U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY
WORKING PAPER SERIES

NATIONAL EUTROPHICATION

SURVEY METHODS

1973 - 1976

WORKING PAPER NO. 175

PACIFIC NORTHWEST ENVIRONMENTAL RESEARCH LABORATORY

An Associate Laboratory of the

NATIONAL ENVIRONMENTAL RESEARCH CENTER - CORVALLIS, OREGON

and

NATIONAL ENVIRONMENTAL RESEARCH CENTER - LAS VEGAS, NEVADA

☆GPO—697-032

NATIONAL EUTROPHICATION

SURVEY METHODS

1973 - 1976

WORKING PAPER NO. 175

National Environmental Research Center
Las Vegas, Nevada

National Environmental Research Center
Corvallis, Oregon

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY

June 1975

NATIONAL EUTROPHICATION SURVEY METHODS

1973 - 1976

by

Water and Land Monitoring Branch
Monitoring Applications Laboratory
National Environmental Research Center
Las Vegas, Nevada

and

Eutrophication Survey Branch
Pacific Northwest Environmental Research Laboratory
National Environmental Research Center
Corvallis, Oregon

Working Paper No. 175

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY

June 1975

CONTENTS

INTRODUCTION

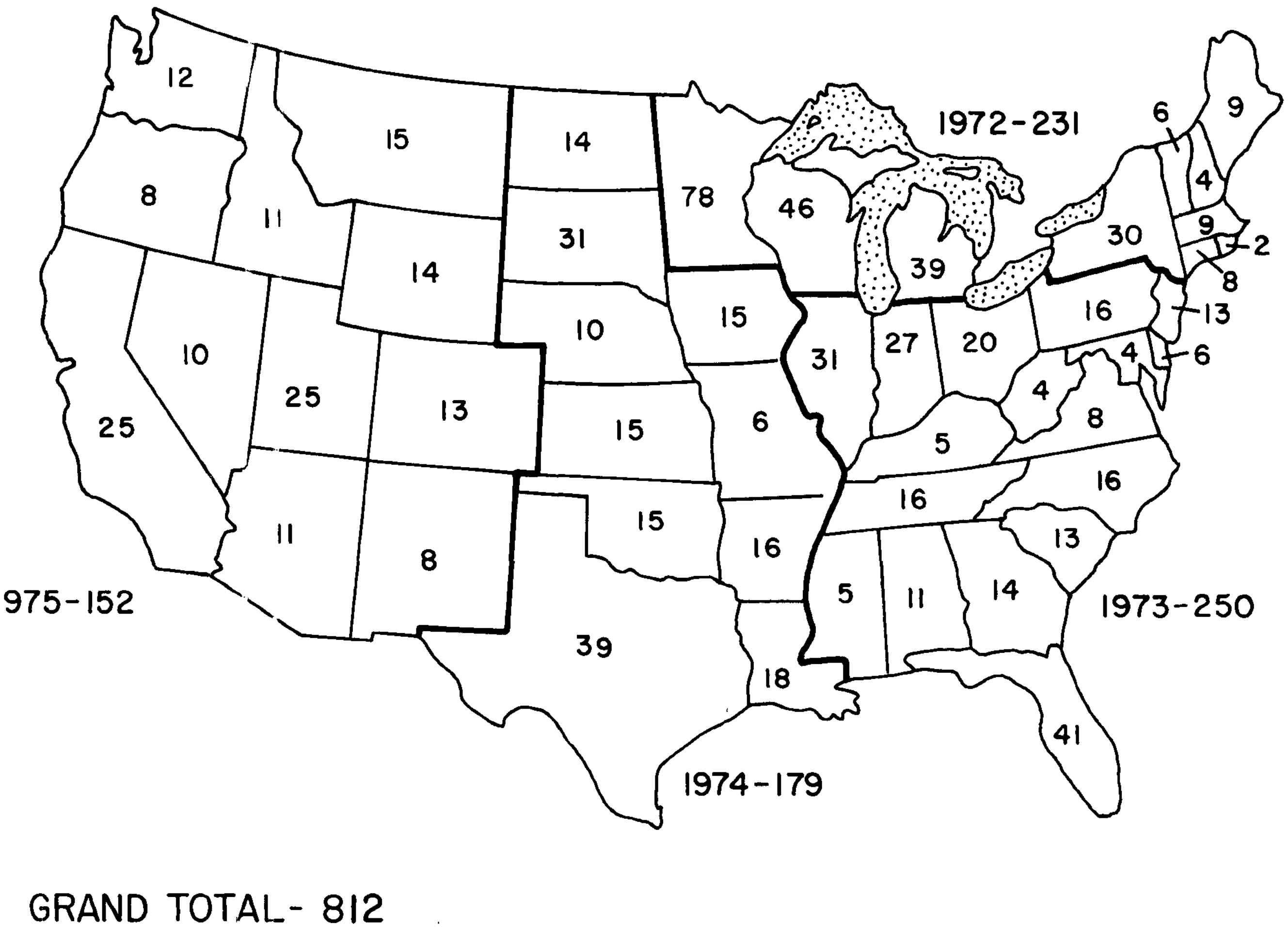
The National Eutrophication Survey (NES) originated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs. The Survey was designed to develop, in conjunction with State environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and State management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

The Survey was initiated in 10 Northeastern and Northcentral States in May 1972. In October 1972, Congress enacted the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500) which reprioritized Federal water quality research goals. Consequently, program objectives were recast in concert with U.S. Environmental Protection Agency (EPA) strategies. Sampling emphasis was shifted from only point source impacted lakes to those subject to nonpoint pollution problems as well. This transition, coupled with substantial improvements in equipment design, field techniques and analytic protocols, has necessitated two separate documents on Survey methodology. The first, Working Paper No. 1, described the approach utilized during the first year of the Survey (1972-1973) in the initial ten-State area. This paper details methods employed throughout the balance of the program in the remainder of the contiguous United States from 1973 through 1976. Figure 1 indicates the distribution by State and year of lake sampling of Survey lakes and reservoirs.

The mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency endorsement or recommendation for use.

NATIONAL EUTROPHICATION SURVEY

NUMBER OF LAKES & YEAR SAMPLED



PARTICIPATING LABORATORIES

Each of the participating laboratories, the National Environmental Research Center-Corvallis (NERC-Corvallis), the National Environmental Research Center-Las Vegas (NERC-LV), the Headquarters Staff, National Eutrophication Survey, Office of Research and Development, Washington, D.C. (NES/HQS), and others have clearly defined roles in the functional organization of the Survey. Table 1 lists the primary responsibilities of the participating agencies, laboratories, and/or individuals.

NES/HQS initiated contacts with the States through EPA Regional Offices. Briefing of appropriate State water officials was arranged and conducted by NES/HQS personnel. The NES program and procedures were discussed and a suggested lake list was presented. Upon commitment of each State to the Survey and receipt of the final lake list from each State, contacts were arranged and subsequent NES/State coordination was performed by NERC-LV or NERC-Corvallis personnel as appropriate. Requests for participation of State National Guards were originated by the Secretary of Defense Liaison Officer to EPA (located at NES/HQS) through formal Defense Department channels. Meetings were arranged with State Adjutant Generals, the NES effort explained, and details of the proposed National Guard involvement presented. Upon commitment of participation by the State National Guard, formal press conferences were held in that State to announce its participation in the Survey and the involvement of State National Guard personnel in collecting stream samples.

Table 1. NATIONAL EUTROPHICATION SURVEY RESPONSIBILITIES

FUNCTION	PNERL	NERC-LV	NES/HQS	OTHERS
I. Planning and Coordination	X	X	X	
II. Selection of Lakes				
A. Preliminary			X	1,2
B. Final	X	X	X	1
III. Lake Sampling				
A. Procedures		X		
B. Sample procurement		X		
C. Field analyses		X		
D. Preliminary lake evaluation		X		
E. Aircraft support		X		
F. Sample and data handling		X		
IV. Stream Sampling				
A. Procedures	X			
B. Sample procurement	X			1,3
C. Sample and data handling	X			
D. Stream flow data	X			4
V. Sewage Treatment Plant Sampling				
A. Procedures	X			
B. Sample procurement	X			1,5
C. Sample and data handling	X			
VI. Chemical Analyses				
A. Lake samples		X		
B. Tributary samples	X			
C. Sewage treatment plant samples	X			
D. Quality control				
1. Within lab	X	X		
2. Interlab	X	X		
VII. Biological Analyses				
A. Chlorophyll-a		X		
B. Phytoplankton identification		X		6
C. Algal Assay Procedure	X			
D. Pathogenic protozoa, bacteria		X		7,8
VIII. Land-Use Studies				
A. Watershed selection	X			
B. Imagery acquisition	X			
C. Imagery interpretation	X			
IX. Data Analyses and Report Preparation	X	X	X	1*, 2*, 9

Key:
1. State pollution control agency
2. EPA Regional Office
3. State National Guard
4. U.S. Geological Survey
5. Municipal sewage treatment plant operators
6. Desert Research Institute
7. Dr. Shih L. Chang, Water Supply Research Laboratory, Cincinnati, Ohio
8. Dr. Victor Cabelli, Northeast Water Supply Laboratory, Narragansett, Rhode Island
9. Florida Lake Reports by Dr. Patrick Brezonik, University of Florida

*Review and comment

SELECTION OF LAKES

Freshwater lakes and impoundments in the Survey were selected through deliberations with EPA Regional Offices and State pollution control agencies (as well as related State agencies managing fisheries, water resources, or public health). Selection criteria were established by EPA to limit the type and number of candidate water bodies consistent with existing Agency water goals and strategies. For the 27 States in the Eastern United States, where screening and selection were accomplished prior to passage of PL 92-500, strongest emphasis was placed on lakes faced with actual or potential accelerated eutrophication problems. As a result, the selection was limited to lakes:

(1) impacted by one or more municipal sewage treatment plant (MSTP) outfalls either directly or by discharge to an inlet tributary within approximately 25 miles of the lake;

(2) 100 acres or larger in size; and

(3) with mean hydraulic retention time of at least 30 days.

Specific selection criteria were waived for some lakes of particular State interest.

In the Western States, these criteria were modified to reflect revised Federal water research mandates, as well as to address more prevalent nonpoint source problems in agricultural or undeveloped areas. Thus, each State was requested to submit a list of candidate lakes for the Survey that were:

(1) representative of the full range of water quality (from oligotrophic to eutrophic);

(2) in the recreational, water supply and/or fish and wildlife propagation use categories;

(3) representative of the full scope of nutrient pollution problems or sources (from municipal waste and/or nutrient-rich industrial discharges as well as from nonpoint sources).

The size and retention time constraints were retained from Eastern States as was the waiver provision.

In all cases, listings of potential candidate lakes or reservoirs, generated in conjunction with the EPA Regional Offices, were made available to the States to initiate the selection process. Table 2 summarizes by year of lake sampling, the numbers of lakes, associated stream monitoring stations, and MSTP effluents sampled, and indicates the month stream sampling was initiated for each State. (Stream and MSTP sampling continued for 12 months following start-up.) Appendices A, B, and C present the names of all lakes and reservoirs by State and County included in the 1973, '74, and '75 coverage areas respectively.

FIELD SAMPLING METHODS

LAKES AND RESERVOIRS

Lake sampling was accomplished by two sampling teams, each consisting of a limnologist, pilot, and sampling technician, operating from pontoon-equipped Bell UH-1H helicopters. A mobile field laboratory provided analytical support.

Lake and reservoir sampling site locations were selected primarily to attempt to define the character of the lake water as a whole, but also to investigate visible or known problem areas (such as an algae bloom in a bay, a visible sediment plume, an area of submerged sewer discharge, etc.). Sites were located based upon available information of lake morphology, potential major sources of nutrient input, known hydrologic characteristics, and the on-site judgment of the limnologist aboard the helicopter. Primary sampling sites were chosen to reflect the deepest portion of each major basin in a Survey lake. Where many basins were present, selection was guided by nutrient source information on hand. The number of sampling sites was limited commensurate with the survey nature of the program and varied in accordance with lake size, morphological and hydrological complexity, and often because of practical considerations of available time, helicopter range, and weather.

