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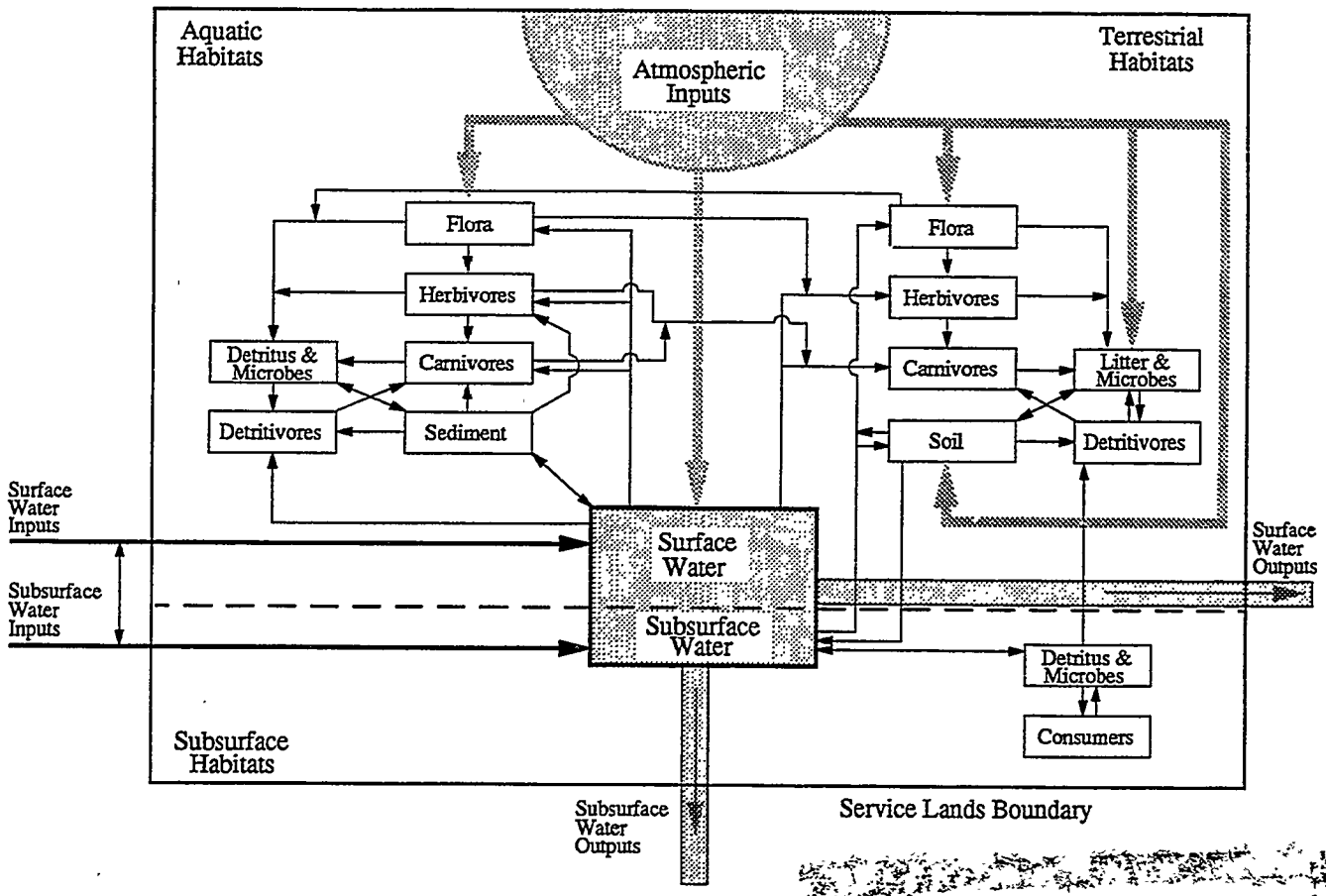
U.S. FISH AND WILDLIFE SERVICE LANDS BIOMONITORING OPERATIONS MANUAL

Volume 1



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U.S. FISH AND WILDLIFE SERVICE LANDS

BIOMONITORING OPERATIONS MANUAL

VOLUME 1

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PREFACE

This is Volume 1 of an operations manual designed to facilitate the development of biomonitoring strategies for U.S. Fish and Wildlife Service (Service) lands. It is one component of the U.S. Fish and Wildlife Service Lands Biomonitoring Operations Manual (Manual). All the documents included in the Manual are listed below. This document may be updated in the future to accommodate changes in sampling and monitoring strategies. A page to document revisions to this Volume and a sheet for suggested revisions is provided in the front of this document.

Volume I

Introduction to the Manual, background information on monitoring, and procedures for developing a biomonitoring strategy for Service lands.

Volume II - Appendices and Summary Sheets

A. Legislative Background and Key to Relevant Legislation
B. Biomonitoring Operations Workbook
C. Air Monitoring - A Reference Manual
D. Introduction to the Flora and Fauna for Biomonitoring
  D.1 Benthic Macroinvertebrate Sampling Reference Field Methods
  D.2 Bird Sampling Reference Field Methods
  D.3 Fish Sampling Reference Field Methods
  D.4 Flora Sampling Reference Field Methods
  D.5 Reptiles and Amphibians Sampling Reference Field Methods
  D.6 Mammal Sampling Reference Field Methods
E. Decontamination Guidance Reference Field Methods
F. Documentation Guidance, Sample Handling, and Quality Assurance/Quality Control Standard Operating Procedures
G. Field Instrument Measurements Reference Field Methods
H. Ground Water Sampling Reference Field Methods
I. Sediment Sampling Reference Field Methods
J. Soil Sampling Reference Field Methods
K. Surface Water Reference Field Methods

Reference Field Method Summary Sheets

BM Benthic Macroinvertebrates
BRD Birds
FSH Fish
FL Flora
HPT Herpetiles
MAM Mammals
DEC Decontamination
DOC Documentation Guidance, Sample Handling, and Quality Assurance/Quality Control Standard Operating Procedures
FIM Field Instrument Measurements
GW Ground Water Sampling
SED Sediment Sampling
SO Soil Sampling
SW Surface Water Sampling

The intention is to revise and update this document as methods and techniques are improved or as corrections are made. This page is provided to document the inclusion of revisions or inserts to this section of the Manual. An example is provided on the first line.

Rev #	Date	Section(s)	Old Pages	New Pages	# of New Pages
EX	10/2/91	2.1	2-4	2-4c	5
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Document Revision Worksheet WS-P

Use this worksheet to document suggested revisions (make a copy for your files) and send it to:

U.S. Fish and Wildlife Service
Division of Environmental Contaminants
4401 North Fairfax Drive, Room 330
Arlington, VA 22201

Commentor's Name		Phone	
Address			
Section to be revised		Page (s)	
Paragraph number(s) (1= paragraph at very top of page)		Line number(s)	
Suggested Revision:			
References (if applicable):			

ABSTRACT

The Biomonitoring Operations Manual is a document developed for the U.S. Fish and Wildlife Service to provide a systematic and consistent approach to contaminant monitoring on lands managed by the Service. The document was developed to improve the process for identifying impacts from contaminants affecting Service managed resources. Another goal is to enhance the Service's ability to collect data of known and consistent quality so comparisons can be made among different management areas.

The Manual is part of a larger effort being developed to monitor the status and trends of contaminants in resources being managed by the Service. The Biomonitoring of Environmental Status and Trends (BEST) program may use information from the Manual and the Biomonitoring Operations Workbook (Workbook) to identify problems or test site specific approaches that can be applied to a regional or national effort. Many of the methods identified in the Manual are being considered for inclusion in the BEST program. The two efforts are designed to be complementary in all possible areas, however, the statistical designs may vary because of the slightly different objectives.

The approach described requires Service personnel to identify the contaminant sources, the associated contaminants, and the different media/biota of the ecosystem that can be affected by contaminants. The contaminant transport pathways to the Service lands are then determined and a conceptual diagram of the system is developed to help identify the optimum components of the ecosystem to monitor. The approach is designed to be applied consistently on all Service lands, but allows for specific characteristics of an area to be addressed. The data collected using this approach will allow the Service to identify the status of contaminants, their effects, and associated risks to the resource. This will enable the Service to establish priorities for addressing contaminant related concerns on the Service lands. Sampling methods for five media, field oriented sampling summary sheets, decontamination guidance, documentation and quality assurance/quality control (QA/QC) standard operating procedures are also provided in the manual.

ACKNOWLEDGMENTS

Developing this manual would not have been possible without the support of numerous people. These people have contributed to the technical content and format of the documents. In particular we want to thank the other members and staff of the Center for Environmental Monitoring and Assessment (Dale Bruns, Al Crockett, Ken Moor, Gail Olson, Greg White, and Bruce Wiersma) for sharing their ideas, technical expertise, and time to help complete this manual. Ken Brown, who was on loan from EPA, also provided considerable technical support. Dave Gianotto, Marilynne Manguba, Dale Sayer, and Dena Tomchak provided the considerable support required for the Manual.

We also want to thank the numerous U. S. Fish and Wildlife personnel who reviewed the documents, participated in the workshops, and provided suggestions for improvements. Specifically, we would like to thank Jack Edmundson, Sean Furniss, Fred Paveglio, Steve Thompson, Don Steffeck, Steve Zylstra, Colleen Baggott, and Pete Lowe.

A list of the authors and significant contributors for each document of the manual is provided in the List of Preparers at the end of this document.

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WORKSHEETS

ACRONYMS AND ABBREVIATIONS

AL	Action Levels
AOI	Area of Interest
ASCS	Agricultural Stabilization and Conservation Service
BEST	Biomonitoring of Environmental Status and Trends
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
BOD	biological oxygen demand
DOD	Department of Defense
DQO	Data Quality Objectives
EC	Environmental Contaminants
EPA	U. S. Environmental Protection Agency
ECDMS	Environmental Contaminants Data Management System
GIS	Geographic Information System
GPS	Global Positioning System
Manual	Biomonitoring Operations Manual
NOAA	National Oceanographic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NTIS	National Technical Information Service
NWF	National Wildlife Federation
NWI	National Wetland Inventory
NWR	National Wildlife Refuge
PCA	Potentially Contaminated Area
QA/QC	Quality Assurance/Quality Control
RFM	Reference Field Methods
SCS	Soil Conservation Service
Service	U. S. Fish and Wildlife Service
SOP	Standard Operating Procedures
TOC	total organic carbon
USDA	United States Department of Agriculture
USFS	United States Forest Service
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
Workbook	Biomonitoring Operations Workbook

U.S. FISH AND WILDLIFE SERVICE LANDS BIOMONITORING OPERATIONS MANUAL VOLUME 1

EXECUTIVE SUMMARY

Purpose

The purpose of the Biomonitoring Operations Manual is to provide an approach to develop and implement biomonitoring activities to assess the status and trends of U.S. Fish and Wildlife Service trust resources. It also provides field sampling methods and documentation protocols for contaminant monitoring activities. Application of the Manual throughout the Service will provide a consistent monitoring approach across all Service lands. The Manual is designed to be used by Environmental Contaminants Specialists (EC Specialists) to develop a biomonitoring strategy for the Service lands Area of Interest (AOI). The Service lands are defined as those lands and aquatic resources managed by the U. S. Fish and Wildlife Service. This includes National Wildlife Refuges, Service facilities (administration and others), easements, waterfowl production areas, coordination areas, wildlife extension areas, fish hatcheries, fish and wildlife research areas, etc. The AOI is defined as the Service lands and the surrounding air and watershed (subsurface water and surface water) that affect, or have contaminant sources that could affect, Service lands and/or the associated biota. The information gathered for the AOI is used to develop specific biomonitoring activities for the Service lands.

The strategy described in the Manual has been designed as a stand alone process to characterize the presence of contaminants on lands managed by the Service. This process can be used to develop a monitoring program for any tract of real estate with potential threats from on- or off-site contaminants. Because the process was designed to address concerns for Service lands that span the United States from Alaska to the Tropical Islands, it has a generic format that can be used in all types of ecosystems, however, significant site specific information is required to complete the Workbook and make the process work successfully.

The Manual is part of a larger effort being developed to monitor the status and trends of contaminants in resources being managed by the Service. The BEST program may use information from the Manual and Workbook to identify problems or test site specific approaches that can be applied to a regional or national effort. Many of the methods identified in the Manual are being considered for inclusion in the BEST program. The two efforts are designed to be complementary in all possible areas, however, the statistical designs may vary because of the slightly different objectives.

Scope

This Manual is intended to guide Environmental Contaminants personnel in developing and implementing biomonitoring activities for Service lands. It provides information and considerations that should be incorporated into routine contaminant monitoring activities. These activities will provide data to assess the current status, and evaluate trends, of contaminant concentrations, their effects, and the biological integrity of Service lands. This Manual is not intended to provide guidance for designing special case studies requiring designs and procedures other than those presented, however, the information discussed should be considered for these situations.

It is beneficial for users of the Manual to participate in a training workshop that will describe the use and procedures of the Manual and provide a case study to work on. In the workshop a biomonitoring strategy could be developed for Service lands that have not completed this process. This would be

beneficial for all participants as well as the manager and EC Specialist associated with the Service lands.

The approach discussed in the Manual is acceptable for developing routine biomonitoring activities. When applied to a specific site, components of this approach that are ignored and/or supplemented must be documented so future monitoring efforts at that location have an "institutional memory" of the approach used in previous monitoring efforts.

The Manual should be considered a "living document." As new, relevant information on sampling/monitoring techniques or contaminants becomes available, it will be considered for inclusion in the Manual. Inclusion of new information will only occur if there is such a directive by the Division of Environmental Contaminants. This will ensure that consistency is maintained throughout the Service lands. As new information is added, insert pages will be provided to replace or add to the current contents. All Service personnel are encouraged to participate in the evolution of this Manual by discussing revisions and additions with Service managers and EC Specialists.

This section provides a brief overview of the Manual and how to use it to develop and implement biomonitoring activities. The main body of the document presents an approach to contaminant monitoring for Service lands. A glossary and bibliography are provided at the end of the document.

How to Use the Operations Manual

Manual Components and Format

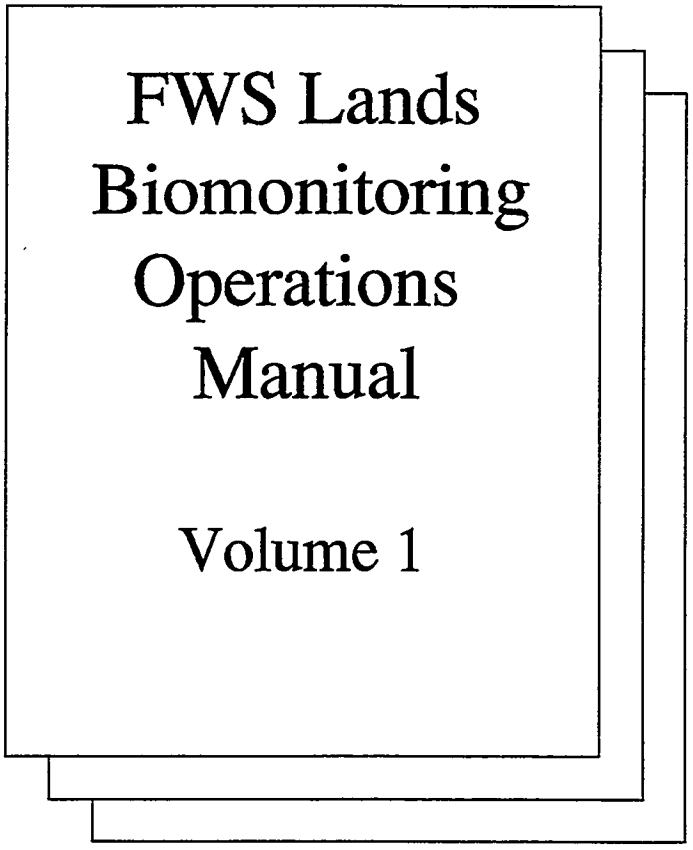
The Manual consists of this Volume and a set of appendices that are to be used together to develop and implement monitoring activities for Service lands. Figures 1 and 2 illustrate these components and a list of the individual documents is provided in the Preface.

This document (Volume I) provides the basis for designing and implementing the biomonitoring activities. It discusses background information regarding contaminant monitoring and the use of an ecosystem approach to monitoring design. Specific procedures are then provided for collecting the information necessary to develop a biomonitoring strategy appropriate for the characteristics of the Service lands in question. A section is also provided that briefly discusses the considerations necessary to evaluate the monitoring activities and associated data.

The appendices (Figure 2) provide the reference field methods (RFM) for collecting samples of various media. The methods were selected based on their general utility and proven acceptability. There will likely be other methods available or developed that might be more appropriate for a given situation, however, those provided here are suitable for routine biomonitoring activities. Using accepted methods will provide consistency throughout the Service. If other methods are used, or modifications to the methods provided are made, complete documentation of the method used should be provided.

The RFMs provide insight into the difficulties and needs associated with collecting a particular medium. Once a medium has been selected for sampling, the specific RFM can be used to select an appropriate sampling method for the given field situation and/or monitoring objective.

NOTE: The RFMs will eventually be validated in the field by the Service. A process for validating the methods is described in the BEST Detailed Plan. Until the validation has taken place, widespread use of these methods should not take place.



Volume 1

Introduction/Background

How to use the Manual

Appendices

Relevant Legislation

Biomonitoring Operations Workbook

Reference Field Methods

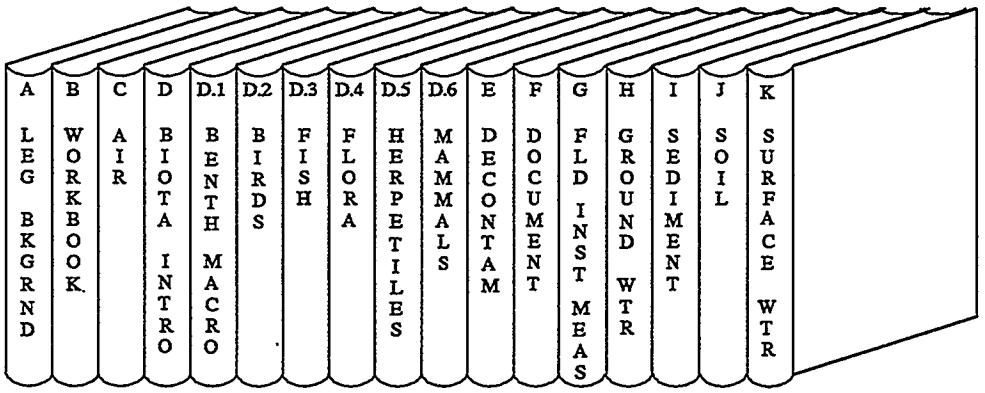
Summary Sheets

Concise Step by Step Instructions for Each Reference Field Method

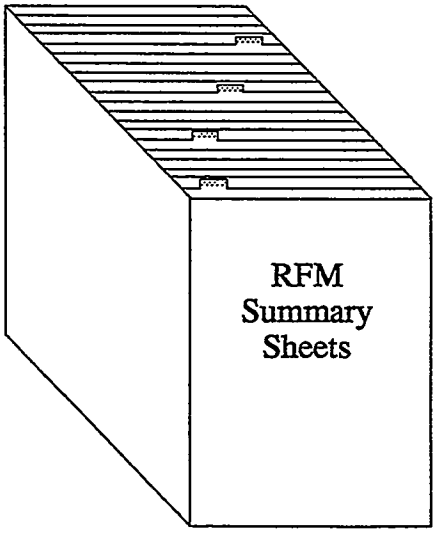
Figure 1. Three components of the FWS Lands Biomonitoring Operations Manual.

FWS Lands Biomonitoring Operations Manual

Appendices



Reference Field Methods Summary Sheets



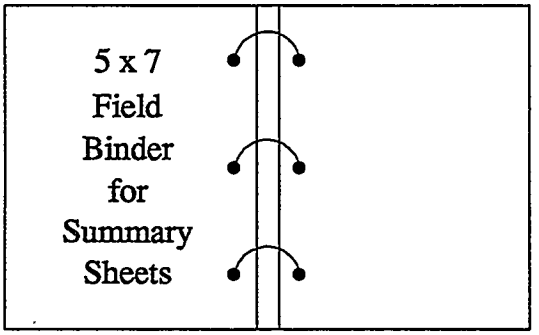


Figure 2. Illustration of appendices and RFM summary sheets.

Several of the appendices do not provide sampling methodologies, but provide information useful for monitoring activities. A description of each of these appendices follows:

Appendix A provides a brief discussion of Federal regulations that could influence the design of monitoring activities.

Appendix B, the Workbook, is to be used in conjunction with Volume 1 to develop the biomonitoring strategy. This workbook provides a form for documenting information collected and decisions made while developing a strategy for monitoring activities.

Appendix C is a general discussion of air monitoring. It describes the various contaminant sources and contaminants associated with the air transport mechanism, existing national air monitoring programs, and educational courses available to Service personnel.

Appendix D is a general discussion of considerations for using biota for contaminant biomonitoring. Other D.x appendices provide field sampling methods for different biota.

Appendix E provides procedures for decontamination of equipment between samples and after use.

Appendix F combines the Standard Operating Procedures (SOP) for documentation of samples collected, chain of custody of samples, and QA/QC procedures.

Field ready "Summary Sheets" for the RFMs are also a component of the Manual (Figure 2). These are concise, step-by-step directions for sample collection that are meant to be taken to the field as a reminder of the sampling, decontamination, and documentation procedures being used. A set of summary sheets is provided for each RFM. They are printed on indestructible paper, and can be taken out individually as needed and placed into a 5 1/2 x 8 1/2-in. binder. This will provide the field investigator with a small information packet for conducting sampling activities.

How to Use the Manual

Figure 3 is an illustration of the general steps to use the Manual. The general steps are as follows:

1. Read and understand the concepts described in Volume 1.

2. Read through Volume 1 and look through the Workbook (Appendix B) at the same time to see how they coincide.

3. Work through the Workbook, completing the documentation as required. Once the Workbook is complete, a biomonitoring proposal will be developed based on the information compiled in the Workbook.

4. Use the sampling guidance and standardized procedures in the RFMs to select media and environmental variables to monitor appropriate sampling methods for various field conditions.

5. Use the Summary Sheets in the field as a reference to the sampling procedures selected.

6. Evaluate sampling results and revise the Workbook yearly to determine how the biomonitoring program can be revised to better achieve the monitoring goals.

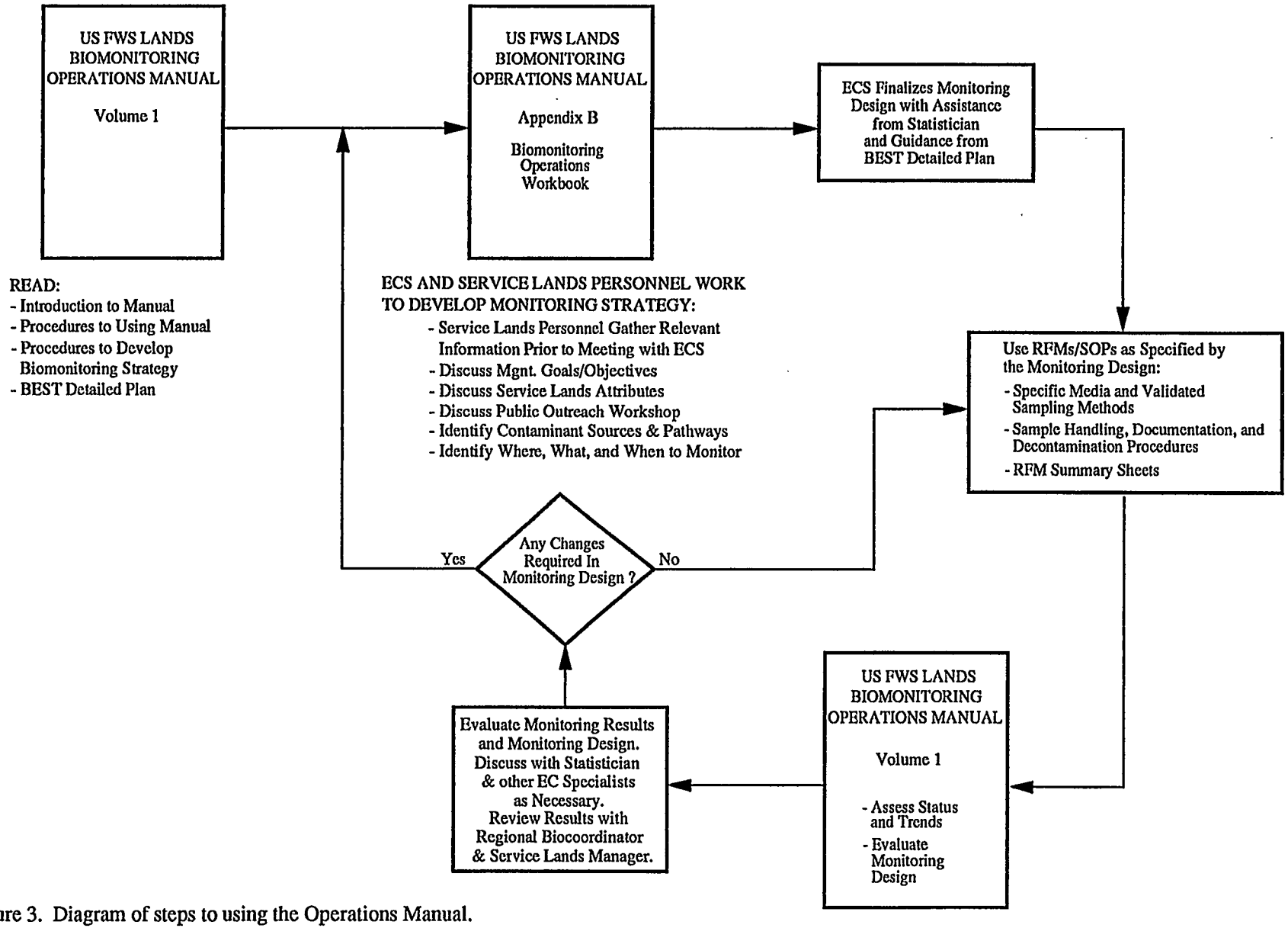


Figure 3. Diagram of steps to using the Operations Manual.

OVERVIEW OF CONTAMINANT BIOMONITORING

Definition of Contaminant Biomonitoring

Contaminants are defined in this manual as substances that are present at an unnatural concentration for the area and can potentially affect the physical and/or biologic characteristics of the area. They include organic substances, such as pesticides, and inorganic substances, such as heavy metals and gaseous emissions.

Contaminant Monitoring is defined in this document as a long-term (>5 years), systematic, and repetitive sampling program, that includes sample collection, analysis, and data interpretation designed to track the status and trends of the concentrations and/or the effects of contaminants.

Biomonitoring is similar to contaminant monitoring, however, this monitoring approach focuses on the use of organisms and ecological responses to indicate the presence of stressors and/or ecosystem health. The approach includes the use of environmental indicators as measurement tools. These include biomarkers, biodiversity, community and population indices, bioassays, landscape indices, etc. as variables for monitoring the status and trends of ecosystem health.

Contaminant Biomonitoring is the use of biomonitoring tools in addition to other (abiotic) monitoring tools (e.g., residue analysis, water quality parameters such as DO, pH, BOD, etc.) for monitoring the status and trends of contaminants and their effects.

Contaminant Sampling (or survey), in contrast, is a one-time or "short-term" collection of samples for contaminant analysis, generally in response to a specific incident or study of a suspected contaminant problem.

Water quality conditions (DO, pH, suspended sediments, temperature, etc.) that are beyond their natural range for the system are also stressors to the ecosystem and can be viewed as contaminants. Additional stressors to the natural system include noise, habitat degredation, exotic species, and sometimes disease when caused by man-made conditions.

As a result of the multitude of stressors affecting the resource, an approach to monitoring that includes measuring variables other than contaminant concentrations is necessary to monitor the overall ecosystem health. This manual primarily focuses on contaminants and their effects, but provides opportunities to address other stressor concerns as a component of the monitoring program. The extent that other stressors are invloved in the monitoring decisions will be up to those designing or implementing the program at the Service lands.

Though this Manual focuses on contaminant monitoring activities, the strategy and techniques employed will also be capable of monitoring general ecosystem health and will provide information for proactive management of the resource. The tools that will be used for contaminant biomonitoring in this manual encompass four lines of evidence that will be used to assess ecosystem health. The techniques that will be used fall into four general categories:

1. biomarker or organism health
2. bioassays or toxicity testing
3. population and community indices
4. chemical residue analysis

The BEST Detailed Plan provides additional information regarding the four lines of evidence and how they will be used for biomonitoring activities.

Background

Purpose of a Monitoring Program

Contaminant biomonitoring should verify the presence or absence of contaminants and/or their effects and assess associated trends.

Information collected from monitoring can also be used to:

- Assess the health of the ecosystem and fish and wildlife resources
- Determine potential source(s) of contaminants entering the area
- Provide information to public health agencies to help identify potential health risks to the public or Service personnel
- Evaluate potential impacts of contaminants to trust resources
- Provide data to determine appropriate mitigative/remedial actions and assess their effectiveness
- Provide data for making informed decisions regarding resource management (e.g., when and what water to accept)
- Provide data for litigation proceedings

There are various functions or purposes for conducting contaminant biomonitoring, most of which are interrelated:

1. Indication of a Problem. A contaminant problem may not be evident until it is analyzed for. Sample analysis can also indicate what contaminant(s) is involved or verify a suspected contaminant problem. Contaminant monitoring can serve as an early warning system, detecting the presence of a contaminant before it actually impacts the ecosystem.

2. Determination of Contaminant Concentration. When possible, contaminant monitoring should be designed to indicate contaminant concentration, distribution (spatial, temporal, and media specific), and biologic effects. At a minimum, it should be able to verify presence/absence at a specified minimum detection limit.

3. Regulatory Compliance. Contaminant monitoring can be used to assess compliance with state and Federal regulatory limits for specified contaminants.

4. Remedial Action. Various acts and regulations, briefly discussed in Appendix A, indicate when remedial action may be necessary. Contaminant monitoring can provide the basis for these actions. Continued monitoring can provide the data required to evaluate the effectiveness of a remedial action.

5. Determine "Benchmark" Values. Benchmark monitoring is sampling/ monitoring to establish an initial data set (the benchmark) from which future data can be compared to assess status and trends.

6. Status and Trend Analysis. One of the main purposes of monitoring contaminants is to assess status and trends for distribution and concentration of contaminants and/or their effects. These activities provide data to support proactive measures that can reduce or eliminate contaminant problems.

7. Research. Contaminant monitoring may also be used in research to examine contaminant effects on ecosystem and community interactions or to carry out toxicological studies.

Ecosystem Approach to Contaminant Biomonitoring

The monitoring approach presented in this Manual is based on multimedia monitoring and an ecosystem approach derived from numerous years of monitoring and research experience at areas including U.S. National Parks, Biosphere Reserves (e.g., Wiersma et al., 1984, 1985; Wiersma and Otis, 1986), and U.S. wilderness areas (e.g., Bruns et al., 1982, 1984).

Components of an ecosystem approach (Wiersma et al., 1986; Bruns and Wiersma, 1988) to environmental monitoring include:

- Evaluation of source-receptor relationships
- Assessment of contaminant transport mechanisms/pathways
- Multimedia monitoring (i.e., air, water, soil, biota, sediment) of key contaminant pathways within the environment
- Use of selected ecosystem parameter measurements to detect anthropogenic effects
- Development of a conceptual diagram of the system.

Figure 4 illustrates the relationship of these components.

The ecosystem approach begins with a general conceptualization of the system to be monitored and is translated into a schematic as shown in Figure 5. Such a diagram is intended as a tool for identifying ecological compartments of concern, delineating potential contaminant pathways through the system, and identifying potential important receptors. This allows one to view the monitoring problem as one of contaminant sources and pathways to critical receptor components of the ecosystem. For example, certain contaminants (e.g., lead) may be expected to reach high levels of accumulation in forest litter (e.g., Wiersma and Otis, 1986).

This approach to environmental monitoring design allows for reevaluation of data sets based on the conceptual diagram and, possibly, model calculations. Often this results in the ability to modify the monitoring design in a way that will allow for more effective monitoring and potential cost-savings.

Evaluation of contaminant sources relative to sensitive receptors is critical in the selection of sampling locations appropriate to the monitoring objectives.

The ecosystem approach to monitoring design for both contaminant and ecosystem measurements is based on a watershed/drainage basin (e.g., Likens 1985; Minshall et al., 1985) and airshed perspective, and links together key aspects of the atmosphere, forest, soils, stream, and lake components along selected ecological pathways within the system (e.g., Wiersma et al., 1986).

For example, the forest canopy is viewed as a major interceptor for deposition of atmospheric contaminants. Contaminants (and nutrients) may move to the soil component as litterfall or throughfall where they may be stored, taken up by organisms, leached to groundwaters, or transported to surface flow in runoff, streams, and lakes. Similar processes (e.g., storage, biological cycling, transport) may occur in these aquatic systems. The crucial aspect in this part of the monitoring design reflects the linkages between terrestrial and aquatic components and the storage, cycling, and transport of materials (and contaminants) through the system.

Atmospheric contaminants are also monitored as inputs to study areas because the atmosphere is an important contaminant exposure pathway to ecosystems in remote areas, far from local sources of

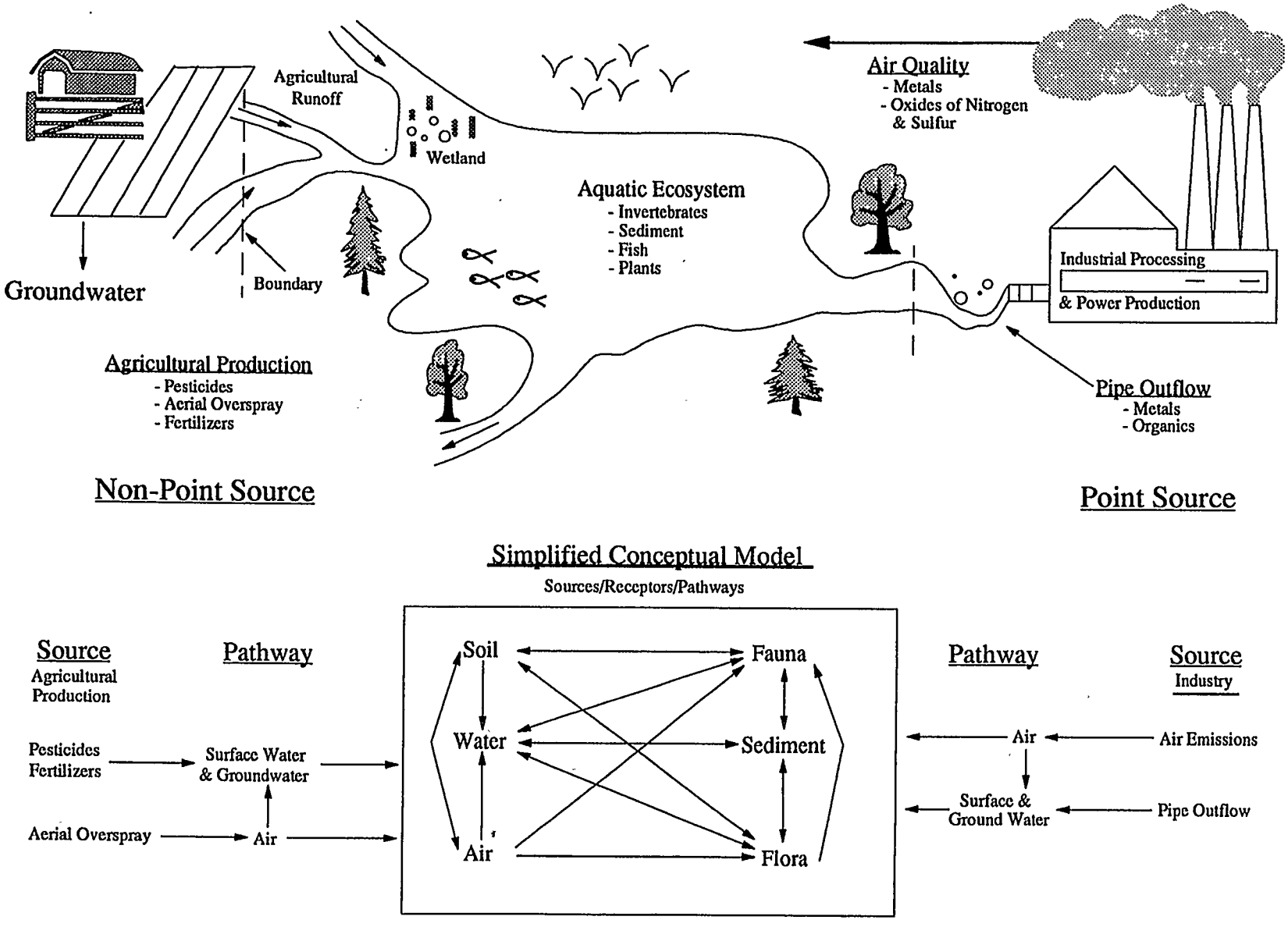


Figure 4. Components of an ecosystem approach to contaminant biomonitoring.

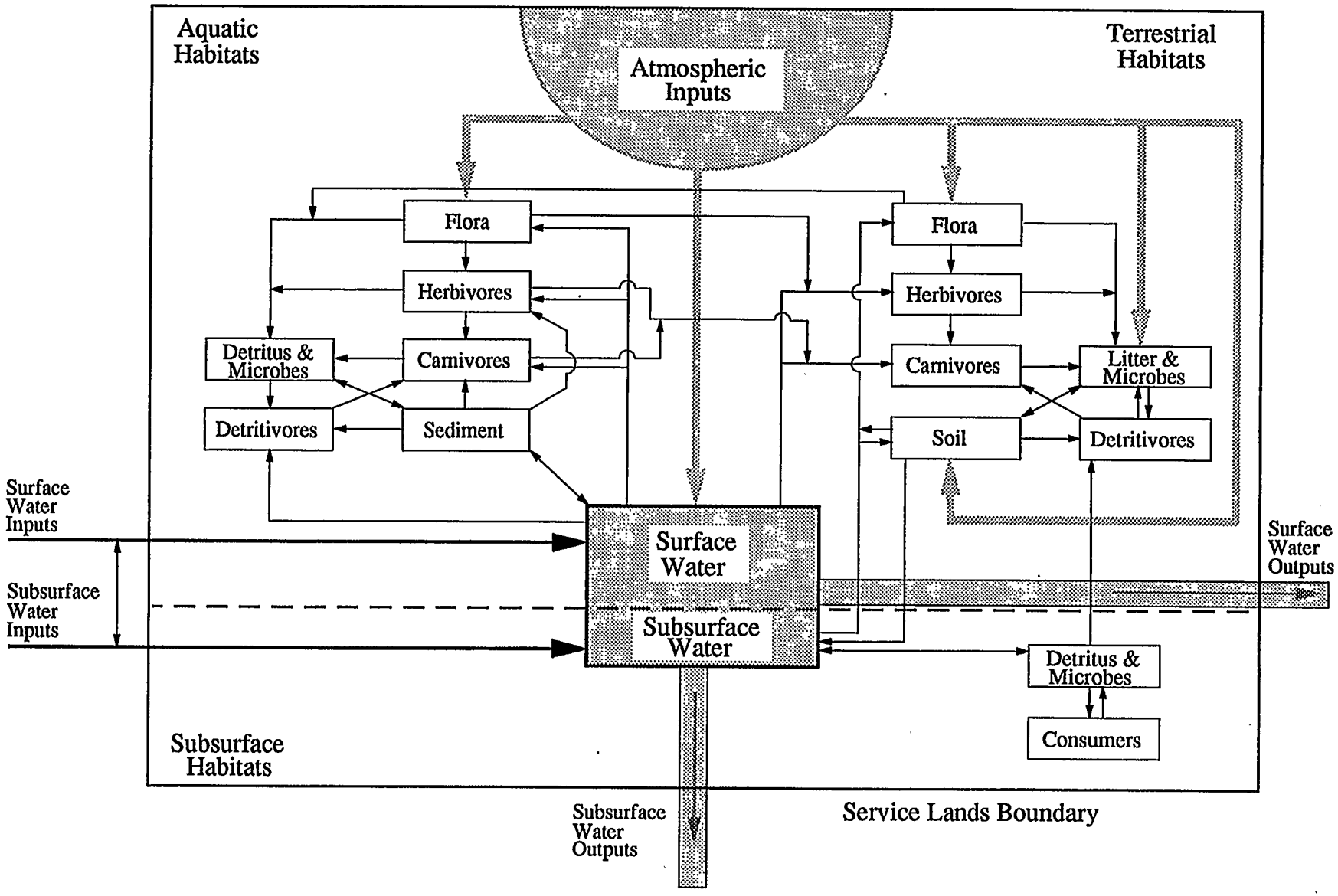


Figure 5. Conceptual model of contaminant transport pathways.

pollution (Bruns et al., 1987, 1987a; Bruns and Wiersma, 1988). This may include measurements of ambient levels of contaminants like trace metals, nitrates, sulfates, ozone, and oxides of nitrogen and sulfur (Bruns and Wiersma, 1988). Also, as part of the multimedia ecosystem approach to environmental monitoring, contaminant levels (e.g., trace metals) may be measured in vegetation, soils, litter, and water.

