A GENERAL GUIDELINES FOR THE ASSESSMENT OF WATER QUALITY

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Preface

This technical release was prepared in the Washington office of the Soil Conservation Service by an ad hoc committee from the Engineering, Plant Sciences, and Environmental Services Divisions. The major part of the technical data was developed in the Lincoln, Nebraska and Fort Worth, Texas, Technical Service Centers by Ray Cope and Gary Margheim, respectively.

This release has been reviewed by all Washington office technical divisions and the four technical service centers. Comments and suggestions from these offices were very helpful and have been incorporated.

TECHNICAL RELEASE

NUMBER 58

GENERAL GUIDELINES FOR THE ASSESSMENT OF WATER QUALITY

PURPOSE

This technical release is intended to supplement the SCS Environmental Assessment Procedure and generally to aid in streamlining the preparation of environmental assessments and impact statements. It is specifically designed to assist personnel responsible for assessing water quality in (1) determining the scope for proposed water-quality studies, (2) selecting test parameters, (3) selecting sampling stations and frequency of sampling, and (4) predicting program or project impacts on water quality.

BASIS

With the advent of the National Environmental Policy Act, the Federal Water Pollution Control Act Amendments of 1972, and the Water Resources Council's "Principles and Standards for Planning Water and Related Land Resources," water-quality investigations have become an integral part of SCS programs. There is a pressing need for SCS water-quality investigations to provide basic data for:

1. Determining the present water quality as needed for environmental assessment.

2. Documenting water quality for an appropriate period before construction of a project.

3. Evaluating the effects on water quality of typical land use and treatment measures and major works of improvement such as PL-566 or RC&D measures during and after construction.

WATER-QUALITY INVESTIGATIONS

Seven basic steps in water-quality investigations are determination of objectives, review of existing data, field reconnaissance, determination of parameters, evaluation of existing data based on identified parameters, sampling and analysis, and evaluation of data and interpretation of results. These are explained in detail in the pages that follow.

1. Determination of Objectives

Water-quality investigation objectives are to be determined by an interdisciplinary team and based on early contacts with all other cooperating groups and federal and state agencies having expertise that can be utilized.

The objectives are to be put in writing. The written objectives should define the purpose and scope of the study, establish responsibility for various phases, and provide a basis for determining if the study, when completed, has accomplished the objectives.

II. Review of Existing Data

A review of pertinent water-quality and related data that have been collected for a given area may indicate additional water-quality problems. Generally, this review is to be conducted by SCS personnel although it may be a part of a water-quality contract.

STORET should always be checked as a possible source of data for the project being planned. STORET is the Water Quality Data Storage and Retrieval System maintained by the U.S. Environmental Protection Agency. Data collected by many agencies on the nation's rivers, lakes, and estuaries are stored in a central computer. Printouts of the data can be obtained at a nominal cost from regional EPA offices.

The Catalog of Information on Water Quality Data is a file of information about water data acquisition activities published by the U.S. Geological Survey Office of Water Data Coordination. The 1972 edition of the Catalog is in 21 separate volumes, one for each of the water resources regions designated by the Water Resources Council. Each volume contains information on water data acquisition activities conducted by federal and nonfederal agencies relating to stage and flow of surface waters and springs and to quality of surface and ground water. The Catalog does not contain the actual data, which must be obtained from the reporting agencies.

A checklist of possible sources of water-quality data is provided in Attachment 4.

III. Field Reconnaissance

Field reconnaissance to observe and inventory potential pollution sources and watershed and stream characteristics that would affect the chemical, physical, or biological quality of water is an important phase in determining investigation needs. There is no substitute for personal observation. Often, an experienced individual can adequately estimate the probability that a watershed can produce water of a quality satisfactory for an intended use.

IV. Determination of Parameters

Water-quality parameters that need to be studied can be determined on the basis of information derived from the first three steps --objectives, existing data, and field reconnaissance. The parameters should be selected to provide answers to specific questions relating to a particular project.