Table 2. THE NUMBER OF LAKES, STREAM SITES, AND MUNICIPAL SEWAGE TREATMENT PLANT EFFLUENTS SAMPLED IN EACH STATE INCLUDED IN THE SURVEY

State	Number of Lakes Included in Survey	Number of Lake Tributaries and Outlets Sampled	Number of Municipal Sewage Treatment Plants Sampled	Month and Year Tributary and Outlet Sampling Was Started
1972				
Connecticut	8	74	17	August 1972
Maine	9	59	5	September 1972
Massachusetts	9	37	15	September 1972
Michigan	39	170	51	October 1972
Minnesota	78	231	56	October 1972
New Hampshire	4	52	5	August 1972
New York	30	242	36	November 1972
Rhode Island	2	28	1	August
Vermont	6	52	23	July 1972
Wisconsin	46	170	16	September 1972
Subtotal	231	1,115	225	

Table 2 (continued). THE NUMBER OF LAKES, STREAM SITES, AND MUNICIPAL SEWAGE TREATMENT PLANT EFFLUENTS SAMPLED IN EACH STATE INCLUDED IN THE SURVEY

State	Number of Lakes Included in Survey	Number of Lake Tributaries and Outlets Sampled	Number of Municipal Sewage Treatment Plants Sampled	Month and Year Tributary and Outlet Sampling Was Started
1973				
Alabama	11	118	35	March 1973
Delaware	6	17	6	April 1973
Florida	41	104	46	March 1973
Georgia	14	100	46	March 1973
Illinois	31	122	28	June 1973
Indiana	27	101	44	June 1973
Kentucky	5	73	14	March 1973
Maryland	4	28	8	May 1973
Mississippi	5	35	12	August 1973
New Jersey	13	52	21	July 1973
North Carolina	16	102	38	March 1973
Ohio	20	97	14	May 1973
Pennsylvania	15	75	52	May 1973
South Carolina	13	96	59	February 1973
Tennessee	16	195	44	April 1973
Virginia	8	61	42	July 1973
West Virginia	4	33	24	July 1973
Subtotal	250	1,409	533	

Table 2 (continued). THE NUMBER OF LAKES, STREAM SITES, AND MUNICIPAL SEWAGE TREATMENT PLANT EFFLUENTS SAMPLED IN EACH STATE INCLUDED IN THE SURVEY

State	Number of Lakes Included in Survey	Number of Lake Tributaries and Outlets Sampled	Number of Municipal Sewage Treatment Plants Sampled	Month and Year Tributary and Outlet Sampling Was Started
1974				
Arkansas	16	132	29	June 1974
Iowa	15	44	3	August 1974
Kansas	15	95	45	October 1974
Louisiana	19	77	18	June 1974
Missouri	6	58	9	September 1974
Nebraska	10	45	8	August 1974
North Dakota	14	45	5	September 1974
Oklahoma	15	113	?	November 1974
South Dakota	31	68	5	October 1974
Texas	39	244	50	September
Subtotal	180	921	172	
1975				
Arizona	11	42	19	December 1974
California	25	119	9	November 1974
Colorado	13	73	26	September 1974
Idaho	13	90	8	October 1974
Montana	15	89	7	October 1974
Nevada	10	45	4	November 1974
New Mexico	8	39	8	December 1974
Oregon	8	44	0	October 1974
Utah	25	104	25	November 1974
Washington	12	56	2	September 1974
Wyoming	14	81	18	October 1974
Subtotal	154	782	126	
GRAND TOTAL	841	4,227	1,056	

Site locations were marked and numbered using U.S. Geological Survey (USGS) 7-1/2' quadrandrangles whenever possible. When these were not available, 15' or 1:250,000 series USGS maps were employed. In some instances, bathymetric maps were obtained through the assistance of State or regional agencies, the U.S. Army Corps of Engineers, or other sources; these were invaluable in selecting sampling sites. Unfortunately, many of the lakes and reservoirs included in the Survey either had not been bathymetrically mapped or the maps could not be obtained prior to sampling. From the marked maps, geographic coordinates were determined and entered on a site description form (Appendix D). Occasionally a sampling site was modified, deleted, or added on subsequent sampling rounds because of a change in lake level or receipt of information relevant to the basic site-selection criteria.

The Survey helicopters were equipped with electric winches and approximately 200 feet of hollow-core, multi-conductor cable attached to a submersible pump and an Interocean Systems sensor package capable of making *in situ* measurements of conductivity, temperature, optical transmissivity, and depth. An *in situ* pH sensor was added to this system for the final sampling round in 1974 and for portions of 1975. Rack-mounted equipment located inside the helicopter provided analog recording capabilities and a digital display of the sensor values. An echo sounder, Secchi disc, sample containers, and related equipment items necessary for water sampling were also carried in each helicopter.

After landing at the approximate site, the helicopter was water-taxied in the area to locate the deepest nearby water. There a small buoy was deployed to serve as a reference to the pilot for maintaining the helicopter on station. Compass bearings were taken to prominent landmarks from each sampling site to permit return to the same location on subsequent sampling rounds. Observations were recorded on the field data sheet (Appendix D) concerning the site location, general lake appearance, phytoplankton bloom conditions, and shoreline development. Secchi disc measurements were made and bucket-dipped surface water samples were collected. A field observation form (Appendix D) was prepared and put into use midway through the 1974 sampling year.

After the sensor-pump package was immersed, sensor outputs were checked, analog recorders were activated and initialled, and the sensor package was lowered slowly through the water column until it contacted bottom (or the cable end was reached). It was then raised to a point 4 feet off the bottom to avoid pump damage from sediments entering the intake. The digital readout of each sensor at that depth was recorded on the field data sheet and the submersible pump was activated. Water samples were collected after allowing sufficient time for the pump to completely purge the hollow cable of water from the previous station. (Purge times were routinely measured for each system.) Sampling depths for the collection of other water samples were chosen after inspection of the analog strip-chart records to best represent the water column. Upon completion of sampling near the bottom, the sensor was raised to the next level, digital values were recorded, the hose was purged, and water samples pumped. This process was repeated at each depth selected for collection of water samples at a given site.

Integrated samples for algal identification and chlorophyll-a analysis were collected by continuing to pump while raising or lowering the sensor package. Water collection was timed to provide a uniform mixture of water from the surface to 15 feet, to the lower limit of the photic zone as determined by the light meter, whichever was greater, or to a point just off the bottom within water less than 15 feet deep.

At each sampling depth water samples were collected for nutrient, alkalinity, pH, conductivity, and dissolved oxygen determinations. For nutrient analysis two 4-ounce sample bottles were filled and the samples immediately preserved with 0.25 ml of mercuric chloride solution (25 g $HgCl_2$/liter of water).*

Samples for dissolved oxygen determinations were collected in 300-ml BOD bottles, immediately fixed with Hach powder pillow reagents, and stored out of direct sunlight. Samples for pH, conductivity, and chlorophyll-a analyses were collected in polyethylene bottles and refrigerated in the dark until completion of the day's sampling operation. Algal identification samples were preserved with acid Lugol's solution aboard the helicopter.

*In 1973 contamination of mercuric chloride preservative with pH buffer occurred. Consequently, nutrient samples collected during a period of several weeks were improperly preserved and results of the subsequent analyses were inaccurate and not entered into the STORET system.

During the first sampling round in 1973 a 5-gallon algal assay water sample was obtained by compositing water collected at each sampling depth and combining these sub-samples from each site on a lake. If a lake had more than four stations, groups of sites were combined into two or more polyethylene cubitainers. Coincident with this, a surface sample for heavy metal analyses was collected in a 1-quart cubitainer that had been pre-rinsed with fuming nitric acid. Surface water from up to four sites (corresponding to the algal assay composite sample) per lake was combined into a single sample. Upon return to the mobile field laboratory these were preserved with additional amounts of nitric acid.

In 1974 and 1975 similar water samples for algal assay and heavy metal analyses were collected on both the first and last sampling rounds. Two-gallon polypropylene jugs were substituted for the five-gallon cubitainers. This change allowed autoclaving to be performed in the original sample container and minimized nutrient loss by adsorption onto container walls. Heavy metal samples were collected in acid rinsed bottles as before, however, they were not preserved with additional nitric acid. Recent investigations have indicated that nearly complete recovery of metals of interest can be made by acid rinsing just prior to analysis.

Both algal assay and heavy metal samples were forwarded to NERC-Corvallis for processing.

Beginning in 1974 bottom sediment samples were attempted at each site using a small brass grab sampler. Samples obtained were placed in plastic bags and labeled. Sediment samples obtained during one sampling round were forwarded to NERC-LV for nutrient analyses and those from the next round to NERC-Corvallis for heavy metal determinations. If sediment sampling was successful at a given site on only one of the sampling rounds, data will only be available for heavy metal and not the nutrient analyses (or vice versa).

Conductivity and pH electrode determinations were made as soon as possible following their delivery to the field laboratory at the end of the day's sampling. A Beckman Electromate portable pH meter and combination electrode were used to determine pH. These determinations were the reported value until the final 1974 sampling round. The reported values for that round were obtained by means of an *in situ* pH probe. Daily calibration checks against the laboratory pH meter were made during this period. Subsequent failure of the sensors and inability to obtain timely replacements forced a return to laboratory determined pH values for the 1975 sampling period. Conductivity measurements were made with a Beckman Model RB338 conductivity bridge. These were utilized as a check on the *in situ* sensors. Dissolved oxygen samples were titrated with phenylarsine oxide in the mobile field laboratory within 16 hours after collection.

Chlorophyll-a analyses were performed at the end of each day in the trailer laboratory according to the fluorometric procedure described by Yentsch and Menzel (1963). One of each pair of nutrient samples was filtered through a type HA 0.45-micron Millipore filter into a clean unused polyethylene bottle, recapped, and, along with its unfiltered counterpart, forwarded to NERC-LV for analysis.

Table 3 provides a summary listing of the lake water samples collected.

STREAMS

Sampling sites were selected on significant tributaries to each lake near the point where the tributary discharged to the lake. Where municipal waste discharges were located on tributaries, sampling sites were also designated upstream from the point of effluent discharge. Sampling sites for outlets of lakes or reservoirs were located at the nearest feasible sampling point downstream from the water body being surveyed.

Monthly samples at the designated stream sites were collected through the volunteer efforts of the National Guard in each of the involved States. When sampling was started in any of the States, a scientist from EPA or the State agency accompanied each National Guard sampling team to each site during the first sampling to train the team in proper techniques of sample collection, preservation and handling. During the first sampling, the unique six-digit station number was stenciled on the bridge or another permanent landmark at the sampling site to insure positive identification of the site. Subsequent monthly sampling for a period of 1 year, plus two additional samples during high flow periods, was done exclusively by the National Guard sampling teams.

Stream samples were collected in clean, previously unused, wide-mouth, 1-liter polyvinyl chloride bottles. These were inserted in a sampler consisting of a section of plastic pipe with a cross-bar bottle retainer at one end and rubber tubing stretched across the other end to secure the bottle. A rope was attached to the sampler to lower it from a bridge or stream bank to the water surface. The water collected in the sample bottle at each site was essentially a surface grab sample, although the sampling rig was lowered to mid-depth in the stream before it was retrieved.

Table 3. LAKE WATER SAMPLE ANALYSES SUMMARY

PARAMETERS	SAMPLE VOLUME	FIELD TREATMENT	WHERE PERFORMED	DEPTH
Temperature			*In situ*	Continuous
Depth			*In situ*	Continuous
Conductivity			*In situ*	Continuous
Turbidity			*In situ*	Continuous
pH	4-ounce	Refrigerated	Field lab	Select levels
Dissolved oxygen	300-ml	Hach chemicals	Field lab	Select levels
Chlorophyll-a	4-ounce	Refrigerated	Field lab	Photic zone integration
Algae identification	4-ounce	Lugol's solution	NERC-LV	Photic zone integration
Total phosphorus, Kjeldahl-N	4-ounce	Unfiltered, $HgCl_2$	NERC-LV	Select levels
Dissolved ortho-phosphorus, Nitrite-nitrate-N, Ammonia-N, Total Alkalinity	4-ounce	Filtered, $HgCl_2$	NERC-LV	Select levels
Algal assay*	2-gallon	Take sub-samples for nutrient analyses	NERC-Corvallis	Water column integration and combined stations
Heavy metals*	1-quart	None	NERC-Corvallis	Surface dip, combined stations

*Not collected on all sampling rounds

Following sample collection at each site, the Guard team completed a label attached to each bottle recording the stream name, station number, date, time, and signature of the individual responsible for collecting the sample. The sample was preserved at the site with mercuric chloride. Following inventory at the Guard base, samples were sent to NERC-Corvallis for analysis.

MUNICIPAL SEWAGE TREATMENT PLANT

Municipal sewage treatment plant (MSTP) effluent data was desired to evaluate MSTP contribution to a lake's nutrient budget. This information, in turn, allowed estimation of the nonpoint source contribution and ultimately permits assessment of the impact of regulating either or both pollution sources. The data obtained have also proven useful in evaluating the efficiency of various types of sewage processing systems as well as the impact of State phosphate detergent bans upon lake eutrophication.

With the cooperation of State agencies, an attempt was made to identify all MSTP's discharging directly or indirectly into each lake. The operator at each MSTP was requested to provide monthly effluent samples for a period of 1 year. Each operator who agreed to cooperate was provided with a sampling kit, mercuric chloride preservative, shipping boxes, and pre-addressed, franked shipping labels.

He was asked to provide one of the following samples (listed in order of descending preference):

(1) a once-monthly 24-hour composite sample (proportional composite if flows were metered or measured),

(2) a once-monthly 8-, 10-, or 12-hour composite sample (proportional if flows were metered or measured),

(3) a once-monthly modified composite sample consisting of about 500 ml collected at 11 a.m. and another 500 ml collected at 4 p.m. of the same day, <u>or</u>

(4) a once-monthly single grab sample of about 1 liter collected on a weekday between the hours of 8 a.m. and 8 p.m.

Following collection, the plant operator preserved the sample by adding to it the contents of a vial containing sufficient mercuric chloride to achieve a concentration of 400 mg/l in the sample. The sample label (Appendix E) was completed by the sample collector and included data on sample type, date, mean flow for the day of sampling, and mean daily flow for the month in which the samples were collected. Samples were mailed to NERC-Corvallis for analysis of phosphorus and nitrogen content.

ANALYTICAL METHODS

NUTRIENT ANALYSES

The analytical methods utilized to process the samples at both NERC-Corvallis and NERC-LV are outlined in Table 4. All of the analyses were performed utilizing adaptations of automated procedures described in "Methods for Chemical Analysis of Water and Wastes" (EPA, 1971).

There were some differences in the analyses performed at each laboratory. The lake water samples were analyzed at NERC-LV for total alkalinity, an analysis not performed at NERC-Corvallis. Conversely, NERC-Corvallis performed independent analyses for nitrite-N and nitrate-N as well as nitrite-nitrate-N. Only the last analysis was conducted at NERC-LV. In addition, Kjeldahl-N digestions were accomplished automatically on the analyzer at NERC-LV, while at NERC-Corvallis a manual digestion procedure was utilized.

USGS ESTIMATES OF STREAM FLOWS AND DRAINAGE AREAS

For each sampled stream the various District Offices of the USGS made estimates of the mean flow for the day of sampling, the flow for each month of sampling, and the "normalized" mean flow for each month (*i.e.*, flows expected during a period of average precipitation and hydrology). In addition, runoff estimates were made for the unsampled portion of the total watershed of each lake and the area of the drainage basin for each sampled tributary stream and for each lake or reservoir was provided.

