a network of county and extension service representatives, OMAF provides recommendations on proper application of fertilizer which will produce high yields of crops but will not result in unnecessary pollution of water. Education programs are on-going to ensure that farmers carry out soil tests and utilize the recommendations.

Despite the use of the Soil Test Program, Ontario farmers have been known to disregard soil test recommendations. Studies carried out by TRIC revealed that only slightly more than one-quarter of the farmers questioned base their rate of fertilizer application on a soil test (TRIC, 1978c). Increased efforts on education programs have been undertaken by OMAF to try and correct this situation (Gallagher, pers. comm. and Heard, pers. comm.).

(d) The Agricultural Code of Practice

The purpose of the Agricultural Code of Practice is to assist farmers in reducing the potential of their livestock operations to pollute air, soil, and water, and to provide guidelines for the rational use of land in relation to the livestock industry. The Code provides management recommendations to control water pollution caused by watering the livestock in streams, ponds or lakes, as well as manure management techniques for controlling runoff from feedlots and fields (OMAF, MOE and MOH, 1976).

The Code is advisory in nature, though farmers are urged to apply for a Certificate of Compliance issued by the Ministries of the Environment, Agriculture and Housing. However, no records are kept on the number or proportion of farms that comply to the Agricultural Code of Practice by watershed. The Code is currently being revised and updated - with assistance being provided by OFA.

(e) The Farm Pollution Advisory Committee

The Farm Pollution Advisory Committee is made up of a peer group of four practicing farmers. The Committee deals with individual members of the farm community who refuse to cooperate with the guidelines, recommendations or requirements of OMAF and MOE. Working on a provincial basis, they attempt to resolve selected pollution problems when all reasonable provincial efforts to achieve abatement have failed and before legal action is taken. Members of the Comittee are named and paid by MOE.

3.1 Background Information[1]

The Lake Simcoe-Couchiching Environmental Strategy was significantly different from the other basin investigations. Besides being unique in terms of studying a lake system versus a river system, the Lake Simcoe-Couchiching Report Committee (LSCRC) used primarily existing studies. Unlike the other water management studies, no funds were allocated for the study and, as a result, no new research was undertaken by the study team.

3.1.1 Basin Description

Lake Simcoe-Couchiching is the largest body of water in Southern Ontario, excluding the Great Lakes. The lakes have a combined water area of 775 sq. km. (300 sq. mi.), and drain a land area of approximately 2,425 sq. km. (940 sq. mi.).

The Lake Simcoe-Couchiching Region is one of Southern Ontario's prime cottage and recreation areas. Reasons for the high recreational value of this area include clear water, good fishing (winter and summer), proximity to the Metropolitan Toronto urban area, and the fact that the lakes are located on the Trent-Severn waterway. Statistics reveal that the fishery in Lake Simcoe alone, generates about 13.6 million dollars in cash flow each year and supplies 15% of the angler recreation in the province (MOE, June 1975).

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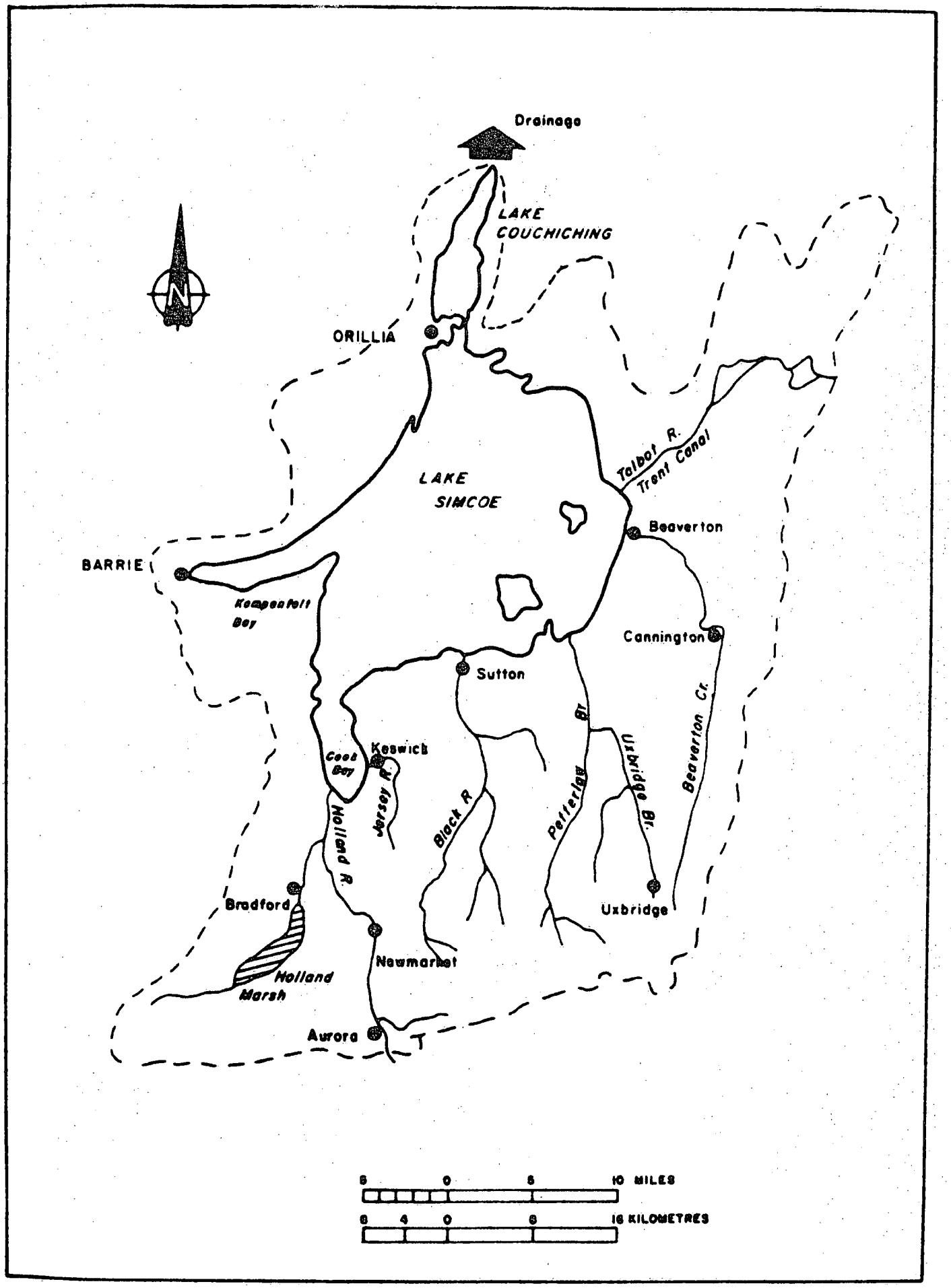
1 Information for this section was derived chiefly from the Lake Simcoe-Couchiching Environmental Strategy, published in 1979 by the Lake Simcoe-Couchiching Report Committee (LSCRC).

Within the drainage basin of Lake Simcoe and Couchiching are a number of urban communities, and agricultural activities. Agricultural operations in the basin are diverse, ranging from intensive market gardening to grazing lands. With the exception of intensive vegetable production in the Bradford (Holland) Marsh area, beef and dairy operations predominate with some swine, sheep and poultry farms. In general, the mineral soils with the best agricultural capability, are found in the southern portion of the watershed.

The permanent basin population is approximately 190,000 people. About 65% of the watershed population live in urban areas, and 35% in rural areas. The four largest urban areas are Barrie, Orillia, Aurora and Newmarket. Ten of the urban areas are supplied with communal sewage systems which discharge treated sewage to Lake Simcoe or to one of the tributaries entering the lake. In addition to the permanent population, there are some 12,000 cottages that surround Lakes Simcoe and Couchiching. Current population projections indicate a future permanent population of 450,000 people (LSCRC, 1979).

3.1.2 Objectives

In the early 1970's, studies undertaken independently by the MOE and the MNR found evidence of water quality deterioration in the Lake Simcoe-Couchiching watershed. The presence of algal scums, attached algae in inshore areas, and a decline in the cold-water fishery, all indicated the existence of significant environmental problems (MOE, 1975). In light of these changes in Lake Simcoe, public pressure, and the possibilities of further environmental aggravation resulting from population growth, municipalities in the basin established a committee of municipal representatives to review and act on programs and policies, pertaining to the protection of the lake. The committee presented a resolution calling for a strong coordinated program of pollution control for the basin as a whole.