In summary, the monitoring design discussed in the Manual is based on an ecosystem view of environmental contamination and potential effects on ecosystems. Contaminant sources (local, regional, global) are identified along with critical receptors in the ecosystem; contaminants are monitored on a multimedia basis; key ecosystem parameters are utilized to assess impacts to both terrestrial and aquatic components of the system; and linkages between the terrestrial and aquatic compartments are delineated for important environmental pathways on a conceptual basis. Thus, an ecosystem approach integrates biogeochemical (including contaminants), meteorological, and ecological monitoring.

1. INTRODUCTION

1.1 Purpose

The purpose of this Manual is to discuss a standard approach for developing biomonitoring strategies for Service lands. Its application will provide a consistent monitoring approach for all Service lands and provide a format for comparison of contaminant issues across all Service lands. Additional guidance for biomonitoring is provided in the BEST Detailed Plan. This document will also provide information on the relationship between Service lands specific biomonitoring activities and regional/national biomonitoring activities.

1.2 Scope

This Manual is intended to guide EC Specialists in developing a biomonitoring strategy for Service lands. It provides the steps and considerations that should be incorporated into routine biomonitoring activities. These activities are designed for routine biomonitoring activities on Service lands and will provide data to assess the current status and evaluate trends of contaminants and the health of Service trust resources.

If some components of this approach are ignored, and/or supplemented, they must be documented to ensure that future monitoring efforts have an "institutional memory" of previous monitoring efforts. This will enhance the ability to compare information over time.

This Volume is to be used in conjunction with the Workbook (Appendix B) and the sample collection methods described in the other appendices. When it is suggested, for example, that sediment samples should be taken, the Sediment RFM should be consulted to determine the appropriate sampling and handling method(s).

Note: The methods used for the monitoring activities must be validated through a process described in the BEST Detailed Plan prior to their use.

1.3 Background and Preparation

The approach to designing biomonitoring activities for Service lands must be based on scientific understanding and should be applied consistently across all Service managed lands. This will help ensure that all Service monitoring concerns are addressed and the appropriate decisions are made in accordance with Service direction. The design of biomonitoring activities should use the same scientific approach regardless of the area's location and characteristics. However, the standardized approach used must be flexible to adequately address the variety of conditions that exist throughout the Service managed lands.

It is possible to establish a consistent approach to designing biomonitoring activities that can address the specific characteristics and issues of each area. This can be accomplished by identifying the important considerations and decisions in the process and providing opportunities to incorporate site-specific characteristics into the monitoring strategy. The approach described here is an attempt to accomplish this goal.

The major components of the biomonitoring approach are illustrated in Figure 1.3. Addressing these steps and considerations while developing a biomonitoring strategy will provide information necessary to protect trust resources.

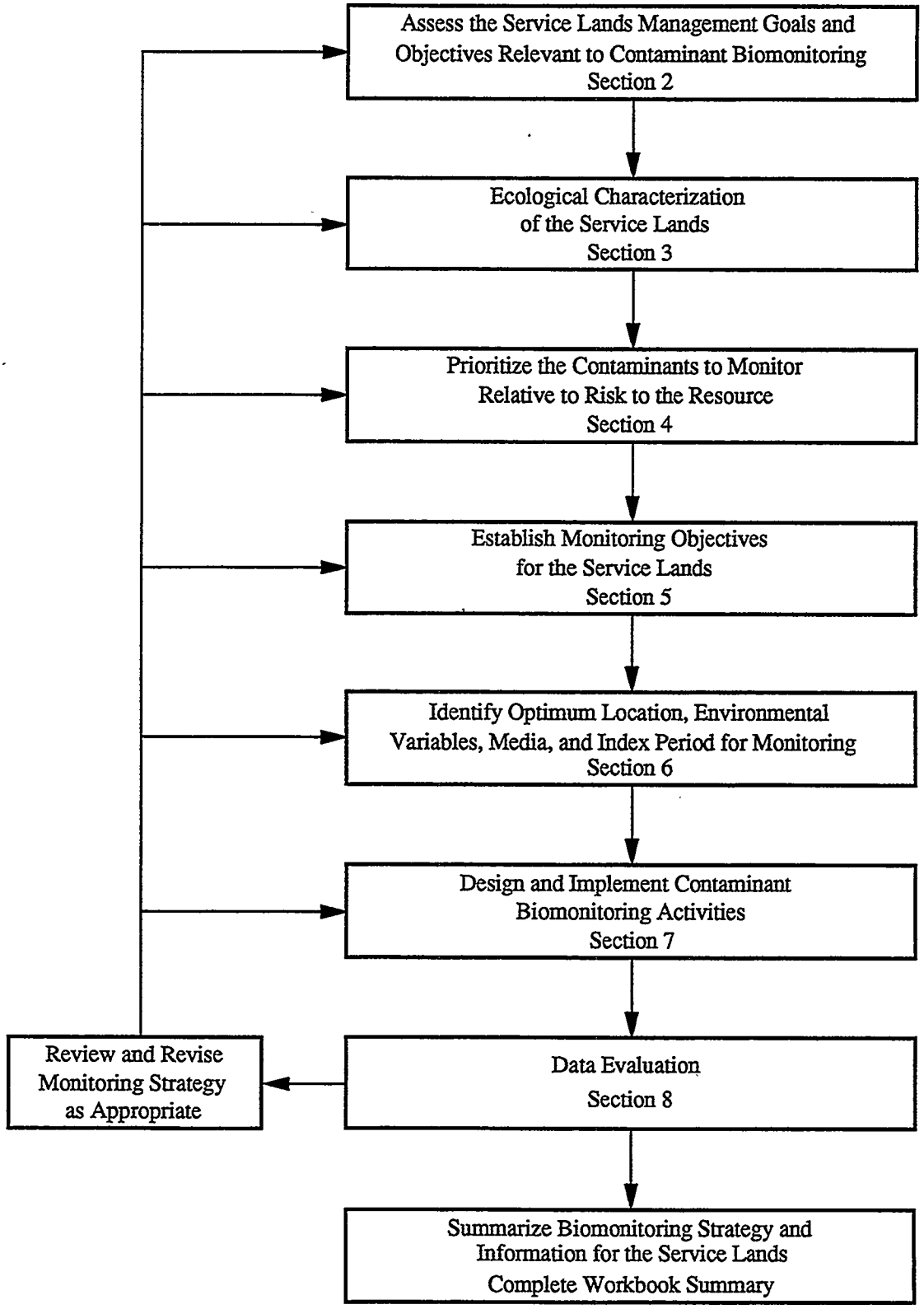


Figure 1.3. Diagram of the major components of the biomonitoring strategy for Service lands.

1.3.1 The Biomonitoring Operations Workbook

The purpose of the Workbook is to provide a short, concise format to develop and document contaminant biomonitoring strategies for Service lands and/or other areas used by trust resources. The Workbook follows the format and content of this document which **must be read and understood prior** to using the Workbook. The background information, procedures, rationale, and examples for the Workbook are also provided in this document.

The Workbook is designed to be a working document. Once completed, it can be referred to as necessary to support monitoring decisions. The Workbook and the associated monitoring activities should be reviewed each year. It should be revised as necessary to meet monitoring and management goals and to address questions resulting from monitoring or related activities.

Some of the tasks described in the Workbook have a space provided to initial when completed. This will help ensure that each task is addressed completely or signal that additional work is needed in that section. Only initial the task when it has been thoroughly completed, this will provide a record of who did the work. If the information collected is incomplete provide a comment in Worksheet WS-1 that describes what still needs to be completed. The Service personnel involved in completing the Workbook must sign and date the space provided on page 2 of the Workbook. This will provide future investigators with a contact should questions arise.

Examples for the worksheets are provided in this document. The information is modeled after the Minidoka National Wildlife Refuge (NWR), however, if additional examples were needed, fictitious information was generated.

Follow the procedures provided in this document and record the information gathered in the Workbook. The Workbook is meant to be completed using a computer, this is the reason for the lack of space for handwriting. WordPerfect 5.1 or higher must be used with a 286 or better computer. If additional space is required, insert additional rows in the worksheet tables (WordPerfect table mode, Alt-F7). Once the Workbook has been completed the Table of Contents can be updated by generating a new one (see the end of the digital Workbook for instruction). It will not affect the existing Table of Contents if you generate it when printing out interim copies.

1.3.2 Workbook Summary

The Workbook Summary is an important component of the Workbook. This will be a summary report that provides a synopsis of the information in the workbook and briefly describes the Service lands, contaminant issues, contaminant biomonitoring strategy, additional information needed, and implementation requirements for the Service lands. This report can reference the workbook and associated worksheets as needed to avoid rewriting detailed information, however, to enhance its use as a stand alone document, this should be minimized. This summary should provide an individual with a general concept of the Service lands, the monitoring goals, issues concerning the health of the ecosystem, requirements necessary for proactive management of the Service lands, and potential future concerns.

Workbook Summary Format

Introduction

Provide the name of the Service lands, its location (state, county, nearest city, etc.), and brief general description [e.g., key species/habitats, associated ecoregion(s) (Omernik), spatial/temporal patterns for the refuge, principal purpose of the Service lands, general information on the area, land

use/industries, etc.]. Provide an assessment of the general health of the Service lands and local off-Service land areas extensively used by trust resources.

Monitoring Strategies

Describe the goals of the biomonitoring program, the on- and off-Service lands concerns and whether there have been documented contaminant problems. Also address local habitat degradation issues important to the Service lands and trust resources that use the area.

Provide an overview of the monitoring strategy for the Service lands. Include the media sampled, the environmental variables measured, the chemical analysis conducted, and index period considerations for sampling.

Briefly describe the selected monitoring sites, why they were selected, what is being monitored there, and why. Include information such as: suspected/known contaminants, high risk contaminants, extent of contamination, contaminant sources (industries, land use, etc.), contaminant transport pathways, habitat loss or degradation, potential changes in land use, and other ecosystem health issues.

Discuss monitoring or survey results that have been obtained thus far and provide a summary of the interpretation of these results and their relevance to the Service lands.

Include a section that discusses the logistic issues for monitoring the Service lands. Include information regarding labor requirements, equipment and training needs, sample analyses requirements, climatic and environmental constraints, and other issues that might limit the ability to conduct the monitoring activities. Limitations on available information and research needs should also be discussed here.

As a part of the Workbook Summary, two summary maps should be produced. One map should illustrate the Service lands plus the cities, general land use, and general hydrologic features surrounding the Service lands. This map should include off-Service land areas important to trust resources and those areas being monitored, if any. The second map should provide a larger scale (more detailed) view of the Service lands with the on-Service land monitoring locations identified.

Worksheets WS-1 (below), WS-6.1a, WS-7.3, and WS-8.1 provide summary information that can be used to augment the Workbook Summary. For Worksheet WS-1, state that the section is "complete" or describe what remains to be done to complete ALL the requested information.

EXAMPLE: Minidoka National Wildlife Refuge

WS-1	STATUS OF INFORMATION FOR THE WORKBOOK Page __ of __
Section #	Discussion of status and information still needed for each section
2.1	Complete
2.2	Still need to get existing ECOMS data. Also need data from BOR studies. UTMs coordinates are general guesses.
2.3	Complete
2.4	Complete
2.5	Need additional information on State and local regulations concerning water quality requirements.
2.6	Complete
2.7	Several key people were unable to attend meeting, should get there input.
3.1	Complete
3.2	Still have sources and associated contaminants to identify for Raft River drainage.
3.3	Complete
3.4	
3.5	
4.1	
4.2	
5.	
6.1	
6.2	
6.3	
7.1	
7.2	
7.3	
7.4	
8.	

2. ASSESSING THE SERVICE LANDS MANAGEMENT GOALS AND OBJECTIVES RELEVANT TO BIOMONITORING

Service biomonitoring efforts will be driven by a combination of factors including overall Service goals, the specific goals and objectives for the Service lands, available financial resources, monitoring goals for the Service lands, and available sampling and analysis techniques.

The Service mission and the management goals and objectives of the Service lands provide the basis for all activities conducted there. Defining and understanding the relationship between the management goals and objectives and the monitoring program, will help focus monitoring efforts on issues that directly support the purpose of the Service lands. This will help ensure that the information gathered from the monitoring effort can be used to support management decisions.

Once the relationship between the management goals and objectives, the environmental characteristics of the area, compliance issues, and the purpose of monitoring are clearly understood, monitoring goals for the Service lands can be established.

The process for defining management objectives, developing monitoring goals, identifying issues, and specifying monitoring objectives includes the following:

1. Review of management plans, if available, to provide guidance on the general management objectives for the Service lands.

2. Development of monitoring goals that support the management objectives (Section 2.6).

3. Identification of site characteristics, contaminant sources, contaminants, transport pathways, and receptors (Section 3).

4. Identification and prioritization of the contaminant issues (Section 4).

5. Development of monitoring objectives to address specific contaminant biomonitoring issues and/or to answer other questions associated with protecting the trust resources (Section 5).

2.1 Management Goals and Objectives for the Service Lands

The purpose of this section is to document why the lands are being managed by the Service and associated Service priorities. This information is critical to identifying key trust resources and monitoring goals for the area.

Management objectives for refuges or Service lands are established through various mechanisms, and are usually outlined in the management plans. An Executive Order may be responsible for the establishment of the refuge. Benton Lake NWR, for example, was established by Executive Order 5228 for "use as a refuge and breeding ground for birds" (U.S. Fish and Wildlife Service, Contaminant Issues of Concern: Action Plans, Region 6, 1986).

The Service lands management plan should also provide guidance for determining the specific goals and objectives of the contaminant biomonitoring activities.

The specific characteristics of the Service lands will also be considered in later sections of the Manual when developing a contaminant biomonitoring strategy. These include the physical and biotic

characteristics that were important considerations when selecting the area for management by the Service (e.g., species/populations, particular habitat/community presence, climatic conditions, geographic location, etc.).

MATERIALS/INFORMATION NEEDS

Worksheets WS-1, WS-2.1
Service lands management plan
Laws or executive orders establishing the Service lands
Service mission statement

PROCEDURE

1. Use Worksheet WS-2.1 to document the management goals and objectives for these Service lands. This should include specific objectives stated in the management plan for the Service lands, as well as, those that support the Service's mission. These statements will be used to support decisions made throughout the manual, therefore it is important that careful consideration be given to them.

2. Worksheet WS-1 is provided to document the progress made for each step in the process. At the end of each section, document the status of that section and what remains to be done until the section is complete. This information will be included in the Workbook Summary to inform management of future information needs. Document the status of this section on Worksheet WS-1 now.

EXAMPLE: Minidoka National Wildlife Refuge

WS-2.1	MANAGEMENT GOALS AND OBJECTIVES FOR THESE SERVICE LANDS	Page 1 of 1
1	**Habitat Management Objectives:** 1) Retain upland in as natural state as possible, 2) maintain natural diversity of plants and to encourage wildlife diversity, 3) utilize forage through livestock grazing only to the extent that it maintains plant vigor.	
2	**Wildlife and Public Use Objectives:** Highest priority: 1) Provide safe nesting and feeding habitat for naturally occurring wildlife species threatened with extinction, 2) provide maintenance habitat for waterfowl with special emphasis for molting birds, 3) provide necessary safe nesting and feeding habitat for production of waterfowl.	
3	High priority: 1) Provide safe nesting habitat for colonial nesting waterbirds, 2) provide migration habitat and maintenance requirements for raptors and shore/marsh/waterbirds, 3) maintain refuge lands in natural open space consistent with other goals, 4) expand visitor understanding and appreciation of wildlife and mans' role in the environment	
4	Moderate priority: 1) Provide opportunities for the public to view and appreciate refuge wildlife, populations, and habitat, 2) provide hunting and fishing opportunities.	
5		

2.2 Preliminary Assessment

The purpose of the preliminary assessment is to identify existing data, become familiar with previous contaminant studies, to assess the area surrounding the Service lands relative to contaminant issues and identify data gaps. The preliminary assessment has two stages: the first is to compile existing data; the second is to perform limited field reconnaissance studies.

Literature Review

In this section you will compile existing data and data sources that are relevant to contaminant sources, receptors, contamination events, other monitoring activities and surveys, etc. for the Service lands and surrounding area. Worksheet WS-2.2a is provided to document the existing information. It provides a concise format to list this information. You might also want to enter this information into a data base.

MATERIALS/INFORMATION NEEDS

Worksheet WS-2.2a
Appropriate maps
Applicable documents/studies/Environmental Contaminants Data Management System (ECDMS) reports
Contacts for other Federal/state/local environmental agencies
Contaminant source information

PROCEDURE

Conduct a literature search (Service documents, other Federal/state agencies, universities, communities, etc.) and compile existing data and data sources for the Service lands that are relevant to contaminant sources, contaminants, receptors, contamination events, land use, etc.

1. Identify the available information regarding: (check those that apply on Worksheet WS-2.2a).

   - Key contacts for existing information
   - Previous die-offs and suspected causes
   - Previous notable population effects (e.g., abnormal population declines, malformations, egg shell thinning)
   - Previous notable abiotic effects (e.g., abnormal conditions: suspended solids, water temperature, pH, nitrification, air pollution, etc.)
   - Previous contaminant events, contaminant sources, specific contaminants, species affected, etc.
   - Activities on the Service lands that could potentially cause contamination problems (livestock, weed eradication, crops, recreation, etc.)
   - Results from previous surveys and monitoring efforts
   - Potential reference site locations or data
   - Key habitats/communities
   - Other

2. Document the information obtained on Worksheet WS-2.2a.

3. If applicable, identify the contaminant sources and contaminant categories identified in the reference.

4. Include a description of the information (dates, names, species, contaminants and sources, references, studies conducted, location of the report(s), etc.).

5. Provide a comment regarding the relevance of the reference or contact to developing the monitoring strategy, i.e., how can this information be used to support the monitoring design decisions.

6. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

Field Reconnaissance

The second component of the preliminary assessment is to visit areas on and off the Service lands that might provide useful information, and/or a perspective that will assist in the assessment process. This knowledge will be applied in subsequent sections when determining contaminant sources, transport mechanisms and pathways, key species, etc. Record information from this reconnaissance on Worksheet WS-2.2b.

For Service lands with extensive areas (e.g., Alaska), the field reconnaissance can be initiated in the office using appropriate maps and existing knowledge of the areas. Use of satellite remote sensing data and aircraft for remote reconnaissance of the area is also recommended. Specific areas of interest can then be identified for ground observation when time is available.

MATERIALS/INFORMATION NEEDS

Worksheets WS-2.2b, WS-2.3
Appropriate maps (see Table 2.2 on following page)
- Service land maps
- USGS 7.5' topographic and 1:250,000 scale land use maps
- National Wetland Inventory (NWI) maps for the area
- Orthophoto quadsheets

Aerial photographs if available
Camera (35mm and/or video) with archival quality film
Contaminant source information
Permission from landowners, if necessary

Table 2.2 Map Matrix

This is a matrix of map types and associated map sizes and where they may be obtained. Many maps are available locally from outdoor or wilderness stores. The USGS has a wide variety of map types available. Call the USGS Headquarters to order free copies of the map index (green book) map catalog (brown book) and the Catalog of Maps brochure.

	Surface Management Status	Topographic	Geologic	Hydrologic	Aerial Photography or Digital Data	Meteorologic or Climatologic	Wetlands	Soil Type
7.5 minute (1:24,000)	----	USGS/BLM	USGS	USGS	USGS/SCS	Information is best obtained from local weather stations, state climatologist, and NOAA	Service, USGS Call 1-800-USA-MAPS to reach the USGS Earth-Info Center	SCS
15 minute (1:62,500)	----	USGS/BLM	USGS	USGS	USGS/SCS			SCS
30'x 60' (1:100,000)	BLM	USGS/BLM	USGS	USGS	USGS/SCS			SCS
1 x 2 degree (1:250,000)	BLM	USGS/BLM	USGS	USGS	USGS/SCS			USGS
State Map Series (1:500,000)	BLM	USGS/BLM	USGS	USGS	USGS/SCS			USGS

This is a matrix of map scale/type versus their primary usefulness for assessing the refuge's Area of Interest (AOI). Maps from the local refuge headquarters (i.e., brochures, aerial photo, habitat type maps, etc) are valuable for assessing the refuge.

	Air Transport	Surface Water	Groundwater	Identifying the Potentially Contaminated Area (PCA)	Reconnaissance	Legal boundaries, dumps, pits, landmarks, landowners, etc.
7.5' and 15' Topographic Maps		X		X	X	X
30'x 60' Surface Management Status		X	X		X	X
1 x 2 degree Topographic	X	X	X			
1:500,000 Surface Management Status	X	X	X			X
County Maps	X				X	X

PROCEDURE

Conduct a reconnaissance of the area (in accordance with Service safety standards and permission from the owner if applicable). Use the management objectives (WS-2.1) and the "Assessment Considerations" on Worksheet WS-2.3 (Section 2.3) for guidance regarding the areas and species to consider during this activity. Conducting the reconnaissance in conjunction with completing Worksheet WS-2.3 may be useful. This may require several trips to ensure that all the relevant assessment considerations identified in Worksheet WS-2.3 are addressed.

Areas on-Service lands suggested to visit

- Previous/current contaminant problem areas
- Suspected contaminated areas
- Important habitats (based on management goals for the Service lands)
- Areas where surface water is entering the Service lands
- Areas with sensitive habitats and/or key species
- areas that could function as reference or comparison sites
- Potential or current monitoring locations (Air,GW,SW,B,SO,SED)
- Other

Suggested off-Service land areas to visit include:

- Local areas important to trust resources; consider seasonal and daily variability
- Previous and/or current problem areas
- Surface water and runoff areas that supply the Service lands
- Areas where fertilizer/pesticides are used
- Areas where potential contaminant sources are located
- Areas that could function as reference or comparison sites
- Potential or current monitoring locations (Air, SW, SSW, B, SO, SED)
- Other

Document the following information on Worksheet WS-2.2b:

1. The personnel conducting the reconnaissance and date.

2. A name or identification number for each area visited. Use the name or identification number marked on the map if there is one. Describe the location and orientation (X miles N of the Service lands) of the site.

3. The coordinates for the site. This can be done at a desk if the sites visited are marked and identified.

   Note: It is suggested that Universal Transverse Mercator (UTM) coordinates be used because of the ease of using meters as units rather than degrees, minutes, and seconds. It is also easier to determine locations with these units on the maps. However, if longitude and latitude coordinates are more familiar and easier to obtain, they can be used.

4. Identify the habitat, plant community, and land use of the site. This information will be used later to identify contaminant source locations, transport pathways, and receptors, and to identify key habitats for protection and monitoring.

5. Identify key species or species groups present and/or those known to use the area. Note which were actually observed.

6. Describe the physical environment (e.g., topography, slope, hydrology) and condition (e.g., dead trees, productive, monoculture) of the area.

7. Provide comments relevant to developing the monitoring strategy (e.g., indicator species present, easy access, key habitat, contaminant sources, good reference site)

8. Take pictures/video of key areas and contaminant sources. Document the frame and film roll number in the "Description" column. If you are in doubt regarding the frame number, write the name of the area on a card and take a picture of it. It's very easy to forget where pictures were taken after a length of time, especially if visiting many areas that look the same.

   If you are using a video camera, state the time, date, and discuss impressions of the area while taking the video. Record the counter number and tape cassette number in the "Description" column. The names of the personnel present should also be stated. Video is a very powerful baseline documentation format that can be used in the future to assess changes to the area, including damage assessment.

9. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

EXAMPLE: Minidoka National Wildlife Refuge

WS-2.2a	EXISTING CONTAMINANT AND MONITORING INFORMATION				Page 1 of 4
	Ref. Material or Contact, Affiliation, & Phone #	Cont. Source *	Cont. Category *	Brief Description of Information	Relevance to Monitoring (location, species, reference site, time of year, etc.)
1	Ivan Hopkins: 208-436-7184 Agricultural Extension Office - Minidoka County	AA AD AC	OP OC SP CB PS	Land use, pesticide use, agricultural practices	Northwest corner of refuge, including Minidoka Dam and refuge HQ. Help identify land owners, type crops grown, and associated pesticides used.
2	Tom Edwards: 208-334-0550 ID Dept. of Environmental Quality - Boise	AP AI	AP GP	Air quality and meteorological info	Helpful in locating air emission sources and the associated contaminants, wind rose data, locations of meteorological stations.
3	Marty Collins: 208-436-3589 F&WS - Minidoka Refuge			Manager of Minidoka NWR	Main contact for information regarding refuge, monitoring sites, access roads, & other refuge activities.
4	Bill Mullins: 208-554-1931 F&WS - Boise			Environmental Contaminant Specialist	Main contact for contaminant issues. Has researched water quality, sediments, & biota at American Falls reservoir.
5	Ron Carlson: 208-525-7161 or 525-7172 Idaho Dept. of Water Resources			Water master for Upper Snake River basin including groundwater	Has data useful for calculating contaminant loads (water volume flow at American Falls dam, Minidoka dam, irrigation canals, reservoir evaporation rates, and estimates of groundwater flow).
6	Roy Fuller: 208-226-2177 Soil Conservation Service - American Falls	CS		Soil classifications for irrigated and non-irrigated lands, soil elevations, geological characteristics, slopes, average precipitation, annual temperatures, maps, aerial photos, some pesticide use information	Useful for mapping/locating monitoring sites, locating runoff routes, determining soil permeability, and identifying agricultural crops.
7	Dr. Brockway: 208-423-4691 University of Idaho - Kimberly Branch	AA AD AC AQ	NU OP OC PS WQ	Expert on Snake River water quality, hydrologic settings, nutrient loading, evaluation of fish hatchery and agricultural impacts, and environmental databases (WATSTORE)	Has worked extensively on Snake River below Milner Dam. Can provide useful advice on setting up a monitoring program and accessing databases.
8	Reconnaissance Investigation of Water Quality, Bottom Sediment, & Biota in the American Falls Reservoir Area; 1988-89	AR AA AC	TE OC NU WQ SD CR SE HG	Info on trace elements, nutrients, and several pesticides in water, sediment, fish & birds at Am Falls Res.	Nearly all samples upstream from refuge; several fish sampled from refuge.
9	Middle Snake River Water Quality Study (Univ. of Idaho) -- 1992	AA AD AC AQ	NU SD WQ	Information on aquaculture effluents, irrigation return flows, tributary stream flows, water quality, monitoring methods, and hydrology.	Useful report. It has identified problems facing Minidoka refuge (nutrient enrichment, agricultural runoff) and data collected is useful for monitoring program.
10	Coordinated Nonpoint Source Water Quality Monitoring Program for Idaho -- 1990	AC FS MC	TE OP OC SP CB PS NU MC	Describes Basin & Watershed Trend Monitoring, Best Management Practices Effectiveness Monitoring. Gives trend in major river basins & watersheds, lists appropriate parameters & protocols. List of agencies monitoring in Idaho and their sample sites.	Checklist of major items to be included in a NPS water quality monitoring plan. Outlines procedure for coordination & standardization of monitoring activities with other agencies.

EXAMPLE: Minidoka National Wildlife Refuge

WS-2.2b	FIELD RECONNAISSANCE DATA WORKSHEET					Page __ of __
	Area Visited (Name/Specific Location)	UTM Coordinates X (long)	Y (lat)	Habitat Type/Land Use	Flora/Fauna Present	Description	Comments Relevant to Monitoring
1	South shore of Snake River between Raft River & Cold Water	320000	4720000	Ag & grazing	Haying, potatoes, alfalfa; possible raptor habitat	Flat land perched above refuge, with steep breaks draining fields into refuge.	Close to refuge, threat of pesticide drift and run-off.
2	Mouth of Raft River	315000	4719000	Ag & grazing	Sagebrush, alfalfa, cattails	Most of riparian vegetation dead.	Drains Raft River Watershed into refuge.
3	Bonanza Bar	325000	4722000	Ag	Potatoes, alfalfa, sugar beets, sagebrush	Ag fields are adjacent to Snake River & refuge. Old gold dredge tailings adjacent to refuge.	Pesticide & fertilizer runoff likely, geese feed in fields during summer. Potential Hg and other trace elements in dredge tailings.
4	Gold dredging operation near Gifford Springs	319000	4721000	grazing	Sagebrush	A hole has been made & is used as a settling pond for sediments from gravel washing. Water is from the Snake River.	State School Section. potential for sediments to enter refuge. More potential for trace elements & fuel products to enter ground water & flow into refuge.
5	Gifford Springs	319000	4721000	Marsh & riparian; grazing; fishing	Grass, willow, sagebrush	Gifford Springs flows form groundwater directly into refuge.	Potential for nutrient enrichment by cattle. Potential for contaminant input from ground water.
6	Refuge Extension Area	329000	4723000	Small canyons with sandy soil	Sagebrush, juniper	Surrounded by ag & grazing.	Isolated from main body of refuge. Potential for pesticide drift into refuge.
7	South Shore of Snake River, east of Cold Water Area	330000	4720000	Ag & grazing	Potatoes, alfalfa, sugar beets, brushland	Adjacent to Snake River & upstream from refuge.	Potential for ag drainage and pesticide drift. Geese may feed in fields in the summer & fall.
8	Minidoka Dam	294000	473100	Irrigation storage, hydroelectric generation, recreation	Trout, birds, riparian vegetation	Campground near dam; dam & powerhouse are being refurbished in 1992-93.	Potential for resuspension of sediments near dam, or for flushing sediments downstream during construction. EIS completed.

2.3 Assessment Considerations for the Service Lands

The purpose of this section is to identify and document specific characteristics of the Service lands that should be considered while developing a monitoring strategy. These characteristics and their associated importance will help identify and prioritize monitoring needs for the Service lands.

Worksheet WS-2.3 will be used to document the priorities given to specific characteristics of the Service lands. It also provides space to document other site-specific information that should be considered when developing the monitoring strategy. The information will be used later in this process to help identify key species using the Service lands that are sensitive to the contaminants that could be present.

This procedure will also begin to focus attention on the areas that are most important to consider when developing the goals and objectives for the contaminant monitoring activities. Therefore, it is important that careful consideration be given to the information included on the worksheet.

Only general categories are provided in the worksheet. Provide a more specific description for the Service lands characteristics in the last column. This should include key species/communities, locations, temporal considerations, etc., and information to support the ranking it received.

For the "General Habitats/Communities on the Service lands" general formations have been described. This general classification system is in part from " A Digitized Classification System for the Biotic Communities of North America, with Community (Series) and Association Examples for the Southwest", (D. E. Brown, et. al., 1979) and provides a general framework for identifying communities on the Service lands.

This information will be used later (Section 3.4) to help identify key species from each community identified for the Service lands.

MATERIALS/INFORMATION NEEDS

Worksheets WS-2.1, WS-2.2b, WS-2.3
Appropriate maps
- Service land maps
- USGS 7.5' topographic and 1:250,000 scale land use maps
- NWI maps for the area

Species lists

PROCEDURE

Are there specific characteristics of the Service lands that should be considered while developing a monitoring strategy?

1. Complete the Assessment Consideration categories on Worksheet WS-2.3 and rank them 1, 2, or 3 according to the priority given them at this area (1 = highly important, 2 = moderate importance, 3 = low importance, and NA = not applicable). This ranking should reflect the management goals and objectives stated in Worksheet WS-2.1. If it doesn't, then this needs to be addressed by changing the ranking or the management goals and objectives.

2. Provide a brief description and comment on the importance of the assessment consideration to developing the monitoring strategy for the area.

3. For the "General Habitats/Communities on the Service lands" general formations have been described. This provides a general framework for identifying communities on the Service lands. Provide more specific information in the last column regarding the communities found on the Service lands. The ranking should reflect management goals and objectives and the ranking given to species groups utilizing the community.

NOTE: If specific habitats, animal, or plant species/communities are necessary to maintain the system, or are indicators of system health, they should be included in the monitoring program. This is true even if they are not ranked highly as a management goal or objective for the area. Monitoring activities could include conducting community composition studies, monitoring the extent and condition of plant communities, and/or monitoring individual indicator organisms. Discussion regarding these monitoring options should be included in WS-2.3.

4. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

EXAMPLE: Minidoka National Wildlife Refuge

WS-2.3 ASSESSMENT CONSIDERATIONS FOR THE SERVICE LANDS BIOMONITORING ACTIVITIES

Rank	Assessment Considerations	Group Code*	Description and Comments Regarding Importance to Monitoring Activities
3	Amphibians	AM	Northern Leopard frog and Spade Footed toad occur on the refuge. Mature frogs are voracious feeders and are known to bioaccumulate various contaminants. May be useful as a bioindicator.
NA	Anadromous fishes	AF	
NA	Catadromous fishes and invertebrates	CA	
2	Raptors	RA	Red-Tailed Hawk, Northern Harrier, & American Kestrel nest on the refuge. Ferruginous & Swainson's Hawks, Prairie Falcon & Loggerhead Shrike may nest on the refuge; Long-Eared, Short-Eared & Great-Horned Owls nest on the refuge; Common Barn, Northern Saw-Whet & Burrowing Owls may also nest on the refuge; All of these plus Merlin, Peregrine, Bald and Golden Eagles, Rough-Legged Hawks, Osprey, Turkey Vulture and the Accipiter may occur during other seasons.
NA	Seabirds	SB	
2	Shorebirds	SH	California Gull. Caspian Tern nest on refuge. The refuge is not a major shorebird area.
1	Waterfowl	WF	Canada Geese, Mallard, Pintail, Gadwall, Cinnamon Teal, Redhead, Ruddy Duck are the major nesting species. A major refuge objective is a molting & migration area for these and other waterfowl species. Swans are also present during migration. The refuge freezes over the winter; few ducks & some geese present during the winter.
1	Other aquatic birds	OB	Black-Crowned Night-Heron, Great Blue Heron, Double-Crested Cormorant, White Pelican, & Snowy Egret. The refuge is also an important feeding area for pelicans & cormorants when it is not frozen over.
2	Other migratory birds	MB	Many species of passerine birds use the refuge. The cottonwood & willow habitats are important for maintaining high avian species diversity.
2	Other resident birds	RB	Pheasant & Gray Partridge are the resident gamebirds; some passerines are resident year round also.
1	Federally listed threatened & endangered, or candidate species (including research)	ES	Bald Eagle, Peregrine Falcon; only eagle known to occur in substantial numbers; eagle present mostly during winter. Seven candidate plant species occur in the counties where the refuge is found; there has been no botanical survey of the refuge; none of the plants are known to occur on the refuge, but their presence is possible. Candidate animals: Ferruginous Hawk, Swainson's Hawk, White-Faced Ibis, Long-billed curlew, Townsend's Big-Eared Bat; both hawks may nest on the refuge.

WS-2.3 ASSESSMENT CONSIDERATIONS FOR THE SERVICE LANDS BIOMONITORING ACTIVITIES

Rank	Assessment Considerations	Group Code*	Description and Comments Regarding Importance to Monitoring Activities
2	Exotic/Pest Species	XS	Common carp is abundant in Lake Walcott, where it is a major food item for piscivorous birds. Carp are a major competitor with waterfowl for aquatic invertebrates. Crested wheatgrass has been planted south of the lake. Other pests include noxious weeds and cheatgrass.
1	Other freshwater species	FW	Stocked Rainbow Trout, Largemouth Bass, Yellow Perch, Channel Catfish are the major game fish species. Utah Chub, Utah Sucker and common carp are the predominant fish present and are the main forage of the aquatic piscivorous birds. There has been some commercial harvest of these species. The spillway area below the dam is a high priority fishery resource.
1	Macroinvertebrates	MI	Benthic & swimming invertebrates are important forage items for fish and birds, and are routes of biomagnification. No known quantitative or qualitative research conducted on refuge detailing benthic communities.
NA	Mammals - Marine	MM	
2	Mammals - Terrestrial	MA	Several small rodents, rabbits, shrews, bats occur on the refuge, but a current species list is not available. These species occur on the refuge: beaver, muskrat, mink, river otter, coyote, bobcat, raccoon, striped skunk, weasels, porcupine, mule deer & pronghorn.
NA	Marine organisms other than mammals (including invertebrates)	MR	
2	Plants-aquatic (food/cover, native habitats, etc.)	AP	The major purpose of the refuge is to provide molting and migrating habitat for waterfowl. The upper end of Lake Walcott is shallow and filled with sago pondweed. Sago pondweed and its associated invertebrates are the major food resource for the molting & migrating waterfowl. Emergent hardstem bulrush and cattail are nesting sites for waterfowl.
3	Plants-terrestrial (food/cover, native habitats, etc.)	TP	Cottonwoods are important cover for nesting herons and some passerine species. Willows are important cover for nesting passerine species. Both are important to migrating passerines. Much of the land south of Lake Walcott has been altered by plantings of crested wheatgrass.
2	Reptiles	RE	Reptiles with ranges on the refuge include Longnose Leopard, Sagebrush, Shorthorned, Side-Blotched, and Desert Horned lizards; Western Skinks and Western Whiptails, and Common Garter, Western Terrestrial Garter, Gopher & Night Snakes, Racer, Rubber Boa, Striped Whipsnake, and Western Rattlesnake.
1	State listed or candidate species	SL	Bald eagle, Peregrine, White Pelican, Ferruginous Hawk, Townsend's Big-Eared Bat, Fringed Myotis, California Myotis. White Pelicans nest on the refuge. Status of bats on the refuge unknown.
	Wildlife, Other Resident Species	RW	
	Other	OT	

WS-2.3 ASSESSMENT CONSIDERATIONS FOR THE SERVICE LANDS BIOMONITORING ACTIVITIES

Rank	Assessment Considerations	Group Code*	Description and Comments Regarding Importance to Monitoring Activities
2	On-Site Pest Management Activities	PM	Refuge personnel spray annually for state designated noxious weeds. Spraying is done with approved pesticides with procedures approved annually by the regional office.
1	Biodiversity		The refuge is remarkably diverse considering its size. Over 200 species of birds have been recorded on the refuge since 1950. The reservoir area and river provide migration habitat for concentrations of up to 100,000 waterfowl. Other wildlife inhabiting the refuge include 25 species of mammals, 11 species of reptiles, and over a dozen species of fish. The spillway area below the dam is an important environmental link between the reservoir and the river and has been evaluated as a high priority fishery resource. Vegetation on the refuge includes trees, shrubs, grasses, and aquatic plants.
1	Geographic location of the area (feeding/staging area, good climatic conditions, breeding area, etc.)		Minidoka is an overlay refuge on the Snake River in southcentral Idaho. The majority of the refuge is Lake Walcott, a reservoir, and the surrounding uplands. The refuge is primarily a molting and migration area for waterfowl. Secondarily it is a waterfowl production area. It freezes over each winter, so does not function as a wintering area.
2	Recreational activities (consumptive and nonconsumptive)		Hunting and fishing are allowed on portions of the refuge. Fishing and boating occur primarily at the west end of Lake Walcott, where the water is deepest. Colonial bird nesting islands and molting areas are closed to public access. The western part of the south shoreline is open to waterfowl and upland bird hunting. Steel shot is required for waterfowl hunting and will probably be required in the near future.
NA	Research (for other than T&E species)		None known at this time
2	Economic uses (grazing, haying, mining, logging, oil)		Fall grazing on the south shore, especially near the water units, these may be contributing to nutrient enrichment. Commercial fishing for rough fish from the south shore across from Smith Springs has occurred in some years. Lake Walcott is controlled by the Bureau of Reclamation, for irrigation and hydroelectric generation. The power house is being overhauled in 1992-93.
3	Other (e.g., wilderness, subsistence, military)		A military low level training route crosses the refuge near its eastern boundary. The Oregon Trail forked near Raft River Bay, one fork going to California and one to Oregon.
3	Previous baseline or reference monitoring		Graduate student measuring nutrient concentrations (NO_2^-, NO_3^-, and PO_4^-), water quality (temperature, pH, dissolved oxygen, conductivity, salinity), and tributary flows on and above refuge.