Table 4. ANALYTICAL METHODS AND PRECISION OF LABORATORY ANALYSES*

PARAMETER	METHOD	PRECISION
Dissolved Orthophosphate	Single reagent methods involving colorimetric determination of antimony-phosphomolybdate complex.	$\pm$ 0.005 mg/l P or $\pm$ 5%
Total Phosphorus	Persulfate oxidation followed by the above method for dissolved orthophosphate.	$\pm$ 0.005 mg/l P or $\pm$ 5%
Nitrite-N	Diazotization of sulfanilamide by nitrite coupled with N-(1-naphthyl)-ethylene diamine.	$\pm$ 0.001 mg/l N or $\pm$ 2%
Nitrite-Nitrate-N	Cadmium reduction followed by the above method for Nitrite-N.	$\pm$ 0.010 mg/l N or $\pm$ 5%
Nitrate-N	Determined by difference between the preceding two reactions.	$\pm$ 0.010 mg/l N or $\pm$ 5%
Ammonia-N	Alkaline phenol hypochlorite reaction producing indophenol blue.	$\pm$ 0.005 mg/l N or $\pm$ 5%
Kjeldahl-N	Acid digestion followed by the above procedure for ammonia nitrogen.	$\pm$ 0.10 mg/l N or $\pm$ 5%
Total Alkalinity	Methyl orange colorimetric.	$\pm$ 0.5 mg/l or $\pm$ 5% as $CaCO_3$

*Although the % precision value does not change, wastewater analyses precision values are an order of magnitude higher than those expressed (*i.e.*, $\pm$0.05 mg/l vice $\pm$ 0.005 mg/l).

In some instances, flow gages were present at sampling sites or within a reasonable distance and were used to provide flow estimates. In cases where sampled tributaries were ungaged, flow estimates were based on correlations with runoff patterns at the nearest gaged stream system. Where available, flow information was also obtained from other sources, such as the Corps of Engineers or power companies which maintained records of reservoir discharge.

The errors in drainage area measurements and flow estimates varied from one area to another and were highly dependent on the availability of topographic maps of the appropriate scale, the number of gaged stream sites for a given lake system, land relief, and other factors. In general, measurements or estimates which were provided by USGS for the larger drainage areas were better since these were subject to less severe fluctuations in stream flow within a given period of time.

Accuracy of drainage area measurements ranged from ± 1% to ± 10% depending on the quality of available maps. Stream flow measurements varied in accuracy from ± 5% in the larger gaged drainage areas to more than ± 100% in some small ungaged drainage areas. Due to extreme fluctuation in stream flow in many of the Western States, staff gages were installed by USGS and read at each sampling event by National Guard teams or else tapedowns from fixed reference points were performed by the Guard. These procedures were initiated to improve the accuracy of stream flow data in areas where the existing network of stream flow gages was insufficient to provide adequate data.

ESTIMATES OF NUTRIENT LOADINGS

TRIBUTARIES AND OUTLETS

Lake tributary and outlet nutrient loads included in each of the lake reports were estimated for a "normalized" or average flow year rather than for the year in which samples were collected. This approach was used because it was deemed more important to determine what sewage treatment plant contributions or land runoff contributions were under average conditions rather than during any extreme hydrological conditions which may have occurred during the year of sampling.

Normally, 14 samples were collected from each stream site. Occasionally the number of data points was less than 14 due to a sample or 2 not being collected during winter ice conditions, sample loss, breakage, or laboratory error. Although these are adequate data to provide a reasonable estimate of the average concentration for a given stream for the sampled year, the data from any one site are not adequate to satisfactorily estimate the relationship between flow and concentration at that site. Variations in flow both within and between years make it unsatisfactory to obtain a loading estimate simply by multiplying the observed average concentration times the annual normalized flow.

The procedure used was to estimate from combined data on a large number of streams the extent of the relationship between concentration and flow for each nutrient. The value so estimated represented the percent change in concentration resulting from a given percent change in flow. This relation does seem to be reasonably constant from stream to stream, although different for the two major nutrients (a stronger relation for phosphorus than for nitrogen). The appropriate statistical procedure for estimating this parameter is to compute the average slope from a large number of linear regressions, for individual streams, of log concentration on log flow. This was carried out using 250 sampling sites in Northeastern and Northcentral States. It was found that, on the average, a 1% change in flow results in a -0.11% change in phosphorus concentration and a -0.06% change in nitrogen concentration. In all other States the slopes used computing phosphorus and nitrogen loads were obtained by averaging the result of all stream sites within the specific State.

The method of estimating loading was essentially to use these estimated relationships to adjust the concentrations to what they would have been for each month under normalized flow conditions, and then add up the estimated loadings for the 12 months. The annual nutrient load, expressed as kilograms/year, was thus calculated by:

$$\text{Annual load} = 74.604\ \bar{c}\ Y\ S \sum_{1}^{12} NF_i$$

Where:

74.604 = factor including average number of days per month and conversion of concentration and flow to kilograms per day,

$\bar{c}$ = mean nutrient concentration in the sampled stream,

NF_i = normalized flow for i^{th} month,

$Y = 10^{b\{\overline{\log NF} - \overline{\log MF}\}}$,

$S = \{\sum_{1}^{12} NF_i \quad 10^{b(\log NF_i - \overline{\log NF})}\} / \sum_{1}^{12} NF_i$,

$\overline{\log NF}$ = mean log normalized flow,

$\overline{\log MF}$ = mean log monthly flow for year sampled,

and b = average slope for nitrogen and phosphorus for all stream sites within each State.

The "Y" factor adjusts the data to account for the fact that the year in which the samples were collected may have been extremely wet or dry which would have had an influence on measured contributions. The "S" factor adjusts the data to account for seasonal flow variations.

The net result of the regression analysis and subsequent calculations is an annual loading value which is generally within a few percent of the loading which would be estimated if it were assumed that nutrient concentrations did not vary with changes in stream flow.

In analyzing the data for a tributary having a point source upstream from the sampling point, the total stream load was estimated first by the method detailed above. If the point source was located reasonably close to the sampling site, the total annual contribution to the stream was subtracted from the total nutrient load at the sampling site, and the difference was attributed to nonpoint source input. If the point source was located several miles upstream from the sampling point, the scientist determining the nutrient loadings analyzed the total stream load (including the point source), the magnitude of the point source load, and the nonpoint source load of other stream systems in the area to determine what portion of the nutrient load at the sampling site could logically be attributed to the point source and subtracted from the total stream load. This procedure was not standardized and was performed on an individual basis for each stream system. However, the general rule was to assume that 100% of the point source load eventually reached the lake or reservoir.

Sampled streams usually included most, but not all, of the lake watershed. Unsampled streams, if any, and drainage from the lakeshore area also contributed nutrients. The nutrient contribution of the unsampled portion of the drainage area was usually estimated by using the average nutrient export per unit area of sampled stream drainage and multiplying that by the area of the unsampled portion. Judgment factors often influenced this estimate and how it was made. If point sources strongly influenced one or more sampled streams in a particular lake system, the scientist may have selected nutrient export values from a representative stream(s) to estimate loadings from the unsampled portion of the drainage area.

Variations from the above procedure, if any, are noted in the individual lake reports.

MUNICIPAL WASTEWATER TREATMENT PLANTS

If the operator of an MSTP impacting a surveyed lake submitted effluent samples for analysis, the results were used to estimate nutrient discharge. For these sampled plants, the nutrient loads were calculated for each day of sampling and averaged for the total sampling period. Mean daily flows for each month of sampling were also averaged and the total annual loads in kg/year were estimated according to the following equation:

$$\text{Annual Load} = (D)(F)(365)$$

where: D = Mean daily load in kilograms per cubic meter.

F = Mean daily flow in cubic meters.

If a plant was not sampled, the nutrient loads were estimated on the basis of sewered population or the 1970 census figures for the municipality if no better sewered population estimate could be obtained. Flows were estimated at 0.38 m^3/capita/day (100 gallons/capita/day).

For areas not under a phosphate detergent ban, the following per capita estimates of total phosphorus and nitrogen contributions were used:

	Total P (lbs/capita/year)	Total N (lbs/capita/year)
Treated Waste	2.5	7.5
Raw Waste	3.5	9.4

The 3.5 lbs total P/capita/year for raw waste discharge was taken from Bartsch (1972). For treated waste it was assumed that regardless of treatment type, approximately 29% of the total phosphorus would be removed leaving a contribution of 2.5 lbs/capita/year.

The nitrogen value of 3.401 kg/capita/year was derived from the information that nitrogen to phosphorus ratios in wastewater range from 3 to 6 (Bartsch, 1972) and that, on the average, treatment removes only 20% of the total nitrogen.

SEPTIC TANKS

Whenever data on the number of lakeshore septic tanks or septic tank nutrient contributions were available, which was infrequently, they were used. In the absence of any given data, the number of dwellings within 100 meters of the lake were counted on the most recent USGS quadrangle map. It was assumed that on a year-long average, 2.5 people occupied each dwelling. Where lakeshore resorts, parks, and/or campgrounds were known, it was assumed that all were served by septic tanks and that each resort was the equivalent of 10 dwellings, that the population of each park was 25 persons per day for 4 months, and that the population of each camp was 50 persons per day for 4 months.

It was also assumed that after septic tank treatment and discharge to the adsorption field that only 0.1134 kg P/capita/year reached the lake. For nitrogen, which is less amenable to removal by treatment or by adsorption to soil particles, it was assumed that 100% of the nitrogen or 4.263 kg N/capita/year reached the lake from septic tank systems on the lakeshore.

PRECIPITATION

A figure of 10.796 kg of total nitrogen/hectare lake surface/year was used as an estimate of nitrogen in precipitation. The estimate was the average result reported by Weible (1969) and Corey *et al.* (1967) for areas receiving approximately 30 inches of rainfall per year.

An estimate of 0.175 kg total phosphorus/hectare/year was used to represent total phosphorus in precipitation. This estimate, which is probably conservative, lies between the number reported by Corey et al. (1967) for soluble phosphorus and the lower end of the range reported by Weible (1969) for the Cincinnati, Ohio area.

ALGAL ASSAY

The procedures used in the algal assay were basically those outlined in the publication entitled Algal Assay Procedure Test (EPA, 1971). The basic differences in the algal assay test between the samples collected in 1973 and in subsequent years (1974-75) were sample containers and storage prior to sample processing. The 1973 lake samples were shipped from the field to the laboratory in nonautoclavable polyethylene containers. Following receipt in the laboratory, the samples were frozen until processing could begin. The 1974-75 samples were shipped to the laboratory in autoclavable polypropylene containers which were placed in a cooler at 4° C, rather than frozen, until they could be processed. Storage time in the cooler was approximately 1 week; however, many samples were processed within 24 hours after receipt at the laboratory.

After the storage period, the lake samples were autoclaved at 121° C and 15 psi for 30 minutes to kill indigenous organisms and solubilize nutrients bound by particulate matter. The 1973 samples were transferred from the original container to a polypropylene container before autoclaving, whereas the samples collected in 1974-75 were autoclaved in the same containers used to ship the sample. After autoclaving, all samples were filtered (0.45-micron filter) to remove particulate matter. Chemical analyses for nutrients and other constituents were performed before and after autoclaving.*

Each lake water sample was spiked with several nutrient levels in separate flasks. In addition, a lake water control with no nutrient supplement was assayed. Nutrient spikes included 0.05 mg/l phosphorus, 1.0 mg/l nitrogen, and a combination of 0.05 mg/l phosphorus plus 1.0 mg/l nitrogen.

After the various nutrient additions had been made to each set of lake water samples, each flask was inoculated with 1,000 cells/ml of the test alga, *Selenastrum capricornutum*. Following inoculation, the cultures were incubated for 14 days at 24° C on gyrorotary shakers under 400 foot-candles of continuous light. Algal growth was monitored throughout the incubation period by cell counts and mean cell-volume measurements made with electronic particle counters. The maximum biomass attained was quantified in terms of milligrams/liter dry weight equivalents of the cell counts and mean cell volumes.

*Results of nutrient analyses performed on unpreserved water samples prior to autoclaving often differed substantially from those of corresponding mercuric-chloride-preserved water samples. Some of these discrepancies may be attributed to the differences in sampling procedures for the two types of samples. Most, however, were due to adsorption onto the container walls during prolonged storage. In particular, significant losses of phosphorus and inorganic nitrogen were sometimes noted. When these losses occurred, the algal assay results were somewhat suspect but were believed to be usable if considered in context with inorganic nitrogen: dissolved orthophosphorus ratios computed from preserved water samples obtained on the date of algal assay sampling. In 1975 two 4-ounce subsamples were taken from the filled and mixed 2-gallon algal assay sample in the field. These were treated similarly as the nutrient lake water samples and forwarded to NERC-Corvallis with the assay samples to aid in determining if adsorption had occurred.

ALGAL IDENTIFICATION AND ENUMERATION

Samples preserved with acid Lugol's solution for algal identification from each sampling station were forwarded to NERC-LV. Small library sub-samples were taken from each sample. The samples from each site were then mixed to provide a specific lake-date composite sample. These composite samples were concentrated by decanting and examined under a compound microscope by a single investigator. Phytoplankters were identified routinely to genus and, whenever possible, to species. Taxonomic problems were discussed and resolved jointly by the research staff and with outside expertise, when necessary.

Following the identification of phytoplankters present in the sample, the investigator enumerated the algae utilizing a Neubauer counting chamber. These differential counts were continued until at least 100 units of the dominant form had been noted or until a minimum of 100 fields of view (X40 objective, X10 ocular) had been observed. Periodically, blind duplicate samples were analyzed and enumerated independently by both investigators or by the original investigator.

Library samples of concentrated algae and permanent slides were prepared and filed at NERC-LV. In addition, permanent Hyrax-mounted diatom slides were prepared after removal of volatile organic matter by incineration.

Identification and count data, converted to organisms per milliliter, were entered into a WYLBUR computer file to increase accessibility and facilitate their use. Data reported include total counts of the number of isolated cells, filaments, and colonies per milliliter, Shannon-Wiener Diversity Index (Shannon and Weiner, 1963), Palmer's Organic Pollution Index (Palmer, 1969), Nygaard's Trophic State Indices (Nygaard, 1949), and phytoplankton associations (Hutchinson, 1967).

External quality control checks were performed under contract by Dr. G. W. Prescott of the University of Montana on 30 samples per year. Objectives were to verify the dominant genera list (five most abundant genera), order of dominance, and relative abundance; verify the total number of organisms per milliliter; and verify the species identification and total number of species present.

