INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

Bell & Howell Information and Learning
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
800-521-0600

UMI®

DISSERTATION

AN EXPERT SUPPORT SYSTEM TO AID TRIBAL ENVIRONMENTAL PERSONNEL IN WATER QUALITY ASSESSMENTS

Submitted by

Stephen W. Johnson

Department of Earth Resources

In partial fulfillment of the requirements

for the Degree of Doctor of Philosophy

Colorado State University

Fort Collins, Colorado

Spring 2000

COLORADO STATE UNIVERSITY

7 April 2000

WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY STEPHEN W. JOHNSON ENTITLED AN EXPERT SUPPORT SYSTEM TO AID TRIBAL ENVIRONMENTAL PERSONNEL IN WATER QUALITY ASSESSMENTS BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

Committee on Graduate Work

Co-advisor

Advisor

Department Head

ABSTRACT OF DISSERTATION

AN EXPERT SUPPORT SYSTEM TO AID TRIBAL ENVIRONMENTAL PERSONNEL IN WATER QUALITY ASSESSMENTS

The U.S. Environmental Protection Agency (EPA) encourages Indian Tribes to develop the capability to assess and report on the quality of water resources on Reservations. A Tribal water quality assessment report under Clean Water Act Section 305(b) provides a means for Tribal environmental decision makers to manage water quality in a meaningful manner and to guide protection, restoration, and assessment efforts. One of the major obstacles to Tribal production of 305(b) reports is the lack of technical transfer of information to Tribal environmental personnel regarding appropriate water quality monitoring, assessment, and reporting methods. The expert support system (ESS) developed for this dissertation is the first of its kind and is designed to eliminate the technical transfer obstacle for tribal 305(b) reporting. The ESS operates on a Windows 95 platform. The executable ESS and Users Manual reside on the internet at www.naein.com/NativeAmerican/crit/index.html.

Stephen W. Johnson
Department of Earth Resources
Colorado State University
Fort Collins, Colorado 80523
Spring 2000

ACKNOWLEDGMENTS

I express my deepest appreciation for my advisor, Dr. Freeman Smith, for his needed support and thoughtful guidance throughout my studies and during the preparation of this dissertation. I cannot thank him enough.

I thank Dr. Robert Ward for his "big picture" approach to water quality assessments. I thank Dr. Jim Loftis for his insights into useful methods of teaching statistical concepts. I thank Dr. James Waltz, my co-advisor, for his valuable information on pragmatic approaches to assessing ground water quality and especially for his encouragement throughout my program.

I extend special thanks to Terry Geiselman and Wendell Smith for their caring support in the funding of this study through the Region IX U.S. Environmental Protection Agency's Clean Water Act Section 106 Water Pollution Control Program. Special thanks to the entire staff at the Colorado River Indian Tribes' Environmental Protection Office, namely Conner Byestewa, Jr. (posthumous), a Shaman and joyful visionary, and Dillon Esquerra, Duncan Fisher, Lesa Flores, Fred Gonzales, and Sharon Burton.

Finally, my love and gratitude to my wife Jodi and our son Taylor for their support and understanding throughout my Ph.D. program.

TABLE OF CONTENTS

Page

TITLE PAGE i

SIGNATURE PAGE ii

ABSTRACT OF DISSERTATION iii

ACKNOWLEDGMENTS iv

1.0 INTRODUCTION 1
- 1.1 Nature of the Problem 1
- 1.2 Problem Statement, Hypothesis, and Objectives of the Study 6
- 1.3 Contribution of the Study 9

2.0 WATER QUALITY ASSESSMENT REVIEW 12
- 2.1 Review of Tribal Environmental Needs of the Expert Support System 12
- 2.2 Review of Applicable Approaches to Tribal Water Quality Assessments 15
- 2.3 Scientific Basis for Water Quality Assessments 22

3.0 METHODOLOGY 26
- 3.1 Step 1 Determination of User Information Needs and Expectations 26
- 3.2 Step 2 Expert Support System Software Selection 34
- 3.3 Step 3 Expert Support System Design 37
- 3.4 Step 4 Knowledge Acquisition 42
- 3.5 Step 5 Prototype Development 51
- 3.6 Step 6 Prototype Testing and Validation 54
- 3.7 Step 7 Final Expert Support System Development 56

4.0 RESULTS AND INTERPRETATION 59
- 4.1 Study Results 59
- 4.2 Achievement of Study Objectives 76

5.0 CONCLUSIONS AND RECOMMENDATIONS 77

6.0 LITERATURE CITED 81

Page

APPENDICES 85
A Section 518 of the Water Quality Act of 1987 86
B Users Manual 89
C Data Analysis and Water Quality Criteria Knowledge Base for the ESS 134
D Beneficial Use Support Determinations Knowledge Base for the ESS 150

LIST OF TABLES

Table		Page
1	Beneficial Uses of Tribal Waterbodies	28
2	Meetings with Tribal Environmental Personnel to Discuss User Needs	31
3	Summary of Approaches Used in the ESS for Water Quality Assessments	40
4	Methods of Water Quality Data Analysis Used in the ESS	45
5	Sources of Information for Ambient Water Quality Criteria	46
6	Example of an If-Then Statement Used in the ESS	52
7	Expert Support System Review and Comment Sheet Summary	57
8	Modifications to the ESS Using the Review and Comment Sheets	58
9	First Time User Overview for the Expert Support System	62
10	Software License Agreement and Copyright Statement	63
11	Expert Support System Example of How to Respond to a Fish Kill	64
12	Brief Report Format for Documenting Water Quality Investigations	66
13	Water Quality Information Expectations of Tribal Management	67
14	Water Quality Data Search Summary	72
15	Example of Water Quality Monitoring Recommendations for a Lake	73

LIST OF FIGURES

Figure		Page
1	Components of an Expert System (modified from Edmonds, 1988)	8
2	Expert Support System Development Interaction Using a Shell	36
3	Approach Using Information Expectations for Water Quality Assessments	38
4	Expert Support System Design Tree	39
5	Review and Comment Form Used in the Prototype Development	55
6	Main Menu Screen for the Expert Support System	60
7	Example of Beneficial Use Impairment Determination Using the ESS	71

1.0 INTRODUCTION

1.1 Nature of the Problem

Section 305(b) of the Clean Water Act requires an inventory of the nation's waterbodies to develop a baseline of water quality conditions, to assess the degree of designated use support for waterbodies, to evaluate trends in contaminant levels, and to measure the effectiveness of restoration practices (USEPA 1997a). A comprehensive and consistent water quality assessment process for 305(b) reporting has not yet been developed for both Tribes and states (GAO 2000, PEER 1999). Water quality assessment reporting must be both comprehensive and consistent to provide needed information to the decision makers entrusted with water quality protection and management efforts. For water quality assessment to be comprehensive, coverage of beneficial use support for all waterbodies (i.e., surface waters, wetlands, and ground waters) must occur within a Tribe's or state's jurisdictional boundaries. In addition, comprehensiveness includes information on trend analysis for indicator variables and a measure of the success of implemented restoration programs for water quality improvement of impaired waterbodies (GAO 2000, PEER 1999). A consistent water quality assessment and reporting format needs to be mandated by EPA as part of its funding to Tribes and states under the Clean Water Act. Consistency in both assessment methods and reporting would provide a

reliable means of comparing water quality conditions both spatially (among Tribal and state geographic areas) and temporally (using time series or trend analysis), and would allow for a true measure of the success of water quality improvement efforts that often occur over many years. The specific problem to be addressed in this study is focused on Tribal needs through development of an expert support system (ESS) to assist environmental personnel in conducting a comprehensive and consistent water quality assessments and 305(b) reporting.

Because of the limited resources available to most Tribes, a decision-making tool is needed to provide an integrated approach to assess Reservation water quality and determine waterbody impairment. An integrated link is missing between the needs of water quality management, water quality monitoring programs, and water quality data analysis. This link's absence is evident in many state, county, and city agencies, but is most apparent on Indian Reservations (over which these agencies have no jurisdiction) because Tribal environmental regulatory agencies responsible for water quality protection are typically either in their infancy or non-existent.

This study involves developing an interactive tool for integrating the many components of water quality assessment to determine Tribal waterbody impairment. The tool is an expert support system that is anticipated to be applicable to state, federal, and Tribal environmental regulatory agencies, but that will be tailored

specifically to the needs of Tribal environmental personnel. The two primary premises of the study are as follows:

- Beneficial uses associated with all ground and surface waterbodies are beneficial to the public health and the environment, and these uses require protection using appropriate assessment methods, such as those included in the Section 305(b) water quality assessment reports; and

- The Tribal environmental regulation goal is to protect the public health and the environment and to report to the public the status of Tribal water quality conditions, such as those included in the Section 305(b) report.

States have been required to produce 305(b) reports since 1977 and have also received funding under the Section 106 Water Pollution Control Program since 1977. Currently all 50 states have produced 305(b) reports, yet only nine of the 357 Indian reservations in the U.S. produced 305(b) reports during the 1998 biennial cycle (Personal Communication 2000).

The Water Quality Act of 1987 (Public Law 100-4) allows Tribes to receive funding under the Section 106 Water Pollution Control Program (Appendix A); this funding provides opportunities for qualified Tribes to conduct water quality monitoring and assessments of Tribal waterbodies and to produce the Section 305(b) water quality assessment reports. Although the Tribes are exempt from 305(b) reporting

requirements, the EPA often requires Tribal 305(b) reporting through CWA Section funding and Tribal 305(b) reports provide Tribes the opportunity to assess the quality of Tribal waterbodies and report this information to Tribal residents, the EPA, and Congress. Tribal participation in the 305(b) reporting process includes the following benefits:

- Provides a tribal water quality data assessment that is meaningful (i.e., meets the information expectations of Tribal environmental decision makers).

- Provides a vehicle for informing and educating Tribal residents and the general public as to the status of Tribal water quality conditions and restoration projects.

- Calls Tribal and EPA attention to special issues (e.g., the sources and causes of Tribal water quality impairment, such as those associated with bacterial contamination of swimming beaches, fish tissue contamination, ceremonial use advisories for wetland areas because of contamination).

- Provides a vehicle for Tribal environmental decision makers to focus their efforts on securing EPA and Tribal funds for restoration of impaired Tribal waterbodies.

- Provides the opportunity for Tribes to monitor the status of Tribal water quality conditions, to evaluate trends in water quality degradation, and to report on the success of water quality restoration projects.

The overall water quality management goal for Tribal and state environmental agencies is to safeguard the public health and the environment with regards to water resources. Additionally for Tribes, cultural uses of waterbodies are uniquely important. The greatest difference between water quality management for Tribes and states is the emphasis on Tribal religious practices and the lack thereof and mandated exclusion of religious considerations by states. The Tribes conduct ceremonies of religious significance, some of which allow public viewing and even participation by the public. While other ceremonial practices not only exclude the public, but are not openly discussed even among non-participating Tribal members. Ceremonial practices vary widely among the Tribes and include sweat lodges, basketry, rites of manhood and womanhood, cremation practices including bathing in natural waters, and consumption of untreated natural waters. Water quality assessments of cultural uses of waterbodies are therefore needed by Tribal water quality management and are addressed in the ESS as one of many beneficial uses to be protected.

1.2 Problem Statement, Hypothesis, and Objectives of the Study

The problem statement for this study is as follows:

> *Tribes need a tool to facilitate the decision-making processes associated with assessing water quality for the development of CWA Section 305(b) water quality assessment reports.*

This problem statement is addressed through development of an interactive program in the form of a knowledge-based ESS. An ESS is a computer software application that is a form of artificial intelligence designed to replicate the problem-solving techniques of an expert in a specialized field; applied reasoning, rather than calculation, is used to reach a decision.

An ESS combines the data-processing and analytical capabilities of a decision support system (DSS) and the decision-making capabilities of an expert system (ES). The DSSs on the market today are an outgrowth of data processing tools, while ESs are an applied outgrowth of artificial intelligence (Luconi *et al.* 1986). The combination of DSS and ES tools available in an ESS extends the capabilities of computer software to enhance data analysis, problem solving, training, and decision making by the potential users.

Developing an ESS involves a Domain Expert, a Knowledge Engineer, and Potential Users of the ESS. The Domain Expert is very knowledgeable within a specific scope

of specialization; in this case, a water quality expert. The Knowledge Engineer works with the Domain Expert and the Potential Users of the ESS to design and build the ESS (Figure 1).

The potential users of the ESS will operate the ESS as a training and water quality assessment tool.

The hypothesis for this study is as follows:

> *Given the problem statement, both the cultural water quality assessment needs and EPA requirements for Tribal 305(b) water quality assessment reports can be met through the development of an expert support system.*

The ESS was developed to address the following five study objectives:

- Develop ESS software that provides a logical framework to assess Tribal water quality and includes the steps needed to produce water quality summary tables for a Tribe's first CWA Section 305(b) Water Quality Assessment Report;

- Tailor the ESS to Tribal environmental personnel with little or no background in water quality assessment;

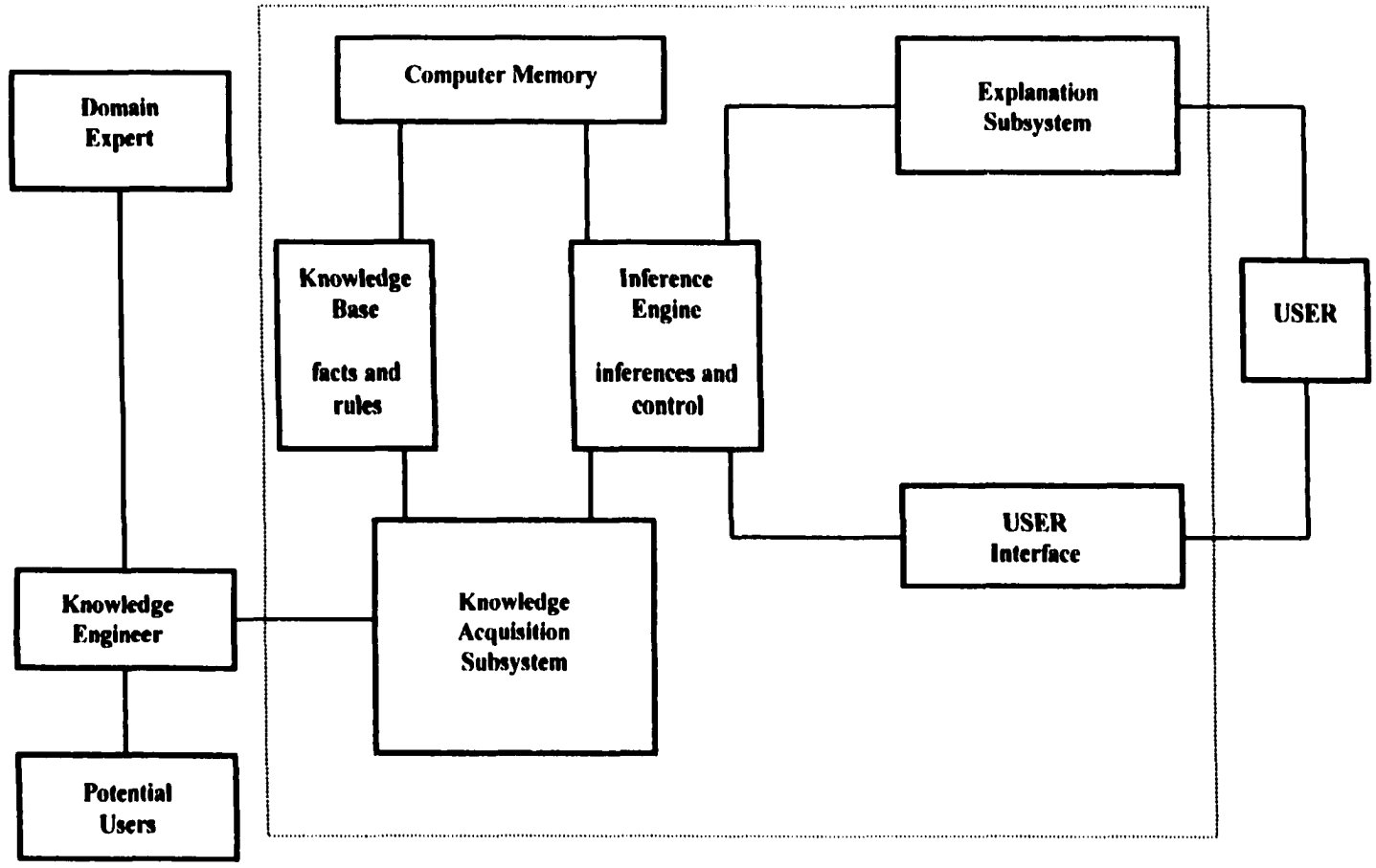


Figure 1. Components of an Expert Support System (modified from Edmunds, 1988)

- Incorporate into the ESS educational routines, examples, and useful Internet links that allow for further evaluation at the user's discretion;

- Select an ESS software package that has a user-friendly interface, requires no programming, requires no prior user training, and has a low level of input data complexity; and

- Select an ESS software package that can be made available in the public domain.

1.3 Contribution of the Study

This study is designed to be an unbiased system to inform Tribal environmental decision makers relative to water quality goals of compliance, restoration, and maintaining conditions. This study will promote the efficient use of personnel responsible for assessing water quality on Indian Reservations. The ESS developed in this study will enhance the ability of Tribes to arrive at sound assessment decisions regarding water quality and will provide these potential users with the rationale for making such decisions. It is impossible to address all possible decisions, so this study will focus only on assessing ground and surface water quality to determine beneficial use impairment. A few examples of the reasons for Tribal environmental regulatory personnel to make assessment decisions are as follows:

- To assess compliance with water quality standards
- To assess whether swimming and wading areas are safe for recreational uses

- To assess sources of water contamination
- To assess causes of non-compliance with water quality standards
- To assess appropriate protection of cultural and ceremonial use of waterbodies

The decisions that will be incorporated into the ESS have been made numerous times by water quality professionals in the past; however, the importance of the ESS developed in this study and the ESS's contribution to science is that it will be the first software program designed to address the logical steps taken to arrive at an informed decision regarding water quality impairment. The ESS will also be the first interactive training tool developed for use by Tribal environmental personnel to make decisions regarding water quality impairment of public health and the environment on Indian Reservations. Developing the approaches for decision making as incorporated into the ESS will require the greatest creative thinking and will provide this study's major contribution to the field of water quality. The decision-making approaches were developed using EPA's multiple guidelines for determining the degree of use support for beneficial or designated uses of waterbodies (USEPA 1997a) and selecting the best guideline as a standard approach for the ESS. The selection involved a standardized use of the following five use support determinations: fully supporting, fully supporting but threatened, partially supporting, not supporting, and unassessed. The EPA's guidelines are inconsistent in the use of the terms "unassessed" and "fully supporting but threatened". However, these terms are consistently used in the ESS to describe conditions of insufficient data available (unassessed) and conditions of meeting all water quality criteria with either a degrading trend, or detected

contaminants, or a land use that could potentially impair water quality (fully supporting but threatened).

2.0 WATER QUALITY ASSESSMENT REVIEW

2.1 Review of Tribal Environmental Needs of the Expert Support System

In the United States, Indian Tribes have faced unique constraints in assessing and protecting water quality (for both human health and the environment) on their Reservations. The EPA's assessment, regulatory, and enforcement strategies to protect the nation's water quality have been largely dependent on delegating to states authority under sections of the CWA. Indian Reservations are held in trust by the federal government and are not under the jurisdiction of any state. Reservations also do not typically receive federal funding for states or revenues generated by state, county, and local agencies. Consequently, since the passage of the 1972 Federal Water Pollution Control Act (PL92-500), commonly known as the Clean Water Act or CWA, the 547 federally recognized Tribes and their land areas (which comprise over 53 million acres on 345 Reservations (larger than the total area of the New England states), have been denied the benefit of billions of dollars in EPA state funds to support water quality programs.

The most recent reauthorization of the CWA, referred to as the Water Quality Act of 1987 (PL100-4), provides a mechanism for changing this regulatory oversight through Section 518 (Appendix A). Section 518 requires the EPA to promulgate regulations

specifying how it will treat qualified Tribes as states under the CWA. Federally recognized Tribes with Reservation land have the opportunity to qualify for authority under CWA section programs and receive funding much in the same way as states do. This *treatment in the same manor as a state* status empowers Tribes to safeguard the public health and welfare of their people, as well as the environment, and allows for the development of programs to assess, protect, and manage water quality on Reservations.

The EPA's policy has been to delegate authority to any state wishing to have authority under various sections of the CWA. Once authorized, these states essentially garner a steady source of federal funds to maintain their CWA programs, whereas Tribes compete for funding from a finite amount of funds which results in fewer Tribal dollars each year for water quality programs as more Tribes receive authority to be funded. In addition, the EPA guidelines (223 pages) on producing Section 305(b) water quality assessment reports are tailored specifically for states (USEPA 1997a) and updated biennially. However, only a one-time publication (17 pages) was produced (USEPA 1995) to meet Tribes' Section 305(b) water quality assessment needs .

Many states typically pursue a water quality assessment strategy that is fragmented and make little effort to work cooperatively with other states. In addition, state water quality assessments are often approached without adequate consideration of management needs. All too often, emphasis is placed on collecting as much water

quality data as possible, rather than on defining specific management information expectations and then collecting only the necessary data. In actuality, a well-designed and implemented assessment program would provide better data at a lower cost and with less effort.

Most Tribes have fewer personnel available to assess water quality than do the 50 states. Furthermore, most states have a multitude of agencies that address water quality to some extent. The majority of Tribes have one Tribal agency made up of just one person or a few persons to assess and report on all Reservation water-quality needs. With the limited resources available to Tribes, it is important that their programs be as cost-effective and efficient as possible, and adopting an existing problematic state program would be detrimental for Tribes.

Efficient and effective water quality assessment is one of the more useful tools for managers on Reservations because of the need to protect Tribal water quality to support beneficial uses, such as swimming and fishing. Many Native Americans are tied to their lands, living in the same region in which their ancestors lived for thousands of years. Contamination of Tribal waterbodies can be particularly devastating to people who have spent their entire lives on Reservation land and to the generations that plan to continue living there.

The EPA takes three approaches to providing Tribes with technical transfer of information on Tribal 305(b) reporting: workshops, written guidelines, and funding of

grant programs under the CWA. The workshops are typically conducted regionally over one week and communicate changes in the state 305(b) guidelines for each reporting cycle. The most recent updates to the state 305(b) guidelines were issued in a memorandum (USEPA 1999), and workshops to convey the updated year 200 305(b) reporting cycle information were conducted only in EPA Region 1 (Personal Communication 2000). But only a one-time guideline of 17 pages was produced for Tribal 305(b) reports, and no updates to the publication are anticipated (Personal Communication 2000).

The ESS developed in this dissertation proposal will be an integral part of the Tribes' overall success and efficiency in assessing Tribal water quality on their respective Reservations. The ESS will enable Tribal environmental personnel to focus on their specific needs and will provide them with information necessary for successful management the quality of Tribal waterbodies. The ESS will also help Tribes develop their understanding of water quality protection and communicate and cooperate with state and other government regulatory agencies on an equal professional level.

2.2 Review of Applicable Approaches to Tribal Water Quality Assessments

The focus of this subsection is not an exhaustive review of the literature on water quality monitoring and assessment, but is a review of approaches applicable to Tribal water quality assessments. The term "applicable" is used to focus the review in a manor that considers the audience or potential users of the ESS, which are Tribal environmental personnel. There are software programs that assist users in water

quality data management such as EPA's waterbody system (WBS), but these management techniques have not been successfully applied nationwide to reservation water resources. The EPA's Center for Exposure Assessment Modeling (CEAM) in Athens, Georgia, has developed software programs for ecological risk assessment, including water quality models. Although none of these models are appropriate for a Tribe's first 305(b) water quality assessment, the following models are useful for updated 305(b) reporting or a more advanced technical analysis: Enhanced Stream Water Quality Model (QUAL2EU); A Surface Water Assessment Model for Back-Calculating Reductions in Abiotic Hazardous Wastes (SARAH); Storm Water Management Model (SWMM); A Hydrodynamic and Water Quality Model (WASP); and Water Quality Assessment (WQA): A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Waters. There are also numerous articles and texts addressing, in whole or part, water quality monitoring or assessment approaches (APHA, AWWA, and WEF 1998, Carlson 1977, De Zuane 1990, Doppelt *et al.* 1993, Eisler 1987, Eisler 1986, Eisler 1985, Hem 1985, Kunkle *et al.* 1987, Loftis and Ward 1982, MacDonald and Carmichael 1991, MacDonald *et al.* 1991, Olem and Flock 1990, Ponce 1980, Schmitt and Brumbaugh 1990, Schmitt *et al.* 1990, USCOE 1987, USEPA 1997b, USFDA 1982, USEPA 1994, USEPA 1989, USEPA 1986b, van Belle and Huges 1983, Ward 1985, Ward 1979, and Whitfield 1988). For

purposes of the ESS, only the following three documents have been selected for review:

1. *Knowing Our Waters: Tribal Reporting under Section 305(b)* (USEPA 1995)

2. *Guidelines for Preparation of the Comprehensive State Water Quality Assessments (305(b) Reports) and Electronic Updates: Report Contents* (EPA1997a)

3. *Design of Networks for Monitoring Water Quality* (Sanders *et al.* 1983)

The EPA publication entitled *Knowing Our Waters: Tribal Reporting under Section 305(b)* is a landmark for Tribal water quality assessment programs. The content of the document is appropriate and achievable given the limited Tribal resources available provided that Tribal environmental personnel have access to interactive technical assistance. A modification to the state 305(b) report contents (USEPA 1997a) is provided in the Tribal 305(b) guidance document (USEPA 1995) as follows.

- An atlas table describing Tribal water resources
- A description of Tribal water quality programs and issues of concern
- Descriptions of monitoring programs and assessment methods
- Summary tables of use support in streams, lakes, and estuaries

- Summary tables of causes and sources of impairment
- Map(s) of waterbodies showing degree of use support, causes, and sources
- A description of public health concerns
- Narrative or tabular presentation of ground water resources and problems
- A table listing waterbodies, degree of use support, causes, and sources

The knowledge gap between presentation of the EPA's requirements, as bulleted above, and the knowledge necessary to conduct these assessment exercises is large for most Tribal environmental agencies. The proposed ESS was developed to narrow or eliminate the knowledge gap. The monitoring, assessment, and reporting aspects of the EPA's Tribal 305(b) reporting requirements are covered in the ESS.

The Tribal 305(b) guidance document displays a figure depicting the relationship of 305(b) reporting to monitoring and assessments as presented below.

Step 1. Interagency Coordinating and Monitoring Design

Step 2. Field Sampling

Step 3. Laboratory Analysis

Step 4. Data Management

Step 5. Assessment = Determine Use Support, Causes, Sources

Step 6. 305(b) Summary Tables and Maps (step 6 appropriately points to Step 1)

In the Tribal 305(b) guidance document a short statement accompanies each of the steps listed above. As opposed to information on conducting each step, Tribal environmental personnel are simply directed to contact the EPA for further information. The specifics regarding how to address each step are found in the voluminous state 305(b) guidance document, but extraction from that document may be too overwhelming. Once again, the proposed ESS was developed to address the six steps and narrow or eliminate the knowledge gap for Tribal 305(b) reporting.

The state 305(b) guidelines are comprehensive and contain an excellent source of information for 305(b) assessments and reporting provided the personnel using the document has the time available to pursue such an endeavor. The guidelines provide data analytical techniques and beneficial use support determination options for states to select from in the preparation of 305(b) reports. The scientific approach to water quality monitoring and assessment methods are presented in a "clearing house" fashion with EPA-preferred selections as opposed to a required standard format. Problems that most Tribal personnel would have with the state 305(b) guidelines are based on the wide range of disciplines required to understand and apply the assessment techniques. The EPA's approach to 305(b) reporting appears to be a regulatory compliance exercise that the states must conduct biennially as opposed to a comprehensive and accurate assessment of water quality conditions and concerns. The EPA's persistent allowances of options for using new or different assessment methods throughout the state 305(b) guidelines is especially problematic. The EPA could provide better guidance to Tribes and states by producing standardized 305(b)

report formats that are consistently required each biennial cycle to allow for temporal trend analyses and comparison of water quality information among Tribes and states (GAO 2000, PEER 1999).

The use of the document entitled *Design of Networks for Monitoring Water Quality* (Sanders *et al.* 1983) is appropriate for Tribal 305(b) reporting due to its total water quality monitoring system approach. Many of the concepts and methods contained in the document are too multi-disciplined for small Tribal environmental offices, but would be especially useful for the states or very large Tribal environmental offices, such as the Cherokee Nation of Oklahoma's Office of Environmental Services. The five-step process described in Chapter 7 provides a comprehensive water quality assessment approach, with some modification, for Tribal environmental personnel. The five step process, including insights into what each step contains, is as follows:

Step 1 Evaluate Information Expectations focuses on the efficient use of funds to formulate the reasons for monitoring and the development of written water quality monitoring goals and objectives.

