

**INTERNATIONAL REFERENCE GROUP  
ON GREAT LAKES POLLUTION  
FROM LAND USE ACTIVITIES**



**INTERNATIONAL  
JOINT  
COMMISSION**

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**DETAILED STUDY PLAN  
SUPPLEMENT AUGUST 1976**

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# DETAILED STUDY PLAN SUPPLEMENT

**FROM THE  
INTERNATIONAL  
REFERENCE GROUP  
ON GREAT LAKES POLLUTION  
FROM LAND USE ACTIVITIES**

**TO THE  
INTERNATIONAL JOINT COMMISSION**

**AUGUST 1976**

SUPPLEMENT TO THE  
DETAILED  
STUDY PLAN TO ASSESS  
GREAT LAKES POLLUTION FROM LAND USE ACTIVITIES

SUBMITTED TO:

GREAT LAKES WATER QUALITY BOARD  
INTERNATIONAL JOINT COMMISSION

BY

International Reference Group on  
Great Lakes Pollution from Land Use Activities

August, 1976





INTERNATIONAL JOINT COMMISSION  
INTERNATIONAL REFERENCE GROUP  
ON GREAT LAKES POLLUTION FROM  
LAND USE ACTIVITIES



August, 1976

*International Joint Commission  
Canada and United States*

*Gentlemen:*

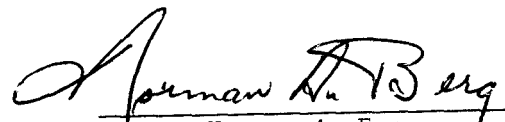
*Pursuant to Article VI, Section 1, subsection f(i) of the Great Lakes Water Quality Agreement, and with reference to Section 16 of Directive Number 2 to the Great Lakes Water Quality Board, the Reference Group on Great Lakes Pollution from Land Use Activities, having submitted its report to the Great Lakes Water Quality Board, takes pleasure in submitting a copy of the Supplement to the Detailed Study Plan to the International Joint Commission.*

*Respectfully submitted,*

*Canada*

  
Murray G. Johnson  
Chairman

*United States*

  
Norman A. Berg  
Chairman



INTERNATIONAL JOINT COMMISSION  
INTERNATIONAL REFERENCE GROUP  
ON GREAT LAKES POLLUTION FROM  
LAND USE ACTIVITIES



August, 1976

*Great Lakes Water Quality Board  
United States and Canada*

*Gentlemen:*

*The Reference Group on Great Lakes Pollution from Land Use  
Activities takes pleasure in transmitting this Supplement to the  
Detailed Study Plan to the Board.*

*Respectfully submitted,*

*Canada*

*Murray G. Johnson*  
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Murray G. Johnson  
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# TABLE OF CONTENTS

	<u>PAGE</u>
LIST OF FIGURES .....	v
LIST OF TABLES .....	vii
LIST OF PLUARG MEMBERS .....	ix
INTRODUCTION .....	1
TASK A .....	3
TASK B .....	33
TASK C .....	35
CANADIAN SECTION .....	35
UNITED STATES SECTION .....	67
TASK D .....	69
CANADIAN SECTION .....	69
UNITED STATES SECTION .....	79
MODELLING PROPOSAL .....	89
BUDGET SUMMARY .....	113





# LIST OF FIGURES

<u>FIGURE</u>		<u>PAGE</u>
1.	Interaction of the various subactivities of Task A, Activity 2.	5
2.	Funding requirements for Task A, Activity 2.	24
3.	Summary of work ongoing in the Canadian Agricultural Watersheds 1975-76.	42
4.	Flow chart for analysis of riverbank material.	65
 <u>Map</u>		
I-1	Proposed locations for public consultation panel meetings.	32
I-2	Location of Canadian agricultural watersheds.	41
I-3	Task C monitoring station locations.	49



# LIST OF TABLES

<u>TABLE</u>		<u>PAGE</u>
1.	Code numbers for Canadian agricultural watersheds.	40
2.	Task C Budget summary.	66
3.	Task D (Canadian) budget summary.	78
4.	Task D (United States) budget summary and schedule of activities.	88



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# INTRODUCTION

The detailed Study Plan for the International Joint Commission's Pollution from Land Use Activities Reference Group was published in February, 1974. Since that time, the study participants have gained a better understanding of the specific requirements needed to meet the request of the IJC to assess the degree of impairment of water quality in the Great Lakes system from Land Use Activities, and to identify the sources of this pollution and recommend practicable remedial measures. While there have been no major shifts in emphasis in the study, many refinements to the original study plan have been made. This supplement to the study plan covers those refinements and expansions. Thus, a full understanding of the work being carried out under the PLUARG programme can be gained from the February, 1974 plan and this supplement.

The PLUARG programme was originally divided into four major Tasks. The charges to these Tasks have remained unaltered. These are:

- Task A. *To assess problems, management programs and research and to attempt to set priorities in relation to the best information now available on the effects of land use activities on water quality in boundary waters of the Great Lakes System.*
- Task B. *Inventory of land use and land use practices, with emphasis on certain trends and projections to 1980 and, if possible, to 2020.*
- Task C. *Intensive studies of a small number of representative watersheds, selected and conducted to permit some extrapolation of data to the entire Great Lakes basin and to relate contamination of water quality, which may be found at river mouths on the Great Lakes, to specific land uses and practices.*
- Task D. *Diagnosis of degree of impairment of water quality in the Great Lakes, including assessment of concentrations of contaminants of concern in sediments, fish and other aquatic resources.*

# TASK A



## TASK A

*To assess problems, management programs and research and to attempt to set priorities in relation to the best information now available on the effects of land use activities on water quality in boundary waters of the Great Lakes System.*

### ACTIVITY 1

To assess the current state of knowledge relating to, and define problems associated with possible pollution of the Great Lakes arising from agriculture, forestry and other land use activities.

### METHODOLOGY

#### United States

A two volume report on this activity was produced by the Great Lakes Basin Commission under contract to EPA and the U.S. Department of Agriculture in November, 1974.

#### Canada

A collection of the Canadian work undertaken is available at the IJC Regional Office, Windsor. A summary of the Canadian and United States state-of-the-art entitled "Summary Review of Pollution from Land Use Activities" was prepared in July, 1975.

### ACTIVITY 2

A review of legislation pertinent to the land use activities under investigation. Documentation of all available remedial measures pertinent to problem areas defined by Tasks C and D. An evaluation of the efficiency and merit of the options available for remedial measures in general, as well as for the specific problems documented. Assessment of the probable cost of the remedial measures to be recommended by the Reference Group to the IJC. This activity will subsequently be integrated with Activity 5 of Task B.

The general nature of this statement and the growing concern felt by Task A members about the real potential for implementation of PLUARG's final remedial measure recommendations, has resulted in the present version of the study plan being developed.

In response to the question asked of the IJC by the two governments - "If the Commission should find that pollution of the character just referred to is taking place, what remedial measures would in its judgement, be most practicable and what would be the probable cost thereof?" the members of Task A assisted by a number of technical advisors have formulated the following study objectives and detailed plan of action.

#### Objectives

- (1) Documentation of all the remedial measures technically pertinent to the solution of the problem areas defined by the Reference Group.
- (2) Assessment of the probable cost of the remedial measures to be recommended by the Reference Group to the IJC.
- (3) Assessment of the practicability from the social perspective of those options for remedial action identified under 1 & 2.
- (4) Preparation of a final report to the Reference Group, outlining individually those options for remedial action most practicable from a technical, economic and social perspective for the solution of the problems of pollution from land use activities.

Ideally, some portions of Activity 2 should only be implemented once definite problem areas have been identified in the monitoring programs undertaken in Task C and D. However, if the reference group is to respond in timely fashion to the foregoing question asked of the IJC by the two governments, a commitment must be made to undertake some aspects of this activity in anticipation of precise problem area identification.

In an area the size of the Great Lakes Basin, 289,000 sq. miles, with a culturally diverse population of approximately 32,000,000, living under a variety of jurisdictional influences, (two federal, eight state and one provincial), the task of developing a series of practical options for remedial measure action which will be acceptable in all regions of the basin will be difficult.

In order to successfully implement this study and achieve the stated objectives, the members of Task A will have to rely on the full cooperation of the members of the Reference Group and its sub-committees. This assistance will include the early identification of apparent problem areas, and the provision of access to the forecasts of future land use patterns.

The study outline has been divided into two major components - sub-activities 2.1, an analysis of existing remedial measures and 2.2, the development of a public consultation program. Each of these sub-activities will function independently until the final stage of Activity 2 when the results from each sub-activity will be integrated in the design of the final remedial measure program (see Fig. 1).

Since the study outline is a joint endeavor (endeavour) between Canada and the United States, every attempt has been made to insure that

TASK A - ACTIVITY 2

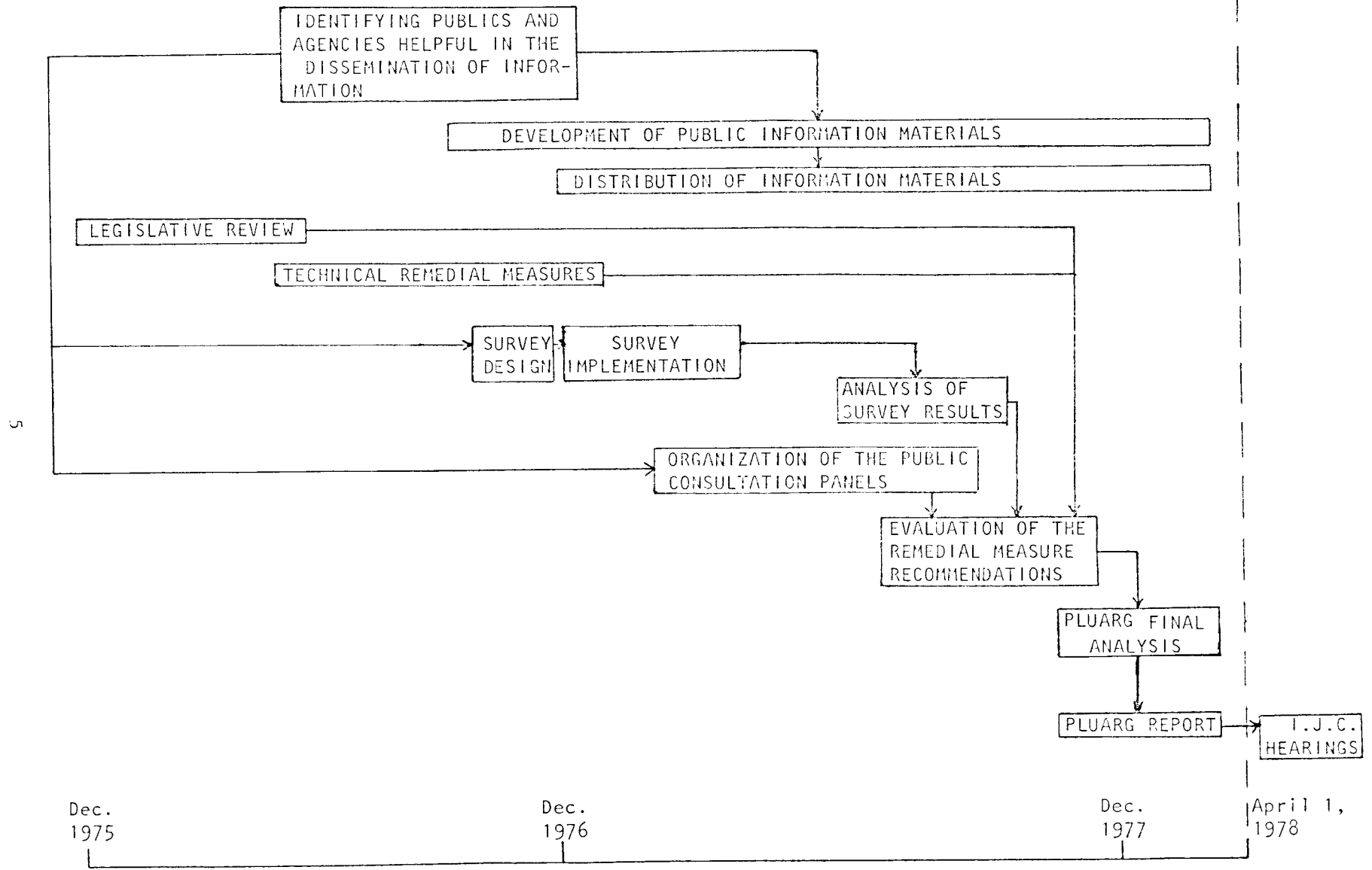


Fig. 1

the study results will be compatible between the two countries and yet useful to the solution of each country's respective problems. In many cases, the terms of reference for a given task are identical, except where some portion of the required work is already available in one country or where the different institutional frameworks require a separate approach to the solution of the problem.

As noted earlier, the members of Task A have enlisted the assistance of a number of technical advisors both in Canada and the United States to provide the necessary background for this detailed study plan. These advisors have not only made an important input to the present study design, but they will also be available to offer critical comment on the progress of each aspect of Activity 2. At present, no formal meeting arrangements have been established for these advisory committees although this situation may change as the study develops.

## Sub-Activity 2.1

### Existing Remedial Measures

#### Introduction

Before PLUARG's final remedial measure recommendations are formulated and presented to the IJC, it is essential that those persons involved in the process of selecting viable management alternatives are cognizant of all the mechanisms available for controlling pollution from land use activities. Without a clear understanding of the options available, the level of enforcement practised and the trends in management techniques, there is a very real risk of the Reference Group recommending remedial action which cannot be justified from a technical and/or fiscal perspective, and which may also be redundant due to duplication of an existing program. Therefore, prior to making remedial measure recommendations, all of these aspects must be considered if the measures are to be adopted and successfully implemented by the respective governments.

Within this sub-activity two objectives have been defined:

#### Objectives

- (1) To document all the remedial measures pertinent to the solution of the problem areas defined by the Reference Group.
- (2) Assessment of the probable costs of the remedial measures which may be recommended by the Reference Group to the IJC.

In order to facilitate the analysis of the existing remedial measures and thereby achieve the two objectives outlined above, it is proposed that this sub-activity be divided into two program areas, one consisting of a legislative review and the other comprised of a review of all relevant technical remedial measures.

### 2.1.1 Legislative Review

The legislative review portion of sub-activity 2.1 will consist of both an inventory and an evaluation phase. Both of these aspects of the review have been included, in order to attain the most realistic assessment of the present situation and the potential for future action. The inventory aspect of the study will be relatively straightforward and will rely to a large extent on existing analyses already completed. The evaluative phase of the study which is perhaps the most important in terms of structuring PLUARG's final remedial measure recommendations, will require actual contact with the persons and agencies responsible for the implementation of the existing legislation. This will undoubtedly be a more sensitive area of study and thus will require the full support of the Reference Group and the agencies represented there. The Reference Group members can also assist by acting as a liaison between the contractors and their respective agencies to help reduce any costly delays in gaining access to the relevant sources.

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Minnesota	PCA	J. Pegors

\* In the U.S., the existence of a "Memorandum of Understanding" between agencies will assist U.S. members in enlisting the cooperation of other agencies in the legislative review.

### Terms of Reference

Although areas of significant difference do exist between Canada and the U.S. in the area of regulation and enforcement of legislation and/or regulations, separate terms of reference have not been developed at this time. However, if the present terms of reference undergo some modification to make them more applicable in either country, these alterations will be minimized as much as possible. Thus, the results of each study will be comparable and in the final report the conclusions and recommendations of each study will be combined to illustrate the positive and negative aspects of the programs and procedures adopted by each country.

- 1) Describe the existing legislation/regulation framework available at each level of government (Federal, Provincial, State and Municipal) for controlling the non-point discharges of sediments, nutrients, pesticides and chemicals associated with the following land use categories: (See the "Summary Review of Pollution from Land Use Activities" for a more complete description of suspected/problem areas).
  - a) Urban Areas
  - b) Transportation Corridors
  - c) Extractive Operations
  - d) Agriculture
  - e) Recreational Areas
  - f) Forested Areas
  - g) Liquid, Solid and Deepwell Disposal Areas
  - h) Shoreline Landfilling Activities
  - i) Lakeshore and Riverbank erosion

Special reference should be made to the provisions made at the local level for controlling these potential diffuse sources of pollution.

- 2) Describe the extent of the regulatory power, the commitment to develop and undertake programs and the degree of enforcement practised at each of the three levels of government relative to pollution from land use activities.
- 3) Identify other relevant government and non-governmental programs and policies which would have a direct bearing on the control of pollution from land use activities (i.e., sediments, nutrients, pesticides and chemicals).

- 4) Identify those land uses for which the four major pollutants (sediments, nutrients, pesticides and chemicals) are least controlled.
- 5) In terms of the present jurisdictional framework outline what possibilities for future action are available to each level of government.
- 6) For each of the major land use categories outlined under (1), assess the impacts that previously implemented legislation has had on the development of this land use - consider both positive and negative factors.
- 7) Develop scenarios for the future evolution of this legislative - regulatory framework based on discussions with those persons actively working with the present framework.
- 8) Work with the other country's contractors to develop a standardized format for comparing the legislative and regulatory approaches taken in each country.

In all cases where investigation is required at the municipal level, it will only be necessary to study a sample of those municipalities located within the Great Lakes Basin. The number and location of these sample municipalities will be agreed upon between the contractor and the design authority at a later date.

\*Funding Requirements

		Canada	United States	
		76/77	FY 76	FY 77
Manpower	M.Y.	1/2	-	-
	\$	12,000	-	-
Contract	\$	13,000	20,000	20,000
TOTAL	\$	25,000	20,000	20,000

\* All funding requirements assume final completion of PLUARG activities by April 1, 1978.

2.1.2 Technical Remedial Measures

A critical area of concern in the final choice of remedial measure recommendations is the technical and economic feasibility of these recommendations. Although the Reference Group has not been charged with the responsibility of

evaluating the physical adequacy of technical remedial measures in the field, it is of critical importance to the final credibility of the Reference Group that steps be taken to insure the effectiveness of those measures recommended for adoption. Within this program area separate studies have not been proposed for Canada and the United States. However, the existing measures utilized in each country will be studied since they do reflect the different cultural adaptations which have evolved for solving specific problems. An appreciation of these variations in design may prove beneficial when the PLUARG recommendations for remedial action are developed.

This will include working closely with personnel representing those states which have made commitments to develop demonstration projects for controlling non-point sources of pollution under PL 92-500, Section 108 and those that have developed area wide waste management treatment plans under PL 92-500, Section 208. Personnel associated with the Coastal Zone Management Programs would also be included in this interchange.

It is essential in this program that personnel from the Reference Group work closely with Task A by providing information on problem areas which have been identified as apparently contributing significant levels of pollutant materials to the receiving waters of the Great Lakes. This approach to preliminary problem are identification will provide Task A with a time frame sufficient for the development of a comprehensive report of the options available to correct a given problem.

Once the technical reliability of a remedial measure has been established, an analysis of the economic implications of adopting this measure must be examined. Both the technical and economic evaluation of remedial measures can be achieved through a commitment to proceed with the terms of reference outlined below.

#### Terms of Reference

- 1) Determine from the ongoing studies in Tasks C and D what apparent problem areas have been identified.
- 2) With the assistance of Tasks C and D technical staff and other acknowledged experts working in similar fields, identify a range of remedial measures which might be undertaken to solve the apparent problems.
- 3) Through a search of the existing literature, determine what other options are available for reducing problems associated with pollution from land drainage in the Great Lakes Basin.



- 4) Identify the kinds of remedial action adopted in different countries as a result of varying cultural responses to the solution of similar problems. Emphasize those areas with similar climatic and physiographic conditions as those found in the Great Lakes Basin.
- 5) Through an analysis of existing research findings in conjunction with the technical staff of Tasks C and D, evaluate the effectiveness of the measures detailed in (2) (3) (4), both in terms of the level of pollutant reductions achieved and anticipated and the level of investment required to implement and operate either by government or by the private sector a particular control.
- 6) Assess both the direct and indirect costs associated with the implementation of these remedial measures.
- 7) Assess the cost of controlling non-point source pollution generated from specific land use activities relative to the cost estimates available for controlling pollution generated from point sources and from atmospheric inputs.

Funding Requirements

		Canada	U.S.	Canada	U.S.
		(76/77)	(FY 77)	(77/78)	(FY 78)
	M.Y.	1/2	-	1	-
Manpower	\$	12,000	-	20,000	-
Contract	\$	-	20,000	-	12,000
TOTAL	\$	12,000	20,000	20,000	12,000

Sub-Activity 2.2 Public Consultation Program

INTRODUCTION

In the past, the accepted approach to problem solving has been characterized as a system which narrowly defined problems and their solutions in terms of the special interests of the professional problem solvers involved. Today, this situation is changing and a new approach, which takes into consideration a wider spectrum of values representative of all of those directly effected by the problem and its eventual solution, is rapidly taking its place. If PLUARG were restricted to the study of a set of problems for which the proposed solutions would not produce any conflicts within the broad spectrum of society,

the need to consider the interests of people in addition to those directly involved within the study, would be unjustified. However, there seems to be a likely potential for PLUARG's final recommendations to affect the normal practices of a diverse number of people living in the basin. In addition, as the land use within the basin becomes more intensive in nature, this potential for conflict will undoubtedly increase.

