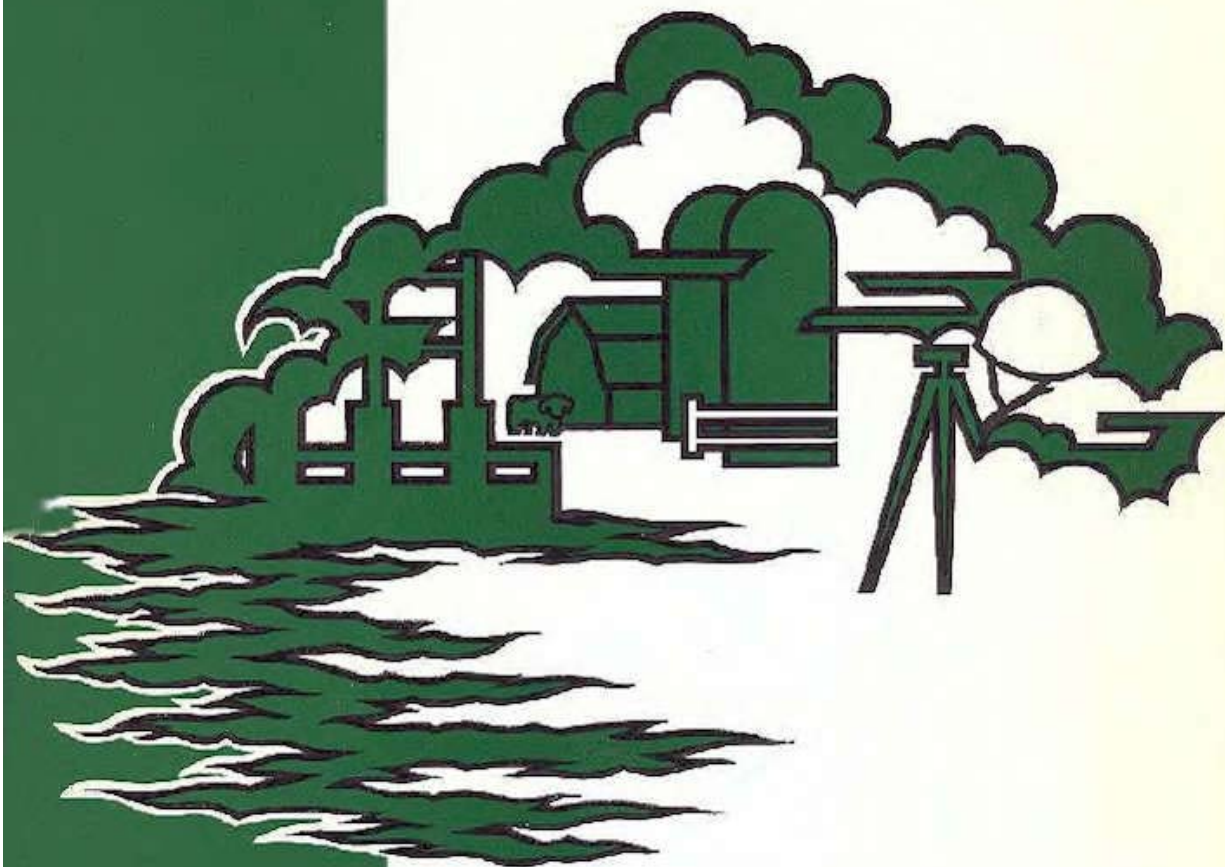


**INTERNATIONAL REFERENCE GROUP
ON GREAT LAKES POLLUTION
FROM LAND USE ACTIVITIES**



**INTERNATIONAL
JOINT
COMMISSION**

**QUALITY CONTROL HANDBOOK
FOR
PILOT WATERSHED STUDIES**

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

(PLUARG)

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INTERNATIONAL JOINT COMMISSION

Regional Office

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1. INTRODUCTION

The primary reason for quality control is to ensure that the conclusions of the various investigators, and the summaries developed therefrom, are based upon comparable data. In addition, the program will aid investigators in ascertaining whether their needs for precision and accuracy are being met and will contribute to overall proficiency by providing opportunities for scientists to discuss solutions to common problems.

This Handbook is intended to give investigators associated with Task Group C studies under PLUARG the guidelines for quality control. The looseleaf arrangement of the Handbook will facilitate updating as additional information becomes available. In this regard, all pages will be dated at the time of issuance.

The TABLE OF CONTENTS lists the sections included in the initial issuance of the Handbook. Additional sections will be added as required. During the 1975 field season, the Handbook will be a Working Document in effect on the date of issuance. Users are requested to send the River Basin Studies Coordinator, in the IJC Regional Office, Windsor, Ontario N9A 6T3, suggestions for improving the Handbook.

Representation of PLUARG on the Data Quality Subcommittee of the Implementation Committee of the Water Quality Board will enhance the efforts of PLUARG in carrying out a data quality control program. The results of that Subcommittee's work will be appropriately incorporated in the Handbook.

2. PARAMETER LISTS

The parameter lists will be considered to contain the general parameters necessary to satisfy the reference, i.e. those parameters believed to be significant causes of degradation to Great Lakes water quality or those parameters likely to be implicated in the transport of pollutants.

Some parameters are essential to enhance the use of data from the pilot watersheds for predictive capability to the Great Lakes Basin. To the extent possible and feasible, all parameters on the list will be investigated in all PLUARG river basin studies. Each watershed project manager will propose to the River Basin Studies Coordinator, for consideration by PLUARG, those specific parameters on the list pertinent to the scope and objectives of the individual projects.

2.1 WATER SAMPLES

2.11 Parameters
(See 3.41 -- Filtration)

2.111

The following parameters are to be run on all water quality samples.

