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The authors of this report wish to express our sincere appreciation to the nearly 100 persons who have provided written and/or oral comments upon which this study is constructed!

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Table of Contents

Summary.....	2
Recommendations.....	3
Introduction.....	13
Scope of Problems.....	15
Present IJC Surveillance Plan.....	16
Lake Erie Surveillance Plan.....	21
1978 Water Quality Agreement.....	22
1978 New Directions.....	24
Analysis of 1975 Surveillance Plan Problems.....	25
Federal State Water Quality Surveillance and Related Research Activities on the Great Lakes.....	28
Tabs	
U.S. Federal Agency Vessels on Great Lakes	1.....40
Summary of Federal/State Budget for Surveillance and Related Research Activities for FY 79 on the Great Lakes	2.....42

SUMMARY

This review was undertaken at the request of Thomas C. Jorling, Assistant Administrator for Water and Waste Management of EPA. A similar study has been undertaken by the Canadian Government.

The review largely focuses on the surveillance and monitoring programs on the Great Lakes and especially as these activities relate to the U.S./Canadian Great Lakes Agreement and Region V of EPA.

The multi-million dollar a year program presently concentrates on a large number of open lake and near shore monitoring stations, for one lake a year and for a limited number of conventional pollutant parameters.

Long term open lake trends and early warning for toxics are presently provided by the Fish and Wildlife Services of both nations. One has to only read the 1977 and especially the 1978 Water Quality Board (I.J.C.) report to see that biological monitoring is emphasized for open lake trends and that very little of the present E.P.A. open and nearshore lakes information is utilized, even under present circumstances.

In view of the new US/Canadian Agreement, requirements of U.S. Laws and the EPA Agency Guidance for 1980/81, recommendations are presented herein for major changes. Compliance monitoring programs of lake shore and tributary point and non-point discharges, primarily through the States, should be emphasized for toxics.

There is a basic constraint for all such programs, limited to the few skilled laboratory personnel available for priority toxic analyses.

RECOMMENDATIONS

Present U.S. water quality surveillance efforts on the Great Lakes were designed to meet the priorities of the 1972 Agreement. However, the 1978 Agreement has re-focused the priorities and basic thrust of water quality surveillance. The new thrust is concerned with compliance monitoring and toxic pollutant control. Toxics introduced into the Great Lakes' ecosystem are ubiquitous, persistent and pervasive. If one doesn't prevent and/or clean-up these pollutants, then the long term trends are predictable.

Thus, the Canadian and U.S. Governments have each undertaken independent reviews of the water quality surveillance and related research activities on the Great Lakes. Recommendations included in this report are based upon the U.S. activities. They reflect the new Agreement requirements for changes in emphasis. These recommendations are designed to help meet the requirements of the Agreements as well as meet the requirements of U.S. Laws!

These recommendations can serve to realize the maximum benefit from all resources applied to the lakes water quality surveillance effort and require the development of a new comprehensive surveillance plan. Concern for compliance monitoring, water quality objective violations, trend monitoring and anticipation of emerging problems in the new agreement shift the 1972 Agreement's concern for nutrient control and add new dimensions for protection, enhancement and maintenance of water quality with respect to toxics. Complex mixes of organic and inorganic chemicals are constantly being introduced to the Great Lakes ecosystem. Data on species or community responses to such pollutants represent a common denominator for identification of trend analysis. Compliance monitoring provides data on the input of pollutants into the Lakes

and should be directed at assisting in clean-up as a first priority. In addition, classical monitoring of the identified toxic pollutants needs to be supplemented by fish and bird tissue assays because:

- o of the large number of chemical species.
- o of the greater capability to detect certain chemicals in flesh rather than water.
- o of our inability to monitor continuously for all pollutants at all times.

Compliance monitoring as defined generally by the U.S. EPA refers to the monitoring of a permitted discharge to determine if the discharges are in compliance with the National Pollutant Discharge Elimination (NPDES) permit conditions. The monitoring is accomplished either by self-monitoring and reporting by the permitted discharge or by surveillance and analysis of areas of concern identified by the States or EPA. The areas of concern should include significant non-point sources of pollution.

Recommendations are presented with a two tier approach. The first tier deals with those actions which are appropriate to the US/Canadian I.J.C. Water Quality Board activities, while the second deals with U.S. Federal and State efforts and resources applied to water quality surveillance activities on the Lakes.

Tier 1 - Water Quality Board

1. It is recommended that the Water Quality Board charge the Surveillance Subcommittee with the development of a new comprehensive Surveillance plan which reflects the new monitoring focus found in the 1978 Agreement particularly with respect to its' emphases on compliance and water quality ob-

jective monitoring and for toxics. The new surveillance plan should be goal oriented. Further, that the surveillance sub-committee and plan should include the following areas:

- o re-structure the membership of the surveillance sub-committee to include a balance between users of monitoring data and developers of such data including the developers of water quality criteria.
- o identify those groups, governmental units and other organizations who will utilize the surveillance information.
- o identify how and where the surveillance information should be used for remedial actions. Establish priorities.
- o establish a method to ensure inputs from data users into the development of the individual surveillance plan, concentrating on compliance monitoring and achievement of water quality objectives.
- o continue the present water intake sampling program as an adjunct to trend monitoring.
- o establish a common rationale for choice of water column and sediment sample sites for open lake trends. The rationale should be based upon a few strategic sites coupled to biological monitoring.
- o establish a program which will provide water quality information to data users including the assessors of total loadings and their effects, for the ultimate use of NPDES and other remedial programs.
- o establish a plan that balances data taking with data analysis and data use.
- o statistical analytical techniques have to be developed to determine the minimum number of samples.

- o establish a consistent ranking of monitoring tasks with each individual lake surveillance plan which will permit the most efficient utilization of resources, including consideration of the limitations of available laboratory, analytical and data analysis capability.
- o establish the surveillance priorities which reflect those in annex 11 of the 1978 Agreement.

2. It is recommended, that the Surveillance Subcommittee in drafting a new Comprehensive Surveillance Strategy focus on toxic pollutants and:

- o establish common sampling protocols.
- o establish common analytical and test protocols methods.
- o establish analytical capabilities for the routine measurement of ambient levels of toxics pollutants in water columns, fish, biota and sediments.
- o establish common quality control and quality assurance programs.
- o establish a common data base for easy assess and exchange of water quality data by all institutions.
- o establish a mechanism which will actively consider and up-date methodologies as new techniques become available.
- o establish joint data analysis and interpretation programs.
- o establish sound data management programs.