The public today is much more vocal in its response to issues, and expects to play a more active role in government affairs. People are generally better informed and educated than they were twenty or even ten years ago, and also less willing to accept government edicts. The public now expects to be considered in any decision which affects them directly. This expectation has manifested itself in a variety of ways including the development of new legislation in both Canada and the United States which requires the consideration of the public's concerns. Undoubtedly, the U.S. has led the way in this direction with its tradition of "grass roots" democracy as opposed to the more tradition bound British parliamentary system adopted in Canada.

In the U.S., under several United States Federal programs, planning units at the state, regional and local levels are required to involve the public. This requirement represents an institutionalization which began in the mid-1960's and has recently intensified. Some examples of this legislative requirement follow:

Coastal Zone Management Act, Section 303. The Congress finds and declares that it is the national policy...(d) to encourage the participation of the public, of Federal, state and local governments and of regional agencies in the development of coastal zone management programs.

National Environmental Protection Act of 1969: In the action section 102, (2) (c) which requires a statement to be prepared for major federal actions, copies of the statement must be made available to the public. Procedures implementing this Act "are designed to encourage public participation in the impact statement process at the earliest possible time" (1500.9 (d) of CEQ Guidelines for Preparation of Environmental Impact Statements, FR Aug. 1, 1973).

Housing and Community Development Act of 1974, Title IV: Comprehensive Planning, requires that "each recipient of assistance...shall carry out an ongoing comprehensive planning process which shall make provision for citizen participation...where major plans, policies, priorities and objectives are being determined."

PL 92-500, Federal Water Pollution Control Act Amendments, Section 101 (e) states: "Public participation in the development, revision and enforcement of any regulations, standard, efficient limitations, plan or program established by the Administrator (of EPA) or any state under this Act shall be provided for, encouraged and assisted by the Administrator and the States."

In Canada there is also legislation available which ensures public input. The following are some examples of this legislation.

Ontario Planning and Development Act/74 Section 3 "the Minister shall establish two or more advisory committees...one of which will be broadly representative of the people of the development planning area to advise and making recommendations to the Minister".

Ontario Environmental Assessment Act/76

Section 5 Subsection

- (2) Any person may inspect an environmental assessment of an undertaking and the review thereof in accordance with the terms of the notice referred to in subsection 1 and may, within thirty days of the giving of the notice or within such longer period as may be stated in the notice,
  - (a) make written submissions to the Minister with respect to the undertaking, the environmental assessment and the review thereof; and
  - (b) by written notice to the Minister, require a hearing by the Board with respect to the undertaking, the environmental assessment and the review thereof.

Section 14 Subsection

- (2) In determining whether to give approval, given approval subject to terms and conditions or refuse to give approval to proceed with an undertaking in accordance with subsection 1, the Minister shall consider,
  - (a) the purpose of this act;
  - (b) the environmental assessment of the undertaking as accepted by the Minister;
  - (c) the submissions, if any, made to the Minister with respect to the environmental assessment.

Obviously, the involvement of the public at the stage when possible remedial measures are being identified within the Reference Group will ensure that their concerns will be better known before the implementation stage when their participation may be afforded by legislation.

Although the original PLUARG study plan did not envision as much depth in this program, there has been a growing awareness by many professionals both

within and outside the Reference Group that if we share the objective of improving Great Lakes water quality there is a definite need to adopt this approach. By involving the public now in PLUARG's deliberations the Reference Group can avoid the negative backlash which might occur later during referral for adoption and implementation by government.

There are numerous examples both in the U.S. and in Canada where costly delays and indefinite postponements of government programs and projects have occurred due to an inadequate regard for the public's concern by those involved in the original programs and/or project design, e.g. Pickering Airport, Spadina Expressway, National Pollutant Discharge Elimination System, as administered in Ohio and the decisions affecting a number of U.S. freeway systems including the Milwaukee Freeway System.

G. Almond and S. Verba (1) have expressed this need very succinctly. "Significant changes in human behaviour can be brought about rapidly only if the persons who are expected to change participate in deciding what the change shall be and how it shall be made."

No one should assume or construe that this sub-activity is an attempt to circumvent existing agencies responsible for program implementation in order to ensure adoption of our recommendations. Rather, the respective agencies will be closely involved in the deliberations. This particular sub-activity has as its primary objective the collection of information on the opinions and preferences of the public which can be considered to be data as much as the specific quantitative information collected in the Reference Group studies.

Not only does this sub-activity provide some assurance that a minimal and non-disruptive delay will be experienced in the adoption and implementation of the final recommendations by the respective governments but it also ensures that during the public hearings which the IJC plans to hold after it receives PLUARG's final report, a more positive input may be expected from the public than was evident at the hearings held at the commencement of PLUARG. Further, it provides an opportunity for the IJC to expand its information programme and enhance its credibility with the public and the media.

A successful hearing process based on a well informed public whose opinions and preference have already been considered can only add further credence to the PLUARG recommendations. If our recommendations achieve social acceptability they are also likely to be politically acceptable.

Ideally, this sub-activity should have been implemented earlier in the PLUARG program where it could have functioned as a more integrated part of the overall study. This delay may hold some negative implications for the success of this program although the positive advantages of proceeding with an abbreviated version should not be underestimated.

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1  
Almond, G., and Verba, S., "The Civic Culture" Princeton University Press, 1963.

## Objectives

- (1) To select from the wide range of remedial measures documented in sub-activity 2.1 those options for remedial action most practical from a social perspective for the solution of the problem areas identified by the Reference Group.
  - (a) To inform the public of the nature of the PLUARG study with sufficient information to enable them to make a positive contribution to the design of a remedial measure program.
  - (b) To provide interested members of the public with structured opportunities to influence and shape the formulation of the final recommendations.
- (2) To provide the members of the Reference Group with information on the public's preferences and suggestions for remedial action.

To achieve these objectives sub-activity 2.2 has been subdivided into three program areas.

### 2.2.1 Public Information Program

The first prerequisite for a successful public consultation program is an effective information program. Without a firm commitment by the members of the Reference Group to contribute to the development of such a program, the success of the later stages of this sub-activity and the IJC's final hearing process will be jeopardized.

This program must necessarily be long term in nature if a public awareness and concern is to be achieved without resorting to sensationalism in the media. Through adoption of the long term approach, the public can be made aware of suspected problem areas and the research being undertaken in PLUARG to further define these areas. As information within the Reference Group becomes more definitive, the public information program and the audience for that program will also become more specific and as the volume of information increases, a public information officer will be required in each country to conduct the information program and the consultation panels in coordination with existing information and participation programs. In the U.S. these would include, the public participation programs developed under PL 92-500, Section 208 and those programs developed within the Coastal Zone Management program. Until these personnel are required, the IJC regional office would be requested to continue to serve PLUARG information needs.

### Sub-objectives

- (1) To develop a general public awareness of the pollution problems associated with land use activities and the IJC's charge from Government.

of the Reference Group to contribute to the development of such a program, the success of the later stages of this sub-activity and the IJC's final hearing process will be jeopardized.

This program must necessarily be long term in nature if a public awareness and concern is to be achieved without resorting to sensationalism in the media. Through adoption of the long term approach, the public can be made aware of suspected problem areas and the research being undertaken in PLUARG to further define these areas. As information within the Reference Group becomes more definitive, the public information program and the audience for that program will also become more specific and as the volume of information increases, a public information officer will be required in each country to conduct the information program and the consultation panels in coordination with existing information and participation programs. In the U.S. these would include, the public participation programs developed under PL 92-500, Section 208 and those programs developed within the Coastal Zone Management program. Until these personnel are required, the IJC regional office would be requested to continue to serve PLUARG information needs.

#### Sub-objectives

- (1) To develop a general public awareness of the pollution problems associated with land use activities and the IJC's charge from Government.
- (2) To report to the public on the specific problems and impacts of pollution as identified by the Reference Group as resulting from land use activities.
- (3) To direct this information toward those publics most likely to be directly affected by PLUARG's final recommendations.

#### Terms of Reference

- (1) Identify those interest groups and governmental agencies operating public participation programs in the basin who may have an interest in PLUARG related activities.
- (2) Determine the extent to which existing agencies, organization, etc., distribute information on PLUARG related issues. Utilize wherever possible these groups for dissemination of information. (Reference Group members will be asked to cooperate in providing access to their own agencies information outlets.)
- \* (3) Prepare a series of articles dealing with land use-pollutant relationships for general distribution through existing media sources.

- (2) To report to the public on the specific problems and impacts of pollution as identified by the Reference Group as resulting from land use activities.
- (3) To direct this information toward those publics most likely to be directly affected by PLUARG's final recommendations.

Terms of Reference

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- (2) Determine the extent to which existing agencies, organization, etc., distribute information on PLUARG related issues. Utilize wherever possible these groups for dissemination of information. (Reference Group members will be asked to cooperate in providing access to their own agencies information outlets.)
- \* (3) Prepare a series of articles dealing with land use-pollutant relationships for general distribution through existing media sources.
- \* (4) As problem areas are more clearly defined prepare a series of fact sheets for distribution to selected audiences.
- (5) Prepare a social profile of the Lakes Basin population in order to identify the locations and characteristics of the various publics likely to be most affected by PLUARG's recommendations.

\* It is proposed that these information releases be screened by the contributing Reference Group member(s) and by the PLUARG editorial committee before they receive widespread distribution. Further, it is proposed that these portions of the activity be supported financially in part by the IJC in accordance with the IJC's publications policy.

To ensure that the information program is not restricted to one way communication, develop a response to public concerns expressed in the media, i.e., letters to the editor, public speaking engagements. This could be carried out most efficiently by enlisting the assistance of the various news clipping services operating within the basin.

### Funding Requirements

	Canada	U.S.	Canada	U.S.	Canada	U.S.
	76/77	FY77	77/78	FY78	78/79	FY79
M.Y.	1/2	1/2	1/2	1/2	1	1
Manpower						
	\$ 15,000	30,000	15,000	18,000	30,000	15,000
Contract	\$ -	-	-	-	-	-
Capital	\$ -	-	10,000	12,000	10,000	5,000
TOTAL	\$ 15,000	30,000	25,000	30,000	40,000	20,000

Since the benefits from this program will accrue directly to both the Reference Group and the IJC, it is recommended that this proposal be submitted to the IJC for additional funding assistance in FY 77/78 and 78/79, for approximately 30 percent of the projected costs.

#### 2.2.2 Survey

Prior to encouraging the public to contribute towards the design of the final remedial measure recommendations, there must be some assurance that the public has developed an awareness about land use-pollutant relationships. Thus, the first objective of this survey will be to determine the level of this awareness.

The second objective of this survey is to develop a means for ensuring that the attitudes and perceptions of those persons who may be unwilling or unable to participate in a more active capacity are considered in the final design of a remedial measure program. Public participation is often limited to the more vocal and active interest groups and while it is important to heed the concerns expressed by the representatives of these groups, the positions which they adopt are not always representative of the vast majority of citizens. This is especially important when dealing with those groups where voluntary implementation of remedial measures will be the only practicable solution.

The agricultural sector has been identified as one land use area where the adoption of remedial measure recommendations may continue to rely on the voluntary cooperation of the individuals involved. As other groups are identified the study requirements will be altered to accommodate them.

In both countries historical data are available on the adoption by a large number of farms of environmentally oriented remedial measures. Through a survey of the farmers who have previously been involved with programs of this nature, some new insights will be gained on the following questions:



- (1) How did the farmer become aware of the problem and why was this awareness translated into action?
- (2) Why did the farmer initially adopt the proposed remedial measures?
- (3) Why were these remedial measures maintained or rejected over the long term?

The magnitude and complexity of the Basin's population will require that further definition of the populations most directly involved in the final remedial action be made before the survey is undertaken. A stratified random sampling technique will be used with clustering to reduce travel time between interviews. The actual sample size will not be determined until the number of key variables are established. With a survey of this nature data collection will be by personal interview.

Sub-objectives:

- (1) To assess the level of public awareness of land use-water quality relationships.
- (2) To determine attitudes towards environmental concerns and willingness to participate in abatement programs.
- (3) To identify which factors have been the most important in bringing about the adoption of environmentally oriented innovations.

Terms of Reference

- (1) Select a representative sample from those publics whose direct support in implementing a voluntary remedial measure program will be required.
- (2) Determine in the sampled population the level of awareness concerning pollution problems related to land use activities. Identify those topics requiring further emphasis and those geographic areas requiring additional information coverage.
- (3) In the agricultural sector, develop a two level survey based on two samples, one comprised of individuals who have previously adopted procedures or techniques for reducing the environmental impacts of their operations and another with no bias towards the environmental awareness of the individuals involved. An attempt should be made to avoid requiring additional time and input on the part of farmers in the agricultural sub-watersheds.

- (4) Determine the level and rate of implementation of previously introduced environmental programs within the sample population. During this analysis identify those factors having an influence during all three phases of the adoption process - invention, diffusion and consequences.
- (5) Assess the attitudes of individuals towards the adoption of environmental practices and their perception of the problem.

Funding Requirements

The funding requirements outlined below include the costs incurred for the following: sample selection, questionnaire design, pretest of questionnaire, interviews and analysis of results. Final costs may fluctuate depending on the scope of the problem areas identified under Task C & D.

Personal Interview Sample Size - Can/U.S. - 1000

	Canada	U.S.	Canada	U.S.
	76/77	FY77	77/78	FY78
M.Y.	1/2	-	1/2	-
Manpower				
\$	12,000	-	12,000	-
Contract \$	30,000	45,000	15,000	-
TOTAL \$	42,000	45,000	27,000	-

Since benefits will accrue to PLUARG directly and the IJC both directly and indirectly, it is proposed that the Commission be requested to fund 25% of this activity.

2.2.3 Public Consultation Panels

The concept of public consultation panels has been included as an integral part of the public consultation program to minimize any negative reaction which could develop towards PLUARG's final recommendations when they are made public. By including this positive means for the concerned public to express concerns at the formulation stage, costly delays due to court action and demonstrations,

etc. may be minimized. The primary purpose of these panels is to bring together technical and social advice from those organizations, etc. representing the interests of those groups which stand to be directly effected by the planned remedial action.

In the previous two program areas, 2.2.1 and 2.2.2, organized under the public consultation program, most of the emphasis has been on one way communication between PLUARG and the public. The inclusion of the consultation panels insures that a two way dialogue with the public will develop. This is essential if the Reference Group members are to develop any appreciation of the concerns of the people living in the Basin. The large physical size of the Basin and the complex social, economic and physical interactions operating there will limit the representativeness of the participants contributing to the panel; however, by including as many interests as possible, a general awareness of the more important concerns will develop.

It is proposed that in the U.S., panels will be organized within state boundaries since this is the basis for program implementation, while in Canada, where there is only one province, the panels will be established on a drainage basin basis. In each country eight panels will be organized and membership will be restricted to a maximum of twenty persons per panel. Several positions will, however, be provided on each panel to encourage the participation of the general non-organized public. Participants on these panels will consist of representatives drawn from the following categories - government, environmental groups, citizen groups, agricultural organizations, professional associations and the general public, thus representing a wide spectrum of opinions.

Not only will each of the consultation panels be required to develop a consensus position on their recommendations for remedial action, but upon completion of this task, representatives from each panel will be required to meet and develop a position representative of the conclusions reached by the other panels. This requirement will have special significance in Canada where the implementation of remedial measure recommendations will be undertaken by one authority, i.e. the provincial government. Conversely in the U.S., implementation will be at the state level and thus the need for a uniform set of recommendations across the basin is not as critical. In each country the respective information officer hired under 2.2.1 will be required to attend all of the public consultation panel meetings. Discussion will be structured around identical agendas to minimize the divergence in position between panels.

As a necessary prerequisite to the implementation of this portion of the public consultation program, factual information must be made available to the panels outlining the problem areas identified in Tasks C and D, the potential for future problems outlined in Task B and the options available for remedial action developed in Task A.

Every effort must be made to develop a rapport between the Reference Group and these panels for while some Reference Group members may be skeptical about the value of including the public in their deliberations, the public may be equally uncertain as to the impact that their input may have. Without a firm commitment by the Reference Group to directly and realistically involve the public in this manner, this portion of the public consultation program will be unsuccessful.

#### Sub-objectives

- (1) To encourage the participation of interested and influential persons representative of a wide range of opinions and viewpoints in the design of PLUARG's remedial measure program.
- (2) To provide these persons with access to the validated research findings developed within PLUARG.
- (3) To provide through the public consultation panels a structured opportunity for citizens to make a positive contribution to the design of the remedial measure recommendations.

#### Terms of Reference

- (1) Identify the agencies, special interest groups, etc., that have expressed some past interest in the relationship between land use and water quality and those that would be willing to serve as members of the public consultation panels.
- (2) Clearly establish the terms of reference for these panels prior to recruiting participants.
- (3) Provide the representatives who have been elected or nominated for positions on these panels with access to the factual information developed within PLUARG.
- (4) Employ the survey data obtained in 2.2.2 as a means of insuring that the public's full interests are considered in the final choice of the remedial measure recommendations.

Funding Requirements

Funding requirement calculations include salary of the U.S. and Canadian panel staff, travel costs for participants and support costs.

		Canada	U.S.	Canada	U.S.
		76/77	FY77	77/78	FY78
M.Y.		-	-	1/2	1/2
Manpower					
	\$	-	-	15,000	15,000
*Special O&M	\$	-	20,000	20,000	-
TOTAL	\$	-	35,000	35,000	-

\*Applies to support costs for panels, e.g. travel costs for participants, meeting rooms, etc.

Since the benefits of this program will be shared by the IJC, it is recommended that the Commission receive this submittal with a request to share in funding area 2.2.3 Public Consultation.

Figures 1 (page 5) and 2 provide a summary of the temporal and fiscal frameworks in which Task A, Activity 2 will operate.

Figure 2

## FUNDING REQUIREMENTS - TASK A ACTIVITY 2

Sub-Activity	<u>CANADA</u> (\$000)		
	76/77 (April 1/76- Mar. 31/77)	77/78 (April 1/77- Mar. 31/78)	78/79 (April 1/78- Mar. 31/79)
2.1.1	25	-	-
2.1.2	12	20	-
2.2.1	15	25	40
2.2.2	42	27	-
2.2.3	-	35	-
TOTAL	94	107	40
PROPOSED IJC FUNDING	-	40	20.5
REVISED ESTIMATES	94	67	19.5
<u>GRAND TOTAL</u>			<u>180.5</u>

	<u>UNITED STATES</u> (\$000)			
	76 (July 1/75- June 30/76)	77 (July 1/76- Sept. 30/77)	78 (Oct. 1/77- Sept.30/78)	79 (Oct. 1/78- Sept.30/79)
2.1.1	20	20	-	-
2.1.2	-	20	12	-
2.2.1	-	30	30	20
2.2.2	-	45	-	-
2.2.3	-	-	35	-
TOTAL	20	115	77	20
PROPOSED IJC FUNDING	-	20	40.5	-
REVISED ESTIMATES	20	95	36.5	20
<u>GRAND TOTAL</u>				<u>171.5</u>

FUNDING BREAKDOWN, TASK A, SUB-ACTIVITY 2.2

2.2.1 Public Information. October, 1976.

76/77 1 MY, \$30,000

- Main activities will be associated with fulfilling the terms of reference 1-3.

77/78 1 MY, \$30,000

In F.Y. 77/78 the two persons working in this program area will now only devote 50% of their time to the Public Information program. The remainder with the Public Consultation Panels 2.2.3.

Capital \$20,000

This cost represents the resources needed to print and distribute an estimated 150,000 fact sheets to selected audiences. This method of information dissemination will only be used when a strong emphasis on a particular information item is required.

Cost/Fact Sheet	\$0.07	Fact Sheet
	\$0.06	Distribution

78/79 2 MY, \$60,000

This budget forecast assumes submission of the final reference group report April 1, 1978. These man years will be devoted to providing the public with further information on the PLUARG study results and recommendations. Much of this effort will be directed towards ensuring the success of the Commission's final hearing process.

Capital \$20,000 - same as 77/78

2.2.2 Survey - Personal Interview. October, 1976.

76/77 0.5 MY, \$12,000

- Determine the relevant population to be sampled - identify special characteristics of this population and the socio-economic and other pertinent factors which would ultimately affect sample design.

- Review the methodology and results of similar surveys already completed.

- Complete preliminary questionnaire design.
- Select and supervise contractor in both Canada and the U.S.

Contract \$60,000. January, 1977.

Interview @ 1,000 individuals - 500 in each country.

Cost/interview @\$90.00 part to be paid to the contractors in 76/77 \$60,000 and part in 77/78 \$30,000.

Contractors responsibilities will include the following:

- questionnaire refinement to meet the requirements of the sample population;
- questionnaire pre-test;
- sample selection - stratified random with clustering to reduce travel time and expenses - strict adherence to probability sampling techniques with a sample size of 500 calculated to yield a confidence level of 95% with a significance level of 0.05;
- training of interviewers;
- undertake interviews with at least four call backs;
- data reduction.

