APPENDIX A: REVIEW OF AVAILABLE MONITORING GUIDANCES

A.1 INTRODUCTION

The monitoring guidances and papers reviewed in this appendix are grouped under the following headings:

- General Monitoring Guidances and References
- Guidances for Stream and River Monitoring
- Guidances for Lake and Reservoir Monitoring
- Guidances for Watershed Monitoring
- Guidances for Ground Water Monitoring
- Guidances for Biological Monitoring
- Program-Specific Monitoring Guidances

The reviews have been organized primarily according to the type of waterbody or waterbody system to which the guidance is most applicable—streams and rivers, lakes and reservoirs, or watersheds. Guidances that are not specific to one type of waterbody are grouped under the remaining headings. For example, a guidance for biological monitoring in streams and rivers is listed under "Guidances for Stream and River Monitoring," whereas a biological monitoring guidance that is not specific to waterbody type is listed under "Guidances for Biological Monitoring." Numerous guidances are not specific to either a waterbody type or a particular type of monitoring, and these are listed under "General Monitoring Guidances and References." Guidances specific to programs mandated under the Clean Water Act, such as the National Pollutant Discharge Elimination System (NPDES) program or the National Estuary Program, are listed separately.

A complete listing of the guidances reviewed in this appendix is presented first, followed by the individual reviews. A table at the end of the appendix indicates at a glance the aspects of monitoring addressed in each guidance. The numbers at the top of the table correspond to the numbers preceding the guidance titles in this listing and in the reviews.

A.2 CATEGORICAL LISTING OF MONITORING GUIDANCES REVIEWED

A.2.1 General Monitoring Guidances and References

1. *National Handbook on Water Quality Monitoring.* USDA-NRCS 1996.

2. *Water Quality Indicators Guide*. USDA-NRCS 1997.

3. *The Nonpoint Source Manager's Guide to Water Quality and Land Treatment Monitoring.* Coffey, Spooner, and Smolen 1993.

4. *Coordinated Nonpoint Source Water Quality Monitoring Program for Idaho*. Idaho Department of Health and Welfare 1990.

5. *Water Quality Monitoring for the Clean Water Partnership. A Guidance Document*. Minnesota Pollution Control Agency 1989.

6. *Evaluating the Effectiveness of Forestry Best Management Practices in Meeting Water Quality Goals or Standards*. Dissmeyer 1994.

7. *Designing Effective Nonpoint Source Water Quality Monitoring Programs*. Maas 1989.

8. *Volunteer Estuary Monitoring: A Methods Manual*. USEPA 1993.

9. *Volunteer Water Monitoring: A Guide for State Managers.* USEPA 1990.

10. *The Volunteer Monitor*. The National Newsletter of Volunteer Water Quality Monitoring.

11. *The Strategy for Improving Water-Quality Monitoring in the United States*. Intergovernmental Task Force on Monitoring Water Quality 1995.

12. *The Strategy for Improving Water-Quality Monitoring in the United States.* Technical Appendixes. Intergovernmental Task Force on Monitoring Water Quality 1995.

13. *Guidance for State Water Monitoring and Wasteload Allocation Programs.* USEPA 1985.

14. *Guidelines for Evaluation of Agricultural Nonpoint Source Water Quality Projects*. USEPA 1981.

A.2.2 Guidances for Stream and River Monitoring

15. *Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska.* MacDonald, Smart and Wissmar 1991.

16. *Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management of Western Rangeland Streams.* USEPA 1993.

17. *Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish.* USEPA 1989.

18. *An Improved Biotic Index of Organic Stream Pollution*. Hilsenhoff 1987.

19. *Using the Index of Biotic Integrity (IBI) to Measure Environmental Quality in Warmwater Streams of Wisconsin.* Lyons 1992.

20. *Evaluation Monitoring of Stream Habitat During Priority Watershed Projects.* Simonson and Lyons 1992.

21. *1996 Water Body Assessment Guidance: A Stream to Standards Process*. Idaho Division of Environmental Quality 1996.

22. *1996 Beneficial Use Reconnaissance Project Workplan.* Idaho Division of Environmental Quality 1996.

23. *Handbook: Stream Sampling for Waste Load Allocation Applications.* USEPA 1986.

24. *Evaluation Monitoring of Stream Fish Communities During Priority Watershed Projects.* Simonson and Lyons 1992.

25. *Techniques for Detecting Effects of Urban and Rural Land-Use Practices on Stream-Water Chemistry in Selected Watersheds in Texas, Minnesota, and Illinois*. Walker 1993.

A.2.3 Guidances for Lake and Reservoir Monitoring

26. *Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analyses*. Volumes I-III. USEPA 1983-1984.

27. *Volunteer Lake Monitoring: A Methods Manual.* USEPA 1991.

28. *Statistical Methods for the Analysis of Lake Water Quality Trends.* USEPA 1993.

29. *Monitoring Lake and Reservoir Restoration.* USEPA 1990.

A.2.4 Guidances for Watershed Monitoring

30. *Monitoring Primer for Range Watersheds.* Bedill and Buckhouse Draft.

31. *Seminar Publication: The National Rural Clean Water Program Symposium. 10 years of controlling agricultural nonpoint source pollution: The RCWP experience*. USEPA 1992.

32. *Watershed Monitoring Manual.* Kansas Biological Survey 1993.

A.2.5 Guidances for Ground Water Monitoring

33. *A Review of Methods for Assessing Nonpoint Source Contaminated Ground-Water Discharge to Surface Water.* USEPA 1991.

34. *Ground Water Monitoring: A Guide to Monitoring for Agricultural Nonpoint Source Pollution Projects.* Goodman, German, and Bishoff 1995.

35. *Response to Ground Water Contaminants Detected through Idaho's Statewide Ambient Ground Water Quality Monitoring Program*. Idaho Department of Health and Welfare 1995.

A.2.6 Guidances for Biological Monitoring

36. *Fish Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters.* USEPA 1993.

37. *Bioaccumulation Monitoring Guidance: Selection of Target Species and Review of Available Bioaccumulation Data.* Volume I. USEPA 1987.

38. *Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents*. USEPA 1973.

A.2.7 Program-specific Monitoring Guidances

39. *Watershed Monitoring and Reporting for Section 319 National Monitoring Program Projects.* USEPA 1991.

40. *NPDES Storm Water Sampling Guidance Document.* USEPA 1992.

41. *Monitoring Guidance for the National Estuary Program.* USEPA 1991.

42. *Water Quality Standards Handbook.* USEPA 1983.

43. *Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document*. USEPA 1989.

44. *Environmental Monitoring and Assessment Program: Ecological Indicators.* USEPA 1990.

45. *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document.* USEPA 1986.

46. *Summary of U.S. EPA-Approved Methods, Standard Methods, and Other Guidance for 301(h) Monitoring Variables*. USEPA 1985.

47. *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities - Interim Final Guidance*. USEPA 1989.

48. *CWA Section 403: Procedural and Monitoring Guidance*. USEPA 1994.

49. *Methods for Collecting Benthic Invertebrate Samples as Part of the National Water Quality Assessment Program.* Cuffney, Gurtz, and Meador 1993.

50. *Methods for Collecting Algal Samples as Part of the National Water Quality Assessment Program.* Porter, Cuffney, Gurtz, and Meador 1993.

51. *Methods for Characterizing Stream Habitat as Part of the National Water Quality Assessment Program.* Meador, Hupp, Cuffney, and Gurtz 1993.

52. *Guidelines for the Processing and Quality Assurance of Benthic Invertebrate Samples Collected as Part of the National Water Quality Assessment Program.* Cuffney, Gurtz, and Meador 1993.

53. *Methods for Sampling Fish Communities as a Part of the National Water Quality Assessment Program.* Meador, Cuffney, and Gurtz. 1993.

54. *Guidelines for Studies of Contaminants in Biological Tissues for the National Water Quality Assessment Program.* Crawford and Luoma 1994.

A.3 GUIDANCE REVIEWS

A.3.1 General Monitoring Guidances and References

1. *National Handbook on Water Quality Monitoring*. USDA-NRCS 1996.

REFERENCE: USDA-NRCS. 1996. *National Handbook on Water Quality Monitoring*. U.S. Department of Agriculture, Natural Resources Conservation Service. December.

CONTENTS: Water quality problem; Objectives; Statistical designs; Scale of study; Variable selection; Sample type; Sampling location; Sampling frequency and duration; Station type; Sample collection and analysis; Land use and management monitoring; Data management.

MAIN FOCUS: Primarily useful for designing a monitoring program. Thoroughly discusses all aspects of monitoring program design (site selection, parameter selection, sampling program design) with numerous examples and illustrations to help the reader determine what is most appropriate for particular applications.

This document describes methods for monitoring water quality responses to land use, land management activities, and conservation practices in streams, lakes, and ground water. It is intended to be a comprehensive guidance for water quality managers who have little experience in monitoring study design and implementation. The many purposes that monitoring studies can serve are discussed to help water quality managers define the scope of their monitoring programs. Examples of programs meant to serve the different purposes are included.

Specific guidance is provided on designing a monitoring study, setting up a monitoring station, and analyzing water quality data. Worksheets are provided to facilitate rapid and complete monitoring study design. The document contains 12 chapters, each of which covers a specific step of monitoring study design: (1) define the water quality problem, (2) define the monitoring objectives, (3) describe statistical design, (4) determine the study scale, (5) select water quality variables, (6) select sample type, (7) determine sampling locations, (8) determine sampling frequency and duration,(9) design station type, (10) describe sample collection and analysis methods, (11) describe land use monitoring, and (12) describe data management.

2. *Water Quality Indicators Guide*. USDA-NRCS.

REFERENCE: USDA-NRCS. 1997. *Water Quality Indicators Guide*. U.S. Department of Agriculture, Natural Resources Conservation Service.

CONTENTS: Pollution related to agriculture; Water quality field analysis; Ecology of freshwater streams; Sediment; Nutrients; Pesticides; Animal Wastes; Salts. Appendices: Water quality procedures; Aquatic organisms; Glossary; Conservation and best management practices; Field sheets.

MAIN FOCUS: Field analysis of water pollution. Indicators for water pollution due to sediment, nutrients, pesticides, animal wastes, and salts are explained and field sheets are provided for tabulating water quality conditions.

The core of the *Water Quality Indicators Guide* is the field sheets and list of associated practices to remedy or abate agricultural nonpoint source pollution. The field sheets are arranged in matrix format

with environmental indicators given for sediment, animal wastes, nutrients, pesticides, and salts. Each indicator is divided into descriptions of the environment from excellent to poor, and each description is given a weighted numerical ranking. The user matches the individual description with what is observed in the water or on the land. By totaling the individual rankings, a score is obtained indicating the potential for agricultural nonpoint source problems. Practices can be selected from the list to alleviate problem situations. *(From document preface.)*

3. *The Nonpoint Source Manager's Guide to Water Quality and Land Treatment Monitoring*. Coffey, Spooner, and Smolen 1993.

REFERENCE: Coffey, S.W., J. Spooner, and M.D. Smolen. 1993. *The Nonpoint Source Manager's Guide to Land Treatment and Water Quality Monitoring*. NCSU Water Quality Group, Department of Biological and Agricultural Engineering, North Carolina State University, Raleigh, North Carolina.

CONTENTS: Overview of monitoring program; Management objectives and problem development; Monitoring program objectives; Monitoring program design; Data collection; Data analysis; Program evaluation.

MAIN FOCUS: Specifically addresses monitoring to track land treatments. Distinguishes between two levels of monitoring: Level I—basic, low-cost monitoring, and Level II—more intensive and comprehensive monitoring, at higher cost. Water quality and land treatment monitoring parameters are discussed separately for each level of monitoring.

This guide discusses the objectives and design of monitoring program used to evaluate present conditions, identify water quality problems, detect trends and impacts, and document water quality improvements associated with the implementation of land treatments. Variations in monitoring program objectives and designs to make them appropriate for streams, lakes, wetlands, and reservoirs are indicated. Two levels of detail, applicable to different monitoring objectives, are discussed separately for each of three types of monitoring programs: land use and land treatment monitoring, water quality monitoring, and loading rate monitoring. For each level of detail and each type of monitoring, appropriate biological, habitat, physical, and chemical variables are discussed.

A chapter on the design of monitoring programs emphasizes the importance of monitoring both land treatments and water quality to provide feedback on the impact of land management activities on water quality. Guidance on the use of existing data in monitoring program design is provided, and estimated costs for some procedures are included to help water quality managers estimate monitoring program budgets. Only brief discussions of data collection and analysis and program evaluation are presented. While this guidance primarily addresses agricultural land treatments, it is equally applicable to designing and implementing programs to monitor the effects of other types of land treatments, or general status and trend monitoring programs.

4. *Coordinated Nonpoint Source Water Quality Monitoring Program for Idaho*. Idaho Department of Health and Welfare 1990.