3. It is recommended, given the focus of the new Agreement on compliance monitoring and concern for meeting the water quality objectives, that the Surveillance Subcommittee in developing the individual lake surveillance plans:

- o establish compliance programs for monitoring for major point, non-point and tributary compliance in support of enforcement and planning efforts.

Note that the *PLUARG study suggests "looking at near-shore areas most affected by man's activities" and provides a guide to areas most impacted by agriculture.

- o establish joint compliance monitoring schedules especially concentrating on major sources of pollution for all lakes.
 - o identify the remedial actions that should be implemented when water quality objectives are exceeded.
 - o identify a mechanism that can be used to identify areas to focus compliance monitoring attention.
 - o provide for a comprehensive review of compliance monitoring data to ensure that data are being used by the remedial programs.
 - o for open lake long term trend monitoring, use the biological monitoring programs of the U.S. and Canadian Fish and Wildlife Services supplemented by strategic location monitoring of water column and sediments.
 - o establish a mechanism to integrate self-monitoring data from the NPDES programs for the United States.
 - o for those Canadian jurisdictions which use limited use zones, that there be a requirement to monitor these closely in order to minimize toxic emissions to the Lakes, in accordance with Annex 12 of the Agreement which states "the philosophy adopted for control of inputs of persistent toxic substances shall be zero discharge."
4. It is recommended that a Water Quality Board member task force (1 U.S. and 1 Canadian) be established with responsibility for reviewing the surveillance plan and providing management direction from the WQB to the Surveillance Subcommittee, on a structured basis.

*PLUARG - Planning and Land Use Activities Reference Group report issued by I.J.C. in 1978.

5. Both Government's should create an independent review team similar to that created for this study to seriously review the research activities on the Great Lakes, because of the limitation of strategic resources (skills and laboratories) and ascertaining whether or not the projects will result in information that will lead to enhanced water quality. A better delineation of research problems should help some research agencies in the design of their programs.

Tier 2 - U.S. - EPA - Federal Agencies - States

It is necessary to coordinate the U.S. Federal and State Agencies responsible for taking water quality data on the Great Lakes if the Agreement monitoring priorities are to be met. The second tier of recommendation deals with this issue.

1. It is recommended that the emphasis within EPA focus on re-inforcing and expanding the present State-EPA compliance monitoring program and that the open lake water quality monitoring efforts be undertaken by the appropriate FWS and NOAA laboratories. Also, that the U.S.G.S. and primarily the States continue to be involved in the tributary monitoring. The funds presently used by GLNPO-Region V for support of "research" should be utilized to assist in support of the State programs. (There is an EPA-ORD research budget designed to support research projects.) This effort will involve:

- o the use of the State-EPA agreement process for implementing much of the proposed new plan building on the present State tributary and compliance programs.
- o the re-establishment of the Federal Interagency Support Committee to the U.S. Great Lakes Water Quality Board Co-Chairman to coordinate and facilitate water quality data collection, analytical procedures

and utilization of water quality data for remedial action. Particular attention should be paid to which agencies can provide analytic data and flow data.

- o establish the requirements of EPA-Region V to carry out effluent standard and non-point source compliance monitoring in addition to that carried out by the States and in support of Enforcement and the Water Division (Planning). Note that the "EPA Agency Guidance for FY 1980/81 calls for expanded S&A Division monitoring of industrial toxics effluents.
- o establish a water quality monitoring program for a few selected strategic locations (for toxics) on every lake every year to supplement the Fish Contaminant Program. The open lakes are relatively homogenous and will only show trends over long periods of time. Several strategic locations for water column and sediment monitoring will be more useful, than very intensive open lake sampling on a lake every nine years, and as a supplement to the biological monitoring program of the FWS (Fish Contaminant Program). The Interagency Agreement between Region V and FWS should provide funds now utilized for the present open lake program.
- o to develop an Interagency Agreement with Fish and Wildlife Service (FWS) to conduct open lake water quality surveillance. This effort should be integrated with the FWS existing fish and wildlife monitoring programs. This will permit the open lake trend monitoring and the connecting channels on an annual basis with fewer vessel resources. The NOAA Laboratory at Ann Arbor should also be given consideration for additional analytical work.
- o transfer to FWS (if they believe these vessels are better than their own) or ORD or retire the 4 large vessels now in operation by the

Great Lakes National Program Office. Having wet lab space on these vessels is of little importance, since "toxics" have to be analyzed by selected shore laboratories! (Note the ORD is supporting 2 other large vessels and that Region II has a 28 foot surveillance craft).

- o continue the water intake monitoring program which also assists in trend monitoring.
- o responsibility for coordination and orchestration of the entire Great Lakes monitoring program should be with Region V, S&A Division. The present GLNPO Surveillance and Research staff should be integrated into that Division.
- o The EPA's Office of Research and Development's large Lakes Research staff at Grosse Ile is in the best position to assist Region V in data analysis and management. The 65 people at Grosse Ile are in better position to provide services for data analysis, interpretation and report preparation than the Region V GLNPO staff. Remedial action recommendations can be augmented and coordinated within EPA for appropriate enforcement action. Grosse Ile staff presently support the enforcement programs of Region V!

2. It is recommended that the State monitoring programs on the Great Lakes be supported via a defined funding mechanism, and that Compliance monitoring and tributary monitoring be carried out by the State. This can be achieved by:

- o providing an assured source of funding via State-EPA agreements.
- o integrating the NPDES self-monitoring data analysis into the compliance monitoring effort.
- o integrating at the State-EPA level the air quality monitoring data as it affects water quality. This should be implemented by the Regional S&A Division and by the States.

- o improving the toxic chemical analytical capabilities of the States as called for in the FY 1980/81 EPA Agency Guidance.

3. It is recommended that a procedure be identified by an EPA-State Task Force (chaired by Region V and Region II for Lake Ontario) in the individual lake water quality surveillance plans to establish a prioritized sample site selection program as called for by Article VI (m) of the Agreement.

Priority consideration is to assess compliance monitoring with pollution control requirements. It will be necessary to:

- o establish a formal procedure for States and EPA to identify problem areas.
- o formulate a means for integrating water quality data into the remedial programs. This will require a close coordination with the U.S. EPA Regional Water Divisions, Enforcement Division and the appropriate State authorities.