A standard list of water-quality parameters cannot be prescribed for all projects. The diagram on the following page has been developed to provide guidance in selecting proper kinds of data to be collected and analyzed for a specific project. For example, assume that a flood-control impoundment is proposed on a fish and wildlife stream and that land use patterns and existing farming practices indicate nutrients are a potential problem. From the diagram, the water-quality parameters to be considered are discharge, dissolved oxygen, temperature, pH, turbidity, suspended sediment, conductance, nitrate, nitrite, total Kjeldahl nitrogen, total phosphorus, and orthophosphate. If water for municipal use is intended in addition to flood control, otner likely water-quality parameters are fecal coliforms, fecal streptococci, hardness, color, manganese, iron, alkalinity, total dissolved solids, phenols, suspended solids, total solids, and any substance suspected.

All parameters listed for a given use or specific problem are not required in all situations, but in some, even additional parameters may be required. Selection of parameters should be made on a case by case basis by the interdisciplinary team.

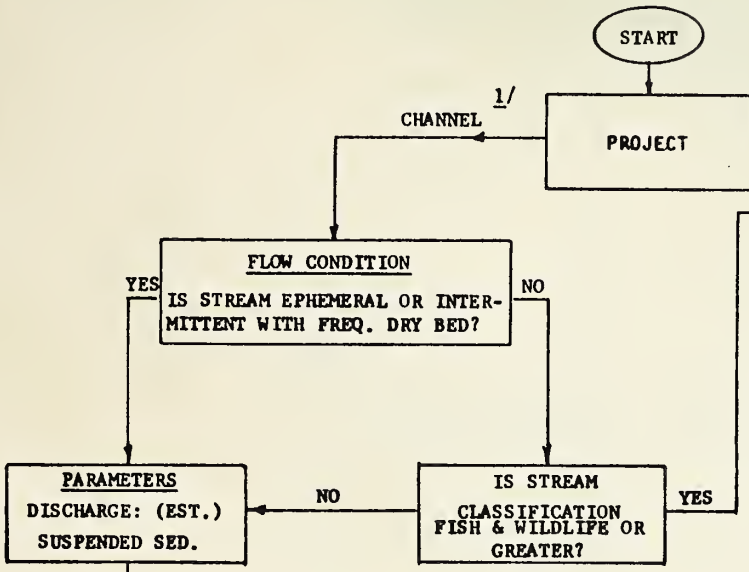
The table on water-quality tests supplements the diagram and provides more specific testing guidelines for various types of projects.

V. Evaluation of Existing Data Based on Identified Parameters

The SCS interdisciplinary team should consider and evaluate existing water-quality data on the basis of applicable parameters, as well as the field reconnaissance and determined objectives. The team should determine which parameters need further investigation. It should also determine if outside expertise is needed and, if so, to what degree. Contracts for additional field sampling, required physical, chemical, and biological testing, and interpretations are to be recommended by the team.

VI. Sampling and Analysis

Generally, SCS will do very little analysis except possibly during field reconnaissance with field kits. But SCS may have responsibility for sample collection in certain cases. If so, it



WATER QUALITY PARAMETERS FOR EXISTING AND PROPOSED USES					
FISH & WILDLIFE	RECREATION	M & I 2/	IRRIGATION	STOCKWATER	FLOOD CONTROL
DISCHARGE DISSOLVED OXYGEN TEMPERATURE pH TURBIDITY	DISCHARGE FECAL COLIFORM FECAL STREPT. pH TURBIDITY TEMPERATURE DISSOLVED OXYGEN ODOR COLOR	DISCHARGE FECAL COLIFORM FECAL STREPT. HARDNESS COLOR TURBIDITY TEMPERATURE pH DISSOLVED OXYGEN MANGANESE IRON ALKALINITY TOTAL DISSOLVED SOLIDS PHENOLS SUSPENDED SOLIDS TOTAL SOLIDS	DISCHARGE CONDUCTANCE pH SODIUM MAGNESIUM CALCIUM TOTAL DISSOLVED SOLIDS	DISCHARGE TOTAL DISSOLVED SOLIDS TURBIDITY DISSOLVED OXYGEN TEMPERATURE	DISCHARGE SUSPENDED SED. CONDUCTANCE TEMPERATURE