WS-2.3 ASSESSMENT CONSIDERATIONS FOR THE SERVICE LANDS BIOMONITORING ACTIVITIES

Rank	Assessment Considerations	Group Code*	Description and Comments Regarding Importance to Monitoring Activities
1	Documented or suspected contaminant concerns		Significant contaminant inputs may be reaching the refuge through the Snake River and its tributaries. Other input may originate at the Bonanza Bar area (ag runoff). There is a small gold dredging operation near Smith Springs (under a State Permit) that could cause Hg contamination from gold dredging operations. There are several Superfund sites in Pocatello that may be contributing contaminants (PCBs, heavy metals) to the refuge via the Snake River. Limited sampling in American Falls Reservoir & several fish samples from Lake Walcott suggest heavy metal & organochlorine contamination may be present.
	Other: _____		
GENERAL HABITATS/COMMUNITIES ON THE SERVICE LAND			
Upland Formations			
1	Agricultural Lands	AG	Large stretches of agricultural activities occur next to the refuge, upstream from the refuge, and next to the tributaries which eventually feed in the refuge. The biggest problems associated with the agricultural activities is sedimentation and eutrophication. Organochlorines, organophosphates, and other pesticides have been, or currently are, used. Other problems associated with agricultural activities are channelization, streambank modification, and changes in flow. Irrigated crops are primarily alfalfa, beans, corn, peas, potatoes, small grains, and sugar beets. One sugar beet processing plant is located near Rupert.
NA	Tundra	T	
NA	Forest (>50' trees)	F	
NA	Woodland (<50' trees)	W	
3	Scrubland (<31'-multibranched)	S	The vegetation of the upland sites is characteristic of a shrub-steppe community. Dominant shrub-species include big sagebrush and rabbitbrush. Common forbs include tumble mustard, prickly lettuce, goatsbeard, and pepperweed. No contaminants known to be threatening these areas.
3	Grassland	GR	The predominant grasses are cheatgrass brome, bluebunch wheatgrass, Sandburg's bluegrass, crested wheatgrass, and needlegrass. No contaminants known to be threatening the grasslands, however, the infestation of non-native cheatgrass does pose threat.
3	Desertland (<12" precip.)	D	Drought conditions in recent years (1988-92) has lowered reservoir reserves and dried soils. Severe wind storms have suspended soils from Ag lands and have been deposited on the refuge; these soil particles may contain pesticides or other contaminants.
	Other Uplands: _____	OU	
Wetland/Aquatic Formations			
NA	Wet Tundra	WT	

WS-2.3 ASSESSMENT CONSIDERATIONS FOR THE SERVICE LANDS BIOMONITORING ACTIVITIES

Rank	Assessment Considerations	Group Code*	Description and Comments Regarding Importance to Monitoring Activities
NA	Swampforest/Riparian	SF	
1	Swampscrub/Riparian	SS	Riparian vegetation found along the refuge are include cottonwoods (support heron rookeries), willows (nesting for passerine species), dogwood, chokecherry, hawthorne, and rose. The riparian areas support diverse flora and fauna.
1	Freshwater Marshland	FM	Some small marsh areas lined with bulrush and cattail near Water Units 1 &-2, Bird Island and Bulrush Island. These areas are important to a variety of waterfowl and migratory birds.
NA	Strandland (beach)	ST	
NA	Saltflats/Mudflats	SM	
1	Submergent Aquatic	SA	Large growths of filamentous algae has led to swimming restrictions due to fear of entanglement. The filamentous algae also clogs the dam, boat props, and irrigation canals.
1	Managed Wetlands	MW	The dikes at water units 1 & 2 are opened in the spring to allow the wetlands to fill with water. When water levels drop, the dikes are closed. Drought conditions have dried these wetlands. Monitoring of vegetation community could document wetland losses.
1	Lake/Pond/Impoundment	L	Lake Walcott reservoir makes up over half the refuge. It likely serves as a sediment and contaminant sink for the area between Minidoka and American Falls dams.
1	Riverine	RS	As noted below, a National Wetlands Inventory designated 30.6ha as Riverine (upper perennial, rocky shore, temporarily flooded. River flow has dropped significantly in recent years due to drought conditions.
NA	Marine	M	
NA	Estuarine	E	
1	Other Wetlands: National Wetlands Inventory	OW	A National Wetlands Inventory was completed in 1988. The coverage of applicable classification units within the project area are as follows: Uplands (40ha), Riverine [upper perennial, rocky shore, temporarily flooded (30.6ha)], Palustrine [scrub-shrub, seasonally flooded (5.4ha)], Palustrine [emergent, seasonally flooded, diked/impounded (0.4ha)], Palustrine [emergent, seasonally flooded (0.08ha)].

2.4 Assessing Local Off-Service Land Areas Important to Trust Resources

The purpose of this section is to identify, document, and describe local off-Service land areas that are important to trust resources and should be considered in the monitoring strategy.

Trust resources are generally not confined to Service managed lands and the Service is generally unable to extensively protect or monitor these other areas. However, there might be select local areas that are used extensively by trust resources and should be identified and evaluated for potential monitoring activities.

In addition to contaminant risk assessment, an assessment of these off-Service land areas as potential reference sites for comparison of contaminant or ecological data is recommended. There are instances where the Service lands ecosystem will be managed to the extent that a natural system no longer exists and adequate reference data for the area can not be obtained. If local areas provide appropriate reference sites, they should be identified here.

Given the additional time required to complete this task it is useful to list the significant areas first using Worksheet WS-2.4a, then prioritize them according to importance and potential risk to the trust resources. More detailed information for the high priority areas will then be gathered and incorporated into Worksheet WS-2.4b.

MATERIALS/INFORMATION NEEDS

Worksheets WS-2.2a, WS-2.2b, WS-2.3, WS-2.4a, WS-2.4b
Appropriate maps
- Service land maps
- USGS 7.5' topographic and 1:250,000 scale land use maps
- NWI maps for the area

Species lists

PROCEDURE

Using Worksheet WS-2.4a, document all local off-Service land areas that should be considered when developing the monitoring strategy and describe the relevant characteristics of these areas. These are areas that are used extensively by trust resources and/or can be used as reference monitoring sites. Therefore they should be considered when developing the monitoring strategy.

1. Identify the area name or give it a identification number

2. Describe its general location, e.g., 5 miles NW of the Service lands on Ali Creek

3. Identify a contact and phone number for the land owner or manager

4. Using the following descriptions, give the area a "Status Ranking":

   Status Ranking:
   1 = Known contaminant sources and documented contamination problems and/or habitat degradation.

2 = Known contaminant sources and contaminant presence, no documented contaminant problems or habitat degradation.
3 = Known contaminant sources, suspected contaminant presence, no documented contaminant problems.
4 = No known contaminant sources other than global atmospheric input and no known habitat degradation.

5. Describe the characteristics of these areas and how the area is relevant to the Service land monitoring activities. This should include general site description, communities, species, etc. If this information has been described in Worksheet WS-2.2b reference this worksheet and site name or copy the information to this worksheet.

6. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

Use Worksheet WS-2.4b to document details on high priority areas and their potential role in the Service lands monitoring strategy.

1. After completing Worksheet WS-2.4a identify those areas with a Status ranking of 1 or 2 and complete Worksheet WS-2.4b for each of these areas. Also complete Worksheet WS-2.4b to document the areas that will likely be used as reference monitoring sites.

2. Some information on this worksheet can be copied directly from Worksheet WS-2.4a. These are:

   - Area name
   - Distance and direction from Service lands
   - General description and importance to Service land monitoring
   - Contact and phone number

3. Identify the UTM zone (found on the lower left side of USGS 7.5' quadrangle maps) and UTM coordinates for the area.

4. Identify any monitoring activities relevant to this area (on-site monitoring, local air monitoring, National Pollutant Discharge Elimination System (NPDE) permit monitoring, etc.)

5. For each "Assessment Consideration" provide a brief comment regarding its relevancy to the Service lands and why it should be considered as a part of the monitoring strategy. Put "NA" in the "Description" column if the category is not applicable to these Service lands.

6. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

   NOTE: If off-Service land areas will be a component of the monitoring strategy, procedures similar to those used for the Service lands should be used to implement contaminant monitoring activities for these areas. If they are located a significant distance from the Service lands and/or have different contaminant sources, transport pathways, or receptors, a separate Workbook should be completed for these areas.

EXAMPLE: Minidoka National Wildlife Refuge

WS-2.4a INDEX TO LOCAL OFF-SERVICE LAND AREAS IMPORTANT TO TRUST RESOURCES

Off-Service Land Area		Description of Area and Importance to Service Land Monitoring
Area Name	Raft River and Raft River Basin	Drainage area ~ 1,510 mi^2, heavily used for irrigation and stock. Mean annual discharge ~ 0.88 cfs. Land uses include alfalfa, potatoes, and sugar beets. Also cattle lots.
Location	South side of Refuge, feeds into Raft River Bay	
Contact and Phone #	Richard Gerard/Cassia Co. Agricultural Extension Office (208) 628-9461	
Status*	3	
Area Name	Bonanza Bar Area	Agricultural land. Crops include alfalfa, potatoes, and sugar beets. Pesticides and fertilizers used in close proximity to Tule Island.
Location	North side of refuge above Tule Island, upstream from refuge	
Contact and Phone #	Stan Gortsema, Power County Agricultural Extension Office (208)226-7621	
Status*	3	
Area Name		
Location		
Contact and Phone #		
Status*		
Area Name		
Location		
Contact and Phone #		
Status*		
Area Name		
Location		
Contact and Phone #		
Status*		

* Status Ranking:

1 Known contaminant sources and documented contamination problems and/or habitat degradation.
2 Known contaminant sources and contaminant presence, no documented contaminant problems or habitat degradation.
3 Known contaminant sources, suspected contaminant presence, no documented contaminant problems or habitat degradation.
4 No known contaminant sources other than global atmospheric input and no known habitat degradation.

EXAMPLE: Minidoka National Wildlife Refuge

WS-2.4b ASSESSING LOCAL OFF-SERVICE LAND AREAS IMPORTANT TO TRUST RESOURCES					Page __ of __
Area Name	Raft River and Raft River Basin				
Distance and Direction from Service Lands	Extends south from refuge and extends >50 miles down into Utah				
UTM Coordinates (centroid)	UTM Zone	12	X (Long.)	315000	
			Y (lat.)	4719000	
General Description	Drainage area - 1,510 mi^2 Heavily used for irrigating agricultural fields and cattle stockyards. Crops include alfalfa, potatoes, and sugar beets.				
Contact or Agency	Richard Gerard Cassia County Agricultural Ext. Office		Phone #	(208) 628-9461	
Monitoring Activities Relevant to this Area	USGS flow data (stations #079901 and #078000) prior to 1988 along with occasional tests for specific conductance, temperature, and pH. Discontinued after 1988				

Assessment Considerations	Description and Comments Regarding Importance to Monitoring Activities
Amphibians	Although the ranges of the Northern Leopard frog and Spade Footed toad occur include this area, it is not known if either inhabit the area.
Anadromous fishes	NA
Catadromous fishes and invertebrates	NA
Raptors	Owls, falcons, and hawks may prey on mammals and/or other carrion in and around the Raft River. Potential accumulation of pesticides.
Seabirds	NA
Shorebirds	None known
Waterfowl	The Raft River does not offer much waterfowl habitat due to the limited amount of open water and riparian areas. Agricultural fields are used primarily as feeding areas during the fall and spring by Canada geese, mallards, and teal. Possible exposure to pesticides and fertilizers from consumption, absorption, or respiratory uptake.
Other aquatic birds	
Other migratory birds	Jays, magpies, crows, and sparrows nest and feed in fields and irrigation pools. Other species of passerine birds also occur. Possible contact through feeding, preening, absorption, or respiratory uptake.
Other resident birds	Some upland game species such as pheasant, morning dove, and quail are associated with the private farmlands. Others, such as sage grouse, Hungarian partridge, and chukkar partridge are associated with the rangelands.
Federally listed threatened & endangered, or candidate species (including research)	Bald Eagle, Peregrine Falcon; Big-eared Bat may possibly use the area, which means the possible exposure to contaminants do exist (bioaccumulation from mammals, fish, and insects). Its unknown if any plant species threatened or endangered plants species utilize the area.
Exotic/Pest Species	Noxious weeds, cheatgrass.

WS-2.4b ASSESSING LOCAL OFF-SERVICE LAND AREAS IMPORTANT TO TRUST RESOURCES	Page __ of __
Area Name	**Raft River and Raft River Basin**
Other freshwater species (including invertebrates)	Salmonid spawning (trout) fathead minnows, benthic and planktonic organisms have been pretty much eliminated in the lower sections of the watershed due to sedimentation, channelization, and low summer flows and are at risk in the upper reaches. It has been rated as a poor fishery area.
Macroinvertebrates	Spatial monitoring of the benthic populations from the headwaters down to the mouth of the Raft River might provide the best indicator of river degradation.
Mammals - marine	NA
Mammals - terrestrial	Most mammal populations utilize the upper reaches of the Raft River basin. These include Mule deer, pronghorns, beaver, mink, and muskrat. Small mammals and rodents such as rabbits, squirrel, chipmunks, field mice, shrews, raccoons, and skunks utilize the lower reaches of the basin. Mammals used as prey for raptors might be included in a monitoring program.
Marine organisms other than mammals (including invertebrates)	NA
Plants - aquatic (food/cover, native habitats, etc.)	The Raft River has decreased emergent vegetation and increased benthic algae and phytoplankton in Lake Walcott.
Plants - terrestrial (food/cover, native habitats, etc.)	Nearly all of the east side of the river is dedicated to agricultural activities an most riparian vegetation has been removed. Erosion has increased the silt in the river. Some woody shrubs and grasses remain on the west side of the river.
Reptiles	Reptiles with ranges in the basin include Longnose Leopard, Sagebrush, Shorthorned, Side-Blotched, and Desert Horned lizards; Western Skinks and Western Whiptails, and Common Garter, Western Terrestrial Garter, Gopher & Night Snakes, Racer, Rubber Boa, Striped Whipsnake, and Western Rattlesnake. The actual presence/absence of each is unknown.
State listed or candidate species	Ferruginous hawks and osprey may use area.
Wildlife/other resident species	As noted above, small mammals (gophers, mice, rabbits) are prey base for higher order animals such as falcons, eagles owls, and coyotes and may lead to bioaccumulation in these organisms. Deer and elk may also utilize resources in and around the Raft River.
Other species	
On-Site Pest Management Activities	Extensive use of insecticides, herbicides, fungicides, and other pesticides used throughout the basin.
Biodiversity	Loss of fish and benthic diversity in river occurring due to sediment loads, channelization, and low summer flows (due to agricultural diversions and drought).
Geographic location of the area (feeding or staging area, good climatic conditions, breeding area, etc.)	Bordered on the west by the Albion Mountains, on the east by the Sublett and Black Pine ranges, and on the south by the Raft River Mountains. The area is used by feeding geese and dabbling ducks that roost on the refuge.
Recreational activities (consumptive and nonconsumptive)	No primary contact (swimming, wading) allowed. Secondary contact uses (fish, boating) at risk. Hunting for deer and upland birds primarily, with some waterfowl hunting. Steel shot required for waterfowl, but not for upland birds (possible lead contamination source).
Research (for other than T&E species)	None known. Check with DEQ for additional information.

WS-2.4b ASSESSING LOCAL OFF-SERVICE LAND AREAS IMPORTANT TO TRUST RESOURCES	Page __ of __
Area Name	**Raft River and Raft River Basin**
Economic uses (grazing, haying, mining, logging, oil)	Farming, haying, cattle grazing.
Other (e.g., wilderness, subsistence, military)	A military low level training route parallels the valley. The Oregon Trail forked near the Raft River Bay, one fork going to California and one to Oregon.
Previous Baseline or Reference Monitoring	Some monitoring of groundwater and surface water volumes in the 1960's and 1980's. The basin was declared a critical groundwater area in 1963 due to low levels. Definitely not a baseline site.
Documented or Suspected Contaminant Concerns	Contaminant concerns include increased sediments, nutrients, organic enrichment, bacteria, salinity, and thermal modification from agricultural and livestock activities. Also, sediment and flow alterations from hydrologic/habitat modifications.
Other	The water from the Raft River, and the land surrounding the Raft River, pose several threats to fish, birds, and other wildlife at Minidoka. Water entering the refuge at the Raft River Bay also impacts the flora and fauna on the Snake River.
UPLAND FORMATIONS	
Agricultural Lands	Irrigated cropland: 93,000 acres Non-irrigated cropland: 70,500 acres Pastureland: 10,000 acres Rangeland: 511,000 acres Forest Land: 194,000 acres
Tundra	NA
Forest (>50' trees)	Lodgepole pine, Douglas fir, Subalpine fir
Woodland(<50' trees)	Quaky Aspens, Junipers
Scrubland (<31'-multibranched)	Woody vegetation is sparse and generally consisting of big sagebrush and rabbitbrush.
Grassland	No substantial areas of natural grasslands. Small sections of crested wheatgrass, bluebunch wheatgrass, and cheatgrass.
Desertland (<12" precip)	Average annual precipitation ranges from 11 inches in the valley to 40 inches in the mountains. No water has flowed into the Snake River from the Raft River in seven years due to drought. However, heavy snowmelt this year has brought substantial amounts of water (and sediment).
Other Uplands _____	
Other Uplands _____	
WETLAND/AQUATIC FORMATIONS	
Wet Tundra	NA
Swampforest/Riparian	NA
Swampscrub/Riparian	The basin has approximately 4000 acres of hydric soils and associated wetlands. Most of the wetlands/riparian areas are alongside the Raft River (max. width 30 feet) and are composed of Willow strips. Most of the riparian vegetation are severely impacted by livestock grazing, pasture area, or for haying.

WS-2.4b ASSESSING LOCAL OFF-SERVICE LAND AREAS IMPORTANT TO TRUST RESOURCES	Page __ of __
Area Name	**Raft River and Raft River Basin**
Freshwater Marshland	At the mouth of the Raft River and in the bay, about 3000 acres are impacted by floodwater and a shallow water table and allows this wetland area to support cattails, rushes, and hydrophytic grasses and sedges.
Strandland (beach)	NA
Saltflats/Mudflats	NA
Submergent Aquatic	At the mouth of the Raft River and in its bay there are large amounts of macrophytes and filamentous algae accumulate from August through October.
Managed Wetlands	The wetland area at the mouth of the Raft River is not managed
Lake/Pond/Impoundment	Much of the water from the Raft River is diverted for irrigation. During normal years water does flow into Lake Walcott. It is estimated that 734,154 tons of sediment enter Lake Walcott annually.
Riverine	In the lower reach the river has intermittent flow with a muddy streambed, however, this is not a deep water habitat and may not qualify as a riverine system.
Marine	NA
Estuarine	NA
Other Wetlands _____	Where the river enters Lake Walcott may be loosely classified as a Lacustrine - Littoral - Aquatic bed.
Other Wetlands _____	
Other Wetlands _____	

2.5 Regulatory Requirements Relevant to Monitoring

This section is designed to document Federal, State and local regulations pertinent to monitoring. Regulatory requirements may mandate that certain contaminants and/or media be monitored and that specific procedures or techniques be used. Regulations also provide the Service with certain legal authority regarding actions that may be taken to protect trust resources.

Appropriate governmental agencies (e.g., Federal and state environmental protection agencies, Department of Health, etc.) should be contacted to determine if any activities on the Service lands are affected by regulations requiring specified monitoring activities. Being in compliance with regulated monitoring is a high priority. It may be that current monitoring efforts will support the contaminant biomonitoring program for the Service lands. See the Fish and Wildlife Service Strategic Plan for addressing contaminant and compliance issues.

Some regulations also provide the Service and/or other governmental agencies with certain legal authority regarding actions that may be taken to protect trust resources. Appendix A provides a brief description of legislation that might support actions taken by the Service to protect fish and wildlife from contaminant related events. Knowledge of the appropriate regulations can provide the information necessary to determine the type and quality of monitoring data required to be admissible in court.

> **Service personnel should confer with the Department of Interior, Office of the Solicitor at (202) 208-4423 for any questions concerning the applicability of any piece of environmental legislation.**

MATERIALS/INFORMATION NEEDS

Worksheets WS-2.5a, WS-2.5b
Appendix A
Understanding of Federal/state/local environmental regulations
Confer with the appropriate state/local agency(ies) regarding relevant regulations

PROCEDURE

1. Identify and document on Worksheet WS-2.5a the Federal laws, policies, and regulations that might affect or direct contaminant monitoring activities on these Service lands. Place an **X** in front of the specific Federal regulations that should be considered and comment on applicable requirements.

   NOTE: See Appendix A for relevant Federal laws and potential applications to the Service.

2. On Worksheet WS-2.5b identify state and local laws and regulations that should be considered and comment on applicable requirements.

3. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

WS-2.5a Page __ of __

FEDERAL LAWS, POLICIES, AND REGULATIONS RELEVANT TO MONITORING

X	Laws, Policies, Regs.	Comments/Relevance to Monitoring Strategy
x	Federal Mandates	There are currently no federal mandates to monitor the Minidoka refuge.
x	Clean Air Act (CAA) - 1970	Permits for Pocatello, Burley, and Rupert detailing emissions, monitoring, record keeping, and reporting available through Department of Environmental Quality - Boise - Permitting Dept. Provide comment on the construction of any new air pollutant emitting facilities to be constructed in the area.
x	Clean Water Act (CWA) - 1983	Guidelines for improvement of municipal wastewater discharge. American Falls wastewater treatment plant. Check with DEQ regarding new storm water discharge and pollution prevention plans. NPDES permits for Pocatello, Burley, and Rupert detailing emissions, monitoring, record keeping, and reporting available through Department of Environmental Quality - Boise - Permitting Dept. Section 404 deals primarily with wetlands and activities that could impact them.
x	Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Superfund) - 1980	Work being conducted at Michaud Flats Superfund site near Pocatello, Idaho National Engineering Laboratory Super Fund site near Arco.
x	Endangered Species Act - 1973	Responsibility for preservation and protection of listed and candidate species. Listed: Bald Eagle & Peregrine Falcon. Candidate: Ferruginous Hawk, Swainson's Hawk, White-faced Ibis, Long-billed curlew, Townsend's Big-eared Bat.
x	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) - 1947	Provides authority to prevent contamination of the environment by pesticides being used by adjacent agricultural lands.
x	Federal Water Pollution Control Act (FWPCA) - 1977	Protects chemical, physical, and biological integrity of water resources. May pertain to Raft River outflow. See Clean Water Act.
x	Fish and Wildlife Act - 1956	Provides the authority to manage and protect wildlife habitat.
x	Fish and Wildlife Coordination Act (FWCA) - 1934	Protects wildlife habitat. Pertinent to Raft River Bay where nutrient and sediment load may be impacting resources
x	Migratory Bird Treaty Act (MBTA) - 1918	Enforcement tool for preserving migratory bird habitat. Especially pertinent to Tule Island, cottonwood rookeries, and emergent marsh vegetation.
x	National Environmental Policy Act (NEPA) - 1970	Promotes the health and welfare of the environment and mandates environmental impact statements (EIS). Pertinent to the modifications at Minidoka Dam. Service should comment on other EISs in the area. EISs should include preliminary assessments and monitoring during and after the proposed activity.
x	Refuge Protection Act	Useful to regulate activities found to have deleterious effects on refuge wildlife.

WS-2.5a FEDERAL LAWS, POLICIES, AND REGULATIONS RELEVANT TO MONITORING		Page __ of __
X	Laws, Policies, Regs.	Comments/Relevance to Monitoring Strategy
x	Resource Conservation and Recovery Act (RCRA) - 1976	Allows Service to consult with EPA if future waste disposal sites are to be located near the refuge. Can be used to force improvements on any current open landfills near the refuge.
x	River and Harbor Act - 1899	Current interpretation of "Waters of the U.S." includes refuge wetlands in addition to the Snake River and its tributaries.
x	Surface Mining Control and Reclamation Act - 1977	Applicable to the gold mining operation at Gifford Spring.
x	Toxic Substances Control Act (TSCA) - 1976	Can be used to justify continuing monitoring of contaminants reaching the refuge or affecting fish or other wildlife resources.
x	BLM Manual (Chapter 6840)	It is the policy of the BLM to conserve threatened and endangered species and the ecosystems they depend upon.
x	U.S. Forest Service Department Regulation 9500-4	Directs the USFS to manage habitats of all existing plants and animals in order to maintain at least viable populations and to avoid action which may cause species to become federally listed.

EXAMPLE: Minidoka National Wildlife Refuge March 22, 1993

WS-2.5b STATE AND LOCAL LAWS RELEVANT TO MONITORING	Page 1 of 1
State/Local Laws	Comments/Relevance to Monitoring Strategy
State Mandates	There are currently no state mandates to conduct monitoring activities at Minidoka.
Idaho Code Section 18-3913	Gives authority to the Department of Parks and Recreation to protect 24 species of native Idaho wildflowers.
Idaho Code Section 36-103	Gives authority to the Department of Fish and Game to preserve, protect, perpetuate, and manage all wildlife.

2.6 Monitoring Goals for the Service Lands

The purpose of this section is to develop general monitoring goals for the Service lands. These will be used later to develop specific monitoring objectives that will be used to develop monitoring and sampling designs.

In Section 2.1 management goals and objectives for the Service lands were identified. Now that additional information has been gathered for the Service lands, they should be reevaluated to determine if they should be changed or if additional statements should be added. It is very important that the management goals and objectives are well founded and are agreed to by the Service lands manager at this time, because they provide the direction and rationale for the monitoring goals and objectives. In general, monitoring goals are directly responsive to the management goals for Service lands.

A statistically defensible monitoring program probably cannot be developed from the monitoring goals alone. It is necessary to define the specific characteristics, ecology, and problems of the area of interest to proceed with identification of variables and times to sample. Monitoring objectives, which address specific issues, are definitive subsets of monitoring goals. They state a clear purpose, and provide the detail necessary to formulate testable hypotheses.

The discussion below is included to provide a better understanding of the relationship between management goals and objectives, monitoring goals, and monitoring objectives.

1. Definitions

A monitoring goal is a statement that provides a focus for the development of monitoring objectives. It is somewhat generic, but reflects the intentions of the management goals and objectives. The purpose of establishing monitoring goals is to ensure that the monitoring activities support the management objectives.

> In the case of Minidoka NWR, a sample monitoring goal would be to "provide data to verify that the waterfowl refuge and breeding grounds are being protected, and are providing suitable habitat for the birds."

Monitoring objectives, in contrast to goals, are specific subsets of the monitoring goals. They are developed with the idea of quantifying or characterizing existing conditions (biotic or abiotic) that can be compared with similar measurements taken at another time such that statements can be made regarding statistically significant changes. Testable hypotheses can be formulated from monitoring objectives.

> An example of a monitoring objective is "to determine the uptake of selenium in widgeons from marsh grass and aquatic invertebrates on the refuge."
>
> Other objectives may be stated to help locate the source of selenium, and tie that source with the marsh grass and aquatic invertebrates.

For Service land monitoring, the interest is to quantify the changes (if any) in environmental conditions and determine if they are natural variations or result from anthropogenic stresses. If they

are anthropogenically induced stresses, the desire is to identify what the stressors are, their environmental and ecological effects, and how they can be reduced or mitigated.

2. The purpose of monitoring goals and objectives

The purpose for stating monitoring goals is to provide a focus for developing a monitoring strategy. The monitoring goals provide a context for defining the contaminant biomonitoring and ecological health issues and identifying pertinent concerns (e.g., contaminants, sources, transport pathways, and receptors, etc.).

The purpose for developing monitoring objectives is to provide manageable questions for monitoring designs. The objectives provide: a purpose for data collection, a format for data interpretation, and are specific enough to develop testable hypotheses and a statistically based sampling design. After identifying specific questions and objectives, it is easier to identify the variables to measure, sites to sample, and the frequency and timing of sampling.

3. When to specify monitoring goals and objectives

Monitoring goals are specified at the beginning of the monitoring strategy development process: after the refuge management goals and objectives have been identified, but prior to an in-depth characterization of the monitoring issues and the specific problems present.

Monitoring objectives are specified after the area of interest and monitoring issues have been characterized and the specific contaminant and other threats have been identified.

4. Consequences of inappropriate monitoring goals or objectives

If monitoring goals do not support the management objectives, the resulting monitoring activities will not be able to verify whether the Service is effectively managing the trust resource. Furthermore, the monitoring results will not provide the information necessary for informed or proactive management decisions.

If monitoring objectives are inappropriate, the results will provide irrelevant or inconclusive information. Most frequently, objectives are too general or vague to develop a statistically sound monitoring program within budgetary constraints. Data gathered from a program that is not statistically based are difficult to interpret, if not meaningless.

5. The process for defining management objectives, developing monitoring goals, identifying issues, and specifying monitoring objectives includes the following:

a. Review of the management plans, if available, to provide guidance on the general management objectives for the Service lands (Section 2.1).

b. Development of monitoring goals that support the management objectives (This Section).

c. Identification of site characteristics, contaminant sources, contaminants, transport pathways, and receptors (Section 3).

d. Identification and prioritization of the contaminant issues (Section 4).

e. Development of monitoring objectives to address specific contaminant biomonitoring issues and/or to answer other questions associated with protecting the trust resources (Section 5).

Once the relationship of the specific Service lands management goals and objectives to contaminant biomonitoring are clearly understood, the types and quality of data required for monitoring need to be identified. Making a decision regarding data needs will require an assessment of existing information/data on the contaminants, contaminant sources, and potential receptors associated with the Service lands. Section 3 discusses a process for identifying, gathering, and documenting the information necessary to determine data quality requirements.

MATERIALS/INFORMATION NEEDS

Worksheets WS-2.6 plus all of those completed thus far
Maps used for reconnaissance

PROCEDURE

1. Identify and document monitoring goals for the Service lands on Worksheet WS-2.6. These goals should support management goals and objectives and focus the following characterization activities on the information necessary to support these goals.

   Considerations for developing contaminant biomonitoring goals include:

   - Protection of Service personnel
   - Federal/state/local environmental regulations
   - Previous contaminant problems
   - Purpose for which the area was established
   - Management goals for the Service lands
     - species/habitat preservation/enhancement
     - recreational resource
     - scientific studies
     - threatened and endangered species
     - maintaining biodiversity
   - Public use of the area
   - Location of the Service lands

2. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

EXAMPLE: Minidoka National Wildlife Refuge

WS-2.6	MONITORING GOALS FOR THE SERVICE LANDS Page 1 of 1
1	Provide information necessary to protect/enhance threatened, endangered, and state listed sensitive species and their habitats.
2	Determine a) which contaminants are present in harmful amounts, b) the source of contaminants detected, and c) harmful effects of contaminants on wildlife.
3	Provide information necessary to ensure suitable habitat exists for colonial nesting waterbirds.
4	Provide information necessary to provide suitable habitat to enhance and maintain the natural aquatic and terrestrial diversity of the area.
5	Ensure fish and water quality are safe for human consumption and use. Ensure compliance monitoring requirements are addressed.
6	The program should provide data to establish "baseline" or "benchmark" values for trend analysis of important parameters (e.g., water quality and biotic parameters, nutrient loading, contaminants or associated effects as identified).
7	Monitoring design and data collected should help to develop a clear definition of a meaningful level of change for parameters being measured.
8	
9	
10	

2.7 Public Outreach Workshop to Discuss Monitoring Program Goals

The purpose of the public outreach workshop is to inform the public about the goals of the Service lands biomonitoring program and to obtain input regarding their concerns and desires for the area. Local residents and visitors can provide valuable information regarding historic and current land uses, and observations regarding species sightings and population changes.

The workshop should be planned for a time after the initial information gathered thus far has been organized and assimilated. This will provide information for an introduction to the workshop and let the participants know what information has been gathered. Providing an overview of this material will stimulate the participants' thinking and maximize the effectiveness of the workshop through participant input.

This activity should be a workshop with the intent of gathering input from the participants regarding information collected thus far and information that will be collected in the following sections. It is very important that the participants consider themselves as information sources and as an active component of initiating the monitoring program. To maximize active participation and allow enough time to provide the background to the program and gather information, the workshop should be held early in the evening or on the weekend.

Though all the public should be invited to this workshop, a special effort should be made to include key organizations or people. This can be accomplished through invitations, leaflets, or even phone calls for particularly important organizations or people. The list below can be used to identify potential participants:

- Other Federal/state/local governmental environmental agencies
  - Environmental Protection Agency (EPA), United States Geological Survey (USGS), Bureau of Land Management (BLM), U.S. Forest Service (USFS), Bureau of Reclamation (BOR), National Park Service (NPS), Soil Conservation Service (SCS), Army Corp. of Engineers, National Oceanic and Atmospheric Administration (NOAA)
  - Water resources or management district organizations
  - State Departments of Environmental Quality or Protection
  - Departments of Agriculture
  - Fish and Game agencies
  - Non-game organizations
  - County/city planners or land managers

- Universities, research organizations, high schools

- Conservation organizations (a few examples)
  - Nature Conservancy
  - National Wildlife Federation
  - Ducks Unlimited
  - Pheasants Forever
  - Wilderness Society
  - Local/state organizations

- Individuals
  - local land owners/managers
  - researchers
  - known frequent visitors and volunteers

MATERIALS/INFORMATION NEEDS

Worksheets WS-2.7 plus all of those completed thus far
Overheads of the worksheets
Maps of the Service lands and surrounding areas
Slides and information materials describing the Service lands
Slides and information to provide an overview of the biomonitoring program
Slides/video taken during the field reconnaissance

POSSIBLE AGENDA FOR WORKSHOP

- Introduction (15 minutes)
  - who we are and who they are
  - purpose of the workshop
  - background to the biomonitoring program and ecosystem health issues

- Discuss Biomonitoring Operations Manual and Workbook (15 minutes)
  - purpose of the Manual
  - overview of the entire approach to developing a monitoring strategy
  - discuss the components of the Workbook to be discussed during the workshop

- Overview of the Service lands (15 minutes)
  - slides of the Service lands (maps, trust resources, habitats)
  - primary purpose of the Service lands

- Go over worksheets completed thus far and solicit input from the participants regarding additional ideas and information to be considered for the worksheets. Concentrate on one worksheet at a time and obtaining input from the participants.
  - Discuss management goals and objectives (WS-2.1)
  - Discuss information acquired during the preliminary assessment and provide slides and information gathered during the reconnaissance (WS-2.2a&b).

  NOTE: Be sensitive regarding how issues are discussed; the perspectives of the responsible parties for land management or the contaminant source owner/manager should be respected. The pertinent issues need to be identified, however, a priority should be placed on working in a cooperative manner to resolve identified problems.

  - Discuss the assessment considerations for the Service lands and their relationship to monitoring and the management goals and objectives (WS-2.3)
  - Discuss off-Service lands important to trust resources and solicit input regarding potential contaminant or land use issues associated with these areas (WS-2.4a&b)
  - Go over the environmental regulations identified on WS-2.5a&b and their relevance to monitoring. Depending on the participants, it might not be an effective use of time to

dwell on legal issues. If participants can provide some important insight to regulations, then this could be an opportunity to gain useful information.

- Discuss the monitoring objectives documented on WS-2.6 and solicit additional suggestions.

- Summarize the components of the process that have been completed and what remains to be done. If a tentative schedule can be provided regarding implementation of the monitoring program, do so, but be realistic.

- Provide a question and answer period. Ask that the participants be sure to sign the participant sign-up sheet and identify specific interests and concerns they might have (WS-2.7).

After the workshop, review **ALL** the completed worksheets and determine if any information should be added or revised. Add the additional contacts and information sources to Worksheet WS-2.2a.

If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

WS-2.7 PUBLIC OUTREACH WORKSHOP PARTICIPANTS Page __ of __

	Participant Name, Address, Phone #	Affiliation	Discussion Comments/Concerns/Interests
1	Laird Noh Statehouse Mail Boise, ID 83	State Senator	Chairman of Natural Resource Committee - concerned about water quality, flow rates, wildlife - also any effect on economy of the area.
2	Larry Pennington 2000 Mill Rd. Twin Falls, ID	Local Businessman	Economic effects of any increased restrictions brought about by results of monitoring - is also a sportsman who fishes and hunts in the area
3	Trish Klahr P.O. Box 844 Boise, ID 83701 345-6933	Water Quality Director, Idaho Conservation League	Concerned about water quality, flow rates, effects on fish and wildlife, also effects of problems in this section of the Snake R. on other parts of the river.
4	Wendy Wilson 300 9th St. Boise, ID 83701	Idaho Rivers United	Concerned about water quality, effects of diversions on water levels, pollution from groundwater
5	Ray Johnson Sunray Trout Farm 3030 Frontage Rd. Minidoka, ID 83343	Trout Farmer	Uses water from River, which is returned downstream, concerned about how his business will be affected, continued water use, restrictions on discharge into river
6	Mike Medberry Mine All Mining Co. Ketchum, ID 83340	President, local mining co.	Additional restrictions on mining operations; costly changes to his operation would put him out of business
7	Ross Thiel 4031 W. Osgood Minidoka, ID 83343	Local Farmer	Also worried about additional restrictions on his operations. Uses pesticides and fertilizers, including some aerial application.
8	Debbie Butler 1420 Main St. Rupert, ID 83350	Audubon Society	Water quality, nesting habitat, recreation disturbance of nesting birds
9	Dr. Wayne Minshall Dept. of Biology Pocatello, ID 83209	Idaho State Univ.	Water quality effects on invertebrates
10	Ron Carlson Idaho Dept. of Water Resources Boise, ID 83720	Watermaster	Water quality/quantity, irrigation use
11	Paul Eastwood 1840 W. Jackson Rupert, ID 83342	Idaho Cattle Association	Concerned about effects on cattle grazing on BLM private land around refuge.

3. ECOLOGICAL CHARACTERIZATION OF THE SERVICE LANDS

Characterization of the Service lands must occur prior to designing a comprehensive contaminant biomonitoring program. This section discusses the information required for a general characterization of the Service lands and surrounding area. This includes a general characterization of the environmental/ecological components of the area, an assessment of contaminant sources and associated contaminants, their transport pathways, and receptors, and an evaluation of the air and water sheds. Below is an illustration of the steps to this process.

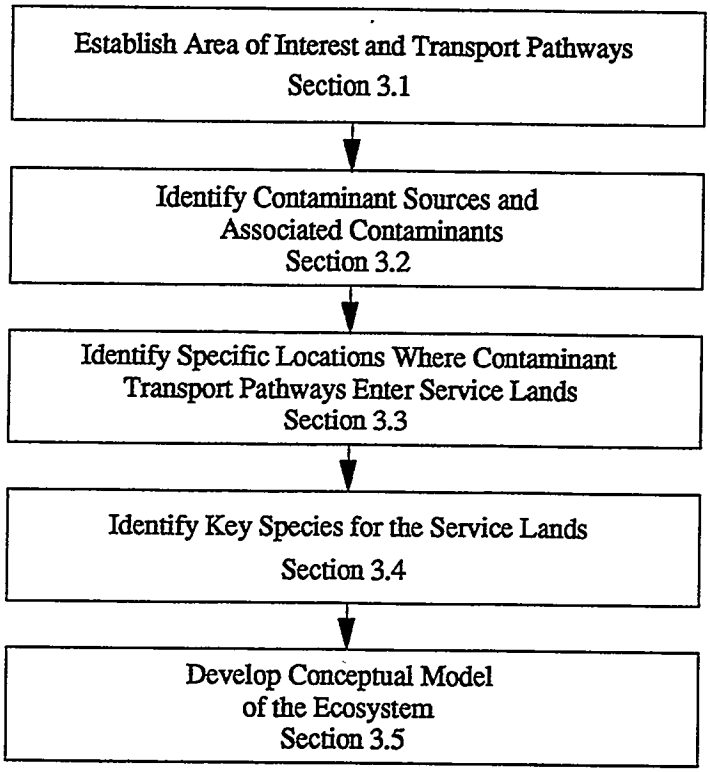


Figure 3.1. Steps to ecological characterization of the Service lands.