4. It is recommended that the EPA Regions II, III and V and States first task be to determine existing laboratory capabilities to measure the water quality objectives in the Agreement. The complexities of measuring the organic and inorganic pollutants at the levels identified in the Agreement and the CWA of 1977 requires analytical procedures far more complex than those procedures now used to measure the more traditional pollutants. It will be very easy to create a large backlog of samples. Hence, in order to maximize the sample collection, analytic procedures and data analysis, it will be necessary to:

- o identify the laboratories within EPA, NOAA and FWS, States, and universities which are equipped and staffed to perform the complex analytical procedures that meet the requirements of the Regional quality assurance program.

- o inventory the present workload of the identified laboratories and determine what additional work loads could be imposed.
 - o define the maximum number of sites which can be sampled given the laboratory constraints.
 - o develop the individual Lake monitoring plans given the monitoring/ analytical realities.
5. It is recommended that common test analytical procedures be established since the new methods are complex and consistent interpretation of results requires common test results. It will be necessary to:
- o establish round-robin analytical test protocols.
 - o establish coordinated analytical procedures between Agencies and States.
 - o establish procedures for the evaluation of new test methods.
6. It is recommended that responsibility for management direction of EPA in these matters reside in the Deputy Administrator or at least with the Director of the Surveillance and Analysis Division of Region V.
7. It is recommended that the Great Lakes research program involve Regional personnel in its planning and implementation similar to the overall ORD effort in EPA. This will include:
- o the present ORD "Research Committee Planning System" expansion to include a module on "Great Lakes Research" with a co-chairman from Region V.
 - o the energy related program at Argonne National Laboratory funded by EPA.
 - o setting of priorities.

Introduction

At the October 1978 meeting of the Water Quality Board of the International Joint Commission (IJC), the United States Environmental Protection Agency and the Department of the Environment of Canada announced that each would undertake a separate and independent review of the water quality surveillance activities of their respective countries on the Great Lakes. They agreed further that the review of the surveillance efforts and plans would be undertaken by individuals not previously involved with the joint US/Canadian Great Lakes water quality surveillance and monitoring planning efforts. The review is to ensure that maximum benefit is derived from all resources applied to the taking of water quality data on the Lakes. The ultimate objective is the "restoration and enhancement" of the Lakes' water quality.

Water quality data gathering programs are broadly interpreted in this study. Both surveillance and related research activities were considered in this study on the Great Lakes since data leading to the understanding of biological, physical and chemical processes ongoing in the Lakes as specified in the Agreement derives from both types of activities. There is an interdependence of resources between surveillance and research as well as some redundancy. State activities and compliance monitoring was included in the cataloging of water quality surveillance activities on the Lakes. The report presents a picture of the "Federal-State" involvement in monitoring and research on the Lakes necessary for the enhancement and maintenance of lake water quality. U.S. agency programs are described but not critically evaluated. The concerns here focus more on how programs could make better use of resources.

The self monitoring program under the National Pollutant Discharge Elimination System (NPDES) was not evaluated in this study. Information from that program will be increasingly utilized as concern focuses on "toxics" monitoring.

Federal Agencies and States and a number of individuals were contacted to better understand the various complex programs underway. These people were very generous with their time and provided the data, much information and suggested many of the recommendations contained within this report. A preliminary draft document describing the activities and missions of the various groups engaged in surveillance and water quality research was completed in February 1979, and circulated for comment to ensure accuracy. Numerous suggestions and additions were made. These ideas were incorporated and are gratefully acknowledged. It is obvious that there is a complex and interrelated effort now ongoing and supported by the dedication of those involved in the surveillance and related research activities.1/

1/ One issue raised during the review of the initial document was that research activities on the Great Lakes related to water quality data and information is separate from and should not be considered in the review of the activities relating to surveillance and monitoring on the Great Lakes. One of the major reasons for including these activities, is that research vessels can and are being used for collection of water quality data for the purpose of background information and for the more conventional surveillance activities. The resources for research and surveillance in this area can be interchangeable. Indeed within EPA, the normal Region V surveillance vessels piggyback research activities and the EPA-ORD research vessels support some other Regional work -- as it should be under present arrangements. A minority of researchers viewed this review with some hostility while others thought it was time for someone to pull these activities together!

It should be also noted that the EPA-ORD program should be developed in closer cooperation with operating programs needs and that within EPA-ORD there are two different Great Lakes research activities which need closer integration with themselves and with the rest of E.P.A.. Sources of funding for Argonne Lab Great Lakes Research as examples, are funded through two EPA sources without coordination.

Scope of Problem

Eighty percent of the fresh surface water supply in North America is contained in the Great Lakes. These Lakes provide 45 million people in the basin with drinking, agricultural and industrial process water. As a consequence, this unique and priceless resource is basic to both the United States and Canada. The Canadian and U.S. governments signed the Great Lakes Water Quality Agreement in 1972 and entered into a new Agreement in 1978 in recognition of the importance of this resource.

A Great Lakes Water Quality Board under the IJC was established and mandated to be the Commission's "principal advisor" in the implementation of the Agreement. The Commission is to collect, analyze and disseminate information relating to the water quality of the Great Lakes, and to tender appropriate advice and recommendations to the governments. Recognizing the need for a uniform surveillance effort as required by the 1972 Agreement, the IJC directed the WQB to develop an international surveillance effort directed by the U.S. and Canada as required by the Agreement in Article VI, (c). In addition, there are large scale fish contaminant studies being conducted under programs coordinated by the Great Lakes Fishery Commission.

The persons who have developed and are implementing the present plan are to be complemented for their work to date. Any critique within this study is based on changing environmental perspectives, and an approach of trying to ascertain who, how, and can the water quality monitoring data be used.

An important and fundamental transition took place in the monitoring

philosophy since the revision of the 1972 Agreement, with the re-orientation to toxic pollutants and with the addition of many new water quality objectives. There will be complex analytical problems associated with monitoring of toxic pollutants and the need for stressing a quality assurance quality control program because of this new thrust. Consideration of non-point sources to lake pollutants loadings will also impose significant monitoring burdens. Hence, a prioritization of efforts is required since there are finite resources available to meet the new task of the 1978 Agreement. As one commentator noted, while "trend monitoring sounds good" such activities must be defined so that "trend stations" will not proliferate beyond available resources.

It must be noted that there is a critical constraint with respect to the availability of the sophisticated analytical laboratory skills that are available. This implies competition for these scarce resources between the needs for water quality data, monitoring programs and research programs.