WATER QUALITY PARAMETERS FOR ADDITIONAL WATER PROBLEMS					
NUTRIENTS	WASTE ASSIMILATIVE CAPACITY	TOXIC MATERIAL	RESERVOIR STRATIFICATION	SALINITY	INDUSTRIAL WASTE
NITRATE NITRITE TOTAL KJELDAHL NITROGEN TOTAL PHOSPHORUS ORTHO PHOSPHATE	TEMPERATURE DISSOLVED OXYGEN BIOCHEMICAL OXYGEN DEMAND NITRITE NITRATE TOTAL KJELDAHL NITROGEN TIME OF TRAVEL	SPECIFIC HEAVY METAL OR SPECIFIC PESTICIDES	TEMPERATURE METEOROLOGICAL DATA	TOTAL DISSOLVED SOLIDS CHLORIDES	CHECK FOR SPECIFIC INDUSTRY AND PROBLEMS UNIQUE TO IT

1/ CHANGES IN HABITAT WITH RESULTANT CHANGES IN BIOLOGICAL COMMUNITIES ARE USUALLY THE MOST SIGNIFICANT ENVIRONMENTAL EFFECTS OF STREAM CHANNEL ALTERATION.

2/ WATER QUALITY PARAMETERS AND REQUIREMENTS FOR INDUSTRIAL USE SHOULD BE OBTAINED FROM SPECIFIC INDUSTRIES INVOLVED.

Water Quality Tests

NO.	ITEM		Project identification 1/							K/L 2/	Remarks
			1	2	3	4	5	6	7		
1	Flow (discharge)	cfs	R*	R 3/	R	R	R	R	R	K	*Estimated
2	Water temperature	°C (°F)	R	R	R	R	R	R	R	K	
3	Color (cobalt scale)			AR 4/	AR	AR	AR	R	AR	K	
4	Odor (observation)		R	R	R	R	R	R	R	-	
5	Solids, foreign		R	R	R	R	R	R	R	-	Visual observations
6	Solids in suspension	mg/l		AR		R	AR	R	R	K/L	
7	Turbidity	JTU		AR		R	AR	AR	R	K	
8	Specific conductance	mhos	AR			R	R	R	R	K	
9	Dissolved solids (total)	mg/l			R	R	R	R	R	L	
10	Total solids	mg/l		R	AR	R	R	R	R	L	
11	Hydrogen ions	pH	AR		R	R	R	R	R	K	
12	BOD_5	mg/l		AR	AR	AR		AR	AR	L	
13	DO	mg/l	AR	AR	R	R	R	R	R	K	
14	COD	mg/l		AR	AR	AR		AR	AR	L	Where BOD is impractical
15	Coliform, fecal	MF/MPN		AR	R	R		AR		L	Counting method to
16	Coliform, total	MF/MPN		AR	AR	R	AR	R		L	match existing
17	Streptoccus, fecal	MF/MPN		AR	AR	R		AR		L	data
18	Phenols	mg/l		AR	AR	AR	AR	R	AR	L	
19	Biocides	µg/l		AR	AR	AR	AR	R	AR	L	State which
20	Metals	µg/l					AR	AR	AR	L	State which

NOTE: THIS TABLE IS ONLY A GUIDE.

Water Quality Tests -- continued

NO.	ITEM		Project identification 1	2	3	4	5	6	7	K/L	Remarks
21	Manganese (Mn)	mg/l					AR	R		K/L	
22	Magnesium (Mg)	mg/l					AR			L	
23	Calcium (Ca)	mg/l					AR			L	
24	Carbonate (CO_3)	mg/l					AR			K	
25	Bicarbonate (HCO_3)	mg/l					AR			K	
26	Hardness, total ($CaCO_3$)	mg/l			AR	AR	AR	R		K	
27	Alkalinity ($CaCO_3$)	mg/l			AR	AR		AR	R	K	
28	Sodium (Na)	mg/l					R		AR	K/L	
29	Potassium (K)	mg/l					AR		AR	L	
30	Chloride	mg/l	AR		AR	AR	R	R	AR	K	
31	Ammonia N (NH_3)	mg/l		AR	R	R	AR	R	R	K/L	
32	Nitrate - Nitrite (NO_3, NO_2)	mg/l			AR	AR	R	R		K/L	
33	Nitrogen (total Kjeldahl)	mg/l			AR	AR	AR	AR		L	For point pollution
34	Nitrogen, total	mg/l	AR	R	R	R	R	R	AR	L	
35	Ortho phosphate	mg/l				AR				K/L	
36	Phosphorus, total	mg/l	AR	R	R	R	R	R		L	
37	Sulfate (SO_4)	mg/l			AR	AR	R			K	
38	Boron (B)	µg/l					AR			L	
39	Arsenic (As)	µg/l						AR		L	
40	Iron, total (Fe)	µg/l					AR	R		K/L	
41	Others		AR	AR	AR	AR	AR	AR	AR	-	State which
42	Bio-test				AR	AR		AR	AR	L	