Map 3. **MAP OF LAKE SIMCOE - COUCHICHING DRAINAGE BASIN**

Source: (LSCRC, 1979)

In response to the concerns indicated in the municipal resolution, the Provincial Government, with agreement from area municipalities, established a Report Committee. The Report Committee included technical staff representation from the Ministries of the Environment, Natural Resources, Agriculture and Food, Industry and Tourism, Housing, Treasury,Economics and Intergovernmental Affairs, and representatives from CORTS (Canada-Ontario-Rideau-Trent-Severn, Secretariat), the South Lake Simcoe Conservation Authority (SLSCA) and some regional, county and local governments. Using primarily existing studies and accepted standards, the Report Committee was directed [by the Cabinet Committee on Resources Development (CCRD)] to: (a) assess the types and magnitude of environmental problems in the Lake Simcoe-Couchiching area; (b) identify the causes of these problems; and (c) propose an environmental development strategy for dealing with the problems. A Steering Committee composed of area municipalities was established to work with the Report Committee on the formulation of the Environmental Strategy. The Report Committee and the Steering Committee met during 1977 and 1978. The tasks of the two committees were divided into five phases:

(1) Background Information;
(2) Problem Identification;
(3) Alternative Environmental Development Strategies;
(4) "Costing" of Management Alternatives; and
(5) Environmental Strategy and Implementation.

Upon completion of the five phases a final report was prepared by the Report Committee which summarized its findings and outlined specific recommendations. This report was presented to CCRD for review and direction in 1979.

3.1.3 Problems Identified

The Report Committee found that while the general water quality of Lakes Simcoe and Couchiching was satisfactory, there were several significant environmental problems. The major overall problem was that population growth

in the basin, with associated urbanization and land-use activities (e.g., agriculture) had resulted in the release of excess nutrients to the lakes, in particular, phosphorus. Periodic algae scums, shoreline growth of attached algae, localized weed problems, and localized turbidity problems were all a result of increased loadings of nutrients to the lakes (LSCRC, 1979).

As well as the aesthetic problems brought about by increased growths of aquatic plants, the increased level of plant decomposition in the bottom layers of Lake Simcoe resulted in reduced levels of dissolved oxygen - such that prior to fall mixing of the lake, the level of dissolved oxygen in the cold bottom waters fell to between 1 and 3 mg/L. This low level of dissolved oxygen was lower than the minimum level of 4 mg/L which was required to ensure a healthy, self-reproducing cold water fishery (LSCRC, 1979).

As a result the Report Committee found that changes in the Lake Simcoe fishery were taking place. The whitefish population was drastically reduced and appeared to be on the verge of extinction. The lake-trout population required heavy stocking to maintain its status and less desirable species such as yellow perch and smelt had greatly increased in number in recent years. While changes in the fishery could not be attributed to a single factor, the alteration in water quality resulting from increased phosphorus loads was concluded to be the most significant factor (LSCRC, 1979).

Other environmental problems identified and dealt with by the Report Committee included: encroachment on marsh and wildlife areas by agricultural drainage and urban expansion; diminishing of forested areas; ground water contamination resulting from poor management of extraction activities; and threatening of sensitive ecological areas (e.g., fish spawning grounds). These problems, however were given little attention. The Report Committee placed most of its emphasis on phosphorus loadings to the Lake and how they could be reduced.

3.2 RURAL NON-POINT SOURCE POLLUTION

Due to the significance of phosphorus loadings in affecting water quality (and thus influencing the fishery) the Report Committee determined the

annual phosphorus loadings and the relative significance of all phosphorus sources to the Lake. Waste water discharges from sewage treatment plants along with urban, agricultural and natural runoff were found to be the major sources of phosphorus (see Table 4). The loading estimates were based on various water quality surveillance programs and intensive studies conducted in Lake Simcoe from 1970 to 1974 by MOE and MNR[2]. The results of the various studies were summarized in MOE (1975). In this report, phosphorus was named as the main pollutant affecting water quality and annual phosphorus loadings were calculated for all phosphorus sources to the lake using the net load concept. This information was updated, adapted and used extensively by the Lake Simcoe-Couchiching Report Committee.

The portion of the total phosphorus loading contributed by rural non-point sources was estimated by a process of subtraction. Phosphorus inputs from municipal sewage treatment plants were calculated from plant operation records and files, and in consultation with appropriate MOE staff. Calculation of loadings from major tributary streams were based on MOE field

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2 These studies included public attitude surveys, chemical-physical water quality, aquatic biology and fish population and habitat investigations.

TABLE 4

RELATIVE SIGNIFICANCE OF PHOSPHORUS SOURCES TO LAKE SIMCOE

Phosphorus Sources	Loading (Metric Tonnes/Year)	% of Total Loading
Sewage Treatment Plant Effluent (with Phosphorus Removal to 1.0 mg/L)	22	11.4
Rivers	26	25.2
Precipitation	21	20.4
Tile Field Leakage - Cottages	3	2.9
Urban Storm	9	8.7
Agriculture and Other Land Use Disturbances	22	21.4
TOTAL	103	100.0

SOURCE: (LSCRC, 1979).

surveys [3]. Estimates of precipitation inputs were obtained from Environment Canada and research conducted on Clear Lake in Haliburton County (Schindler and Nighswander, 1970). Phosphorus loading estimates from tile field leakage (i.e., cottages) were based on a cottagers' questionnaire and a literature review [4]. Inputs of phosphorus from urban storm waters were estimated using existing information concerning urban areas and populations. The phosphorus loading attributed to "agriculture and other land-use disturbances" was then calculated by subtracting the loadings from all other sources from the total phosphorus loading (MOE, 1975 and Salbach, pers. comm.).

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3 All major rivers and streams discharging to the lake were sampled on a routine monthly basis with intensified sampling during the spring runoff period. Streamflow records were obtained from existing flow gauges maintained by the Water Survey of Canada and MOE. Where streamflow records were not available, data from gauges on similar nearby streams were pro-rated. Nitrogen and phosphorus data for the Holland River were obtained from a thesis by K. Nicholls (1972), (MOE, 1975).

4 Some of the factors considered were: the type of sewage system employed; number of cottages; average number of days used and number of people per cottage.

As can be seen from Table 4, agricultural sources were determined to contribute 21% of the total phosphorus load to Lake Simcoe, estimated at 103 metric tonnes per year[5]. The Holland Marsh was identified as the major rural diffuse source of phosphorus. As a result it was dealt with separately within the agricultural portions of the Environmental Strategy; written by OMAF representatives on the Report Committee (Trewin, pers. comm. and Gallagher, pers. comm.). Information for these sections was based, in part, on a literature review undertaken by the Food Land Development Branch of OMAF, at the request of the Lake Simcoe-Couchiching Report Committee. The review described the existing types of farm operations in the basin and summarized a number of pertinent studies regarding agriculture and water quality.

Studies by the Ministry of the Environment and the Department of Zoology, University of Guelph, were used to assess the problems associated with cultivation of the Holland Marsh. These studies measured the water quality impact of the Bradford Marsh on the Holland River and Lake Simcoe. Both sub-surface and runoff water were monitored. Runoff from cultivated areas of the marsh was found to have 4 to 5 times more phosphorus, and 40 to 50 times more nitrate-N than from an uncultivated area of the marsh (Nicholls and MacCrimmon, 1974). The high nutrient concentrations were attributed to the combined effects of fertilization and drainage. Although the nitrogen and phosphorus concentrations in the runoff from the cultivated marsh are not particularly high relative to other agricultural areas, other factors make the nutrient loading more significant. In the Holland Marsh situation, the nutrients are all released to the river during a 5 to 6 week spring pumping period. In addition, more than 90% of the total phosphorus in the runoff is in the soluble reactive form, (as opposed to only 45% from the uncultivated marsh), readily available for algae and aquatic plant growth (Nicholls and MacCrimmon, 1974).

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5 This figure can be misleading since in calculating the relative significance of phosphorus sources to Lake Simcoe, rivers were considered separately. A large portion of the phosphorus loadings to the rivers, however, is the result of runoff from agricultural land.

Discussion of rural non-point source problems in the rest of the basin centered on the potential for pollutant transfer from crop and livestock areas. Fertilizer use and manure storage and application were mentioned as the principle areas of concern. Other agricultural practices identified as contributing to water quality problems were continuous corn-cropping, watering cattle in streams, and drain construction (OMAF, 1977). No specific information on the water quality effects nor the extent of these agricultural practices within the Lake Simcoe basin were outlined.

One study, cited by both the Final Report and the OMAF Literature Review was a study undertaken for PLUARG that grouped soils into categories based on their potential for pollutant transfer from agricultural land to surface and ground waters. This mapping indicated that in general, the area west of Lake Simcoe has a low potential for pollutant transfer, while the remainder of the basin has a highly variable potential for transfer; the Bradford Marsh being identified as an area with a particularly high potential to pollute surface water (OMAF, 1977). Since nutrients from agricultural operations are generally transported to water bodies in conjunction with soil particles, reduction of soil erosion was seen as the best method to substantially decrease this pollutant transfer (LSCRC, 1979).