A. Nutrients

1. Phosphorus

- a. Total Phosphorus on Unfiltered Sample
- b. Total Phosphorus on Filtered Sample
- c. Dissolved Reactive Phosphorus on Filtered Sample

2. Nitrogen

- a. Organic Nitrogen
- b. Ammonium Nitrogen
- c. Nitrate Nitrogen plus Nitrite Nitrogen (Where nitrite N is known to be an important contaminant, nitrite and nitrate N will be determined independently)

B. Salts

1. Alkalinity - Specify whether Filtered or Unfiltered
2. Calcium-Magnesium or Hardness - on Filtered Samples
3. Chloride, and/or Sodium and Potassium-Chloride on Filtered Samples

C. Organic Parameters

1. Organic Carbon - Specify whether Total or Dissolved and whether Filtered or Unfiltered

D. Field Analyses

1. pH
2. Dissolved Oxygen
3. Conductivity - Specify if not Run in Field

4. Temperature
5. Flow

E. Physical

1. Suspended Solids and/or Turbidity

2.112

At the discretion of the watershed project manager, the following parameters will be run less frequently.

A. Salts

1. Sulfate
2. Dissolved Reactive Silicate as Silicon
3. Iron and/or Aluminum

B. Organics

1. Phenolics
2. Cyanide
3. Pesticide Scan

C. Metals

1. Chromium
2. Arsenic
3. Selenium
4. Nickel
5. Cadmium
6. Mercury
7. Copper
8. Lead
9. Zinc

D. Bacteriological Analyses

1. Total Coliform
2. Fecal Coliform
3. Fecal Streptococci

2.2 SEDIMENT, RIVERBANK MATERIALS AND SOIL SAMPLES

2.21 Introduction

The parameter list under 2.23 -- Parameters will be used for suspended sediments, bottom sediments, riverbank or shoreline materials, and soil samples.

Sample residuals will be retained for later analysis for parameters not initially investigated. Proper preparation and storage of such samples will be emphasized.

2.22 Definitions

Each investigator will adequately define sediments in terms of method of sampling, as well as method of handling (sieving, filtering, separation out of organics, etc.), so that the study reports will show what an analysis of "sediment" means relative to the "sediment's" origin, mode of transport and fate.

All sediments will be labelled as organic, inorganic, or mixtures of the two.

The following definitions and discussion, provided by the U.S. Geological Survey, will be used for definition purposes by each investigator.

2.221 Sediment

In the broadest sense, sediment is defined as -"Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity or ice and has come to rest on the earth's surface either above or below sea level." Sediment is further defined as "that material passing through a 2 mm screen and retained on a 0.45 μm filter".

2.222 Suspended Sediments

The amount and nature of materials dispersed in water (streams, lakes, rivers, etc.) is highly variable. Some suspended materials become bottom sediment as soon as quiescent conditions exist. Bottom sediments exposed to high hydraulic or energy conditions, specifically those fractions below 2 mm in diameter and particularly below 10 μm , become suspended sediments. The particulates filtered from water samples should be looked upon as suspended sediment.

For PLUARG studies, suspended sediment is defined as that sediment in suspension that can be sampled with existing samplers and are coarse enough to be retained on a 0.45 μm filter. For instance, suspended inorganic sediment is the inorganic or mineral portion of the sediments being carried in suspension that are coarse enough to be retained on a 0.45 μm filter.

2.223 Bottom Sediments

The problem of differentiating between "bedload sediment" and "bottom sediment" has been considered by technical advisors to PLUARG. The decision has been made to drop the term "bedload". The work underway under PLUARG in New York on evaluating the Bogardi Bedload Sampler may result in further consideration of this decision.

In the broadest sense, bottom sediment (fluvial) is defined as -- "The sediment which forms the bed of a stream or other body of water." The term, bed material, is used generally in the same sense; however, it generally refers to inorganic sediments.

For PLUARG studies, bottom sediment is defined as the unconsolidated material lying in the top 5 to 10 centimeters of a water course bottom, ranging in size between 0.45 μm and 2 mm, and that can be sampled using

currently available sampling equipment. Examples of such samplers are the USBM-54 and USBMH-60.

Samples of bottom sediments collected by coring devices must be so defined in terms of depth of material sampled relative to the bed surface elevation, etc.

2.23 Parameters

To the extent possible and feasible, the following parameters will be investigated in all PLUARG river basin studies.

- A. Total Phosphorus
 - 1. Non-Apatite Inorganic Phosphorus
 - 2. Apatite Phosphorus
 - 3. Organic Phosphorus
- B. Total Kjeldahl Nitrogen
- C. Ammonia Nitrogen (NH_4) -- Extractable Solution being 1N. or 2N. KCl
- D. Extractable -- Solution being 1N. BaCl_2
 - 1. Calcium
 - 2. Magnesium
 - 3. Sodium
 - 4. Potassium
- E. Dithionite - Citrate
 - 1. Iron (Free iron oxides)
 - 2. Manganese
- F. Oxalate -- Solution 1N. $(\text{NH}_4)_2 \text{C}_2\text{O}_4$ at pH 3
 - 1. Iron
 - 2. Aluminum (Selected samples)

G. Heavy Metals

1. Chromium
2. Arsenic
3. Selenium
4. Nickel
5. Cadmium
6. Mercury
7. Copper
8. Lead
9. Zinc
10. Cobalt
11. Tin
12. Manganese
13. Others as appropriate in particular situations

H. Total Sulfur (On selected samples, using Reference: Soil Science Society of American Proceedings 34:62, 1970)

(See Thompson, J. F., under 9. -- REFERENCES)

J. Cation Exchange Capacity -- Direct Method, using 1N. BaCl₂

1. On Total Sediment Sample
2. On Selected Samples of Clay Fraction (<2μ)

K. Total Carbonates

L. Organic Matter

1. Total Carbon
2. Organic Carbon (Total Carbon - Inorganic Carbon)

M. pH (one to one soil-water, measured in the field)

N. Particle Size Distribution

1. Electrolyte Dispersed: sieve + sedimentation
2. Water Dispersed (on selected samples)

O. Mineralogy -- Analyses will be made to permit mineralogical characterization of sediments in each watershed. Messrs. R. L. Thomas, L.P. Wilding, and G. J. Wall will prepare a proposal on this aspect. It appears likely that one laboratory in the U.S. and one in Canada will handle Clay ($<2\mu$) and Sand and Silt ($>2\mu$) mineralogy for all watersheds.