Step 2 Establish Statistical Design Criteria identifies the hypothesis to be tested based on the monitoring goals and objectives as well as the statistical methods needed for testing the hypothesis, such as trend analysis.

Step 3 Design Monitoring Network addresses the features associated with a well planned monitoring design (e.g., selections of water quality variables, sampling sites, and sampling frequencies) which considers accessibility, time constraints, and funding compromises.

Step 4 Develop Operating Plans and Procedures covers the formalization of specific standard operating procedures and quality assurance/quality control methods to be developed prior to the commencement of the field monitoring program.

Step 5 Develop Information Reporting Procedures addresses the reporting and proper distribution of the water quality assessment in a manner that meets the information expectations that dictated the need for the monitoring program.

The most noteworthy contributions to the field of water quality assessment are steps 1 and 5 because these steps focus on the basic need for a water quality assessment and provide a mechanism for conveying useful water quality information to the public, respectively. Two modifications, for Tribal 305(b) reports, to the five step process listed above are the use of a water quality data search and determinations of beneficial use support. The water quality assessment approach used in the ESS is a modification of the five-step process presented by Sanders *et al.* (1983).

2.3 Scientific Basis for Water Quality Assessments

Science provides the basis for the water quality assessment process through the use of the scientific method, and in data analysis, assessment, and reporting. The scientific method is employed throughout the water quality assessment process by defining the method of research needed for the identified problem to be solved, for hypothesis formulation, for empirical testing of the hypothesis, and for determining data requirements. Data analysis techniques must be scientifically based to provide reliable information for assessment and reporting of water quality conditions. The collection of representative water quality data, as part of the experimental design, creates the database that is then analyzed for compliance determinations using measures of central tendency (e.g., arithmetic and geometric means) or extreme values (e.g., critically low dissolved oxygen levels for a fishery). Temporal trend analysis is a useful technique for evaluating changes over time using indicator parameters (e.g., nitrate or trophic status). It is especially useful to detect degrading trends resulting from contaminant loading or a land use modification and for measuring the success of water quality improvement projects. Another data technique requiring a scientific basis is the handling of non-detect values for data analysis in a manner that accurately represents the measured variable level. The use of either zero (an underestimated value) or the detection level (an overestimated value) are unrepresentative, while the use of one-half the detection level provides a representative central tendency approach which is used in the ESS (Nehls and Akland 1973). Science forces the use of an iterative approach to water quality assessments by allowing for a continuing

reevaluation of the representativeness and accuracy of each selected assessment method.

Two general approaches employing the use of scientific methods for water quality assessment are (1) collect as much data as possible using as many methods available as possible then determine what information the data provides, and (2) focus the data collection process on specific goals and objectives using indicator variables according to specific methods then assess the data in a manner that addresses information expectations. The U.S. Geological Survey (USGS) is the lead federal agency responsible for gathering and documenting water quality data on the nation's waterbodies and these data are published annually in Water Resources Data for the states, Puerto Rico, and the Trust Territories (USGS 1999). The USGS water quality data collection and summaries follow the former approach and do not accommodate the need for water quality data for beneficial use support determinations but are based on a suite of water quality variables deemed necessary for characterizing water quality according to USGS goals. With respect to water quality assessment methods, the EPA's 305(b) guidelines also follow the first approach and have contributed to inconsistencies and unrepresentativeness of Section 305(b) water quality assessment reporting by both the Tribes and states (GAO 2000, PEER 1999). The latter approach is recommended as a preferred standardized format for water quality assessments (GAO 2000, PEER 1999, Sanders *et al.* 1983, Whitfield 1988). The standardized approach to water quality assessments provides needed consistency and lends itself to

reliable spatial comparisons among Tribal and state geographic areas and reliable temporal comparisons, such as trend analysis and time series analysis.

To develop a standardized format for water quality monitoring, assessment, and reporting, choices must be made through the selection of certain representative methods. For a Tribe's first 305(b) water quality assessment report, the methods selected for the ESS and the rationale for selection are provided below. Cultural uses of waterbodies have not been developed by EPA (USEPA 1997a) and are therefore addressed by selecting similar EPA-established beneficial uses of water to obtain water quality criteria to support such uses. Examples include use of drinking water standards when ceremonial practices involve consumption of untreated natural water and use of contact recreation (swimming) criteria for cultural practices that involve total body immersion in natural waters. For lake studies, the trophic status indicator (TSI) was selected as the preferred measure of aquatic life indicator because of TSI is a simple and reliable measure of the water quality condition of a lake that encompasses information on nutrient status, biomass production (Carlson 1977), and can be used as a predictor of the magnitude of diel dissolved oxygen fluctuations. When crop irrigation water in the western United States is found to be unsuitable, it is often a result of high sodium relative to calcium and magnesium levels and therefore the sodium absorption ratio (SAR) was selected as the main indicator of crop irrigation use support (NTAC 1968). Drinking water contamination is caused by many constituents but nitrate is the major contributor of non-support for domestic water sources and was therefore selected as the main indicator of drinking water use support

(USEPA 1996). Both contact recreation and partial contact recreation are predominantly impaired in waterbodies as a result of bacterial contamination for which both geometric means and single sample exceedances of *E. coli* have been determined to be the best indicator of water recreational use support (USEPA 1997a). Temporal trend analysis requires consistent methods of sampling for an indicator variable (e.g., nitrate or TSI) over a minimum time period. For the ESS, a linear regression trend line through a minimum of five years of data using standard methods of sampling and analysis was selected for trend analysis (Personal Communication 1998). The final method of water quality assessment selected for the ESS was the use of a standard method of use support determination (e.g., fully supporting or partially supporting) and the use of standard tables for summarizing beneficial use support determinations.

3.0 METHODOLOGY

This section describes the seven steps followed in the development of an ESS for water quality assessment to determine beneficial use impairment of surface and ground waterbodies on Reservations.

Step 1 – Determination of User Information Needs and Expectations

The determination of user information needs and expectations was needed as the first step to provide the ESS's direction and content. The ESS users (i.e., Tribal environmental personnel) have two specific types of information needs and expectations for Tribal CWA 305(b) reporting: the EPA's water quality assessment reporting requirements and cultural water quality assessment needs..

The EPA's reporting requirements are based on its encouragement of Native American Tribes to develop the capability to assess and report on the quality of Tribal water resources. The report is a CWA Section 305(b) water quality assessment report that evaluates whether Tribal waterbodies meet numeric water quality standards and narrative water quality goals and determines beneficial use support of each water waterbody. The CWA's major objective is to determine whether waterbodies are fishable and swimmable, but other beneficial uses of water, such as drinking water,

agricultural uses, and cultural uses, are equally important (Table 1). To address this objective, it is recommended to evaluate trends (only certain parameters) and extremes to assess water quality impairment (Personal Communication 1999). The following are the EPA's requirements for Tribal 305(b) reporting (USEPA 1995):

- Produce Section 305(b) Water Quality Assessment Reports.
- Assess monitoring data in a way that is meaningful to decision makers.
- Develop the capability to assess and report on the quality of Tribal water resources.
- Call attention to issues such as beach closures and fish tissue contamination.
- Go beyond simply summarizing raw data by identifying sources and causes of impairment.

The two sources of EPA requirements for Tribal 305(b) reporting are as follows:

- *Guidelines for the Preparation of the Comprehensive State Water Quality Assessment (305(b) Reports) and Electronic Updates: Report Contents* (USEPA 1997a)

- *Knowing Our Waters: Tribal Reporting Under Section 305(b)* (USEPA 1995)

The first source was written for state 305(b) reporting, and although its contents are extensive and often very useful for Tribal 305(b) reporting, the EPA's 1995 guidelines

Table 1. **Beneficial Uses of Tribal Waterbodies**

Cultural	
• Ceremonial Uses	• Religious Uses
• Wetland Plant Harvesting	• Sweat Lodges
Human Health	
• Contact Recreation (swimming)	• Drinking Water
• Partial Contact Recreation (wading and boating)	• Shellfishing
	• Fish Consumption
Environment	
• Cold-water Aquatic Life	• Fish Propagation
• Wildlife Propagation	• Wetlands Habitat
• Warm-water Aquatic Life	• Crop Irrigation
• Livestock Watering	

are more appropriate for Tribal use and have been selected to provide the direction and content of the ESS. The 1995 guidelines include references to the approach and presentation of one of the first Tribal 305(b) reports produced in the United States (Johnson *et al.* 1994).

The user needs and expectations of Tribal environmental personnel are based on the EPA requirements described previously as well as the cultural needs of each Tribe. Cultural needs include the assessment and reporting of beneficial use support of waterbodies used for ceremonial, religious, and cultural purposes. The cultural needs and expectations for Tribal 305(b) water quality assessment reports are as follows:

- Identify ceremonial, religious, and other cultural beneficial uses of Tribal waterbodies.
- Develop appropriate numeric water quality criteria to protect beneficial uses.
- Develop appropriate narrative water quality criteria to protect beneficial uses.
- Identify sources and causes of water quality impairment for Tribal waterbodies.
- Document water quality information in a single report for public distribution.

The approach taken for generating information on Tribal environmental personnel's user needs was to document in field notebooks meetings on Reservations or in villages (Mexico) with individuals associated with a Tribe. Because Tribal personnel, especially elders, have a strong reliance on the oral tradition or oral history, the approach taken for garnering information on specific user needs was through casual

conversation. Although informal in nature, two questions were always asked during a meeting: "What concerns do you have regarding the protection of water quality?" and "What are the cultural or ceremonial uses of water practiced today by Tribal members?" Preference was given to one-on-one contact with Tribal environmental personnel at their office and in the field whenever possible.

The ESS was tailored to the users' available multi-disciplined resources while accommodating the diverse cultural use of water by Native Americans. The ESS has user-friendly prompts to guide users through the data analysis components that will ultimately lead them through the decision-making process using either real or sample data. The ESS is also educational in that it provides users with not only the appropriate decision, but also with information within the ESS knowledge bases that provides an explanation justifying the decision.

An ESS is useful only if it responds to the needs and expectations of the potential users and contains current and accurate information. To meet these basic needs, an ESS must be able to make and justify water quality decisions based on site-specific information and sound scientific reasoning. To supplement these basic parameters and to determine their specific needs and expectations, feedback from Tribal environmental personnel, especially potential users of the ESS, was solicited (Table 2). These needs and expectations were explored and, as applicable, provided direction on the final content of the ESS.

Table 2. Meetings with Tribal Environmental Personnel to Discuss User Needs

Tribe or Nation	Contact Person	Title	Agency	Date of Contact
Ak Chin Indian Community	Patrick Trusty	Director	Env. Prot. Dept.	03-11-99
	Elaine Peters	Director	Him-Dak Eco.	02-05-99
	Carol Lopez	Enroll. Officer	Tribal Enroll.	05-11-99
	Terry Enos	Prev. Chairman	Tribal Office	02-04-99
Campo Band of Kumeyaay Indians	Ralph Goff	Tribal Chairman	Tribal Office	06-28-94
	Fidel Hyde	Assist. Director	Envir. Prot. O.	05-14-96
	Desi Vela	Water Specialist	Envir. Prot. O.	06-29-94
	George Jones	Water Specialist	Envir. Prot. O.	06-29-94
Chemehuevi Indian Tribe	David Chavez	Chairman	Tribal Office	02-07-00
Cherokee Nation of Oklahoma	Dwyane Beavers	Director	O. Envir. Serv.	09-17-95
	Tim Houseberg	Director	O. Envir. Serv.	05-10-94
Cocopah Indian Tribe	John Swenson	Director	Envir. Prot. O.	11-09-98
	Colin Sota	Technical Assist.	Envir. Prot. O.	11-09-98
Colorado River Indian Tribes	Conner Byestewa, Jr.	Director	Envir. Prot. O.	09-16-94
	Dillon Esquerra	Water Specialist	Envir. Prot. O.	05-20-94
	Duncan Fisher	Water Program	Envir. Prot. O.	11-07-98
Fort Mojave Indian Tribe	Delbert Holmes	Water Technician	Dept. Nat. Res.	11-04-98
	John Algots	Director	Dept. Nat. Res.	09-12-97
Karuk Tribe of California	Little Man	Prev. Chairman	Tribal Office	08-02-94
	Bob Rohde	Natural Resources	Dept. of Nat. Res.	08-01-95
Moapa Band of Paiute Indians	Eugene Tom	Chairman	Tribal Office	02-01-99
	Calvin Meyers	Director	Dept. Envir. Prot.	02-01-99
Necua Kumeyaay	Julian Dominguez	Water Engineer	Tribal Office	03-04-94
Quechan Indian Tribe	Delores Miller	Water Technician	Envir. Dept.	01-09-96
	Mike Jackson	President	Tribal Office	05-24-95
	Keeney Escalanti	Vice President	Tribal Office	05-24-95
San Carlos Apache Tribe	Loretta Stone	Env. Prog. Coor.	EPA Office	09-21-99
	Harrison Talgo, Sr.	Administrator	Tribal Office	04-08-99
	Darryl DJ Monette	Habitat Specialist	Rec. & Wildlife	11-16-95
	Cliff Schluesner	Fish Biologist	USFWS	11-01-99
San Jose de Lazorra	Juan Ayes	Director	Con Grupo Escula	03-04-94
Santa Catarina	Juan Labnaze	Pipi Chief	Tribal Office	08-04-94

Although solicitation can be accomplished over the telephone, the approach used was to visit Tribal environmental personnel at their areas of study (i.e., Reservations in the U.S. and Indian villages in Baja Mexico). Travels to Baja Mexico provided glimpses of pre-Columbian water quality management of Native American people thanks to the existing primitive societies that appeared to have changed little over the last 300 years. Visits to Baja Mexico required both Spanish-English and Kumeyaay-English interpreters. The term "Tribal environmental personnel" is used loosely in these villages because Tribal ceremonies, lifestyle, and religious practices are typically tied closely to water resources. Tribal leaders, cultural advisors, and Tribal members actively practicing cultural uses of waterbodies were very insightful in their concerns for environmental water quality assessment and protection. The initial approach to assessing water quality using an ESS covered only fishable and swimmable uses of stream waters. However, visits to the Kumeyaay Villages in Baja, Mexico resulting in the ESS covering all Tribal waterbodies, based on the Kumeyaay's continued protection and management of spring sources, ponds constructed at the spring source, and riparian areas (wetlands) surrounding the spring source for wildlife habitat and natural water purification. Visits were also made to San Francisco and Washington, D.C. to meet with EPA personnel.

Environmental personnel from the following Tribes were contacted:

- Ak-Chin Indian Community (Pima and Tohono O'odham, previously Papago)
- Campo Band of Kumeyaay Indians

- Chemehuevi Indian Tribe
- Cherokee Nation of Oklahoma
- Cocopah Indian Tribe
- Colorado River Indian Tribes (representing Mojave, Chemehuevi, Hopi, and Navajo)
- Fort Mojave Indian Tribe
- Karuk Tribe of California
- Moapa Band of Paiute Indians
- Necua Kumeyaay (Baja Mexico)
- Quechan Indian Tribe
- San Carlos Apache Tribe
- San Jose de Lazorra Kumeyaay Indians (Baja Mexico)
- Santa Catarina Kumeyaay

Only six of the 32 contact persons listed in Table 2 were not Native Americans. However, all six of the non-Native Americans had spent sufficient time on a Reservation to provide useful information on user needs for the ESS.

Step 2 – Expert Support System Software Selection

The next step was to select a software program to use to develop the ESS. The requirements for the ESS were as follows:

User-Friendly Interface – The ESS software must incorporate a single icon (either in Microsoft Explorer or on the desktop) that opens the ESS when double-clicked. The screens constituting the ESS interface must be easy to read text in dialog boxes accompanied by relevant pictures, whenever possible.

No Programming Required – No computer programming or macros must be required to navigate the ESS. The internal software must use menu-driven prompts to carry out all data analysis computations.

No need for previous training – The ESS must stand alone without requiring user training prior to use. A *Users Manual* (including a tutorial) must be written to provide the user with a guide for navigating the ESS.

Low level of input data complexity – The ESS was not designed to require nor handle large databases, such as spreadsheets or U.S. Geological Survey (USGS) formatted water quality data. The complexity of the user-required input data is intentionally low-level, such as entering numbers for water quality calculations or responding to menu-driven inquiries.

Available as public domain software – The ESS executable file and *Users Manual* were made available on the Internet for free as public domain software.

This study emphasized the use of a strong knowledge base in water quality assessment, as opposed to the software programming aspects of ESS development. To accommodate this emphasis, a software shell for the selected software was proposed. A shell is a developed interactive tool used by the Knowledge Engineer to design and build an ESS without the need for expert programming. By using a shell, the need to write new code is eliminated and the Domain Expert can serve as the Knowledge Engineer (Figure 2). The following ESS programs were evaluated:

- M-4 Classic Shell (Personal Consultants)
- ESTA (PDC Prolog Corporation)
- EXSYS
- VP Expert (decision analysis)
- Expert Choice
- PC Plus (Texas Instruments)
- CLIPS (NASA)

The expert systems EXSYS, VP Expert, Expert Choice, PC Plus, and CLIPS were not interfaced with a shell, and M-4 Classic Shell was a good choice but did not provide a good graphical interface. Expert System for Text Animation (ESTA) met all the requirements described above, was recommended by Dr. Darrell Fontane (a Colorado

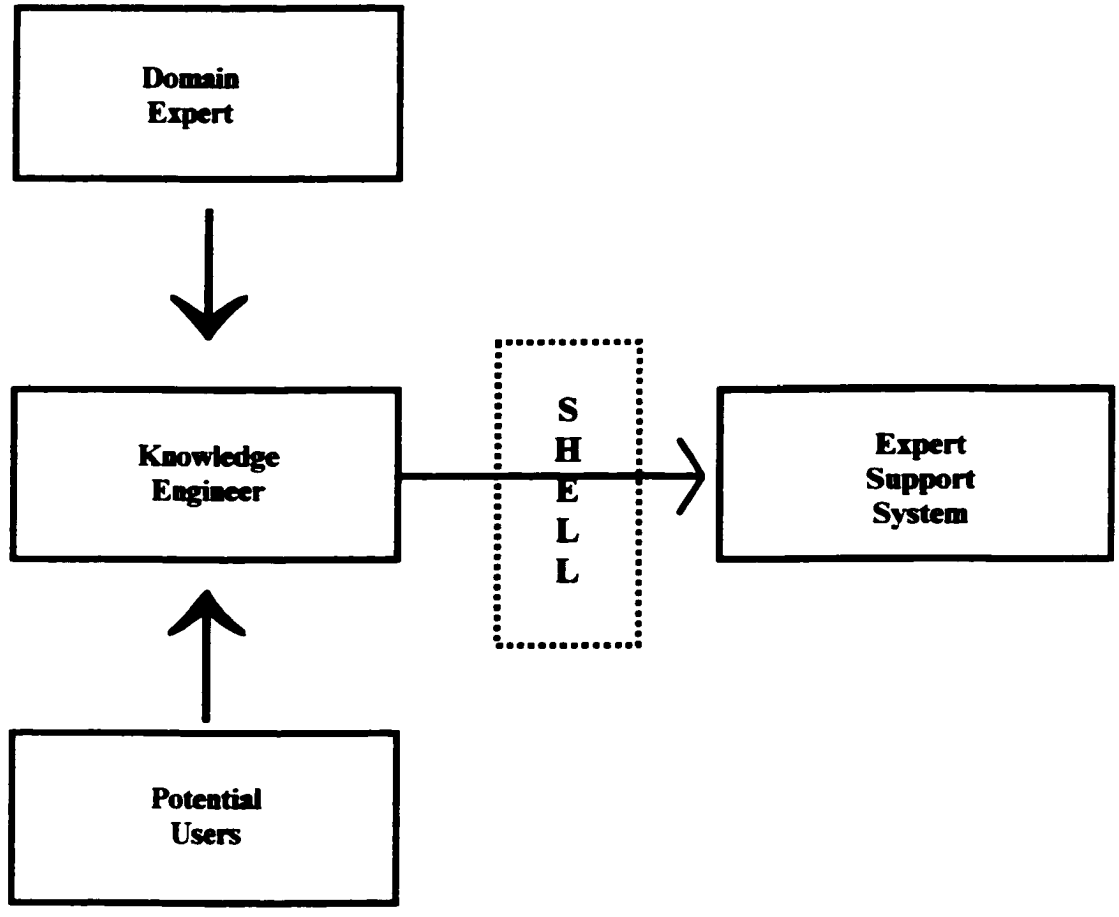


Figure 2. Expert Support System Development Interaction Using a Shell

State University professor who uses ESs (1996 Personal Communication), and was ultimately selected to produce the ESS.

Step 3 – Expert Support System Design

The ESS design covered in this step was based on the need for a decision making tool associated with assessing water quality for beneficial use support determinations and on the need to add to the user's water quality knowledge. Figure 3 illustrates the approach used in the design of the water quality assessment process which was modified from Sanders *et al.* (1983); Figure 4 displays the entire ESS design, which incorporates additional educational routines, Internet links, and water quality management strategies. Table 3 provides the approaches used for developing the knowledge bases for the ESS's water quality assessment portion that involves decision making.

To maintain a manageable and useable ESS, the ESS must be focused and must have boundaries. The ESS focuses on assessing Tribal waterbodies to determine water quality impairment of beneficial uses (Table 1). Fishable beneficial uses include the safe consumption of fish and shellfish by humans and the protection of aquatic life support of desirable fish and other aquatic organisms. Swimmable beneficial uses are recreation on and in the water, including contact recreation (swimming) and partial-contact recreation (wading, boating, and fishing). Other beneficial uses include drinking water, wildlife propagation, wetlands habitat, crop irrigation, livestock watering (USEPA 1986a, USEPA 1976, NAS 1973, and NAS 1972), and religious,

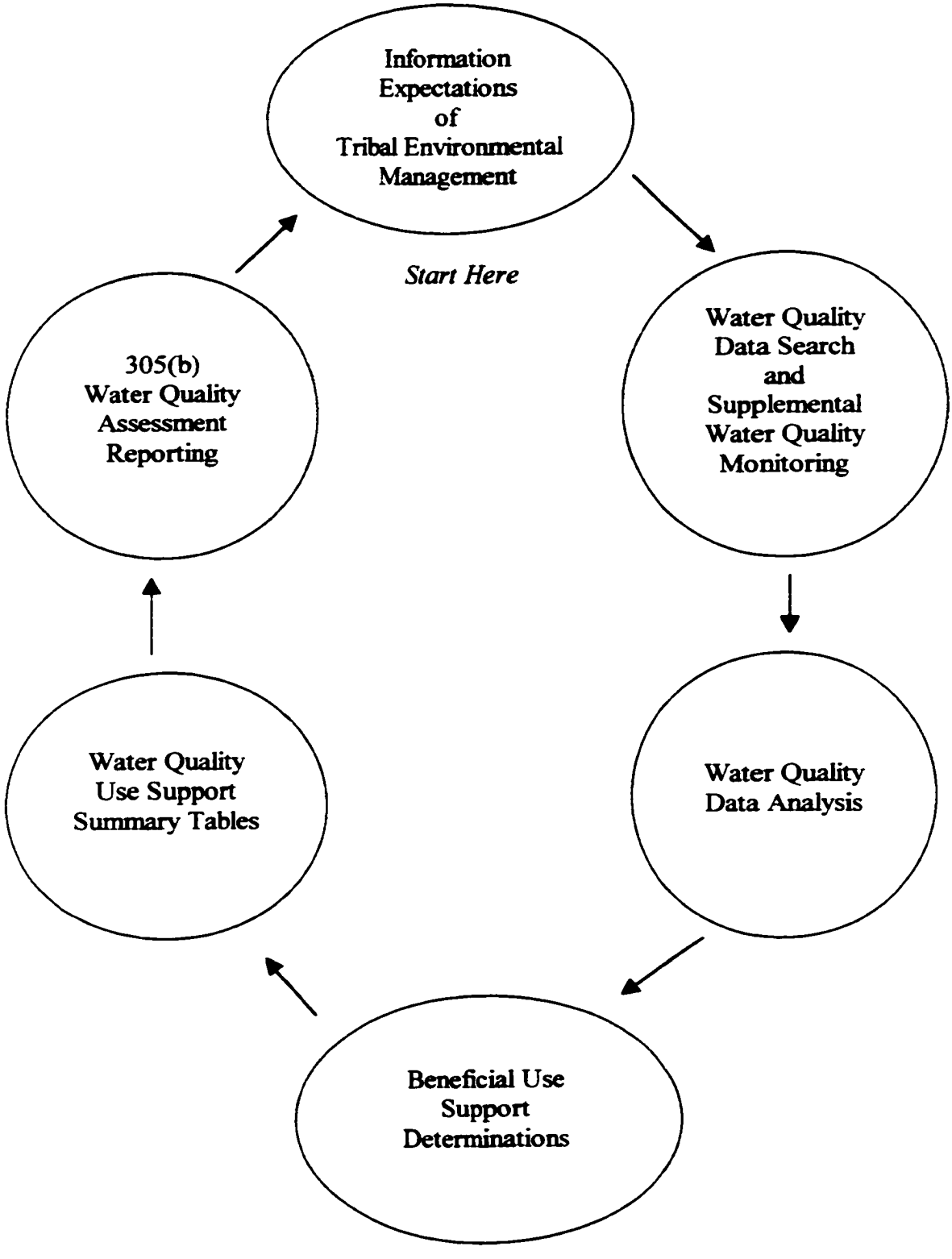


Figure 3. Approach Using Information Expectations for Water Quality Assessments

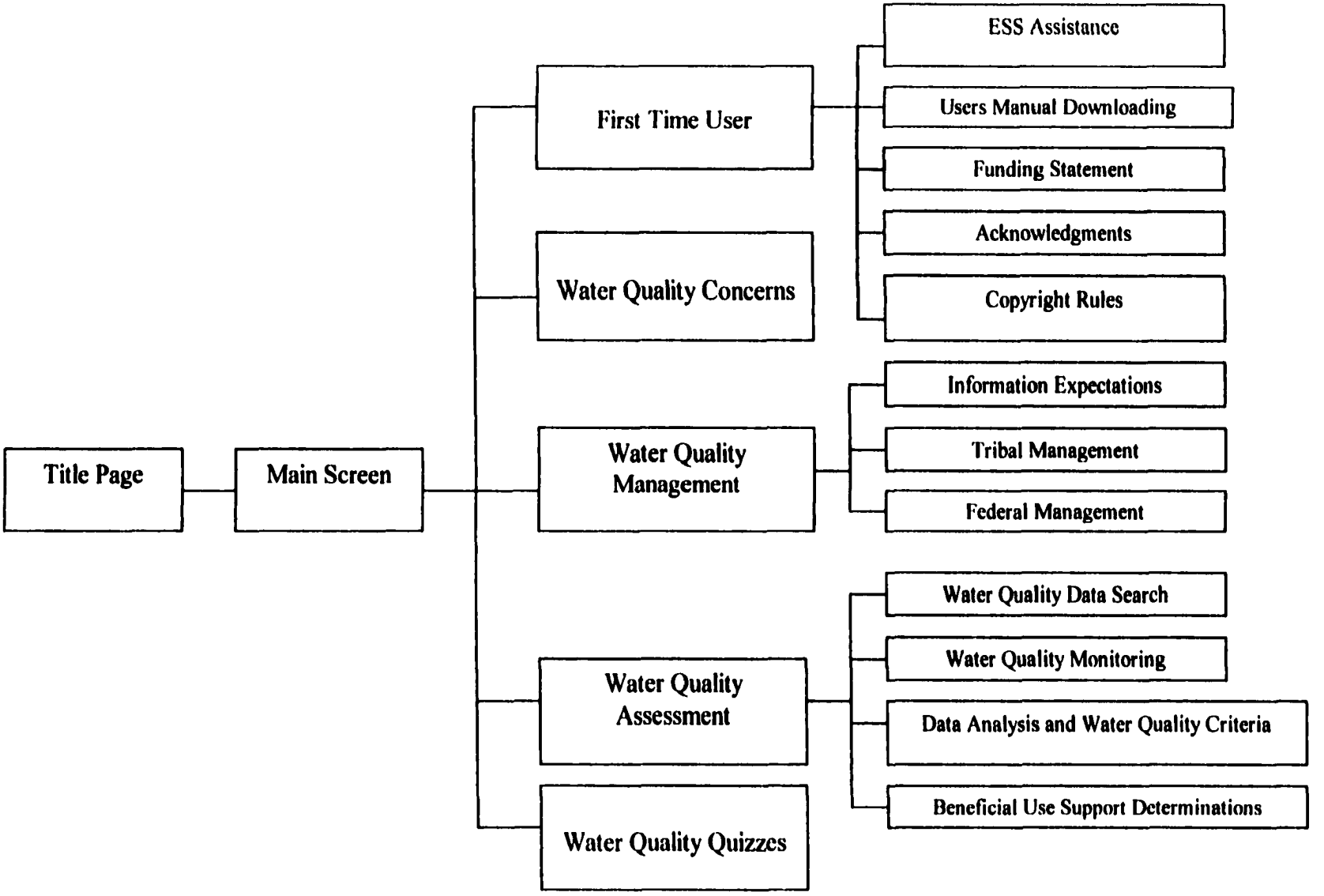


Figure 4. Expert Support System Design Tree

Table 3. Summary of Approaches Used in the ESS for Water Quality Assessments

Water Quality Assessment Tool	Approach
Water Quality Data Search	Provide information (agency name and Internet address or phone number) on contacting sources of existing water quality data.
Water Quality Monitoring	Provide information on minimum water quality monitoring recommendations for each specific beneficial use of water. Information includes reasons why to monitor, when to monitor, how often, and a list of indicator parameters.
Water Quality Data analysis	Provide a menu-driven mechanism for calculations and provide examples of statistics (temporal trend analysis and handling detection levels) used in water quality analyses.
Water Quality Criteria	Provide a list of the latest water quality criteria (including references) for use in determining exceedance evaluations.
Beneficial Use Support Determination	Provide a menu-driven mechanism for determining whether specific beneficial use support is met or not according to EPA requirements under the latest Section 305(b) guidelines.

ceremonial, and cultural uses of water. By limiting the ESS to only beneficial uses and water quality, the ESS can provide specific and detailed responses rather than simple generalities.