1/ Project identification:
1. Nonpermanent bodies of water, streams, etc.
2. Small perennial bodies of water, sediment pools, ditches, and streams
3. Water for recreation purposes - noncontact water sports
4. Water for recreation purposes - contact water sports
5. Water for multiple purpose agricultural use
6. Water for municipal and industrial use
7. Perennial bodies of water, streams, etc., for cold and warm water fish

2/ K/L - Kit or laboratory tests

3/ R - Required test

4/ AR - As required test

is imperative that personnel responsible for sample collection be knowledgeable in water sampling procedures. It must be understood that field kits generally are adequate for reconnaissance surveys only and that laboratory analyses of many parameters are required for more reliable results. Tests for dissolved oxygen, pH, odor, color, and temperature can often be accomplished by SCS personnel. Check with state and federal agencies on the adequacy of various private labs if used. If additional information is required concerning techniques and methods of analysis, the following references may be useful:

1. Standard Methods for the Examination of Water and Wastewater, 13th Edition, American Public Health Association, American Water Works Association, and Water Pollution Control Federation, Washington, DC 20035, 1971, 874 pages.

2. Proposed Criteria for Water Quality, Volumes I & II, U.S. Environmental Protection Agency, Washington, DC 20460, October 1973, 425 pages (vol. I), 164 pages (vol. II).

3. 1975 Annual Book of ASTM Standards, Part 31 -- Water, American Society for Testing and Materials, Philadelphia, PA 19103, 922 pages.

4. Methods for Chemical Analysis of Water and Wastes, U.S. Environmental Protection Agency National Environmental Research Center, Cincinnati, OH 45268, 312 pages.

In any investigation requiring sampling, the results are only as good as the sampling and analysis are. Improperly conducted sampling or analysis results in inaccurate and misleading reports.

VII. Evaluation of Data and Interpretation of Results

Information obtained from water-quality investigations provides the basis for environmental assessment of water resources in their present condition as well as establishment of a baseline from which project impacts on water quality can be estimated.

The environmental assessment generally can be evaluated by thorough interdisciplinary review of collected data. The estimation of project impacts on water quality presents a difficult challenge. Much literature has accumulated on the effects of various physical modifications of streams on water quality. A partial list of references relating to determining water-quality impacts is in Attachment 3. Most of the pertinent data are results of case studies depicting the extent of changes with regard to a specific disturbance or treatment in a given locale under its unique natural conditions.

The following general guideline is suggested for estimating project water-quality impacts:

1. Obtain and study applicable water-quality requirements:

   a. Municipal

   b. Fish and wildlife

   c. Industrial

   d. Recreation

   e. Livestock

2. Quantify the potential water pollutants during construction. Generally, sediment and increased turbidity are major factors. Refer to any specific construction specifications for pollutant minimization. Calculate erosion and estimate transported sediment. (The geologist can make these calculations.)

3. Consider consequences of a construction phase in terms of the following:

   a. Relation to water-quality standards and potential effects on water quality

   b. Time period of decreased water quality

   c. Distance downstream of decreased water quality

   d. Changes in biological community

4. For the use phase also, try to quantify the potential water pollutants.

   a. Refer to applicable discharge standards.

   b. Consider need for pollutant reduction.

      (1) Waste-water treatment

      (2) Reduction of waste-water volume

5. Predict applicable factors affecting downstream or impoundment pollution such as dissolved oxygen levels, thermal, chemical oxidation and/or reduction, dilution of pollutants, sedimentation, bacterial dieoff, incorporation of nutrients and pesticides, etc.

BIOLOGICAL INVESTIGATIONS

Biological surveys provide an insight into environmental conditions through the use of a single species or groups of organisms as indicators of environmental conditions. Biological surveys include the identification of individual species of aquatic organisms and an evaluation of species diversity as an index of ecological well being. Fish and benthos and plankton organisms may be included in diversity sampling. In some cases, quantitative sampling is desirable. For fish, standing crops are usually determined and used as a basis for comparison.