3.1 Establishing the Area of Interest and Identifying the Potential Contaminant Transportation Pathways

The purpose of this section is to identify the relevant contaminant transport mechanisms for the Service lands and their locations. The AOI defines the area (on and off-Service lands) to look for contaminant sources and will be used to evaluate the potential for contaminants to reach the Service lands. It also helps define the area for establishing reference monitoring sites. A transport mechanism is defined as the media that physically moves a substance from one location to another. This includes air, water (surface and subsurface), and biota.

The maps used for this activity will be used for subsequent mapping of contaminant sources, transport pathways, sampling locations, critical habitat identification, etc. **Therefore, it is recommended that you use maps in good condition and that a safe location for working on them and storing them be provided. These maps should be cared for as they will become a hard copy of a spatial data base to be developed for contaminant biomonitoring on the Service lands.** Read through this section to become familiar with the information and material requirements before beginning the work.

3.1.1 Establish the Area of Interest (AOI)

For this manual the "Area of Interest" (AOI) is defined as the Service lands and the surrounding air and watershed (surface and subsurface waters) that affect, or have contaminant sources that could affect, the biotic and abiotic resources of the Service lands. The boundary of this area is determined by the transport mechanisms (e.g., air, surface waters, subsurface water, biota) that could transport contaminants from their sources to the Service lands. These area boundaries will vary between transport mechanisms. Once the cumulative area is delineated, potential contaminant sources and associated contaminants, specific contaminant transport pathways, and important receptors within the area can be identified.

It is recommended that a Geographical Information System (GIS) be used as a data manager. This hardware/software capability can capture and integrate spatial data, conduct analyses on that data, and produce hard copy products. It is unlikely that a single Service land area could provide the financial resources required to operate such a system; however, many Federal and state agencies, large cities, and universities have these systems and might interested in cooperating with the Service. The information gathered for the Service lands assessment would likely be desired by the other government agencies. It is strongly recommended that groups operating such a system be contacted and a cooperative agreement be established. In the future, if the Service obtains a GIS, this data can be transfered to the Service's system.

MATERIALS/INFORMATION NEEDS

Maps of the Service lands and surrounding areas (see below)
Slides/video taken during the field reconnaissance
Waterproof color markers (various colors and thicknesses)
Clear plastic or mylar for overlays to delineate the AOIs on the map. Clear Contact™ paper can also be used, though this will become permanently attached to the map (enough for 6-10 maps)
Access to a GIS data base of the area (if available)
Air, Surface Water, Ground Water RFMs
Identify contacts for planning and information

PROCEDURE

1. Obtain the maps for the Service lands and surrounding areas.

   Potentially useful maps, aerial photographs, and related materials include the following (also see Table 2.2):

   - A 1:500,000 U.S. Department of Interior Bureau of Land Management (BLM) Surface Management Responsibility State map (i.e., BLM Land Status/Ownership Map).

NOTE: Obtain maps of neighboring states if Service lands are near other state borders and use the same scale as the maps from your state.

- A 1:250,000 (1x2 degree) topographic map of Service lands area
- As many 1:100,000 (30x60 minute) BLM Land Status maps are necessary to cover at least 10 miles beyond the borders of the refuge.
- 1:24,000 (7.5 minute) or if available, 1:62,500 (15 minute) topographic maps of entire Service lands.
- U.S. Department of Agriculture-Soil Conservation Service (SCS) soil surveys and general soil map of Service lands and surrounding area.
- Department of Interior - US Geological Survey (USGS) surface geologic and hydrogeologic maps of Service lands and surrounding area
- Habitat types and associated use by important species if available (U.S. Fish and Wildlife Service - National Wetland Inventory, FWS - Division of Realty)
- Meteorologic maps (NOAA, local TV/radio stations, airports) if available
- Other useful regional, state, county, and city maps
- Windrose for the area or from NOAA or local airport
- GIS/remote sensing data (if available)
- Aerial photos if available (Agricultural Stabilization and Conservation Service (ASCS), USGS, Service Wetlands Inventory/Research)

2. Determine the relevant transport mechanisms for the Service lands and delineate the AOI for each. Four contaminant transport mechanisms will be considered:
   - SW - surface water
   - SSW - subsurface Water
   - A - air
   - B - biota

NOTE: Soil and sediment have sometimes been considered transport mechanisms, however, for this manual they are considered an exposure or transport media. Air, surface water, and biota are the transport mechanism for these media. Additional information can be added regarding the media that is being transported by the transport mechanism if this will be helpful with developing the monitoring strategy (e.g, water-suspended sediments).

NOTE: Prior to beginning this activity, read the Introduction in the Surface Water and Ground Water RFMs (Appendices J and H respectively) and Sections 1, 2, and 5 (at a minimum) of Appendix C, "Air Monitoring - A Reference Manual." This information will be helpful for completing the following steps.

- Use the considerations provided below to determine the relevant transport mechanisms for the Service lands and the associated AOI. Use the clear plastic overlays and the smallest scale map first (1:250,000 or smaller if necessary), to outline the AOI for each relevant transport mechanism. A plastic overlay should be developed for each transport mechanism AOI or different colored markers be used for each boundary.

NOTE: Map scale refers to the ratio of the map scale, not the amount of area the map covers. A large scale map is one that has a larger ratio, i.e., it is closer to a scale of 1:1. Therefore a 1:24,000 scale map (7.5' topographic map) is a larger scale map than a 1:250,000 scale map that provides a greater area coverage. A closeup view of a monitoring site would be an even larger scale map.

Delineate the AOI for the Surface Water Transport Mechanism

Use the following considerations to develop the Surface Water AOI:

- Are surface waters (on or off the Service lands) an integral part of managing these Service lands and the associated fish and wildlife?

- Do surface waters exist on the Service lands? If yes, these areas and their watersheds should be included in the surface water AOI.

  If surface waters do not exist on the Service lands, a decision must be made regarding whether to include monitoring of local off-Service land surface waters used by the trust resources associated with these Service lands (refer to Worksheets WS-2.4a&b).

- Are the surface waters on the Service lands supplied from off-Service land surface water sources (other than precipitation) or are they formed entirely from on-Service land run-off, i.e., is the watershed located within the Service lands boundary?

  NOTE: If a watershed is entirely on the Service lands, this can provide unique reference monitoring opportunities if there are no on-site contaminant sources within the watershed.

- Is the off-Service land water source a moderately sized watershed or lake (that is, can the entire area can be covered using a 1:250,000 scale map)?

  If the watershed is too large to include in its entirety (e.g., the Mississippi River) use the guidance provided below for delineating the AOI boundary.

  These Service lands are associated with a large river system, lake, or marine environment. In this situation, the "area of interest" is expansive and likely complex. A professional judgement is now required to delineate the surface water AOI. Given the situation of these Service lands, the following can be done:

  A. Develop reasonably sized AOI boundaries on a 1:500,000 scale map (AK Service lands could use even smaller scale maps). There could be several boundaries; each subsequent boundary extending further up the drainage. Prioritize these areas based on your knowledge of the potential contaminant sources, associated contaminants, and the probability of them affecting the Service lands. Also consider important habitats used

by trust resources and include those that would be associated with this Service lands monitoring activities (refer to Worksheets WS-2.4a&b).

B. If the Service lands is on a large lake or the ocean, the lake/ocean-side boundary could be left open to indicate the potential for numerous contaminant sources to affect the Service lands.

C. If the Service lands are located on a large river, "A" above will provide a good start to developing the area of interest. Identifying all contaminant sources within the AOI will be a significant task if the Service lands is in this situation, therefore prioritizing each defined area will be important. As contaminant sources and habitat information is collected, the high priority areas can be addressed first.

Using plastic, mylar, or Contact™ paper overlay material, draw an AOI boundary for surface water that encompasses the entire watershed upstream of the Service lands and to some extent, includes a small area downstream of the Service lands. The area downstream is included to identify monitoring sites that can be used to evaluate the surface water quality leaving the Service lands, therefore this area should include any habitats that would be included for this evaluation.

NOTE: Contact the local SCS or USGS office, if assistance is needed in locating the entire drainage.

This is the AOI for surface water transport of contaminants to and from these Service lands. This is the area to be examined for contaminant sources that might release contaminants that could reach the Service lands via surface waters (see Figure 3.2 for an example). This AOI also includes surface waters moving off the Service lands that will be considered for assessing water quality.

Considerations for Subsurface Water Transport Mechanism

Use the following considerations to develop the Subsurface Water AOI:

- Look at the small-scale (1:250,000) hydrologic (contour) map and locate the Service lands. Note the subsurface water flow gradients and depth, and determine if these waters are surfacing on or near the Service lands. Use 7.5' topographic maps to identify springs.

- Does the subsurface water provide any water for the Service lands?

- If subsurface waters do not exist on the Service lands, a decision must be made regarding whether to include monitoring of local off-Service land subsurface waters and surface waters (supplied by subsurface waters) used by the trust resources associated with these Service lands (refer to Worksheets WS-2.4a&b).

Identify the up-gradient subsurface water area that encompasses both the Service lands and off-Service land surface waters important to the trust resources associated with the Service lands (refer to Worksheets WS-2.4a&b and the surface water AOI). Using plastic, mylar, or Contact™ paper overlay material, draw an AOI boundary for the subsurface water that encompasses this area and to some extent, includes a small area downstream of the Service lands. The area downstream is included to identify monitoring sites that can be used to evaluate the subsurface water quality leaving the Service

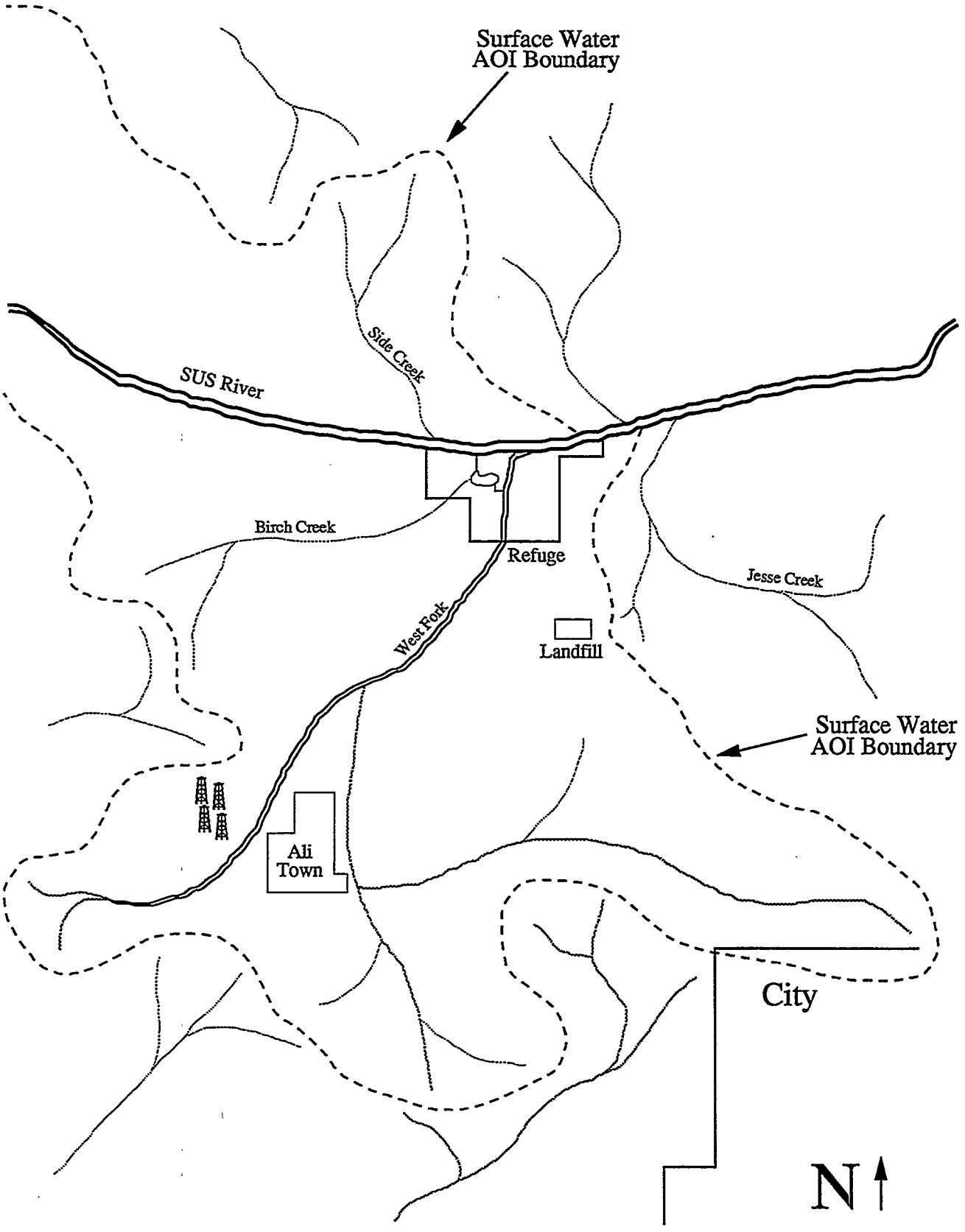


Figure 3.2. Area of interest for the surface water transport mechanism.

lands, therefore this area should include any habitats or wells that would be included for this evaluation.

NOTE: Contact the local USGS office, if assistance is needed in locating the entire drainage.

This is the AOI for subsurface water transport of contaminants to and from these Service lands. This is the area to be examined for contaminant sources that might release contaminants that could reach the Service lands via subsurface waters. This AOI also includes subsurface waters moving off the Service lands that will be considered for assessing subsurface water quality.

Considerations for the Air Transport Mechanism Read Sections 1, 2, and 5 of "Air Monitoring - A Reference Manual" (Appendix C) before proceeding.

Obtain small scale map (state map, section of the U.S. map). Place plastic, mylar, or Contact™ paper overlay material on the map and draw a 100 km radius circle centered on the Service lands. This is the AOI for the air transport mechanism. If a significant air emissions source is identified just beyond the AOI boundary it should be included within the AOI. See Figure 3.3 for an example of the air AOI.

For many Service lands, a series of boundaries should be drawn at some interval distance from the Service lands (e.g., 1 to 10 km for urban areas and 10 to 50 km for more rural areas). For urban areas, you can divide the first 10 km section into 1 km increments; a larger-scale map should be used for this task. This will allow some priority to be given to identifying the closer contaminant sources. Contaminant sources for the air AOI will be identified in the Section 3.2.

NOTE: The distances used above are somewhat arbitrary and are for guidance purposes only. They are reasonable values for determining the primary type of inputs to the system [i.e., local (< 50 km), regional (50 km to 160 km), and regional/global (> 160 km)]. Note that an area with local inputs will still need to consider regional/global atmospheric inputs to the system. These values can, and should be adjusted for the specific conditions at and surrounding the Service lands.

Biotic Transport Mechanisms

This transport mechanism is included to address concerns that contaminants and pathogens are brought to (or carried away from) the Service lands via migrating animals. This includes organisms that commute to off-Service land areas to feed and return to the Service lands with the contaminants consumed and/or attached externally to feathers, fur, skin, etc.

Migratory organisms can act as a conduit for pesticides used in other countries (e.g, DDT from South America) or those adjacent to the Service lands. Accumulation of other contaminants (e.g., metals, PCBs) and exposure to pathogens in high population density situations are equally a concern.

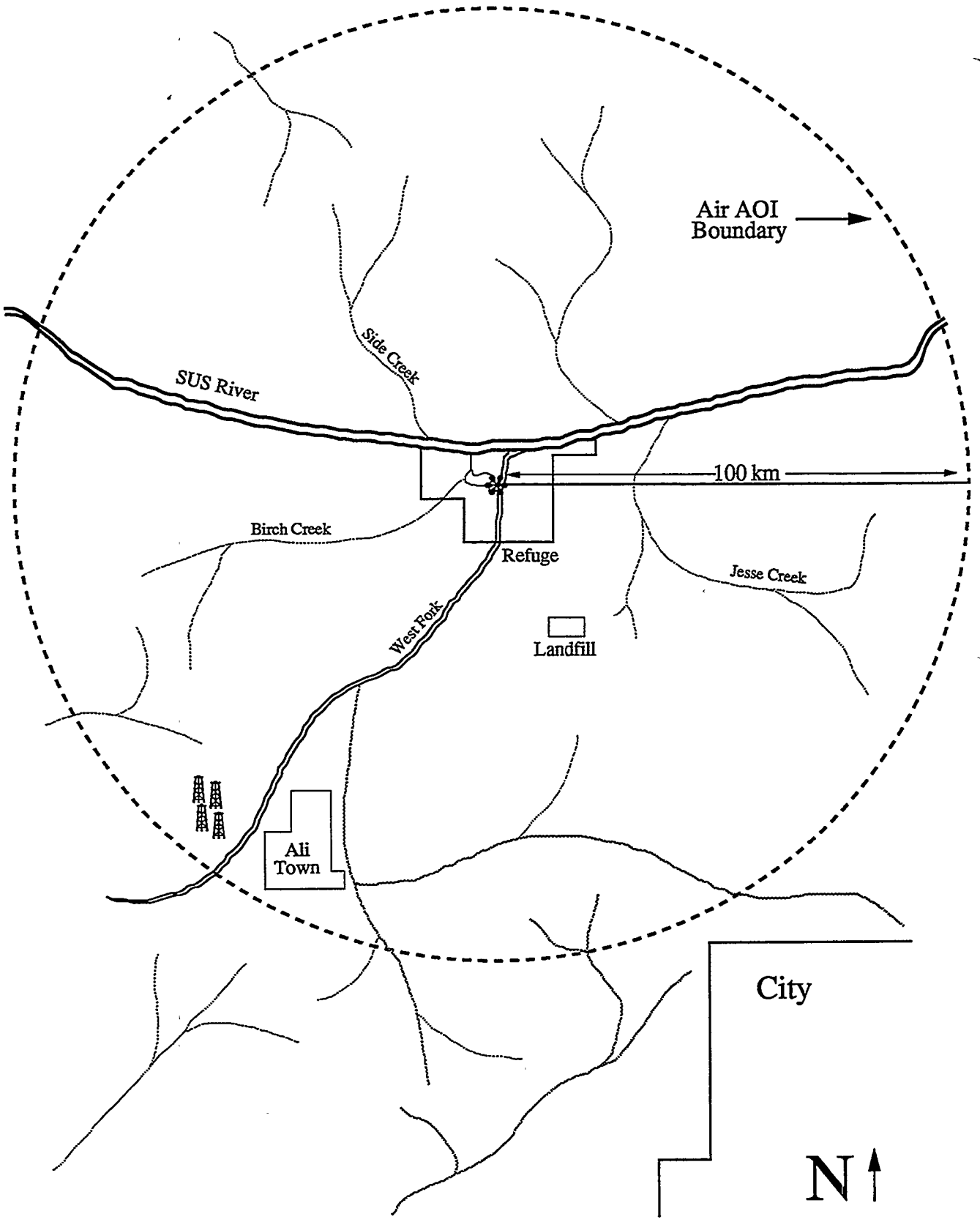


Figure 3.3. Area of interest for the air transport mechanism.

For delineation of the biotic transport mechanism AOI, the scope will generally be limited to local contaminant sources, however, if a regional contaminant source is known to affect trust resources associated with these Services lands, it can be identified on Worksheet WS-3.1.2d.

Using a map(s) of appropriate scale, place plastic, mylar, or Contact™ paper overlay material on the map(s) and draw an AOI boundary that includes the local areas where organisms can be exposed to contaminants or pathogens and transport them back to the Service lands. This is the AOI for the biotic transport mechanism. If time and information is available, smaller scale maps can be used to identify significant regional contaminant sources where migrating organisms are exposed to contaminants.

3. In Section 3.1.1 of the Workbook, mark each relevant transport mechanism identified in the previous procedures. If a transport mechanism is not applicable for the Service lands, provide a comment regarding why it is not.

4. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

3.1.2 Transport Pathways to the Service Lands

The purpose of this section is to identify the specific transport pathways (name, area, direction, or organism) for each transport mechanism identified in Section 3.1.1. A transport pathway is defined as a location or feature (e.g., a watercourse, corridor, portion of an aquifer, wind direction, or biota) that can be identified as the carrier for contaminants from a specific source to a receptor.

MATERIALS/INFORMATION NEEDS

AOI maps of the Service lands and surrounding areas used in Section 3.1.1 and species list

PROCEDURE

1. Use Worksheets WS-3.1.2a through WS-3.1.2d to document the specific names and locations of **ALL** the potential contaminant transport pathways for each relevant transport mechanism identified in Section 3.1.1 and identify where they enter the Service lands.

2. Describe or provide general comments regarding the pathway (e.g., river or watershed size [Sm, Med, Lrg], contaminant sources exist/don't exist [few or many sources], pathway provides baseline or reference monitoring opportunities, importance to the Service lands and trust resource, etc.).

3. In Worksheet WS-3.1.2c (air) identify known regional contaminant sources and potential contaminants. Also identify local contaminant source categories and potential contaminants for each wind direction. Do not spend a significant amount of time on this as specific contaminant sources and contaminants will be identified in Section 3.2.

4. In Worksheet WS-3.1.2d (biotic) indicate the habitats frequented by the organism (to identify potential monitoring locations) and describe where the exposure to contaminants most likely occurs. If regional/global exposure locations are known, identify these areas and associated contaminants.

5. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

EXAMPLES: Minidoka National Wildlife Refuge

WS-3.1.2a SURFACE WATER TRANSPORT PATHWAYS TO THE SERVICE LANDS			
	Watercourse Name	Location Where It Enters SL	Description/Comments
1	Raft River Basin	Raft River Bay on S. side of refuge	Watershed drains irrigated and non-irrigated cropland, pasture land, rangeland, and forest land
2	Upper Snake River Basin	Eastern edge of refuge at Cold Water Area	Cities >50,000 upriver drain into the refuge. Also ag land, feedlots, aquaculture, industry located on river before it enters the refuge.
3			
4			
5			
6			
7			
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10			

WS-3.1.2b SUBSURFACE WATER TRANSPORT PATHWAYS TO THE SERVICE LANDS		
	Subsurface Watershed Location and Area Where It Enters the Service Lands	Description/Comments
1	The Eastern Snake River Plain Aquifer flows from east to west and surrounds the entire refuge.	A state groundwater vulnerability study has designated most of the southern side of the refuge as "very high vulnerability" and the northern side as "high vulnerability". Any contaminants present in the groundwater have a high probability of entering Minidoka.
2		
3		
4		
5		
6		
7		

EXAMPLE: Minidoka National Wildlife Refuge

WS-3.1.2c	AIR TRANSPORT PATHWAYS TO THE SERVICE LANDS	
Wind Direction	**General Area Where Inputs Enter Service Lands**	**Description/Comments** (common contaminants from atmospheric inputs)
Global/Regional Inputs (sources > 160 km) - all wind directions	Throughout the SL; inputs would also be transported to the SL via SW runoff	Gases - CO_2, H_2S, CH_3SCH_3, COS, NH_3/N_2O, HNO_3/NO_3 Particulates - trace metals (e.g., Hg, Pb, Cu, Cr, Fe), sulfates, nitrates, benzene-soluble organics, radioactive fallout
Regional Inputs (sources > 50 km, but < 160 km distance) - most wind directions	Throughout the SL; inputs would also be transported to the SL via SW runoff	As above plus: Gases - SO_2 Chlorinated hydrocarbons (pesticides and others) Organophosphate pesticides
In the Space to the Right Identify Specific Regional Sources and Potential Contaminants for the Service Lands		1. Incinerator plant in Heyburn 2. Paving company in Burley 3. Sugar plant in Rupert 4. Phosphate plants in Pocatello 5. 6.
Local Inputs (sources < 50 km distance)	Likely throughout the SL, however, some areas might be more affected than others; SW runoff in some drainages might receive more input than others	As above plus: Gases - CO, NO/NO_2, Ozone Halogens Hydrocarbons (Table 7 - Air RFM) Particulates - specific local inputs (note what could be carried on dust/soil particles)
Wind Direction	**NA for Not Applicable**	**Identify Local Inputs from Each Wind Direction**
N	NA	
NE	Pocatello, Chubbuck (FMC, Simplot)	Fertilizers and chemicals released into air and fall into Portneuf and Snake River are transported to refuge.
E	American Falls (Lamb Weston)	Potato processing emissions may enter refuge either by air or by water.
SE	NA	
S	NA	
SW	Burley, Heyburn, Rupert	Gordon Paving, sugar plants, incinerator/ Winds predominately from the SW.
W	NA	
NW	NA	

EXAMPLE: Minidoka National Wildlife Refuge

WS-3.1.2d		BIOTIC TRANSPORT PATHWAYS TO THE SERVICE LANDS	
Species or Species Group Name		Habitats/Locations Used Extensively on SL	Description/Comments (likely locations of exposure, distance (L,R,G)*, and contaminant)
1	Migratory Waterfowl	Tule Island, Bird Island, Lake Walcott, Water Control Units 1 & 2	Birds migrating to other states (or countries) may transport contaminants (e.g., organochlorines) back to refuge (G).
2	Small Mammals	Areas surrounding Lake Walcott	Small mammals may accumulate pesticides from agricultural fields and transport them to higher trophic level organisms (L).
3			
4			
5			
6			
7			
8			

NOTE: **These descriptions are for guidance to provide an approximate location (distance) where exposure might occur**

* G = Global/Regional exposure; occurs further than 160 km from the Service lands border
R = Regional exposure; occurs between 50 km and 160 km from the Service lands border
L = Local exposure; occurs within 50 km of Service lands border

3.1.3 Transport Pathways Within and/or Moving off the Service Lands

The final AOI to be discussed is the Service land. Many Service lands have sources of contaminants that can affect the physical and biological conditions at the Service land. The purpose of this section is to identify the contaminant sources on the Service lands and transport pathways within and moving off the Service lands. This information will help ensure that appropriate monitoring is conducted to address these contaminant source pathways.

Monitoring data for transport pathways moving off the Service lands is necessary to determine if the Service lands are contributing to degradation of the environment. Data from "downgradient" monitoring can help determine a contaminant "budget" for some contaminants coming onto the Service lands and give an indication of the potential buildup of contaminants on the Service lands.

MATERIALS/INFORMATION NEEDS

Maps of the Service lands and surrounding areas used in Section 3.1.1
Information regarding on-site contaminant sources

PROCEDURE

Determine if there are contaminant sources on the Service lands and the associated transport mechanisms within the Service lands. Determine if these are transport pathways moving from the Service lands to off-site areas. Mark those that apply (in the Workbook) and comment if not applicable or if information is unavailable.

Transport Mechanism	Comment
___ Surface Water	_____
___ Subsurface Water	_____
___ Air	_____
___ Biota	_____

Use Worksheet WS-3.1.3 to document the specific contaminant transport pathway(s) (mechanism, area names, locations, directions, etc.) moving within and/or off the Service lands and describe the relevance of each to monitoring.

1. Identify the transport mechanism (Air, Surface water, Subsurface water, Biota).

2. Briefly describe the contaminant transport pathway, its location, direction, contaminant sources and potential contaminants, and the material being transported if this is important (e.g., soil, sediment, wind blown soils). Briefly discuss the pathway's relevance to developing the monitoring strategy for the Service lands.

3. Describe the transport pathways moving off the Service lands and potential monitoring sites.

4. Use a map and plastic overlay to identify potential on-Service land contaminant sources and transport pathways.

5. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

This completes this section. At this point in the process, all transport mechanisms and their associated AOI should be identified and marked on map overlays. In Section 3.2 the potential contaminant sources within each area of interest will be identified. This will require a significant amount of effort for many areas, but this is required if a comprehensive assessment of contaminant sources is to be completed.

WS-3.1.3	TRANSPORT PATHWAYS WITHIN AND/OR MOVING OFF THE SERVICE LANDS	Page __ of __
Transport Mechanism		Description and Relevance to Monitoring
1	Surface Water	There are several public access areas on the refuge (boat launch, picnics area). Gasoline, grease, and other contaminants from motor boats, automobiles, etc. can be transported off the refuge.
2	Air	The spraying of pesticides used for noxious weed control may be suspended during routine applications.
3		
4		
5		
6		
7		
8		
9		
10		

3.2 Identifying Contaminant Sources and Associated Contaminants

The purpose of this section is to identify ALL the contaminant sources within the AOI for each relevant transport mechanism. The contaminants associated with each source will also be identified. Once this list is complete, information will be available to identify specific transport pathways, the appropriate media to sample, the contaminants/variables to monitor, and the trust resources at risk. Recognize that several iterations may be necessary to complete this information in the detail required for a comprehensive data base from which informed decisions can be made.

This effort could prove to be extensive if the Service lands are located in an area with a large number of contaminant sources. This information is necessary, however, to properly assess the risks from potential contamination. In cases where there are a significant number of contaminant sources, subdividing and prioritizing the area of interest for one or several transport mechanisms may be helpful. This will require the judgement of those most familiar with the areas and contaminant sources.

Worksheets WS-2.2a and WS-3.2 are provided to document the data gathered in this procedure. Worksheet WS-2.2a is provided as a convenience to record useful information resources contacted in this procedure for future reference. Worksheet WS-3.2 is a summary data sheet that will be used for contaminant monitoring decisions. A computer database could be developed that would allow sorting by any of the data items or fields. This would be extremely useful when identifying all the contaminants in one pathway. WordPerfect 5.1 tables can be sorted. This might be useful until a data base is developed for the Manual.

BE SURE TO BACK-UP THE ORIGINAL WORKSHEET FILE PRIOR TO SORTING

MATERIALS/INFORMATION NEEDS

Worksheets WS-2.2a&b, WS-3.2
Land use maps, city maps, and the maps and overlays used to develop AOIs in Section 3.1
Ruler with appropriate units to determine UTM coordinates
Colored pens

Information contacts need to be identified. Use Worksheet WS-2.2a as a source for contacts and to document additional information sources. The following is a list of other contacts that can provide useful information:

Federal:

Service	BLM
USGS	USFS
EPA	DOD
NOAA	BOR
USDA	NPS
SCS	

State:

- State environmental regulatory agencies
- Department of Environmental Resources or equivalent
- Department of Agriculture.

County:
- County Commissioners
- Extension Office
- County Planners

City:
- City Planners
- Police and Fire Departments
- Business associations
- Water Works and/or Sewage Treatment Departments
- Municipal Airport (weather information).

Other:
- Universities/Colleges
- Nature Conservancy
- Audubon Society
- Sierra Club
- Other special interest groups
- Local TV/radio stations (weather information).

PROCEDURE

Identify the contaminant sources

1. In the Workbook, place an "X" next to each contaminant source relevant to the AOI for any of the transport mechanisms.

CONTAMINANT SOURCES:	CODE*		CODE*
__ Accident ("spill")	AC	__ Medical Waste	ME
__ Agricultural-aerial spray	AA	__ Mil. firing range/target	MF
__ Agricultural-Drainwater	AD	__ Military other	MO
__ Agricultural runoff-Crop	AC	__ Mining - abandoned	MA
__ Agricultural runoff-Livestock	AL	__ Mining - current	MC
__ Air Pollution-Industrial	IA	__ Nuclear Facilities	NF
__ Air Pollution-Other	AP	__ On site pest management	PM
__ Aquaculture	AQ	__ Petrol. explr/prod/refin	PP
__ Contam. buildings	CB	__ Recreation	RC
__ Contaminated Sediments/Soil	CS	__ Runoff urban/airport/hiwy	UR
__ Forestry/Silviculture	FS	__ Underground tanks	UT
__ Landfill/dump/drums-Indust.	ID	__ Wastewater/disch.-Indust.	IW
__ Landfill/dump/drums-Muni.	MD	__ Wastewater/disch.-Muni.	MW
__ Landfill/dump/drums-Military	ML	__ Other	OT
__ Landfill/dump/drums-Other	OD		

*See Table 1 at end of Workbook for Codes.

2. On Worksheet WS-3.2 document All contaminant sources, their addresses, and the contaminant source codes (from Table 1 in Workbook) for each contaminant source identified in the list above. Also identify key contacts that might be able to answer questions regarding the contaminant source, associated contaminants, or transport pathways. Locate these sources on the appropriate AOI map using a stick pin or mark.

   Select the map and AOI overlay developed for one of the transport mechanisms in the Section 3.1. Using land use and/or city planning maps, begin locating contaminant sources known to exist and mark the map overlay. If the AOI for this transport mechanism has been subdivided, prioritize these areas based on the areas you believe pose the greatest risk to the Service lands

(e.g., a stream with the greatest number or most toxic contaminant sources on it). Select the highest priority area and identify all the contaminant sources within that area. Document these sources and associated information on Worksheet WS-3.2.

Use Worksheets WS-2.2a&b to help recall references, locations, and contaminant sources found in the literature or observed during the reconnaissance.

A trip to the county or city planners office, with maps in hand, might be required to locate and identify other sources. These people could also review the resulting map and data worksheets if there is a good chance that some sources might be missed.

An excellent source of information on contaminant sources and associated contaminants is the Toxic Chemical Release Inventory produced by EPA. This data base can be obtained through the National Technical Information Service (NTIS) on CD-ROM for the entire United States, or on floppy disks for individual states. This data base allows queries by area (coordinates), cities, counties, etc., and includes information on contaminant sources, associated contaminants, how they are released, the estimated amounts released, contact phone numbers, to name a few fields of interest.

Use the check-off list above as guidance to the type of sources to consider. The following list provides additional examples of the sources to consider for each transport mechanism:

Surface Waters

Point Sources
- sources with effluent permits (NPDES)
- culverts for surface runoff/storm sewers
- irrigation return water

Non-Point Sources
- Surface runoffs
  - roads
  - airports
  - agricultural fields
  - storage areas
  - parking lots
  - mine tailings
  - timber plots
  - pesticide-treated buildings.

EXAMPLE: Minidoka National Wildlife Refuge

WS-3.2	CONTAMINANT SOURCE DOCUMENTATION WORKSHEET									Page __ of __
	Contaminant Source Name, Location and/or Address, Key Contact, and Phone #	UTM Coordinates (Centroid) X (Long)	Y (Lat)	Cont. Source*	Associated Contaminants and/or Affected Water Quality Parameters	Cont. Category*	Transport Mechanism(s) (A, SW, SSW, B)	Specific Pathway(s) to the Service Lands	Sensitive Key Species Group*	Comments Relevant to Monitoring
1	Mouth of Raft River. Richard Gerard/Cassia County Ag. Extension Office (208) 628-9461	320000	4720000	AD AC AL	Nutrients, pesticides, sedimentation (SS), turbidity, DO, pH, salinity	NU OP OC SP CB PS SD SA WQ	SW	Ag lands --> canals/tributaries --> Raft River --> Raft River Bay --> Lake Walcott	WF ES FW MI	Monitoring will need to place in early spring before it is diverted for irrigation.
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										

* Use codes from Table 1 at the end of the Workbook.

Subsurface Water

Sources (current/historic)
- industries with permitted injection wells
- municipal land fills
- hazardous waste dumps
- chemical storage areas
- underground storage tanks
- irrigation recharge
- septic tanks
- agricultural fields.

Air

Specific Sources
- industries with permitted emissions
- aerial spraying (pesticides, fertilizer).

Non-Specific Sources
- transportation exhaust
- fireplaces
- non-regulated emissions from industries
- cities
- global inputs
- resuspended particulates (from fields and roads)
- radioactive fallout.

Biota

Though this is a transport mechanism, the sources are covered within the other categories. One exception is the source for pathogens. If this is a concern on these Service lands, contact Region 8 personnel to provide guidance on identifying these potential sources. Locations where high density populations occur and areas where previous outbreaks of disease have occurred are good places to start.

3. Document the UTM coordinates for each contaminant source location on Worksheet WS-3.2 in the column next to the source name.

4. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

Identify the Contaminants Associated with Each Source

Identifying the contaminants potentially being released from the identified sources will provide information required to initiate contaminant biomonitoring and will help with an initial assessment of risks to the ecosystem.

NOTE: The information required by this step might be unavailable, or if obtained, inaccurate. Industrial processes, pesticides, and other chemical uses are changing continuously and some industrial process information is proprietary, therefore effluent information might not be available. It is still important to gather as much information as possible and to note unknowns.

Below is a list of references and contacts that can be consulted to identify source-specific contaminants. Also use those identified for the last task.

Contacts

EPA (current/historic permits for release/storage)
USDA/SCS/county extension office
State/county/city regulatory and planning agencies
Managers of the companies

References

Code of Federal Regulations for NPDES permits by industry (CFR #40)
RFMs from this manual
U.S. Fish and Wildlife Service - Contaminant Hazard Reviews ("Hazards" series)
Table 3.2a provides a list of contaminant types commonly associated with various sources. Table 3.2b is a list of references for source-specific contaminants. Table 3.2c is a list of industry groups and commonly associated contaminants.

PROCEDURE

1. Using Worksheet WS-3.2, list all the suspected specific contaminants and contaminant categories for each identified source. Include water quality parameters that might be affected by the contaminant sources.

   Prioritize acquisition of contaminant information based on:
   - Known/suspected contaminants and associated toxicity
   - Known/suspected volumes being released
   - Location of source relative to the Service lands and the pathway (i.e., the probability of the contaminants reaching Service land).

2. Identify all pertinent transport mechanisms for the contaminant source and record in the appropriate column on Worksheet WS-3.2.

3. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

3.3 Identify Specific Location(s) Where the Contaminant Transport Pathway Enters the Service Lands

The purpose of this section is to identify the specific location where a transport pathway from a specific contaminant source enters the Service lands. A transport pathway is defined as the location(s), physical feature(s) (e.g., a stream, corridor, wind patterns, or portion of an aquifer), and/or biota that can be identified as the carrier for contaminants from a specific contaminant source

Table 3.2a. Contaminants Associated with Various Contaminant Sources (Refer to Table 1 for Codes).

Contaminant Source	CONTAMINANT CATEGORY																									
	AB	AP	CB	CR	GP	HG	MC	MD	NU	OC	OD	OI	OP	OR	PC	PH	PS	PT	RM	SA	SD	SE	SG	SP	SV	TE	TH
AA		2	1		2				2	1			1				1							1		2	
AC*		2	2	2	2	2	2		2	2	2	2	2		2	2	2	1	2					2	2	2	
AD			1			2	2		1	1	2	2	1				1	2		1	1	1		1		2	
AP		1		2	1	2					2					2		2								1	
AR			1						1	1			1				1					1		1		2	
CB	1														2				2						2	2	
CS			2	2		2	2		2	2	2	2	2		2	2	2	2	2	2	1	2		2	2	1	
FS		2	2				2		2	2			2				2	2			1			2			
IA	2	1		2	1	2					1	2			2	2		2	2			2				1	
ID	2		2	2	2	2	2			2	1	2	2		1	1	2	2	2					2	1	1	
IW			2	2		2	2		1	2	1	2	2		2	1	2	1		2	2	2	2	2	2	1	1
MA		2		2		1					2								2		2					1	
MC	2	1		2		2			2		2	2				2		2	2	2	1	2			2	1	2
MD	2		2	2	1	2	2			2	1		2		1	1	2	1						2	1	1	
MF		2			2			1			1	1		1				2	2							1	
ML	2			2	1	2	2	1		2	2		2	2	1	1		2	2						1	1	
MO	2	2			2		2	2	2		2	2		2	1		1	1	2				2		2	2	
MW	2			2		2	1		1	2	1	2	2		1	1	2	1	2	1	2	2	1		2	1	2
NF**				2		2	2		2		2	2	2		2	2	2	2	1	2	2	2				1	2
OD	2		2	2		2	2			2	2	2	2		2	2	2	2						2	2	2	
P		1		2	1	2					2	2			2	1	2	1	2	2	1				2	1	2
RC		2			2		2		2									2			2		1			2	
UR			2	1		2	1		1	2	1		2		2	1	2	1		2	1		1		2	1	
UT***					2						1				2	2		1							2	1	

* Will depend on what was involved in the accident
** Includes uranium processing plants
*** Will depend on what was in tank

1 - There is a high probability that the contaminant is associated with this source type.
2 - Contaminant has been linked to this source type, but the association is inconsistent
Blank - no association (or atypical)

NOTE: This table is for general guidance. Contaminant-contaminant source associations will vary with the specific contaminant source characteristics

Table 3.2b. Contaminants by specific contaminant source (list of references)

"Development Document for Proposed Effluent Limitations Guidelines and New Source Performance Standards for ...