QUALITY CONTROL

NERC-CORVALLIS

Quality control began with the receipt of the sample. After all identifying information was logged, a laboratory number was assigned identifying the sample and the analyses to be performed.

The data, entered on laboratory request forms, were teletyped to the Oregon State University computer and processed through the sample handling and verification system (SHAVES) program (Krawczyk and Byram, 1973).

At the request of the analyst, the SHAVES program produces a "run list" for samples indicating, by laboratory number, the sequence in which the sample should be analyzed and also which samples should be replicated and/or spiked with known quantities of the material being analyzed. The run list usually specified a set of standards, 120 samples, and then another set of standards. Every 8th sample was replicated, and every 20th sample was spiked.

Analytical data readouts were entered into the computer which performed a check on calculations and analytical accuracy and precision.

Blind samples (10 sub-samples identified as separate samples) were sent through the system to check both the analysts and the equipment. Scheduled replicate samples provided regular checks on analytical procedures.

NERC-LAS VEGAS LABORATORY

In the Laboratory Operations Branch at NERC-LV every 20th sample was replicated and also spiked with a known amount of the constituent being analyzed. An average of 15 blind samples per month was sent through the laboratory as a check on analysts and instrumentation. Samples of known concentrations were also processed periodically to determine the accuracy of the analytical process.

In addition, unused sample bottles and filters were randomly pulled from incoming shipments and tested to assure that no uptake or loss occurred from contaminated supplies. Periodic tests with duplicate samples forwarded from the field on different dates were also made to assure sample stability.

INTERLABORATORY

Samples for interlaboratory comparison originated from several sources including NES lake and stream samples, Methods Development and Quality Assurance Research Laboratory, NERC-Cincinnati (MDQARL) reference samples and unknown material furnished by International Field Year - Great Lakes personnel. The results of the 1973 interlaboratory testing program for various forms of nitrogen and phosphorus showed no significant differences between laboratories, and compare very favorably with interlaboratory comparisons for nutrients presented in Method Study 2 of the MDQARL. Subsequent analyses performed on duplicate NES lake water samples also indicated no significant difference in the results of nutrient analyses performed at NERC-LV and NERC-Corvallis.

MOBILE FIELD LABORATORY

Close attention was paid to field calibration of analytical instruments. The fluorometer was routinely calibrated between rounds using spinach extract. No significant drift was detected. Replicate analyses of chlorophyll-a were made for each sample. Standardization of dissolved oxygen chemicals were checked periodically, usually about every 2 weeks. No significant errors were detected. Several replicate dissolved oxygen analyses were performed daily and if differences greater than $\pm$ 0.2 mg/l were encountered, additional replicates were run.

Calibration of pH sensors were checked against standard buffer solutions of 4, 7, and 10 every 10 to 15 samples. Laboratory conductivity determinations were made routinely for comparison with the *in situ* sensors.

Periodically, analyses of duplicate samples were also performed.

FIELD TECHNIQUES

Periodically, duplicate samples were obtained at each sample depth. These were treated as previously described. One set of duplicate nutrient samples was forwarded to NERC-LV and the other to NERC-Corvallis for analyses.

In addition, when schedule permitted, occupation of a lake sampling site by one helicopter sampling team would be followed by resampling by the second helicopter team. This allowed direct comparison of differences in field procedures, equipment performance, and individual judgment. No major discrepancies were observed between data collected by one team as opposed to the other.

DRAINAGE AREA STUDIES

The basic objective of the nonpoint source land-use study is to develop nutrient runoff coefficients based on land use and related geographical characteristics. Ambient nutrient levels in streams tributary to NES lakes are determined and compared with land-use patterns in selected watersheds.

Nearly 1,000 drainage areas were selected for study in a variety of geographic and climatic areas. Selection was made from the tributaries to NES lakes based on the following criteria:

(1) availability of accurate topographic maps;

(2) availability of usable aerial imagery;

(3) sufficient relief to permit significant surface runoff;

(4) absence of indirect drainage areas (sub-watersheds associated with upstream nutrient traps such as impoundments);

(5) absence of identifiable point sources; and

(6) homogeneity of land use.

Areas are determined for each selected watershed and determinations of the amount of each general land-use category in each are made. The land-use categories presently being considered are: (1) forest; (2) cleared, unproductive; (3) agriculture; (4) urban; (5) wetland; and (6) other (including barren, extractive, and open water). These may be modified as analyses continue.

Ambient nutrient levels and nutrient loading values of streams draining each watershed are correlated with land use. Details of the methods used and preliminary results obtained from data in the northeastern and northcentral United States are presented in NES Working Paper Number 25, "Relationships Between Drainage Area Characteristics and Non-point Source Nutrients in Streams" (EPA, 1974).

LITERATURE CITED

Bartsch, A. F. 1972. Role of Phosphorus in Eutrophication. EPA Ecological Research Series #EPA-R3-72-001.

Corey, R. B., A. D. Hasler, G. F. Lee, F. N. Schraufnagel and T. L. Wirth. 1967. Excessive Water Fertilization. Report to the Water Sub-Committee, Natural Resources Committee of State Agencies.

Hutchinson, G. Evelyn. 1967. A Treatise on Limnology. Vol II. John Wiley & Sons, Inc., New York. pp. 391-397.

Krawczyk, D. F., and K. V. Byram. 1973. Management System for an Analytical Chemical Laboratory. American Laboratory Vol. 5, pp. 55-64.

Nygaard, G. 1949. Hydrobiological Studies in Some Ponds and Lakes. Part II: The Quotient Hypothesis and Some New or Little Known Phytoplankton Kgl. Danske Vidensk. Selsk. Biol. Skrifter 7(1):1-293.

Palmer, C. Mervin. 1969. A Composite Rating of Algae Tolerating Organic Pollutions. Journal of Phycology 5:78-82.

Shannon, E. E. and W. Wiener. 1963. The Mathematical Theory of Communication. Urbana: University of Illinois Press.

U.S. Environmental Protection Agency. 1971. Methods for Chemical Analysis of Water and Wastes. Analytical Quality Control Laboratory, Cincinnati, Ohio. 312 pages.

U.S. Environmental Protection Agency. 1971. Algal Assay Procedure Bottle Test. National Eutrophication Research Program, Corvallis, Oregon. 82 pages.

U.S. Environmental Protection Agency. 1974. Relationships Between Drainage Area Characteristics and Non-point Source Nutrients in Streams. National Eutrophication Survey Working Paper No. 25. National Eutrophication Research Program, Corvallis, Oregon. 49 pages.

Weibel, S. R. 1969. Urban Drainage as a Factor in Eutrophication. In: Eutrophication: Causes, Consequences, Correctives. National Academy of Science, Washington, D.C. pp. 383-403.

Yentsch, C. S. and D. W. Menzel. 1963. A Method for the Determination of Phytoplankton Chlorophyll and Phaeophytin by Flourescence. Deep Sea Research. Vol. 10, pp. 221-231.

APPENDIX A

LAKES AND RESERVOIRS SAMPLED IN 1973

ALABAMA

STORET #	LAKE NAME	COUNTY
0101XX	Bankhead	Walker
0103XX	Gantt Reservoir	Covington
0104XX	Guntersville Reservoir	Marshall, Jackson
0105XX	Holt Lock and Dam	Tuscaloosa
0106XX	Lay Lake	Chilton, Coosa
0107XX	Martin Lake	Elmore, Tallapoosa
0108XX	Mitchell Lake	Coosa, Chilton
0109XX	Pickwick Lake	Colbert, Lauderdale (Tishomingo in MI & Hardin in TN)
0112XX	Weiss Lake	Cherokee
0114XX	Wilson Lake	Lauderdale, Colbert, Lawrence
0115XX	Lake Purdy	Jefferson, Shelby

DELAWARE

STORET #	LAKE NAME	COUNTY
1002XX	Killen Pond	Kent
1005XX	Moores Lake (Pond)	Kent
1007XX	Noxontown Pond	New Castle
1008XX	Silver Lake	New Castle
1009XX	Williams Pond	Sussex
1010XX	Trussum Pond (Moores Pond)	Sussex

FLORIDA

STORET #	LAKE NAME	COUNTY
1201XX	Alligator Lake	Columbia
1202XX	Lake Apopka	Orange, Lake
1203XX	Banana Lake	Polk
1206XX	Lake Crescent	Putnam, Flagler, Volusia
1207XX	Doctors Lake	Clay
1208XX	Lake Dora	Lake
1209XX	Lake Effie	Polk
1210XX	Lake George	Volusia
1211XX	Lake Gibson	Polk
1212XX	Glenada Lake	Highlands
1214XX	Lake Griffin	Lake
1215XX	Lake Haines	Polk
1217XX	Lake Hancock	Polk
1219XX	Lake Horseshoe	Seminole
1220XX	Lake Howell	Seminole, Orange
1221XX	Lake Istokpoga	Highlands
1223XX	Lake Jessup	Seminole
1224XX	Lake Kissimmee	Osceola
1227XX	Lake Lulu	Polk
1228XX	Lake Marion	Polk

(FLORIDA - continued)

STORET #	LAKE NAME	COUNTY
1229XX	Lake Minnehaha	Orange
1230XX	Lake Minneola	Lake
1231XX	Lake Monroe	Seminole, Volusia
1232XX	Lake Okeechobee	Okeechobee, Glades, Palm Beach, Martin, Hendry
1234XX	Lake Poinsett	Brevard, Osceola, Orange
1236XX	Lake Reedy	Polk
1238XX	Lake South	Brevard
1239XX	Lake Talquin	Gadsden, Leon
1240XX	Lake Thonotossassa	Hillsborough
1241XX	Lake Tohopekaliga	Osceola
1242XX	Trout Lake	Lake
1243XX	Lake Weohyakapka	Polk
1246XX	Lake Yale	Lake
1247XX	Lake Munson	Leon
1248XX	Lake Seminole	Pinellas
1249XX	Lake Lawne	Orange
1250XX	Lake Tarpon	Pinellas
1252XX	Lake Eloise	Polk
1258XX	Lake Jessie	Polk
1261XX	East Lake Tohopekaliga	Osceola
1264XX	Payne's Prairie	Alachua

GEORGIA

STORET #	LAKE NAME	COUNTY
1301XX	Allatoona	Cherokee, Bartow, Cobb
1302XX	Blackshear Lake	Crisp, Sumter, Lee
1303XX	Chatuge Lake	Towns (Clay in TN)
1304XX	Clark Hill Reservoir	Columbia, Lincoln, Elbert (Edgefield, McCormick in SC)
1309XX	Jackson Lake	Butts, Jasper, Newton
1310XX	Lake Sidney Lanier	Hall, Forsyth, Dawson
1311XX	Nottley Lake	Union
1312XX	Lake Seminole (Jim Woodruff Reservoir)	Decatur, Seminole (Jackson, Gadsen in FL)
1313XX	Lake Sinclair	Baldwin, Hancock
1314XX	Lake Eufaula (Walter F. George Reservoir)	Quitman, Clay, Stewart (Henry, Barbour, Russell in AL)
1316XX	Blue Ridge Lake	Fannin
1317XX	Bartlett's Ferry Reservoir (Harding Lake)	Harris (Lee in AL)
1318XX	Lake Burton	Rabun
1319XX	High Falls Lake	Monroe

ILLINOIS

STORET #	LAKE NAME	COUNTY
1703XX	Lake Bloomington	McLean
1706XX	Lake Carlyle	Clinton, Fayette, Bond
1708XX	Lake Charleston	Coles
1711XX	Coffeen Lake	Montgomery
1712XX	Crab Orchard Lake	Jackson, Williamson
1714XX	Lake Decatur	Macon
1725XX	Long Lake	Lake
1726XX	Lake Lou Yaeger	Montgomery
1727XX	Lake Marie	Lake
1733XX	Pistakee Lake	Lake, McHenry
1735XX	Rend Lake	Franklin, Jefferson
1739XX	Lake Shelbyville	Shelby, Moultrie
1740XX	Highland (Silver) Lake	Madison
1742XX	Lake Springfield	Sangamon
1748XX	Vermilion Lake	Vermilion
1750XX	Wonder Lake	McHenry
1751XX	Lake Story	Knox
1752XX	Depue Lake	Bureau
1753XX	Lake Sangchris	Christian
1754XX	Lake Holiday	LaSalle

(ILLINOIS - continued)

STORET #	LAKE NAME	COUNTY
1755XX	Fox Lake	Lake
1756XX	Grass Lake	Lake
1757XX	East Loon Lake	Lake
1758XX	Slocum Lake	Lake
1759XX	Cedar Lake	Lake
1761XX	Lake We-Ma-Tuk	Fulton
1762XX	Raccoon Lake	Marion
1763XX	Baldwin Lake	Randolph
1764XX	Lake Vandalia	Fayette
1765XX	Old Ben Mine Reservoir	Franklin
1766XX	Horseshoe Lake	Madison

INDIANA

STORET #	LAKE NAME	COUNTY
1805XX	Cataract Lake	Putnam, Owen
1811XX	Geist Reservoir	Marion, Hamilton
1817XX	James Lake	Kosciusko
1827XX	Mississinewa Reservoir	Miami, Wabash, Grant
1828XX	Monroe Reservoir	Jackson, Monroe, Brown
1829XX	Morse Reservoir	Hamilton
1836XX	Wawasee Lake	Kosciusko
1837XX	Webster Lake	Kosciusko
1839XX	Whitewater Lake	Union
1840XX	Winona Lake	Kosciusko

(INDIANA - continued)

STORET #	LAKE NAME	COUNTY
1841XX	Westler Lake	Lagrange
1842XX	Witmer Lake	Lagrange
1843XX	Lake Maxinkuckee	Marshall
1844XX	Tippecanoe Lake	Kosciusko
1845XX	Dallas Lake	Lagrange
1846XX	Olin Lake	Lagrange
1847XX	Oliver Lake	Lagrange
1848XX	Sylvan Lake	Noble
1849XX	Hovey Lake	Posey
1850XX	Versailles Lake	Ripley
1851XX	Bass Lake	Starke
1852XX	Crooked Lake	Steuben
1853XX	Lake James	Steuben
1854XX	Long Lake	Steuben
1855XX	Pigeon Lake	Steuben
1856XX	Marsh Lake	Steuben
1857XX	Hamilton Lake	Steuben