77/78 0.5 MY, \$12,000. April, 1977

Interpretation of findings and completion of report.

Costs could be substantially reduced for this program if the Government census groups in each country could be induced to provide assistance in carrying out the survey.



2.2.3 Public Consultation Panels. April, 1977.

1 MY, \$30,000

As indicated under 2.2.1 Public Information, this man year is comprised of two persons - one in each country devoting 50% of their time to this program and the remainder to 2.2.1.

- Establish terms of reference for the panels.
- Develop a list of potential participants through contacts with existing interest groups etc. operating in the Basin.
- Ensure that this program is closely co-ordinated and wherever possible integrated with ongoing public participation programs.

Special O & M \$40,000. October, 1977.

Eight panels for each country @ 20 persons/panel.

4 one day meetings for each panel. Total 1280 man days.

Maximum distance travelled 100 miles round trip - cost .20/mile (see Map for suggested locations of panels).

Information Materials	\$ 4,000	
Travel	25,600	
Meals	4,800	
Sub-Total		\$34,400

Final Meeting - 2 days		
Per Diem Allowance	\$ 640	
Travel Costs	1,600	
Accommodation	960	
Sub-Total		\$ 3,200

TOTAL		\$37,600
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#### Meeting #1

- Provide participants with general study background information on present PLUARG activities and the terms of reference for the panels and how these fit into the overall PLUARG framework. This will essentially be a review since the participants will have had access to this information before the meeting.
- Identification and description of specific land use pollutant problems. Task C and D personnel.
- Participants will be asked to consider these problems and to solicit ideas from their member organizations on how to deal with them.

Between Meeting #1 and #2 provide participants with any further clarification of problem areas that might be requested.

#### Meeting #2

Provide the participants with information on the legislative and technical remedial action available for implementation together with their associated costs.

#### Meeting #3

Commence discussions re the appropriate action available for correcting the problems which were identified earlier. This will require a blending of the action suggested at Meeting #2 with the recommendations generated by the groups involved in this exercise.

#### Meeting #4

Based on further discussions with their respective groups, etc. participants should be in a position to complete their final evaluation of those remedial measures available for implementation.

Prepare a final report containing their recommendations for consideration by the Reference Group and for the use of the two groups who have responsibility for developing a position representative of the conclusions reached by the eight panels in each country.

#### Meeting #5

In each country one representative from each of the eight panels will meet together to attempt to develop a consensus position concerning the recommendations developed by the panels in their respective countries.

## Task A Activity 2 External Resource Requirements

The following is a brief outline of the anticipated commitments which Reference Group members and members of their respective technical committees should be prepared to make to assist Task A in the achievement of the Activity 2 Study Objectives. It should be emphasized that these are only estimates and that at this early stage in the study, it is difficult to anticipate with complete accuracy the time requirements at this level of detail.

### 2.1.1 Legislative Review.

All Reference Group members will be requested to provide wherever possible, easy access to those persons within their agencies whom the contractors feel could provide them with information relevant to the successful completion of their task. This could be achieved either by letters of introduction or by personally introducing the contractor to the individuals involved. This should not require more than 2-3 days/Reference Group member.

### 2.1.2 Technical Remedial Measures.

All Reference Group members and contract leads for specific monitoring projects will be asked to meet individually with Task A representatives to discuss the nature of problems identified in the field and the kinds of remedial action they feel would prove suitable for the correction of the problem. This will probably require about 5-6 man-days for each individual asked to contribute. These same individuals will also be asked to review a draft copy of the final report - time of review will be dependent on the individual involved.

### 2.2.1 Public Information Program.

Reference Group members, and in particular those individuals actually working on field investigations, will be requested to spend time with the public information officer preparing articles for the public information program. These articles could take the form of news releases to newspapers, radio and television or fact sheets for distribution to selected audiences or articles for inclusion in bulletins distributed regularly by interest groups, government, etc. Depending on the nature of the article the person involved could spend 2-3 man-days in providing the information officer with the information and reviewing the final result. Members of the PIUARG editorial committee will also be requested to review these articles before release.

### 2.2.2 Survey.

At the present time, it is proposed that a select sample of individuals who have already implemented remedial measures in the agricultural sector be surveyed. In order to develop this sample, assistance will be required from individuals working with the Soil Conservation Service in the U.S. - through Norm Berg and from individuals working with the Extension Br. of Ont. Min. of Agri. and Food in Canada through Ed. Brubaker.

### 2.2.3 Public Consultation Panels.

As outlined in attachment #1 - "Funding Breakdown" Meeting #1 will emphasize land use-pollutant relationships. A good deal of planning will be required for these meetings especially between members of Task C & D and the co-ordinator of these meetings. Actual meeting time will require 16 days since there will be an identical presentation for each of the sixteen panels. Depending on the nature of the presentation one or more people could be involved from the technical viewpoint.

Background preparation of the common presentation for each panel meeting will probably require one man-month collectively from Task C & D representatives.

Actual presentation to the panel participants will require at least 32 man-days.

Additional time may also be spent after the meeting responding to specific information requests from panel members - allow approximately one man-month.

### Final PLUARG Review of Task A Report - Remedial Measure Recommendations.

- no estimate made.

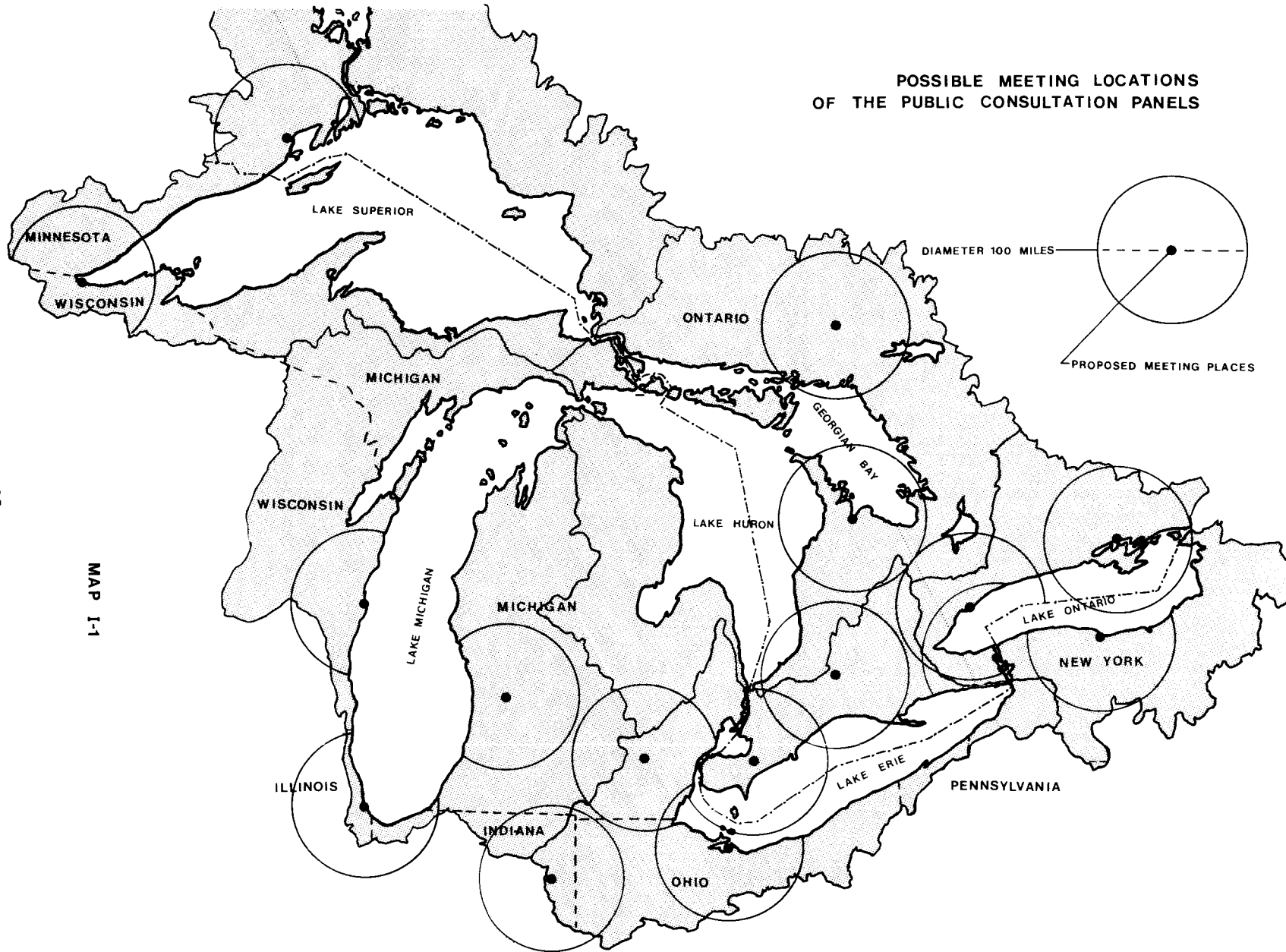
### Task A Technical Sub-committees.

Members of Task A are presently in the process of forming two more technical advisory sub-committees to provide guidance in the undertaking of the Legislative Review and the Review of Technical Remedial Measures. Members of these two technical sub-committees will be asked to provide advice on the actual means whereby the studies should be carried out and to review the study findings as they become available.

Members of the Legislative Review Advisory Sub-committee should only be required to devote about 10 man-days in 1976 to fulfill

their obligations. Due to the longer study period involved, members of the Technical Remedial Measures Advisory Subcommittee will be required to spend approximately 10 man-days in 1976 and an additional 10 man-days in 1977. Only a part of this time commitment will be spent in actual meetings while the remainder will be taken up in reviewing and commenting on the study findings as they become available.

POSSIBLE MEETING LOCATIONS  
OF THE PUBLIC CONSULTATION PANELS



# TASK B

## TASK B

*Inventory of land use and land use practices, with emphasis on certain trends and projections to 1980 and, if possible, to 2020.*

All activities undertaken on both the United States and Canadian sides have been completed, and publication of the United States Task B output is expected within the next year. Canada is currently determining the possibility of altering the format of its output to follow the United States format of a basin by basin report. A supplementary report on Materials Usage in the United States Great Lakes Basin was published in September, 1975.

Critical management practices will be inventoried if Task C feels that such practices are contributing to identified pollutant loads to the watersheds.



# TASK C

## TASK C

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

### CANADIAN SECTION

#### INTRODUCTION

From an evaluation of preliminary, extensive water quality monitoring during 1974, sites were selected within the three major pilot watersheds in Canada for the study of a variety of land uses. The major watersheds, the Grand, Saugeen and Wilton are described in the PLUARG Detailed Study Plan. Additional sites for the study of agricultural land uses not adequately represented in the major basins were selected in sub-watersheds of other basins. Detailed studies were initiated in the major and minor basins in 1975 and are to be continued through the 1977 spring runoff period.

During the period April 1977 to March 1978, efforts will be focussed on information synthesis, data integration, and the prediction of loadings and relative impacts from land uses and management practice throughout the Great Lakes basin for present and selected options of future conditions. Evaluations of remedial measures will be intensified in co-operation with investigators from other PLUARG tasks and emphasis will shift from specific studies to the broad PLUARG charge.

The program follows the general outline of the PLUARG Detailed Study Plan, February, 1974. Information is summarized below, by activity, on studies initiated during 1975-76 on those to be conducted during 1976/77, and on the arrangements for the comprehensive analyses planned for 1977/78. Budget estimates for supplemental PLUARG funding during 1976/77 and 1977/78 are given in Table 2.

## ACTIVITY 1 - Agricultural Watershed Surveys

### OBJECTIVES

The objective of the agricultural surveys and studies is to obtain data on the inputs of pollutants into the Great Lakes Drainage System which have their origins in the complex land use activities known as Agriculture, and to provide information and insight on practicable remedial measures for any significant pollutant sources.

During the preliminary phase of the Task C Agricultural Watershed Study, 1974-75, it was concluded that, in order to meet the overall objectives of PLUARG, continuation of this study should consist of a broader monitoring network program (Phase I) and a detailed study program (Phase II). This would be followed by a third phase to consider future requirements. The following objectives were defined:

#### Phase I (Monitoring Program):

To measure the ambient concentration and loading rates for various potential pollutants that occur with agricultural land use.

#### Phase II (Detailed Studies Program):

- 1) To determine the effects of the soil, land use and associated practices on ambient concentrations and loading rates of selected pollutants from agriculture.
- 2) To derive information on the mechanics of transport and storage of these pollutants within the selected agricultural watersheds.
- 3) To develop relationships so that the information derived can be utilized in a predictive sense and extrapolated to other areas.

#### Phase III (Future Requirements):

To develop recommendations for improvements and remedial measures where significant problems are identified.

### GENERAL METHODOLOGY

Information collected during the preliminary phase (outlined in the PLUARG Detailed Study Plan) formed the basis for the development of the continuing phases of the Agricultural Watershed Studies. Eleven agricultural watersheds were selected for inclusion in the monitoring phase, and six of

these were selected as sites for the detailed studies (Table 1 and Map I-2). The preliminary phase, 1974-75, including the watershed selection process, has been reported in detail in "Agricultural Watershed Studies, Great Lakes Drainage Basin, Canada, Annual Report, 1974-75". A program co-ordinating studies by government agencies, universities and consultants was designed to meet the objectives and is outlined in Figure 3.

#### SUMMARY OF INVESTIGATIONS

The investigations included in the program phases initiated April 1975 have been outlined in detail in "Agricultural Watershed Studies, Great Lakes Drainage Basin, Canada, Detailed Study Plan, 1975-76". A brief summary of the components follows:

## 1975/76 and 1976/77

A monitoring program, covering precipitation (Project 6A, University of Windsor), stream flow quantity and stream quality (Projects 2 and 3, Ontario Ministry of the Environment, Agriculture Canada; Project 4, Ontario Ministry of Agriculture and Food), is being carried out on eleven small agricultural watersheds representative of identified "agricultural regions". An inventory of land use practices is being carried out on these watersheds (Project 5, Ontario Ministry of Agriculture and Food).

For the six watersheds included in the Phase II Detailed Studies, precipitation quality is being determined (Project 6B, University of Windsor). A detailed soil survey is being carried out over a two-year period on these watersheds (Project 7, Ontario Soil Survey). A study on the nature and enrichment of pollutants in agricultural watersheds involves a mineralogical, physical, organic, trace elemental and nutrient characterization of suspended and bottom sediments (Projects 8 and 9, Agriculture Canada, Guelph-Ottawa). These programs are co-ordinated to allow assessment of the relationship of pollutants in the sediments and in the soils. The latter study forms part of an integrated program on agricultural sources, transport and storage mechanisms of metals (Project 9, Agriculture Canada, Harrow and Ottawa).

The study of livestock operations is included in two special studies: the study of pollutant transport to sub-surface and surface waters in an integrated farm operation on the Greenbelt farm of the Animal Research Institute (Project 22, Agriculture Canada); and the study of runoff from cattle feedlots and cattle manure storage areas at four sites in southwestern Ontario (Project 21, Agriculture Canada). An additional study on surface transport of nutrients with emphasis on livestock operation areas is being conducted by BEAK Consultants Ltd. (Project 20).

Several studies being done on two Essex County watersheds have been co-ordinated to form an integrated program for these watersheds. These include the study of sources of nutrients and heavy metals (Project 10, Agriculture Canada, Harrow); the study of the transformation and transport of nitrogen and water in agricultural soils (Projects 11, 12 and 13, Agriculture Canada, Ottawa); and the study of the role of the groundwater flow regime in the transport of nitrates to streams (Project 14, University of Waterloo).

An integrated program on surface sources and flow paths for pollutants from agricultural land includes: surface runoff from small agricultural watersheds (Project 15, University of Guelph); erosional losses from agricultural land (Project 16, University of Guelph, Agriculture Canada); transport of fluvial suspended sediments from agricultural land (Project 17, University of Guelph); and the contribution of phosphorus from agricultural land to streams by surface runoff (Project 18, University of Guelph).

A comparison of the nutrient budget of an agricultural stream and a relatively undeveloped stream is being made. This includes nutrient transport and transformation (Project 19A, University of Guelph) and a 1975 field season study of secondary production and organic drift (Project 19B, University of Waterloo).

Co-ordination and implementation of this program is a joint Ontario Ministry of Agriculture and Food, Agriculture Canada, and Ontario Ministry of the Environment endeavour.

#### 1977/78

During 1977/78, selective monitoring and special studies will be continued to investigate specific problems for which the Phase I and Phase II studies have not yielded an adequate understanding. Information from the PLUARG studies, other relevant investigations, and the literature will be synthesized by agency personnel and contractors to provide answers on the extent of pollution from agricultural sources and practicable remedial measures. Staff will be assigned to the application of unit loading and regression models to calculate pollutant discharge to the Great Lakes under different land-use and management practices, co-operatively with other PLUARG investigators.

#### PARTICIPATING AGENCIES

Agriculture Canada

Ontario Ministry of Agriculture and Food

Ontario Ministry of the Environment

Beak Consultants Limited

University of Guelph

University of Waterloo

University of Windsor

Table 1

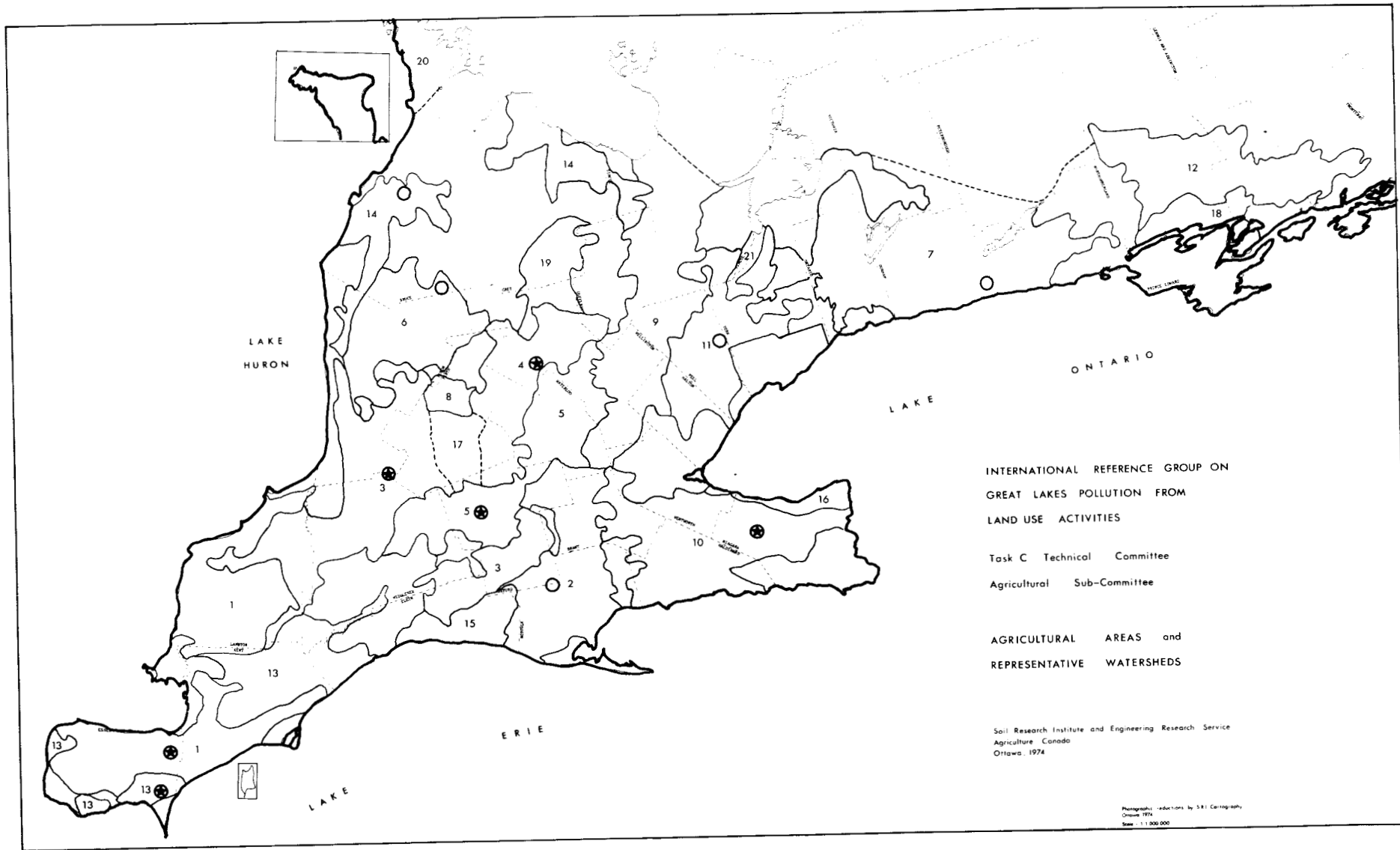
A. AGRICULTURAL WATERSHEDS - PHASE I (MONITORING PROGRAMME)

(For locations, see Map I-2)