The 1978 Agreement clearly states priorities for surveillance and will provide the basis for a number of the recommendations for re-orientation of present efforts. These priorities were also discussed at the Water Quality Board February 1979 meeting.

Present IJC Surveillance Plan

Based upon the 1972 Agreement, a surveillance plan was established in 1975 by the Surveillance Subcommittee of the Water Quality Board, providing for the collection of information which would lead to the establishment of efficient and economical programs for pollution abatement and preservation

efficient and economical programs for pollution abatement and preservation of water quality. A series of general surveillance tasks were identified by the Surveillance Subcommittee in the development of the plan. In general, the identified surveillance tasks were:

- o Objective violations: violations of the water quality objectives (criteria) of the Agreement.
- o Trends: determine compliance with non-degradation and long-term effects of remedial programs.
- o Cause and effects: describe and quantify loads and water quality relationships.

Having identified the specific tasks, the Surveillance Plan presented the operational components required for implementation of the plan. It was recognized that for open lake studies, oceanographic vessels equipped with on board laboratories were required, while in the nearshore areas and the connecting channels, smaller boats would do monitoring work. The 1975 surveillance plan was based on the premise that the governments would operate and maintain two very large vessels (one U.S. and one Canadian) and eight medium size "lab" boats. The plan is generally described below with a critique as to where it was implemented.

The Surveillance Plan identified as an important aspect in managing Great Lakes water quality, the determination of the types and quantities of materials entering the Lakes. The three operational components identified to be monitored were: tributaries, atmospheric and compliance monitoring. A strategy laid out to meet the requirements inherent in monitoring inputs from the three sources included nearshore monitoring. Since the nearshore

areas are the first to react to changes in point-source and land drainage pollutant discharges, this area and the tributaries would be the first to respond to remedial programs.

Open lake monitoring was judged under the comprehensive surveillance plan, to be an important component since:

- o materials enter the Lakes from atmospheric fallout and precipitation.
- o the majority of lake water is in the mainlake and provides a connection between the nearshore areas.
- o the open lake responses were slow to changes.

It was recognized in the 1975 surveillance plan that open lake monitoring is much more difficult and expensive than the nearshore monitoring efforts. A series of additional monitoring components identified were: connecting channels; municipal water intakes; biota; water-sediment analysis for hazardous substances; and fish tissue analysis.

Tasks identified as critical to the overall success of the surveillance plan were:

- o Data quality - a coordinated data quality assurance system between agencies was called for.
- o Data management - implementation of a program to ensure analysis and timely reporting.
- o Data reporting - data analysis and reporting were identified as weak points in past efforts. Therefore, additional resources were requested to bring these areas up to par for the annual assessment -- even at the expense of curtailing data collection.

Scheduling of open lake monitoring activities was planned as a nine year cycle based upon maximizing the use of eight vessels (see Table 1). However, because of the degraded state of Lakes Erie and Ontario, yearly sampling for enrichment parameters (nutrients, dissolved oxygen, chlorophyll and microbiology) was called for. The connecting channels were to be monitored annually along with the tributaries. Nearshore and problem areas were specified to be sampled on a rotating basis with somewhat increased intensity of frequency in number of stations and parameter coverage corresponding with main lake intensive years and the nature of the specific problem.

Implementation of the Surveillance Plan was to be keyed to resource allocations. It was recommended in the plan that rather than eliminate any single component, the plan be carried out in total but that the work be extended over a longer time period; if resources were to be less than those envisioned in the development of the 1975 plan.

Present Great Lakes National Program Office (GLNPO) - Region V monitoring strategy using four large (Tab 1) vessels is to concentrate open lake surveillance efforts on one lake at a time and to focus intensive studies on the nearshore areas of the same lake near where problems exist. The open lake studies are presently the foundation of the surveillance program but a part of the program is concentrated in nearshore areas. The overall schedule consists of a nine year cycle with 2 years spent on each lake, except Superior and Huron where only one year is dedicated for surveillance activities. A year is to be spent studying the connecting channels. The nine year cycle is based upon economic utilization of ships and personnel.

Development of surveillance plans for each of the Great Lakes is the responsibility of the WQB of the IJC under the US/Canadian Agreement. A Surveillance Subcommittee of the WQB was established in 1973 and actually prepared the overall surveillance plan in 1975. The individual lake plans are prepared without concern for resource constraints, and are thus idealized plans as stated in the Lake Erie plan. Membership of the working groups preparing the plan varies between lakes but has representatives from the Canadian Federal government, the Ontario Provincial government, the U.S. EPA- (the Regions and GLNPO), the eight Great Lakes States, and the Fish and Wildlife Service and National Oceanic Atmospheric Administration. The Lake Erie Surveillance plan has been established and Lake Ontario Surveillance Plan has been essentially completed. Lakes Huron, Michigan and Superior surveillance plans are nearing completion. All of the individual Lake plans were scheduled to be completed by April 1979.

While sampling sites have been chosen for many of the Lakes, there is flexibility in changing these sites so long as there is an appropriate rationale and coordination with the Surveillance Subcommittee. The parameters to be covered and objectives are all developed by the Surveillance Subcommittee. For example, on Lake Erie the Canadian government chose the nearshore and tributary sites to be monitored in Canada. The U.S. provided a similar site plan for the U.S. waters. The two plans are then added together to form a single plan.

Lake Erie Surveillance Plan

To better understand a single lake "plan" the Lake Erie plan is reviewed. A two component plan was developed for monitoring Lake Erie. A total of 28 cruises are planned for Lake Erie over the 2 year intensive study time. The cruises are scheduled based upon the seasonal cycles of the Lake and each cruise is intended to monitor the various conditions of the Lake in order to develop a basis for comparison in the future. The first portion involves the tributaries and the second the open lake. Within each component there is a breakdown of sampling sites and the general criteria used for site selection. The priorities of the Lake Erie plan were modified to include "all of the open lake activities but with only three days instead of the five originally scheduled for each nearshore area cruise on the U.S. side." Emphasis once again is on the open lakes.

As noted in the 1978 Sixth Annual Report to the IJC, "some parts of the program that are not fully developed are: the nearshore fish contaminants program, additional sampling for radioactivity and atmospheric loads to the Great Lakes, and sampling of tributaries during heavy runoff periods." It should be noted that tributary monitoring is largely a task of the States and USGS at present. The sampling of organics did not follow the 1975 plan because of lack of analytical capability in the central regional laboratory.