The document serves as a guide for a coordinated statewide monitoring program established in Idaho. It describes basin and watershed trend monitoring, beneficial use monitoring, and best management practice effectiveness monitoring. The three main nonpoint source activities that occur in Idaho—agriculture, forestry, and mining—are addressed by the statewide monitoring program and in the guide. For each of these activities, there is an introduction and objectives section, a description of the current program, and a

description of the recommended program. The monitoring program described in the guide addresses trends in major river basins and watersheds, beneficial use support status, and best management practice effectiveness. The guide also includes a listing of appropriate variables and protocols and a checklist of major items to be included in a nonpoint source water quality monitoring plan. [From document abstract]

REFERENCE: Clark, W.H. 1990. *Coordinated nonpoint source water quality monitoring program for Idaho*. Idaho Department of Health and Welfare, Division of Environmental Quality, Boise, Idaho. January.

CONTENTS: Introduction; Program development; Interagency monitoring responsibilities; Surface water quality program; Monitoring program implementation; Summary. Appendices (partial listing): Idaho monitoring sampling site listing, suggested monitoring parameters and protocols, and a monitoring plan checklist.

MAIN FOCUS: Statewide, integrated nonpoint source monitoring program for Idaho, addressing monitoring for agriculture, forestry, and mining.

5. *Water Quality Monitoring for the Clean Water Partnership. A Guidance Document*. Clean Water Partnership 1989.

REFERENCE: Clean Water Partnership. 1989. *Water Quality Monitoring for the Clean Water Partnership. A Guidance Document*. Minnesota Pollution Control Agency, Division of Water Quality. March.

CONTENTS: Purpose; Steps in developing a monitoring plan; Water quality parameters; Sampling site selection; Sampling strategies; Hydrology; Quality assurance/quality control.

MAIN FOCUS: Brief discussion of each monitoring parameter covering reason for its measurement, considerations for measuring the parameter, and sampling and analysis techniques.

This guidance covers all of the technical steps in developing and implementing monitoring programs for the evaluation of the effect of projects on water quality. Brief descriptions of each of the parameters to be monitored constitute most of the document. The monitoring program described is one that meets the requirements for Clean Water Partnership projects.

6. *Evaluating the Effectiveness of Forestry Best Management Practices in Meeting Water Quality Goals or Standards*. Dissmeyer 1994.

This manual is intended to assist managers and staff in developing water quality monitoring plans to evaluate the effectiveness of forestry BMPs in meeting water quality goals or standards for streams, including chemical, physical, biological, and habitat integrity. The focus is on monitoring project design and parameters and methods selection. The methods discussed in the document are appropriate for fourth order streams and smaller. Monitoring project design is discussed with the intention of separating the NPS impact of management activities from other NPS impacts. The document also addresses assessments of how long BMPs remain effective and which BMPs best protect water quality. Effectiveness monitoring is separated into four levels, depending on program needs. Monitoring methods for chemical, physical, biological, and habitat integrity are recommended to achieve each of the four monitoring levels. Generally, the reader is referred to the original literature or to other documents for procedural details of the monitoring methods, and this guide serves as a manual for monitoring program design.

REFERENCE: Dissmeyer, G.E. 1994. *Evaluating the Effectiveness of Forestry Best Management Practices in Meeting Water Quality Goals or Standards*. USDA Forest Service, Southern Region, Atlanta, Georgia. Miscellaneous Publication 1520. June.

CONTENTS: Planning monitoring projects; Quality assurance/quality control; Statistical considerations; Selecting the appropriate BMP effectiveness monitoring level; Monitoring methods; Deciding on BMP effectiveness: Some case histories.

MAIN FOCUS: Discussion of four levels of monitoring for different monitoring program objectives. Focuses on monitoring program design for determination of BMP effectiveness, management activity water quality impact, choice of BMPs for best water quality protection, and longevity of BMP effectiveness. Discussions of numerous monitoring protocols, with references to detailed descriptions for further information.

7. *Designing Effective Nonpoint Source Water Quality Monitoring Programs.* Maas 1989.

REFERENCE: Maas, R.P. 1989. *Designing Effective Nonpoint Source Water Quality Monitoring Programs*. Prepared for the Tennessee Valley Authority. November.

CONTENTS: I. General guidance for developing nonpoint source monitoring programs: Background; Purposes and objectives of water quality monitoring in NPS projects; Source inventories; Water sampling in NPS control projects; NPS water quality monitoring designs; Biological monitoring; Using preliminary data to get the most from your water quality monitoring program; Determining the minimum detectable change in water quality required to be observable from an NPS water quality monitoring program; Matching purposes and design of nonpoint source water quality monitoring programs; II. Case study: Oostanaula Creek, Tennessee.

MAIN FOCUS: Focuses primarily on monitoring program design for documenting the benefit of NPS control programs; Provides details (i.e., monitoring program design, statistical analyses) about time-trend and paired watershed designs; Includes a case study of implementing a cost-effective NPS monitoring program.

The purpose of this document is to provide guidance to those involved in NPS pollution control in designing and carrying out successful and cost-efficient water quality monitoring programs. It is intended as a technical document to provide NPS monitoring professionals with the necessary resource materials to make informed decisions regarding the design of water quality monitoring programs. It should also provide NPS program managers with sufficient background to evaluate technical decisions on NPS monitoring strategies for their consistency with an overall purpose and their probability of documenting water quality improvement. This document focuses primarily on experience gained through state and federal agricultural and urban NPS projects, such as the Model Implementation Program, initiated in 1978, and the Rural Clean Water Program, initiated in 1980. (from author's preface)

A particularly useful application of NPS monitoring information is to document the beneficial effect of an NPS control program on water quality. This, however, can be a particularly difficult monitoring objective to fulfill. This document examines monitoring design characteristics that maximize the ability to achieve this objective.

8. *Volunteer Estuary Monitoring: A Methods Manual*. USEPA 1993.

REFERENCE: USEPA. 1993. *Volunteer Estuary Monitoring: A Methods Manual*. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 842-B-93-004. December.

CONTENTS: Our troubled estuaries; Setting the stage; Monitoring dissolved oxygen; Monitoring nutrients and phytoplankton; Monitoring submerged aquatic vegetation; Monitoring bacteria; Monitoring other estuarine conditions; Training volunteers; Presenting monitoring results; Appendices.

MAIN FOCUS: Clearly written, intended to serve a lay audience. Step-by-step descriptions of common estuary monitoring methods.

This manual is meant to be a companion to three other EPA documents: *Volunteer Water Monitoring: A Guide for State Managers*, *Volunteer Lake Monitoring: A Methods Manual*, and *Volunteer Stream Monitoring: A Methods Manual*. The manual reviews those water quality parameters considered most important to monitor to determine an estuary's water quality: dissolved oxygen, bacteria, nutrients, phytoplankton, and submerged aquatic vegetation. Each chapter discusses why it is important to monitor the particular parameter, the role of the parameter in estuarine ecology, and sampling equipment for taking measurements of the parameter. Methods for sampling the parameter are set out in easy-to-follow steps. Two introductory chapters discuss the state of the Nation's estuaries, basic estuarine ecology, basic monitoring equipment, and gross conditions to note while monitoring, such as temperature and shoreline condition. Other chapters discuss volunteer training, the importance of credible data, and data presentation techniques. Supply houses are listed in one appendix, and quality assurance is addressed in another.

9. *Volunteer Water Monitoring: A Guide for State Managers*. USEPA 1990.

REFERENCE: USEPA. 1990. *Volunteer Water Monitoring: A Guide for State Managers*. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 440/4-90-010.

CONTENTS: Volunteers in water monitoring; Planning a volunteer monitoring program; Implementing a volunteer monitoring program; Providing credible information; Costs and funding. Appendix: Descriptions of five successful programs.

MAIN FOCUS: A guide to the administrative details of a volunteer monitoring program, including training volunteers, funding, program design, and media relationships. Presentations of volunteer monitoring programs in the appendix provide good examples of program implementation to meet differing needs and to deal with different local and state requirements. State contacts are provided.

This guide is directed toward those contemplating setting up a volunteer monitoring program. Nearly every aspect of creating a successful monitoring program is discussed, including attracting volunteers, keeping volunteers interested and motivated, finding funding sources, quality assurance and quality control, and ensuring that the collected data are put to use. The techniques and methods of monitoring are discussed in other manuals (e.g., *Volunteer Lake Monitoring: A Methods Manual*).

Descriptions of five state volunteer monitoring programs are provided: Illinois, Kentucky, New York, Ohio, and the Chesapeake Bay. Each discussion provides details of program objectives, how volunteers

were recruited and trained, sampling protocols, data management, program administration, volunteer recognition, and expenses and funding. State contact names, addresses, and phone numbers are provided for each program.

10. *The Volunteer Monitor*. Rhode Island Sea Grant.

REFERENCE: *The Volunteer Monitor*. Published by the Coastal Resources Center, the University of Rhode Island, Rhode Island Sea Grant Program, Narragansett, Rhode Island.

CONTENTS: Example issue content: Special topic: biological monitoring; Monitoring groups need a national association; EPA Lakes Methods manual; Wetlands field guide; Lake monitoring network; Technical tips; Doing your own lab analysis for fecal coliform; Monitoring aquatic plants; Monitoring diseased eelgrass; Local bank sponsors River Rescue; Third National Volunteer Monitoring Conference set.

MAIN FOCUS: Typically provides information on monitoring programs throughout the country, new publications, materials and technical methods, contacts for equipment supplies, school programs, and information on monitoring particular plants or animals.

The Volunteer Monitor is a newsletter published by Rhode Island Sea Grant that is devoted entirely to topics related to volunteer monitoring. Issues contain articles on a diversity of topics, including chemical, physical, and biological monitoring, reviews of documents related to monitoring, EPA activities, monitoring conferences, monitoring associations, equipment and methods, data collection and analysis, public education, and technology transfer. Information on purchasing monitoring supplies and articles of special interest, such as on methods to monitor particular species or habitats, are regularly published.

11. *The Strategy for Improving Water-Quality Monitoring in the United States*. Intergovernmental Task Force on Monitoring Water Quality 1995.

REFERENCE: ITFM. 1995. *The Strategy for Improving Water-Quality Monitoring in the United States*. Final report of the Intergovernmental Task Force on Monitoring Water Quality. Intergovernmental Task Force on Monitoring Water Quality. February.

CONTENTS: Major conclusions and recommendations; Summary; General intent; Background; Water quality questions; Nationwide strategy for improving water quality monitoring; Implementation; Initial agency actions to improve monitoring; Conclusion.

MAIN FOCUS: Recommends a strategy for nationwide water quality monitoring and technical monitoring improvements to support sound water quality decision-making at all levels of government and in the private sector.

The Intergovernmental Task Force on Monitoring Water Quality was established to address a need for greater coordination among agencies collecting water-quality information to make that information more meaningful to all users. This is the final report of the ITFM. It describes the strategy of the ITFM for nationwide water quality monitoring and its implementation. Highlights of the strategy and recommendations, discussed in detail in the final report and technical appendixes, include a focus on goal-oriented monitoring and the use of indicators; gathering and using existing information; ensuring institutional collaboration; striving for methods comparability; improving information automation, accessibility, and utility; adhering to quality assurance and quality control protocols; evaluating

monitoring activities; identifying needs for research and development; promotion of training; and provision of adequate funding.

12. *The Strategy for Improving Water-Quality Monitoring in the United States. Technical Appendixes.* Intergovernmental Task Force on Monitoring Water Quality 1995.

REFERENCE: ITFM. 1995. *The Strategy for Improving Water-Quality Monitoring in the United States. Technical Appendixes*. Final report of the Intergovernmental Task Force on Monitoring Water Quality. Intergovernmental Task Force on Monitoring Water Quality. February.

CONTENTS: Glossary; Framework for a water-quality monitoring program; Terms of reference—National Water-quality Monitoring Council; Indicators for meeting management objectives—summary and rationale; Indicator selection criteria; Ecoregions, reference conditions, and index calibration; Multimetric approach for describing ecological conditions; Terms of reference—Interagency Methods and Data Comparability Board; Data comparability and performance-based methods policy paper—comparability of data-collection methods; Target audiences, monitoring objectives, and format considerations for reporting water-quality information; Annotated bibliography of selected outstanding water-quality reports; Ground water quality monitoring framework; Date elements glossary; Evaluation of a performance-based methods system approach to field and prelaboratory methods; Performance-based methods system for biological collection methods—A framework for examining method comparability.

MAIN FOCUS: Discussions of numerous technical points related to the national monitoring program, including indicators, ecoregions, and multimetrics. Provides useful charts and graphs related to these topics.

This companion document to the ITFM 1995 final report provides detailed discussions of the more technical aspects of the national monitoring program. In addition, general information on monitoring programs, such as program objectives and design, are discussed in the context of the national program. Numerous tables related to the technical topics discussed consolidate much information contained in many other technical monitoring documents in a single place.

13. *Guidance for State Water Monitoring and Wasteload Allocation Programs*. USEPA 1985.