- AG- 1 Big Creek Tributary of the Thames River (Essex County)
- AG- 2 Venison Creek Tributary of Big Creek (Norfolk County)
- AG- 3 Upper Little Ausable River (Huron County)
- AG- 4 Upper Canagagigue Creek (Wellington and Peel Counties)
- AG- 5 Holiday Creek tributary of the Middle Thames River (Oxford County)
- AG- 6 Unnamed tributary of the Maitland River (Huron and Wellington Counties)
- AG- 7 Shelter Valley Creek (Northumberland County)
- AG- 10 North Creek Branch of Twenty-Mile Creek (Lincoln County)
- AG- 11 Salt Creek tributary of the West Humber River (Peel County)
- AG- 13 West Branch of Hillman Creek (Essex County)
- AG- 14 Upper Mill Creek, tributary of the Saugeen River (Bruce County)

B. AGRICULTURAL WATERSHEDS - PHASE II (DETAILED STUDIES)

- AG- 1 Big Creek Tributary of the Thames River (Essex County)
- AG- 3 Upper Little Ausable River (Huron County)
- AG- 4 Upper Canagagigue Creek (Wellington & Peel Counties)
- AG- 5 Holiday Creek tributary of the Middle Thames River (Oxford County)
- AG- 10 North Creek Branch of Twenty-Mile Creek (Lincoln County)
- AG- 13 West Branch of Hillman Creek (Essex County)



**MAP I-2: AGRICULTURAL WATERSHEDS - TASK C (CANADIAN SECTION) - PLUARG**

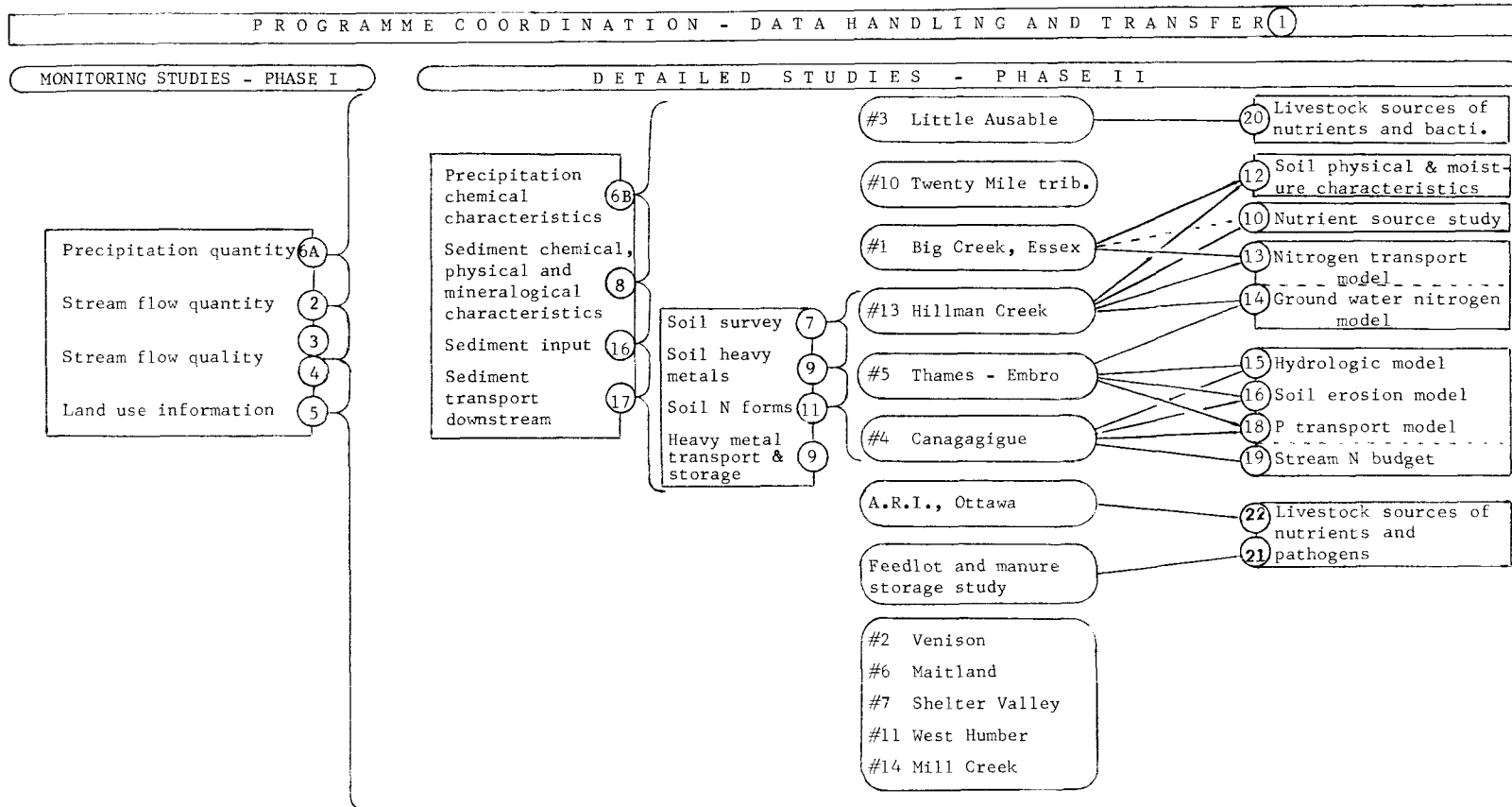
○ PHASE I (Monitoring Study)

● PHASE II (Detailed Studies)



Figure 3

INTERNATIONAL REFERENCE GROUP ON GREAT LAKES POLLUTION FROM LAND USE ACTIVITIES, I.J.C., TASK C, CANADA, AGRICULTURE, 1975 - 76



## ACTIVITY 2 - Forested Watershed Surveys

### OBJECTIVES

To determine the effect that various forest management practices may have on streamflow quality, quantity and timing; groundwater quality and fluctuations; snow pack distribution; and erosion rates.

### NORTHERN ONTARIO WATERSHEDS

Studies by the Great Lakes Forest Research Centre, carried out in the Winnipeg River drainage basin in Northwestern Ontario, will be applied in determining the impact of forestry activities on water quality in Precambrian watersheds with boreal forests.

The Canadian Shield is an extensive area of Precambrian rocks covering approximately 50 percent of the total area of Canada and 60 percent of the surface of Ontario. Another important fact is that Shield areas contribute at least half of the water volume for the Great Lakes-St. Lawrence system.

The friable soils, rugged topography, and remarkably pure water production have resulted in the area being described as one of the most "fragile" of the Shield environments. The area has the climatic, edaphic and vegetation characteristics that would encourage elemental loss from the ecosystem if there is any impact due to forest harvesting. Clear-cutting and scarification are commonly used management practices in the area which allow evaluation of their impact on the environment.

### Method of Investigation

In order to obtain some information on forest management impacts in a restricted time frame the traditional approach of paired catchments was avoided. Instead, a proposal to monitor catchments which had already been treated along with some untreated catchments and use a one-way analysis of variance to test the mean output from each catchment was adopted.

In 1972 twelve small catchments varying in size from 40 to 660 hectares (90 to 1600 acres) were selected. Conditions on these catchments consisted of uncut, one-year-old cuts, and about three-year-old cuts. In addition, records are available for six other uncut catchments from a contract study by the University of Manitoba. By 1975 all twelve of the catchments will be cut and the six reserve (uncut) catchments will be used for baseline comparison.

Parameters Measured:

- Nutrients: Ammonia Nitrogen, Nitrate Nitrogen, Total Dissolved Nitrogen, Suspended Nitrogen, Total Dissolved Phosphorus, Suspended Phosphorus.
- Minerals: Chloride, Sulphate, Silicon, Sodium, Potassium, Magnesium, Calcium, Total Iron.
- Physical: Turbidity, Conductivity, Temperature (present, weekly maximum and minimum), pH, streamflow, rainfall, spring snow pack.
- Organic: Dissolved Organic Carbon, Suspended Carbon.

Time Schedule

1976/77

The monitoring program will be completed during the summer of 1976, and a major report will be prepared.

1977/78

Any required revisions to reports will be made, and expert advice will be provided on the application of the results to the Great Lakes basin.

SOUTHERN ONTARIO WATERSHEDS

To provide additional information on forested areas and land management effects, two preliminary projects are planned for southern Ontario watersheds.

1. To assess water quality from an undisturbed, primarily forested watershed for the purpose of providing specific information on background levels from this land use in southern Ontario.  
During 1976/77 water quality samples will be collected from a stream located in a forested area of the Six Nations Indian Reserve in the Grand River watershed.
2. To assess the effects of forest pesticide spraying on the water quality of some streams discharging to the Lower Lakes. If pesticide spraying is carried out in southern Ontario during 1976, suitable sites will be sought on several streams for sampling both prior to spraying and at short intervals after spraying.

PARTICIPATING AGENCIES

Environment Canada, Great Lakes Forest Research Centre

Ontario Ministry of the Environment

Ontario Ministry of Natural Resources

ACTIVITY 3 - Study of Pollution and Adequacy of Controls Related to Urban Land Development and Use, Transportation and Utility Systems, Sanitary Landfills, Processed Organic Waste Disposal, Extractive Industries, Private Waste Disposal, Recreational Land Use, Wastewater Lagoons and Irrigation Systems, and Land Filling

GENERAL OBJECTIVES

1. To determine the levels and quantities of major and trace constituents, including nutrients, pesticides and sediments, reaching the Great Lakes or moving in flow systems likely to reach the Great Lakes in the future by studying selected operations of the land use activities outlined above in representative basins or areas and extrapolating the results to provide estimates for other areas of the Great Lakes basin.
2. To determine the adequacy of existing control measures related to the above sources of pollution and develop recommendations for improvements and remedial measures as needed.

GENERAL METHODOLOGY

Unlike natural watersheds, the study areas being investigated under Activity 3 do not form independent hydrologic units where water quality and quantity can be measured at the watershed outlet. For Activity 3 studies, it is necessary to monitor each inflow point individually, as well as the outflow point, since most study areas are not situated at the heads of watersheds. The inflow (upstream) monitoring will provide data on the dilution ratio, inflow hydrograph characteristics and background concentration of water quality parameters. The difference between the loading of water quality parameters monitored at sites located upstream and downstream of the study area should provide a measure of the contribution of pollutants from the land use under study.

In order to assist in the accomplishment of the general objectives, the following projects have been identified:

1. All Watershed Studies -
  - (a) The establishment of upstream and downstream water quality monitoring stations to identify the sources of pollution and their relative importance in affecting the water quality of receiving waters.
  - (b) The measurement of the concentration and potential of pollutants (on the receiving waters) which occur as a result of the individual land uses under study.

- (c) The development of relationships between the data which can be used for extrapolation purposes.
  - (d) The identification of existing pollution control measures and the development of recommendations for their improvement.
2. Urban Studies -
- (a) The evaluation of the relative contribution of pollution from storm runoff, sewerage collection and treatment facilities of varying sizes including non-sewered areas.
3. Transportation and Utility Studies -
- (a) The evaluation of the relative contribution of pollution from different sizes and types of transportation and utility systems in relation to various maintenance and construction activities.
4. Sanitary Landfill Studies -
- (a) The determination of the amount of leachate production, its composition, the pattern of migration and the degree of attenuation by the materials through which the leachate is transported.
  - (b) The determination of whether or not changes occur in leachate production, composition, migration and attenuation as the age of the refuse increases and the site becomes stabilized.
5. Processed Organic Waste Disposal Studies -
- (a) The investigation of the effect of sewage sludge application on agricultural land surface and to ground water quality.
  - (b) The examination of the effect of a grass border around a sewage sludge-laden field in reducing the pollutional load from surface runoff.
6. Extractive Industry Studies -
- (a) The determination of whether or not quarry lakes and settling ponds are causing impairment to surface and ground water quality.
7. Private Waste Disposal Studies -
- (a) The determination of the movement of pollutants from septic tank installations.
  - (b) The compilation of information on existing private waste disposal systems.

## SPECIFIC LAND USE STUDY PLANS

The locations of sites and monitoring stations operated for specified land uses during 1975-76 are shown on Map I-3.

### Urban Land Use

The areas being investigated during 1975-76 and 1976-77 are listed below:

#### Grand River Basin:

- (1) The Kitchener-Waterloo-Cambridge urban area (approximate population 230,000, both fully separated and combined systems).
- (2) The City of Guelph (population 64,000, fully separated systems).
- (3) The Town of New Hamburg (population 3,000, fully separated system).

#### Saugeen River Basin:

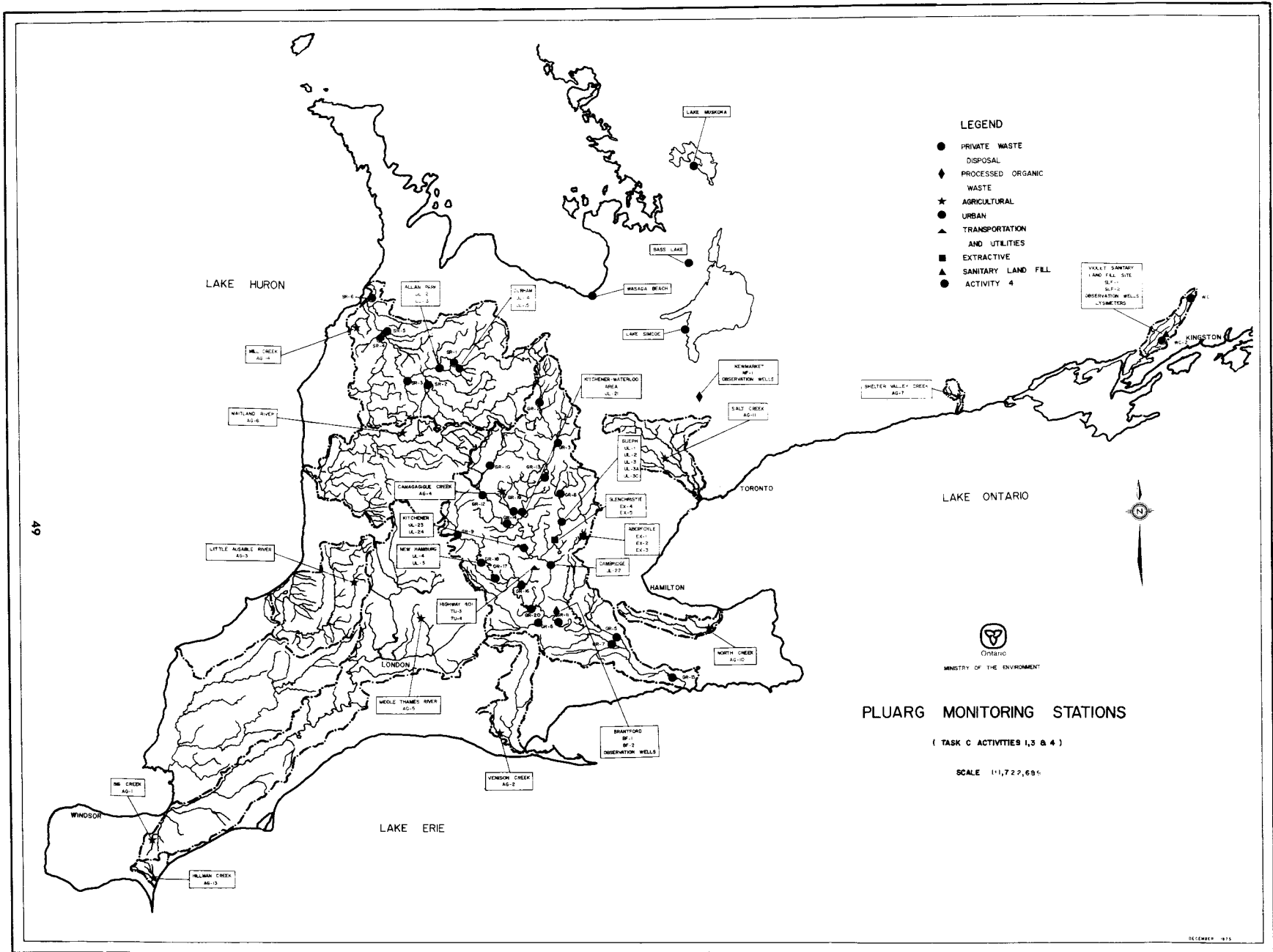
- (4) The Town of Durham (population 2,500, 99% separated, 1% combined system).
- (5) The community of Allan Park (population 100, septic tank system).

During 1976/77, two small watersheds draining urban areas in Kitchener will be monitored in detail, to provide information from areas free of non-urban influences. Monitoring will be reduced in frequency or discontinued at the Towns of New Hamburg and Durham and the community of Allan Park.

### Transportation and Utility Systems

Recent Task A reports have suggested that railroads are not a significant source of pollution to the Great Lakes and, as a result, the study of that particular land use has been assigned a low priority in the Activity 3 program. Other studies which are either proposed or presently under investigation are as follows:

- (1) Construction of the Sarnia to Montreal pipeline (as construction plans are finalized).
- (2) The maintenance of Hydro rights-of-way in the Guelph area (the feasibility of conducting a study is still being investigated).
- (3) Highway 401 near Kitchener (major highway maintenance, presently under study).





## Sanitary Landfills

### 1. Study 1

Location: Violet

General Description: The sanitary landfill site is located in the Wilton Creek Basin and occupies an area of approximately 25 acres, one quarter of which has been or is now being filled with refuse. The site was originally used as a sand and gravel pit. In places where all the overburden has been removed, refuse is being placed directly on limestone bedrock.

Instrumentation and Monitoring:

Precipitation: A MSC tipping bucket rain gauge is located near the site.

Water Quantity: An MOE streamflow gauge is located on Wilton Creek downstream of the study area. Static ground-water levels are obtained from 49 observation wells located in or near the site. One of these is monitored by a continuous water level recorder. Infiltration measurements are obtained from two types of lysimeters.

Water Quality: Manual samples of surface water are taken upstream (SLF-1) and downstream (SLF-2) on Wilton Creek. Samples of ground water are withdrawn from the observation wells by bailer. A continuous conductivity recorder monitors one of the wells within the contaminant plume.

### 2. Other Studies Related to Sanitary Landfill Sites

#### (i) Contaminant Migration from Five Ontario Sanitary Landfill Sites

Five sanitary landfill sites are being investigated by consultants under contract to Environment Canada. The sites are Brantford, Preston, and Paris in the Grand River basin, Hanover in the Saugeen River basin, and Mississauga in the Lake Ontario drainage basin.

#### (ii) Soil-Waste Interactions

The Waterloo Research Institute under contract to Environment Canada is investigating the attenuation and desorption of several different types of industrial wastes with three different soil types.

#### (iii) Industrial Waste Characterization Studies

Seven contracts have been awarded by Environment Canada to consultants to characterize wastes from various industries which are eventually disposed on land.

(iv) Leachate Contaminant Attenuation Study

Under contract to the Ontario Ministry of the Environment the Waterloo Research Institute is investigating the leachate attenuation capacity of different types of soil. Field studies at the Fergus-Elora Sanitary Landfill Site are being carried out to corroborate the laboratory investigations.

## Processed Organic Waste Disposal

### 1. Study 1

Location: Brantford, adjacent to the Brantford water pollution control plant and sanitary landfill site.

General Description: The site is located in the Grand River basin and covers a 40 acre section of a farm. The farm has been in continuous corn production for at least the past 10 years. Digested sewage sludge, from the Brantford pollution control plant, was applied to the study field for the first time in the fall of 1974. Sewage sludge will be applied in the fall of each year for the duration of the study. The land is gently rolling with a soil of sandy-loam texture.

Instrumentation and Monitoring:

Precipitation: A MSC tipping bucket rain gauge is located at the Brantford pollution control plant.

Water Quantity: Surface runoff is measured at each of the two sub-areas by a continuous flow recorder in conjunction with an H-type flume. Ground-water levels are obtained from a total of seven piezometer nests. Each piezometer nest consists of a water-table well and an intermediate depth well. Sub-surface discharge from a tile drainage system is measured manually with a collection container and stop watch.

Water Quality: Samples of surface water runoff are taken at each sub-area by an automatic sampler. Ground water is sampled from the test wells manually with the use of a bailer. Sub-surface discharge from the tile system is sampled manually.

Other: Samples of sewage sludge, soil and vegetation are collected manually as required throughout the study.

### 2. Study 2

Location: Regional Municipality of York, approximately seven miles northeast of the Newmarket water pollution control plant.

General Description: The site is located adjacent to the Black River and covers an eight acre section of a farm. The farm has been in continuous crop production for at least the past ten years. Sewage sludge will be applied in the fall of each year for the duration of the study. The land is undulating to rolling with a soil of sandy-loam texture.

#### Instrumentation and Monitoring:

Precipitation: An AES precipitation station is located at Sharon, 3 1/2 miles from the study site.

Water Quantity: Surface runoff is measured at the study site by a continuous flow recorder in conjunction with a Parshall flume. Ground-water levels are obtained from a total of five piezometer nests. Four of the piezometer nests consist of a water-table well and an intermediate depth well. The fifth nest consists of a shallow well, a water-table well and an intermediate depth well.

Water Quality: Samples of surface water runoff are taken by an automatic sampler. Ground water is sampled from the observation wells with a bailer.

Other: Samples of sewage sludge, soil and vegetation are collected manually as required throughout the study.