Selection of sample sites in the open lake are based on the stations chosen by individual researchers who have worked on the Lakes dating back to 1954 and also by work done by various universities. The Surveillance Subcommittee therefore chose stations where previous work had been performed

and where a partial baseline of data existed for comparison. In Lake Erie, there are 80 stations in the open lake which have been chosen based on sampling stations used in project "HYPO" in a previous R&D sampling program. Also the water quality model developed by Manhattan College for the EPA Laboratory at Grosse Ile dictated the choice of sample sites in addition to these of the International Field Year and the annual Canadian Programs.

1978 Water Quality Agreement

Monitoring priorities have been structured in the Agreement to be compatible with the heightened concern for toxic pollutants. Annex 11 therefore gives first emphasis to compliance monitoring and in achieving the water quality objectives. Evaluation of trends and identification of emerging problems rank as the third and fourth stated priorities. Given the Agreements, rank order for monitoring tasks, the need for "reduced" pollutant discharges and Agency resource constraints, listing of priority tasks must be formulated which can be accomplished with the available resources.

"Cleaning-up" the Lakes and therefore compliance monitoring should be the first order of priority even if the other tasks were not mentioned.

Annex 11 of the new Agreement was discussed at the February Water Quality Board meeting and the following order of priorities was enumerated by the U.S. Co-Chairman:

- o Compliance: Assessment of the effectiveness of jurisdictional control for pollution abatement. If one doesn't clean-up and/or prevent pollution, then the long term trends are obvious.
- o Achievement of general and specific objectives: Definition of the location, severity, area or volume extent, frequency and duration

of non-achievement of the "objectives" as a basis for determining the need for more stringent control requirements.

- o Evaluation of water quality trends: Provision of data on local and whole lake responses to control measures using trend analyses and cause/effect relationships and provision of information to assist in the development and application of predictive techniques for assessing new developments and pollution sources. Results of these evaluations will:

- (i) allow for the assessment of remedial programs and identify improved pollution control requirements.
- (ii) allow for the assessment of enforcement and management strategies.
- (iii) identify the need for future technology and research activities.

- o Identification of emerging problems: To determine undetected problems in the Great Lakes for implementation of appropriate control measures.

Future programs which should address these four priority considerations are to include baseline data collection, sample analysis, evaluation and quality assurance programs (including standard sampling and analytical methodology, inter-laboratory comparisons, and compatible data management) to allow assessments of:

- o inputs from tributaries, pointsource discharges, non-point source discharges, atmospheric deposition and connecting channel quality;
- o whole lake data for nearshoreshore areas (e.g. harbors and embayments,

- general shoreline, cladophora growth areas) and open waters of the lake, fish and wildlife contaminants;
- o outflows including connecting channels, water intakes and outlets;

1978 New Directions

A major shift in emphasis since the 1972 Agreement from an emphasis on conventional pollutant parameters and eutrophication problems to a concern for toxic pollutants in the Great Lakes has occurred. This new focus of the 1978 Agreement is found in:

Article IV (1)(b); (1)(c)

Article VI (1)(e), (1)(e); (1)(m), (1)(e)(viii)

Annex 11

Annex 12, item (4)(a)(d)

Briefly these Articles and Annexes deal with an increase in specific water quality objectives from 8 to 41 toxic pollutants ^{*(1)}; routes of entry to the lakes including atmospheric loading of toxic pollutants; establishment of an early warning system, i.e. fish contaminant study for toxic pollutants; and tributary loading of phosphorus.

Toxic pollutants are of major significance, of far more concern than conventional pollutants, because of human health significance and because they are ubiquitous, pervasive, and persistent.

Activities specified in Annex 11 related to the new toxic focus place additional surveillance responsibilities on the parties and include:

- o Sampling and analytical methods development, statistical analysis,

^{*(1)} EPA is focusing on 65 families and specific toxic pollutants for remedial action. Also, on the basis of a recent study of structure - activity correlations, there may be a number of other toxic pollutants of concern in the Great Lakes Basin.

quality control and data management because of many new water quality objectives.

- o Expanded atmospheric chemistry program.
- o Improved contaminants data for wildlife and fish (early warning).
- o Enhanced tributary monitoring.

Concern for toxic pollutants in the Agreement is parallel with the regulatory efforts and priorities of the U.S. Clean Water Act (CWA). The list of hazardous pollutants in appendices 1 and 2 of the Agreement is equivalent to the CWA, hazardous pollutant list and the water quality objectives of the Agreement are similar in composition to the toxic pollutant list of the CWA and the Agency water quality criteria covered under and published in the Quality Criteria for Water. However, the number of pollutants in the Agreement is less than that in the CWA.

Analysis of 1975 Surveillance Plan Problem Areas

In the context of the new Agreement, the 1975 surveillance plan serves useful experience to build upon. While the 1975 plan expresses concern for data management, there are no specifics given as to how the monitoring program can or should be tied into lake water quality management programs.

There is no guide to the relationships between the publication of data and the needs of the users, nor are the potential users identified. Who is going to use the information? Can the data be used? How are the data used?

- o In the 1975 plan, emphasis was not placed on compliance monitoring and achieving general and specific objectives.
- o There was no development of uniform protocols for data collection

and analysis.

- o There was no strategy to maximize and coordinate use of all Federal and State resources now applied to the lakes to achieve the evaluation of water quality trends and identification of emerging problems.
- o A quality assurance program for monitoring of toxic pollutants was not material.
- o Biological monitoring and open lake studies plan which was consistent between the US and Canada was not presently included.
- o Balance of resources between water quality data analysis and planning and sampling of water quality data leaves much to be desired.
- o The identification and close integration, of the various program needs such as the regional planning requirements of the CWA surveillance and analysis, enforcement, EPA-ORD and the GLNPO was not done.

In addressing the specific program areas the comprehensive surveillance plan would provide a framework within which the specific lake surveillance plans can begin to address the areas defined in the Agreement.

Since the Lake Erie surveillance plan is the most currently adopted plan now being implemented, this plan can serve as a useful example of problems. Specific comments on the Lake Erie plan are as follows:

- o With regard to the format, there is no apparent integration of efforts but rather there seems to be several nearly independent activities. This gives the appearance of a lack of coordination. For example, the surveillance plan lists component parts without

relating the parts to a whole objective for lake improvement and "clean-up".