3. SAMPLE COLLECTION

3.1 GENERAL

Please refer to 6.3 -- DOCUMENTATION OF METHODOLOGY in section 6. of this Handbook on ANALYSIS QUALITY CONTROL and to the publications listed under 9. -- REFERENCES.

3.2 SITE SELECTION

A statement of objectives will be examined for each site. This will allow for adequate consideration of:

- ▶ the land use activity to be studied (i.e., what is to be measured?),
- ▶ the stream use, (i.e., can what is there be measured?),
- ▶ the suitability of the site to meet the objectives,
- ▶ the history of the site, if available,
- ▶ the site access and utilities availability,
- ▶ the availability of instrumentation,
- ▶ the availability of historical data for the site.

Inherent in individual site selection are the basic considerations relating to the basin as a whole, such as basin characteristics (soils, geology, etc.), an adequate watershed description (size, lots, housing, population density, etc.), the availability of other hydrometric data (precipitation, etc.), the degree of representativeness of the basin in terms of a larger area, the degree to which information from the basin can be used for prediction purposes outside the watershed, and the effects of basin characteristics on the parameters to be studied. Site selection depends upon the availability of a review of existing data so that the abovementioned factors can be considered.

3.3 STREAMFLOW MONITORING

Streamflow monitoring will be carried out on a continuous basis wherever possible in order to provide a high degree of accuracy in the preparation of hydrographs. Where continuous monitoring is not possible and flows are estimated or extrapolated, an estimate of the precision (confidence limits) of the data will be given. At least daily hydrographs are required and low flows are considered to be the least important measurements relative to determining total loadings to the Great Lakes.

3.4 WATER QUALITY MONITORING

Water quality monitoring will be carried out on a continuous basis (automatic sampling) wherever possible. The smaller the watershed, the greater is the need for frequent sampling. Automatic sampling will be desirable to assess the response of small watersheds to climatological and physical events. Automatic sampling can be expected to cover the rising limb of the hydrograph on the occasion of a rainfall event and to cover a specific application of a chemical in a small watershed. Although automatic sampling will be point sampling, for small watersheds the variability of water quality with time (or flow) will be more important than its variability as a result of the cross-sectional area. Even with automated sampling systems a manual backup provided by an on-site technician is necessary to ensure the operation of the automatic monitor, to collect and ship bacteriological samples, and to carry out those tests which cannot be delayed until the samples reach the laboratory.

3.41 Filtration

Field filtration through a 0.45 μ filter will be done on samples to be analyzed for nutrients; and, if possible, for other parameters for which analysis on filtered samples is indicated. Laboratory filtration may be required for parameters other than nutrients, if field filtration of large volumes of samples is not feasible.

3.5 SEDIMENT SAMPLING

Sediment sampling will be carried out above and below reservoirs and in proximity of the Great Lakes so that an estimate of total loadings can be determined. Additionally, in selected watersheds sediment samples will be taken at progressive locations from the headwaters and downstream locations to investigate transport mechanisms and changes in pollutant content associated with streamflow. The frequency of sampling needs to be adequate to relate to the total flow hydrograph to establish total loading volumes.

3.51 Suspended Sediment

The problem of obtaining an adequate quantity and representative sediment samples is recognized. Compositing particulates from several separate samplings over the season, however, in order to have a sufficient quantity of sediment for analysis, can produce questionable data.

The Canadian Centre for Inland Waters (CCIW) has been using for some years a continuous centrifuge for separating particulates from 600-1200 liters of sample. The unit is transported from site to site to permit separation of fresh samples. The estimated cost of the centrifuge unit, including truck and generator, is \$70,000. Those desiring further information on this technique should contact CCIW.

3.52 Bottom Sediment

Samples will be removed from locations that have had deposition from upstream. It is appropriate to composite the individual field samples for laboratory analysis. A sufficient number of samples will be taken to ensure representative results, realizing that it is not feasible to predetermine the minimum number of samples generally needed to be taken for all locations in the basin. Investigators are referred to publications listed under 9. -- REFERENCES for information on this subject.

3.6 SAMPLING FREQUENCY

3.61 General

Guidelines for calculating sampling frequency to produce statistically sound data will be inserted here when provided by Dr. John Clark of the IJC Regional Office.

3.62 Water

Stream sampling will be scheduled periodically throughout the year. Where automated sampling is not possible, depth-integrated samples will be taken on a frequent basis.

Arrangements also will be made to obtain samples on an event (e.g. high runoff and "spring flush" periods) basis. Every effort will be made to obtain event samples to permit integrating data for the entire event.

3.63 Sediment

Bottom sediment samples will be removed to permit characterizing the geologic and mineralogic nature of the watersheds.

Samples of bottom and suspended sediments will be taken frequently enough to permit estimating (1) the amount and nature of pollutant contributions moving from the pilot watersheds; and, (2) the changes in the nature and amount of pollutants "carried" by sediments in streamflows; i.e. changes associated with transport and deposition mechanisms.

Where automated sampling is not possible, depth-integrated grab samples will be taken on a frequent basis.

Sediment sampling, particularly suspended sediment, is especially important during the "spring flush". Specific plans and arrangements will be made by responsible investigators to obtain samples during this event.

4. SAMPLE HANDLING

No recommendations for uniformity on sample handling between projects are provided at this time. Each responsible investigator will maintain a record of sample handling procedures and sample preservation techniques (from field to laboratory) for each parameter investigated. Refer to 6.3 -- DOCUMENTATION OF METHODOLOGY in section 6. -- ANALYSIS QUALITY CONTROL.