### 3. Other Studies Related to Land Disposal of Sewage Sludge

Under Canada-Ontario Agreement funding, considerable research work is being carried out in the area of land disposal of sewage sludge.

The following is a list of ongoing research projects:

#### A. Environment Canada Internal Research Projects

- (i) Environmental Effects of Chemical Sewage Sludge Disposal on Land - Lysimeter Studies.
- (ii) Biochemical Characterization of Digested Chemical Sewage Sludges.
- (iii) Sampling Methodology Development for Investigation of the Variability of Sewage Sludges.

#### B. Canada-Ontario Agreement External Research Projects

- (i) An Examination of Sewage and Sewage Sludge for Enteroviruses; by Central Public Health Laboratory, Ontario Ministry of Health.
- (ii) Heavy Metals in Agricultural Lands Receiving Chemical Sewage Sludges; by Institute of Environmental Sciences and Engineering, University of Toronto.
- (iii) Land Disposal of Sewage Sludge; by University of Guelph.
- (iv) Characterization of the Behaviour of Chemically Precipitated Sludges in Soils; by Soil Research Institute, Canada Department of Agriculture.

### Extractive Industries

For the 1975/76 and 1976/77 field season two sites are being studied which incorporate treatment of waste discharges (primarily settling ponds). The sites, which are in the Grand River basin, are as follows:

- (1) Sand and gravel pit operations at Aberfoyle, Ontario, and
- (2) A limestone quarry and lime plant at Glenchristie, Ontario.

Existing information from river monitoring and environmental study programs in the Sudbury area will be examined during 1976/77 to determine if any specific investigations of metal mining operations should be initiated in 1977/78.

## Private Waste Disposal

The Ministry of the Environment investigated pollutant transport from private waste disposal systems at five sites during 1975/76.

### 1. Study 1

Location: On Georgian Bay near Wasaga Beach.

General Description: The study consists of a house and four cottages underlain by a uniform fine sand deposit. There is a group of three septic tank-tile field systems which are more than 10 years old and located about 100 feet from the lake. One of the three field systems is connected to the year round dwelling and two cottages.

Instrumentation and Monitoring:

Water Quantity: A number of ground water observation wells have been installed for this purpose.

Water Quality: Water quality samples are obtained from observation wells by pumping.

### 2. Study 2

Location: On Georgian Bay near Wasaga Beach about 0.6 miles from Study 1 location.

General Description: The study consists of a house connected to a septic tank-tile field system which is about four to five years old. The system is installed in a uniform sandy soil deposit similar to the Study 1 location.

Instrumentation and Monitoring:

Similar to Study 1 location.

### 3. Study 3

Location: On Bass Lake, a few miles west of Orillia.

General Description: The study consists of a house with a tile field system about 11 years old. The system is installed in a deposit of silty sand, approximately nine feet in thickness overlying clayey silt.

Instrumentation and Monitoring:

Similar to Study 1 location.

4. Study 4

Location: On Lake Simcoe, approximately 10 miles south of Barrie.

General Description: The study consists of a house with a tile field system which is about 17 years old. The site is underlain by a deposit of sandy silt extending to a depth of about eight to nine feet. A layer of clayey silt underlies the sandy soil, but its thickness was not determined at the time of field investigation.

Instrumentation and Monitoring:

Similar to Study 1 location.

5. Study 5

Location: On Lake Muskoka, about 10 miles north of Gravenhurst.

General Description: The study consists of a house and septic tank tile field system installed in a raised sand bed on granite outcrop.

Instrumentation and Monitoring:

Shallow well points have been installed to collect water samples in the thin soil mantle above the granite outcrop. In addition, trough structures have been constructed to collect surface runoff for water quality analysis.

An inventory was commenced of information on the number and locations of private waste disposal systems in selected basins and will be continued during 1976/77.

Sampling will be undertaken during the spring of 1976 at some of the sites studied in 1975 to check for seasonal variations of the quality of ground water. Suitable locations for the study of septic tank tile field systems installed in silty and clayey soils will be selected and instrumented for investigation during 1976 and 1977.

### Recreational Land Use

Results from on-going studies by the Ministry of the Environment and the Great Lakes Forest Research Centre will be utilized in assessing the effects of recreational land use on water quality.

1976/77

A study of the effects of recreational camping on soil and vegetation in the Experimental Lakes area in the Winnipeg River drainage basin will be completed by the University of Guelph for Environment Canada. Analysis of the effects on water quality there will be based on samples collected by the Great Lakes Forest Research Centre in 1975.

### Wastewater Lagoons and Irrigation Systems

Available information from inventories and completed studies will be utilized in estimating the significance of pollution loads from municipal and industrial wastewater lagoons and irrigation systems.

### Land Filling

Results of on-going monitoring for suspended sediment by the Metropolitan Toronto and Region Conservation Authority near land filling sites along the Toronto waterfront will be utilized with other existing information in assessing the effects of land filling.

### PARTICIPATING AGENCIES

Environment Canada

Ontario Ministry of the Environment

Hydrology Consultants Limited

University of Guelph

University of Waterloo



## ACTIVITY 4 - Water Quantity and Quality Monitoring Framework

### OBJECTIVES

The objectives of this activity are to determine the levels and quantities of major and trace constituents, including nutrients, pesticides and sediments, reaching the Great Lakes or moving in flow systems likely to reach the Great Lakes in the future by sampling surface and ground waters and operating streamflow gauging networks.

### PROJECTS

The following projects have been identified as being necessary for the achievement of the Activity 4 objectives:

1. Extensive Surveillance Network -
  - (a) The identification of significant land-use activities that have an effect on water quality in the pilot watersheds by operating a network of water quality and quantity monitoring stations.
  - (b) The examination of land-use information and water quality data obtained from Activities 1, 2, 3 and 6 studies and the Activity 4 network to obtain information about the mechanism of pollutant transport and storage, and land use/water quality relationships over the Great Lakes Drainage Basin.
  - (c) The determination of the total loadings to the Great Lakes from the pilot watersheds as accurately as possible, and the evaluation of different methods of calculating loadings by monitoring water quantity and quality continuously at the mouths of the pilot watersheds.
  
2. Intensive Studies Program -
  - (a) The examination of the time-variant nature of pollutant loading during storm and snowmelt events.
  - (b) The improvement of water quality sampling accuracy by testing alternative sample collection and handling techniques.
  - (c) The measurement of changes in the nature and loadings of pollutants during transport through stream reaches by co-ordination with other Ministry of the Environment survey programs.

### Network Stations

The streamflow and water quality stations operated during the 1975/76 field season and forming part of the PLUARG network are listed in Appendix 1. There were 47 streamflow and 62 quality stations in March, 1976.

### Special Projects

Special projects contributing to the objectives are described below.

### Identification of Sinks or Sources of Pollutants

Data obtained from the network of water quality and quantity monitoring stations in the pilot watersheds will be analysed for the purpose of identifying pollutant sinks or sources within each watershed. Continuous water-quantity data, routine water quality data, and land use data are the basic manipulative elements in the computational procedures.

### River Mouth Loadings

Monitoring sites have been selected as close as possible to the mouths of the rivers of the three pilot watersheds—Grand River, Saugeen River and Wilton Creek. Data obtained from these sites will be used in computation of the following:

- (a) Loadings to the Great Lakes at the respective stations,
- (b) A check on the various methods of loading calculations and their accuracies,
- (c) A check on extrapolative techniques relating loadings to land use within these basins.

Daily samples of water quality are being taken and continuous discharges will be synthesized as necessary from neighbouring water-quantity stations because of the difficulty and expenses in gauging the wider sections of these rivers at their mouths. Data obtained from the networks established under Activity 3 in the pilot watersheds will be used in conjunction with data from the river-mouth monitoring to attempt extrapolative analyses.

### Event Sampling

The concentration of a water-quality parameter varies with time, space, and flow. Preliminary results have indicated a great variability for some parameters during storm and snowmelt runoff events. Frequency sampling will be carried out for high runoff conditions during short time periods, as these conditions are expected to be associated with the collection and transportation

of a large proportion of the material input to the system. Data obtained from this study will be analysed for predictive and extrapolative purposes. Some of the questions that this study will try to answer are:

- (a) What is the minimum number of samples required to adequately define the chemograph (concentration plotted against time) during high runoff events?
- (b) Will yearly loading estimates made by computational procedures based on long term averages be significantly different if event loads are excluded?
- (c) If loadings are significantly different, what is an appropriate extrapolative technique that will correct these loading estimates where high runoff events have not been monitored (i.e. missed).

Frequency sampling will be performed for a series of short term (24-96 hr) investigations during these high runoff events. Intensive sampling will be required during the initial phase of the program until the routine frequency methodology is established. Precipitation, water quality and water quantity data are the immediate inputs for this study.

#### Calibration of CAE Automatic Sampler

Provisions have been made in all data storage systems to identify the data-collection technique (manual or automatic). An event marker, or equivalent device, is employed so that sampling time can be accurately determined and equated to a corresponding, instantaneous discharge value.

All materials comprising the automatic sampler have been inventoried and documented for possible contamination sources.

The duration and efficiency of the purging cycle has been documented for each station. The intake line comprises transparent material, so that sediment buildup can be noted and corrected by additional back-wash. To avoid lengthy delays from sample collection to sample analysis, the automatic sampler installation is serviced as frequently as possible. Some absorption on container walls can be expected since the containers cannot be pre-rinsed with a representative sample of stream water. The temperature of the housing structure for the automatic sampler should be controlled to an optimum storage temperature of 4°C. Winter thermostat regulation makes this task simple in the winter months, but it is impossible in the summer heat, unless refrigeration units are installed. Immediate field filtration through an automated system, presently appears impossible.

When field technicians service the automatic sampler installations, a comparison sample is taken by sampling in the prescribed manual fashion and then immediately activating the automatic sampler. Comparison samples are necessary at all automatic sampler locations, because of the variation in physical characteristics that exist from one stream cross-section to another. Since the intake location of the automatic sampler is fixed near the streambed, it is anticipated that suspended-sediment samples collected automatically during high flow conditions will include bedload. Comparing automated and manually collected samples through a full range of streamflow discharge values, will yield specific relationships for determining true chemical and physical concentrations at each site.

The documentation of storage time is essential so that emphasis will be assigned to values obtained from fresh samples.

#### PARTICIPATING AGENCIES

Environment Canada

Ontario Ministry of the Environment

ACTIVITY 5 - Laboratory Support for Water Quality Monitoring and Pollution Source Studies

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CHEMICAL ANALYSES

Laboratory support will be maintained at a high level during 1976/77 to service the full field programs. The PLUARG Quality Control Program will be continued throughout this period to provide an assessment of sampling and laboratory methodology and an opportunity for improving results. During 1977/78, support will be given for the completion of spring runoff sampling and the continuation of selected monitoring programs and investigations required to confirm or extend the findings of the previous field programs.

MICROBIOLOGICAL ANALYSES

During 1976/77, microbiological analyses will be performed on selected samples from network monitoring stations and investigations of urban runoff, processed organic waste spreading, and private waste disposal systems.

The microbiological data collected from intensive studies in agricultural sub-watersheds during 1974 and 1975 will be interpreted and presented in a scientific report. An initial evaluation will be made of the 1974/75 results from network stations and recommendations given for sampling modifications.

During 1977/78, work will focus on interpreting all available microbiological results and applying the information to the Great Lakes basin.

PARTICIPATING AGENCIES

Agriculture Canada, Environment Canada, Ontario Ministry of Agriculture and Food, Ontario Ministry of the Environment, Beak Consultants Limited, University of Guelph, University of Waterloo, University of Windsor.

## ACTIVITY 6 - Riverbank Erosion Surveys

### OBJECTIVE

The objective of the riverbank erosion study is to gain a better understanding of bank recession mechanisms and to determine the qualities and quantities of materials eroded on a representative number of sites such that actual contributions of sediment to streams may be estimated.

### METHODOLOGY

After the conclusion of the preliminary study phase, twenty-five streambanks were selected in various watersheds for further investigation and monitoring. In this selection, an attempt was made to choose banks and watersheds representative of the Southern Ontario situation.

To facilitate the extrapolation of sediment data in conjunction with the sheet erosion research, the majority of sites were chosen in the six Agricultural sub-watersheds undergoing detailed study. Additional sites were chosen from watersheds involved in the preliminary study for reasons related to the morphology of the drainage pattern, the soil type and uniqueness of the banks. An extremely large bank of over one hundred feet in height, for example, was chosen as this type of bank was not represented in the Agricultural watersheds.

Criteria for bank selection within the watersheds related primarily to the photogenic nature of the bank. Most banks chosen are exposed or only lightly vegetated and are representative of typical active bank types in each watershed, in their height, shape, soil type and erosional mechanisms. Access to the site and other practical constraints were also considered.

Two simultaneous studies were initiated on these twenty-five sites early in 1975 and will continue for at least a two-year period.

#### 1. Quantitative Study

The analyses of data collected during the preliminary phase suggested that average erosion rates on streambanks in Southern Ontario involved relatively small quantities, probably in the neighbourhood of 1-2 cm. laterally per year. Due to the size of movement to be measured in so short a study and the accuracy required to allow eventual extrapolation of this data to Southern Ontario as a region, a technique involving terrestrial stereo photography was chosen. Photography is scheduled for early spring and late fall.

Successive sets of photographs when viewed stereoscopically will show areas where change has occurred in the bank between the two points in time. Co-ordinate measurements may be made of these areas and volume determinations of material movements on the bank conducted. Computer programs are being designed to calculate volume changes and correct coordinate systems between successive sets of photographs. Those processes should be fully operative by 1976.

The obtaining and analysis of two sets of photographs a year will continue until at least four complete sets of photographs are studied. Estimates of bank loss on these sites can then be calculated.

## 2. Quality Study

The quality study involves characterization of the bank material to determine the physical and chemical characteristics of sediment produced by erosion on the study banks.

A sampling program was carried out in the spring of 1975 on the twenty-five sites yielding roughly seventy-five soil samples. Bank profiles were described as to depth, colour and presence of mottling, roots and stone layers. Estimations were made of soil structure and permeability of each horizon so that soil erodibility factors could be measured.

The flow chart (Figure 4) describes the steps which the soil samples were carried through to September 1975.

Throughout the quality and quantitative studies, identification of processes and agents of streambank erosion will be noted and documented. These observations and comments will be useful when combined with information obtained from the analysis of the bank materials and stereo photographs in formulating predictive modelling of streambank erosion and extrapolating data to Southern Ontario during 1977/78.

### PARTICIPATING AGENCIES

Ontario Ministry of Natural Resources

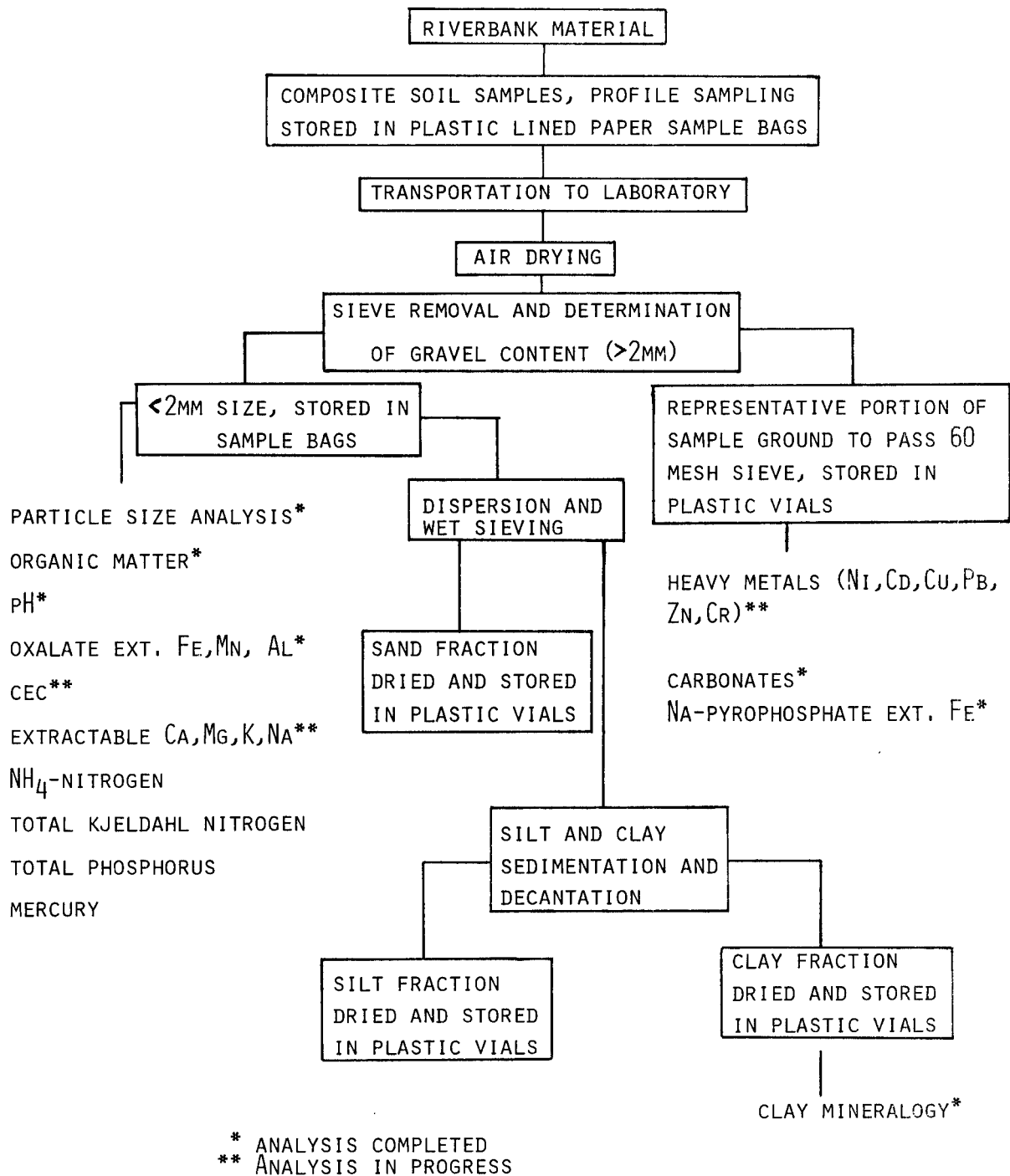


FIGURE 4- FLOW CHART FOR ANALYSIS OF RIVERBANK MATERIAL.



TABLE 2  
BUDGET SUMMARY

Task	Description of Activity	Agency	FY 77	FY 78
			1976-77 \$(000) Suppl.	1977-78 \$(000) Suppl.
	<u>CANADA</u>			
1.	<u>Agricultural Watershed Surveys</u>	CDA	350	290
		OMAF	315	100
		OME	110	40
2.	<u>Forested Watershed Surveys</u>	DOE	15	-
3.	<u>Development and Waste Disposal Uses</u>			
	a. Urban Land Use	OME	55	40
	b. Transportation and Utility Systems	OME	15	10
	c. Sanitary Landfills	OME	25	15
	d. Processed Organic Waste Disposal	OME	44	30
	e. Wastewater Lagoons & Irrigation Systems	OME	-	5
	f. Landfilling (reclamation)			
	g. Extractive Industries	OME	30	30
	h. Private Waste Disposal	OME	45	10
	i. Recreational Lands	DOE	10	-
	j. Data Integration and Loading Calculations	OME	20	100
4.	<u>Water Quantity and Quality Monitoring Network</u>			
	a. Extensive Surveillance Network	OME	200	120
	b. Intensive Studies Program	OME	45	40
5.	<u>Laboratory Support</u>		*	*
6.	<u>Riverbank Erosion Surveys</u>	OMNR	44	25

\*included in costs of other activities.

UNITED STATES SECTION

The studies in the Genesee (New York), Menomonee (Wisconsin) and Maumee River (Ohio) watersheds; in the Felton-Herron and Mill Creeks (Michigan); and on riverbank erosion are proceeding as outlined in the February, 1974, study plan. Some minor adjustments have been made in procedural details as a result of the initial technical review or as a result of preliminary progress. Information regarding these adjustments is available from the principal investigators as follows:

1. Genesee River Watershed

Dr. Leo J. Hetling  
Director, Environmental Quality  
Environmental Research and Development  
New York State Department of Environmental Conservation  
50 Wolf Road, Room 519  
Albany, New York 12201  
(518) 457-7470

2. Menomonee River Watershed

Dr. John G. Konrad  
Supervisor of Special Studies  
Wisconsin Department of Natural Resources  
P. O. Box 450  
Madison, Wisconsin 53701  
(608) 266-7420

3. Felton-Herron Creek and Mill Creek Subwatersheds

Dr. Thomas G. Bahr  
Director, Water Research Institute  
Michigan State University  
East Lansing, Michigan 48823  
(517) 353-3742

4. Maumee River Watershed (Ohio Supplement)

Dr. Terry J. Logan  
Asst. Professor of Agronomy  
The Ohio State University  
1885 Neil Avenue  
Columbus, Ohio 43210  
(614) 422-2601

5. Riverbank Erosion

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U.S. Soil Conservation Service  
Hyattsville, Maryland 20782  
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# TASK D

## TASK D

*Diagnosis of the degree of impairment of water quality in the Great Lakes, including an assessment of contaminants of concern in sediments and fish and other aquatic resources.*

Review and Assessment of Historical Information on Material Loadings to the Great Lakes via Tributary Streams and Shoreline Erosion, including a First-Order Assessment of the Relative Significance of the Various Land Use Activities.