The concepts, or problem-solving components, of the ESS are derived from water quality concepts, theories, and processes and will be the basis upon which water-quality decisions will be made. The problem-solving components include, but are not limited to, established water quality criteria/standards, scenarios, trends, and heuristics (i.e., rules of thumb). Potential users begin by responding to a specific question, then the ESS guides them through a series of prompts that helps them understand which data they need and which method(s) to use to make a decision regarding beneficial use support of Tribal waterbodies.

For example, if a user wants to know if a lake is safe for swimming, the ESS steps the user through a series of screens addressing information needed to make a decision regarding the acceptability of the lake water for recreational uses such as swimming. After the user has acquired the necessary information, the ESS prompts the user for this information and a decision is made as to the suitability of the lake for swimming. The ESS decision is based on EPA's use support determinations for waterbodies (USEPA 1997a) with the addition of cultural use decision making. The decision of suitability is scientifically based on EPA's beneficial uses for Tribal waterbodies (USEPA 1995), EPA and its predecessors' water quality criteria guidelines (USEPA 1986a, USEPA 1976, NAS 1972, and NTAC 1968) as presented in Appendix C, and a

standardized format for making beneficial use support decisions as presented in Appendix D.

The ESS was initially designed to be operational without a manual, but a *Users Manual* was later determined to accompany the ESS. The *Users Manual* incorporates the following three aspects:

- Available in hard copy to assist user in navigating through the ESS
- A tutorial to teach 305(b) water quality assessment concepts through examples
- Presents an example of a water quality assessment that produces 305(b) tables

A copy of the *Users Manual* is included in Appendix B.

Step 4 - Knowledge Acquisition

The objective of the knowledge acquisition step was to gather information on water quality assessment needs and package this information into the ESS. The initial approach to acquiring knowledge for the ESS was to gather sufficient information required by the ESS to create a First Times Users and Water Quality Assessment knowledge base. However, conversations with Tribal environmental personnel and EPA project officers dictated the need for additional knowledge bases on Water Quality Concerns, Water Quality Management, and Water Quality Quizzes.

The First Time Users knowledge base was developed using the initial approach and the following information:

ESS assistance information and ESS overview –The names of the author and an EPA contact, as well as addresses and phone numbers for both individuals, are provided. The ESS overview briefly describes the four categories covered in the ESS.

Information on how to obtain the Users Manual – A brief description of the *Users Manual,* as well as an Internet address to download the manual from the Native American homepage of the Colorado River Indian Tribes (CRIT), are provided.

Funding statement – A statement on the funding for the development of the ESS through CWA Section 106 grant numbers I-999465-97-0 and I-999465-98-0 as well as recognition of the CRIT Environmental Protection Office and Colorado State University, are provided.

Acknowledgements – A list by name and affiliation of individuals contributing to the ESS development is provided.

Copyright rules – A statement is made regarding the ESS being in the public domain, but the software documentation is copyrighted.

The Water Quality Assessment portion of the ESS involves the development of four knowledge bases for assessing Tribal water quality with respect for beneficial use support. The Water Quality Assessment knowledge bases were developed using the initial approach and the following information:

Water quality data search – Information was obtained to describe both numeric and narrative water quality data searches. Sources of water quality data were obtained to provide the user with Internet links and phone numbers for data searches.

Water quality monitoring – Water quality information was acquired on beneficial uses (Table 1) for the following types of waterbodies:

- Streams and rivers
- Lakes
- Estuaries or coastlines
- Wetlands
- Ground water

The EPA does not recognize ground water as a waterbody, but the ESS treats ground water as one of many waterbodies with beneficial uses to Tribes.

Data analysis and water quality criteria – Information was obtained on data analysis (Table 4) and water quality criteria (Table 5) to provide the user with a menu-driven

Table 4. Methods of Water Quality Data Analysis Used in the ESS

Analytical Outcome	Data Requirements	Analytical Method	Source of Information
Bacteria Geometric Mean	-Minimum of five weekly bacteria data	Geometric mean = exp (geometric mean) of ((ln (bacteria1) + ln (bacteria2) + ln (bacteria3) + ln (bacteria4) + ln (bacteria5))) / 5	Quality Criteria for Water [Gold Book] (USEPA 1986a)
Detection Level	-Minimum detection level	Detection level / 2 = value (for use in data analysis)	Nehls and Akland (1973)
Sodium Absorption Ratio (SAR)	-Calcium conc. -Magnesium conc. -Sodium conc.	SAR = (Na * 0.0435) / (sqrt (0.5 * ((Ca * 0.0499) + (Mg * 0.08229))))	Water Quality Criteria [Green Book] (NTAC 1968)
Temporal Trend	-Minimum five years of data -Simple linear regression	Slope of simple linear regression line through a minimum of five years of data	Personal Communication (1998)
Trophic Status Indicator (TSI)	-Secchi disk depth -Total phosphorus level -Chlorophyll *a* level	TSI = ((8.23 * ln (chl *a*) + 33) +(14.42 * ln (Total P) + 4.15) + (60 - 14.41 * ln (Secchi disk depth))) / 3	Carlson, R.E. (1977)
TSI (secchi disk depth only)	-Secchi disk depth	TSI = (60 - 14.41 * ln (Secchi disk depth))	Carlson, R.E. (1977)

Table 5. Sources of Information for Ambient Water Quality Criteria

Ambient Water Quality Criteria	Sources of Information
Aquatic Life	-Quality Criteria for Water 1986 (The Gold Book)
Contact Recreation (swimming)	-Quality Criteria for Water 1986 (The Gold Book)
Crop Irrigation	-Water Quality Criteria 1972 (The Blue Book)
Cultural	- Quality Criteria for Water 1986 (The Gold Book) [criteria based on similar beneficial uses]
Drinking Water (domestic water use)	-Quality Criteria for Water 1986 (The Gold Book)
Fish Consumption	- EPA Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories (1997b)
Livestock Watering	-Water Quality Criteria 1972 (The Blue Book)
Partial Contact Recreation (boating and wading)	-Quality Criteria for Water 1986 (The Gold Book)
Shellfishing	- EPA Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories (1997b) -Quality Criteria for Water 1986 (The Gold Book)
Wetlands	-Statewide Wetlands Strategies (World Wildlife Fund 1992)
Wildlife Propagation	-National Technical Advisory Committee Water Quality Criteria 1968 (The Green Book) -Nevada Division of Environmental Protection Water Quality Regulations (April 1997)

tool for water quality computations required by EPA in Tribal 305(b) reporting and the most recent water quality criteria for determining exceedances, respectively. EPA's amendments to the Water Quality Criteria publication process has eliminated revisions to crop irrigation, livestock watering, and wildlife criteria since 1972 (since 1968 for wildlife propagation). Yet Tribal environmental personnel have expressed concern for these beneficial uses of Tribal waterbodies since reservation lands typically contain large areas of irrigated farmlands, livestock grazing, and habitat for hunting. Furthermore, the EPA has not developed water quality criteria for cultural uses of waterbodies. To address this regulatory oversight, the ESS contains the following beneficial uses that were determined to be sufficiently similar for water quality assessments of cultural uses of waterbodies:

CULTURAL USE	SIMILAR USE
Ceremonial consumption of untreated water	Drinking water standards
Wetland plant harvesting	Wetlands protection
Sacred waterbodies	Outstanding waters
Ceremonial bathing in natural waters	Contact recreation
Sweat lodges	Partial contact recreation

Beneficial use support determinations – The EPA's guidelines on Section 305(b) reporting (USEPA 1997a) were used as an information guide to generate use support determination rule bases and to provide the ESS's decision-making ability. The

artificial intelligence aspect of the ESS is most apparent in the Beneficial Use Support Determination rule base.

The rule bases for use support determinations are presented in Appendix D. The development of a rule base involved a consistent approach to arriving at one of the following five beneficial use support determinations:

Fully Supporting

Fully Supporting But Threatened

Partially Supporting

Not Supporting

Unassessed

Prior to a use support decision the water quality data were analyzed using data analysis techniques and comparisons to water quality criteria established for protection of a given beneficial use of a waterbody. The data analysis techniques and water quality criteria used in the ESS are presented in Appendix C. The following rationales were then used to make the use support determination decision:

A fully supporting decision required no water quality criteria exceedances and no detected contaminants. The term "no detected contaminants" was defined as value equal to or greater than half the water quality criteria value.

A fully supporting but threatened decision required no water quality criteria exceedances, but either contaminants were detected (at a value equal to or greater than half the water quality criteria value), or a degrading trend in a water quality criteria contaminant was apparent, or a land use was present that posed a threat to the beneficial use support of a waterbody.

A partially supporting decision required intermittent exceedances of water quality criteria. The term 'intermittent" was defined as an exceedance frequency between 5 and 10% of the available data.

A not supporting decision required consistent exceedances of water quality criteria. The term "consistent' was defined as an exceedance frequency greater than 10% of the available data.

An unassessed decision was the default decision when there was insufficient data available for making a beneficial use support decision for a waterbody.

When multiple pre-decisions were made for a given beneficial use support determination, the approach taken in the ESS was conservative in that the least supporting pre-decision was the final decision. For example, if the aquatic life beneficial use support pre-decision was fully supporting using toxicity data, but a pre-decision was made of not supporting using physical habitat structure, then the final decision was that the waterbody was not supporting.

The statistical concepts and equations contained in the ESS are those required for Tribal 305(b) assessment and reporting (USEPA 1995). The following statistical concepts and equations are covered in the ESS:

- Temporal trend (water quality degradation trend over time and improvement over time) (Personal Communication 1998) [Addressed by example through the tutorial of the *Users Manual* in Appendix B.]
- Extreme values (compliance with water quality criteria and standards)
- Geometric means (bacteria data analysis)
- Minimum detection levels (use of one-half the detection level for computations as opposed to zero)
- Monitoring design (indicator parameters, sampling site selection, sampling time period and frequency, information expectations, and databases)

The Domain Expert was responsible for contributing technical knowledge gained from both formal education and practical experience. During this stage, the essential components and complexity of the ESS were documented, and limits were imposed upon the ESS. Limits kept the ESS focused and kept the ESS contents from becoming too cumbersome.

Step 5 - Prototype Development

This step involved developing a prototype as a precursor to the final ESS. The development of the prototype ESS took two years to complete and contains ten knowledge bases with a total of 3,742 lines of code. Methods were developed to represent the relevant knowledge in a manner that facilitates accurate decision-making by the ESS's users. The problem-solving techniques of the ESS simulate reasoning rather than computation; reasoning logic is typically displayed as If-Then and If-Then-Else statements. An example of an If-Then statement for determining beneficial use support for aquatic life in the ESS is presented in Table 6.

The purpose of the prototype was to test how well the system performs in light of its well-defined concepts and hardware. The prototype was a fully operating ESS without the fine tuning required of a final product. The prototype was a reasonably workable system, and passed in-house testing before it was considered an acceptable prototype. These tests included (1) usability, (2) acceptability and verification of the rule base, and (3) applicability to the needs of the potential users as determined by the Domain Expert.

The three components of the prototype package are as follows:

- Expert Support System
- *Users Manual*
- Review and Comment Form

Table 6. Example of an If-Then Statement Used in the ESS

section aquatic_life : 'To evaluate whether aquatic life use support (ALUS) of a waterbody is being protected.'
advice'Aquatic life use support (ALUS) determinations are based on the following data analyses:

1. Bioassessments of biological assemblages (fish, macroinvertebrates, or algae) using biological criteria or biocriteria which are numeric values or narrative expressions describing the reference biological condition if aquatic communities.
2. Habitat assessments of stream or lake beds, flow regimes, and riparian zones
3. Physical and chemical analyses (e.g., DO, chlorine, metals, pesticides)
4. Whole effluent toxicity (WET) and sediment toxicity testing results

Note: The selection and characterization of reference sites is recommended as a useful approach to ALUS determinations.'

if (biol_data_aquatic = 'un_biol_aquatic' and hab_data_aquatic = 'un_hab_aquatic' and chem_data_aquatic = 'un_chem_aquatic' and tox_data_aquatic = 'un_tox_aquatic') advice 'Beneficial use support classification is UNASSESSED.'
if (biol_data_aquatic = 'un_biol_aquatic' and hab_data_aquatic = 'un_hab_aquatic' and chem_data_aquatic = 'un_chem_aquatic' and tox_data_aquatic = 'un_tox_aquatic') chain"
if (biol_data_aquatic = 'not_biol_aquatic' or hab_data_aquatic = 'not_hab_aquatic' or chem_data_aquatic = 'not_chem_aquatic' or tox_data_aquatic = 'not_tox_aquatic') advice 'Beneficial use support classification is NOT SUPPORTING.'
if (biol_data_aquatic = 'not_biol_aquatic' or hab_data_aquatic = 'not_hab_aquatic' or chem_data_aquatic = 'not_chem_aquatic' or tox_data_aquatic = 'not_tox_aquatic') chain"
if (biol_data_aquatic = 'part_biol_aquatic' or hab_data_aquatic = 'part_hab_aquatic' or chem_data_aquatic = 'part_chem_aquatic' or tox_data_aquatic = 'part_tox_aquatic') advice 'Beneficial use support classification is PARTIALLY SUPPORTING.'
if (biol_data_aquatic = 'part_biol_aquatic' or hab_data_aquatic = 'part_hab_aquatic' or chem_data_aquatic = 'part_chem_aquatic' or tox_data_aquatic = 'part_tox_aquatic') chain"
if (biol_data_aquatic = 'threat_biol_aquatic' or hab_data_aquatic = 'threat_hab_aquatic' or chem_data_aquatic = 'threat_chem_aquatic' or tox_data_aquatic = 'threat_tox_aquatic') advice 'Beneficial use support classification is FULLY SUPPORTING BUT THREATENED.'
if (biol_data_aquatic = 'threat_biol_aquatic' or hab_data_aquatic = 'threat_hab_aquatic' or chem_data_aquatic = 'threat_chem_aquatic' or tox_data_aquatic = 'threat_tox_aquatic') chain"
if (biol_data_aquatic = 'fully_biol_aquatic' or hab_data_aquatic = 'fully_hab_aquatic' or chem_data_aquatic = 'fully_chem_aquatic' or tox_data_aquatic = 'fully_tox_aquatic') advice 'Beneficial use support classification is FULLY SUPPORTING.'
if (biol_data_aquatic = 'fully_biol_aquatic' or hab_data_aquatic = 'fully_hab_aquatic' or chem_data_aquatic = 'fully_chem_aquatic' or tox_data_aquatic = 'fully_tox_aquatic') chain"

The ESS is the interactive menu-driven software that was tailored to the needs of Tribal environmental personnel while incorporating the EPA's Tribal 305(b) reporting requirements. Testing and verification of the accuracy of the knowledge bases were conducted from 1996 to 2000. The ESS was tested by conducting trial runs of the program with Tribal environmental personnel on the Colorado River Indian Reservation from June 1998 to January 2000, the EPA personnel from Region IX in San Francisco in October 1998, and EPA personnel from the EPA Region VIII in Denver in April 1999. Verification of the knowledge bases was conducted in February 2000 by the Assessment and Watershed Protection Division of the U.S. Environmental Protection Agency in Washington, D.C. The verification process involved determinations of the truth or correctness of the decision-making abilities of the ESS. Comments were obtained over the telephone and addressed in the final ESS.

The *Users Manual* for the ESS used the following guidelines and was written according to preferences voiced by Tribal environmental personnel:

- The manual needs to be available in hardcopy and as a downloadable Internet file.
- A written, easy-to-follow tutorial is needed.
- The 305(b) process and statistical concepts need to be presented as examples.
- Both completed (example) and blank copies of the 305(b) tables are needed.
- An example of a determination of beneficial use support for cultural uses is needed.

These five guidelines have been incorporated into the *Users Manual* (Appendix B).

The graphical interface of the ESS was enhanced during the prototype development step through the use of pictures. The majority of the bitmaps comprising the pictures database are from the EPA's state 305(b) guidelines (USEPA 1997a) and were acquired from the Research Triangle Institute, an EPA consulting firm. The pictures database is accessible by all the ESS knowledge bases and provides the user with images accompanying many of the menu screens.

A review and comment form was also developed to accompany the prototype ESS and *Users Manual* (Figure 5). Note that the form included the previous title "Interactive Program" for the final ESS. The form was developed through iterative discussions with Tribal environmental personnel at the Colorado River Indian Tribes' Environmental Protection Office.

Step 6 - Prototype Testing and Validation

During this step, nine Tribal environmental personnel, three EPA specialists working in the field of Tribal water quality assessment, and two personal reviewers were solicited to review and comment on the overall usefulness and applicability of the prototype ESS and *Users Manual.* The Tribal environmental personnel (potential users of the ESS), EPA specialists (personnel providing oversight of Tribal water quality programs), and personal reviewers were solicited to use a review and comment

REVIEW AND COMMENT FORM

Do you have comments on the enclosed software prototype entitled *An Interactive Program to Aid Tribal Environmental Personnel in Water Quality Assessment and Management*?
☐ YES ☐ NO

If you selected YES, please provide your hand-written or typed comments on this page. Attach additional pages of comments if you wish.

What did you like about the interactive program?_____

_____

What did you not like about the interactive program?_____

_____

Please list all errors in the interactive program that need to be corrected._____

_____

Would you like to be contacted to discuss your review of the interactive program prototype?

☐ YES ☐ NO

Would you like your name & organization included in the acknowledgements for the interactive program? ☐ YES ☐ NO

Please provide any additional comments or suggestions on the interactive program.

_____

Name:_____Organization:_____

Date:_____ Phone Number:_____ Email Address:_____

Please return this form to : Stephen Johnson
Water Quality Technology, Inc.
123 North College Avenue, Suite 215
Fort Collins, Colorado 80524

Review and Comment Deadline is January 31, 2000

Figure 5. Review and Comment Form Used in the Prototype Development

form (Figure 5) to list their likes, dislikes, and constructive criticism of the prototype's operation. The prototype review and comment period lasted one month, from January 1, 2000 to January 31, 2000. However, difficulties in convincing some reviewers to complete the prototype resulted in a subsequent 30-day period in which individuals were given the option of providing comments over the telephone. Table 7 provides a summary of the review team's documented likes, dislikes, and errors in the prototype ESS and *Users Manual*. The tutorial in Appendix B was used in the testing process and provided feedback that the ESS provided valid and consistent decisions.

Step 7 – Final Expert Support System Development

The development of a final ESS was the last step of the study. This step involved reviewing and analyzing the previous testing and validation step's user feedback to determine the direction to be taken for final ESS development. Table 8 summarizes modifications made to the prototype ESS to produce the final ESS. The final ESS was released to the CRIT's Environmental Protection Office and to EPA Region IX in San Francisco and EPA Headquarters in Washington, D.C. for use as public domain software. The executable ESS and *Users Manual* released to the CRIT's Environmental Protection Office reside on the Internet at www.naein.com/NativeAmerican/crit/index.html.

Table 7. Expert Support System Review and Comment Sheet Summary

Affiliation	Reviewer and Title	Likes of the ESS	Dislikes of the ESS	Errors
Ak-Chin Environmental Protection Department	Patrick Trusty, Director	1. excellent time saver	1. no back-up button 2. need fully supportive criteria	None
Cherokee Nation Office of Environmental Services	Dwayne Beavers, Director	1. useful and easy to use 2. basic overview provided	1. need list of guidance books 2. should include EPA websites	None
Cocopah Environmental Protection Office	Wilbert Thomas, Water Pollution Specialist	1. all three quizzes	1. water quality problems in need of immediate attention	None
Colorado River Indian Tribes EPO	R. Dillon Esquerra, Water Quality Specialist	1. the quizzes 2. water monitoring information	1. more information could be added to answers to the quizzes	None
Colorado River Indian Tribes EPO	Duncan Fisher, Water Quality Technician	1. water quality quizzes 2. definitions	None	None
Colorado River Indian Tribes EPO	Lesa Flores, Solid Waste Officer	1. tutorial was easy to use 2. new and useful information	None	None
Karuk Tribe of California Dept. of Natural Res.	Scott Quinn, Water Pollution Specialist	1. easy to use 2. a lot of information	1. need federal and state water quality criteria recommendations	None
Moapa Band of Paiute Indians Dept. Envir. Prot.	Colleen Patrick, Water Pollution Specialist	1. learning capacity it projected 2. you learned from it	1. the answer on the quiz that gave a whole group of grants	None
San Carlos Apache Tribal EPA Office	Loretta Stone, Environ. Programs Coordinator	1. good interactive training tool 2. prompts are easy to follow	None	None
U.S. Environmental Prot. Agency - Headquarters	Tod Dabolt, GIS Coordinator	1. good format for maneuvering 2. follows 305(b) algorithms	1. no backup button available 2. need to discuss biocriteria	None
U.S. Environmental Prot. Agency - Region IX	R. Wendell Smith, EPA WPCP Program Manager	1. excellent for Tribal 305(b) 2. manual is well thought out	1. need a 800 assistance number 2. need assistance seminars	None
U.S. Environmental Prot. Agency - Region IX	Kristin Gullatt, EPA Project Officer	1. great tool for tribes 2. definitions are very useful	1. manual is boring 2. manual needs some color	None
Water Quality Technology, Inc.	Terry Geiselman, Registered Geologist	1. directions/training for 305(b) water quality assessments	1. awkward zoom button 2. usefulness of the why button	Noted errors.
Water Quality Technology, Inc.	Jodi Johnson, Editor/Bookkeeper	1. explain and why buttons 2. English grammar style	None	None

Table 8. Modifications to the ESS Using the Review and Comment Sheets

Affiliation of Reviewer -Tribal Presence on the Reservation	**Dislikes of the ESS**	**Modifications to the Expert Support System**
Ak-Chin Environ. Protection Dept. -Pima Indians -Tohono O'odham (previously Papago)	1. no back-up button 2. need fully supportive criteria	1. instructions on how to return to screens 2. included text on fully supportive criteria conditions using the Explain buttons
Cherokee Nation Office of Environmental Services -Cherokee Nation	1. need list of guidance books 2. need technical references 3. should include EPA websites	1. included listings of guidance documents 2. included listings of technical references 3. expanded links for EPA Web sites
Cocopah Environ. Protection Office -Cocopah Indian Tribe	1. tribal response/assessment of water quality problems in need of immediate attention	1. addressed in ESS knowledge base on Water Quality Concerns
Colorado River Indian Tribes EPO -Chemehuevi Indians -Hopi Indians -Mojave Indians -Navajo Indians	1. answers could be added to the quizzes when an answer is selected incorrectly	1. included the correct answer with each incorrectly selected answer
Karuk Tribe of California Natural Res. -Karuk Tribe of California	1. need federal and state water quality criteria recommendations	1. included text on federal and state water quality criteria recommendations
Moapa Dept. of Environmental Prot. -Moapa Band of Paiutes	1. the answer on the quiz that gave a whole group of grants	1. shortened the answer to the quiz question to include only a subset of important grants
San Carlos Apache Tribal EPA Office -San Carlos Apache Tribe	None	1. none
U.S. Environmental Prot. Agency – Headquarters	1. no backup button available 2. need to discuss biocriteria	1. instructions on how to return to screens 2.included discussion of biocriteria in ESS
U.S. Environmental Prot. Agency - Region IX	1. need a 800 assistance number 2. need assistance seminars	1. included phone numbers and contacts 2. to be address in the summer of 2000
U.S. Environmental Prot. Agency - Region IX	1. manual is boring 2. manual needs some color	1. included a more exciting example in the manual 2. changed the example figure to color
Water Quality Technology, Inc.	1. use of the zoom button 2. use of the why button	1. addressed use of the ZOOM button in the manual 2. addressed use of the WHY button in the manual

4.0 RESULTS AND INTERPRETATION

4.1 Study Results

The ESS and *Users Manual* were first developed as prototypes that were released on the Internet at http://www.naein.com/NativeAmerican/crit/index.html. Problems associated with the downloading of the ESS executable file from the Native American Web page dictated use of another form of distribution. Therefore, a Zip disk was used to distribute the prototype ESS, *Users Manual*, and Review and Comment Form to the reviewers. A hard copy of the *Users Manual* and Review and Comment Form accompanied the Zip disk. The final ESS and *Users Manual* are easy to download and reside on the Internet at the URL address listed above. The following sections provide discussions of the direction and content of the final ESS and *Users Manual*.

Final ESS

The main menu screen for the ESS (Figure 6) is used for navigation through the menu-driven program. There are five options for the user to pursue using the Main menu as a base.

Main Menu – The Main menu screen illustrated in Figure 6 provides a base for selecting and moving into all the knowledge bases of the ESS. Once a user has

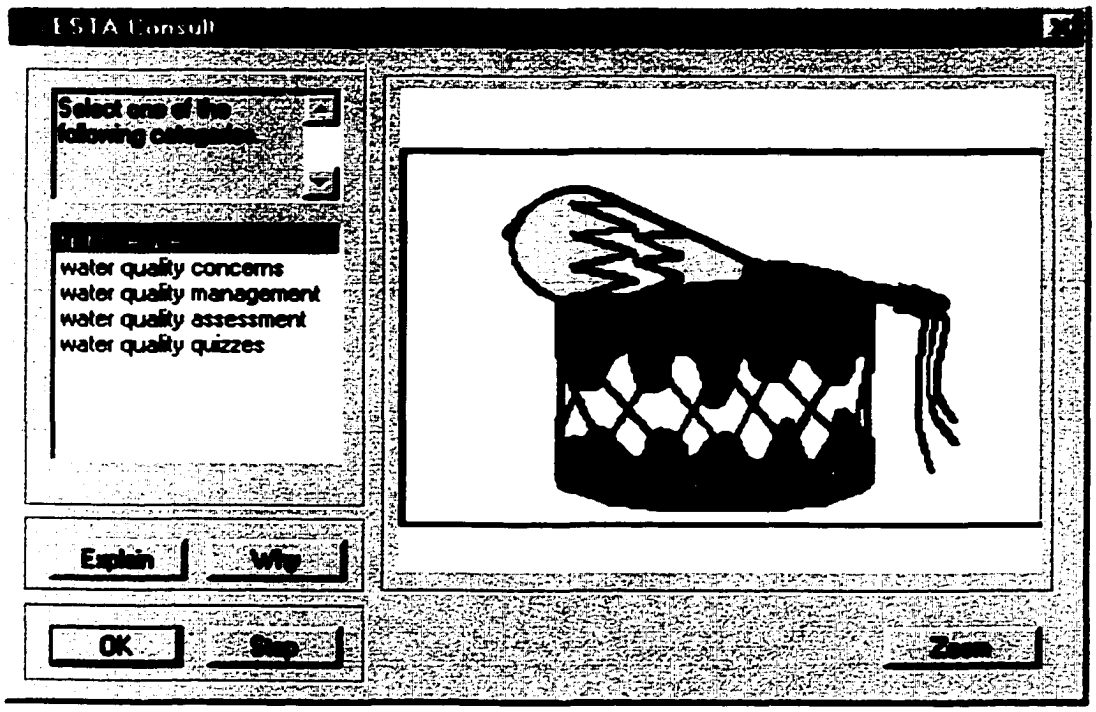


Figure 6. Main Menu Screen for the Expert Support System

entered a new knowledge base, the ESS always allows the user the opportunity to return to the Main menu.