Sample residuals will be retained for later analysis for parameters not initially investigated.

Attention is called to 9.0, the section on REFERENCES; and, all investigators are requested to send the River Basin Studies, Coordinator, IJC Regional Office, any information on this subject they wish to share with others involved in PLUARG.

5. SAMPLE PREPARATION AND ANALYSIS

Laboratory procedures will be at the discretion of the particular laboratory supervisor, except as noted above under 2. -- PARAMETER LISTS for certain specific parameters.

Please refer to 6.3 -- DOCUMENTATION OF METHODOLOGY in section 6. -- ANALYSIS QUALITY CONTROL and to the publications listed under 9. -- REFERENCES.

6. ANALYSIS QUALITY CONTROL

United States and Canadian laboratory analyses will be coordinated under headings as follows:

- ▶ Blind Replicates from Field to Laboratories
- ▶ Reference and Natural Samples for Between-Laboratory Comparisons
- ▶ Documentation of Methodology
- ▶ In-Laboratory Quality Control.

6.1 BLIND REPLICATES FROM FIELD TO LABORATORIES

Each project in which field samples of water, sediment or soil are collected for laboratory analyses will be involved in this aspect of quality control.

Replicate samples will be taken in the field at the time and place of the base line sampling schedule (not for special event sampling, unless the project manager desires to do so) as follows:

- ▶ in any watershed or project with up to 25 sites, one site will be sampled in replicate;
- ▶ in any watershed or project with more than 25 sites, not less than one sample site in each 25 will be sampled in replicate, e.g. a watershed with 26 sampling sites will require that 2 sites be sampled in replicate.

The replicate samples will be removed from the site separately -- not one sample removed from the site and divided and allocated to two sample containers. It is desirable to collect the replicate samples simultaneously. Recognizing the difficulty of doing so, however, the sampler should record the exact time each replicate sample is removed. Samples will be labelled without special designation in order that the replicate samples will be submitted "blind" along with all other samples for routine analysis.

The project manager (leader, principal investigator) will be responsible for designating the site and timing of replicate samples and the on-going evaluation of data from them. This will include prompt notification of the laboratory section chief of the results of his evaluation of data for replicate samples. The project manager will notify the River Basin Studies Coordinator of the schedule and results of replicate sampling.

6.2 REFERENCE AND NATURAL SAMPLES FOR BETWEEN-LABORATORY COMPARISONS

6.21 Reference Samples

The River Basin Studies Coordinator, located in the IJC Regional Office, will be responsible for periodically sending reference samples, both synthetic and stabilized natural, to the participating laboratories for analyses. The participating laboratories will promptly analyze the samples and send their results to the Coordinator.

6.22 Round-Robins

Participating laboratories will be asked to identify existing intercomparisons in which they are participating, or have participated, and to provide a tabulation of the data and identify their performance to the River Basin Studies Coordinator.

The Coordinator will identify the projects requiring similar laboratory analytical functions. He will then ask the managers of such projects to initiate regular sample exchange programs to assess on a continuing basis the degree of data compatibility. Program managers are to inform the Coordinator of the details of the exchange program in advance and have the laboratory results forwarded directly to the Coordinator for compilation and evaluation.

6.23 Special Studies

As problems are identified, or suspected, special inter-comparison studies may be initiated by 1) the project managers, 2) the laboratory analysts, or 3) the Coordinator. The purpose of these studies will be to clarify the nature and effect of various sources of data incompatibility. Certain participants in these special studies may be requested to study these effects in depth.

The River Basin Studies Coordinator will be informed of the structure and intent of all special studies.

6.3 DOCUMENTATION OF METHODOLOGY

All project managers and analytical scientists will be required to document their current techniques for sampling; sample handling, preservation and storage; sample preparation; and final analysis. Two questionnaires 1) Sampling Procedures and Sample Handling and, 2) Analytical Methodology will be used for the documentation to be filed in the Regional Office of IJC at Windsor, Ontario, and used:

- ▶ to assist in identifying possible causes of data incompatibility that are detected in the interlaboratory comparison program so that incompatibility may be corrected,
- ▶ to initiate and assist in discussion of the rationale for use of differing techniques and to lead to a consensus as to preferred procedures and,
- ▶ as a permanent record of the procedures employed by participants during various stages in the PLUARG program.

Modifications of the procedures also will require documentation as they occur.

NOTE: The questionnaires are under development and will be provided later.

6.4 IN-LABORATORY QUALITY CONTROL

The variety of techniques available to the analysts will require one or more workshops to deal with this aspect of overall quality control. The information obtained from the questionnaires referred to under 6.3 -- DOCUMENTATION OF METHODOLOGY will be useful in organizing the workshops. It will be desirable to devote a part of the workshop(s) time to separate sessions of the analysts involved in a group of parameters to relate specific quality control procedures to the specific problems associated with those parameters. The following parameter groups will be established:

- ▶ Nutrient and Water Quality
- ▶ Metals and Industrial Wastes
- ▶ Pesticides
- ▶ Microbiological
- ▶ Physical, including sample preparation techniques for sediments, soils and sludges.

Some form of documentation for data quality procedures will be required, but may vary according to laboratory involvement in PLUARG projects or studies.

7. DATA HANDLING AND PROCESSING

This section of the handbook is under development. The results of the work by the Data Quality Subcommittee of the Implementation Committee of the Water Quality Board, together with the material to follow will be the basis for the contents of this section.

7.1 TASK GROUP C QUALITY CONTROL WORKSHOPS

Data management has been considered at two Task Group C workshops -- East Lansing, Michigan, July 16-17, 1973 and Madison, Wisconsin, December 3, 1974. In addition, technical advisors to Task Group C in Canada and the U.S. have provided suggestions on this subject. The following material is based on the workshops and subsequent suggestions.