- o Several components appear to be either missing or subsumed. There appears to be a massive data collection and in-the-field program while the objectives for both types of projects are not measurable (i.e. how does one define "refinement of knowledge" or "better understanding of"). There is a suggestion that data will be used eventually to develop a management scheme but there is no tangible means indicated as to how this goal will be achieved.
- o There should be a scheme spelled out that will allow lake water quality management which is the objective of the plan. Such a scheme must include compliance activities. Data collection must be related to specific ends. Hence the "needs" for data must be defined. Who is going to use the information? How is it to be used?
- o Time and problem identification is the stated principle for near-shore sampling but the sampling frequency does not follow these principles in order to achieve measurable results. Also there appears to be no integration between point and non-point sources with the in-lake program. Only a portion of the materials balance is included in the study.
- o There is no explanation of the "product" which will result from any of the studies. If one assumes that the results will be published as an IJC surveillance report how will this report translate into a "management scheme?"
- o Finally there ought be in one place in the plan all resources of all the cooperating institutions/organizations in one table under specific objectives. Such format would allow for a ranking of objectives and deciding resource allocations.

Federal-State Water Quality Surveillance and Related
Research Activities on the Great Lakes

Protection and management of the Great Lakes is vested in many Federal Agencies and institutions. There are few historical data bases from which management schemes are developed. These exist almost nowhere for large bodies of water. Programs on the Great Lakes, such as the National Oceanic and Atmospheric Administration (NOAA) or the Fish and Wildlife Service (FWS) have specific charges and program priorities which are related to the sponsoring Agencies mission and responsibilities but which are also totally related to water quality and to resource management and environmental services. There is no attempt to correlate or integrate this data with the present EPA Great Lakes Agreement monitoring program.

Several agencies and at least two components of EPA are sponsoring water quality sampling and data analysis through the use of large research vessels. A list of the larger of these vessels is found in tab 1. In addition, there are a number of laboratories using increasingly sophisticated equipment, that operate in support of the data collection program but with no agreed upon quality assurance program.

Since there are limitations on the amount of skilled manpower available in all of these activities, it is prudent to at least inventory these resources (both in operating programs and in research) in order to assess whether or not these available resources can be used more efficiently in support of the various programs and the objective for "cleaning-up" the lakes.

The review process now being undertaken is to establish where the research program priorities can be meshed with the surveillance activities on the Great Lakes for maximum utilization of resources, keeping in mind the various missions and requirements of the various Federal research programs. What follows is a description of the various research efforts in the Federal establishment.

EPA - GLNPO Activities

Specific GLNPO Great Lakes research and surveillance activities include:

- o Open lake monitoring program for eutrophication and toxic substances and longterm trends largely dependent upon chemical analyses of a few selected parameters.
- o Nearshore monitoring program for eutrophication and toxic substances.
- o Supplementary tributary monitoring to determine annual loadings to lakes.
- o Atmospheric loadings - transfer of materials from air to water.

A nine year (one lake at a time) monitoring cycle was established to determine long term trends in the lakes and provide input for management decisions. This objective is accomplished by a 165 ft. research and monitoring vessel for the open lake surveys and through grants and contracts for nearshore monitoring using other large EPA vessels. Supplementary event monitoring to provide accurate loading estimates through grants and contracts is also utilized.

GLNPO provides Ad Hoc support to the Enforcement Division as required on special cases.

It should be noted that Region II has it's own 28 foot vessel for compliance monitoring purposes on Lake Ontario.

EPA/ORD RESEARCH

Specific ORD Great Lake research efforts involve:

- o Eutrophication and its effects.
- o Problems associated with power production on the biology of the lakes.
- o Hazardous maaterial sources, fate and effects.
- o Disposal of dredging spoils, ecological effects on wetlands of shoreline construction and hydrologic modification.

A five year reserach plan has been developed by ORD to address these issues and encompasses the broad areas outilined above. In addition to these program objectives, ORD provides ad hoc support to the Enforcement and Surveillance and Analysis Divisions of Region V in the form of special environmental studies, expert witnesses and in-review and development of scientific support documentary.

DEPARTMENT OF INTERIOR - Fish and Wildlife Service

Assessment of fisheries resources, trends and biomass in the Great Lakes is the primary mission of the Fish and Wildlife Service (FWS). This objective is accomplished by the Great Lakes Fisheries Laboratory, in Ann Arbor, Michigan which has 5 boats ranging in size of 47 feet to 75 feet. Each of the Lakes is surveyed intensively with from 11 to 12 cruises per season from April to December depending on the Lake.

The primary mission of the FWS is to fulfill the objectives of resource

management in the Lakes but it is currently collecting fish samples for EPA for pollution trend analysis in the fish tissues. While the FWS vessels are equipped for fisheries activities and the scheduling of vessel operations is full, the boats can be equipped to conduct routine liminological survey work and the scheduling may be flexible enough to accommodate EPA sampling requirements and the EPA sample site selection.

Additional FWS investigations on the Great Lakes are conducted by the Regional office in Minneapolis and include pesticide monitoring (PCB, DDT, etc.) and effects of dredged material disposal in the Lakes. The investigations now underway or planned on the Lakes include:

- o Wetland damage area surveys
- o Development of a fish atlas
- o Migratory bird habits
- o Development of an oil spill contingency plan
- o Fish census of the Duluth/Superior area
- o Various benthic studies

Both the Corps of Engineers and the FWS are developing under a cooperative agreement an environmental study plan to determine the effects of winter navigation on the Great Lakes. The development of the Environmental Plan of Action is to be completed early in 1979. It is anticipated that the funding for the whole Great Lakes plan will require approximately \$100 to \$150 million dollars over 20 years. Funding has not yet been obtained for this program.

U.S. GEOLOGICAL SURVEY

Presently, the U.S.G.S. operates gaging and water quality surveillance stations in 69 per cent of the Great Lakes drainage area. Data collected at these sites include, in addition to water flow information, physical parameters as well as suspended sediment concentrations, metals, pesticides and organic materials sorbed onto the sediment. These data are included in the STORET water quality data file. The U.S.G.S. data collection system is operated in conjunction with State and Federal programs. Federal agencies using the U.S.G.S. service include EPA, FWS, DOE, the Forest Service and the Naval Facility Engineering Command.

Data collection frequency and parameter numbers vary with each of the stations. A compilation of the station sites, parameters surveyed and frequency can be found in the U.S.G.S. publications Regional Plan for Federal Water-Data Acquisition, Fiscal Year 1978 - 1979, (Appendix 3- Quality of Surface Water Stations, US/DOI Office of Water Data Coordination.