First Time User – The First-Time User menu provides ESS assistance information (Table 9), an overview of the ESS's content (Figure 6), acknowledgements, and copyright rules for the software used to develop the ESS (Table 10).

Water quality concerns – The Water Quality Concerns knowledge base provides information on reasons to respond to various concerns or complaints regarding water quality. Recommendations are made on what to do during a water quality investigation, how to conduct the investigation, equipment and other monitoring needs, examples of water quality concerns, who to contact for assistance, and where and how to report the investigation. A water quality concerns example of a fish kill investigation is provided in Table 11 and the recommended format for the investigation report is provided in Table 12.

Water Quality Management – The Water Quality Management knowledge base provides useful information expectations, Tribal water quality management, and federal water quality management. Table 13 lists the information on recommendations and examples of water quality information expectations of Tribal environmental management. The concept of and commitment to Tribal sustainable

Table 9. First Time User Overview for the Expert Support System

The following information is presented in the Expert Support System (ESS) to provide the user with an overview of assistance, ESS content, and the ESS manual.

If you need assistance with any portion of this program, please contact either Stephen Johnson or Wendell Smith as follows:

Stephen Johnson
Water Quality Technology, Inc.
123 North College Avenue, Suite 215
Fort Collins, Colorado 80524
970-224-5289

or

R. Wendell Smith
U.S. Environmental Protection Agency-Region IX (WTR-10)
75 Hawthorne Street
San Francisco, California 94105
415-744-2018

This ESS is designed for Tribal environmental personnel and covers the four categories:

Water Quality Concerns - To aid in Tribal response and assessment of water quality problems in need of immediate attention.

Water Quality Management - To aid in understanding options available for Tribal management of water quality on Reservations.

Water Quality Assessment - To aid in assessments of water quality.

Water Quality Quizzes - To provide question-answer quizzes that teach the water quality topics covered in this program.

This program is not intended to be used for database management.

A manual is provided to guide you through this program.

The manual contains a tutorial to provide an example of how to use this software program by following steps beginning with determining the information expectations of Tribal environmental management and ending with producing tables for a Tribal 305(b) water quality assessment report.

For a copy of the manual, download the manual file from the CRIT Home Page which you can be reach on the internet at www.1800cleanup.org. Click on the Native Americans icon, then on the CRIT Home Page icon.

Table 10. Software License Agreement and Copyright Statement

The following information is presented in the Expert Support System to address software license agreement and copyright infringement requirements.

This program is in the public domain and can be used by anyone.

However, the documentation of the software used to create this program is copyrighted, and all rights are reserved. It may not be reproduced, transmitted, stored in a retrieval system, or translated, either by electronic, mechanical, or any other means, without the prior written consent of the Prolog Development Center in Atlanta, Georgia 404-872-5243.

ESTA and PDC Prolog are trademarks of Prolog Development Center. ESTA uses the bwcc.dll dynamic link library from Borland International and included artwork originally distributed with Microsoft Word.

Table 11. Expert Support System Example of How to Respond to a Fish Kill

The following information is presented in the Expert Support System to provide the user with a recommended approach of how to respond to a fish kill.

REASON TO RESPOND TO A FISH KILL
To determine the cause of the fish kill

WHAT TO DO
1. Respond immediately to a fish kill; evidence can disappear quickly.
2. Interview the person who reported the fish kill
3. Visit the area and take notes and photographs of your observations
4. Conduct water quality measurements and collect water samples for analysis

HOW TO DO IT
1. Interview: Record the name, phone number, and all comments of the person(s)
-Conduct all interviews as soon as possible, usually after completion of sampling
-Interviews often provide leads concerning the cause of the fish kill
-Ask the person that reported the fish kill to describe what they observed and when
-Interview others who live nearby the lake or stream (both upstream and downstream)
-Take good notes of your interviews, leave nothing to memory
-Record the full name(s), phone numbers, and addresses of persons interviewed

2. Visit: Good field notes and photographs are important for documentation
-A thorough investigation of the lake shoreline or river banks is a good start
-The upstream area of the fish kill can often provide good evidence of causes
-Potential causes to look for are pipes, ditches, flumes, or evidence of discharges
-Take photographs of any visual evidence of the fish kill

3. Water Quality: the types of water quality measurements depends on the cause of the fish kill
-If you do not know the cause, sample for metals, pesticides, and major ions
-Field measurements always include water temperature, DO, pH, conductivity, and turbidity
-Sample the top one inch of sediment for potential metals or pesticide contaminants
-Sample dead fish for metals and pesticides by wrapping the fish with aluminum foil and freezing before sending it to the laboratory

EQUIPMENT NEEDS
1. Cooler and ice for storing water, sediment, and fish samples
2. Camera (especially one that prints a date on the photographs)
3. Field notebook (preferably waterproof)
4. Permanent marker pens
5. Map of the area (to indicate the location of the problem)
6. Waders
7. Fish net
8. Dissolved oxygen, pH, turbidity, and conductivity meters
9. Sample bottles and preservatives for collecting water samples

Table 11. Expert Support System Example of How to Respond to a Fish Kill (continued)

10. Aluminum foil, plastic bags, and labels for collecting fish samples
11. Wide-mouth jars for collecting sediment samples
12. Dissecting equipment and Bouins solution for preserving fish organs for histological tests

EXAMPLES OF CAUSES OF FISH KILLS

1. Fish present above a discharge point, but not below, indicate the discharge as the cause
2. Releases from upstream reservoirs can result in a pulse of toxic low oxygen water
3. Fish killed by metals typically have a precipitate on the gills
4. NPDES discharge data from upstream outfalls can be evidence of the cause
5. Pesticide applications by aerial spraying during even low winds can result in toxic drift
6. Discharges from upstream sewage lagoons or other septic systems can be toxic
7. Compare water quality, fish tissue, and sediment analyses with water quality standards

WHO TO CONTACT FOR ASSISTANCE

1. Tribal Game and Fish personnel
2. Regional EPA personnel
3. U.S. Fish and Wildlife personnel
4. State Game and Fish personnel

REPORTING

1. Tribal newsletter article
2. Call Jim Siegel at (304) 876-7482 to discuss fish kill investigations
3. Contact a university that handles fish kills using the internet such as at Mississippi State (www.ext.msstate.edu/anr/wildlife/fisheries/fishkill).

Table 12. Brief Report Format for Documenting Water Quality Investigations

The following information is presented in the ESS to provide the user with a recommended brief report format for documenting water quality investigations.

A report should be short, direct, and easy to read. Include the following seven items in your report.

1. Title (describes the type of water quality concern and the location)

2. Date and time of the concern or problem, and the investigation personnel

3. Data on the person who reported the concern: name, address, phone number, and comments

4. Explain, in simple terms, what happened (extent, duration, and anything or anyone exposed)

5. Describe the cause of the concern or problem, or your best guess as to the cause

6. Include all field and laboratory data as well as interpretations of the data

7. Conclusion (need for follow-up study, enforcement action, or a plan to prevent another concern or problem)

Table 13. Water Quality Information Expectations of Tribal Management

The following information is presented in the ESS to provide recommendations of water quality information expectations of Tribal environmental management.

Information expectations are the reasons why water quality monitoring, assessment, and reporting are conducted.

Monitoring simply for the sake of collecting water quality data is short-sighted; you often collect data that is not useful in the assessment. Instead the information expectations provide a purpose for the establishment of each monitoring site, each analysis of a water quality parameter, the duration of the monitoring program, and the assessment and reporting of the water quality data.

In this program, the use support of beneficial uses for each tribal waterbody provides the basis for determining information expectations.

The three general types of information expectations for Tribal environmental management are:

1. Do tribal waterbodies support beneficial uses of waterbodies?

2. Are there any trends towards non-support of beneficial uses?

3. Do water quality complaints indicate non-support of uses?

Management Approach: State in simple terms water quality concerns regarding whether Tribal waterbodies are supporting beneficial uses. Examples include:

1. Is irrigation water safe for crops?
2. Is the water safe for watering cattle and other livestock?
3. Is stream water suitable for support a fishery?
4. Is the lake water at a beach safe for swimming?
5. Is the stream water safe for wading?
6. Is the untreated well water safe to drink?
7. Are the fish safe for humans to eat?
8. Are the fish safe for waterfowl to eat?
9. Is the water safe for ceremonial bathing?
10. Is it safe to collect wetland plants for basket weaving?

There are both temporal trends (significant changes over time) or spatial trends (hot spots or areas of elevated contaminant levels). Temporal trend examples include:

1. Are algal blooms occurring more often in a lake?
2. Are nitrate levels in the drinking water well increasing over time?
3. Has the acreage of wetlands decreased over time?
4. Is the lake changing from a bass fishery to a carp fishery?
5. Is salt cedar encroachment along the river increasing each year?

Table 13. Water Quality Information Expectations of Tribal Management (continued)

Spatial trend examples include:
1. Is the river more saline below the agricultural drain?
2. Are nitrate levels in ground water higher near the irrigated crops?
3. Are bacteria levels in the river too high for safe swimming?
4. Do the largemouth bass contain unsafe levels of DDT?
5. Is the stream reach below the old mine tailings toxic to fish?

Examples of drinking water complaints are:
1. The well water used for drinking smells like rotten eggs and stains the sink.
2. My children get sick after swimming in the lake.
3. There are dead fish floating down the stream.
4. The wetland plants we collect for basket weaving are sprayed by pesticides.
5. The fish we eat out of the lake smell like gasoline.
6. There are floating mats of yellow plant material on the lake surface.
7. My cattle get sick and lose weight after watering at a certain stock tank.

development (President's Council on Sustainable Development 1996) are emphasized in this section as follows:

Sustainability is inherent in Native American management of water quality.

Traditional Tribal ways of management involve many practices of sustainability. Sustainability refers to managing water quality in a manner that maintains water resources at levels that allow future generations of Tribal members the same or similar benefits of water quality protection.

Examples of ways a Tribe can improve sustainability on a Reservation are as follows:

- *Acquiring Tribal authority for Section 401 certification to ensure that future projects do not violate Tribal water quality standards*

- *Implementing best management practices (BMPs) for crop production that maintain soil nutrients and minimize erosion*

- *Implementing BMPs for livestock grazing that improve and maintain good range conditions*

- *Maintaining well production from drinking water aquifers that increase and maintain water table levels*

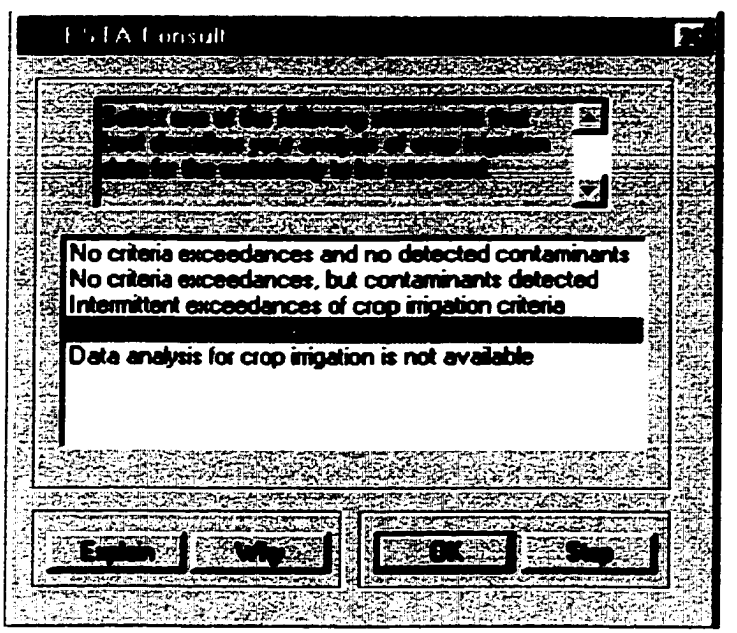
- *Developing and implementing Tribal mechanisms that result in no net loss and long-term gain in Reservation wetlands*

Water Quality Assessment – Figure 7 displays the ESS' assessment screen and beneficial use support classification statement for an assessment of the suitability of water for crop irrigation. Table 14 summarizes the information used to provide Internet addresses and phone numbers for water quality data searches. Table 15 list recommended methods for lake water quality monitoring.

Water quality quizzes – Three water quality quizzes provide a media for teaching water quality concepts and understanding assessment and management needs of Tribal environmental programs.

Users Manual

The *Users Manual* in Appendix B serves many purposes. First of all, the manual provides users with a hard copy guide to the ESS. The manual also includes a comprehensive tutorial to assist users in navigating through the ESS screens. The following is extracted from the tutorial section of the *Users Manual*.



Beneficial use support classification is NOT SUPPORTING

Figure 7. Example of Beneficial Use Impairment Determination Using the ESS

Table 14. Water Quality Data Search Summary

Water Quality Data Need	Agency to Contact	Internet Address or Phone #
Compliance history of NPDES dischargers	U.S. Environmental Protection Agency	- www.epa.gov
Compliance history of public water systems	U.S. Environmental Protection Agency	- www.epa.gov/OGWDW/
Cultural water quality concerns	Cultural Advisory Group	-tribal contacts
Endangered species	U.S. Fish and Wildlife Service	- www.endangered.fws.gov/esa
Fish contaminant levels	U.S. Fish and Wildlife Service	- www.fws.gov
National wetlands inventories	U.S. Fish and Wildlife Service	- www.nwi.fws.gov
Pollutant levels in drinking water	Indian Health Services	-www.ihs.gov -drinking water hotline phone # 800-426-4791
Section 305(b) reporting	U.S. Environmental Protection Agency	- water305b.rti.org
State 305(b) reports	State environmental protection agency	-AZ (www.adeq.state.az.us) -CA (www.state.ca.us/s/environ) -NV (www.state.nv.us) -other states (www.state.##.us)
STORET data from EPA's water quality database	U.S. Environmental Protection Agency	- www.epa.gov
Water resources data	U.S. Geological Survey	-www.usgs.gov

Table 15. Example of Water Quality Monitoring Recommendations for a Lake

The following information is presented in the Expert Support System to provide the user with recommendations for water quality monitoring in a lake.

This section is designed to provide minimum lake monitoring recommendations for a Tribe's first 305(b) water quality assessment report. The material is intentionally brief and simple. Suggestions and sources of additional information on lake monitoring are provided at the end of this section.

Conduct lake water quality monitoring as presented below for every beneficial use that a lake either currently supports or has the potential to support.

1. Drinking Water Supply
Why: To evaluate the suitability of lake water for drinking
When: Any time of the year the lake could be used as a drinking water supply
How Often: 1 to 2 times per year
Valuable Indicators: TDS, nitrate, iron, manganese, coliform bacteria

2. Cultural Uses (specific to each Tribe, so an example is provided)
Why: To evaluate the suitability of water for bathing as part of a ceremony
When: During the time period when the water is used for ceremonial bathing
How Often: 5 samples weekly for a 30 day period
Valuable Indicators: fecal coliform bacteria or *E. coli*

3. Crop Irrigation
Why: To evaluate the suitability of lake water for irrigating crops
When: During the time when crops are being irrigated
How Often: 1 time during the crop irrigation season
Valuable Indicators: TDS, SAR (sodium, calcium, and magnesium)

4. Livestock Watering
Why: To evaluate the suitability of lake water for watering livestock
When: During a time when the lake could be used for livestock watering.
How Often: 1 to 2 times per year
Valuable Indicators: TDS, fecal coliform bacteria, blue-green algae

5. Swimming (contact recreation)
Why: To evaluate the suitability of lake water for swimming
When: During the swimming season (possibly May to September)
How Often: 5 samples weekly for a 30 day period
Valuable Indicators: fecal coliform bacteria or *E. coli*

Table 15. Example of Water Quality Monitoring Recommendations for a Lake (continued)

6. Wading and Boating (secondary contact recreation)
Why: To evaluate the suitability of lake water for wading and boating
When: During the wading and boating season (possibly April to October)
How Often: 5 samples weekly for a 30 day period
Valuable Indicators: fecal coliform bacteria or *E. coli*

7. Fish Consumption
Why: To evaluate whether fish in the lake are safe to eat
When: During the fishing season
How Often: 1 time during the fishing season
Valuable Indicators: mercury, PCBs, pesticides of fish filets

8. Aquatic Life Support
Why: To evaluate how well the lake supports aquatic life
When: Any time of the year the lake could be used as a drinking water supply
How Often: 1 to 4 times per year
Valuable Indicators: shoreline riparian acreage loses, trophic status, fish diversity, dissolved oxygen fluctuations, chronic toxicity testing

Suggestions
1. Review the section on data analysis for SAR and beneficial uses
2. Contact a local bacteriological laboratory for bacteria sampling information
3. A fish shocker is useful for fish consumption studies

Sources of Additional Information
1. Access the EPA internet address for lakes at www.epa.gov/owow/lakes/lakes.html
2. Access the EPA general internet address at www.epa.gov
3. Corps of Engineers 404 permits internet address
www.usace.army.mil/inet/functions/cw/ceco/reg/sec404.htm
4. USFWS endangered species information internet address
www.endangered.fws.gov/esa.html
5. USFWS national wetlands inventory internet address www.nwi.fws.gov/
6. National listing of Fish Consumption Advisories at www.epa.gov/ost/fishadvice/
7. Biocriteria information internet address www.epa.gov/owow/monitoring/

This tutorial is designed to teach you how to use the expert support system by following an example. The example starts with identifying water quality information expectations of tribal environmental management on a small fictitious Indian Reservation, then water quality monitoring guidelines are reviewed with respect to the water quality information expectations, next water quality data are collected, analyzed, and assessed, and finally summary tables for a simple tribal 305(b) water quality assessment report are produced.

The five steps in this tutorial are as follows:

Step 1 *Water quality information expectations of tribal environmental management are identified*

Step 2 *Water quality monitoring guidelines are reviewed*

Step 3 *Existing water quality data are obtained and additional water quality sampling is conducted*

Step 4 *The collected water quality data are analyzed and assessed*

Step 5 *The water quality assessment information is presented in summary tables for a tribal 305(b) report*

The *Users Manual* describes the contents and intent of the ESS. Also provided in the *Users Manual* are water quality definitions, references, and blank 305(b) tables for use in Tribal water quality assessment reporting.

4.2 Achievement of Study Objectives

The developed ESS achieved the following study objectives:

- The ESS provides a logical framework for assessing Tribal water quality conditions.

- The ESS does not require users to have a background in water quality assessment.

- The ESS incorporates examples, educational routines (e.g., water quality quizzes), and Internet links that provide users with additional reference materials.

- The selected ESS package (ESTA using PROLOG as the computer language) is menu-driven with user friendly interfaces, requires no programming experience or prior training, and operates on a low level of input data complexity.

- The ESS and *Users Manual* are free, available for download on the Internet, and in the public domain.

5.0 CONCLUSIONS AND RECOMMENDATIONS

An ESS has been developed to address the problem statement by facilitating the Tribal 305(b) reporting process. The study hypothesis is accepted through the development of an ESS that meets the cultural water quality assessment needs and EPA requirements for Tribal 305(b) reporting. The ESS also addresses the five study objectives as presented in section 4.2.

The EPA is working with the Tribes and states in a manner that allows the option of selecting different monitoring and assessment methods for use in 305(b) reporting. This practice of optional monitoring and assessment methods in 305(b) reporting, although considered respective of Tribal sovereignty and state rights, leads to inconsistent and incomplete 305(b) reports. The ESS developed in this dissertation is a first step towards development of a consistent "standard" format for water quality assessment reporting. Expansion of the ESS could be conducted to accommodate a standard national format for 305(b) reporting as well as possible modifications to address CWA Section 303(d) listings.

The following recommendations are made for the current use of the ESS by Tribal environmental personnel:

- To aid in the production of a Tribe's first 305(b) water quality assessment report
- To assist in developing information expectations, monitoring, data analysis, and assessment of water quality conditions
- To teach water quality assessment and management concepts, including information about Internet links and references

The following recommendations are made for the future use of the ESS by Tribal environmental personnel:

- Portions of the ESS will need to be updated as EPA guidance documents change because the ESS was developed based on the EPA's guidelines for Tribal 305(b) reporting (USEPA 1995) and state 305(b) reporting (USEPA 1997a) which is revised periodically.

- The water quality criteria for determining beneficial use support of waterbodies will need to be updated in the Water Quality Assessment knowledge base of the ESS because the EPA publishes and periodically updates these criteria in Water Quality Criteria books; the most recent publication was the Quality Criteria for Water 1986a "Gold Book". There is no date set by the EPA for publication of the next Quality Criteria for Water "Silver Book".

- The monitoring and assessment portions of the ESS must incorporate changes in the field of water quality including new science and engineering approaches, new regulatory requirements (especially EPA's), and identification of additional cultural uses of water by Tribal environmental personnel.

- The data analysis techniques (Appendix C) could be improved upon through the addition of other computational routines, such as a cation-anion balance, acid neutralizing capacity classification, and routines for cause-source linkages for water quality impairment identifications.

- The rule bases (Appendix D) may require modification to accommodate additional beneficial uses of water and associated criteria for protecting those uses, such as cool water fisheries and endangered species.

The following are recommendations on what could have been done differently if the study were conducted again:

- Incorporate into the ESS a mechanism for printing out Tribal 305(b) summary tables using software such as dynamic data exchange (DDS) or another type of linkage within the PROLOG language used in the ESS software.

- Work as a director or water quality assessment specialist for a Tribal EPA office in an effort to witness first-hand the extraction and carrying out of

obtaining water quality information expectations from Tribal environmental decision makers.

The ESS has greatly enhanced Tribal water quality personnel's accessibility to current computer software technology that is used to design, monitor, analyze, assess, and report on the quality of tribal waterbodies. The ESS is the first of its kind and provides a needed tool supporting EPA's encouragement and requirements for Tribal water quality assessment reporting.

6.0 LITERATURE CITED

APHA (American Public Health Association), AWWA (American Water Works Association), and WEF (Water Environment Federation). 1998. *Standard Methods for the Examination of Water and Wastewater.* Twentieth Edition. Washington, D.C.

Carlson, R.E. 1977. *A Trophic State Index for Lakes.* Limnology 23.

De Zuane, J. De., P.E. 1990. *Handbook of Drinking Water Quality: Standards and Controls.* Van Nostrand Reinhold. New York.

Doppelt, B., M. Scurlock, C. Frissell, and J. Karr. 1993. *Entering the Watershed: A New Approach to Save America's River Ecosystems.* The Pacific Rivers Council. Island Press. Washington, D.C.

Edmonds, R.A. 1988. *The Prentice Hall Guide to Expert Systems.* Prentice Hall. Englewood Cliffs, New Jersey.

Eisler, R. 1987. *Mercury Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review.* U.S. Fish and Wildlife Service Biological Report 85 (1.10).

Eisler, R. 1986. *Chromium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review.* U.S. Fish and Wildlife Service Biological Report 85 (1.6).

Eisler, R. 1985. *Cadmium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review.* U.S. Fish and Wildlife Service Biological Report 85 (1.2).

Federal Water Pollution Control Administration. 1968. *Water Quality Criteria* "The Green Book". Washington, D.C.

GAO (U.S. General Accounting Office). 2000. Water Quality, Key EPA and State Decisions Limited by Inconsistent and Incomplete Data. Washington, D.C.

Hem, J.D. 1985. *Study and Interpretation of the Chemical Characteristics of Natural Water.* USGS Water-Supply Paper 2254. Third Edition.

Johnson, S.W., M.L. Connolly, F.A. Hyde, G.K. Jones, C.A. Lelafu, G.R. Pablo, and P.E. Vela. 1994. *Campo Indian Reservation 1994 Tribal Water Quality Assessment (Clean Water Act Section 305[b] Report).* Fort Collins, Colorado.

Kunkle, S., S.W. Johnson, and M. Flora. 1987. *Monitoring Stream Water Quality for Land-Use Impacts, A Training Manual for Natural Resource Management Specialists.* National Park Service. Washington, D.C. 102 pages.

Loftis, J.C., and R.C. Ward. 1982. *Routine, Fixed-Station Sampling: An Integral Part of Regulatory Water Quality Monitoring. Environmental Management.* Volume 6(4): 279-280.

Luconi, F.L., T.W. Malone, and M.S.S. Morton. 1986. Expert Systems: The Next Challenge for Managers. Sloan Management Review: 3-14. Sloan Management Review Association.

MacDonald, L.H. and C.T. Carmichael. 1991. *PASSFA, Parameter Selection System for Streams in Forested Area, A User's Guide to the Expert System PASSSFA.* Version 1.0. Colorado State University. Fort Collins.

MacDonald, L.H., A.W. Smart, and R.C. Wissman. 1991. *Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska.* EPA Water Division. USEPA/910/9-91-001. 166 pages.

National Academy of Sciences (NAS), National Academy of Engineering. 1972. *Water Quality Criteria 1972* "The Blue Book". Washington, D.C.

National Academy of Sciences (NAS), National Academy of Engineering. 1973. *Section III-Freshwater Aquatic Life and Wildlife,* Water Quality Criteria. Ecological Research Series, EPA-R3-73-033: 106-213.

National Technical Advisory Committee (NTAC). 1968. Water Quality Criteria. "The Green Book". Washington, D.C.

Nehls, G.J. and G.G. Akland. 1973. *Procedures for handling aerometric data.* Journal of the Air Pollution Control Association 23:180-184.

Nevada Division of Environmental Protection. 1997. *Water Quality Regulations.* (April 1997). Carson City, Nevada.

Olem, H., and G. Flock, eds. 1990. *Lakes and Reservoir Restoration Guidance Manual.* 2nd Edition. USEPA 440/4-90-006. Prepared by the North American Lake Management Society for the USEPA. Washington, D.C.

PEER (Public Employees for Environmental Responsibility). 1999. *Murky Waters, Official Water Quality Reports Are All Wet.* Number 27. Washington, D.C.

Personal Communication. 2000. Between Susan Holdsworth (National 305(b) Coordinator in Washington, D.C.) and Stephen Johnson.

Personal Communication. 1999. Between Dr. Robert Ward (Director of the Colorado Water Resources Research Institute and the CSU Water Center) and Stephen Johnson.

Personal Communication. 1998. Between Dr. James Loftis (Colorado State University Professor) and Stephen Johnson.

Personal Communication. 1996. between Dr. Darrell Fontane (Colorado State University Professor) and Stephen Johnson.

Ponce, S.L. 1980. *Water Quality Monitoring Programs.* WSDG Technical Paper WSDG-TP-00002. Fort Collins, Colorado.

President's Council on Sustainable Development. 1996 (February). *Sustainable America: A New Consensus for the Future.* Washington, D.C.

Sanders, T.G., R.C. Ward, J.C. Loftis, T.D. Steele, D.D. Adrian, and V. Yevjevich. 1983. *Design of Networks for Monitoring Water Quality.* Water Resources Publications. Littleton, Colorado. 328 pages.

Schmitt, C.J. and W.G. Brumbaugh. 1990. *National Contaminant Biomonitoring Program: Concentrations of Arsenic, Cadmium, Copper, Lead, Mercury, Selenium, and Zinc in U.S. Freshwater Fish.* 1967-1984. Arch. Environ. Contamin. Toxicol. 19: 731-747.

Schmitt, C.J., J.L. Zajicek, and P.H. Peterman. 1990. *National Contaminant Biomonitoring Program: Residues of Organochlorine Chemicals in U.S. Freshwater Fish.* 1976-1984. Arch. Environ. Contam. Toxicol. 19:748-781.

USCOE (U.S. Army Corps of Engineers). 1987. *U.S. Army Corps of Engineers Wetlands Delineation Manual.* Technical Report Y-87-1. Vicksburg, Mississippi.

USEPA. 1999. *Fact Sheet for Year 2000 305(b) Reports.* Washington, D.C.

USEPA. 1997a. *Guidelines for the Preparation of the Comprehensive State Water Quality Assessment (305(b) Reports) and Electronic Updates: Report Contents..* Office of Water (4503F). Washington, D.C.

USEPA. 1997b. *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories*. Volume 2 . Second Edition. Office of Water. EPA 823-B-97-009.

USEPA. 1996. *National Water Quality Inventory*. 1996 Report to Congress. Office of Water. Washington, D.C.

USEPA. 1995. *Knowing Our Waters: Tribal Reporting Under Section 305(b)* Office of Water (4503F). Washington, D.C. EPA 841 B-95-003.

USEPA. 1994. *Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act*. 40 Code of Federal Regulations Part 136 (as amended).

USEPA. 1989. *Rapid Bioassessment Protocols for Use in Streams and Rivers*. Office of Water. Washington, D.C. EPA/444/4-89-001.

USEPA. 1986a. *Quality Criteria for Water*. The "Gold Book." Office of Water Regulations and Standards. Washington, D.C. EPA 440/5-86-001.

USEPA. 1986b. *RCRA Ground Water Monitoring Technical Enforcement Guidance Document*. Washington, D.C. 208 pages.