KENTUCKY

STORET #	LAKE NAME	COUNTY
2101XX	Lake Cumberland	Pulaski, McCreary, Russell, Wayne, Clinton
2102XX	Dale Hollow Reservoir	Cumberland, Clinton (Clay, Pickett, Overton in TN)
2103XX	Herrington Lake	Boyle, Mercer, Garrard
2104XX	Kentucky Lake	Marshall, Lyon, Trigg, Livingston, Calloway (Henry, Stewart, Benton, Houston, Humphreys, Perry, Decatur in TN)
2105XX	Barren River Reservoir	Allen, Barren

MARYLAND

STORET #	LAKE NAME	COUNTY
2402XX	Deep Creek Lake	Garrett
2403XX	Liberty Reservoir	Carroll, Baltimore
2408XX	Loch Raven Reservoir	Baltimore
2409XX	Johnson Pond	Wicomico

MISSISSIPPI

STORET #	LAKE NAME	COUNTY
2801XX	Arkabutla Reservoir	Desoto, Tate
2802XX	Enid Lake	Yalo Busha, Panola
2804XX	Ross Barnett Reservoir	Hinds, Madison, Rankin
2805XX	Sardis Lake	Panola, Lafayette
2806XX	Grenada Lake	Grenada, Yalo Busha

NEW JERSEY

STORET #	LAKE NAME	COUNTY
3402XX	Budd Lake	Morris
3403XX	Greenwood Lake	Passaic (Orange in NY)
3406XX	Oradell Reservoir	Bergen
3409XX	Pinecliff Lake	Passaic
3410XX	Pompton Lake	Passaic
3412XX	Duhernal Lake	Middlesex
3413XX	Farrington Lake	Middlesex
3415XX	Lake Hopatcong	Morris, Sussex
3417XX	Lake Musconetcong	Morris, Sussex
3419XX	Paulinskill Lake	Sussex
3420XX	Spruce Run Reservoir	Hunterdon
3422X	Union Lake	Cumberland
3423XX	Wanaque Reservoir	Passaic

NORTH CAROLINA

STORET #	LAKE NAME	COUNTY
3701XX	Badin Lake	Montgomery, Stanly
3702XX	Blewett Falls Lake	Richmond, Anson
3704XX	Fontana Lake	Swain, Graham
3705XX	Lake Hickory (Lake Oxford)	Alexander, Caldwell, Catawba
3706XX	High Rock Lake	Davidson, Rowan
3707XX	Hiwassee Lake	Cherokee
3708XX	Lake James	Burke, McDowell
3709XX	Lake Junaluska	Haywood
3710XX	Lookout Shoals Lake	Catawba, Alexander, Iredell
3711XX	Mount Island Lake	Gaston, Mecklenburg
3713XX	Norman Lake	Catawba, Iredell, Lincoln, Mecklenburg
3715XX	Rhodhiss Lake	Caldwell, Burke
3716XX	Lake Santeelah	Graham
3717XX	Tillery Lake	Stanly, Montgomery
3718XX	Waterville Lake	Haywood
3719XX	Lake Waccamaw	Columbus

OHIO

STORET #	LAKE NAME	COUNTY
3901XX	Beach City Reservoir	Stark, Tuscarawas
3902XX	Buckeye Reservoir	Fairfield, Licking, Perry
3905XX	Charles Mill Reservoir	Richland, Ashland
3906XX	Deer Creek Reservoir	Fayette, Pickaway
3907XX	Delaware Reservoir	Delaware
3908XX	Dillon Reservoir	Muskingum
3912XX	Grant Lake	Brown
3914XX	Hoover Reservoir	Franklin, Delaware
3915XX	Indian Lake	Logan
3917XX	Loramie Lake	Shelby, Auglaize
3921XX	Mosquito Creek Reservoir	Trumbull
3924XX	Pleasant Hill Lake	Richland, Ashland
3927XX	Lake Saint Marys (Grand Lake)	Mercer, Auglaize
3928XX	Atwood Reservoir	Carroll, Tuscarawas
3929XX	Berlin Reservoir	Stark, Portage, Mahoning
3930XX	Holiday Lake	Huron
3931XX	O'Shaugnessy Reservoir	Delaware
3932XX	Rocky Fork Lake	Highland
3933XX	Shawnee Lake	Greene
3934XX	Tappan Lake	Harrison

PENNSYLVANIA

STORET #	LAKE NAME	COUNTY
4201XX	Blanchard Reservoir	Centre
4204XX	Conneaut Lake	Crawford
4207XX	Greenlane Dam	Montgomery
4213XX	Pymatuning Reservoir	Crawford, Mercer (Ashtabula in OH)
4216XX	Shenango River Reservoir	Mercer (Trumbull in OH)
4219XX	Beaver Run Reservoir	Westmoreland
4220XX	Beltzville Dam	Carbon
4221XX	Lake Canadohta	Crawford
4222XX	Harveys Lake	Luzerne
4223XX	Indian Lake	Somerset
4224XX	Lake Naomi	Monroe
4225XX	Lake Ontelaunee	Berks
4226XX	Pinchot Lake (Conewago Lake)	York
4227XX	Pocono Lake	Monroe
4228XX	Stillwater Lake	Monroe
4229XX	Lake Wallenpaupack	Pike

SOUTH CAROLINA

STORET #	LAKE NAME	COUNTY
4503XX	Fishing Creek Reservoir	Lancaster, Chester
4504XX	Lake Greenwood	Laurens, Greewood, Newberry
4505XX	Lake Hartwell	Anderson, Oconee, Pickens (Franklin, Hart in GA)
4506XX	Lake Marion	Berkeley, Clarendon, Sumter, Calhoun, Orangeburg
4507XX	Lake Murray	Lexington, Saluda, Richland, Newberry
4508XX	Lake Robinson	Darlington, Chesterfield
4510XX	Lake Wateree	Kershaw, Fairfield, Lancaster
4511XX	Lake Wylie (Lake Catawba)	York (Gaston, Mecklenburg in NC)
4512XX	Lake Moultrie	Berkeley
4513XX	Lake Keowee	Oconee, Pickens
4514XX	Lake Secession	Abbeville, Anderson
4515XX	Saluda Lake	Greenville, Pickens
4516XX	Lake William C. Bowen	Spartanburg

TENNESSEE

STORET #	LAKE NAME	COUNTY
4701XX	Barkley Lake	Stewart, Montgomery (Trigg, Lyon in KY)
4704XX	Boone Reservoir	Washington, Sullivan, Carter
4706XX	Cheatham Reservoir	Cheatham, Davidson
4707XX	Cherokee Lake	Jefferson, Hamblen, Grainger, Hawkins
4708XX	Chickamauga Lake	Hamilton, Rhea, Meigs, McMinn
4711XX	Douglas Lake	Sevier, Jefferson, Cocke
4712XX	Fort Loudon Lake	Loudon, Knox, Blount
4713XX	Great Falls Lake	White, Van Buren
4717XX	Nickajack Reservoir	Marion, Hamilton
4720XX	Old Hickory Lake	Sumner, Davidson, Wilson, Smith, Trousdale
4722XX	Watts Bar Lake	Rhea, Meigs, Cumberland, Roane, Loudon
4723XX	Percy Priest Reservoir	Davidson, Rutherford
4724XX	Tims Ford Reservoir	Moore, Franklin
4725XX	South Holston Lake	Sullivan (Washington in VA)
4727XX	Reelfoot Lake	Obion
4728XX	Woods Reservoir (Elk River Reservoir)	Franklin, Coffee

VIRGINIA

STORET #	LAKE NAME	COUNTY
5103XX	Claytor Lake	Pulaski
5105XX	John W. Flannagan Dam	Dickenson
5106XX	John H. Kerr Reservoir (Buggs Island Lake)	Mecklenburg, Halifax (Granville, Vance, Warren in NC)
5108XX	Occoquan Reservoir	Fauquier
5110XX	Smith Mountain Lake	Bedford, Franklin
5111XX	Lake Chesdin	Dinwiddle
5112XX	Chickahominy Lake	New Kent, Charles City
5113XX	Rivanna (South Fork) Reservoir	Albemarle

WEST VIRGINIA

STORET #	LAKE NAME	COUNTY
5401XX	Bluestone Reservoir	Summers
5402XX	Lake Lynn Reservoir (Cheat Lake)	Monongalia
5403XX	Summersville Reservoir	Nicholas
5404XX	Tygart Reservoir	Taylor

APPENDIX B

LAKES AND RESERVOIRS SAMPLED IN 1974

ARKANSAS

STORET #	LAKE NAME	COUNTY
0501XX	Beaver Lake	Benton, Carroll, Washington
0502XX	Blackfish Lake	Crittenden, St. Francis
0503XX	Blue Mountain Lake	Logan, Yell
0504XX	Bull Shoals Lake	Baxter, Boone, Marion (Taney, Ozark in MO)
0505XX	Lake Catherine	Garland, Hot Spring
0506XX	Lake Chicot	Chicot
0507XX	DeGray Lake	Clark, Hot Spring
0508XX	Lake Erling	Lafayette
0509XX	Grand Lake	Chicot
0510XX	Lake Hamilton	Garland
0511XX	Millwood Lake	Hempstead, Howard, Little River, Sevier
0512XX	Nimrod Lake	Perry, Yell
0513XX	Norfolk Lake	Baxter, Fulton (Ozark in MO)
0514XX	Lake Ouachita	Garland, Montgomery
0515XX	Table Rock Lake	Boone, Carroll (Barry, Taney in MO)
0516XX	Greer's Ferry Lake	Van Buren, Cleburne

IOWA

STORET #	LAKE NAME	COUNTY
1901XX	Lake Acquabi	Polk
1902XX	Big Creek Reservoir	Polk
1903XX	Black Hawk Lake	Sac
1904XX	Clear Lake	Cerro Gordo
1905XX	Lake Darling	Washington
1906XX	Lost Island Lake	Palo Alto
1907XX	Lake MacBride	Johnson
1908XX	Prairie Rose Lake	Shelby
1909XX	Rathbun Reservoir	Appanoose, Wayne, Lucas
1910XX	Red Rock Lake	Marion
1911XX	Rock Creek Lake	Jasper
1912XX	Silver Lake	Worth
1913XX	Spirit Lake	Dickinson
1914XX	Viking Lake	Montgomery
1915XX	West Lake Okoboji	Dickinson

KANSAS

STORET #	LAKE NAME	COUNTY
2001XX	Cedar Bluff Reservoir	Trego
2002XX	Council Grove	Morris
2003XX	Elk City	Montgomery
2004XX	Fall River Reservoir	Greenwood
2005XX	John Redmond Reservoir	Coffey
2006XX	Kanopolis Reservoir	Ellsworth
2007XX	Marion Reservoir	Marion
2008XX	Melvern Reservoir	Osage
2009XX	Milford Reservoir	Clay, Geary, Riley
2010XX	Norton Reservoir	Norton
2011XX	Perry Reservoir	Jefferson
2012XX	Pomona Reservoir	Osage
2013XX	Toronto Reservoir	Greenwood, Woodson
2014XX	Tuttle Creek Reservoir	Marshall, Riley, Pottawatomie
2015XX	Wilson Reservoir	Russell, Lincoln

LOUISIANA

STORET #	LAKE NAME	COUNTY
2201XX	Anacoco Lake	Vernon
2202XX	Bruin Lake	Tensas
2203XX	Lake Bistineau	Bienville, Webster
2204XX	Black Bayou	Caddo
2205XX	Bundicks Lake	Beauregard
2207XX	Cocodrie Lake	Concordia
2208XX	Cotile Lake	Rapides
2209XX	Concordia Lake	Concordia
2210XX	Cross Lake	Caddo
2211XX	D'Arbonne Lake	Union
2212XX	False River Lake	Pointe Coupee
2213XX	Indian Creek	Rapides
2214XX	Saline Lake	LaSalle
2215XX	Turkey Creek	Franklin
2216XX	Lake Verret	Assumption
2217XX	Lake Vernon	Vernon
2218XX	Atchafalaya Basin	
2219XX	Black Lake	
2220XX	Cocodrie Lake (lower)	Rapides

MISSOURI

STORET #	LAKE NAME	COUNTY
2901XX	Clearwater Lake	Reynolds
2902XX	Pomme de Terre Reservoir	Polk, Hickory
2903XX	Stockton Reservoir	Dade, Polk, Cedar
2904XX	Lake Taneycomo	Taney
2905XX	Thomas Hill Reservoir	Macon, Randolph
2906XX	Wappapello Reservoir	Wayne, Butler

NEBRASKA

STORET #	LAKE NAME	COUNTY
3101XX	Branched Oak	Lancaster
3102XX	Harlan County Reservoir	Harlan
3103XX	Harry D. Strunk (Medicine Creek)	Frontier
3104XX	Hugh Butler (Red Willow)	Frontier, Red Willow
3105XX	Johnson Reservoir	Dawson, Gosper
3106XX	Lake McConaughy	Keith
3107XX	Pawnee Lake	Lancaster
3108XX	Sherman County Reservoir	Sherman
3109XX	Site 16	Douglas
3110XX	Swanson Reservoir	Hitchcock

NORTH DAKOTA

STORET #	LAKE NAME	COUNTY
3801XX	Lake Ashtabula	Barnes, Griggs
3802XX	Lake Audubon	McLean
3803XX	Brush Lake	McLean
3804XX	Lake Darling	Renville
3805XX	Devils Lake	Benson, Ramsey
3806XX	Jamestown Reservoir	Stutsman, Foster
3807XX	Lake La Moure	Stutsman
3808XX	Matejcek Lake	Walsh
3809XX	Lake Metigoshe	Bottineau (part in Canada)
3811XX	Pelican Lake	Bottineau
3812XX	Lake Sakakawea (Garrison Reservoir)	Mercer, McLean, Mountrail, Williams, McKenzie, Dunn
3813XX	Spirit Wood Lake	Stutsman
3814XX	Sweet Briar Reservoir	Morton
3815XX	Whitman Lake	Nelson, Walsh