There are no large boats operated by the USGS on any of the Great Lakes. However, two 19 foot boats are used for water quality data collection in the connecting channels between Lakes Erie and Ontario. No open-lake is conducted.

DEPARTMENT OF COMMERCE - NATIONAL OCEANIC ATMOSPHERIC ADMINISTRATION

NOAA's primary mission on the Great Lakes is to conduct research to understand the processes of the lake-land-atmosphere system sufficiently to build useful numerical predictive and simulation models of physical phenomena and the ecosystem; and to assist in solving problems in resource

management and environmental services. The laboratory responsible for this effort is in Ann Arbor, Michigan and has four groups involved in the overall mission. There are 49 full time positions allocated to the laboratory. The Great Lakes Research Program is organized into 3 management activities as follows:

- o Physical phenomenon: to improve data, statistical description, understanding and methods of prediction of physical variables, processes, phenomenon that are hazards and relate to ecosystem dynamics such as currents, temperatures, waves, storms, ice, lake levels, river flows and interdependent atmospheric variables.
- o Lake Ecosystem Dynamic: to improve understanding of existing lake ecosystem conditions, recognition of trends and develop the capacity to predict the future course of events given alternative approach to management of material movement, aquatic ecology models and planktonic succession.
- o Environmental Engineering Tool and Services: to develop, improve useful engineering models, statistical description and environment maps, and conducts system studies to support users needs for information and to provide an enclosed advisory service.

Research is conducted on all the Great Lakes, although some studies have concentrated in particular lakes. A 65 foot converted "T-boat" is operated by NOAA along with two 21 foot boats. These vessels are used to support physical, chemistry and biology field studies. Physical liminology research studies underway for Lake Erie include currents, wind waves and storm surges. The current studies are partially funded by EPA-GLNPO.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Current NASA programs on the Great Lakes involve two major activities: modeling and field work. The basic mission of the programs is to develop a remote sensing activity that will be able to monitor a parameter in water. Equipment available to accomplish this mission are two aircraft with scanners. These aircraft collect the ice cover and thermal data on the lakes. The satellite program using LANDSAT and the Nimbus G are developing methods for measurement of chlorophyll and sediment data in the lakes. There is an inter-agency work group that shares the information and includes EPA. The satellite studies have aided in the PLUARG report. Some EPA vessel time is paid for by NASA and some NASA work is paid for by EPA/ORD funds.

DEPARTMENT OF ENERGY

Great Lakes research conducted by the Department of Energy is funded by pass-through dollars from the EPA/ORD to the Argonne National Laboratories (ANL). The total expenditure from EPA to the ANL is approximately \$1.2 million per year. This involves research efforts predominately on Lake Michigan and makes use of a new research vessel Ekos, a 56 foot vessel commissioned in October 1978. The mission of the ANL vessel is to obtain water, sediment and air samples to help identify transport mechanisms of energy related toxic pollutants (e.g. heavy metals) into and within the Great Lakes.

The objectives of the ANL biological research effort are to:

- o describe biological processes and fate of pollutants.
- o determine effects of pollutants on the lake biota.
- o identify long-term changes in the trends of the biota.

- o develop numerical models to predict pollutant pathways, timescales and suspension in the lakes.
- o determine the bio-geochemical processes which govern the bio-availability of transuranic elements in the Great Lakes.

Effects of chemical pollution are also the subject of the ANL water quality data collection efforts. Sources of pollution input to the Great Lakes are being studied.

CORPS OF ENGINEERS

As noted above, the COE is coordinating a major research planning effort with the FWS on the Great Lakes. This effort is to produce an Environmental Plan of Action for all the Great Lakes and the St. Lawrence River. The thrust of the COE programs are for monitoring dredge and fill activities and the winter navigation program. Biological assessment of the winter navigation program is a task which is being shared with the FWS office located in Minneapolis under a cooperative agreement. Also, the COE is working with the IJC Lakes level board.

STATE SURVEILLANCE ACTIVITIES

All eight States bordering the Great Lakes have some water quality surveillance programs. However, the extent of the efforts vary considerably. Each State's program is described briefly. The objectives of the various State surveillance programs generally are similar, and these are to:

- o assess the effectiveness of the remedial program.
- o monitor drinking water intakes.
- o provide trends analysis by fish tissue monitoring.

An attempt was made to provide a budget breakdown for the Great Lakes State surveillance effort but this was not always possible. Often the States have a total surveillance budget with the Great Lakes effort being a part of the total. Where budgets are given they may be approximate (Tab 2).

State water quality surveillance programs on the Great Lakes are as follows:

New York - A total of \$250,000 is budgeted by the State to collect water, biological and sediment samples. Fish tissues are surveyed to identify potential problems. However, the fish tissue sampling is on a 3 year cycle. A fishing boat is operated on Lakes Erie and Ontario by the State in conjunction with the 3 year fish collection program.

Pennsylvania - A total of between \$10,000 to \$12,000 is budgeted by the State for tributary and drinking water intake monitoring. A fish tissue analysis program is also being conducted by the State. The State does rely upon the I.J.C. to estimate the compliance with remedial programs!?

Ohio - A budget of approximately \$20,000 per year is allocated for tributary and drinking water intake studies. A subcontract with the U.S. Geological Survey is used for the tributary monitoring program.

Indiana - A total budget of approximately \$450,000 is allocated by the State for compliance, biological and chemical monitoring programs. There are basically two programs operated by the States. Tributary monitoring with a total of 33 parameters being tested. The second program is for drinking water intake studies. The State operates a 55 foot boat (Norwester) which is used by the Department of Natural Resources and the State Public Health Department. There is also a proposal for an independent Lake sampling program which extends about 5 miles into Lake Michigan. A fish tissue analysis program is

operated by the State. Sample site locations are chosen by a grid matrix. Representatives from the States are involved with the Region V and GLNPO staff. Michigan - The State has a budget of approximately \$500,000 per year allocated to surveillance programs on the Great Lakes. About 40 per cent of this effort is for samples of discharges, with the remainder split among tributaries, water intakes, studies of nearshore areas and the Detroit River. A fish collection program on Lakes Superior, Huron, Michigan and Erie has been undertaken for fish tissue analysis. There is coordination between the State, IJC and the GLNPO.