USEPA. 1976 (July). *Quality Criteria for Water* "The Red Book". Washington, D.C.

USFDA (U.S. Food and Drug Administration). 1982. *Levels for poisonous or deleterious substances in human food and animal feed*. Washington, D.C.

USGS (U.S. Geological Survey). 1999. *Water Resources Data, Arizona. Water Year 1998*. Water-Data Report AZ-98-1. Tucson, Arizona.

van Belle, G., and J.P. Huges. 1983. "*Monitoring for Water Quality: Fixed Stations Versus Intensive Surveys*." *Journal WPCF*. Volume 55(4): 400-404.

Ward, R.C. 1979. "*Regulatory Water Quality Monitoring: A Systems Perspective*." Water Resources Bulletin. Volume 15(2): 369-380.

Ward, R.C. 1985. *Framework for the Design of Water Quality Information Systems*. Agricultural and Chemical Engineering Department, Colorado State University, Fort Collins, Colorado. 11 pages.

Whitfield, P.H. 1988. *Goals and Data Collection Designs for Water Quality Monitoring*. Water Resources Bulletin Volume 24: 775-780.

World Wildlife Fund. 1992. *State Wetlands Strategies: a guide to protection and managing the resource*. Island Press. Washington, D.C.

APPENDICES

Appendix A.

Section 518 of the Water Quality Act of 1987

Section 518. INDIAN TRIBES.

(a) POLICY.—Nothing in this section shall be construed to affect the application of section 101(g) of this Act, and all of the provisions of this section shall be carried out in accordance with the provisions of such section 101(g). Indian tribes shall be treated as States for purposes of such section 101(g).

(b) ASSESSMENT OF SEWAGE TREATMENT NEEDS; REPORT.—The Administrator, in cooperation with the Director of the Indian Health Service, shall assess the need for sewage treatment works to serve Indian tribes, the degree to which such needs will be met through funds allotted to States under section 205 of this Act and priority lists under section 216 of this Act, and any obstacles which prevent such needs from being met. Not later than one year after the date of the enactment of this section, the Administrator shall submit a report to Congress on the assessment under this subsection, along with recommendations specifying (1) how the Administrator intends to provide assistance to Indian tribes to develop waste treatment management plans and to construct treatment works under this Act, and (2) methods by which the participation in and administration of programs under this Act by Indian tribes can be maximized.

(c) RESERVATION OF FUNDS.—The Administrator shall reserve each fiscal year beginning after September 30, 1986, before allotments to the States under section 205(e), one-half of one percent of the sums appropriated under section 207. Sums reserved under this subsection shall be available only for grants for the development of waste treatment management plans and for the construction of sewage treatment works to serve Indian tribes.

(d) COOPERATIVE AGREEMENTS.—In order to ensure the consistent implementation of the requirements of this Act, an Indian tribe and the State or States in which the lands of such tribe are located may enter into a cooperative agreement, subject to the review and approval of the Administrator, to jointly plan and administer the requirements of this Act.

(e) TREATMENT AS STATES.—The Administrator is authorized to treat an Indian tribe as a State for purposes of title II and sections 104, 106, 303, 305, 308, 309, 314, 319, 401, 402, and 404 of this Act to the degree necessary to carry out the objectives of this section, but only if—

(1) the Indian tribe has a governing body carrying out substantial governmental duties and powers;

(2) the functions to be exercised by the Indian tribe pertain to the management and protection of water resources which are held by an Indian tribe, held by the United States in trust for Indians, held by a member of an Indian tribe if such property interest is subject to a trust restriction on alienation, or otherwise within the borders of an Indian reservation; and

(3) the Indian tribe is reasonably expected to be capable, in the Administrator's judgment, of carrying out the functions to be exercised in a manner consistent with the terms and purposes of this Act and of all applicable regulations.

Such treatment as a State may include the direct provision of funds reserved under subsection (c) to the governing bodies of Indian tribes, and the determination of priorities by Indian tribes, where not determined by the Administrator in cooperation with the Director of the Indian Health Service. The Administrator, in cooperation with the Director of the Indian health Service, is authorized to make grants under title II of this Act in an amount not to exceed 100 percent of the cost of a project. Not later than 18 months after the date of the enactment of this section, the Administrator shall, in consultation with Indian tribes, promulgate final regulations which specify how Indian tribes shall be treated as States for purposes of this Act. The Administrator shall, in promulgating such regulations, consult affected States sharing common water bodies and provide a mechanism for the resolution of any unreasonable consequences that may arise as a result of differing water quality standards that may be set by States and Indian tribes located on common bodies of water. Such mechanism shall provide for explicit consideration of relevant factors including, but not limited to, the effects of differing water quality permit requirements on upstream and downstream discharges, economic impacts, and present and historical uses and quality of the waters subject to such standards. Such mechanism should provide for the avoidance of such unreasonable consequences in a manner consistent with the objective of this Act.

(f) GRANTS FOR NONPOINT SOURCE PROGRAMS.—The Administrator shall make grants to an Indian tribe under Section 319 of this Act as though such tribe was a State. Not more than one-third of one percent of the amount appropriated for any fiscal year under Section 319 may be used to make grants under this subsection. In addition to the requirements of Section 319, an Indian tribe shall be required to meet the requirements of paragraphs (1), (2), and (3) of subsection (d) of this section in order to receive such a grant.

(g) ALASKA NATIVE ORGANIZATIONS.—No provision of this Act shall be construed to—

(1) grant, enlarge, or diminish, or in any way affect the scope of the governmental authority, if any, of any Alaska Native organization, including any federally-recognized tribe, traditional Alaska Native council, or Native council organized pursuant to the Act of June 18, 1934 (48 Stat. 987), over lands or persons in Alaska;

(2) create or validate any assertion by such organization or any form of governmental authority over lands or persons in Alaska; or

(3) in any way affect any assertion that Indian county, as defined in section 1151 of title 18, United States Code, exists or does not exist in Alaska.

(h) DEFINITIONS.—For purposes of this section, the term—

(1) "Federal Indian reservation" means all land within the limits of any Indian reservation under the jurisdiction of the United States Government, notwithstanding the issuance of any patent, and including rights-of-way running through the reservation; and

(2) "Indian tribe" means any Indian tribe, band, group, or community recognized by the Secretary of the Interior and exercising governmental authority over a Federal Indian reservation.

Appendix B.

Users Manual

USERS MANUAL

AN EXPERT SUPPORT SYSTEM TO AID TRIBAL ENVIRONMENTAL PERSONNEL IN WATER QUALITY ASSESSMENTS

Stephen W. Johnson

Department of Earth Resources

Colorado State University

Fort Collins, Colorado

Spring 2000

90

CONTENTS

Page

1.0 INTRODUCTION 92
- 1.1 About this Manual 92
- 1.2 Use of the Expert Support System 94
- 1.3 Funding for the Expert Support System 94
- 1.4 Acknowledgments 94
- 1.5 Copyright Rules for the Expert Support System 95

2.0 GETTING STARTED 96
- 2.1 Computer Requirements for the Expert Support System 96
- 2.2 Loading the Expert Support System 96
- 2.3 Starting and Stepping through the Expert Support System 96

3.0 TUTORIAL 98

4.0 WATER QUALITY CONCERNS 115

5.0 WATER QUALITY MANAGEMENT 116
- 5.1 Water Quality Information Expectations 116
- 5.2 Tribal Water Quality Management 117
- 5.3 Federal Water Quality Management 117

6.0 WATER QUALITY ASSESSMENT 118
- 6.1 Water Quality Monitoring 118
- 6.2 Data Analysis and Water Quality Criteria 118
- 6.3 Beneficial Use Support Determinations 119
- 6.4 Water Quality Data Search 119

7.0 WATER QUALITY QUIZZES 121

8.0 DEFINITIONS 122

9.0 WATER QUALITY REFERENCES 126

10.0 BLANK TRIBAL 305(b) WATER QUALITY ASSESSMENT TABLES 128

1.0 INTRODUCTION

If you need assistance with any portion of the program (expert support system or pictures database), please contact either Stephen Johnson or Wendell Smith:

Stephen Johnson
Water Quality Technology, Inc.
123 North College Avenue, Suite 215
Fort Collins, Colorado 80524
970-224-5289

or

R. Wendell Smith
U.S. Environmental Protection Agency-Region IX (WTR-10)
75 Hawthorne Street
San Francisco, California 94105
415-744-2018

1.1 About this Manual

This manual will guide you through the program containing the expert support system. The program is designed for Tribal environmental personnel and covers the four categories listed below.

1.Water Quality Concerns - To aid in Tribal response and assessment of water quality problems in need of immediate attention.

2. Water Quality Management - To aid in understanding options available for Tribal management of water quality on Reservations.

3. Water Quality Assessment - To aid in assessments of water quality.

4. Water Quality Quizzes - To provide question-answer quizzes that teach the water quality topics covered in this expert support system.

This program is not intended to be used for database management.

The following chapters are covered in this manual.

Chapter 1 is an introduction to the expert support system. Here you learn the purpose and use of the expert support system. Information on the funding for development of this expert support system and acknowledgements to those individuals contributing to the expert support system are presented. The chapter ends with the copyright rules for the documentation of the software used to develop this expert support system.

Chapter 2 provides information on how to get started and step through the expert support system.

Chapter 3 is a tutorial that is designed to teach you how to use the expert support system. The tutorial is based on a water quality assessment for a fictitious Indian Reservation. The final product of the tutorial are completed tables for a simple Tribal 305(b) Water Quality Assessment Report.

Chapter 4 is a section of the expert support system that explains how to respond to water quality disasters and water quality complaints from the public.

Chapter 5 is a section of the expert support system dealing with water quality information expectations of Tribal environmental management. The section also provides brief descriptions of Tribal and federal water quality management.

Chapter 6 is a section of the expert support system that examines tools to use in a water quality assessment such as monitoring, analysis, beneficial use support determinations, a water quality data search.

Chapter 7 describes the water quality quizzes in the expert support system that you can use to test yourself and learn about water quality topics covered in the expert support system.

Chapter 8 lists definitions of terms used in the expert support system.

Chapter 9 lists references consulted in the development of the expert support system.

Chapter 10 provides blank Tribal 305(b) reporting tables for your use in preparing water quality assessment reports. These are the same tables used in the tutorial.

For an additional copy or update of this manual, download the manual file from the CRIT Home Page that can be reached using the internet at www.1800cleanup.org/CRIT.

1.2 Use of the Expert Support System

The expert support system is designed to be used by Tribal environmental personnel but may be useful for other personnel such as county, state, and federal agencies responsible for water quality assessment and management. The expert support system may also be useful as a tool for learning water quality concepts.

1.3 Funding for the Expert Support System

Funding for development of this program was provided by the Region IX U.S. Environmental Protection Agency (EPA) through a contract between the Colorado River Indian Tribes Environmental Protection Office (EPO) and Colorado State University (CSU) under EPA Water Pollution Control Program grant numbers I-999465-97-0 and I-999465-98-0.

1.4 Acknowledgments

The following individuals have contributed to this program:

- Mr. Dwayne Beavers (Cherokee Nation Office of Environmental Services)
- Mr. Barry Burgan (EPA Headquarters)
- Mr. Conner Byestewa (CRIT EPO) [posthumous]
- Edwards, Captain Dennis J. (Submarine Driving Instructor)
- Mr. R. Dillon Esquerra (CRIT EPO)
- Mr. Duncan Fisher (CRIT EPO)
- Ms. Lesa Flores (CRIT EPO)
- Mr. Terry Geiselman (Water Quality Technology, Inc.)
- Ms. Kristin Gullatt (Region IX EPA)

- Ms. Susan Holdsworth (EPA Headquarters)
- Dr. Andrew Kuchukov (PDC Copenhagen, Denmark)
- Ms. Jodi Johnson (Fort Collins, Colorado)
- Dr. Jim Loftis (Colorado State University)
- Ms. Colleen Patrick (Moapa Band of Paiutes Dept. of Environ. Prot.)
- Ms. Lisa Pere (Fort Collins, Colorado)
- Ms. Linda Powell (Region IX EPA)
- Mr. Scott Quinn (Karuk Tribe Department of Natural Resources)
- Dr. Freeman Smith (Colorado State University)
- Mr. Wendell Smith (Region IX EPA)
- Ms. Loretta Stone (San Carlos Apache Tribal EPA Office)
- Mr. John Swenson (Cocopah Tribe Environmental Protection Office)
- Mr. Wilbert Thomas (Cocopah Tribe Environmental Protection Office)
- Mr. Patrick Trusty (Ak-Chin Environmental Protection Dept.)
- Dr. James Waltz (Colorado State University)
- Dr. Robert Ward (Water Resources Research Institute)

1.5 Copyright Rules for the Expert Support System

2.0 GETTING STARTED

2.1 Computer Requirements for the Expert Support System

To use the expert support system, you must have an IBM-compatible computer running Microsoft Windows 95 or Windows 98. It is recommended that you have 5 MB free hard disk space and 4 MB RAM available for use by the expert support system.

2.2 Loading the Expert Support System

The interactive setup program decompresses and copies the expert support system and other expert support system files to your hard disk. The computer software program used to create the expert support system is ESTA which stands for Expert System for Text Animation.

2.3 Starting and Stepping through the Expert Support System

You can start the expert support system from Windows Explorer. Double-click on the ***Esta*** icon with the mouse, then click on the ***File*** drop-down menu and select ***Open***. Select the file ***Begin.kb*** A title page will appear. Click on the ***OK*** button. Finally, choose the ***Consult*** menu and select ***Begin Consultation*** to start the expert support system.

The options you select in the expert support system determine the direction of the program. The following steps are provided to help step you through the expert support system:

Stop button - Stops the current consultation in the expert support system. To start your consultation again, you must select ***Consult*** then ***Begin consultation***.

Explain button – If available, provides you with additional information on the subject.

Why button – Provides a logical explanation associated with the language used to develop the expert support system.

Consult and **Begin consultation** – Allows you to begin stepping through the expert support system.

File then **Open** – Allows you to select the file called **Begin.kb** to start the expert support system.

Zoom button –Increases the size of a picture to cover the entire monitor screen. You can decrease the size of a "zoomed" picture either by clicking on the ***OK*** button or hitting the ***Enter*** key on your keyboard.

OK button – Functions the same as the Enter key on your keyboard. The OK button allows you to step through the expert support system.

Note: There is no backup button to return to a previous screen. However, if you click on the ***OK*** button several times anywhere in the ESS, you will reach options for either the ***main menu*** or ***assessment menu***. Then you can select an option to return to the screen you wanted to back up to in the ESS.

3.0 TUTORIAL

This tutorial is designed to teach you how to use the expert support system by following an example. The example starts with identifying water quality information expectations of Tribal environmental management on a small fictitious Indian Reservation, then water quality monitoring guidelines are reviewed with respect to the water quality information expectations, next water quality data are collected, analyzed, and assessed, and finally summary tables for a simple Tribal 305(b) water quality assessment report are produced.

The five steps in this tutorial are as follows:

Step 1 Water quality information expectations of Tribal environmental management are identified

Step 2 Water quality monitoring guidelines are reviewed

Step 3 Existing water quality data are obtained and additional water quality sampling is conducted

Step 4 The collected water quality data are analyzed and assessed

Step 5 The water quality assessment information is presented in summary tables for a Tribal 305(b) report

How to Start the Expert support system

1. Double-click the **Esta** icon
2. Select the **File** drop-down menu then choose **Open**
3. Double click **Begin.kb** to view the title page
4. Click the **OK** button
5. Select the **Consult** pop-down menu then **Begin Consultation** (a drum is pictured)

How to Step Through the Tutorial

Step 1 Water quality information expectations of Tribal environmental management are identified

The purpose of this step is to introduce the need for documenting water quality information expectations of Tribal environmental management by providing an example of information expectations.

Select ***water quality management*** (a frog is pictured)

Select ***water quality information expectations***

read advice on water quality information expectations

Click the ***OK*** button

read advice on 3 general types of information expectations

Click the ***OK*** button

Select ***yes*** at the question "Do you want to review examples of beneficial use non-support expectations?"

For the tutorial, the following two examples of information expectations are appropriate for Tribal environmental management:

6. Is the well water safe to drink without treatment?
9. Is the water safe for ceremonial bathing?

Click the ***OK*** button through the remaining screens until you reach the water quality management screen (a frog is pictured in the last screen)

Select ***Main Menu***

Step 2 Water quality monitoring guidelines are reviewed

The purpose of this step is to introduce the need for reviewing water quality monitoring needs for waterbodies based on the water quality information expectations of Tribal environmental management.

Select ***water quality assessment*** (a waterfall is pictured)

Select ***water quality monitoring*** (a flowing well pump is pictured)

Select ***groundwater***

read advice for:

1. Drinking Water Supply

read Why, When, and How Often.

Valuable Indicators: nitrate (only nitrate will be used for the tutorial)

Click the ***OK*** button

Select ***lakes***

read advice for:

2. Cultural Uses (specific to each Tribe, so an example is provided)

Why: To evaluate the suitability of water for bathing as part of a ceremony

When: During the time period when the water is used for ceremonial bathing

How Often: 5 samples weekly for a 30 day period

Valuable Indicators: fecal coliform bacteria or E. coli

(only E. coli. will be used as recommended by EPA for swimming)

Note: the use of a water for swimming will be used to assess this cultural use

Click the ***OK*** button

Step 3 Existing water quality data are obtained and additional water quality sampling is conducted

The purpose of this step is to introduce you to the process of collecting existing water quality data and supplementing your collected data with new data generated by you in a short-term sampling plan.

Select ***assessment menu***

Select ***water quality data search***

read through the advice on numeric and narrative water quality data searches

Click on the ***OK*** button

The following question will appear: Do you want to view suggestions for a numeric water quality data search?

Select *yes*

Read through the various agencies that can help you in your water quality data search

For the tutorial, all listed agencies were contacted, but only Indian Health Service had water quality data relevant to the information expectations. For the tutorial, the following drinking water data were obtained from Indian Health Service for the Tribal public water system (PWS) well and a shallow farm well.

Sampling Date	Shallow Farm Well Nitrate (mg/L as N)	Tribal Public Water System Nitrate (mg/L as N)
July 7, 1995	1.2	1.9
July 12, 1996	1.2	<1
July 2, 1997	12.3	1.4
July 16, 1998	15.8	<1
July 8, 1999	18.7	1.6

For the tutorial, there were no bacterial data (*E. coli*) for the ceremonial bathing analysis at Grass Lake, so 5 samples were collected weekly for a 30 day period to determine beneficial use support of the lake for ceremonial bathing use (which will also evaluate swimming use support). The collected bacteria data are as follows:

Sampling Date	Grass Lake *E. coli* (cfu/100mL)
August 4, 1999	17
August 11, 1999	1300
August 18, 1999	59
August 25, 1999	516
September 1, 1999	<1

Click the ***OK*** button through the remaining screens until you reach the assessment menu (a waterfall is pictured).

Step 4 The collected water quality data are analyzed and assessed

The purpose of this step is to provide you an example of the analysis and assessment of water quality data that have been collected based on Tribal information expectations.

Select ***data analysis & water quality criteria*** (a cup of water is pictured)

Select ***drinking water criteria***

Note the nitrate primary drinking water standard

For the tutorial, a nitrate drinking water criterion of "10 mg/L as N" is appropriate for analyzing the drinking water data.

Analysis: The water from the shallow farm well exceeds the safe level for nitrate in drinking water three out of five times, but water from the Tribal public water system well consistently meets the nitrate standard.

Click the ***OK*** button

Select ***cultural analysis***

read advice and note the following information

EXAMPLE 4. After a cremation ceremony, the pallbearers bathe themselves in natural waters

CRITERIA: use contact recreation (swimming) criteria

Click the ***OK*** button

Select ***swimming criteria (to be used for the cultural analysis)***

read advice and note the following information:

Fresh Water Swimming

E. coli 126/100mL (geometric mean)

406/100mL (single sample maximum)

Click the ***OK*** button

Select ***bacteria geometric mean***

enter the E. Coli. data (Note: for the value "<1" use "0.5")

Note: The use of one-half the detection level is recommended for water quality data analysis; so in this case use "0.5" instead of "1". The use of the detection level (for example "1") is too high a concentration to use for this analysis while the use of zero ("0") for detection levels is too low a concentration to use for this analysis and rarely if ever occurs in any water quality analysis.

The result of the calculation is as follows:

The geometric mean of your five bacteria data is 50/100mL

Click the ***OK*** button

The single sample maximum bacteria level is 1300/100mL

Analysis: The E. Coli. data meet the geometric mean criterion for swimming (cultural use) but exceed the single sample maximum.

Click the ***OK*** button

Select ***assessment menu***

Select ***beneficial use support determination***

Select ***cultural use***

The following question will appear: Select one of the following statements that best describes your analysis of cultural use data for the waterbody to be assessed.

For the tutorial you would select "Intermittent exceedances of cultural use criteria".

Click the ***OK*** button

Assessment: Beneficial use support classification is PARTIALLY SUPPORTING (for the lake)

Note: The use support for the lake water for ceremonial bathing is partially supporting because there are times when the E. coli. (bacteria) levels make the water unsafe.

Click the ***OK*** button

It is useful to evaluate whether any water quality trends in ground water contaminant levels are apparent in an effort to correlate a land use with an improvement or degradation in water quality. Trend analysis is also important to allow for measures to be taken before a water quality criteria exceedance occurs. The EPA recommends the use of a trend analysis in 305(b) reporting to determine a trend category (improving, stable, or degrading). A recommended approach for a trend analysis is to collect a minimum of 5 representative data points and plot the points using a simple linear regression line. The nitrate levels for the shallow farm well and Tribal public water system well are plotted below along with a simple linear regression line.

Analysis: The simple linear regression lines indicate that the nitrate trend for Tribal public water system well is stable but the nitrate level for the shallow farm well is degrading.

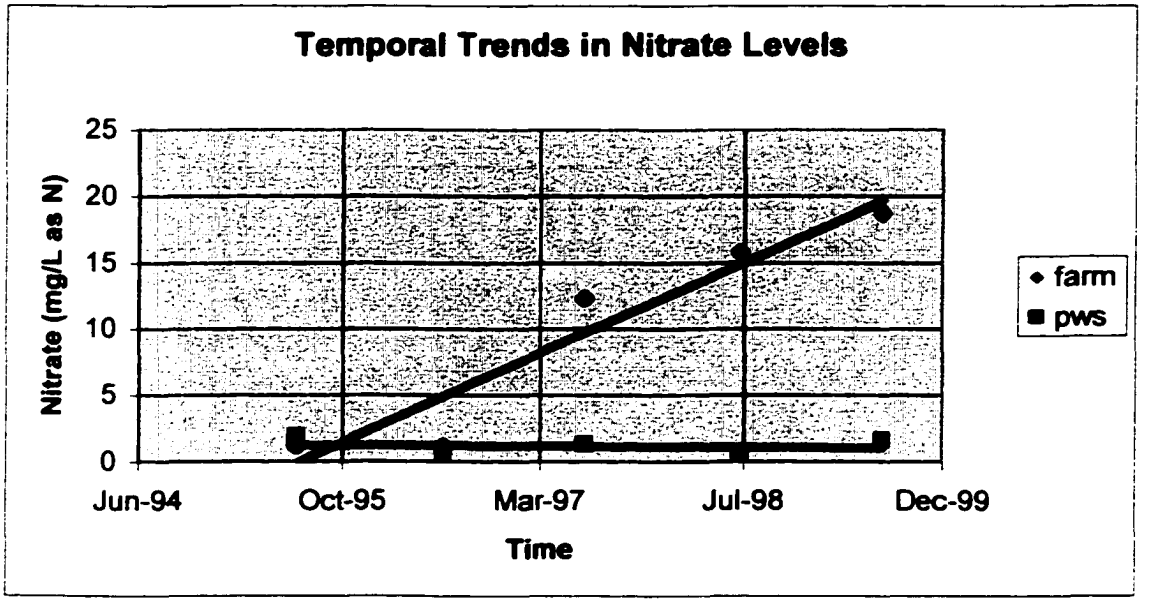
Select ***drinking water source***

The following question will appear: Select one of the following statements that best describes your analysis of drinking water data for the waterbody to be assessed.

For the farm well data used in the tutorial select: " Consistent exceedances of drinking water criteria"

Next the following question will appear: Select one of the following statements that best describes your drinking water use restriction data for the waterbody to be assessed.

For the tutorial, you have no other information for the farm well so select "No drinking water use restriction data available"



Assessment: Beneficial use support classification is NOT SUPPORTING (for the farm well)

Note: The use support of the shallow farm well is not supporting because the nitrate levels in the ground water exceed the nitrate standard for drinking water. The lack of drinking water use restriction data does not change this use support determination.

Click the ***OK*** button

Select ***drinking water source*** again

The following question will appear: Select one of the following statements that best describes your analysis of drinking water data for the waterbody to be assessed.

For the Tribal domestic water well data used in the tutorial select: " No criteria exceedances and no detected contaminants"

Next the following question will appear: Select one of the following statements that best describes your drinking water use restriction data for the waterbody to be assessed.

For the tutorial, the tribe's public water supply well is operating safely so select "No drinking water use restrictions are in effect"

Assessment: Beneficial use support classification is FULLY SUPPORTING (for the public water supply)
Note: The use support of the public water system well is fully supporting based on the low levels of nitrate in the ground water. The information that no drinking water use restrictions are in effect provides additional data on this fully supporting use determination.

Click the ***OK*** button
Select ***assessment menu***
Select ***main menu*** (you are now back to the main menu for the Expert support system)

Step 5 The water quality assessment information is presented in summary tables for a Tribal 305(b) report
The purpose of this step is to demonstrate how you would fill in the tables for a Tribal 305(b) report based on the water quality assessment in the tutorial.

The following Tribal 305(b) tables are filled in for your review. It is recommended that you evaluate why each table is completed based on the example analyses and assessments provided in this tutorial. Please note that table 1 has been completed based on information available through contacts with Tribal agencies, such as Tribal Enrollment, the General Council, and the

Tribal Game and Fish Department. The text for a 305(b) report would include a thorough discussion of the comments column for Table 8.

TUTORIAL ENDS

At this point you may want to review ***first time user***, ***water quality concerns***, and go through the ***water quality quizzes***.

Next you can use the tutorial to help step through the expert support system using water quality information expectations for your own reservation and produce tables for a Tribal 305(b) report.

Table 1. Tutorial Indian Reservation

Topic	Value
Surface area of Tribal Lands (acres)	2700
Tribal population residing on these lands	112
Total miles of rivers and streams on Tribal lands - Miles of perennial rivers/streams (subset) - Miles of intermittent (non-perennial) streams (subset) - Miles of ditches and canals (subset) - Border miles of shared rivers/streams (subset)	4.4 0.7 1.7 2.0 0.7
Number of lakes/reservoirs/ponds on Tribal lands	1
Acres of lakes/reservoirs/ponds on Tribal lands	3.2
Acres of freshwater wetlands on Tribal lands	7.8
Acres of tidal wetlands on Tribal lands	0
Square miles of estuaries/harbors/bays	0
Miles of ocean coast	0
Miles of Great Lakes shore	0

TABLE 2. Individual Use Support Summary

Type of Waterbody: Lakes

Use	Size Supporting	Size Supporting but Threat-ened[c]	Size Partially Supporting	Size Not Supporting	Size Not Attainable	Size Un-assessed
Fish Consumption						2.3 acres
Shellfishing						
Aquatic Life Support						2.3 acres
Swimming			2.3 acres			
Secondary Contact						2.3 acres
Drinking Water Supply						2.3 acres
Cultural/Cere-monial Uses			2.3 acres			
Agriculture						2.3 acres
Tribe Defined: 1 2 3 4 5 6						

Note: Grass Lake is 2.3 acres in size and all use support determinations (for both cultural use and swimming use) are for the entire lake area.

Table 3. Total Sizes of Impaired Waters, by Cause Category

Type of waterbody: Lakes

Cause Category	Size of Waters Impaired
Cause unknown	
Unknown toxicity	
Pesticides	
Priority organics	
Nonpriority organics	
Metals	
Ammonia	
Chlorine	
Other inorganics	
Nutrients	
pH	
Siltation	
Organic enrichment/low DO	
Salinity/TDS/chlorides	
Thermal modifications	
Flow alterations	
Other habitat alterations	
Pathogen indicators	2.3 acres
Radiation	
Oil and grease	
Taste and odor	
Suspended solids	
Noxious aquatic plants	
Filling and draining	
Total toxics	
Turbidity	
Filling and draining	
Exotic species	
Other (specify)	

Table 4. Total Sizes of Impaired Waters Affected by Various Source Categories

Type of Waterbody: Lakes

Source Category	Size of Waters Impaired
Point Sources	
Industrial Point Sources	
Municipal Point Sources	
Agricultural Point Sources (e.g., feedlots)	
Combined Sewer Overflows	
Nonpoint Sources	
Agriculture	
Silviculture	
Construction	
Urban Runoff/Storm Sewers	
Resource Extraction	
Land Disposal	
Hydromodification/Habitat Modification	
Contaminated Sediments	
Atmospheric Deposition	
Unknown Source	
Natural Sources	
Septic system releases	2.3 acres

Note: For the tutorial, leaking septic systems were discovered along the shoreline of Grass Lake. The leaking septic systems are a nonpoint source of pollution causing the release of nitrate, ammonia, and bacteria into the lake water.