### ACTIVITIES (CANADA AND U.S.)

1. Assessment of shoreline erosion.
2. Survey of river sediments and associated water quality.
3. Assessment of the effects of river inputs on Boundary waters.

### ACTIVITY 1 - Shoreline Erosion

Shoreline erosion constitutes a major source of sediment input to the boundary waters of the Great Lakes. The magnitude of the input has been very apparent during the recent high lake levels with severe land loss due to the recession of erodible shorelines.

In Canadian shoreline regions, in particular in the lower Great Lakes, there has been a considerable acceleration in the compilation of detailed assessment inventories of coastal recession. These include annual rates of recession from aerial photography, assessment of land use and shoreline structures, and property evaluation. Coverage includes Lakes Ontario, Erie, St. Clair, south-east Huron and southern Georgian Bay. These inventories form the base data from which the annual tonnage of eroded material can be calculated. In addition, bluff profiles have been established extending to a water depth of 20 meters, below active wave base, to survey the short-term changes in the bluff profiles due to shoreline erosion. One hundred and sixty-two profiles have been established as follows:

Lake Ontario	72
Lake Erie	50
Lake St. Clair	2
Lake Huron-Georgian	38

The studies carried out for Activity 1 take advantage of these profiles as a basis for calculating total tonnages of material input as a control network for sampling.

#### OBJECTIVES

1. To calculate the total quantity of sediment entering into the Great Lakes as a direct product of shoreline erosion.
2. To determine levels of nutrients, trace elements in erosive materials and to calculate their contribution to the lakes.

#### METHODOLOGY

##### Canada

The program comprises the following integrated sub-activities:

##### Sub-Activity 1 -

The compilation of all available information on historical erosion in order to compute a mean annual tonnage of sediment input.

##### Sub-Activity 2 -

The evaluation of the stratigraphy of individual profiles to calculate the mean annual tonnage of individual stratigraphic horizons lost to the lake by shoreline erosion.

##### Sub-Activity 3 -

Sampling the profiles on a stratigraphic basis to conduct the following analyses:

- (a) Particle-size analysis to quantify inputs for 1 and 2 above, in terms of sand and gravel, silt and clay.
- (b) Geochemical analyses of major, minor and trace elements, carbon and nitrogen, to determine the total geochemical input from shoreline erosion.
- (c) The determination of the forms of phosphorus in order to estimate the availability of phosphorus derived from shoreline erosion in the boundary waters.

Sub-Activity 4 -

Determination of the engineering properties of the erodible bluffs relative to dispersion of wave energy in order to elucidate the major mechanisms of shoreline erosion and the efficiency of present day protective structures.

Sub-Activity 5 -

Investigation of the mineralogy of bluff materials to observe stratigraphic variation and to relate such variation to the engineering properties in 4 above.

Sub-Activity 6 -

By observation of variations in the sub-aqueous profiles 0-20 meters, calculation of wave-induced sub-aqueous erosion and to determine onshore/offshore movement of sediment.

It can be seen that the basic study objectives are met by completion of Sub-Activities 1 to 3 inclusive. However, in the investigator's opinion, these data long are insufficient and Sub-Activities 4 to 6 are required in order to understand the process mechanisms involving bluff erosion, sediment transport and deposition as they may relate to present day protection structures, beach nourishment and depletion, etc. Further, the Land Use Activities Reference Group is required to submit suggestions with costing on remedial measures. Such measures cannot be suggested without knowledge of the process involved and costing by qualified authorities will require the data base also generated under Sub-Activities 4 to 6.

PARTICIPATING AGENCIES

Environment Canada - Marine Sciences Directorate (MSD)  
- Lakes Research Division, CCIW

TIME SCHEDULE

- Field studies completed in 1975
- Analyses and data evaluation to be completed in 1976
- Activity 1 Report - 1976

## ACTIVITY 2 - Survey of River Sediments and Associated Water Quality

In order to assess the contribution of compounds associated with land use activities such as pesticides, nutrients, and heavy metals commonly associated with particulate or suspended matter, both the quantity and quality of such particulate materials have been determined. Previous studies on river inputs to the Great Lakes have resulted in the accumulation of substantial quantities of primary data. These data are predominantly composed of water quality parameters and flow rates with some information on particulate inputs. The interpretation of these past data, when related to new information derived from a specific river mouth sampling program to recover and analyze solids, have provided a quantification of materials and compounds entering the boundary waters. The statistical evaluation of these parameters against land use practice for individual watersheds provided by Task B and the pilot watershed studies of Task C of the study plan enables an initial assessment of the contributions of such practices both on the quantity and quality of particulate compounds introduced by river input to the Great Lakes.

### OBJECTIVES

1. To determine, through sedimentation surveys, the extent of transporation of nutrients, selected metals, and pesticides into the lake system based on total sediment loadings.
2. To determine the effect of land use practices on incoming sediment and water quality.
3. To assess the availability of these pollutants on sediments and their present and potential impact on water quality.

### METHODOLOGY

#### Canada

#### Sub-Activity 1 - Evaluation of Existing Data on Tributaries and Nearshore Great Lakes Waters

All available data on discharges and water quality parameters for all river inputs selected for river mouth sampling are being compiled. Data parameters are being machine-processed for all years for which records are available to provide the following information on individual river inputs:

- (a) Monthly, seasonal, and annual mean discharge rates and associated mean turbidity values enabling the selection of optimum sampling periods and forming a basis for the computation of total input loadings and total sediment yield.

- (b) Calculation of the total input of those soluble materials determined during the monitoring programmes.
- (c) By multi-variate and cluster analysis, determining significant groupings of parameters and controlling factors.

In addition to the water quality data from tributaries, historical data from nearshore waters of the Great Lakes are being assessed to identify the impact of materials discharges on adjacent areas of the Lakes. Principal components of this activity are:

- (1) Assessment and aggregation of all data collected in the nearshore areas of the Great Lakes since 1967 by MOE.
- (2) Interfacing Great Lakes and tributary data to identify possible relationships on seasonal and long-term basis.
- (3) Identifying other factors that may be affecting water quality in the Lakes (e.g. shoreline erosion, major marine construction projects, major point sources, etc.)

#### Sub-Activity 2 - River Mouth Sediment Surveys

To recover suspended particulate material from all significant streams draining into the boundary waters of the Great Lakes (streams that have been sampled include all basins evaluated in Activity 2, Sub-Activity 1).

Sampling was conducted during the 1974 spring runoff period in tributaries draining to Lakes Ontario and Huron and during the spring of 1975 in tributaries to Lakes Erie and Superior. Additional sampling every three weeks on a year-round basis was conducted at representative basins draining to the lower Great Lakes and Georgian Bay.

At each river mouth, an integrated water samples was pumped and fed through a continuous flow centrifuge to recover particles in excess of 0.05 microns. A filtered water sample was also collected at each station. The total solids were freeze-dried and subjected to the following analyses:

- Major elements: Si, Al, Fe, Mn, K, Ca, Mg, P and S to provide a chemical assessment of the gross mineralogical composition of the inorganic fraction of the sediment and as an indicator of the form of phosphorus in the sediment. The statistical evaluation of the trace metals and pesticides relative to the major elements provide an insight into the bonding and form of transportation of these components to the Great Lakes. Such interpretations will be confirmed by selective extraction techniques (complete).



- carbon (organic and inorganic), nitrogen (complete)
- trace metals - Hg, Pb, Cu, Zn, Ni, Co, Cr, Cd, Be, V, Sr, As, and Se (complete)
- mineralogy (on selected watersheds only)
- pesticides. Ontario Pesticide Laboratories ran scans on Organochlorine and organophosphates on all samples (complete).

#### PARTICIPATING AGENCIES

Environment Canada - Lakes Research Division, CCIW  
 - Scientific Operations Division, CCIW  
 - Marine Sciences Directorate

Ontario Ministry of Agriculture and Food  
 - Ontario Pesticide Residue Testing Laboratory

Ontario Ministry of the Environment  
 - Water Resources Branch  
 - Pollution Control Branch

#### TIME SCHEDULE

- Activity 2.1 - 3 years, with a final report in 1977.
- Activity 2.2 - 3 years, with a final report in 1978.

#### ACTIVITY 3 - Effects of River Inputs

Information on use patterns within a watershed for contaminants such as metals, pesticides and stable organic compounds are being examined in relation to river inputs to boundary waters for the Task C pilot watersheds and other watersheds examined under Activity 2 of Task D. Such an analysis determines the dispersion of contaminants and indicates areas which merit further examination. However, generalized assessment of the levels of these contaminants in water and aquatic life forms would be of limited value. This is because of the lack of definitive information relating concentrations of contaminants in water, sediments and tissues with the well-being of the biota. Consequently, this study plan purposely avoids collection of more data of the monitoring type.

## OBJECTIVES

1. To assess the significance of specific contaminants gaining access to boundary waters as a result of land use activities.
2. To establish areas which may be adversely affected as a result of such inputs, including a determination of the extent of dispersion of sediments offshore and the extent of impairment of water quality in boundary waters.
3. To determine degree of contamination of fish and other aquatic resources in areas exposed to higher-than-average loadings of specific contaminants.

## METHODOLOGY

### Canada

#### Sub-Activity 1 -

Review input data from Activity 2, Task D and select contaminants attributable to land drainage which appear to represent hazards to aquatic life, municipal water use, etc.

#### Sub-Activity 2 -

Simulate comparable input rates of contaminants in laboratory ecosystem (CCIW Great Lakes Biolimnology Laboratory) and measure the impact of these systems in terms of:

- a) effects on performance of algae, invertebrate fish-food organisms and fish.
- b) biomagnification of contaminants in food chains, relating these levels in fish to both health of fish and marketability of fish.

Existing information attesting to the significance of selected contaminants will guide the development of this activity.

#### Sub-Activity 3 -

To carry out field surveys of selected areas of boundary waters which 1 and 2 above indicate as being potentially adversely affected.

In order to obtain data on contaminant residue levels in the biota, samples of fish, macroinvertebrates, plankton, sediments and lake waters will be collected during two field years and subjected to analyses for pesticides, PCBs and heavy metals. The results obtained from the field studies will be referenced to available information from a literature review undertaken as part of this

sub-activity in order to evaluate the existing (and potential long-term) detrimental effects of contaminants from land drainage on the lakes' biota.

Sub-Activity 4 -

The synthesis of all available information from these limited studies and the many on-going programmes to relate lakewater quality impairment to the relative inputs from all sources of contaminants, nutrients, etc. This calls for a careful examination of land drainage inputs in relation to atmospheric and point-source inputs at present and, when projected into the future, based on detectable trends in water and land resources management (incorporating results from Task B).

a) Atmospheric Model

The atmospheric model developed for the upper Great Lakes (UGLRC) is to be expanded to encompass the entire Great Lakes Watershed. The project will be carried out by contract to Acres Consulting Services Ltd. Projections of atmospheric loadings into the future will be developed from scenarios provided by Environment Canada.

b) Point-Source Inputs

All significant sewage treatment plant and industrial waste discharges to the Great Lakes and tributary streams will be evaluated. The bulk of point-source input data will be obtained from Ontario Ministry of the Environment records. Projections of these point source inputs into the future will be developed from scenarios and point source input models provided by Environment Canada.

c) All data from 3-4 a) and b) (above) will be incorporated in the data files developed under 2.1. These data will be utilized in the statistical package of Activity 2 to investigate historical trends and future loadings under different scenerios based upon Task B's land use predictions.

d) Comparison of trends in pollutant input from diffuse sources, point sources and atmospheric sources in order to determine relative significance of each.

e) Inventories of contaminant levels in biota are to be prepared and compared against loadings from diffuse sources in order to develop relationships between loadings and input.

Sub-Activity 5 -

To assess the spatial extent of high turbidity water and associated areas of localized high planktonic productivity ascribable to sediment input from shoreline erosion and river input by the interpretation of ERTS imagery and multi-spectral photography of the Great Lakes. To further utilize this technique to elucidate suspended sediment transportation pathways with water mass movement as a response to climatic conditions in order to define the zone of effect.

Sub-Activity 6 -

Selected surface sediment samples from the Great Lakes, collected by CCIW, will be analyzed for organochlorine insecticides and PCB's to determine regional residual levels and dispersion pathways in the boundary waters as they relate to past and present practices in the Watershed. Similar studies, on-going in CCIW for trace metals, will also be utilized.

PARTICIPATING AGENCIES

Environment Canada - Fisheries and Marine Science  
- Environmental Management Service  
(Water Quality Laboratory - CCIW)  
(Scientific Operations Div. - CCIW)

Ontario Ministry of the Environment - Water Resources Branch

Ontario Ministry of Agriculture and Food - Ontario Pesticide  
Residue Testing Laboratory

TIME SCHEDULE

Three years, with final report from all Sub-Activities in 1977 or early 1978.

TABLE 3

ACTIVITY COSTS in \$000's

	<u>1975/76</u>	<u>1976/77</u>	<u>1977/78</u>
ACTIVITY 1			
DOE	21 (60)	- (4)	-
ACTIVITY 2			
DOE	110 (180)	55 (96)	30
OME	Nil	Nil	Nil
OMAF	12	3	-
ACTIVITY 3			
DOE	105 (95)	65 (182)	-
OME	23	27	25
OMAF	21	17	10

() indicates funds allocated to PLUARG

No () indicates original estimates in 1974 Study Plan.

UNITED STATES SECTION

METHODOLOGY

ACTIVITY 1 - ASSESSMENT OF SHORELINE EROSION

Sub-Activity 1-1 - Determination of Quantity and Quality of Eroded Material

(a) Samples will be obtained from six different shoreline types which have been identified as being representative of shoreline erosion types. Several different sample profiles will be obtained from each of the shoreline types. Grab samples will be taken at each profile station from appropriate horizons and detailed descriptions (including erosion data) of the shoreline area will be made at each sampling station. These samples will be analyzed for selected nutrients, metals, and other elements of geochemical interest, as well as pertinent physical characteristics (e.g., particle size). In addition, the availability or exchangeability of selected nutrients and metals found in the shoreline samples will be evaluated. The evaluation will be based on bench scale leaching tests of the shoreline sediment samples as well as on the reactivity of the geochemical forms found in the samples as determined from the literature.

(b) The volume of shoreline sediment eroded will be calculated for those areas where data are available. A maximum annual, minimum annual, current annual and average annual amount eroded will be determined for the different shore types. On the basis of (a) above, the elements sampled will be related to volumes eroded to estimate an average annual pollutant loading by shore type and by rate of erosion from shoreline erosion. The laboratory results, the quantity eroded and associated pollutant loadings will be presented in a technical report, including an extensive selected bibliography with abstracts.

Investigators - U.S. Army Corps of Engineers  
- Great Lakes Basin Commission  
- University of Michigan  
- Soil Conservation Service

Subactivity Cost - \$85,000

Completion Date - August, 1976.

Sub-Activity 1-2 - Overview Determination of Pollutant Loadings from Shoreline Erosion

An up-to-date overview report on Great Lakes shoreline erosion and the resulting water quality impacts will be made. The report will be based on the results of the technical report in sub-activity 1-1 as well as any other

obtainable data or existing information and the "best judgement" of the Contractor. Estimates of the total mean annual quantity and quality of eroded shoreline material on the U.S. side will be made for various erosion rate conditions on a planning subarea and lake basin basis. Ongoing activities by States, Federal agencies and universities will be shown. The estimate of pollutant loading contributed by shoreline erosion will be available for comparison to loadings from tributary and atmospheric inputs as determined in other activities in order to determine the relative importance of shoreline erosion to Great Lakes water quality. Management and administration of sub-activity 1-1 is included in this cost estimate.

Investigator - Great Lakes Basin Commission

Sub-activity cost - \$14,000

Completion Date - January 1977

ACTIVITY 2 - SURVEY OF RIVER SEDIMENTS AND ASSOCIATED WATER QUALITY

Sub-Activity 2-1 - Identification and Evaluation of Existing River Mouth Loading Data

(a) All available data on water discharges, sediment, and water quality (including nutrients, pesticides, heavy metals, and refractory organics) for stream mouth inputs will be identified. Other stations and data collection sites on tributaries without stream mouth data will be selected in order that all major tributaries may be considered. No attempt will be made to publish a compilation of all collected tributary data. However, a summary report will be prepared which identifies the tributaries monitored, parameters measured, frequency of sampling, period of record, source of data, location and availability of data, etc.

(b) An evaluation will be made of the adequacy of the sampling network for computing total stream mouth loading to the Great Lakes. Data will be evaluated with regard to how well the sediment and chemical data relate to flow. Gaps in data and evaluations will be identified. All ongoing programs will be considered. Recommendations will be made as to additional sampling (location, event, and element analyses) which, if necessary, will be done between October 1975 and July 1976).

Investigator - Great Lakes Basin Commission

Sub-Activity cost - \$28,733

Completion Date - July 1976

Sub-Activity 2-2 - New Tributary Surveys

Based on the gaps identified in Sub-Activity 2-1, a limited number of stream mouths will be surveyed to establish their pollutant input to Great Lakes. Priority will be given to the filling of any gaps associated with the river mouths of the four pilot watersheds in Task C. Additional stream surveys will be conducted only where it is imperative to obtain additional data to adequately assess the total tributary input to the lake. The sampling program utilized will represent the minimal effort needed to obtain data from which a rough estimate of the annual stream mouth output of certain pollutants can be made. (no new large scale or extensive stream mouth surveys are intended to be accomplished in this sub-activity). Major data gaps which require extensive sampling efforts over long periods and which cannot be accomplished under the time constraints of Task D will be recommended for future study.

Investigators - USEPA - Central Regional Laboratory  
- USEPA - Great Lakes Surveillance Branch  
- Green Valley State College

Sub-Activity cost - \$51,000

Completion Date - July, 1977



Sub-Activity 2-3 - Estimate of Total Tributary Loading

Based on existing data, a careful estimate of the tributary output (input to the Great Lakes) of pollutants, including total suspended solids and chemical pollutants in particulate and soluble forms, will be made. In recognition of the importance of high flow conditions, particularly spring runoff, to the loading of many substances, the output from river mouths during high flow and base flow (no surface runoff) will be considered. Based on estimates of point source inputs to the tributaries, estimates of the pollutant output attributable to diffuse sources will be made. In all cases estimates of the U.S. loading will be delineated according to individual major watersheds, the 15 planning subareas, and the 5 lake basins.

Investigator - Great Lakes Basin Commission

Sub-Activity cost - \$27,730

Completion Date - July, 1977

Sub-Activity 2-3 - An Alternate Approach to Predicting the Effect of Land Use on Stream Water Quality

A determination of the effect of land use on river mouth water quality will be made on a limited number of tributaries where sufficient data are available (such as the pilot watershed tributaries). Statistical methods will be used to attempt to relate selected combinations (co-occurrences) of land use factors to river mouth water quality factors. For example, urban developments in a watershed may have different pollution potential depending on the soil characteristics or slope of the land on which it is situated. Critical combinations of land use, geology, and soil which might interact to influence water quality will be considered as a major feature of this analysis.

Investigator - Great Lakes Basin Commission

Sub-Activity cost - \$17,535

Completion date - July, 1977

Sub-Activity 2-5 - Availability of Pollutants Associated with Suspended or Settled River Sediments which Gain Access to the Great Lakes

Suspended sediments from the mouths of selected major tributaries (including appropriate pilot watershed tributaries) will be sampled during different seasonal events. The potential of these sediments to take up or release key pollutants, such as certain nutrients or heavy metals, under different

environmental conditions which can be expected in the lakes, is to be investigated. Ultimately, the fraction of the total tributary loading that is available for uptake by organisms or which can impair water quality of the Great Lakes in some other way, both now and in the future, is to be estimated.

Investigator - To be selected

Sub-Activity Cost - \$70,000

Completion Date - May, 1977

ACTIVITY 3 - EFFECTS OF RIVER INPUTS

Sub-Activity 3-1 - Sediment Dispersion and Water Quality Offshore of River Mouths

Through field surveys an investigation of the extent of dispersion of stream sediments offshore and the resulting degradation of water quality is to be made. A pilot study will be conducted to determine the dispersion and fate of selected Maumee River pollutants in Lake Erie. The study will be conducted during the maximum spring runoff and other runoff events, and will consist of both shipboard water quality measurements and remote sensing surveys from aircraft. An additional objective of this pilot study will be to demonstrate the usefulness of "near real time" transmission of remotely sensed data to surface vessels to supplement shipboard data collection and increase the efficiency of shipboard operation.

Depending on the success of the pilot study, similar extensive surveys will be conducted at other strategic stream mouth regions. The streams which are being intensively studied under the Task C activities (the Genesee in New York, the Grand in Michigan, and the Menomonee in Wisconsin) will be likely candidates for these studies since in-lake data near the outfalls of these tributaries will serve as a natural extension of the Task C efforts. In addition, the drainage of the four U.S. pilot watersheds represents a substantial percentage of the total U.S. drainage. These surveys, which will include analysis of selected nutrients, pesticides, heavy metals, and refractory organics, will then be used to make an overall assessment of the extent of dispersion and the effect of stream pollutants in areas of stream outfalls in the Great Lakes, if possible.