... the Iron and Steel Industry," EPA 440/1-82/024 (1982).

... the Nonferrous Metals Industry," EPA 440/1-83/019-b (1983).

... the Bauxite Refining Subcategory of the Aluminum Segment of the Nonferrous Metals Manufacturing Point Source Category," EPA 440/1-74/091-c (1974).

... the Copper, Nickel, Chromium, and Zinc Segments of the Electroplating Point Source Category," EPA 440/1-74/003-a (1974).

... the Petroleum Refining Industry," EPA 440/1-82/014 (1982).

... Inorganic Chemicals, Alkali and Chlorine Industry," EPA Contract No. 68-01-1513 (draft) (June 1973).

... the Organic Chemicals Industry," EPA 440/1-74/009-a (1974).

... the Fertilizer and Phosphate Manufacturing Industry," EPA 440/1-74/011-a and 74/006-a (1974).

... the Plastics and Synthetics Industry," EPA 440/1-83/009-b (1983).

... the Major Inorganic Products Segment of the Inorganic Chemicals Manufacturing Point Source Category, "EPA 440/1-74007-a (1974).

... the Phosphorus-Derived Chemicals Segment of the Phosphate Manufacturing Point Source Category," EPA 440/1-74/006-a (1974).

... the Synthetic Resins Segment of the Plastics and Synthetic Materials Manufacturing Point Source Category," EPA 440/1-74/010-a (1974).

... the Canned and Preserved Fish and Seafoods Processing Industry", EPA 440/1-80/020 (1980).

... the Canned and Preserved Fish and Seafoods Processing Industry," EPA 440/1-74/012-a (1974).

... the Dairy Products Processing," EPA 440/1-74/021-a (1974).

... the Citrus, Apple, and Potato Segment of the Canned and Preserved Fruits and Vegetables Processing Point Source Category," EPA 440/1-74/027-a (1974).

... the Unbleached Kraft and Semichemical Pulp Segment of the Pulp, Paper, and Paperboard Mills Point Source Category," EPA 440/1-74/025-a (1974).

Table 3.2b (continued)

... the Builders Paper and Roofing Felt Segment of the Builders Paper and Board Mills Point Source Category," EPA 440/1-80/025-b (1980).

... the Textile Mills," EPA 440/1-82/022 (1982).

... the Leather Tanning and Finishing Industry," EPA 440/1-82/016 (1982).

... Steam Electric Power Plants," EPA 440/1-82/029 (1982).

R. C. Loehr, "Animal Wastes–A National Problem," Proc. Am. Soc. Civil Engrs., J. San. Eng. Div. 95 (SA2) (1969): 189-221.

"Control of Agriculture-Related Pollution", A report to the President submitted by the Secretary of Agriculture and the Director of the Office of Science and Technology, Washington, DC (January 1969).

"Agricultural Waste Waters," Proceedings Symposium of Agricultural Waste Waters, Report No. 10, Water Resources Center, University of California, Davis, California (April 1966).

Source: Viessman, W. Jr. and Mark J. Hammer, Water Supply and Pollution Control, Harper & Row, New York (1985).

Table 3.2c. Significant Wastewater Parameters for Selected Industrial Classifications Group

Group I[a]	Group II[b]
A. Aluminum Industry[c]	
Suspended Solids	Total Dissolved solids
Free Chlorine	Phenol
Fluoride	Aluminum
Phosphorus	
Oil and Grease	
pH	
B. Automobile Industry[c]	
Suspended solids	COD
Oil and Grease	Chlorides
BOD_5	Nitrate
Chromium	Ammonia
Phosphorus	Sulfate
Cyanide	Tin
Copper	Lead
Nickel	Cadmium
Iron	Total Dissolved Solids
Zinc	
Phenols	
C. Beet Sugar Processing Industry	
BOD_5	Alkalinity
pH	Total Nitrogen
Suspended Solids	Temperature
Settleable Solids	Total Dissolved Solids
Total Coliforms	Color
Oil and Grease	Turbidity
Toxic Materials	Foam
D. Beverage Industry	
BOD_5	Nitrogen
pH	Phosphorus
Suspended Solids	Temperature
Settleable Solids	Total Dissolved Solids
Total Coliforms	Color
Oil and Grease	Turbidity
Toxic Materials	Foam
E. Canned and Preserved Fruits and Vegetables Industry[c]	
BOD_5	Color
COD	Fecal Coliforms
pH	Total Phosphorus
Suspended Solids	Temperature
	TOC
	Total Dissolved Solids

Table 3.2c. (continued)

Group I[a]	Group II[b]
F. Confined Livestock Feeding Industry	
BOD_5	Fecal Coliforms
COD	Nitrogen
Total Solids	Phosphate
pH	TOC
G. Dairy Industry[c]	
BOD_5	Chlorides
COD	Color
pH	Nitrogen
Suspended Solids	Phosphorus
	Temperature
	Total Organic Carbon
	Toxicity
	Turbidity
H. Fertilizer Industry[c]	
Nitrogen Fertilizer Industry	
Ammonia	Calcium
Chloride	COD
Total Chromium	Gas Purification Chemicals
Dissolved Solids	Total Iron
Nitrate	Oil and Grease
Sulfate	pH
Suspended Solids	Phosphate
Urea and Other Organic Nitrogen Compounds	Sodium
	Temperature
Zinc	
Phosphate Fertilizer Industry	
Calcium	Acidity
Dissolved Solids	Aluminum
Fluoride	Arsenic
pH	Iron
Phosphorus	Mercury
Suspended Solids	Nitrogen
Temperature	Sulfate
	Uranium
I. Flatglass, Cement, Lime, Gypsum and Asbestos Industries	
Flat Glass	
COD	BOD_5
pH	Chromates
Phosphorus	Zinc
Sulfate	Copper
Suspended Solids	Chromium
Temperature	Iron
	Tin

Table 3.2c (continued)

Group I[a]	Group II[b]
I. Flatglass, Cement, Lime, Gypsum and Asbestos Industries (cont.)	
	Silver
	Nitrates
	Organic and Inorganic Waterbreaking Chemicals
	Synthetic Resins
	Total Dissolved Solids
Cement, Concrete, Lime and Gypsum	
COD	Alkalinity
pH	Chromates
Suspended solids	Phosphates
Temperature	Zinc
	Sulfite
	Total Dissolved Solids
Asbestos	
BOD_5	Chromates
COD	Phosphates
pH	Zinc
Suspended Solids	Sulfite
	Total Dissolved solids
J. Grain Milling Industry[c]	
BOD_5	COD
Suspended Solids	pH
Temperature	TOC
	Total Dissolved Solids
K. Inorganic Chemicals, Alkalies and Chlorine Industry[c]	
Acidity/Alkalinity	BOD_5
Total Solids	COD
Total Suspended Solids	TOC
Total Dissolved Solids	Chlorinated Benzenoids and Polynuclear Aromatics
Chlorides	Phenol
Sulfates	Fluoride
	Silicates
	Total Phosphorus
	Cyanide
	Mercury
	Chromium
	Lead
	Titanium
	Iron
	Aluminum
	Boron
	Arsenic
	Temperature

Table 3.2c (continued)

Group I[a]	Group II[b]
L. Leather Tanning and Finishing Industry[c]	
BOD_5	Alkalinity
COD	Color
Total Chromium	Hardness
Grease	Nitrogen
pH	Sodium Chloride
Suspended Solids	Temperature
Total Solids	Toxicity
M. Meat Products Industry	
BOD_5	Ammonia
pH	Turbidity
Suspended Solids	Total Dissolved Solids
Settleable Solids	Phosphate
Oil and Grease	Color
Total Coliforms	
Toxic Materials	
N. Metal Finishing Industry	
COD	
Oil and Grease	
Heavy Metals	
Suspended Solids	
Cyanide	
O. Organic Chemicals Industry[c]	
BOD_5	TOC
COD	Organic Chloride
pH	Total Phosphorus
Total Suspended Solids	Heavy Metals
Total Dissolved Solids	Phenol
Free-Floating Oil	Cyanides
	Total Nitrogen
	Other Pollutants
P. Petroleum Refining Industry[c]	
Ammonia	Chloride
BOD_5	Color
Chromium	Copper
COD	Cyanide
Total Oil	Iron
pH	Lead
Phenol	Mercaptans
Sulfide	Nitrogen
Suspended Solids	Odor
Temperature	Total Phosphorus
Total Dissolved Solids	Sulfate
	TOC
	Toxicity
	Turbidity
	Volatile Suspended Solids Zinc

Table 3.2c. (continued)

Group I[a]	Group II[b]
Q. Plastic Materials and Synthetics Industry	
BOD_5	Total Dissolved Solids
COD	Sulfates
pH	Phosphorus
Total Suspended Solids	Nitrate
Oil and Grease	Organic Nitrogen
Phenols	Ammonia
	Cyanides
	Toxic Additives and Materials
	Chlorinated Benzenoids and Polynuclear Aromatics
	Zinc
	Mercaptans
R. Pulp and Paper Industry	
BOD_5	Nutrients (Nitrogen and Phosphorus)
COD	Total Dissolved Solids
TOC	
pH	
Total Suspended Solids	
Total and Fecal Coliforms	
Color	
Heavy Metals	
Toxic Materials	
Turbidity	
Ammonia	
Oil and Grease	
Phenols	
Sulfite	
S. Steam Generation and Steam Electric Power Generation	
BOD_5	Boron
Chlorine	Copper
Chromate	Iron
Oil	Nondegradable Organics
pH	Total Dissolved Solids
Phosphate	Zinc
Suspended Solids	
Temperature	
T. Steel Industry	
Oil and Grease	
pH	
Chloride	
Sulfate	
Ammonia	
Cyanide	
Phenol	
Suspended Solids	
Iron	
Tin	
Temperature	
Chromium	
Zinc	

Table 3.2c (continued)

Group I[a]	Group II[b]
U. Textile Mill Products Industry	
BOD_5	Heavy Metals
COD	Color
pH	Oil and Grease
Suspended Solids	Total Dissolved Solids
Chromium	Sulfides
Phenolics	Temperature
Sulfide	Toxic Materials
Alkalinity	

a. Group I consists of the most significant parameters for which effluent limits will most often be set.
b. Group II consists of some additional parameters for which effluent limits can be set on an individual basis.
c. Guidelines for these industries not currently available at time of publication.

Source: Cheremisinoff and Moressi, 1980.

to a receptor(s). Several of each of these components might be included in a single pathway.

In this section each contaminant transport pathway will be considered. Identifying the transport pathway to the Service lands provides information for identifying potential sampling locations, the medium to sample, and index period considerations. This information will also be used to develop and evaluate a conceptual model for the area (Section 3.5). Specific locations where released contaminants enter the Service lands will be identified and recorded on Worksheet WS-3.2. For the air pathway, the direction of the winds carrying the contaminants and most likely deposition areas (if any) will be recorded. For biotic pathways, the species or species group will be recorded.

MATERIALS

- Worksheets WS-3.1.2a-d, WS-3.2
- Maps used for each transport mechanism AOI

PROCEDURE

Surface Water Contaminant Pathway

This is a relatively straight-forward process for surface water transport pathways as there is generally a specific point where the contaminants are being released (e.g., Birch Creek) or drainage where runoff/non-point source contaminants will be entering the Service lands.

1. Locate point and non-point sources and follow the drainage to the Service lands. Refer to Worksheet WS-3.1.2a for the surface water pathways identified previously. If contaminant sources were identified along pathways described on Worksheet WS-3.1.2a as potential reference monitoring pathways, revise this worksheet.

   NOTE: Some releases around cities may not be so easy; underground pipelines could carry releases to another drainage and visa-versa. Check with city planners/engineers.

2. On Worksheet WS-3.2, in the "Specific Pathways" column, identify the specific location (by name, ID #, or coordinates) where the contaminants associated with this pathway would enter the Service lands.

3. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

Subsurface Water Contaminant Transport Pathway

Identifying the subsurface water pathway is more difficult. Subsurface water gradient data can be difficult to find and interpret, and its spatial and temporal resolution is low relative to the surface water pathway. Chemical and physical interactions between the contaminants and subsurface materials can alter the chemical properties and relative amounts of each contaminant in the ground water.

1. Use the subsurface water AOI map and identify the applicable contaminant sources. Use Worksheet WS-3.1.2b to review subsurface water pathways already identified. Use these locations for Step 2.

2. Look at the subsurface water gradient (contour) map and note the flow direction and where the pathway reaches the Service lands boundary or, if applicable, where subsurface water reaches the surface upstream or within the Service lands. USGS personnel can help with this effort.

3. On Worksheet WS-3.2, in the "Specific Pathways" column, identify the area (by name, ID #, or coordinates) where the contaminants associated with the pathway would enter the Service lands.

4. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

Air Contaminant Transport Pathway

The air pathway is also difficult to assess: wind patterns change diurnally, seasonally, or when individual storms blow through. This needs to be considered when documenting this pathway. Also, after deposition, contaminants can enter the Service lands with surface water runoff, or from being resuspended in the air. Surface water drainage needs to be considered because of the runoff pathway.

A wind rose (see Figure 3.4) for the Service lands (or local area) can be used to identify the prevailing wind directions for the area. Using this information and the discussions in Appendix C, locate the cities and other dominant air emission sources upwind from the Service lands.

1. Use Worksheet WS-3.1.2c to review contaminant sources and wind directions associated with transport of their associated contaminants. Use these locations to help with step 2.

2. On Worksheet WS-3.2, in the "Specific Pathways" column, identify the area (by name, ID #, or coordinates) where the contaminants associated with the pathway enter the Service lands.

3. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

Biotic Contaminant Transport Pathway

1. Use Worksheet WS-3.1.2d to review contaminant sources and species associated with transport of the identified contaminants. Use this location to help with step 2.

2. On Worksheet WS-3.2, in the "Specific Pathways" column, identify the species transporting the contaminants and the associated habitats they use that might be affected by contaminants brought to the Service lands. Identify the habitat location (by name, ID #, or coordinates)

3. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

Identify Key Species Groups

In the second to the last column on Worksheet WS-3.2 identify and record the key species groups that are most at risk from this contaminant source. Use the key species group codes and information in Worksheet WS-2.3 and evaluate the potential risk from this contaminant source and associated contaminants. Also consider species groups associated with off-Service lands areas (Worksheet WS-2.4b) if these areas are to be a part of the Service lands monitoring program.

Wind Rose

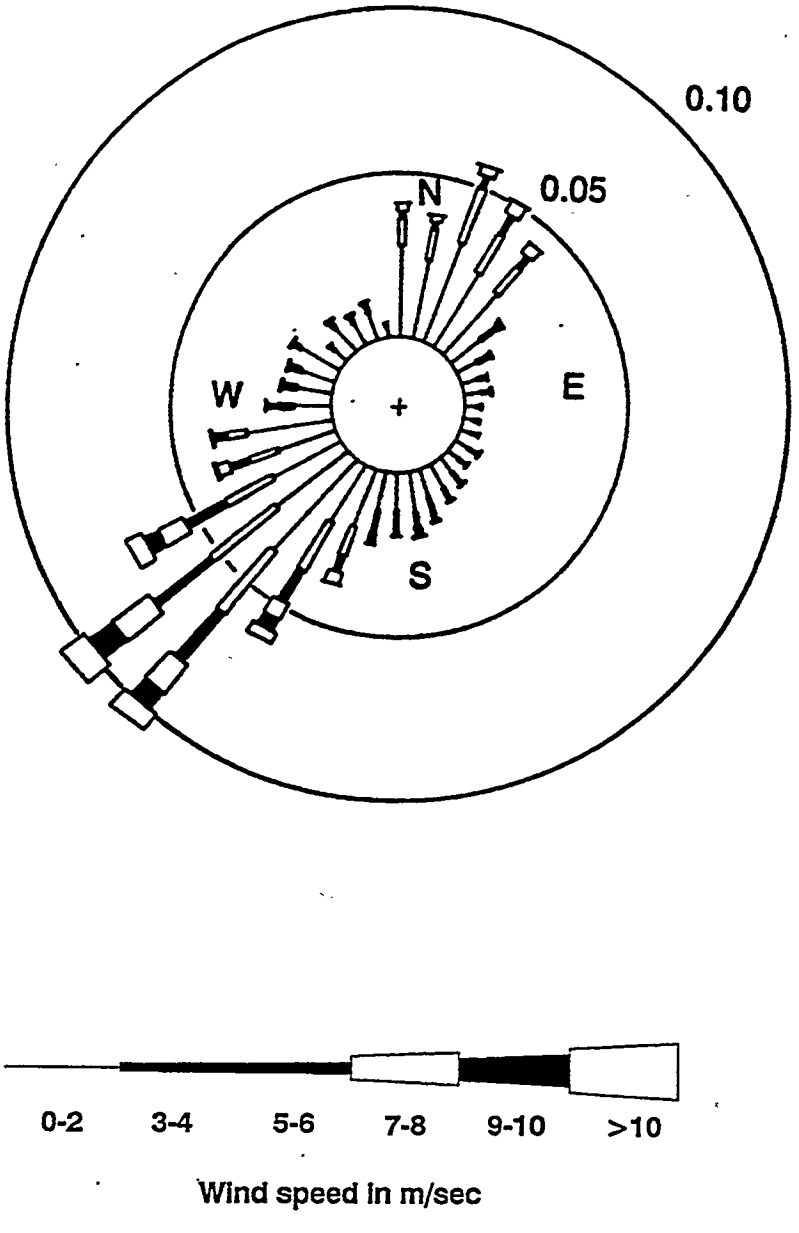

Figure 3.4. Example of a wind rose

Comments Relevant to Monitoring

In the last column, provide comments regarding the contaminant source, associated contaminants, and/or transport pathways that will support the contaminant biomonitoring strategy development. This information could include temporal conditions associated with the contaminant source or transport pathway, knowledge of previous problems associated with the source, or organisms particularly sensitive to the source ant its effects. Any information that can help develop a sound monitoring program should be included.

3.4 Identifying Key Species

The purpose of this section is to identify the key species/species groups for the Service lands. This information will be used to help develop a conceptual model for the Service lands ecosystem, to prioritize the contaminants, media, environmental variables, and locations to be monitored, and to help establish trigger levels for contaminants on the Service lands. Refer to Worksheet WS-2.3 for key species groups and/or species already identified. Worksheet WS-3.4 is provided to document the information gathered in this section.

Key species and habitats are defined in this manual as biota and environments crucial to the maintenance of the ecosystem. This definition includes the species identified as key species and the physical/biological conditions necessary for their survival. Also included are those species identified by the Service as being key species (e.g., threatened/endangered, migratory, game species, etc.). These species might not be crucial to the ecosystem, but are considered a trust resource and therefore of concern (see Table 1 in Workbook for group codes).

MATERIALS

Worksheets WS-2.2b, WS-2.3, WS-2.4a&b, WS-2.6, WS-3.4
Species list(s)
References for the ecosystem being studied
Diagram of the food web (if available)
Maps of habitat types and associated species for the Service lands
AOI maps

PROCEDURE

1. Obtain a species list for the area and other information regarding predator-prey relationships, species groups, etc. (e.g., benthic macroinvertebrates, ducks).

2. Refer to the management objectives (WS-2.1) and the assessment considerations (WS-2.3) to identify all of the key species for the Service lands. Consider the following:
   - Primary producers, key predators and prey, and reproduction, feeding, and resting habitats, etc.)
   - The species listed on Worksheet WS-2.3 that are considered key to the system.
   - Use the habitat/communities identified as present on the Service lands (WS-2.3) to ensure that key species from each habitat are included in the key species list.

3. In the second column, identify the important habitats for these species. The habitat/community codes used in WS-2.3 are to be used for this purpose. Update the information for habitats identified in WS-2.3 if more detail is needed describe them or if this process has identified new information. This information is to identify locations and communities that should be considered to monitor for contaminants or general condition.

4. Use the codes at the bottom of Worksheet WS-3.4 and record the ecological compartment for each key species. This information will support a conceptual model and help identify organisms from several compartments that can be considered for monitoring.

5. Record the Primary food source(s) for each key species. There may be several that change during the year, include all of them. This information is to help identify pathways and potential media to sample.

6. Consider the information recorded in the worksheet for the species. Document any insight or additional details for this species that is important for developing the monitoring strategy. Any insight available will be especially helpful to the next person reviewing the workbook. This information might also trigger additional thoughts later in this process when this worksheet is reviewed to help develop specific monitoring objectives and designs.

7. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

3.5 Developing a Conceptual Model of the Ecosystem

When a system is not well understood, it might not be apparent which variables will indicate meaningful changes in the system or how the variables are related. A conceptual model is useful to determine whether a particular variable can be linked, using cause-effect statements, to specific questions. When there are crucial gaps in understanding, modeling can be initiated to help determine what measurements should be made and where. In addition, the available information should be used to make informed decisions about what should be monitored now (NRC 1990).

A conceptual model can be developed that illustrates the associations between the contaminant sources and key species. This model can help identify key points within the ecosystem where monitoring will provide the most information for assessing contaminant status and trends, potential risk to the system, and general health of the system. The information gathered in previous sections will be used to develop the model. The model will be used to help design the Service lands' contaminant biomonitoring activities.

The purpose of a conceptual model is to provide a visual representation of the ecosystem information that has been gathered. This provides an integrated picture of the relevant components of the system; the contaminants, transport pathways, ecological compartments, receptors, and sinks. Figure 3.5 is example of a conceptual model. They are similar to a food web except that contaminant transport is being considered, rather than food and energy. The main difference is that contaminant transport includes transport pathways other than eating prey (e.g., water, inhalation, absorbance, adsorbance, attachment to skin, fur, and feathers). If a food web diagram exists for the Service lands, it will be useful in this effort and may require only minor alterations to complete this step.

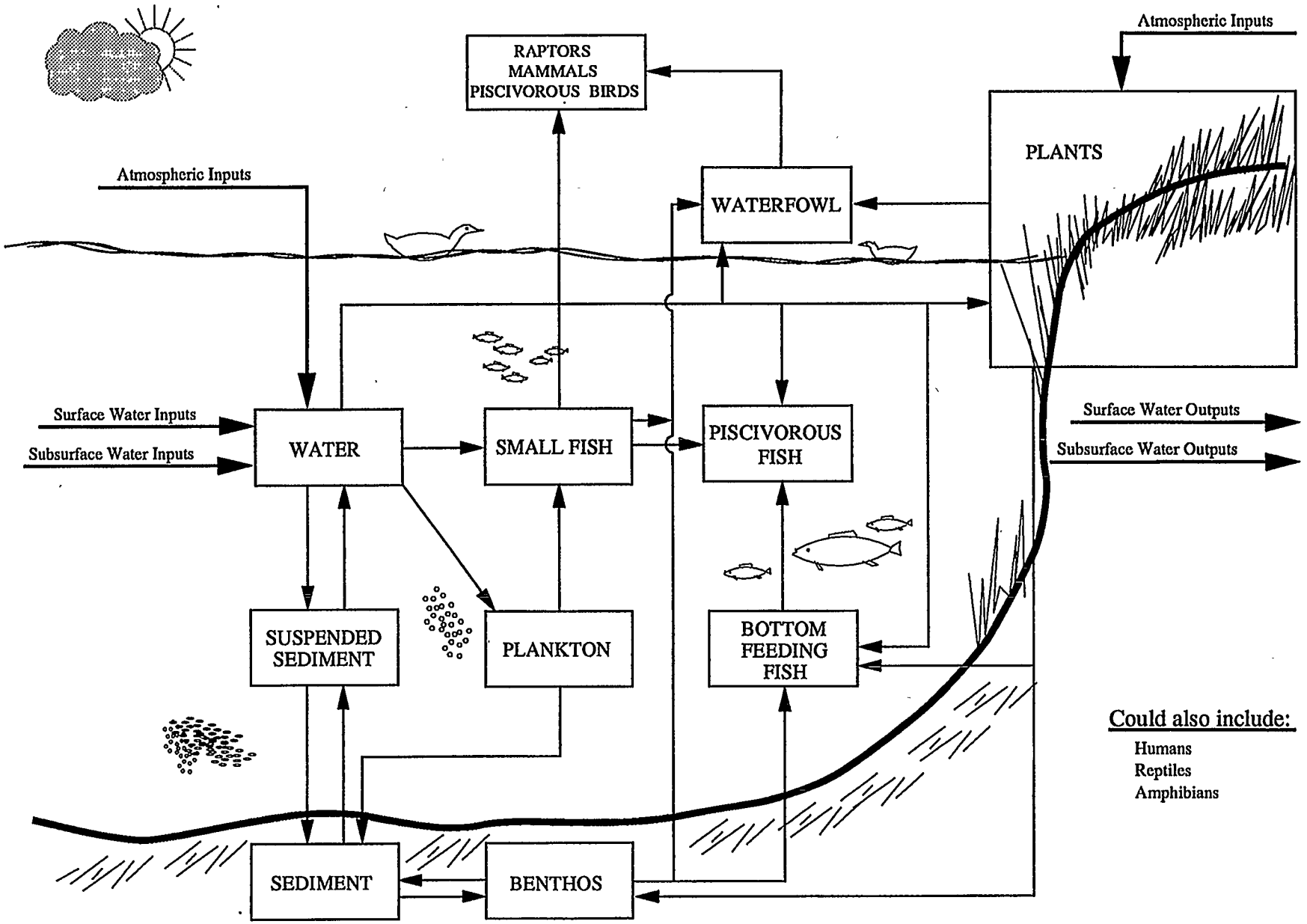

Figure 3.5. Conceptual diagram of contaminant transport pathways for a simplified aquatic system.

Many monitoring and ecological risk assessment studies and development processes recommend developing a conceptual model for use as a tool (Wiersma, 1984, 1985, Norton, 1992, Barnthouse, 1992). Developing such a model for the Service lands is a recommended activity as well. Another benefit of the conceptual model is its use for public outreach. These models quickly illustrate many contaminant transport issues and can be used to discuss specific organisms and habitats.

Given the potential complexity of the resulting model it might be helpful to develop several different models based on the specific contaminant, the transport mechanism, habitat, or the most sensitive species. Once a template for a conceptual model has been developed for the Service lands, this can be copied as necessary to save drawing time.

To minimize the time required for this task, it is acceptable to use Figure 5 as a temporary generic model rather than developing a new model specifically for the Service lands. This figure can be used to identify key species associated with different compartments found in the system. If a model is to be developed, the procedure below can be used for guidance.

MATERIALS

Worksheets WS-2.2b, WS-2.3, WS-2.4a&b, WS-3.2, WS-3.4
Species list(s)
References for the ecosystem being studied
Diagram of the food web (if available)
Paper (large 11" x 17" if available)
Maps of habitat types and associated species for the Service lands AOI maps
Worksheet WS-3.4

PROCEDURE

1. Obtain a species list for the Service lands and other information regarding predator-prey relationships, species groups, habitat use, etc. (e.g., benthic macroinvertebrates, ducks). Worksheet WS-3.4 will be helpful for this.

2. Draw a system boundary (a square/rectangle). Leave enough space to allow for identification of specific transport pathways to the Service lands.

3. Divide the system up into sections for terrestrial, aquatic, and groundwater habitats. Soil and sediment habitats could also be included.

4. Name and identify with arrows the specific surface water transport pathways entering the Service lands (WS-3.1.2a). The air and precipitation pathway exposes the entire Service lands surface via the air or can also be included as input through the surface water pathway. The subsurface water pathway may expose the subsurface water and possibly surface water habitats of the Service lands or areas upstream. Biota might be a potential transport mechanism for some contaminants via migratory species or resident species that feed at areas outside the Service lands (e.g., lead shot, pesticides).

5. Identify relevant compartments within each habitat (e.g., herbivores, carnivores, primary producers, etc.).

6. Draw arrows between the compartments to indicate potential contaminant exposure pathways. Pathways should include primary foodchains and direct exposure to contaminants from the air, water, soil or sediment.

7. On Worksheet WS-3.4, review the information recorded and revise the worksheet as necessary based on the model (e.g, additional key species or habitat information).

8 On Worksheet WS-3.4, record the "Primary Exposure Media" for each key species (e.g., water, soil, sediment, air, biota, unknown). For the biota pathway, indicate the specific pathway (e.g., the specific food items). This can vary with the seasons. This information is for pathway analysis and risk assessment purposes. It also helps to narrow the number of media to monitor when funding is inadequate to cover all the possibilities.

9. In the last column of Worksheet WS-3.4 record the most likely location(s) on the Service lands where each species would be exposed. This could be everywhere and could include areas outside the Service lands. However, if it is possible to narrow the areas down, priorities for sampling locations and media types can be established. Also document any additional information or insight the model might have stimulated.

10. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

EXAMPLE: Minidoka National Wildlife Refuge

WS-3.4 **KEY SPECIES IDENTIFICATION WORKSHEET** **Page ___ of ___**

	Key Species or Species Group Name	Habitat Code*	Ecol. Compartment **	Primary Food Source	Primary Exposure Media***	Comments Relevant to Monitoring: (sensitivity, pathway, temporal considerations, exposure location, etc.)
1	Utah Sucker	FW	O	Plankton, macroinvertebrates	SW SE AN PL	Abundant most of the year in Raft River Bay and Lake Walcott. Organochlorine and trace metal data available from American Falls Reservoir and Portneuf River. Accumulation from both planktonic and macroinvertebrate species. Raft River Bay accessible most of the year.
2	Pondweed (Sago and Horned)	AP	P	Dissolved nutrients	SW	Abundant in late spring through early fall. Useful for trace metal monitoring. Trace metal data available from American Falls Reservoir, Spring Creek, Bannock Creek, and Portneuf River.
3						
4						
5						
6						
7						
9						
10						
11						

* Use Habitat Codes from Worksheet WS-2.3.
** P - Primary producer 1 - 1st order consumer (herbivore) 2 - 2nd order consumer (carnivore) 3 - 3rd order consumer or greater O - omnivore
D - Detritivore/Decomposer
*** A = Air, SW = Surface Water, SSW = Subsurface Water, S = Soil, SE = Sediments, AN = Animal, PL = Plant

4. PRIORITIZE THE CONTAMINANTS RELATIVE TO RISK

The purpose of this section is to prioritize the contaminants relative to risk to the trust resources. In this section the contaminants that could affect the Service lands and associated resources will be evaluated relative to their risk to important receptors. This information will be used to help identify those contaminants and environmental variables to be monitored.

Contaminants must be prioritized to conserve monitoring resources. This effort will indicate contaminants to address first when resources are not available to monitor all contaminants.

4.1 Documentation of Toxicity Data

The purpose of this section is to document studies and toxicity data for the identified contaminants and to determine the sensitivity of different key species found on these Service lands. This information will support the prioritization process (Section 4.2).

Gaps in the toxicity data can help focus research on areas where additional information is needed. These information needs should be identified in the Workbook Summary. The toxicity data can also be used to help develop trigger levels for contaminants on the Service lands.

The information compiled for different Service lands can be used to create a large reference data base for future Service needs. Worksheet WS-4.1 is provided to document the toxicity information. If another reference database is established, it may be used.

Compiling the data that exists is a significant task, however, data bases and reference materials have completed some of this work. In many cases data is not available and surrogate species and similar chemical families will need to be evaluated for toxic effects to the species of concern.

There are numerous references available to determine the toxicity of a substance, however, these values are not available for all substances nor all species. If the information is not available, you can use analogue contaminants or organisms to make a judgement regarding toxicity to the organism in question. Though this is not the preferred method and it can provide erroneous results, at times it is the only way to obtain some value for toxicity.

If this method is used to determine toxicity of a substance for an organism, IT MUST BE DOCUMENTED. In this way, future evaluations of the monitoring strategy will consider this. Further, this information can be used to help direct research of contaminant toxicities for various organisms.

Below are references that might provide contaminant toxicity values for the key species. In addition to these references, the Service research centers can provide expertise in this area.

AQUIRE Toxicity Database
Scientific Outreach Program
U.S.. Environmental Research Laboratory-Duluth
6201 Congdon Boulevard
Duluth, MN 55804 Telephone: (218) 720-5500

STARA Toxicity Database
Environmental Protection Agency
Environmental Criteria and
Assessment Office
Cincinnati, OH 45268

Mayer, F. L., Jr. and M. R. Ellersieck, 1986. Manual of Acute Toxicity: Interpretation and Data Base for 410 Chemicals and 66 Species of Freshwater Animals, Fish and Wildlife Service, Resource Publication 160.

Hudson, R. H., R. K. Tucker, and M. A. Haegele, 1984. Handbook of Toxicity of Pesticides to Wildlife, Fish and Wildlife Service, Resource Publication 153.

Smith, G. J., 1987. Pesticide Use and Toxicology in Relation to Wildlife: Organophosphorus and Carbamate Compounds, Fish and Wildlife Service Resource Publication 170.

U. S. Department of the Interior, Fish and Wildlife Service, Contaminant Hazard Review Series. Report Nos. 1-20

Hill, E. F. and M. B. Camardese, 1986. Lethal Dietary Toxicities of Environmental Contaminants and Pesticides to Coturnix. Fish and Wildlife Technical Report 2.

Herbicide Handbook, 5th edition, Weed Society of America, Champaign, Illinois, 515 pp., 1983, Agricultural chemical toxicity to selected aquatic animals: bluegill, channel catfish, rainbow trout, crawfish, and freshwater shrimp.

MATERIALS/INFORMATION NEEDS

Worksheets WS-3.2, WS-3.4, WS-4.1, WS-4.2
References for toxicity data (see below)
Regulations regarding regulatory limits for contaminants

PROCEDURE

Worksheet WS-4.1 will be used unless a data base is already available or is going to be developed. If a toxicity data base is going to be developed for this Service land, include the same fields that are on Worksheet WS-4.1 at a minimum. Additional fields will be useful for future searches and to provide additional useful information. The ACQUIRE and other toxicity data base fields provide an example of additional fields that could be included.

WS-4.1	REFERENCES FOR TOXICITY VALUES						Page __ of __
Contaminant or Water Quality Parameter	Cadmium						
Regulatory Limits, if applicable	Freshwater	3.9 mg/L acute 1.1 mg/L chronic	Marine		Other		

Key Species (WS-3.4)	Species Used for Toxicity Testing	Acute Toxicity (mg/kg, ppm)		Threshold for Chronic/Sublethal Effects (mg/kg, ppm)	Type of Effect	Exposure Method (oral, dermal, aquatic, etc.)	References	#
		LD50	LC50					
Rainbow Trout	Rainbow Trout	0.001 ppm in water		<0.001 ppm in water	Behavior, growth, and physio-logical effects	Aquatic	EPA, 1986	1
Daphnia magna	Daphnia magna		>0.00015 ppm	0.00015 ppm		Aquatic	#1	

Use the following procedure if the worksheet format is going to be used for referencing the toxicity data.

1. List the all the key species identified in Worksheet WS-3.4 in the first column. Copy the worksheet file to "WS4-1tmp.***" (The extension should identify the Service lands) . This will be a template for all the contaminants and water quality parameters identified on Worksheet WS-3.2.

2. A separate worksheet for each contaminant or water quality parameter (e.g., DO, suspended sediments, BOD, etc.) identified in Worksheet WS-3.2 will be developed. Complete the information at the top of each worksheet.

3. Begin filling in these worksheets. Start with the contaminants and key species of most concern.

4. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

4.1.1 General Toxicity Information Relevant to Contaminant Prioritization

This manual is not meant to provide contaminant toxicity data per se, rather it uses this information as a component of the process to help determine priorities for monitoring. There is a large body of expertise within the Service and this should be utilized along with other resources when there are questions regarding contaminant toxicity. The following information is to provide background for the contaminant prioritization process.

Factors influencing the toxicity of chemicals are the organism's age, size, and physical condition, environmental conditions and stresses, length and mode of exposure, and the concentration and formulation of the chemical.

4.1.2 Acute-Toxicity Rating Scales (from FWS Research Information Bulletin, No. 84-78, August, 1984).

There are approximately 6.5 million known chemical substances and each year new ones are synthesized. Little or no toxicity information is available for the majority of chemicals. It is important to be able to use what information is available to compare the toxicity of one chemical to another and thereby determine which materials are the most harmful. A toxicity rating scale (Table 4.1a) is useful in making these comparisons. Such scales simplify large data collections by grouping substances in a defined range under one index. They also aid in rapid responses to emergency situations and provide a basis for resource management and conservation.

Mammalian toxicologists have used a rating scale since 1947 (included Table 4.2a) which bases relative toxicity on a statistically derived estimate of a single dose of chemical that would be lethal to 50% (LD50) of a very large population of test animals within a designated time. Acute toxicity to avian species is determined by the median lethal dose (LD50) or concentration (LC50) that would kill 50% of a population of the test birds. Therefore the larger the value of the LD or LC50, the less toxic the chemical is; the smaller the number, the more toxic it is.

Table 4.1a. Acute-Toxicity Rating Scales

	Aquatic	Avian	Mammalian
Relative Toxicity	EC or LC50 (mg/L)	LC50 (mg/kg food)	LD50 (mg/kg BW)
Super Toxic	<0.0	<1	<5
Extremely Toxic	0.01-0.1	<40	5-50
Highly Toxic	0.1-1	40-200	50-500
Moderately Toxic	1-10	200-1000	500-5000
Slightly Toxic	10-100	1000-5000	5000-15,000
Practically Nontoxic	100-1000	>5000	>15,000
Relatively Harmless	>1000	--	--

In the aquatic scale, adapted from others previously proposed, a 96-hour LC50 value is the concentration of chemical that would be lethal to 50% of a population of the test organisms (invertebrates, fishes, and amphibians) within 96 hours. Toxicity to some invertebrates (daphnids and midge larvae), expressed as 48-hour EC50, is the estimated concentration of chemical that would produce an effect (immobilization, loss of equilibrium, etc.) within 48 hours.

Table 4.1a is a combination of three different and independent scales. Within a scale, the lowest acute toxicity value listed amount (or between) species should be used, but scales cannot be interchanged. (If a compound is highly toxic to mammals, it does not necessarily follow that it is also highly toxic to aquatic or avian species.) For example, some acute toxicity values for dieldrin found in the literature are listed below in parts per million (Table 4.1b).

Other considerations when using the acute toxicity rating scales include:

1. Because these scales address only acute toxicity, they <u>do not</u> reflect latent or sublethal responses that may ultimately have greater environmental significance.

2. Because the scales are based on laboratory tests, they do not reflect chemical interactions (synergism, antagonism) that may occur in field situations. In many natural situations the actual amount of chemical that will kill an organism may be more or less than the LC50.

3. Life stages that have not been tested may be more susceptible than the stage of organisms tested.

4. In the aquatic scale, variables such as pH, hardness, temperature, and test conditions can significantly alter the toxicity value of many chemicals.

Table 4.1b. Toxicity Values for Dieldren (ppm)

Aquatic	Avian	Mammalian
.190 Daphnia	49 Jap. quail	60 rat
.0012 Rainbow trout	62 Jap. quail	81 rat
.019 Channel catfish	59 Pheasant	68 dog
Using the .0012 value dieldrin is super toxic to aquatic species	Using the 49 value, it is highly toxic to avian species.	Using the 60 value, it is highly toxic to mammals.

Tables 4.1c-4.1i use the aquatic rating scale to illustrate the relative acute toxicities of some of the chemicals that have been tested on trout, bluegill sunfish, and channel catfish.

The toxicity values given in Tables 4.1c through 4.1i are from tests performed at the Columbia National Fisheries Research Lab and from Weed Society 1983 and Mayer and Ellersieck 1986.

Table 4.1j lists some commonly used pesticides and their general application. A review of this list might provide an indication of some of the pesticides used in your area that could present contaminant problems. Table 4.1k is a summary of the EPA's Quality Criteria for Water and Table 4.1l is a summary of the EPA's Marine Water Quality Criteria.