TABLE 5. Individual Use Support Summary

Type of Waterbody: Ground Water

Use	Size Supporting	Size Supporting but Threat-ened	Size Partially Supporting	Size Not Supporting	Size Not Attainable	Size Un-assessed
Fish Consumption						
Shellfishing						
Aquatic Life Support						
Swimming						
Secondary Contact						
Drinking Water Supply	**2,010 acres**			**126 acres**		**564 acres**
Cultural/Cer e-monial Uses						
Agriculture						**2,700 acres**
Tribe Defined: 1 2 3 4 5 6						

Note: The 2,010 acres of size supporting a drinking water supply use support is based on a 1-mile radius around the public water supply well. The 126 acres of size not supporting a drinking water supply use support is based on a 0.25 mile radius around the farm well. The 564 acres of size unassessed is based on the acreage above the ground water system that has no well to monitor and assess its water quality. The 2,700 acres is the size unassessed for agriculture because no agricultural water quality monitoring data are available.

Table 6. Total Sizes of Impaired Waters, by Cause Category

Type of waterbody: Ground Water

Cause Category	Size of Waters Impaired
Cause unknown	
Unknown toxicity	
Pesticides	
Priority organics	
Nonpriority organics	
Metals	
Ammonia	
Chlorine	
Other inorganics	
Nutrients	126 acres
pH	
Siltation	
Organic enrichment/low DO	
Salinity/TDS/chlorides	
Thermal modifications	
Flow alterations	
Other habitat alterations	
Pathogen indicators	
Radiation	
Oil and grease	
Taste and odor	
Suspended solids	
Noxious aquatic plants	
Filling and draining	
Total toxics	
Turbidity	
Filling and draining	
Exotic species	
Other (specify)	

Note: The 126 acres of impaired waters for ground water is based on nitrate (a nutrient) contamination in the farm well.

Table 7. Total Sizes of Impaired Waters Affected by Various Source Categories

Type of Waterbody: Ground Water

Source Category	Size of Waters Impaired
Point Sources	
Industrial Point Sources	
Municipal Point Sources	
Agricultural Point Sources (e.g., feedlots)	
Combined Sewer Overflows	
Nonpoint Sources	
Agriculture	126 acres
Silviculture	
Construction	
Urban Runoff/Storm Sewers	
Resource Extraction	
Land Disposal	
Hydromodification/Habitat Modification	
Contaminated Sediments	
Atmospheric Deposition	
Unknown Source	
Natural Sources	
Other (specify)	

Note: The 126 acres of impaired waters is based on nitrate contamination of ground water caused by poor crop irrigation practices.

Table 8. Waterbody-Specific Assessment Data for the Tutorial Indian Reservation

Waterbody Name	Water-body ID	Description	Total Size	Size Impaired	Designated Use	Degree of Use Support	Causes	Sources	Type of Assessment	Comments
Grass Lake	LGL-001	ceremonial bathing at a lake	2.3 acres	2.3 acres	-cultural use (and swimming)	-partially supporting	pathogen indicators	septic system releases	biosurvey: bacteria sampling	Report to cultural advisors; post a no swimming sign at the beach; need to repair or maintain septic system; consider connecting home(s) to wastewater system
Public Water System Aquifer	GPW-002	ground water tapped by a well	1 mile radius	0 acres	-domestic water supply	-fully supporting -trend analysis indicates stable trend	none	none	drinking water data	none
Farm Well Shallow Aquifer	GFW-003	shallow ground water tapped by a well	0.25 mile radius	126 acres (this is the acreage in a 0.25 mile radius)	-domestic water supply	-not supporting -trend analysis indicates degrading trend	nutrients (nitrates)	agriculture (crop irrigation)	drinking water data	Issue a drinking water use restriction for the farm well; provide bottled water, especially if water is being used for baby formula; consider a public water system.

4.0 WATER QUALITY CONCERNS

The purpose of the Water Quality Concerns section is to provide information on how to respond to water quality disasters and water quality complaints from the public. A recommended outline for a brief report documenting the water quality disaster or complaint is also provided in this section. The following water quality concerns are covered:

- cultural use impaired
- fish kill
- drinking water complaint
- livestock watering complaint
- swimming water complaint
- contaminated fish complaint
- irrigation water complaint
- floating debris on water
- algal bloom

The expert support system allows you to return to the main menu by selecting ***Main Menu*** when you are finished using this section.

5.0 WATER QUALITY MANAGEMENT

The purpose of this section is to provide Tribal environmental personnel with information and guidance on managing water quality on your reservation. The following three types of water quality management options are covered in this expert support system.

5.1 Water Quality Information Expectations

Information expectations are the reasons why water quality monitoring, assessment, and reporting are conducted. Information expectations provide a purpose for the establishment of each monitoring site, each analysis of a water quality parameter, the duration of the monitoring program, and the assessment and reporting of the water quality data. In this expert support system, the use support of beneficial uses for each Tribal waterbody provides the basis for determining information expectations.

Three general types of information expectations for Tribal environmental management are as follows:

1. Do Tribal waterbodies support beneficial uses of waterbodies?
2. Are there any trends towards non-support of beneficial uses?
3. Do water quality complaints indicate non-support of uses?

The Tribal environmental management approach is to *State in simple terms water quality concerns regarding whether Tribal waterbodies are supporting beneficial uses.* Examples of information expectations included in the Water Quality Information Expectations section are:

- Is irrigation water safe for crops?
- Is livestock water safe for watering cattle and other livestock?
- Is stream water suitable for support a fishery?

The expert support system allows you to return to the main menu by selecting ***Main Menu*** when you are finished using this section.

5.2 Tribal Water Quality Management

This section provides information and advice on Tribal water quality management for Tribal environmental personnel. The following water quality regulations are briefly covered in this section:

- Clean Water Act Section 104(b)(3) special projects
- Clean Water Act Section 106 Water Pollution Control Program
- Clean Water Act Section 303 water quality standards
- Clean Water Act Section 319h nonpoint source implementation
- Clean Water Act Section 401 water quality certification
- Clean Water Act Section 402 NPDES
- Clean Water Act Section 404 dredge and fill permits
- Clean Water Act Section 518 Tribal authority for a program
- Safe Drinking Water Act
- RCRA
- Sustainability

The expert support system allows you to return to the main menu by selecting ***Main Menu*** when you are finished using this section.

5.3 Federal Water Quality Management

This section provides information and advice on federal water quality management for Tribal environmental personnel. The following water quality regulations are briefly covered in this section:

- Clean Water Act Section 401 water quality certification
- Clean Water Act Section 402 NPDES
- Clean Water Act Section 404 dredge and fill permits
- Safe Drinking Water Act
- RCRA

The Expert support system allows you to return to the main menu by selecting ***Main Menu*** when you are finished using this section.

6.0 WATER QUALITY ASSESSMENT

6.1 Water Quality Monitoring

The following waterbodies are covered in this expert support system with respect to water quality monitoring:

- streams and rivers
- lakes
- estuary or coastline
- wetlands
- groundwater

The expert support system allows you to return to the assessment menu by selecting ***Assessment Menu.*** To return the ***Main Menu,*** select the ***Assessment Menu*** first then select ***Main Menu.***

6.2 Data Analysis and Water Quality Criteria

The data analysis routines listed below will prompt you for information to be used to calculate values used in water quality assessments.

- trophic status (if you have secchi disk depth, total phosphorus, and chlorophyll *a* data)
- trophic status (if you have secchi disk depth data only)
- sodium adsorption ratio
- bacteria geometric mean

The water quality criteria listed below are taken from the EPA's quality criteria for water publications. These criteria are useful in selecting constituents to measure in a monitoring program and in an analysis of beneficial use support of a waterbody.

- cultural analysis (criteria)
- fish consumption criteria
- shellfishing criteria
- aquatic life criteria
- swimming criteria
- boating and wading criteria
- drinking water criteria

- crop irrigation criteria
- livestock watering criteria
- wildlife propagation criteria
- wetlands criteria

The expert support system allows you to return to the assessment menu by selecting ***Assessment Menu*** as well as the main menu from the Assessment Menu by selecting ***Main Menu*** when you are finished using this section.

6.3 Beneficial Use Support Determinations

The following beneficial use support determinations are covered in this expert support system:

- cultural use
- aquatic life
- wetlands
- fish consumption
- shellfishing
- swimming
- boating and wading
- drinking water source
- crop irrigation
- livestock watering

The expert support system allows you to return to the assessment menu by selecting ***Assessment Menu*** as well as the main menu from the Assessment Menu by selecting ***Main Menu*** when you are finished using this section.

6.4 Water Quality Data Search

Recommended water quality data search methods are covered in this expert support system.

There are two general types of searches for water quality data:

1. Numeric (or numbers) water quality data are based on numeric water quality criteria which are concentrations or levels of pollutants that when exceeded can cause the non-support of a beneficial use of a waterbody.

2. Narrative water quality data are based on narrative water quality criteria which are statements that describe a desired water quality goal.

In this section contact information on various agencies that typically have water quality data useful to tribes are presented for your use in a water quality data search. Examples of agency contacts are: Indian Health Services, the U.S. Geological Survey, the U.S. Environmental Protection , and the U.S. Fish and Wildlife Service.

The expert support system allows you to return to the assessment menu by selecting ***Assessment Menu*** as well as the main menu from the Assessment Menu by selecting ***Main Menu*** when you are finished using this section.

7.0 WATER QUALITY QUIZZES

The purpose of the Water Quality Quizzes section is to provide you with question and answer quizzes to play that teach the water quality topics covered in the expert support system. Your score on the quizzes is presented to you at the end of each quiz. Answers to each question that is incorrectly answered are also presented.

The following three types of water quality quizzes are included in the expert support system:

- water quality complaints
- water quality assessment
- water quality management

The expert support system allows you to return to the main menu by selecting ***Main Menu*** when you are finished using this section.

8.0 DEFINITIONS

The following definitions: are provided for your use in understanding terms used in this expert support system

Acute toxicity: Toxicity involving a stimulus severe enough to rapidly induce a response. In aquatic toxicity tests, an effect observed in 96 hours or less is considered acute.

Agricultural irrigation: The use of a surface water to irrigate crops.

Agricultural livestock watering: The use of a surface water as a water supply for livestock.

Antidegradation: The policy set forth in U.S. Environmental Protection Agency Water Quality Standards regulations under the CWA whereby existing uses and the level of water quality necessary to maintain those uses is maintained and protected (see 40 CFR [Code of Federal Regulations] Section 131.12 [1987]).

Aquatic and wildlife (cold water fishery): A cold water fishery is a stream reach, lake, or impoundment where water temperature and habitat are suitable to support and propagate animals, plants, and other organisms, including salmonids.

Aquatic and wildlife (ephemeral): The use of an ephemeral water by animals, plants, or other organisms, excluding fish, for habitation, growth, or propagation.

Aquatic and wildlife (warm water fishery): A warm water fishery is a stream reach, lake, or impoundment where water temperature and habitat are suitable to support and propagate animals, plants, or other organisms (excluding salmonids).

Beneficial use: A use of a waterbody such as swimming, cultural/ceremonial, aquatic life support, or domestic water source.

Best management practices: Practices undertaken to control, restrict, and diminish nonpoint sources of pollution that are consistent with the purposes of the Water Quality Standards for a reservation.

Clean Water Act (CWA): The Federal Water Pollution Control Act, as amended by the Water Quality Act of 1987.

Colony-forming units (CFU): Expression of bacteria numbers used in microbiological analyses.

Criteria: Elements of water quality standards that are expressed as pollutant concentrations, levels, or narrative statements representing a water quality that supports a designated use.

Cultural full body contact: Use of water during a cultural practice, including but not limited to ceremonies involving full submergence in water, in which full body contact with water occurs or may occur in which there is a probability of ingesting small amounts of untreated water.

Cultural partial body contact: Use of water during a cultural practice, including but not limited to sweat lodges and collecting wetland plants of cultural significance that may cause the human body to come into direct contact with the water, but normally not to the point of complete submergence. The use is such that ingestion of the water is unlikely to occur, nor will sensitive body organs, such as eyes, ears, or nose, normally be exposed to direct contact with the water.

Designated use: A beneficial use of water specified in the water quality standards for a reservation.

Domestic water source: The use of a water resources a potable water supply. Coagulation, sedimentation, filtration, disinfection, or other treatments may be necessary to yield a finished water suitable for human consumption.

Ephemeral water: A surface water whose channel is at all times above the water table and flows only in response to precipitation or snow melt.

Existing use: A use that has actually occurred in a surface water on or after November 28, 1975, or a use that the existing water quality of a surface water will allow.

Fish consumption: The use of a surface water by humans for harvesting aquatic organisms for consumption. Harvestable aquatic organisms include, but are not limited to, fish, clams, turtles, crayfish, and frogs.

Full body contact: Complete submergence of the human body in a surface water, such as during swimming. The use is such that ingestion of the water is likely to occur and certain sensitive body organs, such as eyes, ears, or nose, may be exposed to direct contact with the water.

Fully Supporting Beneficial Use Classification: A finding of use support for a waterbody that describes good water quality based on an assessment that the particular waterbody fully supports a beneficial or designated use, such as aquatic life or drinking water supply.

Fully Supporting but Threatened Use Classification: A finding of use support for a waterbody that describes good water quality that is threatened by either an apparent declining trend in water quality or a potential water quality problem requiring additional study based on an assessment that the particular waterbody fully supports a beneficial or designated use, such as aquatic life or drinking water supply.

Geometric mean: The antilog of the log of a set of numbers. The geometric mean is calculated using the following formula: $(G.M._y = \sqrt[n]{(Y_1)(Y_2)(Y_3)\ldots(Y_n)}$.

Ground water: Subsurface waters (in a zone of saturation) that are or can be brought to the surface of the ground or to surface waters through wells, springs, seeps, or other discharge areas.

Hardness: The sum of the calcium and magnesium concentrations expressed as calcium carbonate ($CaCO_3$) in milligrams per liter.

Micrograms per liter (µg/L): The concentration at which one microgram is contained in a volume of one liter; one microgram per liter is equivalent to one part per billion (ppb) at unit density.

Milligrams per liter (mg/L): The concentration at which one milligram is contained in a volume of one liter; one milligram per liter is equivalent to one part per million (ppm) at unit density.

Mixing zone: A prescribed area or volume of a surface water that is contiguous with a point source discharge where initial dilution of the discharge takes place.

Narrative standard: A standard or criterion expressed using words rather than numbers.

National Pollutant Discharge Elimination System (NPDES): The point source discharge permit program established by Section 402 of the Clean Water Act.

Ninetieth percentile: The value that may not be exceeded by more than 10 percent of the observations in a consecutive 12-month period. A minimum of 10 samples, each taken at least 10 days apart, are required to determine a ninetieth percentile.

Not Supporting Use Classification: A finding of use support for a waterbody that describes poor water quality based on an assessment that the particular waterbody does not supports a beneficial or designated use, such as aquatic life or drinking water supply.

Oil: Petroleum in any form including, but not limited to, crude oil, gasoline, fuel oil, diesel oil, lubricating oil, or sludge.

Partial body contact: The use of a surface water that may cause the human body to come into direct contact with the water, but normally not to the point of complete submergence. The use is such that ingestion of the water is unlikely to occur, nor will sensitive body organs, such as eyes, ears, or nose, normally be exposed to direct contact with the water.

Partially Supporting Use Classification: A finding of use support for a waterbody that describes fair water quality based on an assessment that the particular waterbody partially supports a beneficial or designated use, such as aquatic life or drinking water supply.

Point source: Any discernible, confined, and discrete conveyance from which pollutants are or may be discharged into a water body; does not include return flows from irrigated agriculture.

Practical quantitation limit: The lowest level of quantitative measurement that reliably can be achieved during routine laboratory operations.

Recreational uses: The full-body and partial-body contact designated uses.

Toxic: Pollutants (or combinations of pollutants) that may cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations in any organisms or their offspring after discharge and upon exposure, ingestion, inhalation, or assimilation into such organism, either directly from the environment or indirectly by ingestion through food chains.

Tribal waterbodies: Any and all surface and ground waters that are contained in or flow in or through a reservation, including all rivers, streams, lakes, ponds, wetlands, springs, seeps, canals, irrigation and drainage ditches; does not include the waters in sewage lagoons or in treatment works of disposal systems.

Unassessed Use Classification: A finding of use support for a waterbody that does not describe the water quality as a result of a lack of assessment data that the particular waterbody supports a beneficial or designated use, such as aquatic life or drinking water supply.

Unique water: A Tribal water that has been classified as an outstanding Tribal resource water on a reservation.

Use attainability analysis: A structured scientific assessment of the factors affecting the attainment of a designated use that may include physical, chemical, biological, cultural, and economic factors.

Wetlands: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands include swamps, marshes, bogs, cienegas, tinajas, and similar areas.

Zone of passage: A continuous water route of volume, cross-sectional area, and quality necessary to allow passage of free-swimming or drifting organisms with no toxic effect produced on the organisms.

9.0 WATER QUALITY REFERENCES

The following references were consulted during the development of the expert support system.

American Public Health Association, American Water Works Association, and Water Environment Federation. 1998. Standard Methods for the Examination of Water and Wastewater. Twentieth Edition. Washington, DC

Carlson, R.E. 1977. A Trophic State Index for Lakes. Limnology 23.

COE (U.S. Army Corps of Engineers). 1987. U.S. Army Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1. Vicksburg, Mississippi.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. KWS/OBS - 79/31. Washington, DC.

De Zuane, J.., P.E. 1990. Handbook of Drinking Water Quality: Standards and Controls. Van Nostrand Reinhold. New York.

Doppelt, B., M. Scurlock, C. Frissell, and J. Karr. 1993. Entering the Watershed: A New Approach to Save America's River Ecosystems. The Pacific Rivers Council. Island Press. Washington, DC

Eisler, R. 1987. Mercury Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service Biological Report 85 (1.10).

Eisler, R. 1986. Chromium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service Biological Report 85 (1.6).

Eisler, R. 1985. Cadmium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service Biological Report 85 (1.2).

Federal Water Pollution Control Administration. 1968. Water Quality Criteria "The Green Book". Washington, DC

Gibson, J. H., J.N. Gallaway, C. Schofield, W. McFee, R. Johnson, S. McCarley, N. Dise, and D. Herzog. 1983. Rocky Mountain Acidification Study. FWS/OBS 80/40.17. Air Pollution and Acid Rain Report No. 17. USFWS.

Hem. J.D. 1985. Study and Interpretation of the Chemical Characteristics of Natural Water. USGS Water-Supply Paper 2254. Third Edition.

International Joint Commission (IJC) United States and Canada. 1988. Great Lakes water quality agreement. Amended by protocol signed November 18, 1987. Ottawa, Canada.

National Academy of Sciences, National Academy of Engineering. 1972. Water Quality Criteria 1972 "The Blue Book". Washington, DC

National Academy of Sciences, National Academy of Engineering. 1973. Section III-Freshwater Aquatic Life and Wildlife, Water Quality Criteria. Ecological Research Series, EPA-R3-73-033: 106-213.

Olem, H., and G. Flock, eds. 1990. Lakes and Reservoir Restoration Guidance Manual. 2nd Edition. USEPA 440/4-90-006. Prepared by the North American Lake Management Society for the USEPA. Washington, D.C.

President's Council on Sustainable Development. 1996 (February). Sustainable America: A New Consensus for the Future. Washington, DC

Sanders, T. G., R. C. Ward, J.C. Loftis, T.D. Steele, D.D. Adrian, and V. Yevjevich. 1983. Design of Networks for Monitoring Water Quality. Water Resources Publications. Littleton, Colorado.

Schacklette, H.T., and J.G. Boerngen. 1984. Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States. USGS Professional Paper 1270.

Schmitt, C.J. and W.G. Brumbaugh. 1990. National Contaminant Biomonitoring Program: Concentrations of Arsenic, Cadmium, Copper, Lead, Mercury, Selenium, and Zinc in U.S. Freshwater Fish, 1967-1984. Arch. Environ. Contamin. Toxicol. 19: 731-747.

Schmitt, C.J., J.L. Zajicek, and P.H. Peterman. 1990. National Contaminant Biomonitoring Program: Residues of Organochlorine Chemicals in U.S. Freshwater Fish, 1976-1984. Arch. Environ. Contam. Toxicol. 19:748-781.

USEPA. 1997. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 2 Risk assessment and fish consumption limits. Second Edition. Office of Water. EPA 823-B-97-009.

USEPA. 1997. Guidelines for Preparation of the Comprehensive State Water Quality Assessment (305(b) Report) and Electronic Update: Report Contents. Office of Water (4503F). Washington, DC. EPA-841-B-97-002A.

USEPA. 1994 (August). Water Quality Standards Handbook. Second Edition. Office of Water (4305). Washington, DC. EPA-823-B-94-005a.

USEPA. 1986. Quality Criteria for Water 1986 "The Gold Book". Office of Water, Regulations and Standards. Washington, DC

USEPA. 1976 (July). Quality Criteria for Water "The Red Book". Washington, DC

USFDA (U.S. Food and Drug Administration). 1982. Levels for poisonous or deleterious substances in human food and animal feed. Washington, DC.

10.0 BLANK TRIBAL 305(b) WATER QUALITY ASSESSMENT TABLES

The tables presented in this section are useful in summarizing water quality assessment information for a Tribal 305(b) report.

When a tribe sets their water quality standards, the tribe assigns one or more beneficial uses to each waterbody. Beneficial uses are the uses the tribe wants its waterbodies to support. Examples of beneficial uses are swimming, cultural/ceremonial, aquatic life support, and drinking water supply. Under Section 305(b) of the Clean water Act, a water quality assessment of waterbodies means that water quality data are collected, the data analyzed, and an assessments of beneficial use support of waterbodies are determined. The tables in the following pages are provided for your use in preparing a Tribal 305(b) report.

Table 1. Atlas of Tribal Resources (complete to the extent possible)

Topic	Value
Surface area of Tribal Lands[a]	
Tribal population residing on these lands	
Total miles of rivers and streams on Tribal lands - Miles of perennial rivers/streams (subset) - Miles of intermittent (non-perennial) streams (subset) - Miles of ditches and canals (subset) - Border miles of shared rivers/streams (subset)	
Number of lakes/reservoirs/ponds on Tribal lands[b]	
Acres of lakes/reservoirs/ponds on Tribal lands[b]	
Acres of freshwater wetlands on Tribal lands	
Acres of tidal wetlands on Tribal lands	
Square miles of estuaries/harbors/bays	
Miles of ocean coast	
Miles of Great Lakes shore	

[a] Please define the boundaries of the land and waters under Tribal jurisdiction and included in this report; use a map and/or text descriptions.

[b] Impoundments should be classified according to their hydrologic behavior either as stream channel miles under rivers, or as total surface acreage under lakes/ponds, but not under both categories. In general, impoundments should be reported as lakes/reservoirs/ponds unless they are run-of-river impoundments with very short retention times

TABLE 2. Individual Use Support Summary[a]

Type of Waterbody: Rivers and Streams[b]

Use	Size Supporting	Size Supporting but Threat-ened[c]	Size Partially Supporting	Size Not Supporting	Size Not Attainable	Size Un-assessed
Fish Consumption						
Shellfishing						
Aquatic Life Support						
Swimming						
Secondary Contact						
Drinking Water Supply						
Cultural/Cer e-monial Uses						
Agriculture						
Tribe Defined: 1 2 3 4 5 6						

[a] Prepare one table for rivers and streams, a separate table for lakes, and others for estuaries, coastline and wetlands, as appropriate.

[b] Reported in miles; in the other tables use acres for lakes, square miles for estuaries, miles for coastal waters, and acres for wetlands.

[c] Size threatened is a distinct category of waters and is not a subset of the size fully supporting uses. See Section 3.2.

Note: Tribe defined codes should be established for any important uses that are not included above. Examples of such uses could include Outstanding Resource Waters, Aesthetics, and Industry. To the extent possible, attempt to group waters into the eight general categories of use. Where waterbodies have multiple uses, the appropriate waterbody length/area should be entered in each applicable category.

Table 3. Total Sizes of Impaired Waters, by Cause Category[a]

Type of waterbody: Rivers and Streams[b]

Cause Category	Size of Waters Impaired[b]
Cause unknown	
Unknown toxicity	
Pesticides	
Priority organics	
Nonpriority organics	
Metals	
Ammonia	
Chlorine	
Other inorganics	
Nutrients	
pH	
Siltation	
Organic enrichment/low DO	
Salinity/TDS/chlorides	
Thermal modifications	
Flow alterations	
Other habitat alterations	
Pathogen indicators	
Radiation	
Oil and grease	
Taste and odor	
Suspended solids	
Noxious aquatic plants	
Filling and draining	
Total toxics	
Turbidity	
Filling and draining	
Exotic species	
Other (specify)	

[a] Prepare one table for rivers and streams, a separate table for lakes, and others for estuaries, coastlines, and wetlands as appropriate.

[b] Reported in miles for rivers and streams. When preparing similar tables for other waterbody types, use the following units: lakes, acres; estuaries, square miles; coastal waters and Great Lakes, shore miles; wetlands, acres.

Table 4. Total Sizes of Impaired Waters Affected by Various Source Categories[a]

Type of Waterbody: (Rivers and Streams)

Source Category	Size of Waters Impaired[b]
Point Sources	
Industrial Point Sources	
Municipal Point Sources	
Agricultural Point Sources (e.g., feedlots)	
Combined Sewer Overflows	
Nonpoint Sources	
Agriculture	
Silviculture	
Construction	
Urban Runoff/Storm Sewers	
Resource Extraction	
Land Disposal	
Hydromodification/Habitat Modification	
Contaminated Sediments[c]	
Atmospheric Deposition	
Unknown Source	
Natural Sources[d]	
Other (specify)[e]	

[a] Prepare one table for rivers and streams, a separate table for lakes, and others for estuaries, coastlines, and wetlands as appropriate.

[b] Reported in miles for rivers and streams. When preparing this table for other waterbody types, use the following units: lakes, acres; estuaries, square miles; coastal waters and Great Lakes, shore miles; wetlands, acres

[c] Bottom sediments contaminated with toxic or nontoxic pollutants; includes historical contamination from sources that are no longer actively discharging. Examples of contaminants are PCBs, metals, nutrients (common in lakes with phosphorous recycling problems), sludge deposits.

[d] Sources not due to human influence; e.g., natural-occurring low flow or drought, natural deposits resulting in high metals or salinity.

[e] List additional sources known to cause impairment.

Table 5. Waterbody-Specific Assessment Data for Tribal 305(b) Reporting

Waterbody Name	Waterbody ID	Description	Total Size[a]	Size Impaired	Designated Use	Degree of Use Support	Causes	Sources	Type of Assessment	Comments

[a] Use miles for rivers, streams, and coastline; acres for lakes; square miles for estuaries;
WWTP = wastewater treatment plant

Appendix C.

Data Analysis and Water Quality Criteria Knowledge Base for the ESS

Title: DATA ANALYSIS AND WATER QUALITY CRITERIA
Sections
section ASSESSMENT_menu : 'Used to return to the assessment menu'

chain 'ASSESS.KB'
section aquatic_life_criteria : 'provides a method to analyze aquatic life data'

advice'The following water quality criteria for freshwater are used to evaluate whether water is suitable for aquatic life, such as fish and macroinvertebrates.

FRESHWATER QUALITY CRITERIA

PHYSICAL AND AGGREGATE PROPERTIES
Alkalinity (min. chronic): 20 mg/L as CaCO3
Water Temp. (cold water fishery): 20 C (maximum)
Water Temp. (warm water fishery): 30 C (maximum)

INORGANIC NONMETALLICS (acute/chronic)
Unionized Ammonia: 0.02 mg/L as NH3
Chlorine: 0.019/0.011 mg/L as Cl2
Cyanide: 22/5.2 ug/L as CN
Diss. Oxygen: 6.0 (cold water fishery)
Diss. Oxygen: 7.0 mg/L (spawning cold water fishery)
Diss. Oxygen: 5.0 mg/L (warm water fishery)
Hydrogen Sulfide: 2 ug/L as H2S
pH: 6.5 to 8.5 s.u.