For proposed stream alteration, biological surveys are especially suited to studying the environmental impact and the natural self-healing process. Until information about causes and effects in the aquatic community is supported by more field trials and data, it is preferred that biological surveys, when required, be used in conjunction with chemical tests.

GENERAL GUIDELINES FOR SELECTING SAMPLING LOCATIONS AND FREQUENCY

1. Locating Sampling Stations

   Locate sampling stations according to project purposes, known water-quality problems, and anticipated needs. The following should be considered in selecting locations:

   A. Accessibility of sampling station: near bridges, docks, fords

   B. Locations for special purposes:

      1. Use prior sampling sites when available and advantageous.

      2. To sample spot pollutants, select one station upstream and one downstream from the mixing zone.

      3. Water quality for proposed multiple-purpose structures: Select one station immediately upstream from proposed impoundment, and if impoundment might affect fish and wildlife downstream, select one station downstream from proposed structure site.

      4. Water quality for fishing and spawning grounds: Select sampling stations upstream from, within, and downstream from sensitive area.

   C. General description of water quality for the entire watershed: Choose one station upstream of each confluence with major streams and one station at lower end of the watershed. Unless required for a special purpose, avoid stations immediately below discharges from point sources of pollution.

II. Frequency of Sampling

Frequency of sampling depends largely on the purpose of a study. A "one visit per sampling station" program, even at three different flow stages, is not fully sufficient for a true representation of existing conditions or for the measurement of impacts on water quality resulting from SCS installations. In the planning stage, however, such a simple testing program may suffice for obtaining a description of the environmental setting, especially if data are being updated and augmented before implementation.

Data representative of annual water quality are obtained through a systematic monitoring program. Again, sampling frequency depends on the purpose for which data are collected.

For evaluation of impact on water quality due to project measures, at least three visits at each station during each of low, medium, and high flow stages and during each climatic season are essential. Monitoring of point pollutants and some parameters may require additional visits and sampling sites in order to observe a range of concentrations. For example, monitoring dissolved oxygen requires a sampling frequency of four to six measurements per 24 hours to approximate the diurnal DO curve.

Ideally, monitoring programs should cover an entire year immediately before construction of a measure, since water quality may change with time.

ATTACHMENTS

Attachment 1 is included for use as a technical outline or checklist for the interdisciplinary team making the field reconnaissance of water-quality parameters.

Attachment 2 is a glossary of terms commonly used in water-quality studies.

Attachment 3 is a partial list of references relating to water quality.

Attachment 4 is a checklist of agencies that may have some water-quality data.

ATTACHMENT 1

FIELD RECONNAISSANCE CHECKLIST

SCS in cooperation with other agency representatives, acting as an interdisciplinary team, will develop the requirements for the water-quality investigations.

The following outline can be used as a checklist when making a field investigation of water-quality parameters:

I. Description of streams and other water bodies, including geological and physical descriptions

A. Surface water

List, where applicable, for each stream or body of water:

1. Geological description

a. Location

b. Length within area of concern

c. Confluences

2. Stream classification

a. As classified by state agencies in accordance with federal guidelines or regulations

b. Proposed or anticipated changes in classification

c. If manmade or natural channel and if perennial or ephemeral

3. Physical description

a. Stream channel

(1) Details of flow stages and gradients

(2) Depth, width, permanent pools, wetlands

(3) Types of substrate, including sand or gravel bars, and riffles

b. Banks

(1) Soil phases and characteristics

(2) Stability, presence or absence of erosion

(3) Vegetative cover and density

c. Maintenance, past and present

(1) Clearing of channel, when and how

(2) Weed and shrub control, mechanical or chemical

B. Ground water

List, where applicable, by area, region, or elevation:

1. Geological description

a. Geological formation

b. Depth to ground-water aquifers (wells, drill holes, etc.)

c. Origin, source of recharge, etc.

2. Physical description

a. Extent of present usage

b. Estimated potential and storage

c. Accessibility

II. Chemical and biological tests, including interpretations related to the environmental aspects of the proposed projects

A. Surface water

1. Test. -- State, preferably in tabular form:

a. Test data for chemical and physical constituents and, where applicable, description of organisms for streams and ponds.

b. Data gathered by others

c. In the absence of actual data, opinions of others or personal observations pertaining to odor, turbidity, aquatic plant and animal life

2. Interpretations

a. Describe water quality and environmental setting based on chemical tests and, where applicable, on groups of organisms observed.

b. Comment on specific water uses that are based on quality, including limitations and restrictions, under appropriate headings such as wildlife habitat, recreation, municipal or industrial uses, etc.