No attempt was made to quantify the environmental effect of the livestock industry on Lake Simcoe-Couchiching. The Report Committee felt that although there may be some evidence of localized problems, it was not a serious basin-wide problem (LSCRC, 1979).

The report concluded that the overall impact of agricultural activities on the water quality of Lake Simcoe would not increase for the following reasons: 1) there are reductions of fertilizer used in some areas, (e.g., Bradford Marsh) due to rising costs, better technical advice, and adverse effects of over-fertilization; 2) more and more farmers are following the Agricultural Code of Practice; and 3) it is not likely that the number of hectares farmed will substantially increase in the future (LSCRC, 1979).

Overall, there was very little documentation of the magnitude, the causes and the effects of rural non-point source pollution in the Lake-Simcoe-Couchiching Environmental Strategy.

The Report Committee used existing studies, only a few of which pertained to diffuse sources. The OMAF Literature Review, although somewhat broader, summarized studies undertaken for the most part, elsewhere in the Province. The applicability of these studies to the Lake Simcoe area was questionable due to differences in soil characteristics and crops. It should also be noted that most of the studies cited were short-term, carried out during only one year or season.

3.3 Recommendations to Reduce Rural Non-Point Source Pollution

The "Detailed Strategy" presented in the Lake Simcoe-Couchiching Basin Environmental Strategy (LSCRC, 1979) made some specific recommendations for decreasing rural non-point source pollution loading to the Lake-Simcoe-Couchiching basin. These recommendations were outlined within the context of maintaining the existing water quality in Lake Simcoe -Couchiching. In order to accomplish this objective, a phosphorus loading goal of 103 metric tonnes per year was established by the Report Committee[6].

To reduce the input of phosphorus from agricultural activities the report recommended that remedial measures be introduced in two main areas: the cultivated portion of the Bradford Marsh (Holland Marsh); and the agricultural areas in the remainder of the basin (where beef and dairy operations predominate). Alternatives suggested for the Holland Marsh included: fertilization only to soil-test needs; minimizing pumpage from the Marsh during and shortly after ice cover when the drainage water is stagnant and without oxygen (it is during these conditions that nutrients dissolve into the water); additional fall pumpage of drainage water to precipitate phosphorus, thus reducing the escape of this nutrient to Lake Simcoe; and establishing an aeration lagoon or a treatment tank at the foot of the marsh (LSCRC, 1979).

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7 This figure has since been reduced to a total annual phosphorus loading of 87 metric tonnes (MOE, 1980).

The following remedial measures were recommended for the remainder of the basin: fertilization only to soil-test needs; manure management (greater implementation of the Agricultural Code of Practice); reduction of soil erosion (by crop rotation, strip cropping, contour cultivation, sod buffer strips along watercourses, grassed waterways, and reforestation of shoreline area); restriction of livestock access to watercourses; and better education and communication (LSCRC, 1979).

Other recommendations made by the Report Committee to reduce rural non-point source pollution included: preventing the dredging, filling and development of wetlands and marshy areas; and preserving the existing forest cover.

All these remedial measures were presented with no discussion as to their costs, effectiveness or applicability to the Lake Simcoe-Couchiching area. In fact, planning staff stated that the measures were simply taken directly from PLUARG and other reports (Salbach, pers. comm. and Gallagher, pers. comm.). No new studies were undertaken and no technical reports were cited in the report. The Report Committee maintained that it was impossible to predict in quantitative terms, the reductions in phosphorus inputs with the implementation of the control schemes outlined above (LSCRC, 1979). Moreover, they contended that it was also impossible to quantify the cost of these types of programs (LSCRC, 1979). The basic approach taken for all the recommendations was to stress implementation of the remedial measures and then to monitor the water quality afterwards to determine the effectiveness of the measures introduced.

3.4 Implementation of Recommendations

The Report Committee of the Lake Simcoe-Couchiching Basin Environmental Strategy discussed at length the question of how best to coordinate implementation of their recommendations. Various options such as: establishing a special Provincial-Municipal Implementation Coordination Committee; designating a lead ministry or agency; appointing the Provincial Secretariat for Resources Development; or using existing agencies and

mechanisms, were considered. In the end, the Committee recommended that the strategy be implemented through existing agencies and mechanisms, with the Cabinet Committee for Resource Development (CCRD) acting as coordinator.

One development, however, greatly influenced the implementation of the Report Committee's recommendations. The Ministry of Natural Resources could not accept the phosphorus target load of 103 metric tonnes per year decided on by the Report Committee to maintain existing conditions. They insisted that by maintaining existing conditions the rehabilitation of a naturally reproducing cold-water fishery (lake trout, whitefish) would be unachievable. Discussions were held between representatives of MOE and MNR. The matter was eventually resolved by CCRD and a compromise was reached (Trewin, pers. comm.; Salbach, pers. comm.; and Dawson, pers. comm.).

As a result, CCRD recommended to the Provincial Government acceptance of the recommendations of the Lake Simcoe-Couchiching report with modification. The modification consisted of the reduction by 1983 of the phosphorus loading from the projected 1983 level of 105 tonnes per year with existing controls to 87 tonnes. Three programs were set out to achieve this reduction.

a) remove sewage from Aurora and Newmarket from the Basin to the York-Durham systems (6 tonnes);

b) upgrade sewage treatment facilities at Barrie and Orillia to reduce the phosphorus level in the effluent to 0.3 mg/l (8 tonnes); and

c) reduce the non-point source loading (4 tonnes).

The reduction of non-point source pollution loading was thereby given a greater emphasis for the achievement of the new target load (i.e., over and above that indicated in the Environmental Strategy). Since implementation of the Simcoe-Couchiching Environmental Strategy was assigned to existing agencies and mechanisms, this emphasis was passed on to the agencies responsible (i.e., the SLSCA and OMAF).

The following summarizes the courses of action taken by these agencies with regard to Lake Simcoe-Couchiching Environmental Strategy to reduce non-point pollution.

3.4.1 South Lake Simcoe Conservation Authority

The South Lake Simcoe Conservation Authority (SLSCA) offers various programs for the reduction of agricultural runoff, erosion and siltation. Details of these programs, as well as other relevant activities the Conservation Authority is involved in, are outlined within the context of the relevant recommendations of the Lake Simcoe-Couchiching Environmental Strategy.

Recommendation No. 1 (d) - REDUCTION OF PHOSPHORUS INPUTS FROM AGRICULTURE ACTIVITIES

> STRATEGIES TO REDUCE THE INPUT OF PHOSPHORUS FROM AGRICULTURAL ACTIVITIES SHOULD BE IMPLEMENTED AS SOON AS PRACTICABLE. IN THIS REGARD, REFERENCE SHOULD BE MADE TO PLUARG FINDINGS WHICH PROVIDE GUIDANCE ON THE TYPE OF REMEDIAL MEASURES REQUIRED TO REDUCE NUTRIENT ESCAPE FROM LAND DRAINAGE IN GENERAL AND AGRICULTURE SPECIFICALLY.

The Conservation Authority is currently reviewing several PLUARG reports. The SLSCA intends to make use of PLUARG studies, specifically to determine potential phosphorus inputs for any given area within the watershed and to propose preventative remedial measures for areas of high phosphorus loading.

The Authority is also in the initial stages of developing a cooperative erosion control demonstration project with OMAF. The intent of the program is to show how protective measures can be undertaken to prevent erosion on farms, through projects such as fencing off cattle from streams, streambank erosion protection and rehabilitation, the use of grassed waterways, planting buffers between agricultural fields and streambanks, etc. The protective and remedial measures are intended to reduce sediment and phosphorus loading into streams and lakes. Once a suitable site is agreed upon, both the Authority's erosion control program and the Ministry's soil management and erosion control program will be demonstrated. Authority staff have inspected several potential sites chosen by OMAF. However, an ideal

demonstration project location that meets both agencies' criteria has not yet been selected (Gallagher, pers. comm. and Peterkin, pers. comm.).

Recommendation No. 2 - PROTECTION OF WETLANDS/MARSHY AREAS AND CONSERVATION MEASURES

> DREDGING, FILLING AND DEVELOPMENT OF WETLANDS AND MARSHY AREAS MUST BE PREVENTED, SINCE THESE AREAS ARE GENERALLY UNSUITABLE FOR PRIVATE WASTE DISPOSAL SYSTEMS. THESE ACTIVITIES ALSO MAY IMPAIR WATER QUALITY IN GENERAL, DESTROY FISH SPAWNING AREAS, OR CREATE EROSION AND FLOODING PROBLEMS.

The Authority staff recently completed a draft report titled, Wetlands - Recommendations and Policies (Locke, 1980). This report examined the value of wetlands and existing wetland acquisition programs and policies in the South Lake Simcoe watershed. It also included recommendations for wetland management.