Illinois - No budget breakdown was possible by the State representatives contacted. A drinking water intake monitoring program is conducted by the city of Chicago under a cooperative agreement with the State. This program is coordinated with the GLNPO. A fish tissue analysis is being conducted.

Wisconsin - A budget of approximately \$84,000 is allocated by the State for tributary monitoring, fish collection and tissue and ambient water quality monitoring.

Minnesota - No budget breakdown for the Lake Superior monitoring program was given by the representatives. The object of the program is for compliance monitoring for the point source control program.

NATIONAL POLLUTION DISCHARGE ELIMINATION SYSTEM

Private industry is required under the NPDES system to undertake a self monitoring program. All permitted industrial and municipal discharges collect water quality data on their effluents. The financial burden of collecting these data are placed on the industries or municipalities and no estimate of the total expenditures is available. However, it has been suggested that the cost involved is in the millions of dollars. Data from the self monitoring

program is provided to the Regional Enforcement Divisions.

Problem Areas

In discussion with the Regional personnel in the GLNPO - surveillance staff, Surveillance and Analysis Division, Enforcement Division and the Office of Research and Development, a variety of problems and concerns were made known.

Water quality data for the regional planning activities, calculation of waste load allocations, assessment of the various remedial actions implemented and identification of water quality problem areas, all require the water quality data. However, personnel from the Region are in agreement that a dialogue between the various offices and the GLNPO is at best minimal. One of the underlying points made by Regional personnel was that data should be fed back into the various programs and that planning of GLNPO surveillance activities should be coordinated with the Region and between Regions and States. Again, regional personnel are in agreement that this exchange does not occur. The regional planning agencies do not use the water quality data generated by the Great Lakes Surveillance programs and a consensus of opinion of the Regional personnel was that there is a need for priority attention to the Great Lakes. However, the belief expressed was that the water quality surveillance program should place more emphasis on the regional monitoring needs to determine effectiveness of remedial programs. Program priorities are believed not to be given enough consideration with respect to the monitoring strategy. Further, it was stated that more attention should be given to nearshore and tributary water quality data collection.

Another problem highlighted during discussions with the GLNPO surveillance staff was the imbalance between resources committed for data analysis and data collection. Thus there is a backlog of water quality data to be analyzed even as new water quality data are collected. As noted in the 1975 Great Lakes Surveillance Plan, a priority on data analysis was deemed basic. Another significant problem highlighted was a general lack of common test protocols and procedures between the U.S. and Canada. While there are some common test protocols available, sampling procedures and a quality assurance program between the U.S. and Canada is now beginning to be discussed. This is critical to a good toxic surveillance program for both countries. Quality assurance within the GLNPO office does occur but again only on an ad hoc basis between the U.S. and Canada.

Tab 1

FEDERAL AGENCIES WITH VESSELS
ON THE
GREAT LAKES+

Agency	Vessel	Operating Cost (Total)	Size*	Lakes Covered	Mission :
EPA	Crocket	\$280,000	165 Feet	Erie	Contractor operated for GLNPO - 80 percent Open Lake Surveillance activities - 20 percent NOAA use
	Simons	125,000 (+50,000 R&D)	122 Feet	Erie	On loan to Heidelberg Un. for nearshore monitoring and research work surveillance under 60 percent EPA, 40 percent university work
	Danbach	40,000 (+40,000 R&D)	65 Feet	Erie	On loan to SUNY - Buffalo - for nearshore and research work - 50-60 percent EPA surveillance work
	Hydra	60,000 (+60,000 R&D)	65 Feet	Erie	On loan to Ohio State Un. for nearshore and research work 50 percent surveillance work
	Bluewater	8,000 (+24,000 R&D)	40 Feet	Huron (Saginaw Bay)	ORD uses for research efforts a data collection percent surveillance activities 75 percent R&D data collection
	Aquaguard	4,500	28 Feet	Ontario Erie	Surveillance activities 100 percent
Dept. of Interior FWS	Siscolet	91,000	57 Feet	Superior	11 cruises per year wet lab. space available fish sample collection
	Grayling	115,000	75 Feet	Michigan Superior Huron	3 cruises per year - 2 cruises per year Superior 10 cruises per year - fish stock assessment wet lab. space available
	Cisco	100,000	60 Feet	Michigan	10 cruises per year - fish stock assessment wet lab. space available
	Musky	64,000	45 Feet	Erie	10 cruises per year - fish stock assessment wet lab. space available

cont'd

Agency	Vessel	Operating Cost (Total)	Size*	Lakes Covered	Mission
Dept. of Energy	Kaho	100,000	65 Feet	Ontario	11 cruises per year - fish stock assessment wet lab. space available
	Hiodon	14,000	46 Feet	Lake St. Clair Mt. Clements	No lab space available
Dept. of Energy	Ekos	55,000	56 Feet	Michigan	Collect water, air and sediment samples for chemical and biological analysis - NIE FUND by EPA - Energy money - to be transferred back to EPA in FY 79. ORD will take over program.
Dept. of Commerce NOAA	Shenehon	100,000	65 Feet	Great Lakes plus Connecting Channels	Study currents and water flows; fauna type and distribution; sediment characterization; characterization of water quality; nutrient cycling and toxic dynamics; plankton and benthos processes.

*The Dept. of Transportation - Coast Guard and Corps of Engineers not included

*Size below 40 feet was not recorded except for Region II, EPA.

Tab 2

Summary of State and Federal Expenditures
for Great Lakes Water Quality Surveillance
and Related Research Activities - FY 79

Governmental Organization	Dollars Spent (in Thousands)	Approximate Total Budget
<u>States</u>		
New York	\$250	
Pennsylvania	12	
Ohio	75	
Indiana	450	
Michigan	500	
Illinois	-	
Wisconsin	84	
Minnesota	-	
Total State		<u>\$1,371</u>
Dept. of Interior		
USGS	\$2,500	
FWS	2,092	
Total USDI		<u>4,592</u>

US EPA

GLNPO

ORD

\$3,500

2,100



US EPA		
GLNPO	\$3,500	
ORD	2,100	
Region V, Air Program	103	
Region II	70	
Total EPA	<u>\$5,773</u>	<u>5,773</u>
Dept. of Energy	\$1,200	<u>1,200</u>
Dept. of Commerce		
NOAA (approx.)	\$3,200	<u>3,200</u>
Total Federal Budget (Exclusive of Corps of Engineers and U.S. Coast Guard)		<u>\$14,765</u>
Total Budget including States		<u>\$16,136</u>

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