7.11 System Function

The function of the data management system is to provide available land use and water quality-quantity data to Task C and D participants.

The subfunctions necessary to fulfill the system function are:

- ▶ store, retrieve, prepare, manipulate (statistical analyses) and display land use and water quality-quantity data,
- ▶ transfer data from producer-participants to user-participants,
- ▶ provide interface between pilot watershed studies and between Task C, Task B and Task D.

A distinction is drawn between "data" and "information" with the first simply denoting numerical quantities, while the second term pertains to numerical quantities for which qualifications and interpretations will be provided. "Data" represent only raw numbers, while "information" refers to the processed or interpreted content of the

numbers.

The data management system will be a system for moving data. That is, data qualification and interpretation -- other than possible computation of standard statistics -- will not be part of the system's function. Data qualification or interpretation will be the responsibility of data producers and/or users, subject to their hypotheses or models of the relationships inherent in the data.

7.12 Constraints Imposed on Pilot Watershed Study Requirements

Regardless of the level of detail used to inventory land use in the pilot studies, the data will have to be "upward compatible" with the 18 land use classifications already established by Task B and U.S. Geological Survey Circular 671; 9. -- REFERENCES. Land use projections provided by Task B will be taken as "given", as constraints to the system design.

Water quality-quantity and meteorological data will be included as part of the system. This includes data that may already exist in addition to the voluminous amount of new data to be obtained under the pilot watershed studies.

Compatibility with existing data systems may be a constraint, since water quality-related data derived from U.S. pilot watershed studies must be entered into the U.S. EPA STORET system as a condition of the EPA grants used to fund those studies.

Water quality data derived from Canadian pilot studies may have to be entered into Canada's WQIS (Water Quality Information System).

Computer systems used for data management should be similar to the extent that data can be readily exchanged on media such as magnetic tape, magnetic disk, cards, or through terminals using telephone line linkages.

Existing data, as well as some new data generated by the pilot studies, may need to be accessed and handled manually (from hard-copy or "office" files), since it will not be feasible to design a data management system that can incorporate all types of data from all sources.

Adequate "back-up" and security protection for data must be provided. Explicitly defined procedures must be developed as measures to prevent the loss, destruction or unauthorized or unintended use of data.

The system must meet the needs of the users already identified, including data gatherers, laboratories, investigators, River Basin Studies Coordinator, and Technical Committees B, C and D, as well as unidentified future users of the project results.

Data Identification is essential. Each sample taken must be uniquely identified within the system by time, place and type of sample.

Capacity of the system must be sufficient to accommodate all data to be obtained during PLUARG study.

The system should provide at least one interpreted printed output format for all data.

Quality control prior to input will be needed. Procedures for quality control must be an integral part of the design and use of the system. One data handling sequence which seems logical: laboratory, to temporary storage in the system, to the quality check process, to permanent storage in the system.

In light of the broad range of values to be encountered, it is likely that a manual check by the data-producer would provide the check.

Compatibility of soils data will be difficult. U.S. and Canadian soils classifications differ. Thus, soils data may have to be filed in more than one classification.

Common units of measurement will be used. The Commissioners of IJC have concluded that during the period of U.S. and Canada converting to the metric system, reports to IJC will use English and metric units. The metric (SI--Systeme Internationale) units will be given first, followed by the English (fps) units in parentheses.

The Universal Transverse Mercator (UTM) system will be used for the basic geo-reference system.

A Data Index or catalogue of the identified pieces of information and how they are to be coded will be needed. An index (perhaps a 3 or 4 digit number and a mnemonic code) should be maintained of water quality-quantity parameters, soil parameters and meteorological parameters to identify the type of data and method or technique used to obtain it. This index must be kept current and must be available to all pilot study participants.

7.13 The Ideal System

The ideal system would be one that is centralized, no cost, English language oriented, statistical manipulating, free-format, infinitely large, no-time-lag, full access system to provide available land use and water quality-quantity data to Task Groups C and D participants.

7.14 Potential Alternative Systems

- A. A centralized system - hardware and software - operated by and physically located at the IJC Regional Office or some service bureau. This would be a new system.

- B. STORET, or a modification of, or addition to it. For example, modify to change output formats or add a module for land use data.
- C. Mini-computer data base system.
- D. The following systems should be explored:
 - 1. The U.S. Soil Conservation system for managing soils and related data.
 - 2. USGS (Department of Interior) hydrologic data and water quality data systems.
 - 3. Canada's CANSIS (Canada Soil Information System), used to store and map soils data.
 - 4. New York State Department of Environmental Conservation's water quality-quantity system.
 - 5. Southeastern Wisconsin Regional Planning Commission's land use-natural resource base data system.
 - 6. Canada's WQIS (Water Quality Information System).
 - 7. The IFYGL (International Field Year for Great Lakes) system which was a blend of many systems focusing then at the objective of providing all the data to STORET.
 - 8. "System 2000", for use for water quality-quantity and land use data which is being considered for development at the University of Wisconsin at Madison.
 - 9. Wisconsin DNR's system for water quality data which is under development.
 - 10. Purdue University's MIRACLE system and CEC 6400/ 6500 system for water quality-quantity data, meteorological data and land use data.
 - 11. Canada's NAQUADAT system.
 - 12. Cornell's LUNR system for land use data.
 - 13. Michigan DNR's WISER system.

14. A manual data management system.
15. Ontario sample information system.

7.15 Criteria for Selection of a System

The following list of criteria should be used in selecting the system(s):

- A. Time (time required to make the system operational and response time once the system is operational).
- B. Cost.
- C. Simplicity for users.
- D. Accessibility (for example, physical proximity or access by a remote terminal).
- E. Input-output options.
- F. Compatibility (i.e. standard formats when data are exchanged).
- G. Reliability.
- H. Ability of PLUARG users to control system and effect modifications.
- I. Security.