REFERENCE: U.S. EPA. 1985. *Guidance for State Water Monitoring and Wasteload Allocation Programs*. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington, DC. EPA 440/4-85-031. October.

CONTENTS: Overview of water quality program monitoring; Monitoring for water quality-based controls; Monitoring for compliance and enforcement; Water quality assessments; Quality assurance; Data reporting; Total maximum daily loads and wasteload allocations.

MAIN FOCUS: Provides a general overview of state water quality monitoring responsibilities under the Clean Water Act (pre-1987).

This guidance is oriented toward program management and does not contain extensive technical information on monitoring programs. The guidance is intended to be used by states and EPA regional offices for developing the monitoring and wasteload allocation portions of annual state 106 and 205(j) work programs. Monitoring and wasteload allocation activities are defined in accordance with EPA regulations. Two principal areas are covered by the guidance. The first is an outline of the objectives of the water monitoring program, and the second is a description of the process for calculating total

maximum daily loads (TMDLs), waste load allocations for point sources, and load allocations for nonpoint sources of pollution.

Separate chapters of the guidance address different aspects of state programs (conducting water quality assessments, developing water quality-based controls, and assessing compliance), and for each of these program aspects the guidance discusses the types of data needed, who is responsible for doing the work, the methods to be used, data reporting requirements, parameters, and uses of the data. References to technical guidance and sample program checklists are provided in an appendix.

14. *Guidelines for Evaluation of Agricultural Nonpoint Source Water Quality Projects*. USEPA 1981.

REFERENCE: USEPA. 1981. *Guidelines for Evaluation of Agricultural Nonpoint Source Water Quality Projects*. U.S. Environmental Protection Agency. L.R. Shuyler, EPA project officer. Prepared under the Rural Nonpoint Source Control Water Quality Evaluation and Technical Assistance project.

CONTENTS: Evaluation procedures for nonpoint source control measures; Evaluation and sampling needs; Streams; Lakes; Ground water; Socioeconomic evaluation.

MAIN FOCUS: The sections on streams and lakes contain an assessment of evaluation alternatives and specific monitoring recommendations relevant to the type of receiving water, including guidance for identification of impacted beneficial uses. The important characteristics of each receiving water type that should be monitored are discussed.

This guidance was developed under EPA's Rural Nonpoint Source Control Water Quality Evaluation and Technical Assistance project as a joint effort of EPA and USDA. It is intended to provide basic guidelines for measuring water quality changes and estimating socioeconomic impacts resulting from NPS pollution control programs. Monitoring requirements for a basic, level I monitoring program are discussed, as well as more intensive requirements for a detailed monitoring program. The guidance provided in this document is basic in the sense that the parameters that should be measured for minimum level I and level II assessments are mentioned and discussed briefly, but no guidance for taking measurements, identifying monitoring stations, designing a monitoring program, or analyzing results is provided. Emphasis is placed on the collection of historical data prior to monitoring and on monitoring physical, chemical, and biological characteristics that will indicate present condition and changes in those characteristics due to BMP implementation.

A separate section on socioeconomic evaluation of NPS pollution control programs is provided. Questions of impacts on farmer income, overall project value with respect to alternative community needs, and choices of alternative environmental projects are mentioned as important considerations prior to the implementation of an NPS pollution control project. Two levels of socioeconomic evaluations are discussed. A level I evaluation considers the effects of an NPS pollution control project on land use, crop production, income, pollution control effectiveness, and project efficiency in a cost/benefit sense. A level II evaluation includes the elements of a level I evaluation as well as an estimation of community and off-farm impacts and an evaluation of alternative options. Tables at the end of the paper summarize the recommendations presented in the text.

A.3.2 Guidances for Stream and River Monitoring

15. *Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska.* MacDonald, Smart, and Wissmar 1991.

REFERENCE: MacDonald, L.H., A.W. Smart, and R.C. Wissmar. 1991. *Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska*. U.S. Environmental Protection Agency, Region 10, Water Division, Seattle, Washington. EPA/910/9-91-001. May.

CONTENTS: Part I: Context and structure of monitoring projects; Statistical considerations in water quality monitoring; Principles of developing a monitoring plan and selecting the monitoring parameters; parameter recommendations and interactions. Part II: Physical and chemical constituents; Changes in flow; sediment; Channel characteristics; Riparian monitoring; Aquatic organisms.

MAIN FOCUS: Provides a good review of the importance of proper statistical design in a monitoring program. Tabulates monitoring parameters according to their usefulness for monitoring different land treatments. Specific to monitoring stream conditions in the Pacific Northwest and Alaska.

The focus of these guidelines is on monitoring water quality in streams, and it does not directly address monitoring in lakes, reservoirs, or other downstream areas. The discussions are also limited to conditions in the Pacific Northwest and Alaska, which reduces the scope of conditions and activities considered in the document. However, the information provided on monitoring objectives and monitoring parameters is generally applicable. Information on monitoring to detect the water quality impacts of grazing, mining, and recreation is also provided because these activities occur on or near lands where forestry activities are conducted and it can be difficult to separate the water quality impacts of these activities from those of forestry operations.

The document has two parts. Part 1 discusses seven purposes of monitoring, legal requirements for NPS pollution monitoring, statistical considerations in water quality monitoring, monitoring plan development, and the selection of monitoring parameters. Monitoring parameters are recommended for different forestry-related activities (e.g., forest harvest, road construction). Part 2 is a comprehensive discussion of individual monitoring parameters and is intended to facilitate the selection of the most appropriate monitoring parameters for specific monitoring objectives. This is not a technical guidance on sampling procedures or statistical analyses used for monitoring programs, but rather a comprehensive discussion of the various elements of a monitoring program to help water resource or forestry operations managers make informed decisions concerning monitoring programs. References are provided to direct the reader to the appropriate technical guidance where needed.

16. *Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management of Western Rangeland Streams*. USEPA 1993.

This document describes a monitoring system to assess the impacts of grazing on water quality in streams of the western United States and protocols used to assess changes in water quality that result from stream restoration projects. Protocols that are easy to use and cost-effective (i.e., have reduced sampling frequency, minimized need for specialized equipment, and a reduced requirement for laboratory analyses) were selected. The document focuses on monitoring attributes of the stream channel, stream bank, and streamside vegetation that are important to the support of aquatic life and that are impacted by grazing. A

discussion of the impacts of grazing on stream ecosystems provides a basis for selecting monitoring parameters, and a procedure to develop a monitoring plan is recommended. Methods to stratify and classify stream reaches based on stream type, dominant soils, and riparian vegetation communities are described, and they provide a basis for selecting monitoring sites and reference areas. Forms for recording data and a list of equipment needed for each protocol are provided.

Monitoring methods that are commonly used to assess the effects of grazing on water quality are described, and the attributes of each are tabulated. The advantages and disadvantages of the methods are described and tabulated for ease of comparison, and recommendations for specific protocols are made based on ease of use and cost-effectiveness. These recommended protocols, including data collection and analysis procedures, are then thoroughly described. The recommended protocols are stream temperature and shade, nutrients, bacterial indicators, stream channel morphology, streambank stability, substrate fine sediment, pool quality, and streamside vegetation. A list of references pertaining to each protocol is provided at the end of the discussion of each one. The usefulness of the recommended protocols is not limited to monitoring the impacts of grazing, and the reader should find the discussions of the protocols valuable if the same protocols are being considered for monitoring the water quality effects of other land use activities. Other references should be consulted for specific guidance on sampling and statistical analysis of data.

REFERENCE: USEPA. 1993. *Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management of Western Rangeland Streams*. U.S. Environmental Protection Agency, Region 10, Water Division, Surface Water Branch. EPA 910/R-93-017. October.

CONTENTS: Impacts of grazing on water quality and beneficial uses; Monitoring plan procedure; Stratification, reconnaissance, and classification of rangeland riverine riparian areas; Evaluation/recommendation of monitoring methods: Stream temperature and shade; Nutrients; Bacterial indicators; Stream channel morphology; Streambank stability; Substrate fine sediment; Pool quality; Streamside vegetation.

MAIN FOCUS: Describes a methodology to classify a stream and riparian vegetation prior to selecting monitoring sites. Provides tables of monitoring parameter attributes (sampling frequency, collection time necessary, equipment requirements, lab costs, level of expertise needed). Detailed information on recommended methods is provided.

17. *Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish*. USEPA 1989.

This is a comprehensive technical reference for bioassessment procedures for streams and rivers. Three macroinvertebrate protocols and two fish protocols are presented. The macroinvertebrate protocols were tested in wadable freshwater streams, though they should be applicable to large freshwater rivers as well. They were developed by consolidating various procedures in use by a variety of state water quality agencies, and they require levels of effort ranging from fairly simple to rigorous. The fish protocols were validated in freshwater streams and large rivers and are therefore equally applicable to both. They were developed based on previous work by other researchers and on standard fish population assessment models.

The document contains an introduction to the biomonitoring approach of detecting aquatic life impairments and estimating their severity. Procedures for assessing the habitat where the sampling is done are explained, and the physical and chemical parameters relevant to biological survey data

interpretation are discussed. Complete instructions for conducting benthic biosurveys and fish surveys are provided, laboratory methods and data analysis techniques are explained, and quality assurance and quality control are addressed. Field data forms and guidance for their use are provided.

REFERENCE: U.S. EPA. 1989. *Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish*. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA/440/4-89/001. May.

CONTENTS: The concept of biomonitoring; Overview of protocols and summary of components; Quality assurance/quality control; Habitat assessment and physicochemical parameters; Benthic macroinvertebrate biosurvey and data analysis; Fish biosurvey and data analysis; Integration of habitat, water quality, and biosurvey data. Appendices: Guidance for use of field and laboratory data sheets; Rapid bioassessment subsampling methods for benthic protocols; Family and species-level macroinvertebrate tolerance classifications; Tolerance, trophic guilds, and origins of selected fish species.

MAIN FOCUS: Provides both an introduction to the concept of biomonitoring and detailed methods sections for conducting rapid bioassessment protocols. Sample data sheets for all protocols are provided, and data analysis and interpretation is thoroughly discussed.

18. *An Improved Biotic Index of Organic Stream Pollution*. Hilsenhoff 1987.

REFERENCE: Hilsenhoff, W.L. 1987. An Improved Biotic Index of Organic Stream Pollution. *Great Lakes Entomologist* 20:31-39.

CONTENTS: Abstract; Reassignment of tolerance values; Identification; Collection and evaluation of samples; Literature cited; Appendix 1: Tolerance values for stream arthropods.

MAIN FOCUS: Provides a discussion of identification problems specific to insect orders. Includes a detailed discussion of proper stream arthropod collection techniques. An appendix provides revised tolerance values for stream arthropods.

Hilsenhoff introduced a biotic index for evaluating the water quality of streams in 1977 and offers improvements to it in this paper. The initial index assigned tolerance values of 0-5 to species, but after evaluation of over 1,000 samples the index has been revised to accommodate tolerance values of 0-10 to provide greater precision. Tolerance values of species are provided in an appendix. Some orders of arthropods are difficult to identify, and the problems associated with those orders are discussed. A revised procedure for collecting, sorting, and evaluating samples using the biotic index presented in the paper is provided.

19. *Using the Index of Biotic Integrity (IBI) to Measure Environmental Quality in Warmwater Streams of Wisconsin*. Lyons 1992.

This paper summarizes the results of a 4-year fish collection and data analysis effort aimed at developing a version of the IBI for warmwater Wisconsin streams. The paper is designed primarily as a "how to" manual and therefore contains little discussion of the principles of the IBI. Discussion focuses on collection of fish samples for analysis, and analysis and interpretation of the data. Maximum Species Richness (MSR) plots for data interpretation are provided.

Because of the similarity in stream characteristics and fish fauna between Wisconsin and parts of adjacent states, the Wisconsin version of the IBI described in this paper should be useful in southeastern and northeastern Minnesota, the entire Upper Peninsula and the northern Lower Peninsula of Michigan, extreme northwestern Illinois, and extreme northeastern Iowa.

REFERENCE: Lyons, J. 1992. *Using the Index of Biotic Integrity (IBI) to Measure Environmental Quality in Warmwater Streams of Wisconsin.* U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. General Technical Report NC-149.

CONTENTS: General considerations; Applying the IBI in Wisconsin warmwater streams: Collecting and processing the field data; Analyzing the data; Interpreting IBI scores.

MAIN FOCUS: Complete discussion of data analysis. Provides Maximum Species Richness plots for data interpretation. Applicable to similar streams in nearby states.

20. *Evaluation Monitoring of Stream Habitat During Priority Watershed Projects*. Simonson and Lyons 1992.

REFERENCE: Simonson, T., and J. Lyons. 1992a. *Evaluation Monitoring of Stream Habitat During Priority Watershed Projects*. Wisconsin Department of Natural Resources. May.