At present the SLSCA, with the help of the Nature Conservancy Society[7], is actively acquiring wetlands in two areas within the watershed (i.e., Pottageville Swamp and Scanlon Wetlands). The Pottageville Swamp is a major component in the water management (flood storage, flood protection, summer irrigation) system of the Holland Marsh (MNR, 1973). The major attribute of the Swamp is its ability to function as a surface water storage area, especially in times of severe rainfall. As well, it serves as a groundwater recharge area for the Schomberg watershed (Locke, 1980). The total area of the Pottageville Swamp is 364 hectares (900 A). To date, the SLSCA owns 40 hectares (100 A). The Authority is actively contacting the remaining landowners. So far, the total cost of the project is $450,000 with the province paying 55% of the cost and the Authority's share being paid for by the Nature Conservancy of Canada (Locke, 1980).

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7 The Nature Conservation Society is a non-profit organization primarily involved in the acquisition and preservation of wetlands. In Ontario, Conservation Authorities can acquire property with Provincial Government Assistance (grants of up to 75% of the cost of the land are available) providing the Authority involved can contribute the balance. In many instances this balance is provided by the Nature Conservation Society. Basically, it acts as a fund-raising organization for the acquisition of natural areas.

The other area acquired by the SLSCA, the Scanlon Wetlands (61 hectares), is land that was former marshland which had been diked and drained for agriculture. Tentatively this land will be managed jointly by the Authority and Ducks Unlimited (Noels, pers. comm.).

In conjunction with the Authority's programs and policies for wetlands, the SLSCA has also recently undertaken an Environmental Significant Areas Study (ESA). This study, contracted to "Ecologistics", will identify significant wetland areas within the watershed and will recommend guidelines for policy implementation for the overall management of these areas.

Many of the wetland areas within the watershed are protected under the Authority's regulations. As such, all development proposals and applications for placing fill within the regulated area are reviewed by SLSCA staff. Presently the general policy of the Authority is to discourage filling and construction activities within flood-prone and other hazardous areas (Peterkin, 1980).

As for the second part of the recommendation (i.e., Erosion Control) the South Lake Simcoe Conservaton Authority has also prepared for implementation, a "Private Land Assistance Program" for erosion protection along privately owned streambanks. By stabilizing eroding streambank sites, the SLSCA hopes to reduce sediment and phosphorus loading. Under the program, the landowner pays for all costs of materials (i.e., gabions, railroad ties, rip-rap etc.), and the Authority supplies technical advice from office staff and labour from summer "Experience" students.

One streambank erosion control project was completed in 1979 involving five students for one day. In 1980, one erosion control project was undertaken, employing five students for twelve days. Under the terms of the agreement labour for any maintenance work necessary on the project is supplied by the Authority for a one year period following completion (Peterkin, pers. comm.).

Response to the program has been very slow, (1979 - 2 requests, 1980 - 5 requests) most likely due to inadequate advertising, the economic

situation and because the program is new. When an applicant meets the Authority's requirement for the "Streambank Erosion Control Program (SECP)", in terms of size of project and type of work involved, the project is priorized in the following way: 1) date application received, and 2) degree of erosion and anticipated erosional damage should the project not be undertaken the same year (Peterkin, pers. comm.). In addition, a number of stream surveys were initiated by Authority staff in 1979 to identify erosion-prone areas.

The SLSCA has also engaged in erosion control works in cooperation with MNR. MNR under their SPOF program (Strategic Planning for Ontario Fisheries) provides funding for stream rehabilitation to improve coldwater fisheries habitat. This year the SLSCA has received $15,000 from the Ministry to undertake remedial works in the Uxbridge Brook headwaters areas. Five projects have been undertaken under the SPOF program (Noels, pers. comm.). The projects involve improving or re-establishing fish habitat by means of stabilizing banks, converting ponds to bottom draw, fencing of streams to prevent access by livestock and planting trees and shrubs to provide cover and shading.

Recommendation No. 6 - PRESERVATION OF FOREST COVER

THE EXISTING FOREST COVER SHOULD BE PRESERVED. LOCAL ENFORCEMENTS, THROUGH TREE CUTTING BY-LAWS, IS STRONGLY ENCOURAGED AND DEVELOPERS ARE ENCOURAGED TO MAINTAIN AS MANY QUALITY TREES AS POSSIBLE.

The Authority presently has two different reforestation programs:

1. Private Landowner Reforestation Assistance Program (PRAP)

   The SLSCA supplies men and equipment to machine-plant trees on private land. Also, landowners wishing to plant their own trees may apply to the Authority for an allowable subsidy. All trees are purchased by the landowner from MNR and technial advice is supplied by the Authority.

2. Farm Tree Replacement Program (FTRP)

   This program is designed to provide erosion protection on farmlands through water retention and windbreaks. A minimum of 50 and a maximum of 1,000 trees are planted per site (Peterkin, 1980).

At the present time, the two reforestation programs require that landowners apply to the Authority for assistance. Once it has been determined that an applicant qualifies, trees are planted on a first-come, first-served basis. Implementation of these programs is summarized in Table 4.

Under both Reforestation Programs, the landowner is responsible for maintaining and protecting the project for a 15-year period. As of the end of July 1980, $22,000 had been spent in 1980 on the PRAP, FTRP and SECP Programs.

TABLE 5

SUMMARY OF REFORESTATION PROGRAMS OFFERED BY SLSCA (1980)

PROGRAM	DESCRIPTION	NO. OF PROJECTS UNDERTAKEN	NO. OF PROJECTS REQUESTS
Private Reforestation Assistance Program (PRAP)	Authority machine planting Plantation and windbreak planting.	27	32
	Boy Scouts tree planting plantation planting only	2	2
	Landowner planting SLSCA offers technical assistance along with pick-up of order.	20	20
Farm Tree Replacement Program (FTRP)	Authority staff plants Deciduous trees 2 metres in height on approved sites to create fencerows	13	20

SOURCE: (Peterkin, pers. comm.).

Recommendation No. 11 - PUBLIC EDUCATION

A PUBLIC EDUCATION - INFORMATION PROGRAM SHOULD BE ESTABLISHED TO ENHANCE ENVIRONMENTAL CONSCIENCE AND CULTIVATE PUBLIC SUPPORT FOR THE IMPLEMENTATION OF THE STRATEGY.

The Conservation Authority has just recently expanded its public information and education program by hiring its own community relations officer to promote the services and programs of the Authority and to make people more aware of the problems which exist in the watershed.

3.4.2 Ontario Ministry of Agriculture and Food (OMAF)

The Ontario Ministry of Agriculture and Food (OMAF) was the other agency assigned to implement the Lake Simcoe-Couchiching Environmental Strategy's recommendations to reduce non-point source pollution. OMAF's programs in the Simcoe-Couchiching basin are the same as those offered in the Thames River basin. In fact they are the same right across the province. The programs include: The Ontario Farm Productivity Incentive Program; Extension Services and Education Programs; Soil Testing Program; The Agricultural Code of Practice; and the Farm Advisory Committee (see section 2.4.5).

A summary of the implementation of the Ontario Farm Productivity Program for the Simcoe-Couchiching Basin appears in Table 6. Manure storage facilities were by far the most requested projects, both in terms of cost and number in the Simcoe-Couchiching Basin. Some erosion control projects were undertaken under the OMAF Farm Productivity Incentives Program. However, no alternative watering facilities or education/demonstration projects were initiated. Information was not available for implementation of the other OMAF programs in the Simcoe-Couchiching watershed.

TABLE 6

SUMMARY OF FARM PRODUCTIVITY INCENTIVES PROGRAM
FOR THE SIMCOE-COUCHICHING BASIN
(1979-80)

($ = Thousands of Dollars)
(# = Number of Projects)

	EROSION CONTROL		MANURE STORAGE		ALTERNATE LIVESTOCK WATERING		EDUCATION/ DEMONSTRATION	
COUNTY	#	$	#	$	#	$	#	$
Simcoe N.	1	.17	16	26.38	-	-	-	-
Simcoe S.	2	3.00	5	12.77	-	-	-	-
Victoria	1	.53	12	27.61	-	-	-	-
York	-	-	4	12.00	-	-	-	-
TOTALS	5	3.70	37	79.13	0	0	0	0

Results compiled using political (i.e., county) rather than watershed boundaries, thus the data includes portions of counties outside the watershed.

SOURCE: (OMAF, 1980c)

3.4.3 Ministry of the Environment

Recommendation No. 4 - ADDITIONAL STUDIES REQUIRED

> THE FEASIBILITY AND EFFECTIVENESS FOR REDUCING THE PHOSPHORUS ESCAPING FROM THE HOLLAND MARSH (3.1.1.3) SHOULD BE INVESTIGATED (OMAF).