Table 4.1c. Relative Acute Toxicities to Rainbow Trout*

Super Toxic <0.01 ppm	Extremely Toxic 0.01-0.1 ppm	Highly Toxic 0.1-1.0 ppm	Moderately Toxic 1-10 ppm	Slightly Toxic 10-100 ppm	Practically Nontoxic 100-1000 ppm	Relatively Harmless >1000 ppm
Antimycin A	Captafol	Aldicarb	Alachlor	Acephate	Chlorwax 500C	
Aldrin	Chlordane	Benomyl	Benthiocarb	Aminocarb	Fire-trol 100	
Azinphos methyl	Chlordane-HCS-3260	Carbofuran	Carbaryl	Diflubenzuron	Fire-trol 931	
DDT	Chlordecone	Chlorpyrifos-methyl	Chlorendate dimethyl	Merphos	Haxazinone	
Dieldrin	Chlorpyrifos	Demeton	D-D soil fumigant(EDB)	Mexacarbate	Phos-chek 25	
Endosulfan	D-trans allethrin	Ethofumesate	DEF	Pydraul 115E	Ureabor	
Fenvalerate	DDD	Fenthion	Dichlobenil	Silvex acid		
Heptachlor	Dilan	MBC	Dimethoate	2,4-D/2,4,5-T		
Permethrin	Dinocap	Naled	Diuron			
Toxaphene	Fluchloralin	Ovex	Emcol AD-410			
TCDD	Leptophos	PCB (Aroclor)	Fenithrothion			
	Lindane	Phosmet	Flamprop-methyl			
	Methoxychlor	Phoxim	Fluometuron			
	Phorate	Ronnel	Fluridone			
	Profenofos	Trichlorfon	Fyrquel GT			
	Pyrethrum		Glyphosate			
	Sodium pentachlorophenate		Houghto-safe 1120			
	Terbufos		Kronitex 200			
	Trifluralin		Methomyl			
			Methyl parathion			
			MON 0818			
			Neodol 25-9			
			Nitrapyrin			
			Oxamyl			
			Oxydemeton-methyl			
			Parathion			
			Phosflex 31P			
			Phthalate dibutyl			
			Ryania			
			Santicizer 154			
			Temephos			
			Tetradifon			
			2,4-D dodecyl/ tetrdodecyl amine salt			
			2,4-DB			

*Tests performed under standard conditions at CNFRL (American Society for Testing and Materials ASTM E729-80).

Table 4.1d. Herbicides: Relative acute toxicities to bluegill (*Lepomis macrochirus*).

Extremely Toxic <0.1 ppm		Highly Toxic 0.1-1:0 ppm		Moderately Toxic 1-10 ppm		Slightly Toxic 10-100 ppm	
Common Name	Trade Name	Common Name	Trade Name	Common Name	Trade Name	Common Name	Trade Name
ethalfluralin	Sonalan	2,4-D butoxyethanol ester		2,4-D	several	2,4-D/2,4,5-T (24%/28)	
fluchloralin	Basalin			dodecyl/ tetradodecyl amine salt		2,4-D/2,4,5-T (30%/28%)	
		2,4-D/2,4,5-T (18%/19%)		acetochlor	--	acifluorfen	Blazer,Tackle
profluralin	Tolban	acrolein	Magnacide H	alachlor	Lasso		
		bensulide	Prefar,Betasan	ametryn	Evic	atrazine	several
		bromoxynil	Buctril	azide potassium	bromacil	Hyvar, Krovar, others	
		butachlor	Machete	benzoyl propethyl		cacodylic acids	several
				bifenox	Modown	chloramben	Amiben
		diclofop methyl	Hoelon	butylate	Sutan	chlorpropham	Furloe
		endothall ether ester	several	CDAA	Randox	cyanizine	Bladex
				chlorflurenol	several	cyometrinil	Concep
				Copper ethylenediamine complex	Komeen(Komeen)		
		glycol butyl	--	--	Dead X	cyprazine	Outfox
		sodium azide	Smite	dichlobenil	Casoron	desmedipham	Betanex
		trefmid		diethatyl ethyl	Antor	diallate	Avadex
		triclopyr	Garlon	dinatramine	--	diphenamide	Enide
		trifluralin	Treflan, Trilin	diuron	Karmex, others	EPTC others	Eptam, Eradicane,
				endothall copper salt	--	fenac	Fenatrol, others
				--	Endotoall 282	fluometuron	2Cotoran, Meturon
				ethofumesate	Nortron	fluridone	Sonar, Brake
				flamprop-methyl	Mataven		
				glyphosate	Roundup, Rodeo, others	linuron	Lorox, Linex, several
						MCPA dimethyl amine salt	
				MCPB	several		

Table 4.1d. Herbicides: Relative acute toxicities to bluegill (continued).

Extremely Toxic <0.1 ppm		Highly Toxic 0.1-1.0 ppm		Moderately Toxic 1-10 ppm		Slightly Toxic 10-100 ppm	
Common Name	Trade Name	Common Name	Trade Name	Common Name	Trade Name	Common Name	Trade Name
				merphos	--	nitralin	Planavin
				methazole	Probe	norea	Herban
				naphthalic anhydride	Protect Advantage	paraquat	Gramoxone super
				propachlor	Ramrod	picloram	Tordon
				propanil	Stam, Stampede	prometon	Pramitol
				silvex	several	prometryn	Caparol, Cotton Pro
				terbutryn	Igran	propham	Chem-Hoe
				thiobencarb	Bolero	silvex butoxyethanol ester	--
				triallate	Fargo	simazine	Princep, Aquazine
				vernolate	Vernam, Reward	sodium arsenite	--

Table 4.1e. Fungicides: Relative acute toxicities to channel catfish (*Ictalurus punctatus*).

Extremely Toxic	Highly Toxic	Moderately Toxic	Slightly Toxic
<0.1 ppm	0.1-1.0 ppm	1-10 ppm	10-100 ppm
Benlate	Anilazine	Cycloheximide	Apron
Captafol	Diathianon	Dithane M-45	Bayleton
Captan	Folpet		Hexachlorobenzene
Correx	Thiram		Metalaxyl

Table 4.1f. Insecticides: Relative acute toxicities to bluegill (*Lepomis macrochirus*).

Extremely Toxic <0.1 ppm	Highly Toxic 0.1-1.0 ppm	Moderately Toxic 1-10 ppm	Slightly Toxic 10-100 ppm
Akton	Coumaphos	Aminocarb	Acephate
Aldicarb	Crotoxyphos	Carbaryl	Apholate
Aldrin	DDE	Crufomate	Bacillus thuringiensis
Allethrin racemic mix	Diazinon	Dichlofenthion	Chlodimedform
Amdro	Dichlorvos	Dimethoate	Cryolite
Azinphos-methyl	Disulfoton	Fenitrothion	Dicrotophos
Benzene Hexachloride	DNOC	Fenthion	Diflubenzuron
Bomyl	EPN	Methoprene	Landrin
Carbofuran	Ethion	Methyl parathion	Monocrotophos
Carbophenothion	Methiocarb	Mexacarbate	Oxydemeton-methyl
Chlordane	Methomyl	Nalde	Ryania
Chlordane Trans	Methyl trithion	Oxamyl	
Chlordane-HCS-3260	Parathion	Phosphamidon	
Chlorfenvinphos	Phosalone	Propoxur	
Chlorpyrifos	Phosmet	Ronnel	
Chlordane CIS	Phoxim	SD 16898	
Chlordecone	SD 7438	SD 17250	
Crotoxyphos	Tepp	Temephos	
D-Trans Allethrin	Tetrachlorvinphos	Trichlorfon	
DDT	Trichloronate		
Dieldrin			
Dilan			
Dimethrin			
Dioxation			
Endosulfan			
Endrin			
Ethylan			
Fensulfothion			
Fenvalerate			
Fonofos			
Heptachlor			
Leptophos			
Lindane			
Malathion			
Methiodathion	Extremely Toxic (cont.)		
Methoxychlor	<0.1 ppm		
Mevinphos	Pyrethrum		
Ortho 11775	Resmethrin		
Oxythioquinox	Rotenone		
Parathion dithioate	Ru-11679		
analogue	S. Bioallethrin		
Permethrin	Terbofos		
Phorate	Terpine Polychlorinates		
Profenofos	Toxaphene		

Table 4.1g. Insecticides: Relative acute toxicities to channel catfish (*Ictalurus punctatus*).

Extremely Toxic <0.1 ppm	Highly Toxic 0.1-1.0 ppm	Moderately Toxic 1-10 ppm	Slightly Toxic 10-100 ppm
Aldrin	Akton	Abate	Altosid
Ambush	Amdro	Aminocarb	Bidrin
Attac	BHC	Baygon	Carbaryl
Belt	Carbofuran	Baytex 46%	Chlordimeform
Chlordane	Chlorpyrifos	Bolstar 6 EC	Diflubenzuron
Chrysron	Co-Rol	Ciodrin	Dimecron
Curacron	Comite	Crotoxyphos	Dimilin
D-Trans allethrin	Dibrom	Cytion	Metasystox-R
Dieldrin	Dicofol	DEF	Phosphamidon
Endosulfan	Dipterex	Demeton	Ryania
Endrin	Dursban	Dichlofenthion	Vydate L
Fenvalerate	Dylos	Dicrotophos	Zectran
Flucythrinate	EPN	Disulfoton	
Heptachlor	Jodfenphos	Entex	
Lindane	Kepone	Ethion	
Marlate	Lanate	Ethyl parathion	
Permethrin	Neguvon	Fenitrothion	
Pyrethrins	Nudrin	Guthion	
Rotenone	Phorate	Imidan	
Resmethrin	Proxol	Korlan	
Toxaphene		Malathion	
		Mesural	
		Methyl parathion	
		Methyl trithion	
		Mexacarbate	
		Monocrotophos	
		Phosmet	
		Terbufos	
		Tiguvon	
		Trithion	
		Trolene	
		Viozene	

Table 4.1h. Fungicides: Relative acute toxicities to bluegill (*Lepomis macrochirus*).

Extremely Toxic ≤0.1 ppm	Highly Toxic 0.1-1.0 ppm	Moderately Toxic 1-10 ppm	Slightly Toxic 10-100 ppm
Captafol	Anilazine	Benomyl	Correx
Dinocap	Captan		Fenaminosulf
Folpet			Hexachlorobenzene
			Lime Sulfur

Table 4.1i. Fungicides: Relative acute toxicities to channel catfish (*Ictalurus punctatus*).

Extremely Toxic <0.1 ppm		Highly Toxic 0.1-1.0 ppm		Moderately Toxic 1-10 ppm		Slightly Toxic 10-100 ppm	
Common Name	Trade Name	Common Name	Trade Name	Common Name	Trade Name	Common Name	Trade Name
bromoxynil	Buctril	2,4-D (BEE)	Weedar 64, others	2,4-D DTA	--	2,4-D(DMA)	Several
		chloroxuron	Tenoran				
			DEF				
		endothall	Hydrothall 191 others	merphos	Folex	fluometuron	Cotoran, Meturon
		fluchloralin	Basalin	chlorbromuro	--		
		fluometuron	Cotoran, Meturon	flamprop-methyl	Mataven	cyanazine	Bladex
		fluorodifen	several	linuron	Lorox, Linex	dichlorprop	Weedone 170
		pendimethalin	Prowl	metolachlor	Dual	fluridone	Sonar, Braker
		propachlor	Ramrod	picloram	Tordon	glyphosate	Roundup, Rode
				propanil	Stam,Stampede	molinate	Ordram
				terbutryn	Igran	monuron TCA	Urox
				thiobencarb	Bolero	MSMA	several
			triallate	Fargo			
				trifluralin	Treflan, Trilin, others	paraquat	Gramoxone Super
						silvex	several
					sulfometuron methyl	Oust	

Table 4.1j. Common Pesticide Use and Potential Chemicals to Monitor.

Compound	Type of pesticide	Household uses leading to potential human exposure[a]
Chlorpyrifos (Dursban)	Insecticide	Control of mosquitos, cockroaches and other household insects; turf and ornamental insects; fire ants, termits, and lice
Pentachlorophenol	Fungicide, insecticide	Exterior wood preservative
Chlordane	Insecticide	Subterranean termit control
ortho-Phenylphenol	Disinfectant, fungicide	Household disinfectant
Propoxur (Baygon)	Insecticide	Control of cockroaches, flies, mosquitos; lawn and turf insects
Resmethrin	Insecticide	Control of flying and crawling insects; fabric protection; pet sprays and shampoos; application on horses and in horse stables; greenhouse use
Dicofol	Insecticide	Control of mites on fruit, vegetable, and ornamental crops
Captan	Fungicide	Seed protectant; fungal control on fruits, vegetables, and berries
Carbaryl (Sevin)	Insecticide	Control of insects on lawns, ornamentals, shade trees, vegetables, and pets
Lindane (r-BHC)	Insecticide	Seed treatment; insect control in soil, on vegetables, ornamentals, and fruit and nut trees
Dichlorvos (DDVP)	Insecticide	Household and public health insect control; flea collars and no-pest strips

Table 4.1j. Common Pesticide Use and Potential Chemicals to Monitor (continued).

Compound	Type of pesticide	Household uses leading to potential human exposure[a]
2,4-D esters	Herbicide	Postemergent weed control
Malathion	Insecticide	Insect control on fruits, vegetables, ornamentals and inside homes
Permethrin (cis and trans)	Insecticide	Control of flies, mosquitos, ants, cockroaches, garden insects
Heptachlor	Insecticide	Subterranean termit control
Aldrin	Insecticide	Subterranean termit control
Dieldrin	Insecticide	Subterranean termit control
Ronnel	Insecticide	Fly and cockroach control
Diazinon	Insecticide	Control of flies, mosquitos,
Diazinon	Nematicide	grubs and nematodes in turf; seed treatment and fly control
Methoxychlor	Insecticide	Control of insects in garden, fruit, and shade trees
Atrazine	Herbicide	Weed control

Source: Farm Chemicals Handbook, 1985

Table 4.1k. Quality Criteria for Water - from US EPA - EPA 440/5-86-001, May 1986

	CONCENTRATION IN µg/L						UNITS PER LITER				
	Priority Pollutant	Carcino-gen	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Water & Fish Ingestion	Fish Con-sumption	Drinking Water M.C.L.	Data/ Refer-ence	With Aqua-tic Life Std.
ACENAPTHENE	Y	N	*1,700.	*520	*970	*710				1980 FR	1
ACROLEIN	Y	N	*68.	*21.	*55		320.µg	780.µg		1980 FR	1
ACRYLONITRILE	Y	N	*7,550.				0.058µG**	0.65µG**		1980 FR	
ALDRIN	Y	Y	3.0		1.3		0.074ng**	0.079ng**		1980 FR	16
ALKALINITY	N	N		20,000.						1876 RB	
AMMONIA	N	N	Note #1	Note #1	Note #1	Note #1	Note #1	Note #1		1985 FR	24
ANTIMONY	Y	N	*9.000.	*1,600.			146.µg	45,000.µg		1980 FR	1
ARSENIC	Y	Y					2.2ng**	17.5ng**	0.05mg	1980 FR	21
ARSENIC (PENT)	Y	Y	*850.	*48.	*2,319.	*13.				1985 FR	21
ARSENIC (TRI)	Y	Y	360.	190.	69.	36.				1985 FR	21
ASBESTOS	Y	Y					30k f/L**			1980 FR	
BACTERIA	N	N	Note #2	Note #2	Note #2	Note #2	Note #2		<1/1100ml	1986 FR	56
BARIUM	N	N					1mg		1.0mg	1976 RB	8
BENZENE	Y	Y	*5,300.		*5,100	*700	0.66µg**	40.µg**		1980 FR	1
BENZIDINE	Y	Y	*2,500.				0.12ng**	0.53.ng**		1980 FR	6
BERYLLIUM	Y	Y	*130.	*5.3			6.8ng**	117.ng**		1980 FR	8
BHC	Y	N	*100.		*0.34					1980 FR	
CADMIUM	Y	N	3.9 +	1.1 +	43.	9.3	10.µg		0.010mg	1985 FR	21
CARBON TETRACHLORIDE	Y	Y	*35,200.		*50,000.		0.4µg**	6.94µg**		1980 FR	1
CHLORDANE	Y	Y	2.4	0.0043	0.09	0.004	0.46ng**	0.48ng**		1980 FR	12
CHLORINATED BENZENES	Y	Y	*250.	*50.	*160.	*129.	488.µg			1980 FR	1
CHLORINATED NAPHTHALENES	Y	N	*1,600.	11.	*7.5	7.5				1980 FR	1
CHLORINE	N	N	19.		13.					1985 FR	21
CHLOROALKYL ETHERS	Y	N	*238,000.							1980 FR	1
CHLOROETHYL ETHER (BIS-2)	Y	Y					0.03µg**	1.36µg**		1980 FR	
CHLOROFORM	Y	Y	*28,900.	*1,240.			0.19µg**	15.7µg**		1980 FR	1
CHLOROISOPROPYL ETHNER (BIS-2)	Y	N					34.7µg	4.36mg		1980 FR	

	CONCENTRATION IN µg/L						UNITS PER LITER			Data/ Reference	With Aquatic Life Std.
	Priority Pollutant	Carcinogen	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Water & Fish Ingestion	Fish Consumption	Drinking Water M.C.L.		
CHLOROMETHYL ETHER (BIS)	Y	N					0.00000376ng**	0.00184µg**		1980 FR	
CHLOROPHENOL 2	Y	N	*4,380.	*2,000.						1980 FR	1
CHLOROPHENOL 4	N	N			*29,700.					1980 FR	1
CHLOROPHENOXY HERBICIDES	N	N					10µg			1980 FR	
(2,4,5,-TP)	N	N					100µg			1976 RB	7
CHLOROPHENOXY HERBICIDES (2,4-D)	N	N	0.083	0.041	0.011	0.0056				1986 FR	
CHLORPYRIFOS											
CHLORO-4 METHYL-3 PHENOL	N	N	*30.							1980 FR	
CHROMIUM (HEX)	Y	N	16.	11.	1,100.	50.	50.µg		0.05mg	1985 FR	24
CHROMIUM (TRI)	N	N	1,700.+	210.+	*10,300.		170mg	3,433mg	0.05mg	1985 FR	24
COLOR	N	N	Note #3	Note #3	Note #3	Note #3				1976 RB	
COPPER	Y	N	18.+	12.+	2.9	2.9				1985 FR	20
CYANIDE	Y	N	22.	5.2	1.	1.	200.µg			1985 FR	23
DOT	Y	Y	1.1	0.001	0.13	0.001	0.024ng**	0.024ng**		1980 FR	16
DOT METABOLITE (DDE)	Y	Y	*1,050.		*14.					1980 FR	
DOT METABOLITE (TDE)	Y	Y	*0.06		*3.6					1980 FR	
DEMETON	Y	N		0.1		0.1				1976 RB	
DIBUTYPHTHALATE	Y	N					35.mg	154.mg		1980 FR	
DICHLOROBENZENES	Y	N	*1,120.	*763.	*1,970.		400µg	2.6mg		1980 FR	1
DICHLOROBENZIDINE	Y	Y					0.01µg**	0.020µg**		1980 FR	1
DICHLOROETHANE 1,2	Y	Y	*118,000.	*20,000.	*113,000.		0.94µg**	243.µg		1980 FR	1
DICHLOROETHYLENES	Y	Y	*11,600.		*224,000.		0.033µg**	1.85µg		1980 FR	1
DICHLOROPHENOL 2,4	N	N	*2,020.	*365.			3.09mg			1980 FR	1
DICHLOROPROPANE	Y	N	*23,000.	*5,700.	*10,300.	*3,040.				1980 FR	1
DICHLOROPROPENE	Y	N	*6,060.	*244.	*790.		87.µg	14.1mg		1980 FR	1
DIELDRIN	Y	Y	2.5	0.0019	0.71	.0019	0.071ng**	0.076ng**		1980 FR	16
DIETHYLPHTHALATE	Y	N					350mg	1.8g		1980 FR	
DIMETHYLPHENOL 2,4	Y	N	*2,120.							1980 FR	

	CONCENTRATION IN µg/L						UNITS PER LITER			Data/ Reference	With Aquatic Life Std.
	Priority Pollutant	Carcinogen	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Water & Fish Ingestion	Fish Consumption	Drinking Water M.C.L.		
DIMETHYPHTHALATE	Y	N					313.mg	2.9g		1980 FR	
DINITROTOLUENE2,4	N	Y					0.11µg**	9.1µg**		1980 FR	
DINITROTOLUENE	Y	N					70.µg	14.3mg		1980 FR	
DINTROTOLUENE	N	Y	*330.	*230.	*590.	*370				1980 FR	1
DINTRO-O-CRESOL 2,4	Y	N					13.4µg	765µg		1980 FR	
DIOXIN (2,3,7,8-TCDD)	Y	Y	*0.01	*0.00001			0.000013ng**	0.000014ng**		1984 FR	1
DIPHENYLHYDRAZINE	Y	N					42.ng**	0.56µg**		1980 FR	1
DIPHENYLHYDRAZINE 1,2	Y	N	*270.							1980 FR	
DI-2-ETHYLHEXYLPHTHALATE	Y	N					15.mg	50.mg		1980 FR	
ENDOSULFAN	Y	N	0.22	0.056	0.034	0.0087	74.µg	159.µg		1980 FR	10
ENDRIN	Y	N	0.18	0.0023	0.037	0.0023	1.µg		0.0002mg	1980 FR	18
ETHYBENZENE	Y	N	*32,000.		*430.		1.4mg	3.28mg		1980 FR	
FLUORANTHENE	Y	N	*3,980.		*40.	*16.	42.µg	54µg		1980 FR	1
GASSES, TOTAL DISSOLVED	N	N	Note #4	Note #4	Note #4	Note #4				1976 RB	
GUTHION	N	N		0.01		0.01				1976 RB	8
HALOETHERS	Y	N	*360	*122.						1980 FR	
HALOMETHANES	Y	Y	*11,000.		*12,000.	*6,400.	0.19µg**	15.7µg**		1980 FR	
HEPTACHLOR	Y	Y	0.52	0.0038	0.053	0.0036	0.28ng**	0.29ng**		1980 FR	12
HEXACHLOROETHANE	N	Y	*980.	*540.	*940.		1.9µg	8.74µg		1980 FR	1
HEXACHLOROBENZENE	Y	N					0.72ng**	0.74ng**		1980 FR	
HEXACHLOROBUTADIENE	Y	Y	*90.	*9.3	*32.		0.45µg**	50µg**		1980 FR	2
HEXACHLOROCYCLOHEXANE (LINDANE)	Y	Y	2.0	0.08	0.16				0.004mg	1980 FR	12
HEXACHLOROCYCLOHEXANE-ALPHA	Y	Y					9.2ng**	31.ng**		1980 FR	
HEXACHLOROCYCLOHEXANE-BETA	Y	Y					16.3ng**	54.7ng**		1980 FR	

	CONCENTRATION IN μg/L						UNITS PER LITER				
	Priority Pollutant	Carcino-gen	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Water & Fish Ingestion	Fish Con-sumption	Drinking Water M.C.L.	Data/ Refer-ence	With Aqua-tic Life Std.
HEXACHLOROCYCLOHEXANE-GAMA	Y	Y					18.6ng**	62.5ng**		1980 FR	
HEXACHLOROCYCLOHEXANE-TECHNICAL	Y	Y					12.3ng**	41.4ng**		1980 FR	
HEXACHLOROCYCLO-PENTADIENE	Y	N	*7.	*5.2	*7.		206.μg			1980 FR	3
IRON	N	N		1,000.			0.3mg			1876 RB	15
ISOPHORONE	Y	N	*117,000.		*12,900.		5.2mg	520.mg		1980 FR	
LEAD	Y	N	82.+	3.2+	140.	5.6	50.μg		0.05mg	1985 FR	20
MALATHION	N	N		0.1		0.1				1976 RB	7
MANGANESE	N	N					50.μg	100.μg		1976 RB	7
MERCURY	Y	N	2.4	0.012	2.1	0.025	144.ng	146ng	0.002mg	1985 FR	17
METHOXYCHLOR	N	N		0.03		0.03	100μg		0.1mg	1976 RB	12
MIREX	N	N		0.001		0.001				1976 RB	7
MONOCHLOROBENZENE	Y	N					488.μg			1980 FR	
NAPHTHALENE	Y	N	*2,300.	*620.	*2,350.					1980 FR	1
NICKEL	Y	N	1,400+	160.+	75	8.3	13.4μg	100.μg		1986 FR	10
NITRATES	N	N					10.mg		10.mg	1976 RB	5
NITROBENZENE	Y	N	*27,000.		*6,680.		19.8mg			1980 FR	1
NITROPHENOLS	Y	N	*230.	*150	*4,850.					1980 FR	1
NITROSAMINES	Y	Y	*5,850.		*3,300,000		0.8ng**	1,240.ng**		1980 FR	1
NITROSODIBUTYLAMINEN	Y	Y					6.4ng**	587.ng**		1980 FR	
NITROSODIETHYLAMINEN	Y	Y					0.8ng**	1,240.ng**		1980 FR	
NITROSODIMETHYLAMINEN	Y	Y					1.4ng**	16,000.ng**		1980 FR	
NITROSODIPHENYLAMINEN	Y	Y					4,900.ng**	16,100.ng**		1980 FR	
NITROSOPHYRROLINDINEN	Y	Y					16.ng**	91,900.ng**		1980 FR	
OIL AND GREASE	N	N	Note #5	Note #5	Note #5	Note #5				1976 RB	56
OXYGEN DISSOLVED	N	N	Note #6	Note #6	Note #6	Note #6	Note #6			1986 FR	56
PARATHION	N	N	0.065	0.013						1986 FR	8
PCB's	Y	Y	2.0	0.014	10.	0.03	0.079ng**	0.079ng**		1980 FR	16

	CONCENTRATION IN μg/L						UNITS PER LITER				
	Priority Pollutant	Carcino-gen	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Water & Fish Ingestion	Fish Con-sumption	Drinking Water M.C.L.	Data/ Refer-ence	With Aqua-tic Life Std.
PENTACHLORINATED ETHANES	N	N	*7,240.	*1,100.	*390.	*281				1980 FR	1
PENTACHLOROBENZENE	N	N					74μg	85.μg		1980 FR	
PENTACHLOROPHENOL	Y	N	***20.	***13.	13.	*7.9	1.01mg			1986 FR	2
pH	N	N		6.5-9		6.5-8.5				1976 RB	56
PHENOL	Y	N	*10,200.	*2,560.	*5,800.		3.5mg			1980 FR	23
PHOSPHORUS ELEMENTAL	N	N				0.1				1976 RB	
PHTHALATE ESTERS	Y	N	*940	*3.	*2,944.	*3.4				1980 FR	6
PLOYNUCLEAR AROMATIC HYDROCARBONS	Y	Y			*300.		2.8ng**	31.1ng**		1980 FR	1
SELENIUM	Y	N	260.	35.	410.	54.	10.μg		0.01mg	1980 FR	15
SILVER	Y	N	4.1+	0.12	2.3		50.μg		0.05mg	1980 FR	14
SOLIDS DISSOLVED AND SALINITY	N	N					250.mg			1976 RB	56
SOLIDS SUSPENDED AND TURBIDITY	N	N	Note #7	Note #7	Note #7	Note #7				1976 RB	44
SULFIDE-HYDROGEN SULFIDE	N	N		2.		2.				1976 RB	
TEMPERATURE	N	N	Note #8	Note #8	Note #8	Note #8				1976 RB	56
TETRACHLORINATED ETHANES	Y	N	*9,320.							1980 FR	
TETRACHLOROBENZENE 1,2,4,5	Y	N					38.μg	48.μg		1980 FR	
TETRACHLOROETHANE 1,1,2,2	Y	Y		*2,400.	*9,020.		0.17μg**	10.7μg**		1980 FR	1
TETRACHLOROETHANES	Y	N	*9,320.							1980 FR	1
TETRACHLORETHYLENE	Y	Y	*5,280.	*840.	*10,200.	*450.	0.8μg**	8.85μg**		1980 FR	
TETRACHLOROPHENOL 2,3,5,6	Y	N				*440.				1980 FR	1
THALLIUM	Y	N	*1,400.	*40.	*2,130.		13.μg	48.μg		1980 FR	1
TOLUENE	Y	N	*17,500.		*6,300.	*5,000.	14.3mg	424.mg		1980 FR	1
TOXAPHENE	Y	Y	0.73	0.0002	0.21	0.0002	0.71ng**	0.73ng**	0.005mg	1986 FR	17
TRICHLORINATED ETHANES	Y	Y	*18,000.							1980 FR	

	CONCENTRATION IN µg/L						UNITS PER LITER			Data/ Reference	With Aquatic Life Std.
	Priority Pollutant	Carcinogen	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria	Water & Fish Ingestion	Fish Consumption	Drinking Water M.C.L.		
TRICHLOROETHANE 1,1,1	Y	N			*31,200.		18.4mg	1.03g		1980 FR	1
TRICHLOROETHANE 1,1,2	Y	Y		*9,400.			0.6µg**	41.8µg**		1980 FR	1
TRICHLOROETHYLENE	Y	Y	*45,000	*21,900.	*2,000.		2.7µg**	80.7µg**		1980 FR	1
TRICHLOROPHENOL 2,4,5	N	N					2,600µg			1980 FR	
TRICHLOROPHENOL 2,4,6	Y	Y		*970			1.2µg**	3.6µg**		1980 FR	
TINYLCHLORIDE	Y	Y					2.µg**	525.µg**		1980 FR	
ZINC	Y	N	120.+	110.+	95.	86.				1987 FR	19

g = grams
mg = milligrams
µg = micrograms
ng = nanograms

M.C.L = Maximum Contaminant Level

Y = Yes+ = Hardness Dependent Criteria (100 mg/L used) FR = Federal Register
N = No* = Insufficient Data to Develop Criteria. RB = Quality Criteria
Value Presented is the L.O.E.L.--Lowest Observed Effect Level For Water, 1976
** = Human Health Criteria for Carcinogens Reported For Three (Redbook)
Risk Levels. Value Presented is the 10-6 Risk Level.

Note #1: Criteria are pH and temperature dependent
Note #2: For primary recreation and shellfish uses
Note #3: Narrative Statement in original document
Note #4: Narrative Statement in original document
Note #5: Narrative Statement in original document
Note #6: Warm water and cold water criteria matrix -- see original document
Note #7: Narrative Statement in original document
Note #8: Species dependent criteria -- see original document

Table 4.11. Marine Water Quality Criteria - from EPA, 1985.

	Marine Acute Criteria (µg/L)	Marine Chronic Criteria (µg/L)
Acenapthene	*970	*710
Arsenic (pent)	*2,319	*13
Arsenic (tri)	69	36
Benzene	*5100	*700
Cadmium	43	9.3
Chlordane	0.09	0.004
Chlorinated Benzenes	*160	*129
Chlorine	13.	7.5
Chlorpyrifos	0.011	0.0056
Chromium (hex)	1100	50
Copper	2.9	2.9
Cyanide	1	1
DDT	0.13	0.001
Demeton		0.1
Dichloropropane	10,300	3040
Dieldrin	0.71	0.0019
Dinitrotoluene	*590	*370
Endosulfan	0.034	0.0087
Endrin	0.037	0.0023
Fluoranthene	*40	*16
Guthion		0.01
Halomethan	*12,000	*6,400
Heptachlor	0.053	0.0036
Lead	140.	5.6
Malathion		0.1
Mercury	2.1	0.025
Methoxychlor		0.03
Mirex		0.001
Nickel	75	8.3
PCBs	10	0.03
Pentachlorinated Ethanes	*390	*281
Pentachlorophenol	13	7*7.9
pH		6.5-8.5
Phosphorus Elemental		0.1
Phthalate Esters	*2,944	*3.4
Selenium	410	54
Sulfide-Hydrogen Sulfide		2
Tetrachloroethylene	*10,200	*450
Tetrachlorophenol 2,3,5,6		*440
Toluene	*6,300	*5,000
Toxaphene	0.21	0.0002
Zinc	95	86

* Insufficient data to develop criteria.
Value presented is the L.O.E.L. - Lowest Observed Effect Level

4.2 Prioritize the Contaminants

The prioritization process is to help identify the contaminants that pose the greatest threat to the Service lands and key species. Prioritizing the contaminants threatening the system will also help select appropriate media and environmental variables to monitor, and the associated level of effort for monitoring. The risk information will also support specific monitoring objectives to be developed in Section 5. Worksheet WS-4.2 is provided to document results from this process.

There are four main issues associated with assessing risk and prioritizing the contaminants and water quality parameters:

1. Regulatory limits
2. Toxicity
3. Exposure
4. Uncertainties

Considerations regarding each of these components are provided below:

Regulatory Limits

Addressing contaminant or water quality parameters with regulatory limits commands a priority by their legal status alone; the Service must be in compliance. The fact that there are limits indicates that risks have been identified and that they are significant enough to regulate the contaminant. This doesn't address the question of whether the limits identified are appropriate for the environmental conditions found at any particular location. Information provided through monitoring can help support the revision of regulations if it is demonstrated to be necessary.

Most of the regulated contaminants and associated limits are associated with the risk to humans from consumption or other methods of exposure (inhalation, absorption). Protection of the public and Service personnel is of utmost importance. Risk to humans from known and suspected contaminants is an important consideration for the prioritization process. Other limits have been established to protect fish and wildlife.

Regulated contaminants and water quality parameters should be monitored if their concentrations or conditions are subject to exceeding their regulatory limits. Trigger levels for these contaminants will need to be established to identify the level where more intensive monitoring efforts should be initiated. Trigger levels should also be established for initiation of mitigation and remedial action activities.

Regulations also provide the Service with a legal means to address contamination problems through mitigation and remedial actions that can be funded by the responsible parties. This supports the rationale for monitoring contaminants (or indicators of their presence) that are suspect at a given area. It also supports the idea of gathering baseline data for areas with a potential for being contaminated from an accidental spill or from new land uses in the surrounding area.

Toxicity

The toxicity of contaminants and how they affect the system also need to be addressed in the prioritization process. Several considerations for prioritizing contaminants based on toxic effects are listed below:

Acute vs. Chronic/sublethal toxic effects for the trust resources
- LC_{50}/LD_{50} concentrations
- threshold levels for an observable effect

Type of effects exhibited by the trust resources
- carcinogenic
- teratogenic
- mutagenic
- synergistic
- behavioral
- reproductive
- growth
- enzymatic (ChE, ACAD, other - neurological path lesions)
- physical (feather, fur - [oil - thermal effects])

Exposure

The following considerations are related to the potential for exposure to the contaminant by humans or the trust resources:
- current status of the contaminant - present/not present and concentration
- areal extent/location/habitat
- persistence in the environment
- bioavailability
- bioaccumulation
- biomagnification

Uncertainty

Uncertainty analysis should be an integral component of any risk assessment and should also be considered for prioritizing the contaminants or water quality parameters to monitor. Uncertainty analysis considers the reliability of the information (e.g., toxicity, probability of exposure, concentrations) being used to support the risk assessment. Uncertainties are addressed only partially and qualitatively in this prioritization process. This is done by identifying whether the contaminant or environmental condition is known to exist, only suspected, or known to not exist. It addresses toxic effects in a similar manner based on the evidence that effects do exist, are suspected, or do not exist. To perform a comprehensive risk assessment the uncertainties need to be quantified in some manner. At present, this is beyond the scope of the Manual.

MATERIALS/NEEDS

Worksheets All worksheets completed thus far plus WS-4.2
Knowledge of applicable regulations, WS-2.5a&b

Maps of the Service lands and AOIs
References on toxicity data for the identified key species, WS-4.1
Expertise available to discuss transport and fate of contaminants

PROCEDURE

1. Using Worksheet WS-3.2 identify the specific contaminants moving on to the Service lands or with the potential to do so. List these down the first column of Worksheet WS-4.2 (insert rows in the worksheet file if necessary). Also list those water quality parameters that can be affected by the contaminant sources, contaminants, or are a priority concern at this area. Make a copy of this worksheet file **NOW** and give it an appropriate name, such as WS4-2tmp.*** (the extension should be letters for this Service land). This will be a template if additional worksheets are necessary to list all the key species.

2. List the key species (from Worksheet WS-3.4) across the top of Worksheet WS-4.2. If additional space is needed to address all the key species, make a copy of the template made in the first step and add the additional species. Make as many copies of the worksheet as necessary. Grouping similar species (family/class) on the same worksheet could be helpful. Clumping similar key species into one column is acceptable (e.g.,those with similar habitats and similar reactions to contaminants) However, if there is a need to address certain key species separately, (e.g., threatened and endangered) give them their own column on the worksheet. Eventually, all the key species will need to be addressed individually. Also identify key habitats or communities that are important to the system or key species. These habitats should also be considered because they could be affected by anthropogenic activities.

3. In the 2nd through 6th columns indicate a Yes or No to the following questions:

   If answers to these questions are unknown, type a U in the space until an answer is known.

   a. Are there regulatory limits for this contaminant or water quality parameter?
   b. Does the contaminant bioaccumulate?
   c. Is the contaminant biomagnified through the food chain?
   d. Are there known synergistic effects associated with the contaminant?
   e. Are there known teratogenic effects associated with the contaminant?
   f. Are there known carcinogenic effects associated with the contaminant?

4. In the boxes below each key species two factors will be considered:
   a. the toxicity of the contaminant to the species, and
   b. the probability that the organism will be exposed to the contaminant.

   These values will be recorded with the **Toxicity Value** first followed by a dash then the **Potential Exposure Value** will be recorded (e.g., H-2 = high toxicity value and a moderate probability of the species being exposed to the contaminant.)

Toxicity Value - This value will address all the considerations associated with the toxicity of the substance or water quality parameter for the identified key species. Record one of the following in the box:

H = high toxicity if **any** of the following is true:

- If toxicity data are available for this species (or a closely related species), or if regulatory criteria are available for this contaminant or water quality parameter, and the value falls into one of the following Acute-Toxicity Rating Scale categories from Table 5:

  Super Toxic, Extremely Toxic, or Highly Toxic

- The species is very sensitive to the contaminant or water quality parameter; toxic effects (chronic or acute) are observed at very low contaminant concentrations or if the water quality parameter deviates slightly from its natural range. The threshold is very low for the species.

- There is documented evidence of this contaminant killing this species at this Service land on in local off-Service land areas.

- There is documented evidence of this water quality parameter exceeding its natural range and killing this species on this Service land.

- Little is known about the effects of the contaminant or water quality condition for the key species, but biological effects are highly suspect at the levels present on the Service lands. The contaminant is known to be present at significantly elevated levels or the water quality conditions exist at the Service lands well beyond the natural range (e.g., 2 standard deviations).

M = moderate toxicity if **any** of the following is true:

- If toxicity data are available for this species (or a closely related species), or if regulatory criteria are available for this contaminant or water quality parameter, and the value falls into one of the following Acute-Toxicity Rating Scale categories from Table 4.2a:

  Moderately Toxic or Slightly Toxic

- The species is moderately sensitive to the contaminant or water quality parameter; toxic effects (chronic or acute) are observed at moderate contaminant concentrations or if the water quality parameter deviates moderately (e.g., 1 standard deviation) from its normal range. The threshold is moderate for the species.

- There is no documented evidence of this contaminant killing this species at this Service Land, however, there is evidence that this has occurred at other locations (on- or off-Service lands).

- There is no documented evidence of this water quality parameter exceeding its natural range and killing this species on this Service land, however, there is evidence that this has occurred at other locations (on- or off-Service lands).

- Little is known about the effects of the contaminant or water quality condition for this key species, but biological effects are suspected at the levels present on the Service lands. The contaminant is suspected to be present at elevated levels or the water quality conditions exist at the Service lands well beyond the natural range (e.g., 2 standard deviations).

L = low toxicity if **any** of the following is true:

- If toxicity data are available for this species (or a closely related species), or if regulatory criteria are available for this contaminant or water quality parameter, and the value falls into one of the following Acute-Toxicity Rating Scale categories from Table 4.2a:

  Practically Non-toxic or Relatively Harmless

- The species is not sensitive to the contaminant or water quality parameter; toxic effects (chronic or acute) are only observed at high contaminant concentrations or when the water quality parameter deviates well beyond (e.g., 2 standard deviations) its natural range. The threshold is very high for the species.

- There is no documented evidence of this contaminant killing this species at this Service land or another area.

- There is no documented evidence of this water quality condition existing killing this species at this Service land.