CONTENTS: Station summary data sheet; Station map data sheet; Station flow data sheet; Transect data sheet; Appendix: Gear used for habitat sampling.

MAIN FOCUS: Each data element to be recorded is explained separately. Data recording forms are provided.

This paper describes all of the data elements to be recorded during evaluation phase monitoring of fish habitat for WDNR Priority Watershed Projects. The purpose of the monitoring is to document changes in fish communities and fish habitat that occur in streams where improved land use practices are implemented to reduce NPS pollution. The level of detail given for each data element make this paper a manual for conducting an evaluation, not just a discussion of data elements. Two sets of sample data entry sheets are provided, one blank and one filled out with example data. The gear needed to conduct an evaluation is described in an appendix, and the names and addresses of suppliers are provided.

21. *1996 Water Body Assessment Guidance: A Stream to Standards Process*. Idaho Division of Environmental Quality 1996.

The guidance presents the assessment method that Idaho uses to list water quality-limited water bodies and to designate beneficial uses. The guidance incorporates a beneficial use attainability designation process for unclassified waters. The method used by Idaho uses ecological indicators to make water quality assessments. The document is easy to follow, owing to its flow chart type of organization. In this manner, an assessment is broken down into many easily-answered questions.

REFERENCE: Idaho Division of Environmental Quality. 1996. *1996 water body assessment guidance: A stream to standards process*. Idaho Department of Health and Welfare, Division of Environmental Quality, Boise Idaho. August.

CONTENTS: Introduction; Water body initialization; Aquatic life beneficial uses status determinations; Recreational beneficial uses status determinations; Water supply beneficial uses status determinations; Wildlife habitat and aesthetics beneficial uses status determinations; Idaho water quality standards and wastewater treatment requirements narrative criteria; Criterion evaluation process; Beneficial use attainability; Beneficial uses status determinations appeals process; Listing water quality-limited water bodies. Appendices (partial listing): Macroinvertebrate biotic index; Habitat index; Reconnaissance index of biotic integrity; Index of biotic integrity; Algal biotic index; Water body assessment form; Water body assessment guidance assumptions.

MAIN FOCUS: An analytical tool for determining if a water body is or is not supporting a beneficial use.

22. *1996 Beneficial Use Reconnaissance Project Workplan.* Idaho Division of Environmental Quality 1996.

REFERENCE: Idaho Division of Environmental Quality. 1996. *1996 Beneficial Use Reconnaissance Project workplan*. Idaho Department of Health and Welfare, Division of Environmental Quality, Boise Idaho. May.

CONTENTS: Introduction: Beneficial uses, Purpose, Objectives, Scope, Rationale for stream selection; Methods: Stream site selection, Core parameters, Pilot investigations to validate procedures, Rationale for parameter selection and summary of procedures, Recommended procedure sequence for site evaluation; Quality assurance; Safety training and certification; Data analyses and interpretation; Appendices: Streams proposed for monitoring in 1996, Field equipment check list, Field forms, Audit forms.

MAIN FOCUS: Descriptive overview of IDDEQ's Beneficial Use Reconnaissance Project.

The workplan lists the parameters to monitor, with references for each method where detailed information on them can be obtained, and monitoring level-of-intensity information for each parameter. The quality assurance (QA) section summarizes the QA approach for the project and references QA manuals to be consulted for detailed information. The workplan is modified annually to incorporate changes in methods and protocol. This workplan is to be used as a guide for training stream monitoring field crews. It describes the Beneficial Use Reconnaissance Project, but is not a detailed "how-to" manual.

The protocols used by IDDEQ to measure water quality, beneficial use attainability, beneficial use status, and general stream health are described in it. The protocols are meant to provide a reconnaissance level screen of stream conditions, and as reconnaissance level protocols they are only intended to differentiate between impaired and non-impaired streams. The protocols are meant to be applicable to any wadable stream regardless of location in Idaho. Another objective of the protocols is to identify the principal measures that are likely to provide insight into stream ecology, biology, and water quality, and to determine their relationships to beneficial uses. Time constraints, staff limitations, and cost effectiveness were considered in selecting the protocols.

23. *Handbook: Stream Sampling for Waste Load Allocation Applications*. USEPA 1986.

REFERENCE: USEPA. 1986. *Handbook: Stream Sampling for Waste Load Allocation Applications*. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC. EPA/625/6-86/013. September.

CONTENTS: Sampling requirements for wasteload allocation modeling; Sampling requirements for conventional pollutants; Sampling requirements for toxic pollutants; Whole effluent approach; Example application.

MAIN FOCUS: Summarizes data requirements for modeling applications and discusses the applicability and advantages of numerous models. Flow charts for modeling approaches and parameter formulas are provided.

This report discusses sampling requirements in support of wasteload allocation studies in rivers and streams. Two approaches to wasteload allocation are addressed: the chemical-specific approach and the whole effluent approach. Numerical or analytical toxicant fate models are used to implement the chemical-specific approach. Modeling requirements and sampling guidelines are delineated for this method.

For the whole effluent approach, the method is summarized and then instream dye study requirements are presented. The report concludes with example applications of the chemical-specific approach for conventional and toxic pollutants.

This guidance does not discuss equipment requirements, personnel requirements, sample collection, stream characterization, or laboratory analytical techniques. The primary purpose of the document is to assist water quality specialists in designing stream surveys to support modeling applications for wasteload applications. The data collection process required to calibrate, verify, and apply models used for wasteload allocations to critical design conditions is described.

24. *Evaluation Monitoring of Stream Fish Communities During Priority Watershed Projects*. Simonson and Lyons 1992.

REFERENCE: Simonson, T., and J. Lyons. 1992b. *Evaluation Monitoring of Stream Fish Communities During Priority Watershed Projects*. Wisconsin Department of Natural Resources. May.

CONTENTS: Station summary data sheet; Catch summary data sheet; Individual fish data sheet.

MAIN FOCUS: Each data element to be recorded is explained separately. Data recording forms are provided.

This paper, the companion to Simonson and Lyons' paper *Evaluation Monitoring of Stream Habitat During Priority Watershed Projects*, describes the data elements to be recorded during evaluation phase monitoring of fish communities for WDNR Priority Watershed Projects. This paper is similar in content to that paper, except that only one set (blank) of data sheets is provided.

25. *Techniques for Detecting Effects of Urban and Rural Land-Use Practices on Stream-Water Chemistry in Selected Watersheds in Texas, Minnesota, and Illinois*. USGS 1993.

REFERENCE: Walker, J.F. 1993. *Techniques for Detecting Effects of Urban and Rural Land-Use Practices on Stream-Water Chemistry in Selected Watersheds in Texas, Minnesota, and Illinois*. U.S. Geological Survey and Wisconsin Department of Natural Resources. USGS Open-file Report 93-130.

CONTENTS: Techniques for detecting effects of land-use practices on water chemistry; Application of techniques to selected watersheds; Summary and conclusions.

MAIN FOCUS: Statistical techniques for the detection of effects of land-use practices on water chemistry are applied to selected watersheds. Alternative procedures for assessing the effects of land-use practices are compared.

There is little information available about the effectiveness of best management practices at the watershed scale. This report presents a discussion of several parametric and nonparametric statistical techniques for detecting changes in water-chemistry data. The use of storm load data is discussed as an alternative to using fixed-frequency instantaneous concentration data. Statistical techniques were applied to three urban watersheds in Texas and Minnesota and three rural watersheds in Illinois. For the urban watersheds, single- and paired-site data collection strategies were considered. For the rural watersheds, the selected techniques were found not to be effective at identifying changes. The use of regressions improved the ability to detect changes. (from author's abstract)

A.3.3 Guidances for Lake and Reservoir Monitoring

26. *Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analyses.* Volumes I-III. USEPA 1983-1984.

REFERENCE: USEPA. 1983. *Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analyses*. Volume I. U.S. Environmental Protection Agency, Office of Water, Washington, DC. November.

USEPA. 1984. *Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analyses*. Volume II: Estuarine systems. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 1984. *Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analyses*. Volume III: Lake systems. U.S. Environmental Protection Agency, Office of Water, Washington, DC. November.

CONTENTS: Volume I: Physical evaluations; Chemical evaluations; Biological evaluations; Interpretation. Volume II: Physical and chemical characteristics; Characteristics of plant and animal communities; Synthesis and interpretation. Volume III: Physical and chemical characteristics; Biological characteristics; Synthesis and interpretation.

MAIN FOCUS: A general discussion of conducting physical, chemical, and biological analyses of river and stream, estuarine, and lake systems.

These documents contain EPA guidance to assist states in implementing the revised Water Quality Standards Regulation that appeared in the *Federal Register* in November 1983. Consideration of the suitability of a waterbody for attaining a given use is an integral part of the water quality standards review and revision process. This guidance is intended to assist states in determining the uses currently being

achieved, the potential uses of the waterbodies, and the causes of any impairment of the uses. A framework for determining the attainable aquatic protection use is described, and parameters to be used to make the determinations mentioned above are provided. Methods and approaches that can be used by states for conducting use attainability analyses are discussed. Volume I discusses rivers and streams, Volume II discusses estuarine systems, and Volume III discusses lake systems.

27. *Volunteer Lake Monitoring: A Methods Manual*. USEPA 1991.

REFERENCE: USEPA. 1991. *Volunteer Lake Monitoring: A Methods Manual*. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 440/4-91-002. December.

CONTENTS: Focusing on a lake condition; Monitoring algae; Monitoring aquatic plants; Monitoring dissolved oxygen; Monitoring other lake conditions; Training citizen volunteers; Presenting monitoring results. Appendix: Scientific supply houses.

MAIN FOCUS: Specifically addresses lake monitoring. Provides step-by-step instructions for setting up and implementing a volunteer lake monitoring program. Sample data collection forms are provided, and a discussion on lake ecology provides background for volunteer monitors. Well-illustrated.

This manual presents specific information on volunteer lake water quality monitoring methods. It is intended for organizers of volunteer lake monitoring programs and for the volunteers who actually sample lake conditions. It summarizes the steps necessary to plan and manage a volunteer monitoring program, including setting general goals, identifying the uses and users of collected data, and establishing sound quality assurance procedures. The document concentrates special attention on three of the most common lake pollution problems: increased algal growth, increased growth of rooted aquatic plants, and lowered or fluctuating levels of dissolved oxygen. It also briefly discusses other lake pollution problems: sedimentation, turbidity, lake acidification, and bacteriological conditions. Appropriate parameters to monitor and specific steps for each selected monitoring method are identified, and example sampling forms are provided.

28. *Statistical Methods for the Analysis of Lake Water Quality Trends.* Reckhow, Kepford, and Hicks 1993.

REFERENCE: Reckhow, K.H., K. Kepford, and W.W. Hicks. 1993. *Statistical Methods for the Analysis of Lake Water Quality Trends.* U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 841-R-93-003. December.

CONTENTS: Basic statistics and statistical concepts—Descriptive statistics; Robustness, resistance, and influence; Hypothesis testing; Statistical methods for trend detection. Individual lake analysis—Summary statistics; Graphical analyses; Normality; Seasonality; Independence; Trend detection in total phosphorus; Total nitrogen; Conclusions; Regional and statewide lake analysis. Appendices—Basic descriptive statistics; Introduction to SAS macros; SAS tables; List of SAS programs and files on disk.

MAIN FOCUS: Guides lake program managers on the application and interpretation of methods of trend detection in lake water quality. Provides step-by-step descriptions of statistical methods, as well as graphs and figures demonstrating analyses.

This manual is a technical supplement to *The Lake and Reservoir Restoration Guidance Manual*. This document and the accompanying software in the SAS system present nonparametric statistical methods for trend assessment in water quality, emphasizing lakes. The purpose of the document is to provide lake program managers with guidance on the application and interpretation of methods for the detection of trends in lake water quality. This manual discusses basic statistical concepts and approaches in applied statistics that are relevant to trend detection, before introducing the procedures and tests. Numerous graphs and figures demonstrate analyses done with actual data.

29. *Monitoring Lake and Reservoir Restoration*. USEPA 1990.

REFERENCE: USEPA. 1990. *Monitoring Lake and Reservoir Restoration*. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 440/4-90-007. August.

CONTENTS: Planning the monitoring program; Monitoring methods; Watershed monitoring; In-lake restoration techniques and monitoring; A long-term monitoring protocol; Case study: Detection of trends and sampling strategy evaluations.

MAIN FOCUS: Three levels of watershed monitoring are discussed. Complete discussions of lake and reservoir restoration objectives and the methods used to achieve the objectives are provided.

This manual is a technical supplement to *The Lake and Reservoir Restoration Guidance Manual* (USEPA, 1988). It provides guidance for both design and implementation of a monitoring program by outlining specific standards for specific types of lake restoration and protection projects. It is intended to guide monitoring carried out under the Clean Lakes Program in connection with the Phase II or implementation portion of a lake restoration project. Phase I or diagnostic/feasibility monitoring is more exploratory in nature and more generic in terms of parameters used, and it is not directly addressed in this guidance. The primary users of this guidance are expected to be Regional EPA Clean Lakes project officers, state and local project managers, and project sponsors and consultants.