A pilot study ($15,000) was contracted by MOE to Rupke and Associates, Bradford. The purpose of the study, undertaken in the winter of 1979 - 80, was to determine if the concentration of phosphorus in the drainage waters of the Holland Marsh can be reduced by aeration of the waters stored in the central drainage canal during the winter. This study proved unsuccessful. The Ministry of the Environment is currently planning further extensive aeration studies ($100,000+) starting this winter (Trewin, pers. comm.).

CHAPTER 4

GRAND RIVER BASIN WATER MANAGEMENT STUDY

4.1 Background Information

The Grand River Basin Water Management Study is scheduled to be completed in September 1980. With a budget of 1.663 million dollars, a vast network of monitoring stations, and data and results from PLUARG, Ministry of the Environment (MOE) and Grand River Conservation Authority (GRCA) studies, it is by far the most intensive river basin study undertaken in Ontario.

4.1.1 Basin Description

The Grand River basin is the largest river basin in Southern Ontario. Extending from Port Maitland on Lake Erie in the south, 308 km. (185 mi.) to the headwaters close to Georgian Bay in the north, the watershed covers an area of 6,500 sq. km. (2,600 sq. mi.). The basin can be divided into three sections. The upper portion of the basin, or the headwater region, is predominately rural and agricultural. The land is rugged and contains numerous small streams, springs and marshes. The middle third of the watershed, by contrast, is highly urbanized; taking in such major industrial and commercial centres as Kitchener, Waterloo, Guelph, and Cambridge. The lower portion is primarily rural and agricultural. However, unlike the upper rural section, most of the land is intensively cultivated and the land is less rugged.

In the Grand River basin, agricultural land comprises approximately 78% of the total drainage area. The three major crops are row crops, small grain and hay. Intensive livestock operations, including the raising of pigs, sheep, chickens and cattle are the other major agricultural activities [Grand River Basin Water Mangement Study (GRBWMS), 1980].

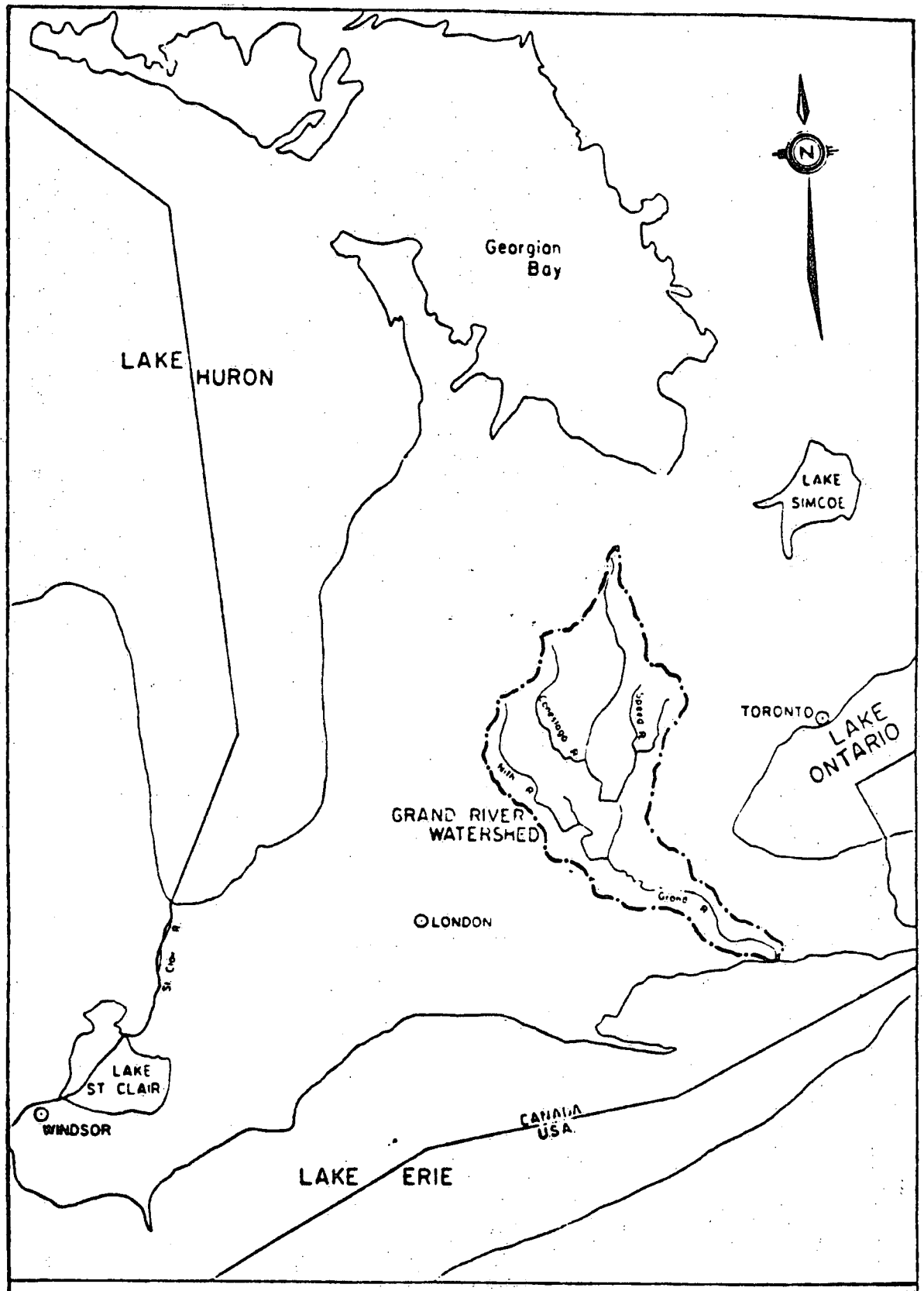
Only 3% of the basin is urbanized. An area commonly referred to as the industrial triangle (Kitchener/Waterloo/Cambridge), represents the highest density of population (53% of the basin's urban population of 435,000) and industrial activity (more than 650 water-using industries) in the basin. The other main urban centres are Guelph and Brantford. Most of the remaining 19% of the land area is wooded or idle (GRBWMS, 1979).

Current population projections estimate that the population in the basin will increase from 545,000 in 1976 to between 800,000 and 960,000 in 2001. It is believed that most of this increase will be centered in the industrial triangle (GRBWMS, 1979).

The Grand River System is very important to the people in the watershed, providing water for: domestic, industrial and agricultural uses; recreation; and acting as a vehicle for the conveyance of wastes. It also poses a serious hazard to significant portions of the population from time-to-time due to flooding. Some of the water and land uses conflict with one another. With increasing population and development, further demands are being placed on the limited resources.