B. Ground water

1. Test. -- State, preferably in tabular form, test data including those obtained by others.

2. Interpretations

a. Describe water quality according to chemical tests; point out excessive concentrations and general assessment.

b. In the absence of actual data, relay observations pertaining to present use such as irrigation, domestic or municipal water supply, etc.

c. Comment on specific use potentials under appropriate headings, especially if ground water is proposed for use as major resource or as alternate source for irrigation or municipal supply, etc.

ATTACHMENT 2

GLOSSARY OF TERMS

Benthic region
- a) Bottom of a waterway
- b) Substratum that supports the benthos

Benthos
Aquatic bottom-dwelling organisms

Biochemical oxygen demand (BOD)
The amount of dissolved oxygen required by organisms for the aerobic biochemical decomposition of organic matter present in water

Biocide
An organic chemical agent used for the destruction of living organisms (herbicide, insecticide, fungicide)

Chemical oxygen demand (COD)
The amount of oxygen required for the oxidation of chemically oxidizable materials in water

Diurnal
- a) Pertaining to day; daily
- b) Diurnal curve for dissolved oxygen (DO): curve showing daily variation of DO

Ephemeral
- a) Shortlived
- b) Streams that do not flow continuously

Grab sample
A sample, usually manually collected, for observing constituents at the time of sampling as opposed to continuous sampling

Macro-organisms
- a) Organisms visible to the unaided eye
- b) Organisms retained on Taylor screen No. 30 (0:589 mm)

Nitrogen - Kjeldahl N
Total Kjeldahl nitrogen is the sum of free ammonia and organic nitrogen compounds that are converted to ammonium sulphate under defined conditions of digestion. (Does not include nitrates or nitrites; may be modified to do so)

Parameter
A characteristic element or constituent

Plankton
: Suspended micro-organisms, plants (phytoplankton), animals (zooplankton) floating in aquatic systems

Sessile
: Pertaining to those organisms that are attached to a substrate and not free to move about

ATTACHMENT 3

REFERENCES ASSOCIATED WITH WATER QUALITY AND THE DETERMINATION OF WATER QUALITY IMPACTS

1. AVCO Economic Systems Corporation, "Storm Water Pollution from Urban Land Activity," Program No. 11034 FKL, Contract No. 14-12-187, Federal Water Quality Administration, Department of the Interior, U.S. Government Printing Office, Washington, DC 20402, July 1970, 325 pages.

2. Brezonik, Patrick L., "Nitrogen Sources and Cycling in Natural Waters," EPA 660/3-73-002, Research Grant No. 16010-DCK, Office of Research and Monitoring, U.S. Environmental Protection Agency, Washington, DC 20460, July 1973, 167 pages.

3. Canter, L. W., "Environmental Study of Little River State Park, Final Report," Division of State Parks, State of Oklahoma, Oklahoma City, Oklahoma, December 1973, 173 pages.

4. Forcier, L. K., Knudsen, G. M., and Omodt, F. H., "Precipitation as a Nutrient and Hydrogen Ion Source for Forested Watersheds in the Missoula Vicinity." Project A-066 MONT, Montana University Joint Water Resources Research Center, Bozeman, Montana 59715, December 1973, 34 pages.

5. Hem, John D., "Study and Interpretation of the Chemical Characteristics of Natural Water," USGS Water-Supply Paper 1473, 1959, 269 pages.

6. Kittrell, F. W., "A Practical Guide to Water Quality Studies of Streams," U.S. Department of the Interior, FWPCA, CWR--5, 1969, 135 pages.

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8. McGauhey, P. H., "Engineering Management of Water Quality," McGraw-Hill Book Co., New York, NY, 1968, 295 pages.

9. McKee, Jack Edward and Wolf, Harold W. (Editors), "Water Quality Criteria," Second Edition, Publication No. 3-A, The Resources Agency of California, State Water Quality Control Board, 1963, 550 pages.

10. Markofsky, Mark and Harleman, Donald R. F., "A Predictive Model for Thermal Stratification and Water Quality in Reservoirs," Research Grant No. 16130 DJH, Water Quality Office, Environmental Protection Agency, January 1971, 283 pages.