7.16 Recommendations

A review of the constraints and in consideration of the above criteria, against the set of options, results in two general conclusions. First, the necessary information types are a broader range than presently incorporated in any of the alternative systems. Second, the time constraint eliminates many of the alternatives. These realities result in the following specific recommendations.

7.161 Phase 1 -- Characteristics of the Data Management System (DMS)

- A. The DMS should perform the following overall function: provide available water quality-quantity, meteorological and land use data to Task C and D participants.

- B. Within the above overall function, the DMS should perform the following subfunctions:
 - 1. Store, retrieve, prepare, manipulate (statistical analyses), and display all data.
 - 2. Transfer data from producer to user.
 - 3. Provide interface capability between pilot watershed studies and between Tasks B, C and D.

- C. The DMS should provide for the management of "data" and not necessarily "information". "Data" simply denotes numerical quantities while "information" pertains to numerical quantities for which qualifications and interpretations are provided. Data qualification and interpretation -- other than possible computation of some standard statistics -- is not part of the DMS's function, but a part of the research role of the analysts.

- D. The DMS should have the capability to accommodate water quality-quantity data, meteorological data and land type and use data.

- E. The DMS should be designed so that land type and use data in the system be "upward compatible" with the 18 land use classifications established by the Task B subgroup and U.S. Geological Survey Circular 671; 9. -- REFERENCES. The land use coding classifications must be such that they can be aggregated into the more general 18 classes.

- F. The DMS should be compatible with the U.S. EPA STORET system.
- G. The DMS should utilize interface computer systems that are compatible with respect to both hardware and software.
- H. Defined security and back-up provisions should be incorporated into the DMS to prevent the loss, destruction or unauthorized or unintended use of the data.
- I. The DMS should be made operational, at least with respect to the selection of data formats, by early 1975 so as to be available for use as data production begins under the pilot watershed studies.
- J. The DMS should be designed to meet the needs of PLUARG study participants as well as potential future users outside of and/or subsequent to the PLUARG study.
- K. Each item of data (sample results) entered into the DMS should be uniquely identified by type, place and time with such identification being provided by a numerical index in combination with a Mnemonic code.
- L. The DMS should have sufficient capacity to accommodate all data to be obtained under the PLUARG study.
- M. The DMS output should be provided in a readily interpreted format.
- N. Quality control capability should be designed into the DMS system and quality control procedures should be carefully followed in using the system.
- O. Since soils classifications systems differ between and within the U.S. and Canada, soils data should be entered into the DMS in more than one

classification system where feasible.

- P. All water quality-quantity and meteorological data should be entered into the system in metric units and land use and related data should be filed in English units.
- Q. Primary consideration should be given to the use of the UTM (Universal Transverse Mercator) system as the means of identifying the geographic location of data entered into the DMS.

7.162 Phase 2 -- Process for Implementing the Data Management System

- A. The IJC Regional Office should become the repository for pilot watershed study data and maintain that data for an indefinite period extending beyond the duration of the PLUARG study.
- B. Individual pilot studies may use a data management system to meet their specific needs, but each study investigator should supply data in a standard format for purposes of data exchange among PLUARG study participants.
- C. The U.S. EPA should consider expanding STORET to include meteorological, land use and other data as required by the PLUARG study. This action would make maximum use of the data management efforts already initiated by the U.S. EPA and recognize the broadened objectives of the PLUARG relative to the existing STORET system.
- D. The River Basin Studies Coordinator should be assigned the responsibility of data management activities between Task C participants and related data management activities of Task B and D participants.

8. DATA ASSESSMENT

Assessment of data during the course of the study will facilitate making any desirable adjustments in the watershed studies to meet the needs of PLUARG.

8.1 DATA FROM BETWEEN-LABORATORY COMPARISONS

The River Basin Studies Coordinator will promptly analyse and summarize the results of the laboratories on each set of reference samples. He will report back to the laboratories the target values for the samples and a summary of the results. He will also inform each project manager of the performance of the laboratory(ies) providing services for that project.

Similarly, the Coordinator will be responsible for assessing the results of round-robins and reporting his assessment to the laboratories and project managers concerned.

8.2 ANNUAL DATA

In addition to the continuing assessment of data by each study leader for his or her project or subproject, an overall annual assessment of data is desirable. To permit this latter assessment the following procedures will be used:

8.21

As soon after the close of the field season as possible, each study leader will send a summary of the data covering analyses for each parameter monitored in that study to the Coordinator. The summary should consist of a tabulation of the raw data, including sample source, date of sampling and analytical results for each of the

parameters analyzed in duplicate. Data should be grouped chronologically according to 8.211.

8.211 Format for Annual Data Assessment

COMPARISON OF WATER QUALITY ANALYSES*
LABORATORY X AND LABORATORY Y
Agricultural Watershed K, Site 4

Date	Total N (Mg/L)		Nitrate N (Mg/L)		Total P (Mg/L)	
	Lab. X	Lab. Y	Lab. X	Lab. Y	Lab. X	Lab. Y
1975						
Apr. 19	9.3	8.8	8.2	7.7	0.182	0.150
May 29	3.7	6.9	5.5	5.6	0.656	0.290
July 10	6.5	6.6	5.6	5.6	0.279	0.270
Oct. 28	2.8	3.6	1.9	2.8	0.150	0.150
Dec. 23	13.4	13.6	12.3	13.0	0.166	0.110

* The information required under 6.3 -- DOCUMENTATION OF METHODOLOGY and, if appropriate, under 6.1 -BLIND REPLICATES FROM FIELD TO LABORATORIES will be used for data assessment in association with the analyses results.

8.22

The Coordinator will review the data and take the necessary steps for clarification of questionable data with the study leaders reporting on the same parameter(s).