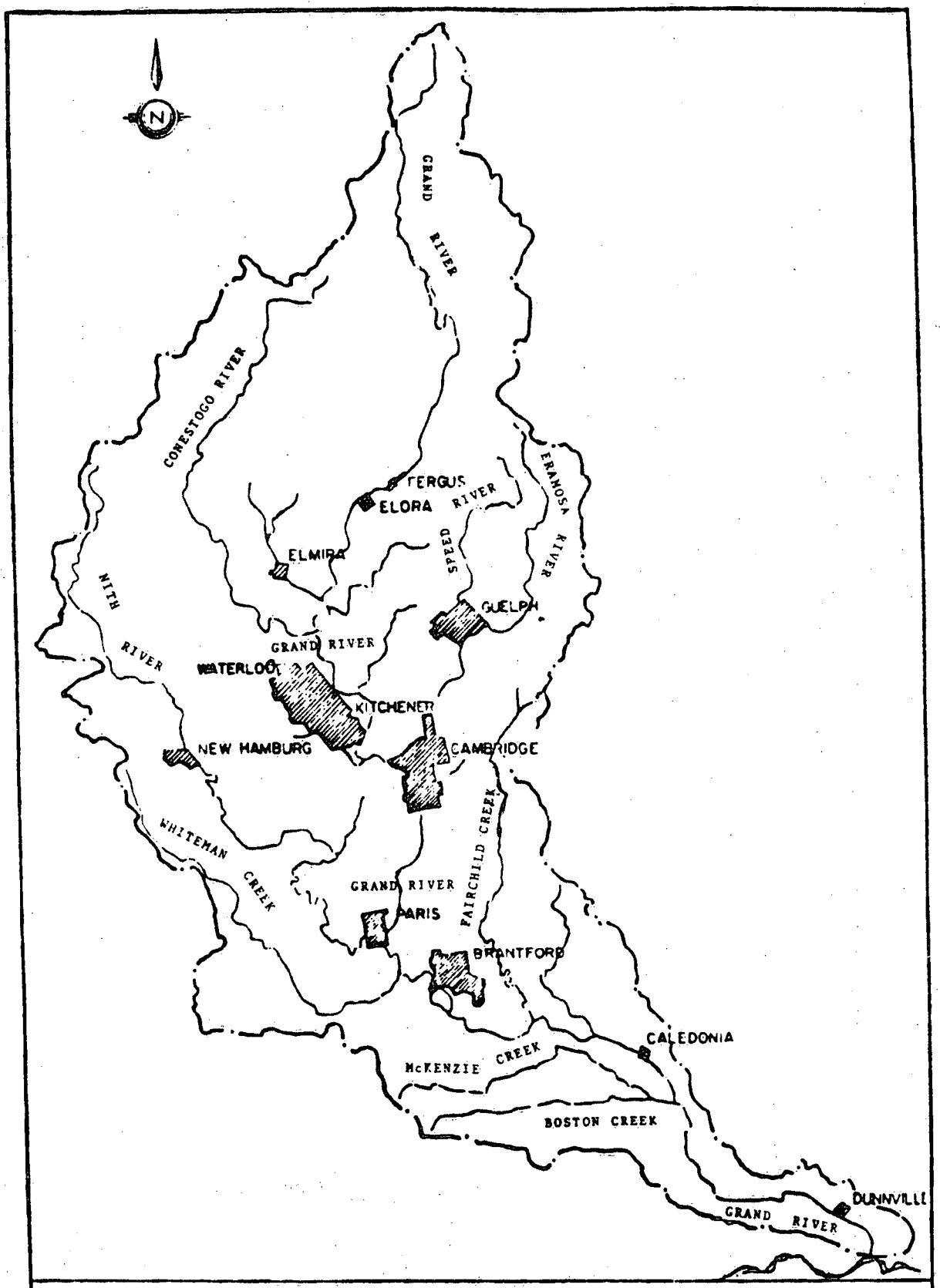
4.1.2 Objectives

Various studies were undertaken by provincial and local agencies to resolve many of the local problems and conflicts. The report Review and Planning for the Grand River Watershed, published by the Ontario Treasury Board Secretariat in 1971, addressed the most pressing water management problems in the Grand River basin and made specific recommendations to overcome them. The need for long term comprehensive planning was strongly advocated. In response to the report, the Grand River Implementation Committee (GRIC) was formed by the Province of Ontario in 1972. With an annual budget of $200,000, "GRIC" was responsible for implementing the recommendations contained in the report and resolving immediate water management problems.



Map 4. Location and Extent of the Grand River Basin

Source: (Hore and Ostry, 1978)



GRAND RIVER BASIN

Map 5. Source: (Hore and Ostry, 1978)

The report of the Royal Commission Inquiry into the Grand River Flood published in 1974, further emphasized the need to take a comprehensive approach to watershed management and stated, "that the provincial government take the initiative to establish a multi-disciplinary planning team to be responsible for the development of a comprehensive water management plan for the Grand River Basin."

As a result, GRIC was expanded and made responsible for developing an integrated water mangement study for the basin. The Committee presently consists of the following member agencies:

Ministry of the Environment;
Ministry of Natural Resources;
Grand River Conservation Authority;
Ministry of Agriculture and Food;
Ministry of Housing;
Ministry of Treasury and Economics; and
Ministry of Intergovernmental Affairs.

Some of the working groups for the Basin study have representatives from municipalities, universities, and the public. The Committee reports through the Chairman of Senior Management of the Ministry of the Environment, which is the lead agency.

The terms of reference for GRIC were also broadened to include:

1. Planning and directing the Grand River Basin Water Management Study;

2. Coordinating the implementation of the recommendations of the reports Review of Planning for the Grand River Watershed and Inquiry into the Grand River Flood; and

3. Providing forums for the exchange of information among provincial and area representatives and residents during the course of the study through:

   (a) meetings;

   (b) news releases and reports; and

   (c) subcommittees and task forces (GRBWMS, 1978).

Approved by the province in 1977, 1.663 million dollars were allocated by the Province of Ontario for the Grand River Basin Water Management Study. The overall objectives of the basin-wide investigation are:

1. To develop viable water management options needed to plan for and encourage the integrated use of water and land resources within the Grand River Basin;

2. To identify the necessary trade-offs to achieve protection against flooding, acceptable disposal and transport of waste effluents;

3. To provide adequate supplies of good quality water to meet water supply, aesthetics, fish, wildlife and recreational desires and needs; and

4. To ensure a productive and fulfilling environment for the people of the basin.

The study when completed is intended to provide the information needed to plan for and select measures required for water supply, water pollution control, flow augmentation and flood protection for the current and projected populations.

4.1.3 Problems Identified

At the writing of this report, the final report of the Grand River Basin Study has not yet been released. The Grand River study team has completed all field work and data collection for the program. The results have been analyzed and options have been evaluated, some technical reports have been published and preliminary water management plans have been developed. Evaluation of various plans is currently underway. This evaluation will take into consideration economic, social and environmental factors and measure the success of the plans in meeting the study's objectives.

From the preliminary technical reports and the PLUARG studies, it can be assumed that the two major problems that will be identified in the Grand River basin (GRIC) will be water quality impairment and flooding.

4.2 Rural Non-Point Source Pollution

The Grand River Basin Water Management Study (GRBWMS) unlike the other water management studies, placed heavy emphasis on rural non-point source pollution. In fact, the study established a separate subcommittee dealing solely with diffuse sources. In addition, four related technical reports were published by GRBWMS. Through all the reports, considerable use was made of the PLUARG Grand River Pilot Watershed Study[1].

The PLUARG Study identified excessive inputs of sediment, phosphorus and nitrogen as major causes of water quality problems in the Grand River basin. PLUARG determined that a large portion of the loading - 84% of the sediment, 67% of the total phosphorus, 47% of total kjeldahl nitrogen and 81% of nitrite and nitrate - came from rural diffuse sources (Hore and Ostry, 1978).

For the PLUARG Study an extensive stream quality monitoring network was installed in the basin. During the 2-1/2 year study period (1975 - 77), streamflow levels were monitored at each station. Water and sediment samples were collected and analyzed for a variety of water quality parameters, including suspended solids, nutrients (phosphorus and nitrogen), pesticides, heavy metals and chemicals (chlorides and synthetic organics).

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1 The Grand River basin was chosen as a pilot watershed for intensive study by PLUARG . A detailed survey of the basin, undertaken by PLUARG between the years 1975 and 1977, determined the sources of pollutants, their relative significance and provided an assessment of the degree of transmission of pollutants to boundary waters (Hore and Ostry, 1978). The Grand River Water Management Study relied heavily on PLUARG data and results. These data were supplemented with data from the routine MOE/GRCA water quality monitoring network and the automatic monitoring stations established for the Grand River Study.

The water quality and quantity data generated at the sampling sites were then translated into quantitative estimates of pollution loadings (Hore and Ostry, 1978). Loadings were expressed as unit area loads; that is total pollutant loads for a given time period averaged over the drainage areas upstream of the monitoring sites. Data on unit-area loads among monitoring sites provided a relative comparison of pollutant loads at various locations in the basin.

By combining monitoring stations sub-basin pollutant loads were also calculated. These loads represented the input from both point and diffuse sources within the sub-basins. That portion contributed by rural diffuse sources was obtained by subtracting the loads contributed by all point sources (sewage treatment plant effluent and industrial waste discharges) and urban runoff within the sub-basin from the total sub-basin load (GRBWMS, 1980).

Pollutant loads were compared and high source areas were identified. This information was documented and illustrated on separate colour-coded maps in GRBWMS (1980). The areas identified as contributing the largest amount of sediment and nutrients were the middle Grand (between Fergus and Cambridge), the Nith River, and the Conestogo River (GRBWMS, 1980)[2].

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2 Similar results were obtained in the study Agricultural Land Uses, Livestock and Soils of the Canadian Great Lakes Basin undertaken by PLUARG (Coote, et. al., 1974). Based on the topography of the basin and the characteristics of its soils (such as texture, drainage capability and depth), this study prepared a map for the Grand River basin on the potential of surface and ground water pollution. The map showed that pollution potentials varied from location to location; with the Lower Grand River downstream of Paris, the upper parts of the Conestogo River, the Nith River and Whitemans Creek being identified as areas most susceptible to surface water pollution.

The Grand River Water Management Study named agricultural land use as the major non-point source of pollution. Agricultural watershed information from the PLUARG study indicated that the nature and type of agricultural activity was reflected in the water quality of the receiving streams (Hore and Ostry, April 1978). Simple correlations between ten sub-basin characteristics and the unit-area loads of suspended solids, total phosphorus, filtered reactive phosphorus, total kjeldahl nitrogen and filtered nitrite and nitrate were calculated. Relatively strong correlations were found between the unit-area loads and the following parameters: % farmland; % cropland, % small grains, % hay, intensity of livestock operations and % clay (GRBWMS, 1980). A number of these correlations suggested that the unit area loads of phosphorus and nitrogen would depend greatly on: the amount of fertilizers used and manure produced in the sub-basin; soil characteristics; and agricultural practices. Surface runoff from cropland, municipal drains and field tile systems and drainage from intensive livestock operations were recognized as the major causes of rural diffuse source pollutant loading to the basin (GRBWMS, 1979).