Investigators - Nemadji River - Dr. Michael Sydor, Univ. of Minnesota,  
Menomonee River - Dr. John G. Konrad, WI Dept. of  
Nat. Res.; Grand River - Dr. Andrew Robertson, Great  
Lakes Env. Res. Lab., NOAA; Maumee River - Dr.  
Chas. Herdendorf, Ohio State Univ.; Genesee River -  
Dr. Robt. A. Sweeney, State Univ. College at Buffalo;  
National Aeronautics Space Adminis. - Dr. R. Gedney.

Sub-Activity Cost - \$220,000

Completion Date - February, 1977

Sub-activity 3.1 (a) Development of methodology for the correlation of plume water analysis with remote sensing and extrapolation of findings from listed areas to the entire Great Lakes System.

Studies of pollutants discharged into river mouths of the Nemadji, Menomonee, Grand, Maumee and the Genesee and transported through plumes to the international boundaries to fulfill the requirements of Sub-activity 3-1 and 3-3(a) are now underway. These studies involve the sampling of waters in these plumes and

analyses to determine the pollution load. Concomitant to the sampling, there will be overflights of the areas for multispectral band remote sensing. A similar study was conducted in 1975 at the mouth of the Maumee River. The 1975 study data and the ongoing study will be made available so that an analysis and evaluation of these data can be made to determine the extent the pollutants can be quantified to remove sensing without the necessity for ground truth (water sampling and analyses). A methodology will be developed to extrapolate the findings in these areas to the entire Great Lakes System.

Investigator - to be selected

Sub-activity Cost - \$9,500

Completion date - March, 1977.

Sub-Activity 3-2 - Assessment of the Degree of Contamination of Organisms in Areas Exposed to Higher-Than-Average Loadings

Selected "indicator" organisms whose movement in the lake is limited and restricted to localized areas, such as certain benthic organisms, will be sampled near the outfalls of the four pilot watershed streams. These organisms will be analyzed for accumulation of pesticides and other toxic materials thought to be derived from land drainage. Contaminant concentrations in organisms in outfall areas will be correlated to concentrations in organisms outside of the stream discharge areas. Organisms will likely be sampled along transects designed to relate to stream sediment deposition offshore. The results will also be correlated with detailed loading data as well as the results of the field surveys conducted in Sub-Activity 3-1 of Task D.

Investigator - To be selected

Sub-activity Cost - \$50,000

Completion date - May, 1977

Sub-Activity 3-3 - Significance of Wind-Induced Mixing on the Uptake or Release of Substances Associated with Sedimented Material in Nearshore Areas of the Lakes

(a) Samples will be taken at different strategic locations in the pilot watershed stream discharge areas and possibly in other strategic locations (e.g., Saginaw Bay, Green Bay, western Lake Erie) during or immediately following wind events and analyzed for selected nutrients, pesticides, metals, and refractory

organics and other appropriate parameters related to the effects of land drainage. Results of analysis will be compared to water quality prior to storm events in order to determine any changes in water quality brought about by sediment disturbances.

Investigators - see Sub-Activity 3.1

Sub-Activity Cost - \$60,000

Completion Date - January, 1977

(b) A survey of the frequency and extent of storm-induced sediment/water mixing of nearshore areas and embayments will be made. This information will be related to predictive methodologies being developed by Case Western Reserve University to assess the effect of currents and waves on mixing processes and the distribution of hazardous materials in the near-shore areas of the Great Lakes.

Investigator - Great Lakes Basin Commission

Sub-Activity Cost - \$20,825

Completion Date - Scheduled for FY 77

Sub-Activity 3-4 - Critical Assessment of Water Quality Impairment  
Resulting from Land Drainage

(a) A critical assessment will be made of the overall significance of contaminants, including nutrients, pesticides, heavy metals, and refractory organics, which enter the Great Lakes and which are attributable to land runoff from the U.S. side. This assessment is designed to identify those substances contributed by land runoff from the U.S. side in sufficient quantities to impair or potentially impair the quality of the Great Lakes and to provide an overview type estimate of the present degree of impairment. Specific examples of impairment are to be documented. This assessment will make use of Activities 1 and 2 of Task D, the Canadian activities under Task D, and other ongoing projects, such as the Upper Lakes Reference Group Study. Because of the variability of contaminants in water, sediments, and biota and the well-being of the biota, it is recognized that the degree of impairment of the Lakes cannot be determined with certainty at this time. Thus, areas which need further study will be identified in the assessment. The significance of probable future pollutant loading reductions from land drainage on the quality of the boundary waters will be also be addressed.

Investigator - To be determined

Sub-Activity Cost - \$20,000

Completion Date - Scheduled for FY 77

(b) A quantitative assessment of the pollutant loading from U.S. land drainage as determined in Sub-activity 2-3 relative to atmospheric inputs directly to the lake, point source inputs and shore erosion inputs will be made. Atmospheric inputs will be estimated based on the literature available and the information derived from the Canadian Task D atmospheric input model, while shore erosion and point source inputs will be obtained from Sub-activity 1-2 and 2-3, respectively. Projections will also be made of future pollution from land drainage based on projected trends in land use and resource management (as provided by Task A, B, and C).

Investigator - To be determined

Sub-Activity Cost - \$25,000

Completion Date - Scheduled for FY 77

TABLE 4 U.S. TASK D, PLUARG - SCHEDULE OF ACTIVITIES

Activity	DIRECT COSTS*	COMPLETION DATE		
Activity 1 - ASSESSMENT OF SHORELINE EROSION				
1.1 (a) (b) Determination of quantity and quality of eroded material	\$85,000			
1.2 Overview determination	<u>14,000</u>			
	\$99,000			
Activity 2 - SURVEY OF RIVER SEDIMENTS AND ASSOCIATED WATER QUALITY				
2.1 (a) (b) Identification and evaluation of existing river mouth loading data	28,733			
2.2 New tributary surveys	51,000			
2.3 Total tributary loading	27,730			
2.4 Alternate - land use/water quality	17,535			
2.5 Availability of pollutants	<u>70,000</u>			
	\$194,998			
Activity 3 - EFFECTS OF RIVER INPUTS				
3.1 Sediment and water quality offshore of river mouths	220,000			
3.1 (a) Development of methodology	9,500			
3.2 Assessing degree of contamination	50,000			
3.3 (a) Significance--wind-induced mixing	60,000			
3.3 (b) Frequency/extent--storm-induced mixing	20,800			
3.4 (a) Land drainage/water quality impairment	20,000			
3.4 (b) Relating land drainage/point sources/shore erosion/atmospheric; also consider future trends.	<u>25,000</u>			
	\$405,300			
GRAND TOTAL	\$699,298	1976	1977	1978

\*Direct costs to U.S. PLUARG: does not include ongoing or planned programs funded separately.

# PLUARG MODELLING PROPOSAL



## PLUARG MODELLING PROPOSAL

The Reference Group recognized in its Detailed Study Plan (1974) that to answer the reference questions adequately, some considerable degree of data extrapolation was necessary. In formulating the study plan, some limited work elements were budgeted in Task C and D for the application of mathematical models to the data to aid in this extrapolation. Early in 1976, however, the reference group felt that these essentially independent efforts had to be unified under the structure of a PLUARG, basin wide modelling project. The scope of some of the modelling being undertaken had to be expanded, bringing together information from all PLUARG Task Groups.

The Task C modelling subcommittee produced a summary report in January, 1976, outlining the options open to Task C in its own internal modelling programme. It was this summary that was taken by the Reference Group as a basis upon which to develop a basin wide modelling programme.

The summary that follows outlines the alternatives available to PLUARG. It should be noted that the Reference Group elected to proceed with alternative 4 (unit load and regression analysis methods with a project manager), subject to funding. The time frame in which this modelling can be undertaken is limited. If the model is not operational by the autumn of 1977 at the latest, the modelling work may well carry on past the July 1978 date for the final report.

### I. CHARGE TO THE COMMITTEE FROM PLUARG

- A. To review the January 1976 report of the Task C Subcommittee on Modelling (attached as Exhibit B) and develop detailed recommendations concerning implementation of Recommendation E-1<sup>1</sup>

### II. REVIEW OF THE JANUARY 1976 REPORT OF THE TASK C SUBCOMMITTEE ON MODELLING

- A. The Committee reviewed written comments received from PLUARG participants and concluded that the comments, while generally supportive of the report, contained the following key ideas that should be included in the report to PLUARG:
  - 1. Explicit reference to modelling of the pollutional impact of future hypothetical land uses in the Great Lakes basin in addition to existing land use patterns.

<sup>1</sup>"That a Great Lakes Basin Modelling Project be established within PLUARG for the period from about June 1, 1976, to September 30, 1977".

Note: For the sake of brevity, only Exhibits A and B have been included here. The other exhibits referred to in the text may be obtained from Dr. H. Shear at the IJC Regional Office.

2. Incorporation of Upper Lakes Reference Group, Corps of Engineers Lake Erie study methodology, and other related diffuse source study findings into the modelling project.
  3. Emphasis on the importance of using Task C findings in the modelling project.
  4. Provision for adequate documentation to assure that the results of the modelling project could be readily updated and refined subsequent to completion of the PLUARG study.
- B. The Committee endorsed the report of the Task C Subcommittee on Modelling subject to the following modifications:
1. Change "Great Lakes Basin Modelling Project" to "Great Lakes Land Drainage Modelling Project" (GLLDM Project) to clearly indicate that the proposed project will not address in-lake processes, that is, the project will provide estimates of the yield of potential pollutants from the terrestrial portion of the Great Lakes basin.
  2. Change the duration of the proposed project from June 1, 1976 - September 30, 1977, to a recommendation that the model be operational by September 30, 1977.
  3. Although, in an ideal sense, the six stated objectives are desirable, the Committee felt that only those objectives set forth in Part VI of this report could be achieved.

### III. DATA REQUIREMENTS AND DATA AVAILABILITY

- A. The Committee developed a preliminary description of the data base for the 196,500 sq. mi. terrestrial portion of the 291,180 sq. mi. Great Lakes Basin that may be needed to develop the proposed GLLDM Project.
1. This data base identification is intended primarily to provide an estimate of the magnitude of the data assembly effort that may precede actual model development.
  2. This data base identification is not intended to be a definitive description of all the data that would be used if a modelling project is actually developed--it is only a first approximation that must be refined if such a modelling project is undertaken.
- B. After developing the preliminary description of the data base, the Committee established the likely availability of each type of data for the Great Lakes Basin.
1. The availability of data was pursued to the extent necessary to provide an estimate of the magnitude of the data assembly effort that might be included within a modelling project.
  2. The determination of data availability is not intended to be complete--it is only a first approximation that must be refined if a modelling project is undertaken.
- C. The results of the Committee's analysis of data requirements and data availability are summarized below. Supporting information is presented in the referenced exhibits prepared by Committee members as indicated.
- D. Water Quality Data
1. Data that may be required.
    - a. Surveillance data: all in-stream concentrations (not loads and not only at river mouths) for the entire Great Lakes Basin.
    - b. PLUARG Pilot Study data: all in-stream concentration data.
  2. Data availability.
    - a. Surveillance data: Canada
      - i. See Exhibit C for a description of data sets held or being assembled at Queen's University, Kingston, Ontario.
      - ii. Summary: Approximately 10 year data set on tape. Routinely available chemical data include: four nitrogen forms, two phosphorus forms, chloride, suspended solids and total solids. Routinely available biological data include: total coliform bacteria; dissolved oxygen, BOD<sub>5</sub>.

- b. Surveillance data: U.S.
  - i. See Exhibits D and E for a description of the availability of surveillance data.
  - ii. Summary: U.S. Task D has prepared a Data Availability Matrix--location vs. data type and source--for primarily river mouth data. It is estimated that approximately 80 percent of the identified data are in STORET. Extensive editing may be required if these data are to be used. The IJC Surveillance Subcommittee is compiling a file of surveillance data but that file is not complete.
- c. Pilot Study data: U.S. and Canada
  - i. The Task C Data Handling and Processing Work Group recommended that each pilot study either store data in computer processible form in the specified format or develop the capability of supplying data in that format on request from PLUARG study participants.
  - ii. Status of U.S. Pilot Study water quality data files: Menomonee River Watershed Study data are routinely entered into a digital computer file system having the capability of providing data in a format compatible with that recommended by the Data Processing and Handling Work Group. A data management system is operational for the Felton-Herron and Mill Creek watersheds and includes the capability to process water quality data in the STORET format and will include the capability to process water quality data in the format recommended by the data handling and processing work group. The Genesee River and Maumee River watershed projects plan to develop the capability to provide water quality data in the format recommended by the data Handling and Processing Work Group.
  - iii. Status of Canadian Pilot Study water quality data files: It is anticipated that a substantial portion of the Canada Pilot Study Data will be available for general use in the specified format by October of each year following the calendar data year. See Exhibit F.

E. Water Quality Data

1. Data that may be required

- a. Daily stream flow in the Great Lakes basin for the period corresponding to the water quality data.

2. Data Availability

a. Canada:

- i. See Exhibit C for a description of data sets held or being assembled at Queen's University.
- ii. Summary: Available for all stations for period of record through 1974.

b. U.S.

- i. See Exhibit G for a discussion of stream flow data available from the U.S. Geological Survey.
- ii. Summary: The U.S. portion of the Great Lakes Basin contains approximately 1500 USGS discharge or stage stations. Some of the data are maintained on computer files by the USGS.

F. Point Source Data

1. Data that may be required

- a. Daily loadings (Mean daily loading per year) from all municipal STP's and significant industrial sources on streams tributary to the Great Lakes including the location of each discharge.

2. Data availability: Canada and U.S.

- a. See Exhibit C for a description of data sets held or being assembled at Queen's University.
- b. See Exhibit D for a description of U.S. EPA point source data.
- c. See Exhibit H for a description of Upper Lakes Reference Group method for synthesizing point source loads.
- d. Summary: Most available Canadian data have been or will be placed in a computer file. A similar file is not available for U.S. data. The Upper Lakes Reference Group has a model for estimating municipal and industrial loads.

G. Physiographic Data

1. Data that may be required

- a. Thickness and composition (till, sand, clay, etc.) of unconsolidated overburden.

- b. Bedrock geology.
- c. Surface slope or other relief index.

## 2. Data Availability

### a. Canada

- i. See Exhibits C and I for descriptions of available soil data, unconsolidated deposits data and bedrock geology data including additional data for the pilot study watersheds.
- ii. Summary: Soil surveys are available for all but one county of the lower basin area-they are of variable age, scale and accuracy. Updated detailed soil surveys will be available through the PLUARG Program for 6 of the 11 agricultural watersheds. Broad scale bedrock geology information is mapped for the whole area, and more detailed maps of surficial and bedrock geology, and bedrock topography are available for part of the lower basin.
- iii. Slope index to be derived from available topographic maps.

### b. U.S.

- i. SCS standard soil surveys have been completed for most of the Great Lakes Basin.
- ii. See Exhibit J for a description of available bedrock data.
- iii. Summary: Bedrock geology data are available for most of the Great Lakes Basin but map scale and interpretation problems exist.
- iv. Slope index to be derived from available USGS topographic maps.
- v. See Exhibit K for a description of soils, unconsolidated deposits and bedrock geology data available for the pilot watersheds.
- vi. Summary: Bedrock geology and SCS soil surveys are available for all four watersheds.

## H. Land Use Data

### 1. Data that may be required

- a. Location and areal extent of the following land uses: urban and urban sub-categories, cropland and improved pasture, pasture (rough), woodland, and wetland.

### 2. Data availability

#### a. Canada

- i. Refer to Exhibit C for a summary of data sets held or being assembled at Queen's University.
- ii. Summary: Land use data on tape from Canada Land Use Inventory. May be mapped and statistics may be provided by county and major and minor watershed.
- iii. Refer to Exhibit L for a description of additional land use data available for pilot studies.
- iv. Summary: Canada Land Inventory maps of 18 land use categories available at a scale of 1:250,000; Statistics Canada enumeration area data from census; air photos - ranging in date from 1966 to 1972; and ground survey as needed, especially in agricultural study areas where a farm-by-farm survey was conducted in 1975.

#### b. U.S.

- i. Refer to Exhibit D for a description of the Purdue-ERTS project data.
- ii. Summary: The land use data (four major land uses and seven subclasses) were developed for the U.S. side of the Great Lakes by Purdue University using ERTS data. The information is available on magnetic tapes. The data are presented on a county basis and are also aggregated into planning subareas (GLBC units).
- iii. Refer to Exhibit M for a description of additional land use data available for pilot studies.
- iv. Summary: U.S. pilot study data are available in a wide range of detail and filing systems.

- c. Refer to Exhibit N for a comparison of U.S. -Canada land use data as prepared by Task B at its December 16, 1975 meeting. Differences exist but they do not appear to pose intractable problems with respect to a GLLDM Project.
- d. The amount and general spatial location of future land use is being determined under Task B-5.

I. Summary

- 1. Data types likely to be required for a GLLDM Project exist.
- 2. The data may vary widely in quality and spatial and temporal resolution.
- 3. No major systematic effort has been undertaken or are planned to convert the available data to uniform formats and to create readily accessible computer files--a notable exception is the data base being developed at Queen's University.
- 4. Depending on the analytic techniques selected for the GLLDM Project, a massive data base development effort may be required.

IV. LAND USE AND LAND MANAGEMENT--AN IMPORTANT DISTINCTION

- A. Objective A of the GLLDM Project is to indicate the relative significance of land uses on the yield of pollutants to the Great Lakes, whereas Objective B is to indicate the relative significance of land management on the pollutant yield.
- B. The Committee concluded that while it is likely that a Great Lakes Land Drainage Model can be developed with land use as an input parameter it is unlikely that such a model can be developed with land management (other than alternative future land uses) as an input parameter. This conclusion is based on the observation that whereas reasonably compatible land use data are available for the entire Great Lakes Basin, similar land management data are not available.
- C. Therefore, the relationships between land management and pollutant yields will have to emanate from other sources, mainly, literature survey work by Task A and coordinated interpretations of pilot study data by Task C. Interpretative reports and integrative efforts by Task C are the primary means by which the PLUARG study will make an original contribution to the effect of land management on the yield of pollutants by land drainage.
- D. Exhibit O is a schematic representation of the source and use of land management information with emphasis on its relationship to the model and the development of alternative management plans for the Great Lakes Basin.



V. DESCRIPTION OF ALTERNATIVE APPROACHES TO THE GLLDM PROJECT

- A. The Committee identified four alternative approaches to the GLLDM Project, more specifically, four ways to obtain estimates of the yield of potential pollutants from the land surface to the Great Lakes under existing and hypothetical future land use conditions. The resource, cost and time requirements of each approach were estimated. Alternative approaches were developed in order to provide a full array of choices to PLUARG. A supplemental benefit of this analysis was improved understanding of current PLUARG integrative efforts in the area of "modelling".

The four alternative approaches--each of which would function for two years--from about mid-1976 to mid-1978--are discussed below.

B. Alternative 1 - Maintain Status Quo

1. This alternative was identified, not because it was thought to be a viable choice, but because it provides a baseline or benchmark against which the "cost and benefits" of the other three alternatives may be measured.
2. Under the Maintain Status Quo alternative, no significant changes would be made in those aspects of the PLUARG study--principally Task C and D--that relate directly to estimating the yield of diffuse source pollutants to the Great Lakes. Furthermore, the principal integrative effort would begin under the report preparation process in early 1978.
3. This is a "no cost" approach in that no additional--that is, not now anticipated--work elements would be required.

C. Alternative 2 - Existing Program Plus Integrator

1. Under this alternative, no significant changes would be made in those aspects of the PLUARG study--principally Task C and D--that relate directly to estimating the yield of diffuse source pollutants to the Great Lakes.
2. However, a formal limited integrative effort would be initiated immediately in the form of a professional who would, with modest support services:
  - a. become intimately familiar with past, current and projected Task C and D efforts;

- b. using results of those efforts--e.g., unit loads of selected potential pollutants for some land use-cover complexes as may be provided by a Task C pilot study and estimated total annual loads of selected potential pollutants for some major watersheds in the Great Lakes Basin as provided by Task D--the professional would estimate total loads of selected potential pollutants to the Great Lakes under existing and hypothetical future conditions, and;
  - c. prepare a report for submission to and review by PLUARG. It is anticipated that the professional would rely primarily on the results and findings of existing activities as opposed to working with the basic data.
3. The professional would ideally come from within the PLUARG study because of familiarity with the project but could be retained from outside PLUARG on a consultant or other basis.
  4. The professional would be an "integrator" as opposed to a "coordinator" or "manager" in that while he or she would have access to the continuous flow of data and information being produced primarily by Tasks C and D, the professional would not have authority to control or direct any aspects of the work efforts.
  5. The estimated cost of this approach, as developed in Exhibit P, is \$100,000 over a two year period. This would be an additional cost to the PLUARG project in that this work element is not in the current study plan.