METALS AND SEMIMETALS (acute/chronic)
Antimony: 9000/1600 ug/L as Sb
Arsenic : 850 ug/L as
Beryllium: 130/0.53 ug/L as Be
Cadmium: 3.9/1.1 ug/L as Cd*
Chromium III: 1700/600 ug/L as Cr*
Chromium VI: 16/11 ug/L as Cr
Copper: 18/12 ug/L as Cu*
Iron: 1000 ug/L as Fe (chronic)
Lead: 82/3.2 ug/L as Pb*
Mercury: 2.4/0.012 ug/L as Hg
Nickel: 1400/16 ug/L as Ni*
Selenium: 260/35 ug/L as Se
Silver: 4.1/0.12 ug/L as Ag*
Thallium: 1400/40 ug/L as Tl
Zinc: 120/110 ug/L as Zn*

Notes: * = hardness dependent criteria using 100 mg/L as CaCO3 hardness concentration

Source of Information
EPA"s Quality Criteria for Water 1986 (the Gold Book) '
chain"

```
section bacteria_geometric_mean : 'determines the geometric mean of bacterial data'

assign geomean := (( ln(bacteria1) + ln(bacteria2) + ln(bacteria3) + ln(bacteria4) +
ln(bacteria5))) / 5
assign geomean := exp(geomean)
advice'The geometric mean of your five bacteria data is ' int(geomean) '/100mL.'

assign single_max := max(bacteria1, bacteria2)
assign single_max2 := max(single_max, bacteria3)
assign single_max3 := max(single_max2, bacteria4)
assign single_max4 :=max(single_max3, bacteria5)
advice'The single sample maximum bacteria level is ' int(single_max4)'/100mL.'

chain"
section boating_and_wading_criteria : 'provides criteria for evaluating secondary contact
recreation'

advice'The following water quality criteria are used to evaluate whether boating and wading
(secondary contact water recreation) are safe in fresh water (such as lakes, ponds, and streams)
and in the ocean (marine waters).

FRESH WATER BOATING AND WADING
Fecal coliform bacteria: 2000/100mL (geometric mean)
or
Enterococci: 33/100mL (geometric mean)
or
E. coli: 408/100mL (geometric mean)

Note: Geometric means are based on a minimum of 5 bacteria samples collected within 30
days during the boating and wading season.

Note: Either fecal coliform or enterococci or E. coli analyses are acceptable as criteria for
boating and wading.

Note: EPA recommends use of either enterococci or E. coli analyses for boating and wading
water use assessments.


OCEAN BOATING AND WADING
Enterococci: 276/100mL (geometric mean)

Note: Geometric means are based on a minimum of 5 bacteria samples collected within 30
days during the boating and wading season.

Source of Information
EPA"s Quality Criteria for Water 1986 (the Gold Book)'
```

chain"
section crop_irrigation_criteria : 'provides crop irrigation criteria for data analysis'

advice'The following water quality criteria are used to evaluate whether water is suitable for crop irrigation.

Fluoride: 1.0 mg/L as F
pH: 4.5 to 9.0
Sodium Absorption Ratio (SAR): 8
Arsenic: 0.10 mg/L as As
Boron: 0.75 mg/L as B (some plants are more sensitive to boron, such as citrus trees)
Cadmium: 0.01 mg/L as Cd
Chromium: 0.10 mg/L as Cr
Copper: 0.20 mg/L as Cu
Iron: 5.0 mg/L as Fe
Lead: 5.0 mg/L as Pb
Manganese: 0.20 mg/L as Mn
Nickel: 0.20 mg/L as Ni
Selenium: 0.02 mg/L as Se
Zinc: 2.0 mg/L as Zn

Source: Water Quality Criteria 1972 (The Blue Book) by the National Academy of Sciences'

chain"
section cultural_analysis : 'provides cultural water quality criteria for data analysis'

advice'The following cultural water quality criteria are used to evaluate whether cultural beneficial uses of waterbodies are being supported.

Cultural criteria are different than all other water quality criteria. The following criteria are presented as a guide to cultural use monitoring and analysis for use support determinations.

Water quality criteria for cultural uses vary widely, so the following five examples of water quality criteria are provided as a guide:

EXAMPLE 1. Small amounts of water are consumed from a stream, lake, or spring as part of a ceremony
CRITERIA: use drinking water standards as criteria

EXAMPLE 2. A wetland area is sacred to a Tribe
CRITERIA: use pristine (no degradation allowed)levels of water quality criteria to protect area as an outstanding water resource

EXAMPLE 3. A traditional ceremony uses cottonwood, willow, and cattails as part of the ceremony
CRITERIA: use wetland water quality criteria

EXAMPLE 4. After a cremation ceremony, the pallbearers bathe themselves in natural waters
CRITERIA: use contact recreation (swimming) criteria

EXAMPLE 5. Certain wetland plants, such as rushes and willows, are used for basket making and sweat lodge construction
CRITERIA: use wetland water quality criteria for basket making
CRITERIA: use wetland water quality criteria and drinking water standards criteria for sweat lodges'

chain"
section drinking_water_criteria : 'provides criteria for analyzing water supply data'

advice'The following water quality criteria are used to evaluate whether water is safe for drinking and other domestic uses.

PRIMARY DRINKING WATER STANDARDS (HEALTH BASED)

INORGANIC NONMETALLICS
Cyanide: 0.2 mg/L as CN
Fluoride: 4.0 mg/L as F
Nitrate: 10 mg/L as N
Nitrite: 1 mg/L as N
Nitrate and Nitrite: 10 mg/L as N

METALS AND SEMIMETALS
Antimony: 0.006 mg/L as Sb
Arsenic: 0.05
Barium: 2
Beryllium: 0.004
Cadmium: 0.005
Chromium: 0.1
Copper (at tap): 1.3
Lead (at tap): 0.015 mg/L as Pb
Mercury (inorganic): 0.002
Nickel: 0.1 mg/L as Ni
Selenium: 0.05 mg/L as Se
Thallium: 0.002 mg/L as Tl

BACTERIA
Total Coliform: 1/100mL

RADIONUCLIDES
Gross alpha particle activity: 15 pCi/L
Radium 226+228: 5 pCi/L
Uranium: 20 ug/L as U

PESTICIDES
(see federal water quality standards listing using the internet at www.epa.gov/OGWDW/ or call the Drinking Water Hotline at 800-426-4791)

SECONDARY DRINKING WATER STANDARDS (AESTHETICALLY BASED)

The following secondary drinking water standards are not to be used as drinking water criteria, but are useful to determine if the water has any taste, odor, or other aesthetic problems.

PHYSICAL AND AGGREGATE PROPERTIES
Color: 15 color units
Corrosivity: non-corrosive
Foaming agents: 0.5 mg/L
Odor: 3 threshold odor numbers
Total Dissolved Solids (TDS): 500 mg/L

INORGANIC NONMETALLICS
Chloride: 250 mg/L as CN
Fluoride: 2.0 mg/L as F
pH: 6.5 to 8.5 standard units
Sulfate: 250 mg/L as SO4

METALS AND SEMIMETALS
Aluminum: 0.05 to 0.2 mg/L as Al
Copper: 1.0 mg/L as Cu
Iron: 0.3 mg/L as Fe
Manganese: 0.05 mg/L as Mn
Silver: 0.1 mg/L as Ag
Zinc: 5 mg/L as Zn

Source of Information
EPA"s Quality Criteria for Water 1986 (the Gold Book)'

chain"
section fish_consumption_criteria : 'provides criteria for analyzing fish consumption data'

advice'The following water quality criteria are used to evaluate whether fish tissue is suitable for eating by humans Note: ppm = mg/kg.

METALS
Arsenic (inorganic): 3 ppm
Cadmium: 10 ppm
Mercury: 0.6 ppm
Selenium: 50 ppm
Tributyltin: 0.3 ppm

ORGANOCHLORINE PESTICIDES
Chlordane (sum of all metabolites): 0.08 ppm
DDT (sum of all metabolites): 0.3 ppm
Dicofol: 10 ppm
Dieldrin: 0.007 ppm
Endosulfan (I and II): 60 ppm
Endrin: 3 ppm
Heptachlor epoxide: 0.01 ppm
Hexachlorobenzene: 0.07 ppm
Lindane: 0.08 ppm
Mirex: 2 ppm
Toxaphene: 0.1 ppm

ORGANOPHOSPHATE PESTICIDES
Chlorpyrifos: 30 ppm
Diazinon: 0.9 ppm
Disulfoton0.5 ppm
Ethion: 5 ppm
Terbufos: 1 ppm

CHLOROPHENOXY HERBICIDES
Oxyfluorfen: 0.8 ppm

PAHS
Benzo(a)pyrene: 0.01 ppm

PCBs
Total PCBs (sum of all Aroclors): 0.01 ppm

DIOXINS/FURANS
2,3,7,8-TCDD: 0.0000007 ppm

Note: Analyze for dioxins/furans if pulp and paper mill effluent is a potential pollutant source.

Sources of Information
EPA Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories Volume 1 (EPA 823-R-95-007) and Volume 2 (EPA 823-B-97-009)'

chain"

section livestock_watering_criteria : 'provides criteria for livestock watering data analysis'
advice'The following water quality criteria are used to evaluate whether water is suitable for livestock watering.

Chloride: 1500 mg/L as Cl
Dissolved Oxygen: aerobic
Fluoride: 2.0 mg/L as F
Nitrate: 100 mg/L as N
Nitrite: 10 mg/L as N
pH: 5.0 to 9.0
Total dissolved solids (TDS): 3000 mg/L
Arsenic: 0.20 mg/L as As
Boron: 5.0 mg/L as B
Cadmium: 0.05 mg/L as Cd
Chromium: 1.0 mg/L as Cr
Copper: 0.50 mg/L as Cu
Lead: 0.10 mg/L as Pb
Mercury: 0.01 mg/L as Hg
Selenium: 0.05 mg/L as Se
Zinc: 25 mg/L as Zn

Source: Water Quality Criteria 1972 (The Blue Book) by the National Academy of Sciences'

chain"
section shellfishing_criteria : 'provides criteria for shellfishing analyses'

advice'The following water quality criteria are used to evaluate whether shellfish are suitable for eating by humans.

WATER QUALITY SAMPLING

Fecal coliform bacteria: 15/100mL (geometric mean)
43/100mL (single sample maximum)
or

Total coliform bacteria: 70/100mL (geometric mean)
230/100mL (single sample maximum)

Note: Geometric mean and single sample maximum are based on a minimum of 5 bacteria samples collected within 30 days.

Note: Either fecal coliform or total coliform analyses are acceptable as criteria for shellfishing.

SHELLFISH TISSUE SAMPLING

METALS
Arsenic (inorganic): 3 ppm
Cadmium: 10 ppm
Mercury: 0.6 ppm
Selenium: 50 ppm
Tributyltin: 0.3 ppm

ORGANOCHLORINE PESTICIDES
Chlordane (sum of all metabolites): 0.08 ppm
DDT (sum of all metabolites): 0.3 ppm
Dicofol: 10 ppm
Dieldrin: 0.007 ppm
Endosulfan (I and II): 60 ppm
Endrin: 3 ppm
Heptachlor epoxide: 0.01 ppm
Hexachlorobenzene: 0.07 ppm
Lindane: 0.08 ppm
Mirex: 2 ppm
Toxaphene: 0.1 ppm

ORGANOPHOSPHATE PESTICIDES
Chlorpyrifos: 30 ppm
Diazinon: 0.9 ppm
Disulfoton0.5 ppm
Ethion: 5 ppm
Terbufos: 1 ppm

CHLOROPHENOXY HERBICIDES
Oxyfluorfen: 0.8 ppm

PAHS
Benzo(a)pyrene: 0.01 ppm

PCBs
Total PCBs (sum of all Aroclors): 0.01 ppm

DIOXINS/FURANS
2,3,7,8-TCDD: 0.0000007 ppm

Note: Analyze for dioxins/furans if pulp and paper mill effluent is a potential pollutant source.

Sources of information
EPA Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories Volume 1 (EPA 823-R-95-007) and Volume 2 (EPA 823-B-97-009)
EPA"s Quality Criteria for Water 1986 (the Gold Book)'

chain"

```
section sodium_adsorption_ratio : 'calculates a sodium adsorption ratio'

assign sar := (na * 0.0435) / (sqrt (0.5 * ((ca * 0.0499) + (mg * 0.08229))))

if (sar >= 0 and sar < 4) advice 'The SAR value for your waterbody is ' int(sar) ' which has a
low sodium hazard potential for irrigated soils.'
if (sar >= 4 and sar <= 8) advice 'The SAR value for your waterbody is ' int(sar) ' which has a
medium sodium hazard potential for irrigated soils.'
if (sar > 8) advice 'The SAR value for your waterbody is ' int(sar) ' which has a high sodium
hazard potential for irrigated soils.'

chain"
section start : 'water quality analysis categories'

if analysis = 'trophic_status' do trophic_status
if analysis = 'trophic_status_secchi_only' do trophic_status_secchi_only
if analysis = 'sodium_adsorption_ratio' do sodium_adsorption_ratio
if analysis = 'bacteria_geometric_mean' do bacteria_geometric_mean
if analysis = 'cultural_analysis' do cultural_analysis
if analysis = 'fish_consumption_criteria' do fish_consumption_criteria
if analysis = 'shellfishing_criteria' do shellfishing_criteria
if analysis = 'aquatic_life_criteria' do aquatic_life_criteria
if analysis = 'swimming_criteria' do swimming_criteria
if analysis = 'boating_and_wading_criteria' do boating_and_wading_criteria
if analysis = 'drinking_water_criteria' do drinking_water_criteria
if analysis = 'crop_irrigation_criteria' do crop_irrigation_criteria
if analysis = 'livestock_watering_criteria' do livestock_watering_criteria
if analysis = 'wildlife_propagation_criteria' do wildlife_propagation_criteria
if analysis = 'wetlands_criteria' do wetlands_criteria
if analysis = 'assessment_menu' do assessment_menu
section swimming_criteria : 'provides criteria for analyzing bacteria data for swimming water
protection'

advice'The following water quality criteria are used to evaluate whether swimming is safe in
fresh water (such as lakes, ponds, and streams) and in the ocean (marine waters).

FRESH WATER SWIMMING
Fecal coliform bacteria:  200/100mL (geometric mean)
                          400/100mL (single sample maximum for not more than 10% of
samples)

or

Enterococci:  33/100mL (geometric mean)
              61/100mL (single sample maximum)
or

E. coli:  126/100mL (geometric mean)
          406/100mL (single sample maximum)
```

Note: Geometric mean and single sample maximum are based on a minimum of 5 bacteria samples collected within 30 days during the swimming season.

Note: Either fecal coliform or enterococci or E. coli analyses are acceptable as criteria for shellfishing.

Note: EPA recommends use of either enterococci or E. coli analyses for swimming water use assessments.

OCEAN SWIMMING
Enterococci: 35/100mL (geometric mean)
104/100mL (single sample maximum)

Note: Geometric mean and single sample maximum are based on a minimum of 5 bacteria samples collected within 30 days during the swimming season.

Source of Information
EPA"s Quality Criteria for Water 1986 (the Gold Book)'

chain"
section trophic_status : 'determines the trophic status of a lake, pond, or reservoir'

assign tsi := ((8.23 * ln (chl_a) + 33) +(14.42 * ln (total_p) + 4.15) + (60 - 14.41 * ln (secchi_disk))) / 3

if (tsi >= 0 and tsi <=40) advice 'The trophic status value for the waterbody is ' int(tsi) ' which is oligotrophic.'
if (tsi > 40 and tsi <=50) advice 'The trophic status value for the waterbody is ' int(tsi) ' which is mesotrophic.'
if (tsi > 50 and tsi <= 70) advice 'The trophic status value for the waterbody is ' int(tsi) ' which is eutrophic.'
if (tsi > 70) advice 'The trophic status value for the waterbody is ' int(tsi) ' which is hypereutrophic.'

chain"
section trophic_status_secchi_only : 'determines the trophic status of a lake, pond, or reservoir using only a secchi disk depth'

assign tsi := (60 - 14.41 * ln (secchi_disk))

if (tsi >= 0 and tsi <=40) advice 'The trophic status value for the waterbody is ' int(tsi) ' which is oligotrophic.'
if (tsi > 40 and tsi <=50) advice 'The trophic status value for the waterbody is ' int(tsi) ' which is mesotrophic.'
if (tsi > 50 and tsi <= 70) advice 'The trophic status value for the waterbody is ' int(tsi) ' which is eutrophic.'
if (tsi > 70) advice 'The trophic status value for the waterbody is ' int(tsi) ' which is hypereutrophic.'

chain"

section wetlands_criteria : 'provides wetlands criteria for data analysis'

advice'The following water quality criteria are recommended by the author to evaluate whether beneficial uses of wetlands are being supported.

Wetlands criteria are different than all other water quality criteria. The following criteria are presented as a guide to wetlands monitoring and analysis of wetlands data for use support determinations.

Five major wetlands water quality criteria categories are:

1. Changes in the presence of exotic species (such as tamarisk) over time

2. Changes in the presence of cultural plants in the wetland over time

3. Changes in the wetland habitat for waterfowl and other animals

4. Changes in the plant composition of wetlands over time

5. Changes in wetlands acreage over time'

chain"
section wildlife_propagation_criteria : ' '

advice'The following water quality criteria are recommended to evaluate whether water is suitable for the propagation of wildlife.

Alkalinity: >30 to 130 mg/L as CaCO3 (this is a minimum level)
Chloride: 1500 mg/L as Cl
Dissolved Oxygen: aerobic
Fluoride: 2.0 mg/L as F
Nitrate: 100 mg/L as N
Nitrite: 10 mg/L as N

Sources of Information
National Technical Advisory Committee Water Quality Criteria 1968 (the Green Book)
Nevada Division of Environmental Protection Water Quality Regulations (April 1997)'
chain"

```
Parameters
parameter analysis : 'performs various water quality data analyses'
type category
explanation 'This section allows you to perform various water quality analyses.'
options
  assessment_menu - 'assessment menu',
  trophic_status - 'trophic status',
  trophic_status_secchi_only - 'trophic status secchi only',
  sodium_adsorption_ratio - 'sodium adsorption ratio',
  bacteria_geometric_mean - 'bacteria geometric mean',
  cultural_analysis - 'cultural analysis',
  fish_consumption_criteria - 'fish consumption criteria',
  shellfishing_criteria- 'shellfishing criteria',
  aquatic_life_criteria - 'aquatic life criteria',
  swimming_criteria - 'swimming criteria',
  boating_and_wading_criteria - 'boating and wading criteria',
  drinking_water_criteria - 'drinking water criteria',
  crop_irrigation_criteria - 'crop irrigation criteria',
  livestock_watering_criteria - 'livestock water criteria',
  wildlife_propagation_criteria - 'wildlife propagation criteria',
  wetlands_criteria - 'wetlands criteria'.
 /* rules field */
question 'Select one of the listed calculations, numeric water quality criteria, or the assessment
menu.'
picture 'cup'
parameter bacteria1 : 'To determine the first bacteria value for calculation of a geometric
mean.'
type number
explanation 'Input the first of five bacteria data to calculate a geometric mean.'
/* rules field */
/* range field */
question 'What is your first bacteria level in units of #/100mL?'
picture ' '
parameter bacteria2 : 'To determine the second bacteria value for calculation of a geometric
mean.'
type number
explanation 'Input the second of five bacteria data to calculate a geometric mean.'
/* rules field */
/* range field */
question 'What is your second bacteria level in units of #/100mL?'
picture ' '
parameter bacteria3 : 'To determine the third bacteria value for calculation of a geometric
mean. '
type number
explanation 'Input the third of five bacteria data to calculate a geometric mean.'
/* rules field */
/* range field */
question 'What is your third bacteria level in units of #/100mL?'
picture ' '
```

```
parameter bacteria4 : 'To determine the fourth bacteria value for calculation of a geometric
mean.'
type number
explanation 'Input the fourth of five bacteria data to calculate a geometric mean.'
/* rules field */
/* range field */
question 'What is your fourth bacteria level in units of #/100mL? '
picture ' '
parameter bacteria5 : 'To determine the fifth bacteria value for calculation of a geometric
mean. '
type number
explanation 'Input the last bacteria level to calculate a geometric mean.'
/* rules field */
/* range field */
question 'What is your last bacteria level in units of #/100mL?'
picture ' '
parameter ca : 'input calcium concentration for SAR calculation'
type number
explanation 'Input your calcium concentration to calculate an SAR.'
/* rules field */
/* range field */
question 'What is the calcium concentration in units of mg/L as Ca?'
picture ' '
parameter chl_a : 'to obtain a chlorophyll a conc.'
type number
explanation 'Input your chl a concentration.'
/* rules field */
/* range field */
question 'What is the chlorophyll a concentration in units of ug/L? '
picture ' '
parameter geomean : ' '
type number
explanation ' '
/* rules field */
/* range field */
question ' '
picture ' '
parameter mg : 'input of magnesium concentration for SAR calculation'
type number
explanation 'Input your magnesium concentration to calculate an SAR.'
/* rules field */
/* range field */
question 'What is the magnesium concentration in units of mg/L as Mg?'
picture ' '
```

```
parameter na : 'input of sodium concentration for SAR calculation'
type number
explanation 'Input your sodium concentration to calculate an SAR.'
/* rules field */
/* range field */
question 'What is the sodium concentration in units of mg/L as Na?'
picture ' '
parameter sar : 'sodium adsorption ratio'
type number
explanation ' '
/* rules field */
/* range field */
question ' '
picture ' '

parameter secchi_disk : 'input a secchi disc depth.'
type number
explanation 'Information on secchi disk depth is needed to calculate a trophic status.'
/* rules field */
/* range field */
question 'What is the secchi disc depth in units of meters?'
picture ' '
parameter single_max : ' '
type number
explanation ' '
/* rules field */
/* range field */
question ' '
picture ' '

parameter single_max2 : ' '
type number
explanation ' '
/* rules field */
/* range field */
question ' '
picture ' '

parameter single_max3 : ' '
type number
explanation ' '
/* rules field */
/* range field */
question ' '
picture ' '
```

```
parameter single_max4 : ' '
type number
explanation ' '
/* rules field */
/* range field */
question ' '
picture ' '


parameter total_p : ' to obtain a total phosphorus conc.'
type number
explanation 'This value is used in a trophic status calculation.'
/* rules field */
/* range field */
question 'What is the total phosphorus concentration in units of ug/L as P?'
picture ' '
parameter tsi : ' '
type number
explanation ' '
/* rules field */
/* range field */
question ' '
picture ' '
```

Appendix D.

Beneficial Use Support Determinations Knowledge Base for the ESS

```
Title: BENEFICIAL USE SUPPORT DETERMINATIONS
Sections
section aquatic_life : 'To evaluate whether aquatic life use support (ALUS) of a waterbody is
being protected.'

advice'Aquatic life use support (ALUS) determinations are based on the following data
analyses:

1. Bioassessments of biological assemblages (fish, macroinvertebrates, or algae)

2. Habitat assessments of stream or lake beds, flow regimes, and riparian zones

3. Physical and chemical analyses (e.g., DO, chlorine, metals, pesticides)

4. Whole effluent toxicity (WET) and sediment toxicity testing results

Note: The selection and characterization of reference sites is recommended as a useful
approach to ALUS determinations.'

if (biol_data_aquatic = 'un_biol_aquatic' and hab_data_aquatic = 'un_hab_aquatic' and
chem_data_aquatic = 'un_chem_aquatic' and tox_data_aquatic = 'un_tox_aquatic') advice
'Beneficial use support classification is UNASSESSED.'
if (biol_data_aquatic = 'un_biol_aquatic' and hab_data_aquatic = 'un_hab_aquatic' and
chem_data_aquatic = 'un_chem_aquatic' and tox_data_aquatic = 'un_tox_aquatic') chain"
if (biol_data_aquatic = 'not_biol_aquatic' or hab_data_aquatic = 'not_hab_aquatic' or
chem_data_aquatic = 'not_chem_aquatic' or tox_data_aquatic = 'not_tox_aquatic') advice
'Beneficial use support classification is NOT SUPPORTING.'
if (biol_data_aquatic = 'not_biol_aquatic' or hab_data_aquatic = 'not_hab_aquatic' or
chem_data_aquatic = 'not_chem_aquatic' or tox_data_aquatic = 'not_tox_aquatic') chain"
if (biol_data_aquatic = 'part_biol_aquatic' or hab_data_aquatic = 'part_hab_aquatic' or
chem_data_aquatic = 'part_chem_aquatic' or tox_data_aquatic = 'part_tox_aquatic') advice
'Beneficial use support classification is PARTIALLY SUPPORTING.'
if (biol_data_aquatic = 'part_biol_aquatic' or hab_data_aquatic = 'part_hab_aquatic' or
chem_data_aquatic = 'part_chem_aquatic' or tox_data_aquatic = 'part_tox_aquatic') chain"
if (biol_data_aquatic = 'threat_biol_aquatic' or hab_data_aquatic = 'threat_hab_aquatic' or
chem_data_aquatic = 'threat_chem_aquatic' or tox_data_aquatic = 'threat_tox_aquatic') advice
'Beneficial use support classification is FULLY SUPPORTING BUT THREATENED.'
if (biol_data_aquatic = 'threat_biol_aquatic' or hab_data_aquatic = 'threat_hab_aquatic' or
chem_data_aquatic = 'threat_chem_aquatic' or tox_data_aquatic = 'threat_tox_aquatic') chain"
if (biol_data_aquatic = 'fully_biol_aquatic' or hab_data_aquatic = 'fully_hab_aquatic' or
chem_data_aquatic = 'fully_chem_aquatic' or tox_data_aquatic = 'fully_tox_aquatic') advice
'Beneficial use support classification is FULLY SUPPORTING.'
if (biol_data_aquatic = 'fully_biol_aquatic' or hab_data_aquatic = 'fully_hab_aquatic' or
chem_data_aquatic = 'fully_chem_aquatic' or tox_data_aquatic = 'fully_tox_aquatic') chain"



section assessment_menu : 'Used to return to the assessment menu'

chain 'ASSESS.KB'
```

section boating_and_wading : 'To evaluate whether the water quality of a waterbody is safe for boating and wading.'

advice
'The following determination of beneficial use support for boating and wading (partial contact recreation) is based on a minimum of five weekly bacteria samples collected during the boating season and/or information on bathing area closures.'

if (bacteria_data_boating = 'no_data_available_boating' and closure_data_boating = 'no_closure_data_boating') advice 'Beneficial use support classification is UNASSESSED.'
if (bacteria_data_boating = 'no_data_available_boating' and closure_data_boating = 'no_closure_data_boating') chain"
if (closure_data_boating = 'closures_or_weeks_long_boating'or bacteria_data_boating = 'exceed_geomean_boating') advice 'Beneficial use support classification is NOT SUPPORTING.'
if (bacteria_data_boating = 'exceed_geomean_boating' or closure_data_boating = 'closures_or_weeks_long_boating') chain"
if (bacteria_data_boating = 'single_exceed_not_geomean_boating' or closure_data_boating = 'closure_or_one_week_boating') advice 'Beneficial use support classification is PARTIALLY SUPPORTING.'
if (bacteria_data_boating = 'single_exceed_not_geomean_boating' or closure_data_boating = 'closure_or_one_week_boating') chain"
if (bacteria_data_boating = 'no_exceed_trend_boating' or closure_data_boating = 'no_closure_sources_boating') advice 'Beneficial use support classification is FULLY SUPPORTING BUT THREATENED.'
if (bacteria_data_boating = 'no_exceed_trend_boating' or closure_data_boating = 'no_closure_sources_boating') chain"
if (bacteria_data_boating = 'no_exceed_boating' or closure_data_boating = 'no_closures_or_restrictions_boating') advice 'Beneficial use support classification is FULLY SUPPORTING.'
if (bacteria_data_boating = 'no_exceed_boating' or closure_data_boating = 'no_closures_or_restrictions_boating') chain"

section crop_irrigation : 'to evaluate beneficial use support of irrigation water for crops'

if (monitor_data_irrigation = 'no_detects_no_exceed_irrigation') advice 'Beneficial use support classification is FULLY SUPPORTING.'
if (monitor_data_irrigation = 'no_detects_no_exceed_irrigation') chain"
if (monitor_data_irrigation = 'detects_no_exceed_irrigation') advice 'Beneficial use support classification is FULLY SUPPORTING BUT THREATENED.'
if (monitor_data_irrigation = 'detects_no_exceed_irrigation') chain"
if (monitor_data_irrigation = 'exceed_criteria_intermittent_irrigation') advice 'Beneficial use support classification is PARTIALLY SUPPORTING.'
if (monitor_data_irrigation = 'exceed_criteria_intermittent_irrigation') chain"
if (monitor_data_irrigation = 'exceed_criteria_consistently_irrigation') advice 'Beneficial use support classification is NOT SUPPORTING.'
if (monitor_data_irrigation = 'exceed_criteria_consistently_irrigation') chain"
if (monitor_data_irrigation = 'no_data_available_irrigation') advice 'Beneficial use support classification is UNASSESSED.'
if (monitor_data_irrigation = 'no_data_available_irrigation') chain"

section cultural_use : 'to evaluate the beneficial use support for culture, ceremonial, or traditional'

if (monitor_data_cultural_use = 'no_detects_no_exceed_cultural_use') advice 'Beneficial use support classification is FULLY SUPPORTING'
if (monitor_data_cultural_use = 'no_detects_no_exceed_cultural_use') chain"
if (monitor_data_cultural_use = 'detects_no_exceed_cultural_use') advice 'Beneficial use support classification is FULLY SUPPORTING BUT THREATENED.'
if (monitor_data_cultural_use = 'detects_no_exceed_cultural_use') chain"
if (monitor_data_cultural_use = 'exceed_criteria_intermittent_cultural_use') advice 'Beneficial use support classification is PARTIALLY SUPPORTING.'
if (monitor_data_cultural_use = 'exceed_criteria_intermittent_cultural_use') chain"
if (monitor_data_cultural_use = 'exceed_criteria_consistently_cultural_use') advice 'Beneficial use support classification is NOT SUPPORTING.'
if (monitor_data_cultural_use = 'exceed_criteria_consistently_cultural_use') chain"
if (monitor_data_cultural_use = 'no_data_available_cultural_use') advice 'Beneficial use support classification is UNASSESSED.'
if (monitor_data_cultural_use = 'no_data_available_cultural_use') chain"

section drinking_water_source : 'To evaluate whether a waterbody is a safe source of drinking water.'