OKLAHOMA

STORET #	LAKE NAME	COUNTY
4001XX	Altus Reservoir	Greer, Kiowa
4002XX	Arbuckle Lake	Murray
4003XX	Lake Ellsworth	Caddo, Comanche
4004XX	Lake Eufaula	Haskell, McIntosh, Okmulgee, Pittsburg
4005XX	Fort Cobb Reservoir	Caddo
4006XX	Fort Supply Reservoir	Woodward
4007XX	Foss Dam Reservoir	Custer
4008XX	Lake Frances	Adair
4009XX	Grand Lake O' The Cherokees	Mayes, Delaware, Craig, Ottowa
4010XX	Lake Hefner	Oklahoma
4011XX	Keystone Reservoir	Tulsa, Creek, Osage, Pawnee
4012XX	Oologah Lake	Nowata, Rogers
4013XX	Tenkiller Ferry Reservoir	Cherokee, Sequoyah
4014XX	Lake Thunderbird	Cleveland
4015XX	Wister Reservoir	LeFlore

SOUTH DAKOTA

STORET #	LAKE NAME	COUNTY
4601XX	Lake Albert	Kingsbury, Hamlin
4602XX	Alvin Lake	Lincoln
4603XX	Angostura Reservoir	Fall River
4604XX	Brant Lake	Lake
4605XX	Lake Byron	Beadle
4606XX	Clear Lake	Marshall
4607XX	Clear Lake	Minnehaha
4608XX	Cochrane	Deuel
4609XX	Cottonwood Lake	Spink
4610XX	Deerfield Reservoir	Pennington
4611XX	Enemy Swim Lake	Day
4612XX	Lake Herman	Lake
4613XX	John Lake	Hamlin
4614XX	Lake Kampeska	Codington
4615XX	Madison Lake	Lake
4616XX	Lake Mitchell	Davison
4617XX	Lake Norden	Hamlin
4618XX	Oakwood Lake East	Brookings
4619XX	Oakwood Lake West	Brookings
4620XX	Pactola Reservoir	Pennington

STORET #	LAKE NAME	COUNTY
4621XX	Pickerel Lake	Day
4622XX	Lake Poinsett	Hamlin, Lake
4623XX	Lake Red Iron South	Marshall
4624XX	Richmond Lake	Brown
4625XX	Roy Lake	Marshall
4626XX	Sand Lake	Brown
4627XX	Sheridan Lake	Pennington
4628XX	Stockade Lake	Custer
4629XX	East Vermillion Lake	McCook
4630XX	Wall Lake	Minnehaha
4631XX	Waubay Lake North	Day

TEXAS

STORET #	LAKE NAME	COUNTY
4801XX	Amistad Lake	Val Verde (part in Mexico)
4802XX	Bastrop Lake	Bastrop
4803XX	Belton	Bell, Coryell
4804XX	Lake Braunig	Bexar
4805XX	Brownwood Lake	Brown
4806XX	Lake Buchannon	Burnet, Llano
4807XX	Caddo Lake	Marion, Harrison (Caddo in LA)
4808XX	Calaveras Lake	Bexar
4809XX	Canyon Reservoir	Comal
4810XX	Lake Colorado City	Mitchell
4811XX	Corpus Cristi Lake	Live Oak, San Patricio
4812XX	Diversion Lake	Baylor, Archer
4813XX	Eagle Mountain Lake	Tarrant
4814XX	Fort Phantom Hill Lake	Jones
4815XX	Garza Little Elm Reservoir (Lewisville Reservoir)	Denton
4816XX	Kemp Lake	Baylor
4817XX	Houston Lake	Harris
4818XX	Lake of the Pines	Marion
4819XX	Lavon Reservoir	Collin
4820XX	Livingston Lake	Walker, Trinity, Polk, San Jacinto

(TEXAS - continued)

STORET #	LAKE NAME	COUNTY
4821XX	Lyndon B. Johnson Lake	Burnet, Llano
4822XX	Medina Lake	Medina, Bandera
4823XX	Lake Merideth	Potter, Moore, Hutchison
4824XX	Palestine Lake	Henderson, Smith, Anderson, Cherokee
4825XX	Possum Kingdom Reservoir	Palo Pinto, Young
4826XX	San Angelo Reservoir	Tom Green
4827XX	Sam Rayburn Reservoir	San Augustine, Angelina, Nacogdoches, Jasper, Sabine
4828XX	E.V. Spence Reservoir	Coke
4829XX	Somerville Lake	Burleson, Washington
4830XX	Stamford Lake	Haskell
4831XX	Stillhouse Hollow Reservoir	Bell
4832XX	Tawakoni Lake	Hunt, Rains, Van Zandt
4833XX	Texarkana Lake (Wright-Patman Reservoir)	Bowie, Cass
4834XX	Texoma Lake	Grayson, Cooke (Love, Johnson, Marshall, Bryant in OK)
4835XX	Travis Lake	Travis
4836XX	Trinidad (Texas Power & Light Co. Lake)	Henderson, Navarro
4837XX	Twin Buttes Reservoir	Tom Green
4838XX	White River Reservoir	Crosby
4839XX	Whitney Lake	Bosque, Hill, Johnson

APPENDIX C

LAKES AND RESERVOIRS SAMPLED IN 1975

ARIZONA

STORET #	LAKE NAME	COUNTY
0401XX	Big Lake	Apache
0402XX	Fools Hollow	Navajo
0403XX	Lake Havasu	Mohave (San Bernadino in CA)
0404XX	Luna Lake	Apache
0405XX	Lyman Lake	Apache
0406XX	Lake Mohave	Mohave (Clark in NV)
0407XX	Lake Pleasant	Yavapai, Maricopa
0408XX	Lake Powell	Coconino (Kane, Garfield, San Juan in UT)
0409XX	Rainbow Lake	Navajo
0410XX	Roosevelt Lake	Gila
0411XX	San Carlos Reservoir	Graham, Gila

CALIFORNIA

STORET #	LAKE NAME	COUNTY
0601XX	Amador Reservoir	Amador
0602XX	Boca Lake	Nevada
0603XX	Lake Britton	Shasta
0604XX	Casitas Reservoir	Ventura
0605XX	Crowley Lake	Mono
0606XX	Don Pedro Reservoir	Tuolume
0607XX	Lake Elsinore	Riverside
0608XX	Fallen Leaf Reservoir	El Dorado
0609XX	Lake Hennessey	Napa
0610XX	Lake Henshaw	San Diego
0611XX	Iron Gate Reservoir	Siskiyou
0613XX	Lower Klamath Lake	Siskiyou
0614XX	Lopez Lake	San Luis Obispo
0615XX	Lake Mary	Mono
0616XX	Lake Mendocino	Mendocino
0617XX	Nicasio Reservoir	Marin
0618XX	Lower Otay Reservoir	San Diego
0619XX	Lake Pillsbury	Lake
0620XX	Santo Margarita Lake	San Luis Obispo
0621XX	Shasta Lake	Shasta
0622XX	Shaver	Fresno
0623XX	Silver Lake	Mono
0624XX	Tullock Reservoir	Tuolume

STORET #	LAKE NAME	COUNTY
0625XX	Upper Twin Lakes at Bridgeport	Mono
0626XX	Lower Twin Lakes at Bridgeport	Mono

COLORADO

STORET #	LAKE NAME	COUNTY
0801XX	Barker	Boulder
0802XX	Barr Lake	Adams
0803XX	Blue Mesa Reservoir	Gunnison, Montrose
0804XX	Cherry Creek	Arapahoe
0805XX	Cucharas Reservoir	Huerfano
0806XX	Dillon	Summit
0807XX	Grand Lake	Grand
0808XX	Green Mountain Reservoir	Summit
0809XX	Holbrook Lake	Otero
0810XX	Lake Meredith	Crowley
0811XX	Milton Reservoir	Weld
0812XX	Navajo Lake	Archuleta (San Juan, Rio Arriba in NM)
0813XX	Shadow Mountain Lake	Grand

IDAHO

STORET #	LAKE NAME	COUNTY
1601XX	American Falls Reservoir	Bannock, Bingham, Power
1602XX	Cascade Lake	Valley
1603XX	Coeur d'Alene	Benewah, Kootenai
1604XX	Dworshak Reservoir	Clearwater
1605XX	Hauser Lake	Kootenai
1606XX	Hayden Lake	Kootenai
1607XX	Island Park Reservoir	Fremont
1608XX	Lake Lowell (Deer Flat Reservoir)	Canyon
1609XX	Magic Reservoir	Blaine, Camas
1610XX	Palisades Reservoir	Bonneville (Lincoln in WY)
1611XX	Lower Payette	Valley
1612XX	Lower Twin Lakes	Kootenai
1613XX	Upper Twin Lakes	Kootenai

MONTANA

STORET #	LAKE NAME	COUNTY
3001XX	Canyon Ferry Reservoir	Lewis & Clark, Broadwater
3002XX	Clark Canyon Reservoir	Beaverhead
3003XX	Flathead Lake	Flathead, Lake
3004XX	Georgetown Reservoir	Granite, Deer Lodge
3005XX	Hebgen Reservoir	Gallatin
3006XX	Koocanusa Reservoir	Lincoln
3007XX	Mary Ronan Lake	Lake
3008XX	McDonald Lake	Flathead
3009XX	Nelson Reservoir	Phillips
3010XX	Seeley Lake	Missoula
3011XX	Swan Lake	Flathead
3012XX	Tally Lake	Flathead
3013XX	Tiber Reservoir	Toole, Liberty
3014XX	Tongue River Reservoir	Big Horn
3016XX	Whitefish Lake (lower)	Flathead

NEVADA

STORET #	LAKE NAME	COUNTY
3201XX	Lake Mead	Clark (Mohave in Arizona)
3202XX	Lahontan Reservoir	Lyon, Churchill
3204XX	Rye Patch Reservoir	Pershing
3205XX	Lake Tahoe	Washoe, Carson City, Douglas (Placer, El Dorado in CA)
3206XX	Topaz Reservoir	Douglas (Mono in CA)
3207XX	Upper Pahranagat Lake	Lincoln
3208XX	Washoe Lake	Washoe
3209XX	Wildhorse Reservoir	Elko
3210XX	Wilson Sink Reservoir	Elko
3211XX	Walker Lake	Mineral

NEW MEXICO

STORET #	LAKE NAME	COUNTY
3501XX	Alamogordo	De Baca, Guadalupe
3502XX	Bluewater	Valencia, McKinley
3503XX	Conchas Reservoir	San Miguel
3504XX	Eagle Nest Lake	Colfax
3505XX	Elephant Butte Reservoir	Sierra
3506XX	El Vado Reservoir	Rio Arriba
3507XX	Lake McMillan	Eddy
3509XX	Ute Reservoir	Quay

OREGON

STORET #	LAKE NAME	COUNTY
4101XX	Brownlee Reservoir	Baker (Washington in Idaho)
4102XX	Diamond	Douglas
4103XX	Hells Canyon Reservoir	Wallowa, Baker (Adams in Idaho)
4104XX	Hills Creek Reservoir	Lane
4105XX	Owyhee	Malheur
4106XX	Oxbow Reservoir	Baker (Adams in Idaho)
4107XX	Suttle Lake	Jefferson
4108XX	Waldo Lake	Lane

UTAH

STORET #	LAKE NAME	COUNTY
4901XX	Bear Lake	Rich (Bear Lake in ID)
4902XX	Lower Bown's Reservoir	Garfield
4903XX	Deer Creek Reservoir	Wasatch
4904XX	Echo Reservoir	Summit
4905XX	Lynn Reservoir	Box Elder
4906XX	Fish Lake	Seiver
4907XX	Huntington North Reservoir	Emery
4908XX	Joe's Valley Reservoir	Emery
4909XX	Minersville Reservoir	Beaver
4910XX	Moon Lake	Duchesne
4911XX	Navajo Lake	Kane

(UTAH - continued)

STORET #	LAKE NAME	COUNTY
4912XX	Newcastle Reservoir	Iron
4913XX	Otter Creek Reservoir	Piute
4914XX	Panquich Lake	Garfield
4915XX	Pelican Lake	Uintah
4916XX	Pineview Reservoir	Weber
4917XX	Piute Reservoir	Piute
4918XX	Porcupine Reservoir	Cache
4919XX	Pruess (Garrison) Reservoir	Millard
4920XX	Sevier Bridge Reservoir	Sanpete, Juab
4921XX	Starvation Reservoir	Duchesne
4922XX	Steinaker Reservoir	Uintah
4923XX	Tropic Reservoir	Garfield
4924XX	Utah Lake	Utah
4925XX	Willard Bay Reservoir	Box Elder

WASHINGTON

STORET #	LAKE NAME	COUNTY
5301XX	American Lake	Pierce
5302XX	Banks Lake	Grant, Douglas
5303XX	Chelan Lake	Chelan
5304XX	Diamond Lake	Pend Oreille
5305XX	Green Lake	King
5306XX	Keechelus Lake	Kittitas
5307XX	Mayfield Lake	Lewis
5308XX	Medical Lake	Spokane
5309XX	Moses Lake	Grant
5310XX	Ozette Lake	Clallam
5311XX	Sammamish Lake	King
5312XX	Whatcom Lake	Whatcom

WYOMING

STORET #	LAKE NAME	COUNTY
5601XX	Big Sandy Reservoir	Sublette, Sweetwater
5602XX	Boulder Lake	Sublette
5603XX	Boysen Reservoir	Fremont
5604XX	Lake De Smet	Johnson
5605XX	Flaming Gorge Reservoir	Sweetwater (Dassett in Utah)
5606XX	Fremont Lake	Sublette
5607XX	Glendo Reservoir	Converse, Platt
5608XX	Key Hole Reservoir	Crook
5609XX	Ocean Lake	Fremont
5610XX	Seminoe Reservoir	Carbon
5611XX	Soda Lake	Sublette
5612XX	Viva Naughton Reservoir	Lincoln
5613XX	Woodruff Narrows Reservoir	Uinta
5614XX	Big Horn Lake (Yellowtail Reservoir)	Big Horn (Big Horn, Carbon in Montana)

APPENDIX D

LAKE SAMPLING FIELD FORMS

NATIONAL EUTROPHICATION STUDY

STATION DESCRIPTION (MUST BE COMPLETED FOR NEW STATIONS)

NEW STATION ☐

STATION CODE 4 9

STATE

COUNTY

TOTAL DEPTH OF WATER (FT) 30 0

LAKE NAME

WORD DESCRIPTION

DATA CODING RECORD

CARD			LOCATION			YR	MO	DY	HR	MN	24	25	TOTAL DEPTH, FT.	CHLOR-A, µ G/L	SECCHI, IN.
D												0			

	DEPTH, FT.	SAMPLE, #	LIGHT, %	COND., µMHO	TURB., %TRANS	TEMP., °C	DO., MG/L	PH., STD. UNITS			BOD, #
	XXXX	XXXXXX	XXX.X	XXXX	XXXX	XX.X	XX.X	XX.X			
1	0										
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
	AIR READING										

COMMENTS

ADDITIONAL SAMPLES TAKEN:

SEDIMENT CORE ☐

PAP 5 GAL. CONTAINER ☐

QUAL CONTROL REPLICATES ☐

OTHER (SPECIFY): ☐ ☐

INITIALS

LIMNOL

TECH.