Procedures for performing in-lake sampling, measuring stream flow, handling and preserving samples, and analyzing data are described. Three levels of watershed monitoring are described: watershed inventories, limited stream monitoring, and comprehensive watershed monitoring. Control techniques for four lake restoration objectives are described. The four objectives are the control of nuisance algae, an increase in depth, the control of nuisance plants, and the mitigation of acidic conditions. Where appropriate, monitoring parameters for both during and after the treatments are tabulated and discussed. Formulas for the calculation of monitoring parameters are provided. Guidance is also provided for implementing a long-term monitoring protocol.

A.3.4 Guidances for Watershed Monitoring

30. *Monitoring Primer for Range Watersheds*. Bedill and Buckhouse Draft.

This short document provides a general introduction to monitoring in the context of rangeland management. Watersheds are defined, their characteristics and functions are described, and the rationale behind their being the unit for rangeland management and monitoring is discussed. The focus of the document is on monitoring riparian areas and vegetation, not upland areas or streams. A general discussion of the concepts and steps involved in designing and implementing a rangeland monitoring

program is provided. Detailed information on designing a monitoring program, selecting monitoring parameters and protocols, sampling procedures, and data analysis is not provided.

REFERENCE: Not available.

CONTENTS: Basis and rationale for monitoring in range watersheds; Water quality in the context of range watersheds; Some new concepts to go with the current ones; Environmental factors and range watersheds; Management of range watersheds which directly affects water quality; Monitoring methods and measurements.

MAIN FOCUS: Provides a good introduction to monitoring terms and concepts. Although the document is directed toward range monitoring, the terms and concepts are generally applicable to all monitoring.

31. *Seminar Publication: The National Rural Clean Water Program Symposium. 10 Years of Controlling Agricultural Nonpoint Source Pollution: The RCWP Experience*. USEPA 1992.

REFERENCE: USEPA. 1992. *Seminar Publication: The National Rural Clean Water Program Symposium. 10 Years of Controlling Agricultural Nonpoint Source Pollution: The RCWP Experience.* September 13-17, 1992. U.S. Environmental Protection Agency, Office of Research and Development, Office of Water, Washington, DC. EPA/625/R-92/006. August.

CONTENTS: Water quality and land treatment monitoring; Relating water quality to land treatment; Land treatment and operation and maintenance of BMPs; Project coordination and farmer participation; Institutional arrangements, program administration, and project spin-offs; Information and education; Socioeconomics, technology transfer, lessons learned; Research needs and future vision; Additional information.

MAIN FOCUS: Reports of hands-on experiences encountered during nonpoint source and watershed project implementation. Since the RCWP had projects in states from most regions of the United States, this document contains specific information relevant to a variety of circumstances.

This symposium proceedings is intended to provide guidance for state nonpoint source programs and local watershed projects. It is the result of 10 years of experience of the National Rural Clean Water Program, and the papers in this document address both the successes and difficulties experienced in the 21 projects that composed the program. The papers included in the proceedings were peer reviewed. Most of the papers address individual projects of the RCWP, and they provide valuable insights into the variety of approaches and solutions for addressing specific circumstances and obstacles that may be encountered during the implementation of a nonpoint source or watershed program. In this respect the information in this document goes beyond the general "how-to" information provided in most guidance documents.

32. *Watershed Monitoring Manual.* Kansas Biological Survey 1993.

The manual is a guide for field crews undertaking long-term watershed monitoring. The manual describes all field procedures and local laboratory procedures to be undertaken for the measurement of chemical, physical, and biological parameters. The manual is geared toward a specific project, but the procedures can serve as a guide for monitoring streams for other projects. Each section (on chemical, physical, and biological measurements) is presented as separate procedural descriptions of the various

tasks to be performed. Each procedure is presented with an objective statement, listing of necessary equipment, and detailed description of the sampling procedure to follow. Reference sections list the literature from which the procedures are taken. *[From document introduction]*

REFERENCE: Kansas Biological Survey. 1993. *Watershed monitoring manual*. Ecotoxicology Program, Kansas Biological Survey, University of Kansas, Lawrence, Kansas. July.

CONTENTS: Introduction and background information; Chemical measurements: Grab samples, *In situ* water quality analyses, Local water quality analyses; Physical measurements: Habitat, Stream discharge; Biological measurements: Macroinvertebrate, Fish, Drift sampling, Primary productivity; Biological laboratory procedures; Appendices: Preparation of equipment and supplies; Water quality glassware and plasticware washing procedure; Glass fiber filter preparation.

MAIN FOCUS: Detailed instructions of methods for stream monitoring.

A.3.5 Guidances for Ground Water Monitoring

33. *A Review of Methods for Assessing Nonpoint Source Contaminated Ground-Water Discharge to Surface Water*. USEPA 1991.

REFERENCE: USEPA. 1991. *A Review of Methods for Assessing Nonpoint Source Contaminated Ground-Water Discharge to Surface Water*. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 570/9-91-010. April.

CONTENTS: Methods for measuring or estimating nonpoint source contaminated ground-water discharge to surface water; The impact of nonpoint source contaminated ground-water discharge to surface water in water quality-limited water bodies: determining total maximum daily load and waste load allocations.

MAIN FOCUS: Each method is thoroughly described, including any limitations and assumptions in its use, the expertise needed to apply it, and data inputs and data outputs. A short evaluation of the method and relevant references with full citations are then provided.

This document is a summary of methods that have been applied to measure or estimate nonpoint-source-contaminated ground-water discharge to surface water. An overview of methods is presented, but this guidance is not a manual for employing the methods described. After the review of analytical methods, a separate chapter presents an overview of the total maximum daily load assessment and waste load allocation processes and discusses the applicability of the methods described. Some of the methods reviewed are the use of seepage meters, geophysical techniques, numerical models, and isotope methods.

An annotated bibliography is available as a companion volume to this report. The papers that provided the background for this guidance are referenced throughout and are abstracted in the annotated bibliography. Full citations for each of the background papers are provided in this report.

34. *Ground Water Monitoring: A Guide to Monitoring for Agricultural Nonpoint Source Pollution Projects.* Goodman, German, and Bishoff 1995.

REFERENCE: Goodman, J., D. German, and J. Bishoff. 1995. *Ground Water Monitoring: A Guide to Monitoring for Agricultural Nonpoint Source Pollution Projects.* Draft. February.

CONTENTS: Rural Clean Water Program background; Nonpoint source project process; Vadose zone monitoring. Ground water monitoring—Monitoring project planning; Monitoring system development; Monitoring system implementation; Quality assurance/quality control; Data management and evaluation; New developments in ground water monitoring. Ground water/surface water monitoring.

MAIN FOCUS: Geared mainly toward hydrologic systems and geologic regimes of the glaciated regions of the upper midwestern area of the United States. Includes detailed considerations and steps to take in nearly all of the content areas.

This document provides a usable "how to" handbook for designing and operating a ground water monitoring network for nonpoint source pollution control projects. It is the product of a comprehensive ground water monitoring and evaluation project that was conducted in the Oakwood Lakes-Poinsett area of east-central South Dakota under the Rural Clean Water Program (RCWP). This document is not intended to be an all-encompassing guidebook, but it does document the successes and failures in the South Dakota RCWP project and other RCWP projects that conducted ground water monitoring.

35. *Response to Ground Water Contaminants Detected through Idaho's Statewide Ambient Ground Water Quality Monitoring Program*. Idaho Department of Health and Welfare 1995.

REFERENCE: Cardwell, J. 1995. *Response to ground water contaminants detected through Idaho's statewide ambient ground water quality monitoring program*. Water Quality Monitoring Protocols - Report No. 9. Idaho Department of Health and Welfare, Division of Environmental Quality, Monitoring and Technical Support Bureau, Boise, Idaho. January.

CONTENTS: Introduction; Notification procedure; Protocol; Quality assurance project plans; Data management. Appendices (partial listing): Selected ground water quality information sources listing; Selected pollutants measured and their most commonly associated uses; Selected analytes measured and their most commonly associated uses.

MAIN FOCUS: Investigation and reporting protocols for reports of ground water contamination in Idaho.

This document provides guidance to the IDDEQ for response to ground water quality contaminant detections reported by the Idaho Statewide Ambient Ground Water Quality Monitoring Program. The objective of the protocol is to describe how IDDEQ can investigate a contaminant detected through statewide monitoring and to establish consistent guidance for the development of information to be provided to IDDEQ for the determination of an applicable response. A phased approach for characterizing the nature and extent of reported contamination is taken in the protocol, with separate phases to investigate whether the contaminant detected is associated with a known problem or existing project; persistent or non-persistent; isolated, localized, or regional; and whether it can be associated with a suspected source.

A.3.6 Guidances for Biological Monitoring

36. *Fish Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters*. USEPA 1993.

REFERENCE: USEPA. 1993. *Fish Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters*. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC. EPA/600/R-92/111. March.

CONTENTS: Quality assurance and quality control; Safety and health; Sample collection for analysis of the structure and function of fish communities; Specimen processing techniques; Sample analysis techniques; Special techniques; Fish bioassessment protocols for use in streams and rivers; Family-level ichthyoplankton index methods; Fish health and condition assessment profile methods; Guidelines for fish sampling and tissue preparation for bioaccumulative contaminants; Fisheries bibliography.

MAIN FOCUS: Provides guidance for all methods of fish collection, from netting to electrofishing, and rapid bioassessment protocols. A sample analysis section discusses fish identification and how specimens are measured and weighed properly for data analysis purposes. Separate sections discuss fish kill investigations and marking and tagging techniques. The fisheries bibliography is comprehensive.

This document describes guidelines and standardized procedures for the use of fish in evaluating the biological integrity of surface waters, and it provides biomonitoring programs with fisheries methods for measuring the status and trends of environmental pollution. Separate chapters in the document describe a variety of fish collection methods, including the use of nets, electricity, chemicals, and hook and line; specimen handling; specimen analysis; and methods to calculate the age of fish. The use of fish for rapid bioassessments of habitat and water quality impacts to fish populations is also discussed. A section on special techniques discusses flesh tainting methodology (used to relate flavor impairment to a particular waste source), fish kill investigations, and Instream Flow Incremental Methodology (IFIM), which measures impacts to fish and other aquatic organisms resulting from changes in instream flow. An extensive bibliography that is organized by topic is provided. It includes a section on fish identification, with the references separated by geographic region of the United States and by marine and freshwater species.

37. *Bioaccumulation Monitoring Guidance: Selection of Target Species and Review of Available Bioaccumulation Data*. USEPA 1987.

REFERENCE: USEPA. 1987. *Bioaccumulation Monitoring Guidance: Selection of Target Species and Review of Available Bioaccumulation Data*. Volume I. U.S. Environmental Protection Agency, Office of Marine and Estuarine Protection, Washington, DC. EPA 430/9-86-005. March.

CONTENTS: Recommended target species; Additional sampling considerations; Historical data for target species; Summary of recommendations.

MAIN FOCUS: Specifically addresses monitoring fish and macroinvertebrates for bioaccumulation of toxic substances. A separate section discusses the use of historic data, and data summaries of metals and priority pollutant concentrations for target species are provided for reference.

This guidance is intended for 301(h) programs, but the information presented is applicable to bioaccumulation monitoring in general. Guidance for the selection of target species for bioaccumulation monitoring is its main focus. A compilation, evaluation, and summarization of 1987 data on concentrations of priority pollutants in the suggested target species is included. This information provides a set of data for comparative purposes, to aid the user in interpreting data. The document explains the ranking procedure and criteria used to select the target species. Selected target species are tabulated geographically. Species of fish are selected for the geographic areas of Massachusetts to Virginia, and California and Washington, and macroinvertebrates are selected for Massachusetts to Virginia; Alaska to California; Florida, the Virgin Islands, and Puerto Rico; and Hawaii. Information on the types of tissue to analyze, the time of sampling, and the use of historical data is provided as well.

38. *Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents*. USEPA 1973.

REFERENCE: USEPA. 1973. *Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents*. C.I. Weber, ed. U.S. Environmental Protection Agency, National Environmental Research Center, Office of Research and Development, Cincinnati, Ohio. Program Element 1BA027. EPA-670/4-73-001. July.

CONTENTS: Biometrics; Plankton; Periphyton; Macrophyton; Macroinvertebrates; Fish; Bioassay; Appendix.

MAIN FOCUS: A section on biometrics provides a complete discussion of data analysis. Bioassays for phytoplankton/algae, periphyton, macroinvertebrates, and fish are discussed.