- Little is known about the effects of the contaminant or water quality condition for the key species, but biological effects are not suspected at the levels present on the Service lands. The contaminant is suspected to be present at elevated levels or the water quality conditions exist at the Service lands beyond the natural range (e.g., 1 standard deviation).

There are situations where it is possible to have statements that are true in each of these Toxicity Value categories. A conservative approach is to be taken here, that is, use the **highest** Toxicity Value where a true statement exists.

Potential Exposure Value

Using your knowledge of the AOI plus the aid of additional expertise as needed, make a professional judgement regarding:

- the probability of exposure to the contaminant by the species, or
- the probability of exposure to a situation where the water quality condition associated with the parameter in question would pose a risk to the species.

Considerations should include contaminant and source characteristics, transport pathways, receptor characteristics (e.g., habitat use, prey), and physical/hydrologic conditions where the species might be located. Select one of the following probabilities and put its value next to the toxicity ranking:

1 = High Probability if any of the following apply:

- The contaminant or abnormal water quality condition is known to be present on the Service lands where this species will contact it
- The contaminant source is close to the Service lands and a transport pathway provides easy transport of the contaminant to the Service lands where this species will contact it
- The contaminant is present and is persistent in the environment; it will not degrade, be neutralized, or sorbed before reaching the Service lands
- The contaminant is present and is known to be bioaccumulated and biomagnified within organisms that will be preyed upon by this species

2 = Moderate Probability if any of the following apply:

- The contaminant or abnormal water quality condition is suspected to be present on the Service lands where this species will contact it
- The contaminant source is at a moderate distance from the Service lands and a transport pathway exists for the contaminant to enter the Service lands where this species will contact it
- The contaminant might be present and is moderately persistent in the environment; it will partially degrade, be neutralized, or sorbed before reaching the Service lands
- The contaminant might be present and is known to be bioaccumulated and biomagnified within organisms that will be preyed upon by this species

3 = Low Probability if any of the following apply:

- The contaminant or abnormal water quality condition is not thought to exist on the Service lands where this species will contact it
- The contaminant source is not close to the Service lands
- There is no transport mechanism that provides easy transport of the contaminant to the Service lands
- The contaminant is not thought to be present and is not persistent in the environment; it most likely will degrade, be neutralized, or sorbed before reaching the Service lands
- The contaminant is not thought to be present and is not known to be bioaccumulated and biomagnified within organisms that will be preyed upon by this species

As with the toxicity value, there are situations where it is possible to have statements that are true in each of these Potential Exposure Value categories. A conservative approach is to be taken here, that is, use the **highest** Potential Exposure Value where a true statement exists.

NOTE: In addition to the probability of exposure to these contaminants while on the Service lands, exposure to them if the animals move off the Service lands should also be considered. As suggested in Section 2.4, if off-Service land areas are used

extensively by the trust resources, a separate monitoring strategy should be established for them.

5. Overall Risk - For each contaminant or water quality parameter, record the highest Toxicity Value for all the species and the highest Potential Exposure Value for all the species (e.g., H-1 is higher than M-2)

6. Contaminant Priority Level - To prioritize the contaminants and/or water quality parameters requires a professional judgement decision. The two primary components completed in the previous sections must be considered: 1) the Potential Exposure Value and 2) the Overall Risk. Use the levels and definitions provided below and fill in the this box.

   Complete this column using the definitions below for the priority levels:

H = High Priority	Contaminant/W. Q. parameter should be routinely monitored because of its high toxicity and high probability of exposure to key species/habitats or humans (i.e., it presents a high risk situation). Regulatory requirements require this to be monitored.
M = Medium Priority	Contaminant/W. Q. parameter should be surveyed for and/or baseline data should be obtained. Toxicity and probability of exposure indicate a moderate risk to key species/habitats or humans. Concerns regarding regulatory requirements support monitoring, but not required. Baseline data to support potential resource damage assessments would be worthwhile because of the probability of an accidental spill or other impact.
L = Low Priority	Contaminant/W. Q. parameter toxicity and probability of exposure is low for key species/habitats and humans, it presents a low risk situation. Baseline data would be useful to establish a benchmark for trend analysis. No regulatory requirements or there are no concerns regarding meeting the regulatory limits.

7. Will Monitor - based on all the information in the row (from column 2 on), decide if this contaminant will be monitored. Place a Y or N in the last column for each contaminant. The considerations in below should be addressed when determining which contaminants or water quality parameters to monitor.

   - Regulatory requirements (federal and state)
   - Risk to Service personnel and the public
   - Relative risk of contaminant to key species that use the Service Lands
   - Contaminant priority level
   - The number of key species affected by the contaminant
   - Value of the monitoring data for protecting the resource
   - Usefulness for baseline monitoring
   - Trigger Level values for contaminant concentration vs. known or potential concentrations
   - Extent of occurrence - temporal and spatial
   - Potential for exposure and availability of exposure media

- Contaminant characteristics
  - persistence
  - potential for biomagnification (octanol/H_2O partitioning coefficient)
  - potential for bioaccumulation
- Historical significance (e.g., existing monitoring data)
- Service Program directives
- Toxicity types and effects (direct/indirect)
  - acute
  - chronic/sublethal
  - reproductive
  - growth
  - tumors
  - enzymatic (ChE, ACAD, other - neurological path lesions)
  - physical (feather, fur - [oil - thermal effects])
  - mutagenic
  - carcinogenic
  - teratogenic
- Available sampling/analysis techniques
- Available resources

8. Overall Sensitivity of the Species, Group, Habitat (at the bottom of the worksheet) - record the highest toxicity value in the column for the species (H = the highest). This will provide an indication regarding the sensitivity of the species to the contaminant or water quality condition evaluated.

9. Primary Habitats Where Exposure Occurs (at the bottom of the worksheet) - Identify the important habitats for this species. If this is important for establishing monitoring locations, record the relevant codes from the" Habitat/Community Types" in Worksheet WS-2.3.

10. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

WS-4.2	CONTAMINANT PRIORITIZATION WORKSHEET																		Page __ of __		
Contaminant or Water Quality Parameter (WS-3.2)	Reg. Lim. Y/N	Bio-acc. Y/N	Bio-mag. Y/N	Syn. Eff. Y/N	Terat Eff. Y/N	Carc. Eff. Y/N	Key Species/Species Groups/Habitat (WS-3.3)												Overall Risk: Tox = (H,M,L) Expos = (1,2,3)	Cont. Prior. Level (H,M,L)	Will Monitor (Y/N)
							Rainbow Trout	Utah Sucker	Fresh water Shrimp	Mayfly nymphs	Sago pond-weed	Mallard									
Cadmium	Y	Y	Y	Y	Y	Y	H-1	M-1	H-1	H-1	M-1	M-2								H-1	H	Y
Mercury	Y	Y	Y	Y	Y	Y	H-1	M-1	H-1	H-1	M-1	H-2								H-1	H	Y
Lead	Y	Y	Y	Y	Y	Y	H-1	M-1	H-1	H-1	M-1	H-1								H-1	H	Y
Selenium	Y	Y	Y	Y	Y	N	H-2	M-2	H-2	H-2	M-2	M-2								H-2	H	Y
Arsenic	Y	Y	Y	Y	Y	Y	M-2	M-2	M-2	M-2	H-2	H-2								H-2	H	Y
Organochlorines	N	Y	Y	Y	Y	N	H-2	M-1	H-1	H-2	M-2	H-2								H-1	H	Y
Organophosphates	N	N	N	Y	N	N	M-2	M-2	M-2	M-2	L-2	H-2								H-2	H	Y
	Overall Sensitivity of Species, Group, or Habitat						H	M	H	H	H	H										
	Primary Habitat(s) Where Exposure Occurs						RS	RS	L	FM	L	FM										

5. ESTABLISH MONITORING OBJECTIVES FOR THE SERVICE LANDS

The purpose of this section is to establish and document specific monitoring objectives for the Service lands. Monitoring objectives provide a specific purpose for data collection, a format for data interpretation, and are specific enough to develop a statistically-relevant sampling plan. Monitoring objectives help identify specific variables to measure, locations to focus on, and the frequency to sample and the index period.

Now that the area of concern has been adequately characterized and the specific contaminant issues threatening the resource have been identified, it is possible to develop specific monitoring objectives. The purpose of developing monitoring objectives is to provide a manageable topic for a monitoring program. Along with existing data (which help determine natural variability) they also assist a statistician to formulate a workable null hypotheses and to determine how many samples are required to avoid falsely accepting or rejecting the null hypothesis.

Monitoring goals and objectives were discussed in Section 2.6. Review Section 2.6 if there is some question regarding the difference between the monitoring goals developed previously and the monitoring objectives to be developed in this section.

An example of an unworkable monitoring objective (but perhaps an appropriate monitoring goal) is "to determine the effect of recreational activities on water quality". A more workable objective would be "to determine the effect of overnight camping on the bacteriological quality of streams draining the XYZ Wilderness Area." (Example from EPA, 1991: "Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska," by Lee McDonald, Alan W. Smart and Robert C. Wissmar).

MATERIALS/NEEDS

Worksheets All worksheets completed thus far plus WS-5
Knowledge of applicable regulations WS-2.5a&b
Maps of the Service lands and AOIs
References on toxicity data for the identified key species WS-4.1

PROCEDURE

1. Prior to developing the specific monitoring objectives, reevaluate the monitoring goals established on Worksheet WS-2.6 and determine if they need to be revised in light of new information regarding the contaminant sources, contaminants, AOI, transport pathways, and key species.

2. Using the characteristics of the Service Lands, the contaminant and ecological integrity issues identified in the previous sections, establish monitoring objectives for the Service Lands. The following should be considered:

- management goals and objectives
- monitoring goals
- contaminant sources and contaminants
- contaminant transport pathways
- receptors (key species and habitats)
- assessed risk to the trust resource
- future potential impacts
- regulatory issues
- contaminant priority list (WS-4.2)
- reference data needs
- what is a meaningful change in the contaminant(s) or variable(s) for this area

Record the monitoring objectives in Worksheet WS-5. These objectives should support the monitoring goals (Section 2.6) for the Service Lands and should address the contaminant and water quality issues identified in the previous sections.

3. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

Example: Minidoka National Wildlife Refuge March 22, 1993

WS-5 MONITORING OBJECTIVES FOR THE SERVICE LANDS Page __ of __

	Monitoring Objective	Contaminant Issue/Location/Rationale
1	Determine concentrations of trace metals and organochlorines in sediments.	Metals and other contaminants attached to sediments from the Raft River may bring contaminants directly onto the refuge.
2	Collect water quality data (temp., pH, dissolved oxygen, conductivity, salinity, hardness, alkalinity, turbidity) at various location on the refuge.	It will be useful to establish current water quality conditions because 1) the toxicity of other contaminants often depends other water quality parameters, and 2) it will help to distinguish between natural fluctuations and actual trends.
3	Determine Kjeldahl nitrogen, nitrate + nitrite, total phosphate, orthophosphate, ammonia, and sulfate concentrations at Raft River, Lake Walcott, and Spillway below dam.	Increasing eutrophic conditions has become a major problem on the refuge. It will be necessary to document current conditions in order to detect future trends or establish the effectiveness of any future remediation activities
4	At important wetland (water units 1 &2) and terrestrial sites Bird Island, Tule Island) determine richness, diversity, % areal cover, dominance, soil types, and other parameters that quantify and qualify the characteristics.	It is necessary to establish current conditions in order to detect any gains or losses in habitat. This will provide data on which to base future management activities related to habitat preservation.
5		
6		
7		
8		

6. IDENTIFYING THE OPTIMUM LOCATION, ENVIRONMENTAL VARIABLES, MEDIA, AND INDEX PERIOD TO SAMPLE

The purpose of this section is to determine the optimum locations, environmental variables, media, and index periods for monitoring. This information will be used with the stated objectives (WS-5) to develop the statistical designs for monitoring activities.

A preliminary characterization of the Service lands and identification of high priority contaminants have now been completed and selection of the locations, environmental variables, media, and index period can take place. An iterative process is required to complete this task. To arrive at a final decision regarding where, what, and when to sample requires that all three be considered and evaluated interactively. One component is not necessarily more important than another. A good understanding of the characteristics of the contaminant, its source, the transport mechanisms, and the receptors involved is also necessary.

Optimum in this context describes the ability to provide the appropriate information and accomplish the monitoring objectives as effectively and efficiently as possible with minimal cost.

The stated objectives of the monitoring effort must be used to guide these decisions.

6.1 Identify the Locations for Monitoring

6.1.1 Identify the Potentially Contaminated Areas

A Potentially Contaminated Area (PCA) is defined as a place that has been identified to establish a sampling station(s) or a sampling grid to monitor contaminant concentrations or specific biotic/abiotic variables. Ideally this is a location where the investigator can observe the contaminant or its effects soon after it moves onto the Service lands or associated areas. There may be numerous PCAs for the Service lands depending on the contaminants, transport pathways, receptor characteristics, and monitoring objectives.

PCA locations are purposefully biased toward potential hot spots or indicator areas that will permit measurable contaminant levels or observable effects earlier than randomly selected locations on the Service lands. These areas will not provide an indication of the average conditions for the Service lands. Monitoring the status and trends of average conditions will be addressed more thoroughly with data from reference monitoring sites (next section) and other components of the BEST program.

The following are potential PCA locations:

- At major inlets/outlets to/from a body of water
- At "key" locations in eutrophic areas
- At locations upstream and downstream from "significant" waste discharges
- At representative sites within the body of water (or other media)
- At major use areas by key species (e.g., feeding, breeding or recreation areas)

- Sediments should be sampled at deposition or sink areas.
- At primary airborne particulate deposition zones

The following locations are suggested for running water:

- At locations where the water (or other media) is well mixed
- At the center of the water channel at 0.4-0.6 times the depth, from the bottom.

As stated previously, the first set of suggested locations would not give an accurate description of the entire Service lands; rather, the estimates would be biased. However, these suggested areas might help to determine maximum concentrations (hot spots) for the area. On the other hand, the second set of suggestions may be accurate, but they would provide little or no information on maximum concentrations (unless the contaminants are uniformly distributed throughout the media).

MATERIALS/NEEDS

Worksheets All worksheets completed thus far plus WS-6.1a & WS-6.1b
Maps of the Service lands and AOIs

PROCEDURE

1. Locate the transport pathway(s) from each source for the contaminant(s) identified on Worksheet WS-4.2 "To Monitor". Identify an optimum location(s) within each transport pathway to collect samples. These will be the Potentially Contaminated Area (PCA) monitoring locations for these contaminants. Once these sites are determined, use WS-6.1a to complete the steps below. This Worksheet will provide an index to all the monitoring locations.

   Considerations for selecting the PCAs include:

   - The purpose/objectives of the monitoring effort
   - Is it a likely location for the contaminant to be present in highest concentration
   - The appropriate media and environmental variables to monitor for the contaminants are present
   - Indicator species/variables are present
   - There is access to the area
   - Multiple contaminants and/or environmental variables can be monitored at this location
   - Key species are present
   - A low number of samples is adequate to characterize the area (i.e., low spatial variability)
   - The most uncomplicated, least costly sampling methods can be used.

2. Identify appropriate PCA monitoring sites located within the transport pathways recorded on Worksheet WS-3.1.2a-d that have contaminant sources associated with them. On Worksheet WS-6.1a record a "Monitoring Site Number".

3. Record its general location (e.g., Jesse's Cove, at the mouth of Birch Creek) and provide a general description of the area.

4. In the "Monitoring Issues and Rationale for Selection", describe the principal monitoring issues for this site (e.g., sensitive key species, importance of this area to the system, primary threats, etc.). Also, provide the rationale for selecting this site. Use the considerations above to help support the rationale.

5. Use the Monitoring Level definitions below and record the monitoring level that best corresponds to this location (more discussion on these monitoring levels is provided in Section 7.1.1).

Monitoring Level 4

- Pristine/uncontaminated location
  - No known or suspected contaminant sources
  - Only global or long-range contaminant sources
  - No known degradation of the resource.

Monitoring Level 3

- Potential contaminant sources exist
  - Suspected sources exist on and/or off-Service lands and transport pathways have been identified to this location, however, contaminants have a low probability of reaching this site and affecting the system.

Monitoring Level 2

- Suspected contaminants very likely (or known) to exist or to be moving to this location, but a specific problem has not been identified

- Regulatory requirements relevant to monitoring are not being adequately addressed at this location

Monitoring Level 1

- Contaminant problems have been identified at this location:
  - Contaminant is present and is a threat to the system and/or humans.
  - Significant effects to the system have been observed (dieoffs, morphological/physiological/behavioral effects, habitat degradation, etc.), however, the specific cause(s) might not be known
  - Trigger levels have been reached for a contaminant and/or a contamination event has occurred to initiate mitigative/remedial actions or additional studies.

- A contaminant problem has been identified at this location and mitigative and/or remediation measures have been implemented that are likely to resolve the problem. This situation still requires special studies and/or monitoring to verify that the mitigation/remediation activities are working.

6. Now complete a separate Worksheet WS-6.1b for each PCA site listed in Worksheet WS-6.1a.

NOTE: If there are contaminants or water quality parameters that will be monitored at nearly all monitoring locations, complete "e" below NOW for all the common variables that will be monitored. Copy this file to "WS61btmp.***" (*** extension should be specific to the Service lands). Use this template for all the applicable Monitoring sites. Once the variables are in the table it's much easier to erase those not needed, rather than reentering them several times. If you get into table mode (Alt-F7) in WordPerfect, entries can be moved or erased easily.

a. On Worksheet WS-6.1b record the Monitoring Site Number (from Worksheet WS-6.1a).

b. Record the Project Number for this monitoring activity, if there is one.

c. Identify the monitoring site's specific location (UTM coordinates preferred). These coordinates will be used for mapping the site and to help generate GIS coverages. The coordinates should be obtained from a permanent benchmark or correspond to a permanent land feature that can be used as a reference point for establishing sampling grids (if this will occur here).

The preferred method to obtain the coordinates for the site is by using a Global Positioning System (GPS) receiver (3D mode with differential correction). However, until this capability is available, use the coordinates from a USGS 7.5' topography map.

d. State the purpose and **specific** objectives for the monitoring activities here.

e. List the contaminants and water quality parameters from Worksheet WS-4.2 "To be Monitored" that are associated with this monitoring site. **Complete a separate WS-6.1b Worksheet for each monitoring site.**

7. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

6.1.2 Select Reference Monitoring Sites

The terms "reference" and "baseline" site are often used interchangeably in the literature. "Control" is occasionally used in the same context as the other two. The following definitions are used for this manual:

Baseline Monitoring Site - A true baseline (or background) site is one that has not been affected by human activities (Keith, 1988). Such sites may be difficult, if not impossible, to find because of transport processes that spread man-made contaminants throughout the biosphere and it is often necessary to settle on the least contaminated site. Biosphere observatories in the International Geosphere and Biosphere Program are examples of baseline monitoring sites (Bruns, Wiersma, and Rykiel, 1990).

Reference site - A site selected to compare with the PCA. A reference site is not necessarily pristine, but would have the "best attainable physical habitat, water chemistry, and biological parameters for specific environmental conditions" (Plafkin et al., 1989).

Control site - A control site is a site designated for no treatment in an experiment. For example, a study to determine the impacts of pesticides on fish populations in a pond would likely have some ponds with known pesticide additives and a control pond, which would have no pesticides added.

Many areas of uncontaminated Service lands may qualify as reference sites by these definitions, but not as baseline sites. Some areas of some refuges (e.g., the ANWR) may qualify as a baseline site (as well as a reference site) due to its pristine environment. Control sites may be available at most Service lands, depending on the specific treatment.

6.1.2.1 The Need for Control and Reference Sites and Reference Data

Control Sites

The purpose of a control site (or control population) is to determine whether or not a factor of interest is present in a population under study but not present in the control (Keith, 1988). It is not required that a control site be pristine or completely uncontaminated. The basic principal for choosing a control site is to select a site as similar to the study site as possible **except** for the presence of the contaminant(s) or environmental conditions (e.g., DO, nutrients) of concern. The control site samples are used to determine ambient concentrations. The results from the study site are compared to the results from the control site and allow judgement regarding whether the study site has a high, low, or insignificant concentration of a contaminant. Control sites or populations can be classified as local, area, or national as described below (ACS, 1988).

Local Control Sites

A local control site is a control near the sample of interest in time and space. Factors to be considered in the selection of local control sites include the following:

- Local control sites should be upwind of the facility (determined from a wind rose) and samples should only be taken when the wind is from the sampler toward the site.
- Local control sites should be upgradient from the facility with relation to surface and groundwater flow.
- The potable water source should not be affected by site effluents.
- Travel between control site and the facility should be minimal because of problems associated with transport by vehicles.

Area Control Site

This control site is in the same area (e.g., a city or county) as the pollutant source but not adjacent to it. The factors to be considered in site selection are similar to those for local control sites. All possible effort should be made to make the sites identical except for the presence of the pollutant at the site under investigation.

National Control Sites

In general, national control sites tend to be very broad, or less specific, than local or area controls but can identify anomalous results. Some of the factors to consider in selecting national controls are the following:

- Similar data should be available (national soil, water, and air monitoring programs as well as some bioassay data are available).
- Area should be similar (e.g., data from farming areas should not be compared with data from industrial areas).
- Monitoring data should be upwind and upgradient from any possible sources such as waste disposal areas and smokestack industries.
- If possible, control data from several such areas should be chosen.

Reference Sites

Reference site conditions are established through systematic monitoring of "least disturbed" sites that represent the natural range of variation for ambient water chemistry, habitat, and biological condition. Of these, ambient water quality may be the most difficult to characterize because of the complex array of chemical constituents (natural and otherwise) that affect it. Considerable effort may be required initially to identify reference sites. However, when the initial reference database includes a spectrum of "least disturbed" habitats and concomitant biotic conditions, the need for site-specific controls may be reduced.

Reference sites provide locations for detecting environmental changes. They not only serve as a reference point, but are used to determine natural variability of ecological systems. As Ford (1989) observes, "Failure to have reference data will cast doubt on the causal linkage between stress and effect, because observed 'effects' may fall within the range of natural variability of the ecosystem." Ford (1989) describes three basic types of information needed for effective ecosystem management:

1. Knowledge about the baseline condition of the ecosystem and its natural range of variation

2. Identification of the point at which we can say confidently that the system has begun to deviate from its normal condition

3. An understanding of the stress limits of the ecosystem. Given that a system has begun to change, we need to be able to describe the range of probable trajectories, and the point(s) (if any) at which change can be stopped or redirected.

   Reference data are needed any time a contaminant monitoring program is undertaken, and specifically when:

   - Contaminant effects are suspected
   - Contaminants are a present threat
   - Contaminants are a possible future threat

Selecting a Reference Site

The objectives of the monitoring effort should guide the selection of the reference site. If the objective is to study the amount of a pesticide entering a pond from nearby spraying activities, the reference site would be a pond that is similar to the impacted pond(s).

To measure the natural variability of ecosystem parameters, it is necessary to collect reference data over a range of sites and over a sufficient time period (through four seasons at a minimum). By selecting sites ecologically similar to each other and the PCAs, parameter variability due to habitat differences can be minimized.

Some general guidance on site selection follows:

- Select as natural a site as possible; avoid locally modified sites such as bridge areas. The aim is to select the site with the "best attainable physical habitat, water chemistry [or chemical parameters], and biological parameters for specific environmental conditions" (Plafkin et al., 1989). A reference site should be as free of contamination as possible.

- Select sites that are ecologically comparable to each other and to the Contaminant Assessment Area. Consider the soil, vegetation, species composition, temperature and moisture regimes, slope, aspect, stream factors (e.g., width, depth, velocity, relative numbers of pools and riffles, composition of substrate, temperature).

- Select sites with reasonable access relative to required frequency of data collection (that is, a site with difficult access may be acceptable if only infrequent sampling is required).

- Avoid sampling streams at their confluence with larger water bodies as these sites will exhibit habitat characteristics more typical of the larger body.

- Make sure desired parameters can be measured at the sites.

In some instances it may be necessary to locate reference sites off Service lands. For example, if there is only one stream or river feeding the area and it is known to be contaminated upstream of the area, it will be necessary to gather reference data upstream of the pollution source, or from a nearby, unpolluted watershed in the same ecoregion. A third alternative would be to examine historical records or archived samples.

To Summarize

Baseline Monitoring Site - An unimpacted site; pristine; a site unaltered by human activities (to the extent possible).

- Representative of the most pristine areas on earth
- Examples are Biosphere Observatories and ANWR

Reference Site - A site selected for comparison with a contaminant assessment area

- Not necessarily "pristine"
- Best attainable physical habitat, chemical and biological status
- Ecologically comparable to the PCA

Control Site - A site receiving no treatments or additives.

Why Reference Sites and Reference Data are Needed

- To establish points of reference for comparing measured environmental variables, i.e., to gain knowledge about the baseline condition of the ecosystem
- To gain knowledge of the natural variability of ecosystem parameters
- To be able to detect deviation from normal

When Reference Sites and Reference Data are Needed

- When contaminant effects are present
- When contaminants are suspected and present a threat
- When contaminants are a potential future threat
  (i.e., whenever a contaminant biomonitoring program is initiated)
- When information regarding natural variability is needed

Selecting a Reference Site

- Consider monitoring objectives
- Select "natural" sites
- Select sites ecologically similar to each other and similar to the PCA
- Select sites with reasonable access relative to required frequency of data collection
- Make sure desired variables (i.e., the same variables as measured at the PCA) can be measured at the reference sites

Considerations in Selecting Reference Sites

- vegetation and soils
- species composition
- stream factors (width, depth, velocity, number of pools and riffles)
- composition of substrate
- temperature and moisture regime
- slope and aspect
- similar spatial and temporal conditions

MATERIALS/NEEDS

Worksheets All worksheets completed thus far plus WS-6.1a & WS-6.1b
Maps of the Service lands and AOIs

PROCEDURE

Considerations for the reference site selection include:

- The purpose/objectives of the monitoring effort
- It provides a good site for comparison to PCAs
- The appropriate media and environmental variables to monitor for the contaminants are present
- Indicator species/variables are present
- There is access to the area
- A number of indicator variables can be monitored at this location
- Key species are present
- A low number of samples is adequate to characterize the area (i.e., low spatial variability)
- The most uncomplicated, least costly sampling methods can be used.

1. Identify sites for reference monitoring that are located within the potential transport pathways recorded on Worksheet WS-3.1.2a-d that don't have contaminant sources associated with them. It might be necessary to go outside the AOI to locate good reference monitoring sites for some variables. On Worksheet WS-6.1a record a "Monitoring Site Number".

2. Record its location (e.g., Birch Creek where it crosses Ali lane) and provide a general description of the area.

3. In the "Monitoring Issues and Rationale for Selection", describe the principal monitoring issues this site is providing a reference for (e.g., sensitive key species, water quality parameters, natural variability for specific variables, etc). Also, provide the rationale for selecting this site. Use the considerations above to help support the rationale.

4. Use the Monitoring Level definitions below and record the monitoring level that best corresponds to this location (more discussion on these monitoring levels is provided in Section 7.1.1). For a reference site, the monitoring level should generally be a 3 or 4.

   Monitoring Level 4

   - Pristine/uncontaminated location
     - No known or suspected contaminant sources
     - Only global or long-range contaminant sources
     - No known degradation of the resource.

   Monitoring Level 3

   - Potential contaminant sources exist
     - Suspected sources exist on and/or off-Service lands and transport pathways have been identified to this location, however, contaminants have a low probability of reaching this site and affecting the system.

Monitoring Level 2

- Suspected contaminants very likely (or known) to exist or to be moving to this location, but a specific problem has not been identified

- Regulatory requirements relevant to monitoring are not being adequately addressed at this location

Monitoring Level 1

- Contaminant problems have been identified at this location:
  - Contaminant is present and is a threat to the system and/or humans.
  - Significant effects to the system have been observed (dieoffs, morphological/physiological/behavioral effects, habitat degradation, etc.), however, the specific cause(s) might not be known
  - Trigger levels have been reached for a contaminant and/or a contamination event has occurred to initiate mitigative/remedial actions or additional studies.

Example: Minidoka National Wildlife Refuge March 22, 1993

WS-6.1a	INDEX TO MONITORING SITES	Page __ of __
PCA or Reference Site		

Monitoring Site #	TS27.5S	**Monitoring Level**	1
Location and General Description	**Raft River at Frontage Road.** The monitoring site is at an elevation of 4216 ft at river mile 691. Access to the monitoring site is via auto. The site is located about a mile upstream from Lake Walcott at Frontage road. Measurements and samples can be made by wading.		
Monitoring Issues and Rational for Selecting this Site	Inputs from the Raft River pose a significant threat to the refuge. This site allows a determination of what contaminants are entering the border of the refuge. It should provide easy access year round. The USGS staff gauge at this site is no longer monitored so flow data is not available. However, flow measurements can easily be made with a current meter.		

Monitoring Site #	IS05M	**Monitoring Level**	2
Location and General Description	**Lake Walcott near Minidoka Dam.** The monitoring site is at an elevation of 4195 ft at river mile 676. Access to site is via boat. The site is located directly south from the public boat launch near the Minidoka NWR headquarters approximately halfway between the north and south shore.		
Monitoring Issues and Rational for Selecting this Site	The station monitors the in-stream water quality just before going through Minidoka Dam. The lentic conditions allow for stratification measurements. Reservoir's daily capacity and evaporation rates can be obtained form the Idaho Department of Water Resources.		

Monitoring Site #	IS07M	**Monitoring Level**	2
Location and General Description	**Snake River below Minidoka Dam.** The monitoring site is at an elevation of 4155 ft at river mile 674. Access to sampling station is via boat. The station is located in the middle of the river at the USGS gauging station.		
Monitoring Issues and Rational for Selecting this Site	The station monitors the final output (ending point) of the refuge. Discharge measurements from Minidoka Dam can be obtained from the Idaho Department of Water Resources. The USGS also makes monthly flow measurements at this site.		

Monitoring Site #		**Monitoring Level**	
Location and General Description			
Monitoring Issues and Rational for Selecting this Site			

Monitoring Site #		**Monitoring Level**	
Location and General Description			
Monitoring Issues and Rational for Selecting this Site			

- A contaminant problem has been identified at this location and mitigative and/or remediation measures have been implemented that are likely to resolve the problem. This situation still requires special studies and/or monitoring to verify that the mitigation/remediation activities are working.

5. Now complete a separate Worksheet WS-6.1b for each reference monitoring site listed in Worksheet WS-6.1a.

   NOTE: If there are variables that will be monitored at nearly all reference monitoring locations, complete "e" below **NOW** for all the common variables that will be monitored. Copy this file to "WS61btmp.***" (*** extension should be specific to the Service lands). Use this template for all the applicable Monitoring sites. Once the variables are in the table it's much easier to erase those not needed, rather than reentering them several times. If you get into table mode (Alt-F7) in WordPerfect, entries can be moved or erased easily.

   a. On Worksheet WS-6.1b record the "Monitoring Site Number" (from Worksheet WS-6.1a)

   b. Record the "Project Number" for this monitoring activity, if there is one

   c. Identify the monitoring site's specific location (UTM.coordinates preferred). These coordinates will be used for mapping the site and to help generate GIS coverages. The coordinates should be obtained from a permanent benchmark or correspond to a permanent land feature that can be used as a reference point for establishing sampling grids (if this will occur here).

      The preferred method to obtain the coordinates for the site is by using a GPS receiver (3D mode with differential correction). However, until this capability is available, use the coordinates from a USGS 7.5' topography map.

   d. State the purpose and specific objectives for the monitoring activities there.

   e. List the contaminants and water quality parameters from Worksheet WS-4.2 "To be Monitored" that will be compared with this reference monitoring site.

6. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

Example: Minidoka National Wildlife Refuge

March 22, 1993

WS-6.1b **MONITORING ACTIVITIES FOR MONITORING SITES** Page __ of __

Monitoring Site Number	TS27.5S	UTM Coordinates	X (Long)	315000	Y (Lat)	4719000
Project Number	001-93-R1-14614					
Specific Purpose & Objectives	Raft River at Frontage Road. Quantify sedimentation, water quality, trace metals, pesticides, nutrients in order to assess the impact on the refuge					

	Contaminant or Water Quality Parameter to Monitor (WS-4.2)	Media to Sample (6.2)	Variable & Line of Evidence (6.2)	When to Sample: Month/Time (6.3)	Cont. Monit. Level (7.2)	Cont. Priority Level (WS-4.2)	Sampling Method (7.2)	# of Samples/ Sample Period (7.2)	Frequency (# Times) Per Yr. (7.2)	Sample Plot # (7.2)	Comments/Rationale for Decisions
1	Trace Metals (To include arsenic, boron, cadmium, chromium, copper, lead, mercury, and selenium)	Sediments	Trace metal concs.(4)	During spring runoff and late summer	2	H	App. I Sec. 2.1, 2.2, 2.3	3	2	RR1-TE-93	High metal concentrations found on the Snake River. The Raft River may be the possible source.
2	Trace Metals (as above)	Biota (Benthic Macro-inverts)	Index of Biotic Integrity (3)	Soon after spring runoff and summer	2	H	App. D.1 Sec. 2.1	1	2	RR1-TE-93	The analysis of several species of the benthos can be an informative and practical technique for determining the ecological effects of trace metals.
3	Nitrate+Nitrite as N	Surface Water	Nitrogen Concs. (4)	During spring runoff and late summer	2	M	App. K Sec. 2.1.1	3	2	RR1-NU-93	Eutrophic conditions have been increasing in Lake Walcott. It is suspected the Raft River is a major source of nutrient enrichment.
4	Organochlorines (To include aldrin, p,p' DDT, p,p' DDE, dieldrin, oxychlordane, HCB, total PCBs)	Biota (Benthic Macro-inverts)	OCs concs. (2)	After initial spring runoff, middle and late summer	2	H	App. D.1 Sec. 3.1.1	2	2	RR1-BM-93	Periodic fish die-offs in Lake Walcott downstream from the Raft River Bay may be caused by pesticide loads from the Raft River.
5											
6											
7											
8											

Lines of Evidence

1. Biomarker/organism health 2. Bioassay or toxicity testing 3. Population or community indices 4. Chemical Analysis

6.2 Selecting the Media and Environmental Variables to Monitor

The purpose of this section is to determine the optimum media and environmental variables to monitor to address the specific objectives for the monitoring site.

An indicator media for contaminant biomonitoring is one where the contaminant, or its effects, can be measured or observed soon after the contaminant's introduction into the system and/or the contaminant will be found in the greatest concentration relative to other media in the system.

An indicator variable for contaminant biomonitoring is one with a response that is directly correlated with the contaminant, or its effects, and can be measured or observed soon after the contaminant's introduction into the system. An indicator variable could also provide an indication of the general health of the system in conjunction with other indicators (e.g., IBI for benthic macroinvertebrates).

An optimum indicator medium or variable will be effective and efficient at quantifying the contaminant, its effects, or general system health. It must also satisfactorily address the specific goals and objectives of the monitoring effort. Indicator media/variables can be either abiotic or biotic. A monitoring program generally will include measurements of both.

A useful reference for potential indicators is a document produced by the EPA entitled "Environmental Monitoring and Assessment Program - Ecological Indicators" (Hunsaker, 1990). This document provides a description of numerous types of ecological indicators for different situations. The BEST Detailed Plan describes a process that will be implemented for indicator validation. Validation of indicators at some level will be required prior to their use for Service monitoring activities.

Criteria for a good indicator **medium** include:

- The contaminant accumulates rapidly
- It has a high concentration of the contaminant relative to other media within the system
- It is associated with a number of key species either through the food chain or other method of exposure (this is where the conceptual diagram developed in Section 3.5 can be helpful)
- It is relatively easy and inexpensive to sample and analyze
- The contaminant concentration detected is directly correlated with that found in the environment
- It is widespread and/or has an analog in other ecosystems

Criteria for a good indicator **variable** include:

- There is a direct correlation between its value and the contaminant concentration
- Its response to the contaminant is rapid and persists
- It is relatively easy and inexpensive to measure
- It is widespread and/or has an analog in other ecosystems/species
- Its value is indicative of ecosystem/species health

Section 7 "Selecting Variables to Measure" provides additional insight regarding considerations for selecting monitoring variables.

BEST Four Lines of Evidence

For contaminant biomonitoring at least one variable from each of the four lines of evidence (that are applicable for the situation) must be selected for each monitoring site. Worksheet WS-6.1b will be used to record the contaminant or variable to be monitored, the applicable line of evidence, and associated media to sample.

The four lines of evidence and their rationale are described in detail in the BEST Detailed Plan. Consult this document if additional information is needed for these decisions. The lines of evidence fall into four categories (see below). How these methods and techniques can be used for monitoring is described in the BEST Detailed Plan.

Lines of Evidence

1. Biomarker/organism health
2. Bioassay or toxicity testing
3. Population or community indices
4. Chemical analysis

Numerous references are available to aid in the selection of variables to monitor for different contaminants or contaminant effects. Some of the references below were used to help develop Tables 6.2a, 6.2b, and 6.2c and provide useful information for this step. Ultimately there will be a list of methods and techniques provided through the BEST Program that will have been validated through a standardized process (see the BEST Detailed Plan).

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Irving, P. M., 1991. Acid Deposition: State of Science and Technology. Summary Report of the U.S. National Acid Precipitation Assessment Program. Washington D.C.

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Miskiewicz, A. G. and P. J. Gibbs, 1992. Variability of Organochlorine Analysis in Fish: An Interlaboratory Study and Its Implications for Environmental Monitoring and Regulatory Standards. Arch. Environ. Contam. Toxicol, 23:45-53.

ORGANOPHOSPHATE (OP)

Belisle, A. A. and D. M. Swineford, 1988. Simple, Specific Analyses of Organophosphorus and Carbamate Pesticides in Sediments Using Column Extraction and Gas Chromatography. Environmental Toxicology and Chemistry, 7:749-752.

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MATERIALS

Worksheets WS-2.2a&b, WS-2.3, WS-2.4b, WS-2.5a&b, WS-3.1.2 a-d, WS-3.1.3, WS-3.2, WS-5, WS-6.1b
Maps of the AOIs, Service lands, and individual monitoring sites (if available)
Tables 6.2a, 6.2b, 6.2c
RFMs (for the media of interest)
BEST Detailed Plan

PROCEDURES

The following instructions pertain to completing one Worksheet WS-6.1b at a time.

1. Use the WS-6.1b Worksheets that were started in Section 6.1 and obtain, or draw, a large scale map of the monitoring site associated with each of these worksheets (see Figure 6.2a and 6.2b).

2. Review Worksheets WS-3.2 and WS-3.4, and the conceptual diagram(s) for the Service lands (or the specific monitoring site if one has been developed). Note the relevant transport pathway(s) for each contaminant listed (one contaminant at a time).

3. Determine the specific transport pathway(s) and the associated medium (media) that will be used for monitoring the contaminant and/or its effects. Record the medium (media) to sample in the second column of WS-6.1b. If more than one medium will be sampled for a specific contaminant, record it as well. Do this for each specific contaminant and its associated transport pathway(s).

4. Refer to Tables 6.2a, 6.2b, and 6.2c, the RFMs (especially for biota), and the BEST Detailed Plan, to identify the optimum variable(s) to monitor for the contaminant or environmental condition (e.g., chemical concentration, IBI, # of tumors, population #, age class structure, microtox test, etc.). Record the selected "Variable" to monitor and the associated "Line of Evidence" number (in parentheses) in the third column.