HELICOPTER NO.

DATE COLLECTED:	BY:	SAMPLING SITE:	
FILTERED:	BY:	DOOR FACTORS	1 = 10 =
EXTRACTED:	BY:		3 = 30 = TAU =

*			*			*	*	*	*			
SAMPLE DESCRIPTION and NO.	IN VIVO		VOLUME FILTERED	VOLUME EXTRACTED	DIL	TOTAL	DR #	R_b	R_a	CHL_a	$PHEO_a$	$CHL_{a'}$
	DR	READING										

ST-45

FIELD OBSERVATION FORM EXPLANATION

Introduction

This form is intended to gather additional data regarding the nature of the lake. Its intended use is in the preparation of reports; any navigational or hazard warning information should be noted on the field data sheet, not this form. For this reason too, the form has been arranged to facilitate coding for computer entry and yes-no rather than verbal answers are generally requested. An attempt has been made to organize the form so as to reduce the effort required by the limnologist in providing much needed information. It is also realized that many of the judgments are subjective, require estimates, or may be open to interpretation.

The limnologist is expected to do his best and to temper his judgments with practical considerations including time constraints. This document is intended to help describe what information is desired and what its ultimate use will be in order to assist the limnologist in making these judgments.

Headings

These identify the lake described. In some cases, such as large lakes, it may be desirable to split the lake into smaller pieces for the purposes of this form. If this is done, please indicate the STORET numbers covered, or alternately, the portion of the lake described on this sheet. (For example: The portion of the lake south of HW35 causeway.)

Sampling Conditions

1. Wind: These data are desired to account for possible anomalies in depth of the mixed layer, concentrations of algae due to wind drift, and extent of turbidity. Direction is the direction from which the wind comes (i.e., direction you look when facing into the wind). Velocity in mph. is desirable if it is readily available. Visible erosion is usually identified by the presence of substantially discolored water along the shore line due to suspended sediment.

2. Cloud Cover: These data are desired to help explain plankton distribution and related data as well as possible secchi disc and/or color anomalies, The categories are clear, P/C-Partly cloudy, B/C-Broken clouds, bright O/C-Bright overcast, dark O/C-dark overcast, and thunderheads.

3. Precipitation: The reasons for these data are for the obvious explanation of anomalous data brought about by recent rainfall.

4. Air Temperature: The air temperature in ^{o}C is wanted for possible future correlations involving interface reactions. Relative humidity would also be desirable if it is readily available.

General Lake Conditions

These data are designed to augment the physical measurements made with the instrumentation. They will assist in resolving anomalies and may help to better define the sources of nutrient contributions.

1. Water Level: This is felt to be self-explanatory.

2. Color-causes: This refers to the cause of the actual color of the water (as it would appear if placed in a large enough glass container). Generally, it will only apply to green, brown, or discolored water. Very clear waters obtain their coloration from backscattering and adsorbtion by the water and are therefore heavily dependent upon light conditions. Waters with pigments or particulate matter are largely colored due to reflected light and are not as dependent upon light conditions.

3. Turbidity-causes: Try to identify the source of particulate elements within the water itself (as opposed to purely color causes such as dissolved humics). The two categories, color and turbidity, are not mutually exclusive. "None" would be used with very clear water.

4. Floating Debris: Describe both debris on and in the water. Logs, twigs, etc. usually float on the surface, but many leaves, paper, etc. are found in suspension. Again, this information may help to identify contributing nutrient sources. "Heavy" and "light" are very subjective terms and left to the discretion of the observer. "Type" is self-explanatory. "Location" will require some verbage. Concentration of debris near a tributary outlet, around a marina, along a mid-lake strand line, or along the west shore all describe different situations with different implications.

5. Emergent Trees or Stumps: This information is generally descriptive of the lake. However, trees can act as a sediment trap, substrate for periphyton, and if alive, as a source of allochthonous debris. For this reason, a brief description of the trees as to whether live or dead, brush or stumps, dense or scattered is requested.

6. Other Observations: 'A place to express yourself. Any comments you feel are pertinent should be entered here. We won't object even if they aren't pertinent.

Aquatic Vegetation

These data are needed to assist in determination of the trophic state of the lake. If the water is obviously green, a plankton bloom can usually be assumed to exist. The presence of any surface scums, algae mats, or other nuisance conditions should be noted and their location described. If the bloom exhibits patchiness, strong interfaces and variations of intensity, etc., please describe the condition. Information on aquatic vegetation is wanted, not on submerged terrestrial plants. By the same token, aquatic plants that have been exposed on the beach due to drops in water level should be noted. Emergents are generally reedy plants (cattails, etc.), floaters are such things as duckweed, lily pads, or hyacinths, and the submerged weeds anachoris (the weed you buy in aquarium stores) or other types.

Land Use and Development

This information will assist in making nutrient loading estimations and determining lake use. You are asked to describe by % use the land within roughly 1/4 mile of the lake. The categories are generally straightforward. "Fallow" refers to fields that do not presently appear to be under cultivation but have not been abandoned either. Note any husbandry activities including the type of animal being raised and a guess as to how many "beasties" are present. "Campgrounds" should refer to developed campsites with associated privies or restrooms. Overnight trailer parks would be included, mobile home sites would not.

If the lakeshore is rimmed with cottages or houses, try to estimate either the total number or density of the dwellings and whether they appear to be year-round or seasonal dwellings (or a combination). Again the intent is to use this for loading estimates, particularly of cess pool contributions. Please note the number of private docks and/or boats associated with the cottages (even "lots", "few", "scattered", etc. would be acceptable).

The number of marinas, public access areas, and swimming beaches will provide additional information for both loading and lake use purposes. Cattle watering areas refer to narrow access areas for livestock (as opposed to open pasture land bordering the lake). Either a number of the total observed or a check for each one observed may be used. A marina is differentiated from a boat rental by its larger size and presence of larger, private boats. A boat rental is envisioned as a dock where you can rent row boats.

Shore Type

These data refer to the immediate shoreline area where the water meets the land. "Slope" refers to the area leading to the lakeshore. "Steep" is envisioned as cliffs, bluffs, or slopes where handholds may be required to navigate it. "Gradual" would be a distinct slope that a person could climb with full hands and a minimum of slipping and sliding. "Flat" refers to land that is periodically flooded, marshy or swampy.

"Substrate" refers to the area visible at the edge of the lake. "Muck" differs from "Mud" in that the former appears to have a much higher organic content. "Clay" is generally a fairly cohesive sediment although the surface layer may be in suspension. "Gravel" refers to a gentle sloping beach of unconsolidated, pebble sized rocks as opposed to "Rocky" which describes boulder or cobbly beaches, consolidated clumps of aggregate, cliffs, tilus piles, etc. The last two are self-explanatory.

Comments

In this section put any explanatory notes, additional information (such as fish kills, lots of ducks, etc.), disclaimers, hedges, or personal feelings. Notes on land use activities, dredging operations, oil wells, duck blinds, etc. are also desired.

FIELD OBSERVATION FORM - NATIONAL EUTROPHICATION SURVEY

Lake Name ________ State____ Date______ STORET #(s)______

I. Sampling Conditions

Wind:
- Calm______
- Light______
- Moderate______
- Strong______
- Direction______
- Velocity*______

Cloud Cover:
- Clear______
- P/C______
- B/C______
- Bright O/C______
- Dark O/C______
- Thunderheads______

Precipitation:
- Mist______
- Light______
- Heavy______
- Recent Significant______
- None______
- Extended Drought______

Air Temp.______

Relative Hum.*______

II. General Lake Conditions

Water Level:
- Flooded______
- Normal______
- Low______
- Very Low______
- Undetermined______

Color Causes:
- Humics______
- Sediment______
- Algae______
- Other______

Turbidity Causes:
- Sediment______
- Algae______
- Other______
- None______

Floating Debris:
- Heavy______
- Light______
- Absent______

Type & Location:______

Emergent Trees &/or Stumps:
- Many______
- Few______
- None______

Locate & Describe______

Other Observations:______

III. Aquatic Vegetation (mark if present)

Phytoplankton:
- Algae Bloom______
- Surface Scum______
- Floating Mats______
- Open Lake______

Macrophytes (% of shoreline):
- Emergents______
- Floaters______
- Submerged Weeds______

Discrete Arm or Locality (describe):______

IV. Land Use & Development (¼ mile perimeter of shore). Enter % estimated

Agricultural:
- Orchard______
- Grain______
- Leafy Vegetable______
- Pasture______
- Other______
- Active______
- Fallow______
- Abandoned______
- Plowed______
- Husbandry______

Other:
- Urban______
- Parks______
- Campgrounds______
- Industrial______
- Highway, Roadway______
- Wooded______
- Chapparal______
- Prairie______
- Desert______
- Barren Rock______

Lakeshore Residences:
- Year Round______
- Seasonal______
- Total #______
- % of Shoreline______
- #/mile______
- # Private Docks______

(Check for each case observed):
- Marinas______
- Public Access______
- Swimming Beaches______
- Cattle Watering Areas______
- Boat Rentals______

V. Shore Type (Enter % estimated)

Slope:
- Steep______
- Gradual______
- Flat______

Substrate:
- Muck______
- Mud______
- Clay______
- Sand______
- Gravel______
- Rocky______
- Obscured by Vegetation______
- Other______

VI. Comments

* Optional

APPENDIX E

MUNICIPAL SEWAGE TREATMENT PLANT
GUIDELINES AND FORMS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
PACIFIC NORTHWEST ENVIRONMENTAL RESEARCH LABORATORY
CORVALLIS, OREGON 97330

NATIONAL EUTROPHICATION SURVEY

EFFLUENT SAMPLING GUIDELINES

We are requesting your participation in a most important part of the National Eutrophication Survey; the once-a-month collection (for a year) of wastewater treatment plant effluent samples for subsequent chemical analysis at U.S. Environmental Protection Agency laboratories.

Because of the great nationwide variation in the types and sizes of wastewater treatment plants, in the degree of plant operation required, in the numbers of operators per plant, in the sampling equipment available, etc., we recognize that the kinds of effluent (discharge) samples that operators can collect will also vary.

Listed below are the general kinds of effluent sampling methods for conventional treatment plants that can yield needed information, ranging from the most desirable (number 1) to the least desirable (number 4). We ask that you select the method, or variation thereof, that will provide the best samples possible without interfering with your duties and responsibilities in the operation of your plant.

1. A once-monthly 24-hour composite sample (proportional composite if flows are metered or measured), or

2. A once-monthly 8-, 10-, or 12-hour composite sample (proportional if flows are metered or measured), or

3. A once-monthly modified composite sample consisting of about 500 milliliters (ml) collected at 11 AM and another 500 ml collected at 4 PM of the same day, or

4. As the least desirable alternative, a once-monthly single grab sample of about one liter collected on a weekday between the hours of 8 AM and 8 PM.

If your treatment facility is a stabilization pond or lagoon with a detention time of at least 30 days, method 4 is quite acceptable. If your pond does not overflow ordinarily but is drawn down once or twice a year, please collect an 8-hour equal-portion composite or, as a minimum, collect a grab sample during draw-down and indicate the area of the pond and the total amount of the draw-down (for example, "ten acres - two-foot draw-down").

OVER

Composite samples should be collected in separate glass or plastic containers (clean gallon jugs, one-gallon plastic milk containers, etc., are suitable), and the samples should be refrigerated, iced, or otherwise kept as cool as possible during the period of collection. Grab samples should be preserved immediately after collection, as indicated below, but can be kept cool until a convenient time to preserve them.

After the final portion of the composite sample or the grab sample has been collected, add one vial of the mercuric chloride preservative to the plastic sample container we have provided ("cubitainer") and then fill the cubitainer with the well-stirred composite or grab sample (leave a little air space). The mercuric chloride has been supplied to you in vials and each vial contains the exact amount needed to preserve a one-quart sample. All you need to do is add the entire contents of the vial to the cubitainer. Please remember that mercuric chloride is a poison and should not be handled carelessly. In particular, avoid contact of the solution with the eyes or mucous membranes such as the lining of the mouth.

After adding the sample, insert the red cup-shaped cap plug in the opening of the cubitainer, replace the cap, and tighten the cap securely (don't be afraid to use some force!).

Next, complete the information label (in pencil, please). Except for draw-down ponds as noted above, the best possible flow data are needed for the day the sample is collected and, if possible, the average daily flow for the month in which the sample is collected. Flow units used on these tags are "millions of gallons per day" (MGD). Therefore, a flow rate of 2,000,000 gallons per day would be recorded as "2.0". A flow rate of 500,000 gallons per day would be recorded as "0.5". If you wish to provide flows in some other units, please specify those units on the tag and cross out the MGD. If you have no means of measuring flows, please indicate the actual or estimated number of people served by your plant and note any industries that are also served by your plant.