This manual was published to provide pollution biologists with a methods reference guide for measuring the effects of environmental contaminants on freshwater and marine organisms. Both field and laboratory methods are discussed for fish, macroinvertebrates, plankton, periphyton, and macrophyton. A section on biometrics provides a full discussion of sampling (simple random and stratified random) and statistical analysis methods (T-test, chi square, F-test, analysis of variance, confidence intervals, and linear regression). Sections on different types of organisms to be sampled (e.g., fish, periphyton) discuss sample collection and preservation, sample preparation and analysis, sampling methods, and special techniques where appropriate. References are provided for each section of the manual. Special sections on fathead minnow and brook trout chronic tests are included in a section on bioassay techniques. An appendix contains data recording sheets and a discussion of equipment and supplies.

A.3.7 Program-specific Monitoring Guidances

39. *Watershed Monitoring and Reporting for Section 319 National Monitoring Program Projects*. USEPA 1991.

Under section 319 of the Clean Water Act as amended in 1987, EPA is establishing a national program to intensively monitor and evaluate a subset of watershed projects. A nationally consistent protocol is to be followed by the projects, and EPA has developed and distributed a national framework for the National Monitoring Program. This guidance provides monitoring and reporting guidelines for the program.

Nonpoint Source Management System (NPSMS) software has been developed and distributed to states that have received grants under section 319 of the Clean Water Act. The software facilitates information tracking and reporting under the National Monitoring Program. It is menu-driven, and this document

discusses the proper entry of data into the software system and provides a step-by-step guide to it. Much of the information presented is therefore not of relevance to the reader interested in designing a monitoring program, though there is limited discussion of monitoring objectives, monitoring program design, and monitoring parameters.

REFERENCE: USEPA. 1992. *NPDES Storm Water Sampling Guidance Document*. U.S. Environmental Protection Agency, Office of Water. Washington, DC. EPA 833-B-92-001. July.

CONTENTS: Background for storm water sampling; Fundamentals of sampling; Analytical considerations; Flexibility in sampling; Health and safety.

MAIN FOCUS: Contains a good discussion of grab and composite samples, sample collection methods, and sample handling and documentation. Addresses many points specific to the NPDES program.

40. *NPDES Storm Water Sampling Guidance Document*. USEPA 1992.

REFERENCE: USEPA. 1991. *Watershed Monitoring and Reporting for Section 319 National Monitoring Program Projects*. U.S. Environmental Protection Agency, Office of Water, Washington, DC. August.

CONTENTS: Selection criteria for National Monitoring Program projects; NonPoint Source Management System (NPSMS) software; Management file; Monitoring plan file; Annual report file.

MAIN FOCUS: Outlines the types of data that should be collected and documentation that should be kept for watershed monitoring projects; specifically addresses the requirements of the National Monitoring Program established pursuant to CWA Section 319.

This guidance is intended for operators of facilities that discharge storm water containing industrial pollutants and operators of large and medium-sized municipal separate storm sewer systems. Its purpose is to assist facility operators and/or owners in planning for and fulfilling the NPDES storm water discharge sampling requirements for NPDES permit applications. The information presented pertains to individual industrial storm water applications, group storm water applications, and municipal storm water permit applications. The guidance was issued in support of EPA regulations and policy initiatives involving the development and implementation of a national storm water program, and serves as Agency guidance.

The legal requirements of storm water sampling under the Clean Water Act are explained, and storm water sampling methodologies, other measurements necessary for permit compliance (e.g., flow, rainfall), sample documentation, and sample analysis requirements are discussed. Modifications to standard sampling procedures, which are allowed under specific circumstances on a case-by-case basis, are explained. Acceptable techniques for manual and automatic sample collection are described. Health and safety considerations are also discussed.

NPDES storm water permit requirements are the focus of this guidance, and much of the information provided in it is not directly related to monitoring the water quality and habitat effects of NPS pollution.

However, the technical information that it contains on choosing sampling locations and sampling procedures should be useful to those monitoring storm water as part of an NPS monitoring program.

41. *Monitoring Guidance for the National Estuary Program*. USEPA 1991.

REFERENCE: USEPA. 1991. *Monitoring Guidance for the National Estuary Program*. U.S. Environmental Protection Agency, Office of Water. EPA 503/8-91-002. August.

CONTENTS: Develop monitoring objectives and performance objectives; Establish testable hypotheses and select statistical methods; Select analytical methods and alternative sampling designs; Evaluate monitoring program performance; Implement monitoring study and data analysis; Communicate program results; Appendices: Case studies; Methods.

MAIN FOCUS: Appendices contain case studies of the Puget Sound and Chesapeake Bay monitoring programs, and detailed methods sections. The methods sections include water column physical and chemical parameters, sediment, plankton, aquatic vegetation, benthos, fish, bioaccumulation, and bacteria and viruses. Each method section discusses monitoring design, analytical methods, QA/QC, and statistics for the parameter.

The National Estuary Program (NEP) was created by the Water Quality Act of 1987 to promote long-term planning and management in nationally significant estuaries threatened by pollution, development, or overuse. Management conferences, with representatives from EPA, the affected state(s), local governments, the scientific community, and citizens' groups, are established to develop Comprehensive Conservation and Management Plans (CCMPs) for the estuaries. The first task of a management conference is to identify and characterize the problems in the estuary. Then, based on the findings, a CCMP is developed to guide the implementation of actions undertaken to overcome the identified problems and protect the estuarine environment. A requirement of the enacting legislation is that the effectiveness of actions taken pursuant to CCMPs be monitored, and this document provides guidance on the design, implementation, and evaluation of NEP monitoring programs.

NEP monitoring programs are designed to serve two goals—to measure the effectiveness of management actions and programs implemented under CCMPs, and to provide essential information that can be used to redirect and refocus the estuarine management efforts. Because the intended audience for this document is those involved in estuary management efforts, including environmental managers, governmental agencies, and citizens, this guidance discusses both background issues and technical aspects relevant to estuarine monitoring programs.

This guidance presents a systems design approach to designing a monitoring program, with discussions of each of the steps involved in the approach: developing monitoring program objectives, designing a monitoring program, establishing hypotheses, selecting statistical methods and sampling designs, evaluating the monitoring program's performance, and managing and analyzing data. An extensive methods section is organized according to the parameter being monitored, e.g., water column chemistry, sediment grain size, aquatic vegetation, fish community structure, viral pathogens. Numerous references to other texts providing in-depth discussions of each step in monitoring program design are provided. Two case studies, the Puget Sound Ambient Monitoring Program and the Chesapeake Bay Monitoring Program, are used to provide examples from existing estuarine monitoring programs. In addition, the case studies also address options for funding monitoring programs, how to incorporate existing

monitoring studies into a coordinated basin-wide monitoring effort, and methods for determining the effectiveness and feasibility of monitoring efforts.

42. *Water Quality Standards Handbook*. USEPA 1983.

REFERENCE: USEPA. 1983. *Water Quality Standards Handbook*. U.S. Environmental Protection Agency, Office of Water Regulations and Standards. Washington, DC. December.

CONTENTS: Water quality standards review and revision process; General program guidance; Water body survey and assessment guidance for conducting use attainability analyses; guidelines for deriving site-specific water quality criteria. Appendices: Bioassay test methods; Determination of statistically significantly different LC50 values; Case studies.

MAIN FOCUS: Provides a complete discussion of the state water quality standards development process and the process for conducting waterbody surveys and use attainability analyses. Excellent background material on state water quality standards and stream classification systems.

This guidance is meant to assist states in implementing the 1983 water quality standards regulation (48 FR 51400, November 8). It is not a monitoring guidance per se, but rather a guidance for determining whether awaterbody survey and/or use attainability analysis, as required by the Clean Water Act, meets specifications set forth by EPA. Numerous case studies illustrate acceptable state approaches.

The handbook provides a general description of the standards setting process, information on program administrative policies and procedures, and a description of analyses used to determine appropriate water uses and criteria. States are to use the data and analyses set forth in this document, or similar data and analyses, to conduct use attainability analyses or to establish water quality criteria. Certain regulatory requirements to which states must adhere when they develop water quality criteria are discussed as well. EPA has determined that certain types of scientific and technical data and analyses are necessary in order for the public and EPA to conduct informed reviews of proposed water quality standards. Data and analyses required for this purpose are noted. Explanations of terms and concepts used in the regulatory language, e.g., mixing zone and antidegradation, are provided.

While this document does not provide guidance on the development or implementation of a monitoring program, it is a useful reference for those interested in the rationale behind and derivation of water quality standards. Monitoring is an essential step in setting and modifying site-specific water quality standards. Therefore, this document is valuable as a companion to documents that deal more directly with monitoring program design and implementation.

43. *Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document*. USEPA 1989.

This is a comprehensive field and laboratory reference document for the design, implementation, and interpretation of ecological risk assessments, and it specifically addresses assessments of hazardous waste sites. Complete discussions of ecological endpoints, assessment methods, statistical considerations, toxicity testing, field assessments, and data interpretation are provided. The section on toxicity testing is divided into subsections on aquatic, terrestrial, and microbial tests; the section on field assessments is divided into subsections on aquatic, vegetation, terrestrial vertebrates, and terrestrial invertebrates.

REFERENCE: USEPA. 1989. *Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document*. W. Warren-Hicks, B.R. Parkhurst, and S.S. Baker, Jr., eds. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC. EPA/600/3-89/013. March.

CONTENTS: Ecological endpoints; Assessment strategies and approaches; Field sampling design; Quality assurance and data quality objective; Toxicity tests; Biomarkers; Field assessments; Data interpretation.

MAIN FOCUS: A comprehensive discussion of all aspects of ecological risk assessment. A specific list of references follows each subsection that discusses a technical aspect of risk assessment.

44. *Environmental Monitoring and Assessment Program: Ecological Indicators*. USEPA 1990.

REFERENCE: USEPA. 1990. *Environmental Monitoring and Assessment Program: Ecological Indicators*. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC. EPA/600/3-90/060. September.

CONTENTS: EMAP indicator concepts; Indicator strategy for near coastal waters; Indicator strategy for inland surface waters; Indicator strategy for wetlands; Indicator strategy for forests; Indicator strategy for arid lands; Indicator strategy for agroecosystems; Indicators relevant to multiple resource categories; Indicator strategy for atmospheric stressors; Conclusions and future directions; Appendices (indicator fact sheets).

MAIN FOCUS: EMAP indicators are related to ecological and social (e.g., recreation) variables and to monitoring objectives. The reasoning behind the choice of each indicator is fully explained.

The Environmental Monitoring and Assessment Program (EMAP) is a nationwide initiative to assess and document the status and trends in the condition of the Nation's ecological resources. The program is organized into seven resource groups that focus monitoring and assessment activities on defining the environmental condition of agricultural lands, estuaries, forests, the Great Lakes, lakes and streams, rangelands, and heterogeneous ecological resources (landscape ecology). Regional EMAP (REMAP) projects that use the same approach as the nationwide EMAP program focus on issues of particular importance in the region or a state or states within the region.

This report presents the approach proposed to describe ecological condition; defines a common strategy within the program for selecting and prioritizing; and summarizes the indicators chosen for evaluation as core indicators for major types of ecosystems. The discussions in this document of monitoring indicators for the major types of ecosystems provide valuable information on types of indicators to choose for different monitoring goals. Indicators that were considered but not chosen for use in EMAP are also discussed, and this is valuable in that it points out the purposes for which these monitoring parameters would be inappropriate. Fact sheets for each of the indicators chosen for EMAP are included as appendices. Each fact sheet discusses the particular indicator's application, measurement, variability, and primary problems, and provides pertinent references.

45. *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*. USEPA 1986.

REFERENCE: USEPA. 1986. *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC. OSWER-9950.1. September.

CONTENTS: Characterization of site hydrogeology; Placement of detection monitoring wells; Monitoring well design and construction; Sampling and analysis; Statistical analysis of detection monitoring data; Assessment monitoring.

MAIN FOCUS: Provides technical information on site characterization, well placement, and well design and construction. Sample collection, handling, and preservation techniques are thoroughly discussed.

This guidance describes in detail what EPA deems to be the essential components of a ground water monitoring system that meets the goals of the Resource Conservation and Recovery Act (RCRA). It is intended to be used by enforcement officials, permit writers, field inspectors, and attorneys at the federal and state levels to assist them in making informed decisions regarding the adequacy of existing or proposed ground water monitoring systems.

The guidance contains technical information on site characterization, well design and construction, and assessment of contamination of ground water. Hydrogeologic regimes vary widely from site to site, and this guidance does not attempt to address all possible circumstances for the purposes of ground water monitoring programs. It does provide a framework within which a decision-making process can be applied using site-specific considerations.

Ground water monitoring is a specific type of monitoring and may be beyond the scope of many monitoring programs. Although this guidance is specific to the RCRA program, the protocols presented are rigorous and could be used to provide defensible data for any ground water monitoring program.

46. *Summary of U.S. EPA-Approved Methods, Standard Methods, and Other Guidance for 301(h) Monitoring Variables*. USEPA 1985.

REFERENCE: USEPA. 1985. *Summary of U.S. EPA-Approved Methods, Standard Methods, and Other Guidance for 301(h) Monitoring Variables*. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 503/4-90-002. September.