In order to assess the extent, location and severity of these problems in the problem areas identified, two field surveys, as well as a study of aerial photographs, were undertaken by GRIC.

The first field survey, conducted in the summer of 1978, covered seven sample areas: the Upper Nith River, the Lower Nith River, Horner Creek and Kenny Creek and Fairchild Creek. Within the sample areas, observations were made, at each road crossing, of: the extent and severity of streambank erosion; and the width of the buffer strips. In addition, the presence of manure piles in the vicinity of the stream, non-contour cropping practices and cattle access to the stream were noted.

A more intensive field survey was conducted the following summer, in the Nith River, the Upper Conestogo and the Irvine Creek areas. For this survey at each observation site: the stability of the streambanks was assessed according to the slope, shape and height of the banks and the vegetation coverage; the presence of erosion, tile outlet, manure storage and cattle access problems were noted; the width of buffer strips were measured; and land use data in, and adjacent to, floodplains were obtained. In addition, information was collected from farmers concerning crop rotation, cropping, tillage and fertilizer application practices.

From the aerial photographs study, the extent and severity of streambank erosion in three areas - the Lower Conestogo River, the Middle Grand River and Whitemans Creek were investigated. Moreover, those areas with inadequate buffer strips were located.

To relate the measured unit-area loads to the sub-basin characteristics, five regression models were developed by GRIC (GRBWMS, 1980). The GRIC models, based on models developed by PLUARG, were used to compute rural diffuse source pollutant loads for each sub-basin according to the 1976 agricultural land use conditions. Where appropriate, the estimated loads were adjusted, using information from the field survey and air photo studies, so as to account for the loads contributed by poor agricultural land management practices and streambank erosion (GRBWMS, 1980).

These models were then used to project pollutant loads to the years 2001 and 2031 for each sub-basin. The projection of the unit-area and total suspended solid loads was based on the area of row crops projected for each sub-basin (Miller and McBride, 1979). The estimation of the unit-area and total loads of total phosphorus, filtered reactive phosphorus, total kjeldahl nitrogen and filtered nitrite and nitrate were based on projections on fertilizer usage and manure projection (GRBWMS, 1980). The same models were also used to estimate the projected effectiveness of recommended remedial measures (see section 4.3).

As can be seen from the preceeding discussion, rural non-point source pollution was given considerable attention in the Grand River Water Management

Study. The fact that the Grand River Basin was chosen as a pilot watershed study by PLUARG made data and results from an extensive stream quality monitoring network available. This led to much more accurate estimates of pollutant loadings than the other water management studies and allowed the study to identify problem areas with improved precision. Moreover, pollutant loadings were calculated for a greater number of water quality parameters. Throughout all the rural diffuse source pollution-related technical reports published by GRBWMS, constant use was made of PLUARG findings. Information was based almost entirely on PLUARG studies. In fact, it may be argued that the Grand River Study merely restated, with some minor refinement, the results of the PLUARG Pilot Watershed Study.

4.3 Recommendations to Reduce Rural Non-Point Source Pollution

At the writing of this report, the Grand River Basin Water Management Study has not yet outlined recommendations to reduce rural non-point source pollution input to the Grand River watershed. However several technical reports, published by GRBWMS, recommend specific remedial measures that should be undertaken. The following summarizes these recommendations and examines their basis.

The technical report Problems in Land Management Practices in the Grand River Basin with Suggested Remedial Measures, prepared for the Diffuse Sources Subcommittee of GRBWMS, studied problems in agricultural practices in the Grand River Basin and made recommendations to remedy them (Neilson, 1978). To substantiate the need for agricultural remedial measures, problem areas were identified using the 1978 summer survey and the PLUARG land inventory. In addition, possible remedial measures were discussed for two major agricultural activities: livestock and cropping (Neilson, 1978).

Livestock Remedial Measures

1. Manure application guidelines such as those outlined in the Ontario Agricultural Code of Practice (1976) or the Canada Animal Waste Management Guide should be observed.

2. Manure storage capacity should be sufficient to avoid winter spreading and manure storage areas should be roofed to reduce runoff.

3. Location of new manure storage areas and feedlots should be based on considerations of local hydrology.

4. For established manure storage areas, runoff from manure piles, should be diverted or concrete tanks or retaining walls should be constructed.

5. Land application of manure should be limited to recommended levels, based on soil type.

6. Applied manure should be immediately ploughed or disced to minimize surface runoff.

7. Timing of manure application should attempt to avoid conditions that would allow drainage of manure effluent readily into natural water courses, such as during spring runoff.

8. Cattle access to streams should be prevented by fencing stream areas or pumping water to cattle.

Cropping Remedial Measures

1. Fertilization above recommended rates should be actively discouraged.

2. Improved estimates of fertilizer rates should be developed.

3. Timing of fertilizer application should be modified to reduce nutrient loss and maximize crop nutrient uptake (e.g., split application of nitrogen to corn; elimination of fall application of fertilizers; controlled release of fertilizers).

4. Techniques such as banding instead of surface broadcasting should be promoted to reduce surface runoff.

5. Different crop rotation systems should be encouraged which would reduce nutrient runoff, e.g., incorporating crops which require little or no fertilizer addition; winter cover cropping to utilize unused nutrients.

6. Crop breeding programs should be promoted to develop varieties with reduced nutrient requirements.

7. To reduce nutrient loss associated with sediment, erosion control practices such as: conservation tillage; sod-based

rotations; winter cover crops; contour ploughing and planting; strip cropping; improved soil fertility; grassed waterways; and elimination of fall ploughing should be utilized.

Neilson, (1978) also examined the farmers' receptiveness to these recommended remedial measures. This was accomplished by looking at the results of farmer attitude surveys previously conducted in the Province (i.e., by PLUARG and the Thames River Implementation Committee) as well as analyzing the results of a Grand River Basin Survey[3].

The study concluded that while a number of management methods already exist for the reduction of rural non-point source pollution, such methods are being used by a minority (10-20%) of farmers. Therefore an expanded emphasis on conservation practices by agricultural extension workers was advocated by the study. It also recommended that research be undertaken to determine the effectiveness of some of these practices and their applicability to the Grand River Basin (e.g., no tillage; slow release fertilizers).

An unusual feature of the study was that discussion centered exclusively on reducing nitrogen loadings to the basin. Nitrogen is not the nutrient, however, that most frequently causes water quality deterioration (IJC, 1978). Still, the remedial measures outlined would also decrease phosphorus and sediment inputs. Throughout the report no references were given; nor were technical reports cited. Information for the report was based on PLUARG Studies (Mason, pers. comm.).

Another technical report, Existing Water Quality Conditions, prepared by the Water Quality Subcommittee of GRBWMS included a section dealing specifically with rural non-point sources of pollution (GRBWMS, 1979). This section described the impact of rural land use on stream water quality in the Grand River basin. Rural non-point source pollutants (sediments, phosphorus, nitrogen, pesticides, heavy metals, and chemicals were discussed individually

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3 In order to verify that the results of the two previous surveys also applied to the Grand River basin, a short survey was developed by GRBWMS in conjunction with Ontario Federation of Agriculture (OFA) representatives. This survey was essentially just a shortened version of the Thames Valley Survey.

and remedial measures for each pollutant were outlined. The measures enumerated were almost identical to the ones listed in Neilson (1978). In addition to remedial measures being outlined, conservative estimates were also made of the effectiveness of such measures as crop rotation, good management practices, grassed waterways, strip cropping and spring plowing for reducing sediment loads. These estimates were determined by computer simulation - not by actual measurement. Grassed waterways and buffer strips were found to be the most effective methods of sediment control, with a predicted reduction of 40% (GRBWMS, 1979). Technical reports prepared for the PLUARG study were the source of most of the information contained in this report.

Another report, Rural Non-Point (Diffuse) Sources of Pollution[4] (GRBWMS, 1980), included an assessment of remedial measures. Essentially the same measures were mentioned. However, the report also included a discussion of their applicability and cost-effectiveness. Using information from the field surveys and aerial photography study, remedial measures that were applicable to the Grand River basin were identified. These measures, ranked in descending order of importance, were: stream stabilization, no cropping in the floodplain, fencing to restrict cattle access to streams, spring plowing, increasing the width of buffer strips and crop rotation (GRBWMS, 1980).