D. Alternative Approach 3 - Unit Load Method With Manager

1. Under this approach, the unit load method would be used to estimate the yield of diffuse source pollutants to the Great Lakes under existing and hypothetical future land use conditions.
2. Unit load factors might be obtained from: the Task C Technical Committee, Task D based on its analysis of river mouth data and from Working Groups A and B of the Upper Lakes Reference Group. While it is anticipated that a substantial effort would be made to use basic or raw Task C pilot study data and historic surveillance data to develop unit load factors, this approach would not envision using all available data, that is, historic surveillance data plus pilot study data.

3. A schematic representation of this approach and its relationship to other aspects of the PLUARG project is attached as Exhibit 0.
4. This approach would consist of two parallel but integrated phases. Phase I would be an integrated analysis and process model-oriented effort by Task C which would provide three key outputs:
  - a. Unit load factors for some land use-cover complexes.
  - b. An improved understanding of land washoff and instream transport of potential pollutants.
  - c. Information on the technical feasibility of some land management techniques.

Phase II would consist of the use of unit loads provided by the Task C Technical Committee and developed from surveillance data coupled with process understanding developed by Task C and other Task D results to estimate diffuse source loadings from the land surface to the Great Lakes under existing and hypothetical future conditions.

5. The two-phase approach was selected in recognition of existing Task C and Task D activities which would form the basis of, respectively, Phase I and Phase II, and to provide the opportunity to pursue different but coordinated and potentially complimentary approaches thereby increasing the likelihood of success.
6. Under this approach, a manager operating under PLUARG, would be charged with the responsibility of developing estimates of diffuse source loadings from the land surface to the Great Lakes under existing and hypothetical future land uses. In order to make optimal use of existing resources and work elements, the manager would have the authority to give functional guidance to Task C and Task D efforts. Therefore, under this alternative it is very likely that Task C and Task D study plans would be altered.
7. The manager would ideally come from within the PLUARG study because of familiarity with the project but could be retained from outside PLUARG on a consultant or other basis.

8. The estimated cost of this approach, as developed in Exhibit Q, is \$145,000 over a two year period. This would be an additional cost to the PLUARG project in that this work element is not in the current study plan.

E. Alternative Approach 4 - Unit Load and Regression Analysis Methods with Manager

1. Under this approach, both the unit load and regression analysis methods would be used to estimate the yield of diffuse source pollutants to the Great Lakes under existing and hypothetical future land use conditions.
2. The two methods would be applied by drawing on a digital-computer based data set consisting of "all" pilot study quality and quantity data and "all" historic quality and quantity surveillance data for the Great Lakes basin plus point source, physiographic and land use data.
3. A schematic representation of this approach and its relationship to other aspects of the PLUARG project is attached as Exhibit O.
4. This approach would consist of two parallel but integrated phases. Phase I would be an integrative analysis and process model-oriented effort by Task C which would provide three key outputs:
  - a. Unit load factors for some land use-cover complexes.
  - b. An improved understanding of land washoff and instream transport of potential pollutants.
  - c. Information on the technical feasibility of some land management techniques. Phase II would consist of the use of "all" pilot study and surveillance data as well as process understanding developed by Task C to apply the unit load and regression analysis methods for estimating diffuse source loadings from the land surface to the Great Lakes under existing and hypothetical future conditions.
5. The two-phase approach was selected in recognition of existing Task C and Task D activities which would form the basis of, respectively, Phase I and Phase II and to provide the opportunity to pursue different but coordinated and potentially complementary approaches thereby increasing the likelihood of success.

6. Under this approach, a manager operating under PLUARG, would be charged with the responsibility of developing estimates of diffuse source loadings from the land surface to the Great Lakes under existing and hypothetical future land uses. In order to make optimal use of existing resources and work elements, the manager would have the authority to give functional guidance to Task C and Task D efforts. Therefore, under this alternative it is very likely that Task C and Task D study plans would be altered.
7. The manager would ideally come from within the PLUARG study because of familiarity with the project but could be retained from outside PLUARG on a consultant or other basis.
8. The estimated cost of this approach, as developed in Exhibit R, is \$417,500 over a two year period. This would be an additional cost to the PLUARG project in that this work element is not in the current study plan.

VI. COMPARISON OF ALTERNATIVE APPROACHES TO THE GLLDM PROJECT

- A. Comparison on the basis of use of available data, uniformity of technique with respect to the entire Great Lakes Basin, and cost. The first two factors are likely to significantly affect the quality and credibility of the results.

Alternative	SELECTED CRITERIA		
	Degree to Which All Available Surveillance and Pilot Study Date Would be Used <sup>a</sup>	Degree to Which Uniform Technique Would be Applied to Entire G.L.Basin <sup>a</sup>	Incremental Cost Relative to Existing PLUARG Study Plan (Dollars)
1. Maintain Status Quo	0	0	0
2. Existing Program Plus Integrator	1	0	100,000
3. Unit Load Method with Manager	2	2	145,000
4. Unit Load and Regression Analysis Methods with Manager	3	3	417,500

<sup>a</sup>Rating: 0 poor  
 1 fair  
 2 good  
 3 excellent

B. Comparison on the basis of ability to satisfy modelling objectives as set forth in Exhibit B.

Modelling Objectives and Degree<sup>a</sup> to Which They Would Be Satisfied

Alternative	A Pollution Sources	B Management Effects	C In-stream Transport	D Seasonal Loadings	E Extreme Events	F Improve Monitoring	Totals
1. Maintain Status Quo	0	0	0	0	0	1	1
2. Existing Program Plus Integrator	1	0	0	1	0	1	3
3. Unit Load Method With Manager	2	0	0	2	0	2	6
4. Unit Load and Regres- sion Analy- sis Methods with Manager	3	1	1	3	0	3	11

<sup>a</sup>Rating: 0 poor  
1 fair  
2 good  
3 excellent

C. Based on the above comparison, the Committee concludes that Alternative 4-- Unit Load and Regression Analysis Methods with a Manager--is the technically superior approach for the GLLDM Project.

VII. SUMMARY

- A. The PLUARG Ad Hoc Committee on Modelling endorses, with minor revisions, the report of the Task C Subcommittee on Modelling.
- B. Basin-wide data likely to be required for the GLLDM Project exist but a massive data base development effort would be required to make full use of the available data.
- C. It is unlikely that a GLLDM can be developed with land management as an input parameter.
- D. The following four alternative approaches and corresponding incremental costs were developed:
  - 1. Maintain Status Quo \$0
  - 2. Existing Program Plus Integrator 100,000
  - 3. Unit Load Method with Manager 145,000
  - 4. Unit Load and Regression Analysis 417,500  
Methods with Manager.
- E. Based on a consideration of the degree to which available data are used, uniformity of approach and the extent to which modelling objectives are likely to be met, the Committee concludes that Alternative 4 --Unit Load and Regression Analysis Methods With A Manager--is the technically superior approach for the GLLDM Project.

LIST OF EXHIBITS

- A. Members of the Ad Hoc Committee on Modelling
- B. Summary of the January 14-15, 1976 Meeting of the PLUARG Task C Subcommittee on Modelling.



MEMBERS OF THE PLUARG AD HOC COMMITTEE ON MODELLING

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Represented by Mr. Merle Tellekson at the March 29 and 30, 1976 meeting and at the April 26 and 27, 1976 meeting.

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SUMMARY

of the

PLUARG TASK C SUBCOMMITTEE ON MODELLING

I. CHARGE TO THE COMMITTEE

- A. To recommend a method or methods for integrating pilot study and other available monitoring and modelling information into a predictive tool ("Great Lakes Basin Model") for the Great Lakes Basin.

II. OBJECTIVES OF THE BASIN MODEL

- A. To indicate the relative significance of the specific sources (i.e. land uses, such as cropland, pasture land, forest land and residential land, as well as point sources) which yield pollutants of concern in the Great Lakes to the tributary stream system.
- B. To indicate the relative significance of management practices (i.e., practices such as contour farming, fertilization procedures, tile drainage, minimum tillage and crop type on cropland; street cleaning, street salting and types of sewer systems on residential land; and levels of treatment at point sources) on the yield of pollutants of concern in the Great Lakes to the tributary stream system.
- C. To indicate the degree to which these pollutants are transmitted from sources along the rivers to the Great Lakes.
- D. To determine the average seasonal loadings of sediment, phosphorus, nitrogen, pesticides and other organic contaminants, heavy metals, and other materials as yet unidentified to the Great Lakes in terms of area, drainage system, streamflow, land use, land management, soils, geology, topography, meteorology, etc.
- E. To determine the statistical characteristics of pollutant loadings with emphasis on extreme events; e.g. the standard deviation of the annual loading of sediment, or the 10-year loading of sediment, or the relative magnitude of the 20-year, 10-year and average annual sediment loadings.
- F. To indicate ways in which streamflow and water quality monitoring programs and other data collection activities might be improved with respect to the types of data collected, the location and frequency of data collection, and the manner in which the data are filed or reported.

### III. TIME AND FUNDING RESTRICTIONS

#### A. Time Frame

1. Based on the current flow chart for the PLUARG study, the Basin Model should be available for use during the period from April 1 to September 30, 1977.
2. Therefore, the development of the Basin Model must be completed prior to April 1, 1977.

#### B. Funding Available

1. Apparently there are no work elements nor funds within the Task C pilot watershed studies designated for the development and use of a Great Lakes Basin Model.
2. Task D includes some work elements and funding arrangements for the development and use of a Great Lakes Basin Model.

### IV. AVAILABLE MODEL TYPES

The Subcommittee identified the following types of models to consider for possible use in developing a Great Lakes Basin Model.

#### A. Unit Load Model

With this technique, coefficients giving the annual or other temporal loading of particular constituents per unit area would be applied to the various land uses and land management practices in the Great Lakes Basin and a total load from the land surface to the stream system would be calculated. The unit loads would be obtained from the PLUARG monitoring studies and from the literature. The Unit Load Model is most likely to contribute to the achievement of objectives A, B, D and F.

#### B. Statistical Models

1. Regression Model: With regression or multivariate techniques, a relationship would be developed giving the concentration or loading of particular constituents to the Great Lakes as a function of factors such as area, drainage system, discharge, land use, land management practices, soils, geology, etc.

Regression models are most likely to contribute to the achievement of objectives A, B, C, D, and F.

2. Time Series Analysis Model: With this technique, characteristics regarding the time sequence of particular constituents, discharge, and meteorological variables would be determined. Relationships among the various time series would be of particular use for meeting objectives D, E and F.

C. Process-Oriented Model

With this technique, hydrologic, hydraulic and water quality processes are represented by algorithms linked together as to simulate the overall behaviour of a watershed in response to meteorologic and waste discharge conditions. Long term process-oriented models continuously and sequentially simulate watershed hydrologic, hydraulic and water quality processes during and between runoff events. Discrete event process-oriented models simulate the response of a watershed to major rainfall-snowmelt events. Process-oriented models could contribute to the achievement of all of the stated objectives.

D. Optimization Model

With this technique, functional relationships are developed, an objective is defined and an analytic technique such as linear programming is used to determine the optimum set of activities or decisions. This model might contribute to the achievement of objective B in the sense that it would be useful in the selection of the optimum management strategies in relation to environmental objectives.

V. ASSESSMENT OF MODEL TYPES

The Subcommittee assessed the manner in which each of the five model types would contribute to the achievement of each of the six objectives of the Basin Model. A matrix summarizing this assessment appears as an Attachment. The following factors were used in developing this matrix: PLUARG study time frame, data availability, cost, modelling, state-of-the-art, and probable accuracy of the results.

VI. RECOMMENDATIONS

- A. It is recommended that a Great Lakes Basin Model be developed on the basis of Unit Load and Regression techniques. These two model types appear to be the most feasible in light of the time, data, cost and state-of-the-art constraints imposed on the PLUARG study.
- B. It is recommended that the reliability of the Basin Model output, as influenced by such factors as input data quality and the nature of model structure, be determined during the development and application of the Model.

- C. Even though Process-Oriented models are not suitable for the Basin Model primarily because of data and cost limitations, it is recommended that they be used on the pilot studies because of their potential for addressing a wide variety of PLUARG concerns.
- D. It is recommended that a procedure be developed to allow and to encourage the flow of interpretive information from the pilot watershed studies to the Great Lakes Basin Modelling effort. The intent of this procedure is to provide the modelling effort with interim information as possible input to model development prior to the development of final interpretive reports.
- E. In order to implement the above recommendations, it is further recommended:
  - 1. That a Great Lakes Basin Modelling Project be established within PLUARG for the period from about June 1, 1976 to September 30, 1977;
  - 2. That one person already within the PLUARG study be given the responsibility for managing the Project; and
  - 3. That adequate support staff and computer facilities be assembled at one location.

Notes:

(i) The amount of resources required for the recommended Project and the likelihood of meeting the recommended time schedule will be significantly influenced by the availability and compatibility of the necessary data from the entire Great Lakes Basin.

(ii) The Great Lakes Basin Model is viewed as a critical synthesizing work element in the PLUARG study. Therefore, if the above recommendations are not implemented, the overall objectives and time-table of PLUARG will probably not be met.

Task C Subcommittee on Modelling Meeting

January 14-15, 1976

MATRIX SHOWING ABILITY OF MODEL TYPES TO SATISFY BASIN  
MODEL OBJECTIVES

(Scores out of 10)

<u>MODEL TYPE</u>	OBJECTIVE*						<u>TOTAL</u>
	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>F</u>	
UNIT LOAD	9	8	6	8	0	8	39
REGRESSION	8	8	6	8	7	10	47
TIME SERIES	0	0	0	6	7	6	19
PROCESS	4	4	4	4	4	7	27
OPTIMIZATION	<u>0</u>	<u>8</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	8
TOTAL	21	28	16	26	18	31	

\*OBJECTIVES - as stated in Section II of this report.

- A SOURCES OF POLLUTANTS
- B MANAGEMENT OPTIONS
- C TRANSPORT IN RIVERS
- D SEASONAL LOADINGS
- E EXTREME EVENTS
- F IMPROVING MONITORING



# BUDGET SUMMARY

Task	Description of Activity	Agency	1975-76		1976-77		1977-78		1978-79	
			FY76	\$000's	FY77	\$000's	FY78	\$000's	FY79	\$000's
			Ongoing	Suppl.	Ongoing	Suppl.	Ongoing	Suppl.	Ongoing	Suppl.
A.	<u>CANADA</u>									
	1. Compilation and Assessment of Management and Research Information.	Ont. Min. Environ.	-	-	-	5	-	10	-	-
		Environ. Canada	-	50	-	94	-	67	-	19.5
	2. Assessment and review of legislation technical remedial measures and recommendations for most practicable remedial measures.	Ont. Min. Environ.	-	-	-	10	-	20	-	-
		IJC	-	-	-	-	-	40	-	20.5
		Ag. Can.*	-	-	-	-	-	-	-	-
	SUB TOTAL			<u>50</u>		<u>109</u>		<u>137</u>		<u>40</u>
	<u>UNITED STATES</u>									
	1. As above	EPA	Completed							
	2. As above	EPA	-	20	-	95	-	36.5	-	20
		IJC	-	-	-	20	-	40.5	-	-
	SUB TOTAL			<u>20</u>		<u>115</u>		<u>77</u>		<u>20</u>
	TOTAL			<u>70</u>		<u>224</u>		<u>214</u>		<u>60</u>

\* Agr. Can. - To be provided from agricultural watershed funding as needs are identified.

Task	Description of Activity	Agency	1975-76		1976-77		1977-78		1978-79	
			Ongoing	Suppl.	Ongoing	Suppl.	Ongoing	Suppl.	Ongoing	Suppl.
			FY76 \$000's		FY77 \$000's		FY78 \$000's		FY79 \$000's	
C.	<u>CANADA</u>									
	1. <u>Agricultural Watershed Surveys</u>	Ag. Can.	400	} 640	400	335*	-	200*	-	-
		Ont. Min. Env.	N.D.		N.D.	110	-	40	-	-
		Ont. Min. Ag. & Food	180		180	315	-	80*	-	-
	SUB TOTAL		<u>580</u>	<u>640</u>	<u>580</u>	<u>760</u>		<u>320</u>		
	2. <u>Forested Watershed Surveys</u>	Env. Canada	160	-	-	15	-	-	-	-
	SUB TOTAL		<u>160</u>			<u>15</u>				
	3. <u>Development and Waste Disposal Uses</u>									
	a. Urban Land Development & Use	Ont. Min. Env.	-	116	-	55	-	40	-	-
	b. Transportation & Utility Systems	Ont. Min. Env.	-	-	-	15	-	10	-	-
	c. Sanitary Land-Fills	Ont. Min. Env.	-	52	-	25	-	15	-	-
	d. Processed Organic Waste Disposal	Ont. Min. Env.	-	125	-	44	-	30	-	-

\*Some funds transferred to Land Drainage Model.

Task	Description of Activity	Agency	1975-76		1976-77		1977-78		1978-79	
			Ongoing	Suppl.	Ongoing	Suppl.	Ongoing	Suppl.	Ongoing	Suppl.
			\$000's		\$000's		\$000's		\$000's	
C.	3e. Wastewater lagoons and irrigation systems	Ont. Min. Env.	-	-	-	-	-	5	-	-
	f. Landfilling (reclamation)		-	-	-	-	-	-	-	-
	g. Extractive industries	Ont. Min. Env.	-	-	-	30	-	30	-	-
	h. Private Waste Disposal	Ont. Min. Env.	-	96	-	45	-	10	-	-
	i. Recreational Lands	Env. Can.	-	-	-	10	-	-	-	-
	j. Data Integration and Loading Calculations	Ont. Min. Env.	-	-	-	-	-	50*	-	-
	SUB TOTAL			<u>389</u>		<u>224</u>		<u>190</u>		
	<u>4. Water Quantity and Quality Monitoring Network</u>									
	a. Extensive Surveillance network	Ont. Min. Env.	-	197	-	200	-	120	-	-
	b. Intensive Studies Programme	Ont. Min. Env.	-	54	-	45	-	40	-	-
	SUB TOTAL			<u>251</u>		<u>245</u>		<u>160</u>		

\*Some funds transferred to Land Drainage Model.

Task	Description of Activity	Agency	1975-76		1976-77		1977-78		1978-79	
			Ongoing	Suppl.	Ongoing	Suppl.	Ongoing	Suppl.	Ongoing	Suppl.
			FY76		FY77		FY78		FY79	
			\$000's		\$000's		\$000's		\$000's	
C.	5. Laboratory Support**		-	-	-	-	-	-	-	-
	6. Riverbank Erosion Surveys	Ont. Min. Nat. Res.	-	60	-	44	-	25	-	-
	SUB TOTAL			<u>60</u>		<u>44</u>		<u>25</u>		
	TOTAL		<u>740</u>	<u>1340</u>	<u>580</u>	<u>1288</u>	-	<u>695</u>	-	-
C.	<u>UNITED STATES</u>  All pilot watershed studies essentially unchanged from 1974 Detailed Study Plan.									

\*\* Included in the cost of other activities.

Task Description of Activity	Agency	1975-76 FY76 \$000's		1976-77 FY77 \$000's		1977-78 FY78 \$000's		1978-79 FY79 \$000's	
		Ongoing	Suppl.	Ongoing	Suppl.	Ongoing	Suppl.	Ongoing	Suppl.
D. CANADA									
1. Shoreline Erosion	Env. Can.	100	21 <sup>+</sup> (60)*	-	-(4)	-	-	-	-
2. River Inputs	Env. Can.	-	110(180)	-	55(96)	-	30	-	-
	Ont. Min. Env.	-	-	-	-	-	-	-	-
	Ont. Min. Agr.&Food	-	12	-	3	-	-	-	-
3. Effects of River Inputs	Env. Can.	50	105(95)	50	65(182)	-	-	-	-
	Ont. Min. Env.	-	23	-	27	-	25	-	-
	Ont. Min. Agr.&Food	-	21	-	17	-	10	-	-
SUB TOTAL		<u>150</u>	<u>391</u>	<u>50</u>	<u>329</u>	-	<u>65</u>	-	-

117

\* Figures in parentheses indicate allocations to PLUARG.

+ Figures not in parentheses indicate budget estimates.



			1975-76 FY76 \$000's		1976-77 FY77 \$000's		1977-78 FY78 \$000's		1978-79 FY79 \$000's	
Task	Description of Activity	Agency	Ongoing Suppl.		Ongoing Suppl.		Ongoing Suppl.		Ongoing Suppl.	
FINAL REPORT	Preparation of charts graphs, maps, photos and text plus re-duction									
	CANADA	Env.Can.	-	-	-	-	-	100	-	-
	UNITED STATES	EPA., S.C.S.	-	-	-	-	-	100	-	-
	TOTAL							<u>200</u>		
LAND DRAINAGE MODEL	CANADA	Ag. Can Ont. Min. Env.	-	-	-	35.0	-	160.0		
	UNITED STATES	EPA	-	-	-	156.6	-	52.2		
	TOTAL					<u>191.6</u>		<u>112.2</u>		
GRAND TOTAL			<u>890</u>	<u>2315</u>	<u>630</u>	<u>2237.6</u>	-	<u>1460.2</u>	-	<u>60</u>