CONTENTS: Introduction; Table 1: U.S. EPA-Approved Methods and Guidance Documents for Measuring Biological, Sediment, and Water Quality Variables in 301(h) Monitoring Programs; Water Quality Variables; Sediment Analyses; Biological Variables; References.

MAIN FOCUS: A convenient listing of where to find information on analytical techniques for many monitoring variables.

This short (16-page) document tabulates the types of analytical methods available for the water quality, sediment, and biological variables used in 301(h) monitoring programs. The methods are listed as EPA-approved, EPA-suggested, standard, or additional, and the availability of guidance for each method is noted. Following the table is a brief note specifying method numbers (e.g., USEPA method No. 150.1; additional procedure No. 413.2) for each of the variables listed. A list of references at the end of the

document indicates where to find information about each of the monitoring variables and analytical methods.

47. *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities - Interim Final Guidance*. USEPA 1989.

REFERENCE: USEPA. 1989. *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities - Interim Final Guidance*. U.S. Environmental Protection Agency, Office of Solid Waste, Waste Management Division, Washington, DC. EPA/530-SW-89-026. NTIS PB89-151047. February.

CONTENTS: Regulatory overview; Choosing a sampling interval; Choosing a statistical method; Background well to compliance well comparisons; Comparisons with MCLs or ACLs; Control charts for intra-well comparisons; Miscellaneous topics; Appendices.

MAIN FOCUS: Detailed discussion of all aspects of statistical analyses of ground-water monitoring data. Flow charts are provided to assist the reader in choosing the proper statistical method and interpreting data.

The hazardous waste regulations under the Resource Conservation and Recovery Act (RCRA) require owners and operators of hazardous waste facilities to use design features and control measures that prevent the release of hazardous waste into ground water. This document provides guidance to RCRA facility permit applicants and writers concerning the statistical analysis of ground water monitoring data at RCRA facilities. Sections of the document provide an overview of regulations concerning the statistical analyses of ground water monitoring data, hydrogeologic parameters to consider when choosing a sampling interval, guidance on choosing an appropriate statistical method, statistical methods that may be used to evaluate ground water monitoring data, statistical procedures that are appropriate for special circumstances, and special topics. Appendices cover general statistical considerations, a glossary of statistical terms, statistical tables, and references.

48. *CWA Section 403: Procedural and Monitoring Guidance*. USEPA 1994.

REFERENCE: USEPA. 1994. *CWA Section 403: Procedural and Monitoring Guidance*. U.S. Environmental Protection Agency, Office of Water, Oceans and Coastal Protection Division, Washington, DC. EPA 842-B-94-003. March.

CONTENTS: Section 403 procedure; Options for monitoring under the basis of "no irreparable harm"; Summary of monitoring methods: physical characteristics, water chemistry, sediment chemistry, sediment grain size, benthic community structure, fish and shellfish pathology, fish populations, plankton, habitat identification methods, bioaccumulation, pathogens, effluent characterization, mesocosms and microcosms.

MAIN FOCUS: Each monitoring parameter is dealt with separately, with a separate discussion of monitoring design, analytical methods, QA/QC, statistical considerations, and use of data. An appendix contains an extensive list of monitoring methods references.

This document is designed to provide EPA Regions and NPDES-authorized states with a framework for the decision-making process for section 403 (ocean dumping) evaluations and to provide guidance on the type and level of monitoring that should be required as part of permit issuance under the "no irreparable harm" provisions of section 403. Options for monitoring under the basis of no irreparable harm,

including criteria for evaluating perceived potential impact and establishing monitoring requirements to assess actual impacts, are discussed. Summaries of monitoring methods for evaluating numerous parameters (see contents listing) are provided. Each method section contains an explanation of the usefulness of the parameter of concern in a 403 monitoring program and a discussion of analytical methods, the use of data generated, and considerations of monitoring design, statistical design, and quality assurance/quality control.

49. *Methods for Collecting Benthic Invertebrate Samples as Part of the National Water Quality Assessment Program.* Cuffney, Gurtz, and Meador 1993.

REFERENCE: Cuffney, T.F., M.E. Gurtz, and M.R. Meador. 1993. *Methods for Collecting Benthic Invertebrate Samples as part of the National Water Quality Assessment Program.* USGS Open-File Report 93-406. U.S. Geological Survey, Reston, Virginia.

CONTENT: National Water Quality Assessment Program sampling design; Sampling design for benthic invertebrates; Methods for collecting benthic invertebrates; Maintenance of sampling equipment; Sample processing and labeling; Field data sheets; Contract laboratories and the Biological Quality Assurance Unit; Adapting collection methods for other National Water Quality Assessment Program objectives; Safety and health.

MAIN FOCUS: Evaluating benthic invertebrate communities as part of the ecological survey component of the U.S. Geological Survey's National Water Quality Assessment Program.

This document presents a variety of sampling methods and procedures for collecting benthic invertebrates as part of the National Water Quality Assessment (NAWQA) Program. Numerous sample-collecting techniques, equipment, and data forms are presented for use at basic fixed sampling sites. Each technique or method is thoroughly explained with diagrams, flowcharts, or examples. These techniques and methods are easily adaptable for use in other components of the NAWQA Program, or where needed in other programs of the USGS's Water Resources Division. Field data sheets are provided.

The objectives of benthic invertebrate community characterizations are to develop for each site a list of taxa within the associated stream reach and determine the structure of the benthic invertebrate communities within selected habitats of that reach. This document presents the nationally consistent approach used by the USGS to achieve these objectives. It provides guidance on site, reach, and habitat selection and methods and equipment for qualitative multihabitat sampling and semi-quantitative single-habitat sampling. Appropriate quality assurance and quality control guidelines are used to maximize the ability to analyze data within and among study units.

50. *Methods for Collecting Algal Samples as Part of the National Water Quality Assessment Program.* Porter, Cuffney, Gurtz, and Meador 1993.

This document describes the sampling methods, procedures and equipment for collecting algal samples as part of the National Water Quality Assessment (NAWQA) Program. The approach used in the sampling design for algal communities provides a common spatial scale to assess biological communities and habitat characteristics. The design also addresses seasonal and hydrologic conditions that affect algal communities. The NAWQA Program provides an integrated assessment of water quality within selected environmental settings by collecting and analyzing a combination of physical, chemical, and biological

data. The algal component of the data is designed to characterize the species distribution and community structure of benthic algae and their relation to water quality.

REFERENCE: Porter, S.D., T.F. Cuffney, M.E. Gurtz, and M.R. Meador. 1993. *Methods for Collecting Algal Samples as part of the National Water Quality Assessment Program.* USGS Open-File Report 93-409. U.S. Geological Survey, Reston, Virginia.

CONTENT: National Water Quality Assessment Program sampling design; Sampling design for algal communities; Methods for collecting algal samples; Sample processing and labeling; Contract laboratories and the Biological Quality Assurance Unit.

MAIN FOCUS: Describes methods, procedures, and equipment for collecting algal samples at basic fixed sites as part of the U.S. Geological Survey's National Water Quality Assessment Program.

A variety of sample collection methods focus on qualitative multihabitat and quantitative targeted habitat periphyton samples. Forms for recording sampling data are provided. This manual also discusses preservation methods, preparation of subsamples, and labeling while processing algal samples.

51. *Methods for Characterizing Stream Habitat as Part of the National Water Quality Assessment Program.* Meador, Hupp, Cuffney, and Gurtz 1993.

REFERENCE: Meador, M.R., C.R. Hupp, T.F. Cuffney, and M.E. Gurtz. 1993. *Methods for Characterizing Stream Habitat as part of the National Water Quality Assessment Program.* USGS Open-File Report 93-408. U.S. Geological Survey, Reston, Virginia.

CONTENT: National Water Quality Assessment Program sampling design; Stream habitat sampling design; Methods for characterizing stream habitat.

MAIN FOCUS: Provides detailed procedures for characterizing stream habitat as part of the U.S. Geological Survey's National Water Quality Assessment Program.

This document provides detailed instructions for characterizing stream habitat as part of the National Water Quality Assessment (NAWQA) Program. These procedures allow for appropriate habitat descriptions and standardization of measurement techniques to create unbiased evaluations of habitat influences on water resource conditions at a variety of spatial levels. Using the methods presented, evaluation of stream habitat is based on a spatially hierarchical framework that incorporates habitat data at basin, segment, reach, and microhabitat scales. This framework provides a basis for national consistency in collection techniques while allowing flexibility in habitat assessment within individual study units. Procedures are described for collecting habitat data at basin and stream segment scales using geographic information system (GIS) databases, maps, and aerial photographs. Detailed diagrams and characterization forms are provided.

52. *Guidelines for the Processing and Quality Assurance of Benthic Invertebrate Samples Collected as Part of the National Water Quality Assessment Program.* Cuffney, Gurtz, and Meador 1993.

REFERENCE: Cuffney, T.F., M.E. Gurtz, and M.R. Meador. 1993. *Guidelines for the Processing and Quality Assurance of Benthic Invertebrate Samples Collected as part of the National Water Quality Assessment Program.* USGS Open-File Report 93-407. U.S. Geological Survey, Reston, Virginia.

CONTENT: Sample processing strategy; Specifications for sample processing by contract laboratories; Biological quality assurance unit.

MAIN FOCUS: Specifies the procedures and guidelines that contract laboratories should use to identify and quantify invertebrates from the large-rare and main-body components of benthic invertebrate samples collected as part of the U.S. Geological Survey's National Water Quality Assessment Program.

This report provides nationally consistent guidelines and criteria for the processing of benthic invertebrate samples collected as part of the National Water Quality Assessment (NAWQA) Program. These guidelines include procedures for the tracking and labeling of samples, the use of standard methods and equipment for removing benthic invertebrates from the sample matrix, subsampling procedures, target levels of identification for major groups of invertebrates, quantification procedures, quality assurance/quality control procedures, and standard formats for reporting data. In addition, standards and procedures for the initial qualification and continual review of contract laboratories are discussed. Diagrams, flow charts, example data sheets, and examples of situations are used in the presentation of these guidelines.

53. *Methods for Sampling Fish Communities as a Part of the National Water Quality Assessment Program.* Meador, Cuffney, and Gurtz. 1993.

REFERENCE: Meador, M.R., T.F. Cuffney, and M.E. Gurtz. 1993. *Methods for Sampling Fish Communities as a part of the National Water Quality Assessment Program.* USGS Open-File Report 93-104. U.S. Geological Survey, Reston, Virginia.

CONTENT: National Water Quality Assessment sampling design; Fish community sampling design; Fish community sampling considerations; Methods for sampling fish communities; Biological Quality Assurance Unit; Field data sheets.

MAIN FOCUS: Provides detailed procedures for use by biologists to evaluate stream fish communities as part of the U.S. Geological Survey's National Water Quality Assessment Program.

This manual provides complete instructions for procedures used to sample and evaluate stream fish communities as part of the National Water Quality Assessment (NAWQA) Program. The methods allow standardization of collection methods and descriptions of fish communities to facilitate unbiased evaluations of the relationships between physical, chemical, and biological components of water quality conditions. The methods are established standard procedures for characterizing fish communities in streams ranging from headwaters to large rivers. The focus of the sampling procedures is electrofishing and seining techniques, but other methods are mentioned. Taxonomic identification, physical measurements, examination of fish for external anomalies, and preservation of specimens are covered in the discussion of sample processing. Forms for recording these data are provided.

54. *Guidelines for Studies of Contaminants in Biological Tissues for the National Water Quality Assessment Program.* Crawford and Luoma 1994.

REFERENCE: Crawford, J.K., and S.N. Luoma. 1994. *Guidelines for Studies of Contaminants in Biological Tissues for the National Water Quality Assessment Program.* USGS Open-File Report 92-494. U.S. Geological Survey, Reston, Virginia.

CONTENT: Tissue analysis in the National Water Quality Assessment Program. Tissue analysis activities of other agencies—USFWS, NOAA, EPA National Study of Chemical Residues in Fish, EPA EMAP, Regional and state. Approach of tissue analysis surveys—General approach; Objectives, priorities, and time line; Study strategies; Factors affecting selection of target chemicals; Target compounds for contaminant occurrence; Targeted chemical analyses following the contaminant-occurrence survey; Selection of taxa for analysis; Field procedures for collecting and processing tissue samples; Field records; Laboratory procedures for analyzing tissue samples; Quality assurance and quality control; Voucher collections and sample archival; Data management; Data interpretation.

MAIN FOCUS: Describes the concepts and field methods to be used by the U.S. Geological Survey's National Water Quality Assessment Program for evaluating contaminants in tissues of organisms.