Based on the previously mentioned studies, the projected effectiveness of the remedial measures identified were also determined. It was estimated that sediment loads could be reduced by as much as 70% if all applicable remedial measures were implemented. The corresponding reductions in the loadings in phosphorus, metals and nitrogen were estimated at 50%, 50% and 20%, respectively (GRBWMS, 1980). In addition, the report also calculated the costs of implementing the remedial measures in the Nith River, the Contestogo River, Irvine Creek and the Middle Grand River watersheds. In terms of cost per unit watershed area, streambank stabilization and buffer strip widening were determined to be the least expensive measures, followed by

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4 The Report Rural Non-Point (Diffuse) Sources Of Pollution (GRBWMS, 1980) used in this study was a rough draft. The report was incomplete and in the process of being revised.

no cropping in the floodplain and crop rotation (GRBWMS, 1980). Upon comparing the cost-effectiveness of the applicable remedial measures it was found that streambank stabilization, no cropping in the floodplain and widening buffer strips were more cost-effective than crop rotation and winter crop cover (GRBWMS, 1980). Based on unit-cost values,it was determined that a 50% reduction in the present loadings of sediment and phosphorus would cost about $\$3.3 \times 10^6$/year and a 30% reduction would cost about $\$1.0 \times 10^6$/year (GRBWMS, 1980). The report concluded that implementation of the remedial measures should begin in the key contributing areas.

4.4 Implementation of Recommendations

Since the Grand River Basin Water Management Study has not yet been completed, a discussion of the implementation of the study's recommendations is impossible. However, the Grand River Conservation Authority (GRCA) and the Ontario Ministry of Agriculture and Food (OMAF) both offer programs, similar to the ones outlined in the Thames River and Simcoe-Couchiching basins, directed toward the reduction of non-point source pollution. The following summarizes these programs and outlines their implementation in the Grand River watershed.

4.4.1 Grand River Conservation Authority

The Grand River Conservation Authority (GRCA), a key member of GRIC, has various programs of its own designed to assist private landowners control soil erosion. The programs are comparable to those offered by UTRCA and SLSCA. These include:

a) Reforestation

Under the "Conservation Services Program", the GRCA offers two major tree planting programs:

1. Reforestation Program

   GRCA supplies men and equipment to machine plant seedlings on private land, subsidies are also given to landowners wishing to

plant their own trees. All trees are purchased by the landowner from MNR.

2. Shade Tree Program

Using stock from its own nursery, GRCA plants shade trees (4 to 6 feet in height) to provide erosion protection on farm lands.

To qualify for these programs landowners must own at least 2 acres of land. They must also sign an agreement with the Authority to protect the planting site from livestock, fire, machinery, insects, wildlife and disease for a 15-year period. All planting plans are to be drawn or approved by Authority staff.

b) Erosion Control Program

The Authority plans and carries out erosion control projects on private land. GRCA supplies men and equipment and a subsidy of 68% of the total project costs (up to a maximum of $2,000) to the landowner. This includes one year free maintenance by the Authority staff. The landowner must give the Authority a working and maintenance easement and a firm agreement regarding invoicing, maintenance and protecting the project.

A subsidy for an erosion control project is also available to landowners who wish to do the work themselves. A grant of 50% of the costs of construction up to a maximum of $1,000 can be obtained from the Authority.

Soil erosion control projects eligible for this program are: grassed waterways, gully erosion control and streambank stabilization.

c) Water Quality Improvement Program

The GRCA provides manpower and equipment to landowners interested in water quality and stream improvement projects on their land. All projects must be planned, supervised and carried out by Authority staff and equipment.

They are approved only if the plan improves the quality of the stream for fish, wildlife and water. The owner must agree to and pay 32% of the project costs. Each landowner is entitled to no more than a maximum grant of $2,000 for the total cost of any one project. The landowner must also own 10 acres of land or more.

All technical advice and technical assistance is offered to the landowner free of charge for the above programs. Applicants are handled on a first come, first served basis, subject to the budgetary limits of the Authority (GRCA, 1980). A summary of the implementation of the "Conservation Service Program" by GRCA appears in Table 7.

In Table 7 the very heavy emphasis placed on reforestation by the Grand River CA is apparent. Almost the whole of the relatively large "Conservation Services Program" budget goes toward planting trees. One forestry technician is employed full time by the Authority providing technical assistance and supervising the Reforestation Program. Response to the other programs (i.e., Streambank Erosion Control and Water Quality Improvement) is limited.

4.4.2 Ontario Ministry of Agriculture and Food (OMAF)

OMAF's programs in the Grand River basin are the same as those offered in the Thames River and Simcoe-Couchiching basins (see section 4.2.4). Emphasis is placed on education/information through the local county agricultural representative. A summary of the Ontario Farm Productivity Program for the Grand River basin appears in Table 8. Implementation of the Ontario Farm Productivity Program in the Grand River watershed varies greatly from county to county, reflecting the different land uses of the basin as well as the efforts of the local agricultural representatives in promoting the program. Manure storage projects were by far the greatest in number applying for OMAF Grants.

TABLE 7

CONSERVATION SERVICES ON PRIVATE LAND
(GRAND RIVER CONSERVATION AUTHORITY)

PROGRAM	Number of Projects		Budget ($)	
	1980	1979	1980	1979
Reforestation	100	100	50,000	28,000
Shade Tree	100	60	18,000	12,000
Erosion Control	10	2 or 3	5,000	2,000
Water Quality Improvement	1	1	1,500	1,500
TOTAL	211	164	96,500*	76,000*

* Total Budget for "Conservation Services Program" on private land includes all other programs offered as well as salaries, wages, materials, and supplies.

SOURCE: (Hurford, pers. comm.).

TABLE 8

SUMMARY OF FARM PRODUCTIVITY INCENTIVES
PROGRAM FOR THE GRAND RIVER BASIN
(1979-80)

($ = Thousands of Dollars)
(# = Number of Projects)

	EROSION CONTROL		MANURE STORAGE		ALTERNATE LIVESTOCK WATERING		EDUCATION/ DEMONSTRATION	
COUNTY	#	$	#	$	#	$	#	$
Brant	-	-	13	35.40	-	-	-	-
Dufferin	-	-	9	12.31	1	.73	-	-
Haldimand	-	-	15	43.18	-	-	-	-
Norfolk	2	2.77	11	28.25	-	-	-	-
Oxford	3	1.61	65	171.80	-	-	-	-
Perth	1	.13	79	209.42	-	-	-	-
Waterloo	3	3.42	50	99.63	-	-	-	-
Wellington	2	1.65	54	158.83	-	-	-	-
TOTALS	11	9.58	296	758.82	1	.73	0	0

Results compiled using political (i.e., county) rather than watershed boundaries, thus the data includes portions of counties outside the watershed.

SOURCE: (OMAF, 1980c).

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APPENDIX A

TERMS OF REFERENCE

STUDY OF OUT-OF-STREAM LAND TREATMENT WATERSHED MANAGEMENT TECHNIQUES

OBJECT

Under the joint direction of Environment Canada (CCIW) and Ministry of Natural Resources (CAWMB) prepare a review and analysis of available information on out-of-stream watershed management techniques. This study should use the Grand River and Thames River Basin Studies and the Simcoe-Couchiching Report as primary sources since they represent the most current multiple objective watershed planning exercises in the province which reflect PLUARG related objectives. The work should concentrate on land treatment measures in agriculture, wetland and forest management both in terms of planning and implementation where applicable.

The final report will describe available information, current research initiatives and areas of information inadequacy and deficiency with respect to the evaluation of land treatment measures for watershed planning and management.

SUGGESTED STEPS

1. Review summary Planning Document from three primary studies and other relevant information for:
   i) background to the studies; and
   ii) planning objectives.

2. Discuss the planning process and plan preparation and implementation (if applicable) with planning staff of the 3 studies. These discussions should concentrate on the identification and evalution of alternatives stage in order to determine what consideration has been given to land treatment alternatives.

3. Obtain, review and analyze appropriate land treatment technical documents which were developed during the planning process. This review should include:

   i) a description of the planning process;
   ii) an outline of how land treatment measures have been considered in plan development;
   iii) an analysis of land treatment literature and information cited and considered in plan development or implementation. In particular concentrate on:
   - conclusions that are contradictory;
   - the relevancy of the available literature to the Ontario situation;
   - identification of recent relevant information;
   - identification of proposed areas of research based on the availability or adequacy of information; and
   - applicability of plot or small basin studies to larger areas.

4. Based on the above 3 steps prepare a report which summarizes the findings with regard to those items identified in Section 3 (iii) above, for review by Environment Canada and Ministry of Natural Resources.

5. Review edited report with the 3 Basin Studies staff.

6. Revise as necessary after further discussion with Environment Canada and Ministry of Natural Resources staff.

7. Prepare final report.