if (monitor_data_drinking = 'no_data_available_drinking' and drinking_water_restriction = 'no_restriction_information_drinking') advice 'Beneficial use support classification is UNASSESSED.'
if (monitor_data_drinking = 'no_data_available_drinking' and drinking_water_restriction = 'no_restriction_information_drinking') chain"
if (drinking_water_restriction = 'restrictions_caused_closures_drinking'or monitor_data_drinking = 'exceed_criteria_consistently_drinking') advice 'Beneficial use support classification is NOT SUPPORTING.'
if (monitor_data_drinking = 'exceed_criteria_consistently_drinking' or drinking_water_restriction = 'restrictions_caused_closures_drinking') chain"
if (monitor_data_drinking = 'exceed_criteria_intermittent_drinking' or drinking_water_restriction = 'restrict_costly_treatment_drinking') advice 'Beneficial use support classification is PARTIALLY SUPPORTING.'
if (monitor_data_drinking = 'exceed_criteria_intermittent_drinking' or drinking_water_restriction = 'restrict_costly_treatment_drinking') chain"
if (monitor_data_drinking = 'detects_no_exceed_drinking' or drinking_water_restriction = 'some_restrict_pot_impacts_drinking') advice 'Beneficial use support classification is FULLY SUPPORTING BUT THREATENED.'
if (monitor_data_drinking = 'detects_no_exceed_drinking' or drinking_water_restriction = 'some_restrict_pot_impacts_drinking') chain"
if (monitor_data_drinking = 'no_detects_no_exceed_drinking' or drinking_water_restriction = 'no_restrictions_drinking') advice 'Beneficial use support classification is FULLY SUPPORTING.'
if (monitor_data_drinking = 'no_detects_no_exceed_drinking' or drinking_water_restriction = 'no_restrictions_drinking') chain"

section fish_consumption : 'To evaluate whether fish consumption is safe for humans.'

if (monitor_data_fish = 'no_data_available_fish' and advisory_fish_consume = 'no_advisory_information_fish') advice 'Beneficial use support classification is UNASSESSED.'
if (monitor_data_fish = 'no_data_available_fish' and advisory_fish_consume = 'no_advisory_information_fish') chain"
if (advisory_fish_consume = 'gen_no_consume_comm_ban_fish'or monitor_data_fish = 'exceed_criteria_consistently_fish') advice 'Beneficial use support classification is NOT SUPPORTING.'
if (monitor_data_fish = 'exceed_criteria_consistently_fish' or advisory_fish_consume = 'gen_no_consume_comm_ban_fish') chain"
if (monitor_data_fish = 'exceed_criteria_intermittent_fish' or advisory_fish_consume = 'restrict_consume_subpop_ban_fish') advice 'Beneficial use support classification is PARTIALLY SUPPORTING.'
if (monitor_data_fish = 'exceed_criteria_intermittent_fish' or advisory_fish_consume = 'restrict_consume_subpop_ban_fish') chain"
if (monitor_data_fish = 'detects_no_exceed_fish' or advisory_fish_consume = 'some_restrict_pot_impacts_fish') advice 'Beneficial use support classification is FULLY SUPPORTING BUT THREATENED.'
if (monitor_data_fish = 'detects_no_exceed_fish' or advisory_fish_consume = 'some_restrict_pot_impacts_fish') chain"
if (monitor_data_fish = 'no_detects_no_exceed_fish' or advisory_fish_consume = 'no_advisory_no_bans_fish') advice 'Beneficial use support classification is FULLY SUPPORTING.'
if (monitor_data_fish = 'no_detects_no_exceed_fish' or advisory_fish_consume = 'no_advisory_no_bans_fish') chain"

section livestock_watering : 'to evaluate the beneficial use support for livestock watering'

if (monitor_data_livestock = 'no_detects_no_exceed_livestock') advice 'Beneficial use support classification is FULLY SUPPORTING.'
if (monitor_data_livestock = 'no_detects_no_exceed_livestock') chain"
if (monitor_data_livestock = 'detects_no_exceed_livestock') advice 'Beneficial use support classification is FULLY SUPPORTING BUT THREATENED.'
if (monitor_data_livestock = 'detects_no_exceed_livestock') chain"
if (monitor_data_livestock = 'exceed_criteria_intermittent_livestock') advice 'Beneficial use support classification is PARTIALLY SUPPORTING.'
if (monitor_data_livestock = 'exceed_criteria_intermittent_livestock') chain"
if (monitor_data_livestock = 'exceed_criteria_consistently_livestock') advice 'Beneficial use support classification is NOT SUPPORTING.'
if (monitor_data_livestock = 'exceed_criteria_consistently_livestock') chain"
if (monitor_data_livestock = 'no_data_available_livestock') advice 'Beneficial use support classification is UNASSESSED.'
if (monitor_data_livestock = 'no_data_available_livestock') chain"

section shellfishing : 'To evaluate whether the consumption of shellfish is safe for humans. '

if (monitor_data_shellfish = 'no_data_available_shellfish' and advisory_shellfish_consume = 'no_advisory_information_shellfish') advice 'Beneficial use support classification is UNASSESSED.'
if (monitor_data_shellfish = 'no_data_available_shellfish' and advisory_shellfish_consume = 'no_advisory_information_shellfish') chain"
if (advisory_shellfish_consume = 'gen_no_consume_comm_ban_shellfish' or monitor_data_shellfish = 'exceed_criteria_consistently_shellfish') advice 'Beneficial use support classification is NOT SUPPORTING.'
if (monitor_data_shellfish = 'exceed_criteria_consistently_shellfish' or advisory_shellfish_consume = 'gen_no_consume_comm_ban_shellfish') chain"
if (monitor_data_shellfish = 'exceed_criteria_intermittent_shellfish' or advisory_shellfish_consume = 'restrict_consume_subpop_ban_shellfish') advice 'Beneficial use support classification is PARTIALLY SUPPORTING.'
if (monitor_data_shellfish = 'exceed_criteria_intermittent_shellfish' or advisory_shellfish_consume = 'restrict_consume_subpop_ban_shellfish') chain"
if (monitor_data_shellfish = 'detects_no_exceed_shellfish' or advisory_shellfish_consume = 'some_restrict_pot_impacts_shellfish') advice 'Beneficial use support classification is FULLY SUPPORTING BUT THREATENED.'
if (monitor_data_shellfish = 'detects_no_exceed_shellfish' or advisory_shellfish_consume = 'some_restrict_pot_impacts_shellfish') chain"
if (advisory_shellfish_consume = 'no_advisory_no_bans_shellfish' or monitor_data_shellfish = 'no_detects_no_exceed_shellfish') advice 'Beneficial use support classification is FULLY SUPPORTING.'
if (monitor_data_shellfish = 'no_detects_no_exceed_shellfish' or advisory_shellfish_consume = 'no_advisory_no_bans_shellfish') chain"

```
section start : 'This section provides an assessment of water quality impairment of Tribal water resources. '

if use = 'cultural_use' do cultural_use
if use = 'aquatic_life' do aquatic_life
if use = 'wetlands' do wetlands
if use = 'fish_consumption' do fish_consumption
if use = 'shellfishing' do shellfishing
if use = 'swimming' do swimming
if use = 'boating_and_wading' do boating_and_wading
if use = 'drinking_water_source' do drinking_water_source
if use = 'crop_irrigation' do crop_irrigation
if use = 'livestock_watering' do livestock_watering
if use = 'assessment_menu' do assessment_menu
```

section swimming : 'To evaluate whether the water quality of a waterbody is safe for swimmers.'

advice
'The following determination of beneficial use support for swimming (contact recreation) is based on a minimum of five weekly bacteria samples collected during the swimming season and/or information on bathing area closures.'

if (bacteria_data_swimming = 'no_data_available_swimming' and closure_data_swimming = 'no_closure_data_swimming') advice 'Beneficial use support classification is UNASSESSED.'
if (bacteria_data_swimming = 'no_data_available_swimming' and closure_data_swimming = 'no_closure_data_swimming') chain"
if (closure_data_swimming = 'closures_or_weeks_long_swimming'or
bacteria_data_swimming = 'exceed_geomean_swimming') advice 'Beneficial use support classification is NOT SUPPORTING.'
if (bacteria_data_swimming = 'exceed_geomean_swimming' or closure_data_swimming = 'closures_or_weeks_long_swimming') chain"
if (bacteria_data_swimming = 'single_exceed_not_geomean_swimming' or
closure_data_swimming = 'closure_or_one_week_swimming') advice 'Beneficial use support classification is PARTIALLY SUPPORTING.'
if (bacteria_data_swimming = 'single_exceed_not_geomean_swimming' or
closure_data_swimming = 'closure_or_one_week_swimming') chain"
if (bacteria_data_swimming = 'no_exceed_trend_swimming' or closure_data_swimming = 'no_closure_sources_swimming') advice 'Beneficial use support classification is FULLY SUPPORTING BUT THREATENED.'
if (bacteria_data_swimming = 'no_exceed_trend_swimming' or closure_data_swimming = 'no_closure_sources_swimming') chain"
if (bacteria_data_swimming = 'no_exceed_swimming' or closure_data_swimming = 'no_closures_or_restrictions_swimming') advice 'Beneficial use support classification is FULLY SUPPORTING.'
if (bacteria_data_swimming = 'no_exceed_swimming' or closure_data_swimming = 'no_closures_or_restrictions_swimming') chain"
if not (closure_or_restriction) and not (closure_week_exceed) and not
(bacteria_geomean_exceed) and not (bacteria_single_exceed) and not
(bacteria_increase_indications) and not (info_that_unattainable) advice 'Waterbody use support is FULLY SUPPORTING.'
if not (closure_or_restriction) and not (closure_week_exceed) and not
(bacteria_geomean_exceed) and not (bacteria_single_exceed) and
bacteria_increase_indications and not (info_that_unattainable) advice 'Waterbody use support is FULLY SUPPORTING BUT THREATENED.'
if closure_or_restriction and not (closure_week_exceed) and not (bacteria_geomean_exceed) and bacteria_single_exceed and not (info_that_unattainable) advice 'Waterbody use support is PARTIALLY SUPPORTING.'
if not (info_that_unattainable) and closure_week_exceed or bacteria_geomean_exceed advice 'Waterbody use support is NOT SUPPORTING.'
if (info_that_unattainable) advice'Waterbody use support is UNATTAINABLE.'
chain"

section wetlands : 'monitoring recommendations for wetlands'

advice
'This section is designed to provide minimum wetlands monitoring recommendations for a Tribes first 305b water quality assessment report. This section is intentionally brief and simple. Additional information on wetlands monitoring is provided at the end of this section.

Conduct wetlands water quality monitoring as presented below for every beneficial use that a wetland either currently supports or has the potential to support.

1. Riparian Buffer
Why: To evaluate the condition of a wetland used as a riparian buffer
When: During the mid to late growing season
How Often: 1 time per year
Valuable Indicators: wetlands acreage loses, habitat loses, removal or reduction in sources of water to the riparian area (such as a levy road)

2. Cultural Uses (specific to each Tribe, so an example is provided)
Why: To evaluate the suitability of a wetland to provide cultural uses such as containing medicinal or ceremonial plants
When: During the mid or late growing season when plants are easiest to identify
How Often: 1 time per year
Valuable Indicators: lose of acreage of individual plants or habitat for medicinal or ceremonial plants, grazing pressure, accessibility to the plants

3. Wildlife Habitat
Why: To evaluate the suitability of an estuary or shoreline for wildlife habitat
When: During the growing season is preferred
How Often: 1 time during the growing season
Valuable Indicators: wildlife corridors between the wetland and nearby waterbody or uplands with cover
4. Shellfishing
Why: To evaluate the suitability of estuary or shoreline water for shellfish to be consumed by humans
When: During the shellfish growing season
How Often: 1 to 2 times per year
Valuable Indicators: coliform bacteria or E. coli., habitat

5. Aquatic Life Support
Why: To evaluate how well the wetland supports aquatic life
When: During the mid to late growing season
How Often: 1 time per year
Valuable Indicators: wetland riparian acreage loses, trophic status, fish diversity, dissolved oxygen fluctuations, chronic toxicity testing

Suggestions
1. Review the section on data analysis for beneficial uses
Sources of Additional Information
1. State Wetlands Strategies document (World Wildlife Fund 1992)
2. EPA''s internet number epa.gov'
chain"

```
Parameters
parameter advisory_fish_consume : 'To determine the type of fish tissue advisory available '
type category
explanation 'Based on the information available on fish consumption advisories, respond to
the question '
options
  no_advisory_no_bans_fish - 'No fish consumption restriction or ban are in effect',
  some_restrict_pot_impacts_fish - 'Consumption restriction occurred or are likely to occur',
  restrict_consume_subpop_ban_fish - 'Consumption restriction in effect or ban for
subpopulation',
  gen_no_consume_comm_ban_fish - 'Consumption ban in effect or commercial ban in effect',
  no_advisory_information_fish - 'No fish consumption advisory information available'.
/* rules field */
question 'Select one of the following statements that best describes your fish consumption
advisory information for the waterbody to be assessed.'
picture ' '

parameter advisory_shellfish_consume : 'To determine the type of shellfish advisory available
'
type category
explanation 'Based on the information available on shellfish consumption advisories, respond
to the question.'
options
  no_advisory_no_bans_shellfish - 'No shellfish consumption restriction or ban are in effect',
  some_restrict_pot_impacts_shellfish - 'Consumption restriction occurred or are likely to
occur',
  restrict_consume_subpop_ban_shellfish - 'Consumption restriction in effect or ban for
subpopulation',
  gen_no_consume_comm_ban_shellfish - 'Consumption ban in effect or commercial ban in
effect',
  no_advisory_information_shellfish - 'No shellfish consumption advisory information
available'.
/* rules field */
question 'Select one of the following statements that best describes your shellfish consumption
advisory information for the waterbody to be assessed.'
picture ' '
```

```
parameter bacteria_data_boating : 'To determine the type of bacteria data for boating available'
type category
explanation 'Based on the data available on bacteria analyses for boating and wading, respond
to the question.'
options
  no_exceed_boating - 'No geometric mean or single sample max exceedances',
  no_exceed_trend_boating - 'No exceedances, but bacteria levels increasing',
  single_exceed_not_geomean_boating - 'Single sample max exceedances, geometric mean
met',
  exceed_geomean_boating - 'Geometric mean exceedances of  boating/wading criteria',
 no_data_available_boating - 'Bacteria data for boating/wading are not available'.
/* rules field */
question 'Select one of the following statements that best describes your analysis of bacteria
data for the waterbody to be assessed.'
picture ' '

parameter bacteria_data_swimming : 'To determine the type of bacteria data for swimming
available'
type category
explanation 'Based on the data available on bacteria analyses for swimming, respond to the
question.'
options
  no_exceed_swimming - 'No geometric mean or single sample max exceedances',
  no_exceed_trend_swimming - 'No exceedances, but bacteria levels increasing',
  single_exceed_not_geomean_swimming - 'Single sample max exceedances, geometric mean
met',
  exceed_geomean_swimming - 'Geometric mean exceedances of  swimming criteria',
 no_data_available_swimming - 'Bacteria data for swimming are not available'.
/* rules field */
question 'Select one of the following statements that best describes your analysis of bacteria
data for the waterbody to be assessed.'
picture ' '

parameter bacteria_geomean_exceed : 'To determine whether the bacteria geometric mean has
been exceeded. '
type boolean
explanation 'The minimum number of weekly bacteria samples to calculate a geometric mean
is 5.'
/* rules field */
question 'Has the geometric mean criterion of the bacteria data been exceeded?'
picture 'swimming'
```

```
parameter bacteria_increase_indications : 'To determine if there are any indications of future
increases in bacteria levels in the waterbody.'
type boolean
explanation 'A waterbody may be considered threatened if there is information indicating that
bacteria levels are likely to increase in the future, such as from septic systems in disrepair that
could leak into the waterbody.'
/* rules field */
question 'Is there an indication that bacteria levels in the waterbody will increase, such as from
new sources of bacteria loading to the waterbody?'
picture 'swimming'

parameter bacteria_single_exceed : 'To determine if the single bacteria level criterion was
exceeded.'
type boolean
explanation 'The single-sample criterion for bacteria is specific to each bacteria indicator.'
/* rules field */
question 'Has the single-sample criterion for bacteria been exceeded? '
picture 'swimming'

parameter biol_data_aquatic : 'to determine the type of biologic data available for aquatic life'
type category
explanation 'Based on the information available on biological assessments for assemblages
(fish, macroinvert., or algae), respond to the question.'
options
  fully_biol_aquatic - 'Data indicate functioning, sustainable assemblages',
  threat_biol_aquatic - 'Same as above, but declining quality or pot. impairment',
  part_biol_aquatic - 'At least one assemblage indicates moderate impairment',
  not_biol_aquatic - 'Data indicate severe impairment of biological community',
  un_biol_aquatic - 'Biological data for assemblages are not available'.
/* rules field */
question 'Select one of the following statements that best describes your analysis of biological
data for the waterbody to be assessed.'
picture ' '

parameter chem_data_aquatic : 'to determine the type of physical and chemical data available
for aquatic life'
type category
explanation 'Based on your available data on physical and chemical data analyses, respond to
the question.'
options
  fully_chem_aquatic - 'One exceedance or less for acute and chronic criteria',
  threat_chem_aquatic - 'Same as above, but declining quality or pot. pollutants',
  part_chem_aquatic - 'Acute or chronic exceedances, but in <10% of samples',
  not_chem_aquatic - 'Acute or chronic exceedances in >10% of samples',
  un_chem_aquatic - 'Physical and chemical data are not available'.
/* rules field */
question 'Select a statement that best describes your analysis of physical/chemical data for the
waterbody to be assessed.'
picture ' '
```

```
parameter closure_data_boating : 'To determine the type of boating closures data available'
type category
explanation 'Based on the information available on boating (or wading) closures, respond to
the question.'
options
  no_closures_or_restrictions_boating - 'No boating closures during reporting period',
  no_closure_sources_boating - 'No boating closures, but bacteria sources present',
  closure_or_one_week_boating - 'Average of one closure/year that is <1 week long',
  closures_or_weeks_long_boating - 'Boating closures/year is >1 or >1 week long/year',
  no_closure_data_boating - 'No boating area closure data available'.
/* rules field */
question 'Select one of the following statements that best describes your boating (or wading)
closures data for the waterbody to be assessed.'
picture ' '

parameter closure_data_swimming : 'To determine the type of swimming closures data
available'
type category
explanation 'Based on the information available on swimming closures, respond to the
question.'
options
  no_closures_or_restrictions_swimming - 'No swimming closures during reporting period',
  no_closure_sources_swimming - 'No swimming closures, but bacteria sources present',
  closure_or_one_week_swimming - 'Average of one closure/year that is <1 week long',
  closures_or_weeks_long_swimming - 'Swimming closures/year is >1 or >1 week long/year',
  no_closure_data_swimming - 'No swimming area closure data available'.
/* rules field */
question 'Select one of the following statements that best describes your swimming closures
data for the waterbody to be assessed.'
picture ' '

parameter closure_or_restriction : 'To determine if any swimming area closures or restrictions
have occurred. '
type boolean
explanation 'Bathing area closures and restrictions are based typically on sewage
contamination in swimming areas and are determined by a Tribal environmental protection
agency or a Tribal health department.'
/* rules field */
question 'Have there been any bathing area closures or bathing restrictions in effect during the
reporting period?'
picture 'swimming '

parameter closure_week_exceed : 'To determine info on bathing closure duration'
type boolean
explanation 'Tribal health departments and Tribal environmental protection agencies typically
determine the duration of a bathing area closure or restriction.'
/* rules field */
question 'On average, has there been one or more bathing area closures per year that lasted
more than one week?'
picture 'swimming'
```

```
parameter drinking_water_restriction : 'To determine the type of drinking water restriction
information available '
type category
explanation 'Based on the information available on drinking water restrictions, respond to the
question '
options
  no_restrictions_drinking - 'No drinking water use restrictions are in effect',
  some_restrict_pot_impacts_drinking - 'Some restrictions occurred or a potential for impacts',
  restrict_costly_treatment_drinking - 'Restrictions resulted in need for costly treatment',
  restrictions_caused_closures_drinking -'Drinking water use restrictions resulted in closures',
  no_restriction_information_drinking - 'No drinking water use restriction data available'.
/* rules field */
question 'Select one of the following statements that best describes your  drinking water use
restriction data for the waterbody to be assessed.'
picture ' '

parameter hab_data_aquatic : 'to determine the type of biologic data available for aquatic life'
type category
explanation 'Based on your available data on habitat assessments (stream channel [or lake or
estuary bottom], flow regime, and riparian zone), respond to the question.'
options
  fully_hab_aquatic - 'Habitat is natural and minimally or not modified at all',
  threat_hab_aquatic - 'Same as above, but actual or potential declining quality',
  part_hab_aquatic - 'Slight to moderate habitat modifications present',
  not_hab_aquatic - 'Severe habitat modifications present',
  un_hab_aquatic - 'Data on habitat conditions are not available'.
/* rules field */
question 'Select one of the following statements that best describes your analysis of habitat
conditions for the waterbody to be assessed.'
picture ' '

parameter info_that_unattainable : 'To determine if there is information that the beneficial uses
for a waterbody are unattainable.'
type boolean
explanation 'An unattainable determination for a waterbody can only be made based on a use
attainability analyses using chemical/physical, toxicity, or biological/habitat indicators.'
/* rules field */
question 'Has a use attainability study been conducted that indicated beneficial uses for the
waterbody are unattainable?'
picture ''
```

```
parameter monitor_data_cultural_use : 'To determine the type of cultural_use data available'
type category
explanation 'Based on the information available on cultural use analyses, respond to the
question.'
options
  no_detects_no_exceed_cultural_use - 'No criteria exceedances and no detected
contaminants',
  detects_no_exceed_cultural_use - 'No criteria exceedances, but contaminants detected',
  exceed_criteria_intermittent_cultural_use - 'Intermittent exceedances of cultural use criteria',
  exceed_criteria_consistently_cultural_use - 'Consistent exceedances of cultural use criteria',
  no_data_available_cultural_use - 'Data analysis for cultural use is not available'.
/* rules field */
question 'Select one of the following statements that best describes your analysis of cultural
use data for the waterbody to be assessed.'
picture ' '

parameter monitor_data_drinking : 'To determine the type of drinking water data available'
type category
explanation 'Contaminants detected is defined as a concentration level of 50% or greater of the
maximum contaminant level for a contaminant, such as nitrate.'
options
  no_detects_no_exceed_drinking - 'No criteria exceedances and no detected contaminants',
  detects_no_exceed_drinking - 'No criteria exceedances, but contaminants detected',
  exceed_criteria_intermittent_drinking - 'Intermittent exceedances of drinking water criteria',
  exceed_criteria_consistently_drinking - 'Consistent exceedances of drinking water criteria',
  no_data_available_drinking - 'Data analysis for drinking water is not available'.
/* rules field */
question 'Select one of the following statements that best describes your analysis of drinking
water data for the waterbody to be assessed.'
picture ' '

parameter monitor_data_fish : 'To determine the type of fish tissue data available'
type category
explanation 'Based on the information available on fish tissue analyses, respond to the
question.'
options
  no_detects_no_exceed_fish - 'No criteria exceedances and no detected contaminants',
  detects_no_exceed_fish - 'No criteria exceedances, but contaminants detected',
  exceed_criteria_intermittent_fish - 'Intermittent exceedances of fish tissue criteria',
  exceed_criteria_consistently_fish - 'Consistent exceedances of fish tissue criteria',
  no_data_available_fish - 'Data analysis for fish tissue is not available'.
/* rules field */
question 'Select one of the following statements that best describes your analysis of fish tissue
data for the waterbody to be assessed.'
picture ' '
```

```
parameter monitor_data_irrigation : 'To determine the type of crop irrigation data available'
type category
explanation 'Based on the information available on crop irrigation analyses, respond to the
question.'
options
  no_detects_no_exceed_irrigation - 'No criteria exceedances and no detected contaminants',
  detects_no_exceed_irrigation - 'No criteria exceedances, but contaminants detected',
  exceed_criteria_intermittent_irrigation - 'Intermittent exceedances of crop irrigation criteria',
  exceed_criteria_consistently_irrigation - 'Consistent exceedances of  crop irrigation criteria',
  no_data_available_irrigation - 'Data analysis for crop irrigation is not available'.
/* rules field */
question 'Select one of the following statements that best describes your analysis of crop
irrigation data for the waterbody to be assessed.'
picture ' '

parameter monitor_data_livestock : 'To determine the type of livestock watering data
available'
type category
explanation 'Based on the information available on livestock watering analyses, respond to the
question.'
options
  no_detects_no_exceed_livestock - 'No criteria exceedances and no detected contaminants',
  detects_no_exceed_livestock - 'No criteria exceedances, but contaminants detected',
  exceed_criteria_intermittent_livestock - 'Intermittent exceedances of livestock watering
criteria',
  exceed_criteria_consistently_livestock - 'Consistent exceedances of  livestock watering
criteria',
  no_data_available_livestock - 'Data analysis for livestock watering is not available'.
/* rules field */
question 'Select one of the following statements that best describes your analysis of livestock
watering data for the waterbody to be assessed.'
picture ' '

parameter monitor_data_shellfish : 'To determine the type of shellfish data available'
type category
explanation 'Based on the information available on shellfish analyses, respond to the question.'
options
  no_detects_no_exceed_shellfish - 'No criteria exceedances and no detected contaminants',
  detects_no_exceed_shellfish - 'No criteria exceedances, but contaminants detected',
  exceed_criteria_intermittent_shellfish - 'Intermittent exceedances of shellfish criteria',
  exceed_criteria_consistently_shellfish - 'Consistent exceedances of  shellfish criteria',
  no_data_available_shellfish - 'Data analysis for shellfish is not available'.
/* rules field */
question 'Select one of the following statements that best describes your analysis of shellfish
data for the waterbody to be assessed.'
picture ' '
```

```
parameter tox_data_aquatic : 'to determine the type of physical and chemical data available for
aquatic life'
type category
explanation 'Based on your available data on whole effluent toxicity (WET) or sediment
toxicity results, respond to the question.'
options
  fully_tox_aquatic - 'No toxicity indicated in either acute and chronic tests',
  threat_tox_aquatic - 'Same as above, but increased toxicity trend apparent',
  part_tox_aquatic - 'No acute toxicity, but slight or infrequent chronic toxicity',
  not_tox_aquatic - 'Toxicity indicated frequently in acute and chronic tests',
  un_tox_aquatic - 'Toxicity data for water or sediment are not available'.
/* rules field */
question 'Select one of the following statements that best describes your analysis of toxicity
data for the waterbody to be assessed.'
picture ' '

parameter use : 'Selection of the beneficial use of water to be assessed. '
type category
explanation 'Select one beneficial use of water at a time  to evaluate with respect to water
quality protection. '
options
  assessment_menu - 'assessment_menu',
  cultural_use  - 'cultural use',
  aquatic_life  - 'aquatic life',
  fish_consumption - 'fish consumption',
  shellfishing - 'shellfishing',
  swimming - 'swimming',
  boating_and_wading - 'boating and wading'
  drinking_water_source - 'drinking water source',
  crop_irrigation- 'crop irrigation',
  livestock_watering - 'livestock watering'.
 /* rules field */
question 'Select a use of water to consult or the assessment menu.'
picture 'bird'
```