11. Martin, Robert G. and Stroud, Richard H., "Influence of Reservoir Discharge Location on Water Quality, Biology and Sport Fisheries of Reservoirs and Tailwaters, 1968-1971," U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, Contract No. DACW31-67-C-0083, November 1973, 128 pages.

12. Masch, Frank D. and associates, et al., "Simulation of Water Quality in Streams and Canals," Texas Water Development Board, Austin, TX 78711, May 1971, 64 pages.

13. Middlebrooks, E. Joe, Falkenborg, Donna H., and Maloney, Thomas E. (Editors), "Modeling the Eutrophication Process," Ann Arbor Science Publishing Inc., Ann Arbor, Michigan 48106, 1974, 228 pages.

14. Mitchell, Ralph (Editor), "Water Pollution Microbiology," Wiley-Interscience, John Wiley & Sons, Inc. New York, NY, 1972, 416 pages.

15. National Technical Advisory Committee to the Secretary of the Interior, "Water Quality Criteria," Federal Water Pollution Control Administration, U.S. Department of the Interior, U.S. Government Printing Office, Washington, DC 20402, April 1, 1968, 234 pages.

16. Nemerow, Nelson L., "Scientific Stream Pollution Analysis," Scripta Book Company, Washington, DC, McGraw-Hill Book Company, New York, NY, 1974, 358 pages.

17. Ortolane, Leonard (Editor), "Analyzing the Environmental Impacts of Water Projects," AD-766 286, Contract Number DACW 31-71-C-0127, National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22151, March 1973.

18. Rainwater, F. H. and Thatcher, L. L, "Methods for Collection and Analysis of Water Samples," USGS Water Supply Paper 1454, 1960, 301 pages.

19. Pacific Northwest Water Laboratory, "Industrial Waste Guide on Thermal Pollution," Revised, Federal Water Pollution Control Administration, U.S. Department of the Interior, September 1968, 112 pages.

20. Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, "Temperature Prediction in Stratified Water: Mathematical Model-User's Manual (Supplement to Report 16130DJH01/71," Research Grant No. 16130 DJH, Environmental Protection Agency, April 1971, 125 pages.

21. Sawyer, Clair N. and McCarty, Perry L., "Chemistry for Sanitary Engineers," Second Edition, McGraw-Hill Book Company, New York, NY, 1967, 518 pages.

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23. Symons, James M., Weibel, Samuel R., and Robeck, Gordon G., "The Effects of Streamflow Regulation on Water Quality," U.S. Department of Health, Education, and Welfare, Public Health Service, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, August 1964, 57 pages.

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26. Water Resources Engineers, Inc., "Mathematical Models for the Prediction of Thermal Energy Changes in Impoundments," Project #16130 EXT, Contract # 14-12-422, Water Quality Office, Environmental Protection Agency, December 1969, 157 pages.

ATTACHMENT 4

CHECKLIST OF AGENCIES AS SOURCES OF WATER QUALITY DATA

Data Source	Format
Department of Agriculture	-
Soil Conservation Service	
Forest Service	
Atomic Energy Commission (radioactive substances)	-
Department of the Interior	
Bureau of Reclamation	-
Bureau of Land Management (public lands)	-
Bureau of Indian Affairs (Indian, lands)	-
Bureau of Outdoor Recreation	-
Fish and Wildlife Service	-
Geological Survey.	Water Resources Data
Water Resources Division	National Reference List of Water Quality Stations
Office of Water Data Coordination.	Catalog of Information on Water Quality Data
Office of Saline Water	-
Environmental Protection Agency.	STORET
Council on Environmental Quality	"102" Monitor
Department of Health, Education and Welfare	-
Department of Defense	-
Army Corps of Engineers	
Department of the Navy (ship pollution control)	
National Aeronautics and Space Administration (remote sensing)	
Department of Transportation	-
Coast Guard (oil spills, ship sanitation)	
Department of Commerce	-
National Oceanic and Atmospheric Administration	
Water Resources Council and Water Resources Inst.	
River Basin Commissions (as geographically appropriate)	

State:

Game and Fish Commission
Colleges & Universities
Department of Natural Resources
Health Department
Pollution Control Agencies
Water Resources Commission
Planning Commissions
Stream Pollution Control Agencies

Other:

Local Government Agencies
River Basin Districts
Water & Sanitary Districts
Private Labs & Consultants