9. REFERENCES

- Anderson, James R., Hardy, Ernest E., and Roach, John T.; 1972; A Land Use Classification System for Use with Remote Sensor Data; USGS Circular 671; U.S. Geological Survey, Washington, D.C. 20242.
- Armstrong, D.E., *et. al.*, Minutes of July 16-17, 1974 meeting Subcommittee on Analytical Methods, Task Group C Technical Committee, PLUARG, (Available from River Basin Studies Coordinator, IJC Regional Office, Windsor, Ontario, N9A 6T3).
- Federal Advisory Committee on Water Data, Summary of Eighth Meeting, May 9, 1973; Office of Water Data Coordination, U.S. Geological Survey, National Center, MS 417, Reston, Virginia 22092.
- Federal Interagency Work Group on Designation of Standards for Water Data Acquisition, 1972, Recommended Methods for Water Data Acquisition; Chief, Office of Water Data Coordination, U.S. Geological Survey, National Center, MS 417, Reston, Virginia 22092.
- Guy, Harold P., 1969, Laboratory Theory and Methods for Sediment Analysis; Techniques of Water-Resources Investigations; Book 5, Chapter CI, U.S. Geological Survey; U.S. Government Printing Office, Washington, D.C. 20402 -- Stock Number 2401-0501, Price 65 cents.
- Guy, Harold P., and Norman, Vernon W., 1970; Field Methods for Measurement of Fluvial Sediments -- Techniques of Water-Resources Investigations; Book 3, Chapter C2, U.S. Geological Survey; U.S. Government Printing Office, Washington, D.C. 20402 -- Stock Number 2401-0936, Price 70 cents.
- Porterfield, George, 1972, Computation of Fluvial-Sediment Discharge; Techniques of Water-Resources Investigations; Book 3, Chapter C3, U.S. Geological Survey; U.S. Government Printing Office, Washington, D.C. 20402 -- Stock Number 2401-2061, Price 75 cents.
- Thompson, J.F., Manual of Analytical Methods: Prepared by the Pesticides and Toxic Substances Effects Laboratory, National Environmental Research Center, Research Triangle Park, North Carolina 27711. (Those wishing this Manual should contact Mr. Thompson at the above address.)

10. INVESTIGATORS

The following list of Investigators is incomplete. An attempt has been made to list those investigators for programs requiring interaction between field activities and laboratory analyses.

All recipients of the Handbook are requested to provide the River Basin Studies Coordinator the names of others who should be listed and any corrections desirable on this initial listing.

10.1 CANADA

Name, Address, Telephone	Responsibility or Interest
Dr. D. Richard Coote Engineering Research Service Agriculture Canada Ottawa, Ontario K1A 0C6 (613) 994-5247	Coordination of Agricultural Watershed Studies.
Mrs. E. M. MacDonald Soil Research Institute Agriculture Canada Ottawa, Ontario K1A 0C6 (613) 994-9657	Coordination of Agricultural Watershed Studies.
Mr. R.C. Hore Water Resources Branch Ontario Ministry of the Environment 135 St. Clair Avenue, West Toronto, Ontario M4V IP5 (416) 965-2105	Water sample parameters at outlet of Agricultural Watersheds, except pesticides.

Name, Address, Telephone	Responsibility or Interest
<p>Dr. R. Frank Ontario Ministry of Agriculture & Food Ontario Pesticides Laboratory University of Guelph, Ontario N1G 2W1 (519) 824-4120</p>	<p>Pesticide parameters.</p>
<p>Dr. M. Sanderson Department of Geography University of Windsor Windsor, Ontario (519) 253-4232</p>	<p>Analyses of precipitation.</p>
<p>Dr. G. J. Wall Agriculture Canada Department Land Resource Science University of Guelph Guelph, Ontario N1G 2W1 (519) 824-4120</p>	<p>Physical and Mineralogical characteristics of sediment and comparison with data on soils.</p>
<p>Mr. A. J. MacLean Soil Research Institute Agriculture Canada Ottawa, Ontario K1A 0C6 (613) 994-9657</p>	<p>Organic and trace element characteristics of sediment and heavy metal transport and storage.</p>
<p>Mr. M. Schnitzer Soil Research Institute Agriculture Canada Ottawa, Ontario K1A 0C6 (613) 994-9657</p>	<p>Organic and trace element characteristics of sediment and heavy metal transport and storage.</p>
<p>Mr. M. H. Miller Department of Land Resource Science University of Guelph Guelph, Ontario N1G 2W1 (519) 824-4120</p>	<p>Nutrient characteristics of sediments and transport of phosphorus to streams.</p>

Name, Address, Telephone	Responsibility or Interest
<p>Mr. J. D. Gaynor Agriculture Canada Research Station Harrow, Ontario NOR 1G0 (519) 738-2251</p>	<p>Heavy Metal transport and storage and source of nutrients.</p>
<p>Mr. M. Ihnat Chemistry and Biology Research Institute Agriculture Canada Ottawa, Ontario K1A 0C6 (613) 994-9721</p>	<p>Heavy metal transport and storage.</p>
<p>Dr. J. M. Fulton, Director Research Station Agriculture Canada Harrow, Ontario (519) 738-2251</p>	<p>Source of nutrients and heavy metals.</p>
<p>Mr. C. G. Kowalenko Soil Research Institute Agriculture Canada Ottawa, Ontario K1A 0C6 (613) 994-9657</p>	<p>Nitrogen transformations of soils.</p>
<p>Mr. G. C. Topp Soil Research Institute Agriculture Canada Ottawa, Ontario K1A 0C6 (613) 994-9657</p>	<p>Physical characterization of soils related to storage and transmission of water solutions.</p>
<p>Mr. D. R. Cameron Soil Research Institute Agriculture Canada Ottawa, Ontario K1A 0C6 (613) 994-9657</p>	<p>Transformations and transport of nitrogen through soils to groundwater.</p>
<p>Mr. E.O. Frind Department of Earth Sciences University of Waterloo Waterloo, Ontario (519) 885-1211</p>	<p>Transport of nitrates in groundwater to streams.</p>