Once the label is completed, stick it on the cap of the cubitainer (this makes it easier to remove in the laboratory), and place the cubitainer in the preaddressed cardboard shipping carton. Finally, seal the carton with the tape we have supplied and drop it in the mail (no postage is necessary).

We appreciate your assistance in this important part of the National Eutrophication Survey.

NATIONAL EUTROPHICATION SURVEY

STORET NO.:..

PLANT NAME:..

COLLECTION DATE:..

CIRCLE SAMPLE TYPE: GRAB COMPOSITE

COLLECTION TIME: ....

SAMPLE DAY FLOW: .... MGD

AVG. DAILY FLOW FOR MONTH .... MGD

PRESERVATIVE ADDED ....

COLLECTORS NAME: ....
(2700) (Print)

APPENDIX F

TRIBUTARY SAMPLING GUIDELINES AND FORMS

THE NATIONAL EUTROPHICATION SURVEY

UNITED STATES · ENVIRONMENTAL PROTECTION AGENCY

INSTRUCTIONS FOR TRIBUTARY SAMPLERS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

NATIONAL EUTROPHICATION SURVEY

Statement of

Definition of Eutrophication,

Perspective,

Goal of National Eutrophication Survey,

and Objectives of Phase III Tributary Sampling

I. DEFINITION

Eutrophication is the process of nutrient enrichment of lakes which usually stimulates algal scums and causes shallows to be choked with masses of rooted plants.

As a direct result of the high production of aquatic plants,

a. The value of a lake as a water resource is greatly impaired,

b. Aesthetic qualities are virtually destroyed, and

c. Depleted oxygen and reduced water clarity force valued game species -- trout, salmon, and smallmouth bass, for instance -- to be dominated by those species better adapted to eutrophic conditions such as carp and suckers.

Eutrophication is accelerated principally by concentrations of phosphates and nitrates. A sufficient balance of these nutrients, necessary for normal plant and fish growth, is generally provided through natural land runoff. Man's technology and advances, however, have created intense sources of abundant phosphates and nitrates, mainly municipal sewage treatment plant effluent, industrial discharges, and fertilized cropland and feedlot drainage.

Evidence indicates that eutrophication accelerated by mankind is a reversible process. Given sufficient and necessary knowledge of specific growth-stimulating nutrients and sources involved, the rate of reversal in a lake is essentially a function of the comprehensiveness of the management practices relating to:

a. Nutrient removal from sewage treatment plant effluent and industrial discharges, and

b. Land use controls in the tributary drainage areas.

II. PERSPECTIVE

Recently, the initial data assessment and final lake selection of Phase I were completed in your state through EPA Washington, D. C., coordination with state water authorities and EPA Regional officials.

Phase I further data assessment and Phase II lake sampling are now in progress and will be supplemented by Phase III nutrient input sampling.

The "who," "basic procedure," and "for what scientific reason" of each phase may be capsulized in the manner:

Phase I -- Data Assessment and Lake Selection

State water authorities, EPA Regional officials, and EPA Washington, D. C., analyze existing data to select those lakes in need of further study and sampling. Existing eutrophication data become integral element of Survey.

Phase II -- Lake Sampling

By helicopter, EPA technicians sample selected lakes to determine present nutrient condition and tolerance for further nutrient inflow.

Phase III -- Nutrient Input Sampling

a. Tributary Sampling

National Guardsmen, on a volunteer basis under provisions of DoD Domestic Action Directive 5030.37, sample tributaries of selected lakes. Sampling procedure aids identification of sources; analysis of samples indicates degree of nutrient threat to selected lakes.

b. Municipal Sewage Treatment Plant Sampling

Municipal sewage treatment plant operators provide composite samples; analysis indicates plant nutrient outflow.

c. Flow Data

U. S. Geological Survey furnishes tributary flow data.

III. SURVEY GOAL

The goal of the National Eutrophication Survey is to provide Phase I existing data assessment and lake selection, Phase II determination of present nutrient condition and tolerance of selected lakes, and Phase III source identification and analysis of nutrient threat in a form and manner significantly contributing toward fulfillment of the stated goal of the Federal Water Pollution Control Act Amendments of 1972, ". . . to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."

IV. PHASE III TRIBUTARY SAMPLING OBJECTIVES

In support of the National Eutrophication Survey goal, basic objectives of phase III tributary sampling are twofold:

a. To develop sufficient and necessary knowledge of nutrient source, concentration, and threat to selected fresh water lakes as a basis for recommendations leading to comprehensive and coordinated national, regional, and state management practices relating to sewage treatment plant effluent and industrial discharge nutrient removal and land use controls in tributary drainage areas by:

1. Establishing an effective, statewide National Guard volunteer organization to plan, direct, and coordinate experimentally-controlled tributary sampling, including obtaining, stabilizing, and shipping of samples, and

2. Insuring systematic National Environmental Research Center, Corvallis, Oregon, analysis of tributary samples.

b. To enhance public awareness of National Guard commitment to, and participation in, a constructive community services activity contributing to the restoration and maintenance of the integrity of the Nation's fresh water resources.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

NATIONAL EUTROPHICATION SURVEY

National Guard Obtaining, Identifying,

Stabilizing, and Shipping

Phase III Tributary Samples

I. A FUNDAMENTAL PRINCIPLE

Precise attention to detail is an "absolute" in any scientific project which involves experimentally-controlled sampling and rigorous chemical analysis.

It is important, therefore, that sampling techniques be thoroughly understood. Even what might seem a slight deviation from established procedures could cause serious errors in EPA's findings.

II. BEFORE YOU GO OUT

Double-check equipment before leaving your unit. Insure that you have:

-- one bottle for each sampling site your team will cover, plus several extras (without opening, check bottles and lids for defects such as cracks and faulty seams),

-- a sampling "rig" (check sturdiness of rubber strap and nylon handle),

-- a length of nylon rope,

-- a #2 pencil (the lid site information must be completed in pencil inasmuch as ink will smudge when wet),

-- a plastic pail for wide stream composite samples (if needed), and

-- the site description list.

III. ACTUAL SAMPLING

EPA's scientists are conducting tributary analyses in a manner that will determine accurately the concentrations of phosphorus and nitrogen.

But the accuracy begins at the sampling site. Your personal objective is to draw samples which authentically represent the stream.

Water taken too close to a muddy bottom, for instance, or at the surface may yield misleading data. Contamination by the phosphates from your hand, caused by touching the inside surfaces of bottles and lids, will significantly alter the findings.

Thus, by (a) using the proper precautions for handling the sampling equipment (it is preferred, for example, that bottles not be opened until you have arrived at the sampling site and are ready to begin), and (b) taking samples midway between the surface and bottom and in that portion of the stream carrying the greatest flow, reasonably assures that the sample will be a true representation of the stream.

On the day you take your first samples, an EPA or state "stream biologist" will accompany you to the various sample sites. He will:

-- select the exact point where the sample will be collected,

-- identify the site by stenciling the STORET* code number, and

-- review the specific sampling procedures. Considering the varying circumstances of each site, the biologist will determine whether to sample from a bridge by lowering the rig, sample from the bank by casting the rig into the flow, hand-dip the bottle, or take a wide-stream multiple sample.

---

*STORET (STOrage and RETrieval is a computer system which processes and maintains water resources data.

In the case of bridge sampling, first insure that the bottle is fully "seated" in the rig, with the rubber strap secured over the top. (In the process, remember to avoid touching the inside surfaces of the bottle and lid. If this accidentally occurs, discard the bottle/lid and use another.)

Second, be sure that the length of nylon rope is tied to the nylon handle of the sampling rig with a firm knot -- such as a bowline. Avoid square knots, as they tend to slip on nylon.

Third, lower the rig by its rope to a point approximately three feet above the water's surface, then drop it the rest of the way to submerge it. Let it sink halfway to the bottom before pulling it out of the water and onto the bridge. Use this first water as a rinse for the bottle and lid. Then, throw aside the rinse, lower the rig, and collect your sample.

The bottle is filled to the lowermost of the lid thread marks (approximately 7/8 inches from the top). Essentially, this is the amount of sample water necessary for various analytic procedures at the Corvallis, Oregon, laboratory.

If your sample is taken from a bank, position yourself as close as safely possible to the edge, then, in life-buoy fashion, cast the rig into the stream flow. Let it settle to the proper depth before pulling it in. As in the bridge sample, use the first water as a rinse, recast the rig, and draw the sample.

If the rig should scrape the bottom, whereby mud or rocks get into the sample, rinse the bottle and retake.

At small streams, the most practical way to take the sample may be to hand-hold the bottle, facing the mouth upstream (should the bottle face downstream, the flow by your hand will pick up phosphates, then contaminate the sample).

Occasionally, samples must be drawn where a stream is unusually wide, or where the flow is not well mixed. In these cases, multiple samples will be taken, mixed into a pail, and then poured into a sample bottle, Your biologist will inform you when this procedure is necessary, then give more specific instructions.

IV. LABELING YOUR BOTTLES

When recording site information on the lid, precautions are necessary to prevent:

-- the identified lid of one sample bottle being erroneously put onto the bottle of another sample, and

-- the site identification from becoming obscured so as to be unreadable.

For these reasons, two guidelines are:

(1) Work with only one sample bottle and lid at a time. Undo a lid, take the sample, recap, and then record the site information before becoming involved with the next sample.

(2) Use a #2 pencil to record the site information. Inks will smudge.

This is the label attached to each lid:

NATIONAL EUTROPHICATION SURVEY

STREAM NAME____________________________

STORET CODE____________________________

DATE______________TIME______________

SIGNATURE____________________________

The STORET code will be provided by the biologist during the initial sampling, then may be taken from the on-site stenciled numbers during the remainder of the Survey. IMPORTANT: Do not pre-record the site number before leaving your unit, for it is relatively easy for lids to become mixed with improper sample bottles.

Record the time in the military manner of 0900, 1400, etc.

V. AFTER THE SAMPLE IS TAKEN

Once taken, you have only three hours to return a sample to your unit to be chemically stabilized. Beyond that time, despite precautions, there is a substantial risk that biological activity will alter the phosphates and nitrates within a sample, thereby rendering it virtually useless for analysis.

When your sample has been drawn, use these field precautions to preserve the integrity of the sample:

-- keep as cool as possible (warmth will significantly increase detrimental biological activity), and

-- keep from sunlight (which also stimulates activity).

A solution for keeping the sample cool and from sunlight is to invert a jiffy bag (furnished to your unit) over the bottle, then emplace the jiffy bag/bottle in an EPA shipping carton. Place the carton in the shade in your vehicle.

VI. STABILIZING AND PREPARING SAMPLE FOR SHIPMENT

Once the samples have been returned to the unit within the three hour time period, they must be stabilized with mercuric chloride. This chemical agent kills living organisms which might otherwise alter the nitrate and phosphate nutrient content.

For control and safety, one Guardsman should be designated for this task, as follows:

-- Open and stabilize only a single bottle at a time (which prevents lids from being replaced on wrong bottles). When placing the lid aside, be extremely careful not to contaminate the inside surface.

-- Use the calibrated eye-dropper, and dispense exactly 1.2 milliliters of mercuric chloride (twice the eye-dropper filled to the 0.6 ML mark). Improper amounts of mercury in the sample may not stop biological activity and will cause difficulties in the chemical analysis, so be careful to add the precise amount.

W A R N I N G

MERCURIC CHLORIDE IS HIGHLY POISONOUS AND CORROSIVE TO MUCUOUS MEMBRANES. INGESTION MAY CAUSE SEVERE NAUSEA, VOMITING, OR EVEN DEATH. HANDLE WITH EXTREME CARE! KEEP AWAY FROM FOOD AND CIGARETTES; KEEP AWAY FROM CHILDREN. ANYONE HANDLING THIS CHEMICAL STABILIZER MUST WASH HIS HANDS IMMEDIATELY UPON COMPLETION OF STABILIZING.

-- Replace the lid, making sure that it is tightly sealed. Shake the bottle well, both to diffuse the mercuric chloride evenly throughout the sample and to test the lid seal.

-- Mark two green stripes across the middle of the lid label with the green wax pencil. (Avoid obscuring site information, however.) The marks serve as a procedural-control device at your unit and to inform Corvallis laboratory technicians that the samples indeed have been stabilized.

After samples have been stabilized, they must be sealed with tape around the neck of the bottle. A jiffy bag is then inverted over the top.

If there are insufficient bottles to completely fill the shipping container, tightly stuff the remainder of the carton with newspaper or other packing materials. Mail to the state's central collection point using the franked labels provided for that purpose (or use other channels as may be designated in your state, such as USP&FO). At the central collection point, the state Project Officer will inventory all statewide samples taken, then repack, as necessary, for shipment to Corvallis.

VII. IN THE EVENT OF AN UNCOLLECTABLE SAMPLE

During the conduct of your stream sampling, it is foreseeable that samples may be uncollectable at sites for various reasons, owing primarily to ice, drought, flood, or other climatic conditions.

In such an event, an empty sample bottle represents the sample. All label information is to be completed (stream name, STORET code, date, time, and signature), and a note included within the bottle explaining, "thick ice," dry stream," or whatever the reason might be. The missing-sample bottle is then forwarded, along with other collected unit samples, to the state collection center.

VIII. AN E-P-A "THANKS" TO NATIONAL GUARDSMEN

The Administrator of the U. S. Environmental Protection Agency is grateful for the initiatives extended by you and your fellow National Guardsmen towards the restoration and maintenance of the Nation's fresh water resources.

The information derived from your samples is unique for each of the many lake basins throughout the country. Each monthly sample you draw during the course of the next twelve months will be irreplacable.

Your samples will contribute to the advancement of the state-of-knowledge concerning pollution difficulties. In essence, what you do for the Survey will impact dramatically on whether a given lake is restored and maintained, or eventually lost.

Your personal involvement is greatly appreciated!