This document presents the rationale, objectives, approach, and procedures to be used in the National Water Quality Assessment (NAWQA) Program for determining the occurrence, distribution, and trends in concentrations of trace elements and synthetic organic compounds in tissues. Part 1 of this manual describes the rationale for analyzing tissue contaminants and overviews the approach used. Part 2 explains the tissue-contaminant strategies of other agencies and compares them to the strategy used in the NAWQA Program. Part 3 discusses the approach for the use of tissue analysis as an aid to interpret water quality in NAWQA study units. Also, suggestions for interpretation of data are offered to facilitate consistency between study units.

Table A.1. Summary of guidances reviewed.

SUBJECTS DISCUSSED	GUIDANCE REFERENCE NUMBER																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Guidance for Monitoring:																		
Streams & Rivers	●	●	●		●	●			●	●	●	●	●		●	●	●	●
Lakes & Reservoirs	●	●	●		●				●	●	●	●	●					
Estuaries/Marine								●	●	●	●	●						
Ground Water	●				●						●	●						
Storm Water																		
Land Use	●					●	●					●						
Land Management	●					●												
Forest				●		●						●						
Range																		
Agriculture		●		●			●					●						
Watersheds	●		●				●					●						
Program Elements:																		
Objectives	●		●	●	●	●	●	●	●		●	●	●			●	●	
Design	●		●	●	●	●	●		●	●	●	●			●	●	●	●
Protocols	●			●		●				●	●	●				●	●	●
Parameters	●	●		●	●	●				●	●	●				●	●	●
Related Subjects:																		
Data Analysis	●		●			●			●							●	●	●
Data Management	●		●	●			●		●		●	●	●				●	
QA/QC			●	●	●	●		●	●		●	●	●				●	
Stream Classification																●		

(Table continued on next page)

SUBJECTS DISCUSSED	GUIDANCE REFERENCE NUMBER																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Samples and Sampling:																		
Types of Samples	●				●			●							●		●	●
Sampling Equipment	●									●								●
Sampling Techniques					●			●		●							●	●
Sample Handling	●							●		●							●	●
Sample Documentation								●									●	
Sample Analysis	●							●		●							●	
Sampling Locations	●		●		●			●		●					●	●	●	●
Sampling Frequency	●			●	●			●							●	●	●	
Health and Safety										●								
Monitoring Parameters:																		
Physical Constituents			●	●	●	●		●		●					●	●	●	
Chemical Constituents		●			●	●		●		●							●	
Nutrients		●	●	●	●			●		●					●	●		
Sediment	●	●	●							●		●			●	●	●	
Bacteria & Viruses		●	●		●			●		●		●			●	●		
Phytoplankton	●	●	●		●			●		●								
Zooplankton	●		●		●	●				●		●						
Macroinvertebrates	●	●	●			●				●		●			●		●	●
Fish	●	●	●			●				●					●		●	
Aquatic Vegetation	●	●	●			●		●		●		●			●		●	
Riparian Vegetation			●							●		●			●	●	●	
Habitat Quality			●			●										●	●	
Flow	●											●			●		●	
Channel Morphology						●						●			●	●	●	
Bank Stability						●										●	●	

SUBJECTS DISCUSSED	GUIDANCE REFERENCE NUMBER																	
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Guidance for Monitoring:																		
Streams & Rivers	●	●	●	●	●	●		●			●		●	●				●
Lakes & Reservoirs								●	●	●	●		●					●
Estuaries/Marine								●			●							●
Ground Water													●		●	●	●	
Storm Water																		
Land Use													●			●		
Land Management													●					
Forest																		
Range												●						
Agriculture													●			●		
Watersheds							●				●	●	●	●		●		
Program Elements:																		
Objectives		●		●	●	●			●		●	●						●
Design		●		●	●	●					●	●	●			●	●	●
Protocols	●	●				●					●					●		●
Parameters	●	●			●	●					●	●						●
Related Subjects:																		
Data Analysis	●						●			●	●							●
Data Management									●		●		●				●	●
QA/QC				●					●		●					●	●	●
Stream Classification				●														

(Table continued on next page)

SUBJECTS DISCUSSED	GUIDANCE REFERENCE NUMBER																	
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Samples and Sampling:																		
Types of Samples	●				●		●		●		●			●	●			●
Sampling Equipment														●		●		
Sampling Techniques		●				●			●		●			●	●			●
Sample Handling											●			●				●
Sample Documentation	●										●			●				●
Sample Analysis											●			●				●
Sampling Locations	●	●			●	●	●		●		●			●		●		
Sampling Frequency		●			●	●	●		●		●			●		●		
Health and Safety																		●
Monitoring Parameters:																		
Physical Constituents		●		●				●	●		●			●				●
Chemical Constituents		●						●	●		●			●				●
Nutrients											●			●				
Sediment				●				●	●		●							
Bacteria & Viruses									●									
Phytoplankton		●	●						●		●			●				
Zooplankton																		
Macroinvertebrates			●	●				●						●				
Fish	●		●	●		●		●			●			●				●
Aquatic Vegetation		●							●		●							
Riparian Vegetation								●										
Habitat Quality			●	●				●						●				●
Flow		●		●				●			●			●				
Channel Morphology		●						●										
Bank Stability		●	●															

SUBJECTS DISCUSSED	GUIDANCE REFERENCE NUMBER																	
	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Guidance for Monitoring:																		
Streams & Rivers		●	●			●	●	●					●	●	●	●	●	●
Lakes & Reservoirs		●	●			●		●										
Estuaries/Marine	●	●	●		●			●		●		●						
Ground Water							●		●		●							
Storm Water				●														
Land Use																		
Land Management																		
Forest								●										
Range								●										
Agriculture								●										
Watersheds								●										
Program Elements:																		
Objectives		●	●		●		●	●	●			●	●	●	●		●	●
Design		●			●		●		●		●	●	●	●	●		●	●
Protocols	●	●					●				●	●	●	●			●	●
Parameters	●	●					●	●	●			●						●
Related Subjects:																		
Data Analysis	●	●					●		●		●	●						●
Data Management											●							●
QA/QC					●		●		●			●				●	●	●
Stream Classification															●			

(Table continued on next page)

SUBJECTS DISCUSSED	GUIDANCE REFERENCE NUMBER																	
	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Samples and Sampling:																		
Types of Samples	●	●		●			●				●	●	●	●				
Sampling Equipment													●	●			●	
Sampling Techniques		●					●		●			●	●	●			●	●
Sample Handling		●		●			●		●				●	●		●	●	●
Sample Documentation		●		●					●				●	●		●	●	●
Sample Analysis		●		●			●									●		●
Sampling Locations	●							●	●		●	●	●	●	●		●	●
Sampling Frequency	●						●	●	●		●	●	●	●			●	●
Health and Safety				●					●									
Monitoring Parameters:																		
Physical Constituents					●					●		●						
Chemical Constituents					●		●			●		●						
Nutrients					●					●								
Sediment					●					●		●						
Bacteria & Viruses					●					●		●						
Phytoplankton		●			●					●		●		●				
Zooplankton		●			●					●		●						
Macroinvertebrates	●	●			●					●		●	●					●
Fish	●	●			●					●		●					●	●
Aquatic Vegetation					●													●
Riparian Vegetation																		
Habitat Quality												●						
Flow					●							●						
Channel Morphology																		
Bank Stability																		

Index

1. *Water Quality Monitoring.* USDA-SCS Draft.
2. *Water Quality Indicators Guide*. USDA-NRCS 1997.
3. *The Nonpoint Source Manager's Guide to Water Quality and Land Treatment Monitoring.* Coffey, Spooner and Smolen 1993.
4. *Coordinated Nonpoint Source Water Quality Monitoring Program for Idaho*. Idaho Department of Health and Welfare 1990.
5. *Water Quality Monitoring for the Clean Water Partnership. A Guidance Document*. Minnesota Pollution Control Agency 1989.
6. *Evaluating the Effectiveness of Forestry Best Management Practices in Meeting Water Quality Goals or Standards*. Dissmeyer 1994.
7. *Designing Effective Nonpoint Source Water Quality Monitoring Programs*. Maas 1989.
8. *Volunteer Estuary Monitoring: A Methods Manual.* USEPA 1993.
9. *Volunteer Water Monitoring: A Guide for State Managers.* USEPA 1990.
10. *The Volunteer Monitor.* The National Newsletter of Volunteer Water Quality Monitoring.
11. *The Strategy for Improving Water-Quality Monitoring in the United States*. Intergovernmental Task Force on Monitoring Water Quality 1995.
12. *The Strategy for Improving Water-Quality Monitoring in the United States. Technical Appendixes*. Intergovernmental Task Force on Monitoring Water Quality 1995.
13. *Guidance for State Water Monitoring and Wasteload Allocation Programs.* USEPA 1985.
14. *Guidelines for Evaluation of Agricultural Nonpoint Source Water Quality Projects*. USEPA 1981.
15. *Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska.* MacDonald, Smart and Wissmar 1991.
16. *Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management of Western Rangeland Streams.* USEPA Draft.
17. *Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish.* USEPA 1989.
18. *An Improved Biotic Index of Organic Stream Pollution.* Hilsenhoff 1987.
19. *Using the Index of Biotic Integrity (IBI) to Measure Environmental Quality in Warmwater Streams of Wisconsin.* Lyons 1992.
20. *Evaluation Monitoring of Stream Habitat During Priority Watershed Projects*. Simonson and Lyons 1992.
21. *1996 Water Body Assessment Guidance: A Stream to Standards Process*. Idaho Division of Environmental Quality 1996.
22. *1996 Beneficial Use Reconnaissance Project Workplan.* Idaho Division of Environmental Quality 1996.
23. *Handbook: Stream Sampling for Waste Load Allocation Applications.* USEPA 1986.
24. *Evaluation Monitoring of Stream Fish Communities During Priority Watershed Projects.* Simonson and Lyons 1992.

25. *Techniques for Detecting Effects of Urban and Rural Land-Use Practices on Stream-Water Chemistry in Selected Watersheds in Texas, Minnesota, and Illinois*. Walker 1993.

26. *Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analyses*. Volumes I-III. USEPA 1983-1984.

27. *Volunteer Lake Monitoring: A Methods Manual.* USEPA 1991.

28. *Statistical Methods for the Analysis of Lake Water Quality Trends.* USEPA 1993.

29. *Monitoring Lake and Reservoir Restoration.* USEPA 1990.

30. *Monitoring Primer for Range Watersheds.* Bedill and Buckhouse Draft.

31. *Seminar Publication: The National Rural Clean Water Program Symposium. 10 Years of Controlling Agricultural Nonpoint Source Pollution: The RCWP Experience*. USEPA 1992.

32. *Watershed Monitoring Manual.* Kansas Biological Survey 1993.

33. *A Review of Methods for Assessing Nonpoint Source Contaminated Ground-Water Discharge to Surface Water.* USEPA 1991.

34. *Ground Water Monitoring: A Guide to Monitoring for Agricultural Nonpoint Source Pollution Projects.* Goodman, German, and Bishoff 1995.

35. *Response to Ground Water Contaminants Detected through Idaho's Statewide Ambient Ground Water Quality Monitoring Program.* Idaho Department of Health and Welfare 1995.

36. *Fish Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters.* USEPA 1993.

37. *Bioaccumulation Monitoring Guidance: Selection of Target Species and Review of Available Bioaccumulation Data.* Volume I. USEPA 1987.

38. *Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents*. USEPA 1973.

39. *Watershed Monitoring and Reporting for Section 319 National Monitoring Program Projects.* USEPA 1991.

40. *NPDES Storm Water Sampling Guidance Document.* USEPA 1992.

41. *Monitoring Guidance for the National Estuary Program.* USEPA 1991.

42. *Water Quality Standards Handbook.* USEPA 1983.

43. *Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document*. USEPA 1989.

44. *Environmental Monitoring and Assessment Program: Ecological Indicators.* USEPA 1990.

45. *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document.* USEPA 1986.

46. *Summary of U.S. EPA-Approved Methods, Standard Methods, and Other Guidance for 301(h) Monitoring Variables*. USEPA 1985.

47. *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities - Interim Final Guidance*. USEPA 1989.

48. *CWA Section 403: Procedural and Monitoring Guidance*. USEPA 1994.

49. *Methods for Collecting Benthic Invertebrate Samples as Part of the National Water Quality Assessment Program.* Cuffney, Gurtz, and Meador 1993.

50. *Methods for Collecting Algal Samples as Part of the National Water Quality Assessment Program.* Porter, Cuffney, Gurtz, and Meador 1993.

51. *Methods for Characterizing Stream Habitat as Part of the National Water Quality Assessment Program.* Meador, Hupp, Cuffney, and Gurtz 1993.

52. *Guidelines for the Processing and Quality Assurance of Benthic Invertebrate Samples Collected as Part of the National Water Quality Assessment Program.* Cuffney, Gurtz, and Meador 1993.

53. *Methods for Sampling Fish Communities as a Part of the National Water Quality Assessment Program.* Meador, Cuffney, and Gurtz. 1993.

54. *Guidelines for Studies of Contaminants in Biological Tissues for the National Water Quality Assessment Program.* Crawford and Luoma 1994.