Name, Address, Telephone	Responsibility or Interest
<p>Mr. J. Cherry Department of Earth Sciences University of Waterloo Waterloo, Ontario (519) 885-1211</p>	<p>Transport of nitrates in groundwater to streams.</p>
<p>Mr. J. B. Robinson Department of Environmental Biology University of Guelph Guelph, Ontario N1G 2W1 (519) 824-4120</p>	<p>Nutrient transport and transformation in streams.</p>
<p>Mr. H. B. N. Hynes Department of Biology University of Waterloo Waterloo, Ontario (519) 885-1211</p>	<p>Movement of nutrients by drift of solid organic matter.</p>
<p>Mr. S. L. Hodd Beak Consultants Limited 306 Rexdale Blvd. Toronto, Ontario M9W 1R6 (416) 743-9000</p>	<p>Livestock sources of nutrients and bacti.</p>
<p>Mr. F. R. Hore Engineering Research Section Research Branch Agriculture Canada Ottawa, Ontario K1A 3C6 (613) 994-9561</p>	<p>Feedlot and manure storage area contributions to nutrients, solids and organic content; and nutrient transport to surface and subsurface waters.</p>
<p>Dr. ?? Derbyshire c/o Dr. R. Frank Ontario Ministry of Agriculture & Food Ontario Pesticides Laboratory University of Guelph Guelph, Ontario N1G 2W1</p>	<p>Feedlot and manure storage area contributions of pathogens.</p>

Name, Address, Telephone	Responsibility or Interest
<p>Mr. E. Leggatt Microbiology Section Ontario Ministry of the Environment P.O. Box 213 Rexdale, Ontario M9W 5L1 (416) 248-3008</p>	<p>Feedlot and manure storage area bacteriological studies.</p>
<p>Mr. N. K. Patni Animal Research Institute Agriculture Canada Ottawa, Ontario K1A 0C6 (613) 994-9723</p>	<p>Nutrient transport to surface and subsurface waters.</p>
<p>Mr. A. D. Tennant, Manager Lab. Services, DOE-EPS Environmental Health Centre Room 210 Ottawa, Ontario K1A 0H9</p>	<p>Transport of bacteriological parameters in surface and subsurface waters.</p>
<p>Mr. R. Grinnell Great Lakes Forest Research Centre Ministry of Natural Resources Toronto, Ontario</p>	<p>Water quality in forested watersheds.</p>
<p>Mr. Robert Ostry Ontario Ministry of the Environment 135 St. Clair Avenue West Toronto, Ontario M4V 1P5 (416) 965-1655</p>	<p>Selected parameters for land uses other than agriculture and forestry.</p>
<p>Mr. S. Black Pollution Control Planning Branch Ontario Ministry of the Environment 135 St. Clair Avenue, West Toronto, Ontario M4V 1P5 (416) 965-1655</p>	<p>Selected parameters for processed organic wastes applied to land.</p>

Name, Address, Telephone	Responsibility or Interest
Mr. T. Chan Ministry of the Environment 135 St. Clair Avenue West Toronto, Ontario M4V 1P5 (416) 965-1655	Selected parameters for septic tanks.
Mr. W. Ullah Ministry of the Environment 135 St. Clair Avenue West Toronto, Ontario M4V 1P5?	Water parameters.
? Fresh Water Institute Winnipeg, Manitoba ?	Water parameters in forested watersheds.
Mr. R. C. Ellis, Project Leader Great Lakes Forest Research Centre Canadian Forestry Service P. O. Box 490 Sault Ste. Marie, Ontario P6A 5M7 ?	Soil and water parameters in forested watersheds.

10.2 UNITED STATES

Name, Address, Telephone	Responsibility or Interest
Dr. John Konrad Supervisor of Special Studies Wisconsin Department of Natural Resources Madison, Wisconsin 53701 (608) 266-7420	Water and sediment parameters.
Dr. Thomas G. Bahr Director Water Research Institute Michigan State University East Lansing, Michigan 48823 (517) 353-3742	Water and sediment parameters.

Name, Address, Telephone	Responsibility or Interest
<p>Dr. L. J. Hetling, Director Environmental Quality Research and Development Unit New York State Department of Environmental Conservation 50 Wolf Road, Room 519 Albany, New York 12201 (518) 457-7470</p>	Water and sediment parameters.
<p>Mr. Larry P. Wilding Ohio State University Dept. of Agronomy 1885 Neil Avenue Columbus, Ohio 43210</p>	Water and sediment parameters.
<p>Dr. Terry J. Logan Asst. Professor of Agronomy The Ohio State University Columbus, Ohio 43210 (614) 422-2001</p>	Water and sediment parameters.
<p>Dr. Mathew J. Zabik, Associate Director Pesticide Research Center Michigan State University East Lansing, Michigan 48824</p>	Pesticides.
<p>Mr. Douglas J. Dube Wisconsin State Lab. of Hygiene 465 Henry Mall Madison, Wisconsin 53706 (608) 260-0100</p>	Water Parameters.
<p>Dr. G. W. Fuhs, Director Labs and Research Environmental Health Center New York State Department of Health New Scotland Avenue Albany, New York 12201 (518) 474-4150</p>	Water and sediment parameters.

Name, Address, Telephone	Responsibility or Interest
Mr. Michael Reddy N. Y. State Department of Health Division of Labs. & Res. New Scotland Avenue Albany, New York 12201 (518) 474-7958	Water and sediment parameters.
Mr. Frank D'Itrie Institute of Water Research Michigan State University East Lansing, Michigan 48824	Water and sediment parameters.
Dr. Charles Annett Institute of Water Research Michigan State University East Lansing, Michigan 48824	Water and sediment parameters.
Dr. James C. Daly Quality Control Officer Environmental Health Center N. Y. State Department of Health 99 Central Avenue Albany, New York 12206	Water and sediment parameters.