   Lines of Evidence

   1. Biomarker/organism health
   2. Bioassay or toxicity testing
   3. Population or community endocyst
   4. Chemical analysis

Example: For surface water transport of cadmium (a trace element - TE) look at Table 6.2a. The choices in this table for a medium and type of analysis are:

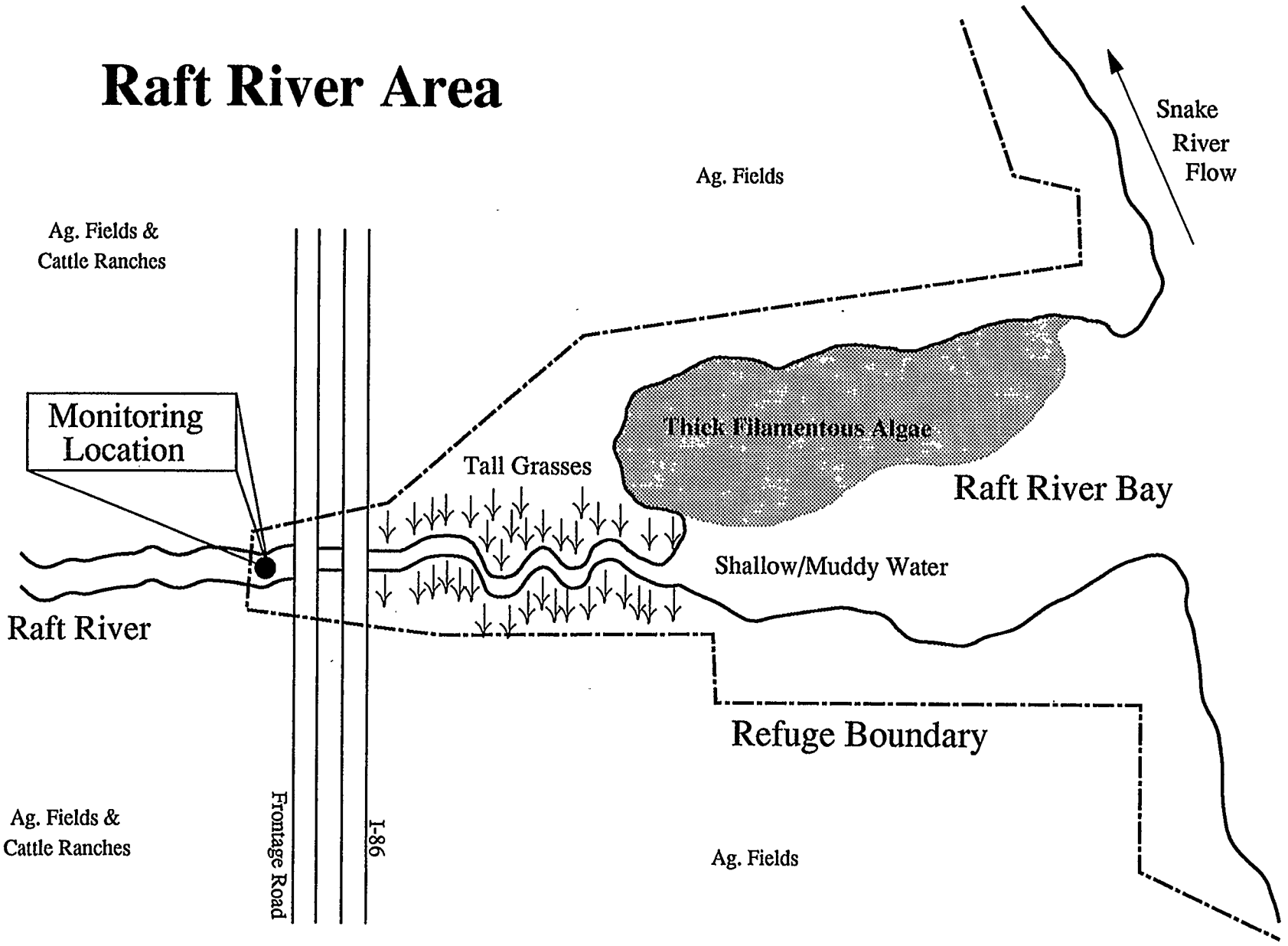


Figure 6.2a. Example of PCA large scale map.

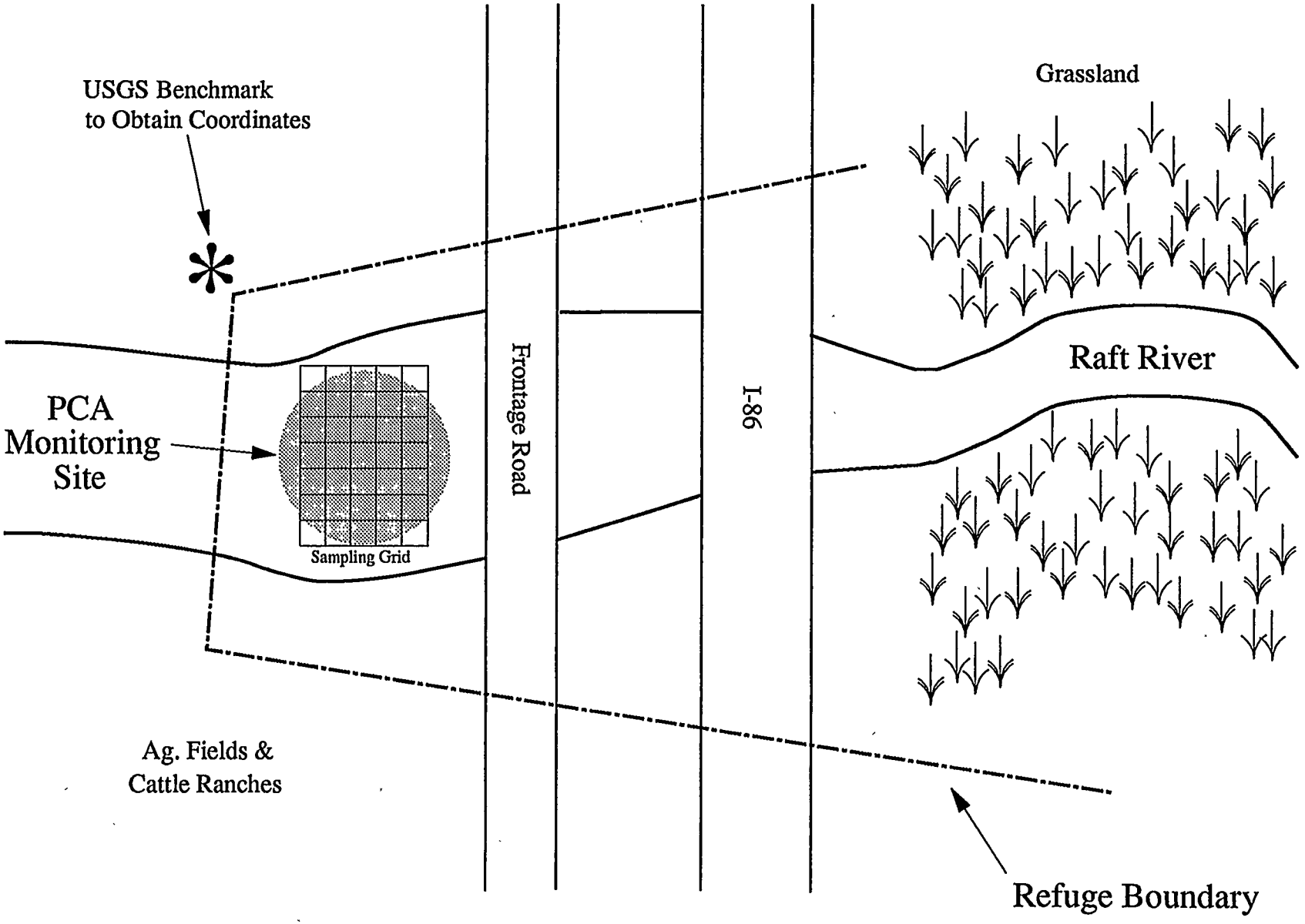


Figure 6.2b. Example of PCA monitoring site map.

Table 6.2a Recommended Media/Variables to Sample/Measure for Surface Water Transport Mechanism.

Contaminant Type*	Surface Water	Sediments	AQUATIC BIOTA					TERRESTRIAL BIOTA					
						Plants			Birds		Amphibians		
			Mollusks	Benthic Macro.	Fish	Vasc	Non-vasc	Mammals	Aquatic	Terr	Larva	Adult	Riparian Plants
TE	2-C-H	1-C	2-C-B-L	3-P-H	4-C/P-H	1-C	4-C-L						
SE	2-C-H	1-C-H			1-C-L 2-C/P-H	3-C-L			2-C-L 3-M-H				
HG	2-C	1-C	4-C	3-P	2-C	4-C	4-C	4-C	1-C-L	1-C-L		4-C	
CR	2-C-H	1-C-H	2-C-L	4-P-H	1-C-L		4-C		4-C				
OP				4-P	1-BR				3-BR-H			2-BR-H	
OC		1-C-H	1-C-L	3-P	2-C/M				3-C		4-B		
SP				2-P	1-P:4-B						3-P:4-B		
CB				4-P	1-BR-H				3-BR-H			2-BR-H	
PS			1-C-L	1-P	2-C-L:3-B						4-B		
SG	1-C/Ba	4-C/Ba	4-B	2-P	3-P		4-P						
NU	1-C			2-P	3-P		4-P						
HC	1-C/Ba	2-C/Ba		3-P			4-P						
TH	1-Temp-H		3-P-L	2-P-L	2-P-H	2-P-H	1-P-L/3-P-H	4-P-L					
SV	1-C	2-C	3-C										
SD	1-Susp. sediments		4-P	2-P	3-P								
RM**	2-Rad Anal	1-Rad Anal	2-Rad Anal		3-Rad Anal								
PH		1-C-L	2-C/M-H	3-C	1-M/B-H				2-C		4-M/B-H		
PC		1-C	2-C-L	4-P-H	2-C-H				3-C		4-B		
PT	2-C	1-C	3-C	4-P	4-C								
OD		1-C-L	2-C	3-P	1-C-H								
SA	1-C	2-C		3-P-L	3-P-H								
AB	1-C	2-C											
OI	2-C	1-C							3-C		4-C		

1 - 1st choice
2 - 2nd choice
3 - 3rd choice
4 - other options
* Refer to Table 1 for Code
** Depends on the specific radionuclide in question

B - Conduct Bioassay
Ba - Bacteria coliform assay (E. coli)
BR - Biochemical Response
C - Chemical Analysis

H - Assess morphological aberrations
P - Population/community studies
L - Low Suspect[illegible]ncentrations or temperature
H - High Suspe[illegible]ncentrations or temperature

NOTE: This table is intended for guidance regarding initial samples for contaminant monitoring activities. As more information is gathered oth types of samples/analyses may be more appropriat

Table 6.2b Recommended Media/Variables to Sample/Measure for Groundwater Transport Mechanism.

Contaminant Type*	IN SAMPLE WELL	
	Ground Water	Air Space
HM	1-C	
SE	1-C	
HG	1-C	
CR	1-C	
OP	1-C	
OC	1-C	
SP	1-C	
CB	1-C	
PS	1-C	
SG	1-C/Ba	
NU	1-C	
MC	1-Ba	
SV	1-C	2-C
RM	1-C	
PH	1-C	2-C
PC	1-C	
PT	1-C	2-C
OD	1-C	2-C
SA	1-C	
OI	1-C	

1 - 1st choice Ba - Bacteria coliform analysis
2 - 2nd choice C - Chemical Analysis
* Refer to Table 1 for codes.

NOTE: Groundwater seeps are commonly associated with a depauperate fauna because of the lack of nutrients, constant temperature and high carbon dioxide. In limestone areas, there is also deposition of calcium carbonate on all surfaces. Also seeps and springs are often too small to support fish. However, as you move downstream in clean areas, a full range of fauna appears. For these reasons, biological sampling at the seep site may be very limited. However, for samples that can be collected, the same types of analyses should be done as are listed in Table 16 (Surface Water Transport Mechanisms). Once groundwater rises to the surface, it becomes surface water and the effects and sinks of contaminants will be the same.

Table 6.2c Recommended Media/Variables to Sample/Measure for Air Transport Mechanism.

					AQUATIC BIOTA					TERRESTRIAL BIOTA								
								Plants			Birds		Amphibians		Plants			
Contaminant Type*	Air	Surface Water	Soil	Sediments	Mollusks	Benthic Macro.	Fish	Vasc	Non-vasc	Mammals	Aquatic	Terr	Larva	Adult	Vasc	Non-vasc	Litter	Earth worms
TE	1-C-H		2-C-H	3-C-H				4-C-H							4-C-L	1-C-L	2-C-L	3-C-L
SE	1-C-L		2-C-H	4-C		4-P	1-P-H: 3-C-L	2-C-L	4-C	4-C	3-M-H				4-C		4-C	
HG	2-C-H		1-C-H	3-C-L	4-C	2-C-L	1-C-L	4-C										
CR	1-C-H		2-C-H	3-C-H			4-C	4-C							4-C	1-C-L	2-C-L	3-C-L
OP	4-C		3-C				1-BR-H					2-BR-H		4-BR	3-C-H			4-C
OC	1-C-H		2-C	3-C			1-C-L				3-C-L	2-C-L						4-C
SP	1-C-H		2-C			2-P-L	1-P-L						3-P-L					
CB	4-C		3-C			3-P	1-BR-H				2-BR-H	2-BR-H		4-BR	3-C-H			
PS	1-C		2-C			3-P	1-C/BR-L			1-C	3-C/BR-L	2-C/BR						
NU	1-C		2-C						2-P						3-P			
GP	1-C		2-C-H					3-C							1-C		4-C	
AP	1-C		2-C					4-C							2-C	3-C	4-C	
RM	1-C		2-C															
PH	1-C		2-C															
PC	2-C		1-C				2-C			3-C								
PT	1-C		2-C															
OD	1-C		2-C				3-C			3-C	4-C	4-C						

1 - 1st choice
2 - 2nd choice
3 - 3rd choice
4 - other options
* Refer to Table 1 for codes

B - Conduct Bioassay
Ba - Bacteria coliform assay (E. coli)
BR - Biochemical Response
C - Chemical Analysis

M - Assess morphological aberrations
P - Population/community studies
L - Low Suspected concentrations
H - High Suspected concentrations

NOTE: This table is intended for guidance regarding initial samples for contaminant monitoring activities. As more information is gathered other types of samples/analyses may be more appropriate.

Choice		
1st	1-C	Sediments - chemical analysis
2nd	2-C-H	Surface water - chemical analysis (for High TE concentrations)
2nd	2-C-B-L	Mollusks - chemical analysis and/or a bioassay (for Low TE concentrations)
3rd	3-P-H	Benthic macroinvertebrates - population/community studies (for High TE concentrations)
4th	4-C/P-H	Fish - chemical analysis and/or population studies (for High TE concentrations)
4th	4-C-L	Non-vascular plants - chemical analysis (for Low TE concentrations)

If the decision was to conduct a trace element analysis of the sediment, plus conduct a community study on the benthic macroinvertebrate community using an IBI, this would be recorded as shown below:

Cadmium	Sediment	Cadmium Concentration (4)
	Biota	Benthic Macroinvertebrate IBI (3)

As many variables as desired can be selected, some will provide information for several contaminants. In this case, two of the four lines of evidence are represented at this site.

5. For each monitoring site there should be one of each of the four lines of evidence included as a part of the monitoring effort (if applicable for the monitoring site).

NOTE: The monitoring location (previous section) and index period considerations (next section) are also important in selecting the media or variable to monitor. If the most desirable location or time is not conducive to sampling the medium selected, an alternative plan needs to be selected (repeat step 3 above).

6. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

6.3 Index Period Considerations

For many contaminants and transport pathways, selecting the time to sample is as important as the media and location considerations. Referring to the objectives for the specific monitoring activities will provide guidance for determining when to sample. Understanding the characteristics of the contaminant source, transport mechanisms, and receptors is also necessary. It might be necessary to assess temporal considerations for each contaminant and/or contaminant source separately if there are significant differences between their characteristics.

Index period is the sampling period that yields the maximum amount of information during the year, which may vary from one indicator or resource class to another (Hunsaker, 1990).

Considerations to help determine the index period are listed on Worksheet WS-6.3.

MATERIALS/INFORMATION

Worksheets WS-2.2a&b, WS-2.3, WS-2.4b, WS-6.1b, WS-6.3
Maps of the AOI, Service land, and individual monitoring sites (if available)
RFMs (for the media of interest).
Knowledge of the local meteorologic temporal characteristics (discuss with NOAA or local weather/airport personnel)
Knowledge of the contaminant source(s) temporal characteristics (discuss with owners/operators of the sources and/or government agency personnel (County Extension Office, EPA, SCS, USGS, BLM, USDA, etc.)
Understanding the periodic nature of the physical and biological components at the monitoring site

PROCEDURE

Complete a separate WS-6.3 Worksheet for each monitoring site.

1. On Worksheet WS-6.3 record the monitoring site number and list the contaminant(s), water quality parameter, or other variable(s) being monitored in the first column. The appropriate number (from WS-6.1b) or an abbreviation can be used instead of writing out the contaminant since they are already identified on WS-6.1b.

2. Record its associated transport mechanism and/or exposure medium in the second column using the codes at the bottom of the worksheet.

3. Read the index period considerations on Worksheet WS-6.3 and review the objectives of this monitoring effort. In the third column, record the five most important temporal considerations for each contaminant, water quality parameter, or variable.

4. Determine the optimal index period for each contaminant or variable and transport pathway and write this in the space provided. This will depend on the contaminant source, transport mechanism(s), variable being monitored, and the media being sampled.

5. Determine selected time to sample and record this in the space provided. This may differ from the optimal time due to logistic constraints.

6. In the last column, provide the rationale for the selected time to sample. Comments should reflect the most important temporal considerations and, if applicable, why a time other than the optimum time was selected for sampling.

7. Do the decisions made regarding when to sample address the objectives of the monitoring effort and are they compatible with the media and monitoring location decisions?

   If yes, the next step is to develop a sampling design for each contaminant, water quality parameter, or other variables selected. On the appropriate WS-6.1b Worksheet, record the final decisions regarding when to sample for the contaminant(s) and other variable(s) at the monitoring site.

If no, reevaluate the monitoring site location, variables to monitor, and index period considerations, and prioritize them based on the monitoring objectives. Develop a more compatible solution.

NOTE: If the "most compatible solution" does not adequately address the monitoring objectives, it is not a solution. Don't sacrifice data quality requirements, resolve the problem. This might require additional information (site, contaminant, receptor characteristics, etc.) and/or an increased monitoring effort (increased scope and additional funds/labor).

8. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

Example: Minidoka National Wildlife Refuge

March 22, 1993

WS-6.3	INDEX PERIOD CONSIDERATIONS FOR MONITORING				Page __ of __
Monitoring Site #	TS27.5S (Raft River at Frontage road)			Date	3-20-93
Contaminant, Water Quality Parameter, or Biotic Variable(s) Being Monitored	Transport Mechanism or Exposure Medium (A, SW, SSW, SO, SE, AN, PL)	Most Important Index Period Considerations	Optimum Time to Sample	Selected Time to Sample	Comments: Provide rationale for the optimum and/or selected sampling time
1 Trace metals	SE	1, 2, 4	During spring runoff	March or April	Important to collect samples as close to initial spring runoff pulse as possible due to heavy sedimentation rates.
2 Nitrate	SW	1, 2, 4	Spring, summer, and fall	March, June, September	It will be useful to sample prior to, during, and after agricultural activities. It will be useful to sample during storm events also.
3 Organochlorines	AN	2, 6	Spring, summer, and fall	Soon after spring runoff, and middle summer	Collect samples after initial spring runoff and middle summer to allow time for bioaccumulation.
4					
5					

1. Transport/Exposure Mechanism Codes

A = Air
SW = Surface water
SSW = Subsurface
SO = Soil
SE = Sediments
AN = Animal
PL = Plant

2. Index Period Considerations

1 Storm events (pulses of contaminants)
2 Wet vs. dry periods/seasons
3 Temperature affects (DO, respiration, etc.
4 Agricultural activities (fertilizers, amount and type of Pesticides, aerial spraying)
5 Turnover period and stratification of standing water
6 Biotic activities (life cycle, peak population numbers, hormonal cycles, migration, exposure potential, etc.)
7 Wind or storm intensity
8 Wind direction
9 Stagnation events
10 Dryness (resuspension of particulates)

7. DESIGNING AND IMPLEMENTING BIOMONITORING ACTIVITIES

This section briefly discusses some of the considerations associated with sampling design and provides procedures to establish sampling designs for monitoring activities at each PCA. EC Specialists should collaborate with statisticians, if necessary, to develop monitoring designs that will address the statistical and QA/QC requirements to meet the monitoring objectives.

An excellent source for information on monitoring program design and implementation is Managing Troubled Waters: The Role of Marine Environmental Monitoring (NRC 1990). This book discusses the required components of environmental monitoring using examples from marine monitoring activities. The discussions are directly applicable to Service monitoring activities and should be reviewed by personnel involved in designing monitoring plans. The following, italicized, pages are primarily excerpts from the book that are relevant to sample design.

Linking Testable Questions to Useful Information

The steps outlined in Figure 7.1a ensure that sampling and measurement designs will be appropriate for the monitoring objectives. The feedbacks ensure that the evolving sampling design will produce information needed to answer the specific questions to be addressed. The elements of this process include:

- Identifying the kinds and amounts of change that are meaningful
- Identifying and quantifying the sources of variability that may obscure or confound responses
- Deciding what to measure, in light of logistical constraints and limitations on scientific knowledge
- Developing a sampling design that provides the logical structure for the measurement program by specifying how variability will be partitioned
- Specifying statistical models that are the basis for selecting the kinds and numbers of measurements that should be taken
- Performing optimization and power analyses to determine whether the monitoring design can measure meaningful levels of change
- Defining data quality objectives
- Developing the sampling/measurement design that incorporates all the above elements.

STEPS FOR MONITORING SAMPLING DESIGN DEVELOPMENT

Defining Meaningful Change

The goal of a monitoring sampling design should be the detection of specific kinds and amounts of change in the resources at risk, in surrogate variables related to them, or in variables involved in model validation or increasing the understanding of important natural processes (e.g., Fredette et al. 1986).

Attempts to define meaningful amounts of change are confused by meanings of "significant" (Sharma, Buffington, and McFadden 1976; Christensen, Van Winkle, and Mattice 1976; Zar 1976). Significant

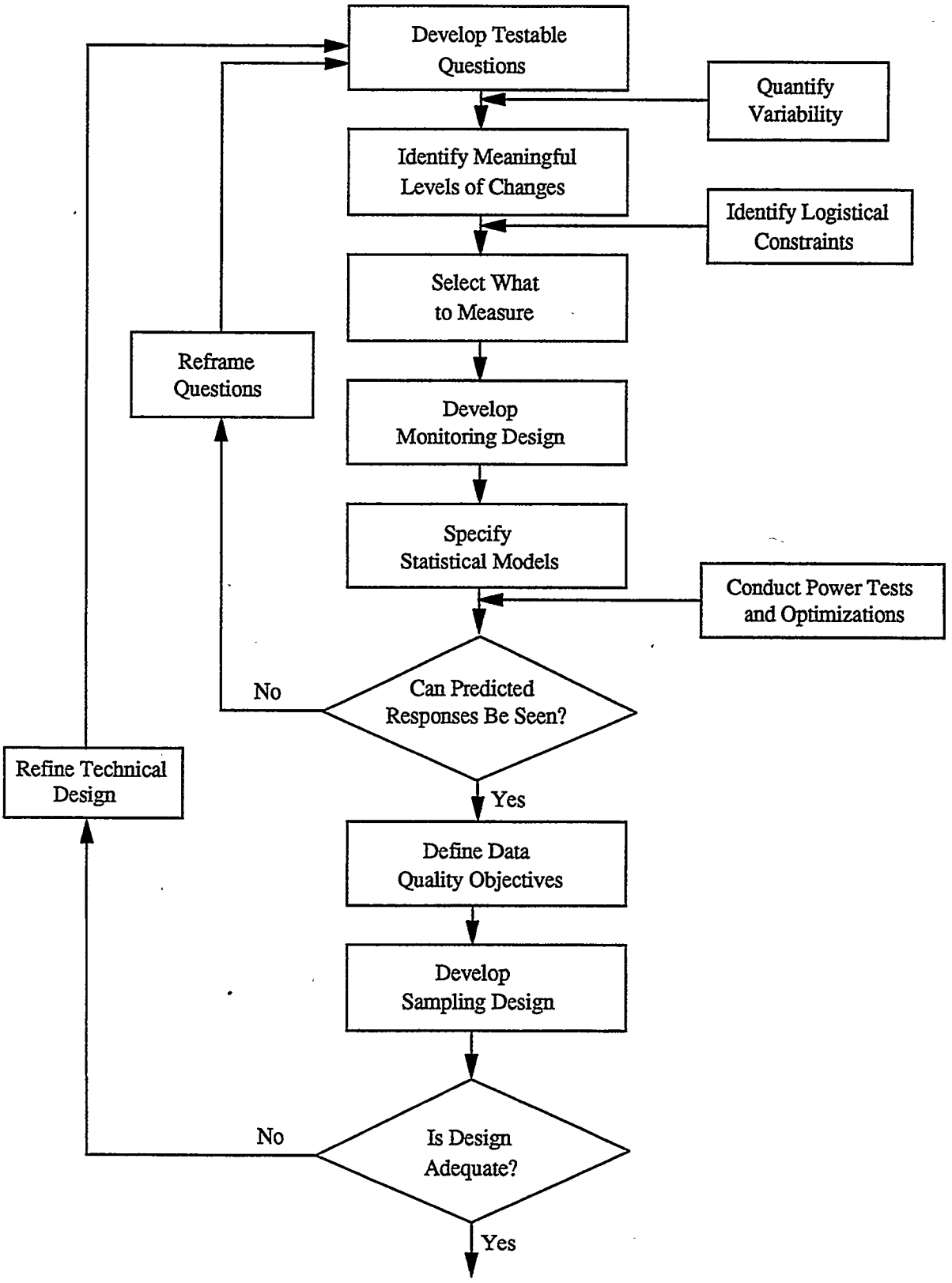


Figure 7.1a. Steps for monitoring sampling design development (NRC 1990).

means, "having meaning...; having or likely to have influence or effect" (Merriam-Webster Inc. 1986), but it also refers to the statistical difference, at a specified probability level, between or among two or more sampling distributions.

How large a change is important? *One that is statistically significant is not necessarily meaningful. Virtually any change can be statistically significant, depending in part on the sampling effort. Thus a monitoring program with a small sampling effort will detect only large changes, but one with an intensive sampling effort could find even miniscule changes statistically significant. Whether changes in the environment are statistically significant has no bearing on the extent to which the changes may be either meaningful or important (i.e., have ecological or human consequences).*

The definition of ***"meaningful change"*** *is based on testable questions. All kinds and levels of change are not equally important. It is therefore not possible to decide what variables should be measured and when, where, and how measurements should be made until a determination is made about what kinds and levels of change are meaningful. When a decision about meaningful change has not been made, "monitoring programs run the risk, on the one hand, of having little or no chance of detecting anything but catastrophic change, or, on the other, of sampling far in excess of what is necessary..." (Bernstein and Zalinski 1983).*

Deciding what kinds and amounts of change are meaningful (and to whom) is neither simple nor easy. Beanlands and Duinker (1983) note that statistical, scientific, project-specific, and wider societal concerns all contribute to definition of meaningful changes. The benefits of defining how much change is meaningful cannot be overstated. This determination not only allows the designers of monitoring programs to focus resources more efficiently but also provides managers and decision makers with higher-quality information with which to make decisions. For example, it might be determined that an average decrease of 20 percent of population levels of a certain indicator organism would indicate an impact from a specific contaminant. A monitoring program could then then be designed with a specific probability of detecting this change.

The definition of meaningful change is not static. It can shift with changing spatial and temporal boundary conditions or new information. For example, a short-term one-time change in a water quality parameter or contaminant level should probably be viewed differently than the same degree of change in the long-term average.

The Influence of Natural Variability

Natural variability creates a background of change that may make it difficult to quantify environmental responses to human activity (Nichols 1985a). Thus defining meaningful change depends in part on identifying and accounting for natural sources of variability. For example, El Ninos and occasional large winter storms in Southern California can destroy kelp bed canopies and prevent the detection of subtle impacts of human activities on the kelp beds. Seasonal changes in the abundance of the benthos in Chesapeake Bay affect population dynamics in ways that can also obscure benthic responses to human impacts (Holland, Shauhnessy, and Hiegel 1986). Similarly, large-scale climate-related shifts in marine fish distributions can make it difficult to identify and measure the effects of harvesting (Sherman and Alexander 1986).

Natural variation affects sampling design in two major ways. First, natural changes may be so large that they mask changes of human origin. Second, random or periodic variations not accounted for in

the sampling design can result in noise or false signals that make it difficult to determine the response of the ecosystem (Christie, 1985; Coull 1985; Lie and Evans 1973).

Understanding variability aids development of a sampling design in several ways: it helps construct a conceptual model that includes key natural processes and linkages that affect the resources being monitored, it helps partition variability by collecting data on appropriate space and time scales (Livingston 1987; Kerr and Neal 1976), and quantitative measures of variability provide input of the optimization and power analyses that predict whether the monitoring design can detect meaningful levels of change (Cohen 1988).

Characterizing variability can be difficult because of its many sources and scales in the marine environment. Natural spatial and temporal variability can reflect simple gradients in the physical environment (e.g., depth, salinity, and temperature), or it may reflect more complex processes such as succession and ecological interactions among ecosystem components (Levin 1978; Pearson and Rosenberg 1978; Nichols 1985b; Holland et al. 1986; Holling 1978). In addition to these natural kinds of variability, human activities and their impacts vary in space and time, and they can interact with natural processes to create intricate and sometimes perplexing patterns. As Wolfe et al. (1987) point out, cycles of temperature, light, and other factors interact with tidal cycles, seabed topography, and processes such as evaporation, turbulent diffusion, ion exchange, respiration, growth, and predation. Failure to understand fully such factors affecting the resources at risk can make it difficult or impossible to design monitoring programs that produce useful management information.

Each of the three uses of information about variability (i.e., conceptual modeling, monitoring design development, and optimization and power analyses) requires somewhat different kinds of information. Building a realistic conceptual model of the system requires a comprehensive review of all possible sources of variability. At this point in the monitoring design methodology, it is more important to have a qualitative understanding of the relationships among most or all sources of variability than a more quantitative description of a few. Failure to include an important source of variability can result in unrealistic assumptions about how impacts are created.

Developing an adequate monitoring design depends on somewhat more quantitative knowledge about variability because the monitoring design must specify where and when measurements should be taken.

Optimization and power analyses require quantitative estimates of the major sources of variability. It is impossible to allocate limited sampling resources without such information. For example, if year-to-year variability in a particular system is much greater than seasonal variability, then proportionally more resources should be devoted to sampling additional years rather than additional seasons within years. Such decisions cannot be made without knowledge about at least the relative magnitudes of the various sources of variability.

Selecting Variables to Measure

Most monitoring programs do not have the resources to monitor all variables of concern. The limited resources available must then be focused on the system attributes that are of the greatest concern and provide the most information about system status or changes in status. Thus actual sampling may not focus directly on the resources at risk but on surrogate variables. Surrogate variables include resources of intrinsic importance (e.g., economically key species, endangered species), early warning indicators (e.g., variables that respond rapidly to the stress of concern), sensitive indicators (e.g.,

variables that have a high degree of specificity to stress), process indicators (e.g., variables that provide insight into the effects of stress on complex system interactions, and variables with high information redundancy (i.e., those that are generally representative of the behavior of a number of important variables). The rationale for monitoring surrogate variables is that they might provide clearer or simpler information than the resources would. This statement may not always apply (Wolfe and O'Connor 1986; O'Connor and Demling 1986; Bryan and Gibbs 1987), and specific criteria need to be applied to the selection of surrogate variables on a case-by-case basis. For example, diversity indices are often used to provide summary information about impacts on communities containing many species. However, much important information can be discarded in the calculation of these indices (May 1985). In addition, changes in diversity can be ambiguous, particularly when the assemblage being studied is exposed to more than one source of disturbance (NRC 1986). Criteria that should be used to select surrogate variables include sensitivity to the stress of concern, reliability and specificity of responses, ease and economy of measurements, and relevance of the indicator to specific concerns (NRC 1986).

Two important issues are involved in the choice of variables to monitor. The first relates to the depth of knowledge about a particular system (e.g., specificity and reliability of responses) and the second to the statistical efficiency of sampling alternative variables (e.g., the signal-to-noise ratio). A prime consideration for any monitored variable is that it should be tied directly to the specific questions to be answered and the resources at risk. In other words, changes in the status of the selected variable must unambiguously reflect changes in the resources at risk. How much they can be tied together depends largely on the depth of knowledge about the system and process being monitored. In well-understood systems, it will be clear which variables to measure and how to draw conclusions from them regarding the state of the resources. For example, understanding the process leading to oxygen depletion and eutrophication has focused modeling and monitoring on nutrient levels (Hydroscience 1974; HydroQual 1986). When a system is less understood, it may not be apparent which variables will indicate meaningful changes in resources. Then a **conceptual model** *should be used to determine whether a particular variable can be linked to the specific questions to be answered with cause-effect statements. When crucial gaps in scientific understanding occur, research or modeling may be initiated to help determine what measurements should be made. In addition, the available information should be used to make an informed decision about what to monitor now.*

A second major consideration in selecting monitored variables is their statistical distributions and characteristics (e.g., signal-to-noise ratio). Monitored variables should provide the most accurate and precise estimates for the smallest required sampling effort, thus maximizing information return per sampling effort expended. Variables with high variability or unknown distributions impair the ability to draw conclusions from monitoring data. Such variables are not appropriate for routine monitoring programs.

The Sampling Design and Its Statistical Basis

The sampling design is the central element of the design methodology (Figure 7.1a). It provides the logical structure of the study (Cochran 1977; Fisher 1954) because it specifically defines how questions will be evaluated and how variation associated with different sources (e.g., spatial and temporal as well as human-induced variation) will be measured.

In many monitoring and assessment programs, it is not possible to collect preoperational data or to establish baseline conditions before an impact has occurred. Statistical comparisons in such cases are

limited to comparing distributions among locations of concern to distributions at sites that are assumed to be appropriate reference areas (Green 1979). Selection of appropriate reference areas is always problematic. It is a particularly difficult problem in estuaries, where a natural salinity gradient that may vary in location from year to year generally requires broad regional sampling and application of estimation techniques to assess conditions that may occur at any particular location (Holland, Shaughnessy and Hiegel 1986).

A poorly thought out sampling design usually results in testing of inappropriate questions, incomplete evaluation of questions, inability to separate change due to natural processes from change due to multiple activities, relatively low ability to detect change (low statistical power), and poor use of resources due to oversampling (e.g., Gore, Thomas, and Watson 1979; Hurlbert 1984; Stewart-Oaten and Murdoch 1986; Green 1979; Thomas 1978; Bernstein and Zalinski 1983; Toft and Shea 1983; Trautmann, McCulloch and Oglesby 1982; Skalski and McKenzie 1982; Millard and Lettenmaier 1986). A well-planned sampling design, however, provides a logical basis for evaluating questions and a clear definition of a meaningful level of change, proper matching of variables with questions, quantification and partitioning of background variability, and proper assignment of sampling units among conditions or treatments.

Once a sampling design has been developed, it becomes the basis for a statistical model, which is a formal mathematical statement of the specific questions to be tested. By structuring how questions will be asked and by formally describing and partitioning sources of variability, the statistical model furnishes an objective method for allocating sampling or measurements resources. Two statistical tools that aid in the fine-tuning and refinement of the sampling design are optimization and power analyses. When sampling resources are limited, optimization techniques help decide how to make trade-offs needed to control for several sources of variability (e.g., Gunnerson 1966). Power analysis is a procedure for determining the level of change a given sampling design will detect (Cohen 1988; Trautmann, McCullough and Oglesby 1982). These analyses can be conducted before samples are taken, after part of the samples have been collected, or after the program has ended. This knowledge can be invaluable in determining whether the resources available for monitoring are likely to produce useful information before a program is initiated. If power analyses show that meaningful levels of change cannot be detected with the available resources, then the monitoring program can be redirected before these resources are wasted on trying to answer unanswerable questions. They also provide scientists and decision makers with an estimate of the level of uncertainty and thus the degree of confidence they should place in a given analysis result at the conclusion of a program.

7.1 Contaminant Biomonitoring Design Considerations

Specific sampling designs for each contaminant or variable being monitored will be developed by the EC Specialist, Biocoordinators, and research statisticians. The statisticians will need to know the objectives of the monitoring activity, the characteristics of the area being monitored, the media/variables being monitored, how the data is to be used, and the confidence level required for the data. Most of this information will have been considered in earlier steps of this manual and may already be documented on a worksheet or in your notes.

Consider the following prior to developing the monitoring design:

- The monitoring ranking level for the contaminants at each PCA. You will want to determine the level of effort for monitoring each contaminant. Not all PCAs or contaminants need to be monitored with the same intensity; the monitoring level of effort should be comparable to the risk to the key species as determined in Worksheet WS-4.2. This approach will help reduce the costs required to implement the monitoring activities without reducing the ability to protect the trust resource.

- The objective(s) of the monitoring effort and how the data are to be used. Separate, more specific objectives might be required for different contaminants and/or PCAs.

- Data quality objectives

- Characteristics of the contaminant being monitored
  - temporal variability
  - physical and chemical characteristics
  - bioavailability and potential for bioaccumulating and biomagnification
  - toxicity to key species and its effects
  - potential concentrations
  - potential observable effects

- Monitoring site characteristics for each medium/variable to be sampled/measured
  - temporal and spatial variability of physical conditions
  - temporal and spatial variability of biotic conditions
  - physical conditions of the media being considered

- Sampling and analysis method(s) being considered

- Available resources for sampling, sample processing, and analysis.
  - availability of funding
  - availability of labor
  - availability of equipment/materials
  - availability of space for processing, analysis, and storage.

7.1.1 Description of Monitoring Ranking Levels and Associated Monitoring Activities

The purpose of this section is to define monitoring levels. The monitoring levels are based on the probability of exposure and the information collected throughout this Workbook. The monitoring level will help distinguish the level of effort at a monitoring site for different contaminants and variables. The level of effort should be based on the need to obtain data for that monitoring site, which is based on the risk to the resource at that location or the ability of that location to predict potential negative effects to the trust resources.

The following pages define the monitoring levels and provide guidance regarding the level of effort to be applied for the situation.

DEFINITIONS FOR MONITORING LEVELS

Monitoring Level	Definitions
4	Pristine/uncontaminated environment
	• No known or suspected contaminant sources
	• Only global or long-range contaminant sources
	• No known degradation of the resource
3	Potential contaminant sources or deleterious water quality conditions may exist:
	• Potential contaminant sources (on/off-Service lands) and transport pathways have been identified
	• Contaminants have a low probability of reaching Service lands and affecting the system
	• Water quality conditions do not generally present a risk to the resource, however, the physical conditions of the area and potential contaminants could affect water quality
2	Contaminants or deleterious water quality conditions are very likely (or known) to exist on the Service lands, but a specific problem due to those contaminants or conditions has not been identified
	• Contaminant problem or deleterious water quality condition has been identified, however, mitigative and/or remediation measures have been implemented that are likely to resolve the problem
	• Regulatory requirements relevant to monitoring are not being adequately addressed
1	Contaminant problems have been identified:
	• Contaminant or water quality condition is present and is an immediate threat to the system and/or humans
	• Action levels have been reached for a contaminant and/or a contamination event has occurred to initiate mitigative/remedial actions or additional studies

PURPOSE AND RATIONALE FOR EACH MONITORING LEVEL

Monitoring Level

4 Purpose

- To establish baseline data for assessing status and trends of selected ecosystem variables and possible future contaminant inputs

Rationale

- To establish baseline/benchmark conditions for the Service lands.
- Provides data that will allow for identifying changes from baseline conditions that might indicate potential contaminant effects or global changes affecting the Service lands
- Changes may indicate impacts to migrant species at other areas which may affect the ecosystem at this Service lands
- Provides the data for developing action levels for the Service lands

3 Purpose

- To determine if contaminants from identified sources are reaching the Service lands and to determine their concentrations in selected indicator media and/or to determine if sensitive bioindicators are being affected by contaminants.

Rationale

- Specific contaminants from suspected sources will be monitored to verify their presence/absence and concentrations. This provides data required to determine if more intensive monitoring should take place, the contaminants (or effects) to monitor, and where and when to monitor

2 Purpose

- To determine if contaminants from suspected/known contaminant sources are reaching the Service lands and their concentrations within several indicator media and biotic compartments.
- To assess effects on the bioindicators appropriate for the specific identified contaminants or water quality conditions.
- To provide additional data for intensive Service lands characterization (if it becomes necessary)

Monitoring Level

2 cont.

- Provide data to prioritize the contaminants that are present
- To determine if action levels have been reached and appropriate actions to take
- For evaluation of existing mitigative/remediation measures

Rationale

- Additional data quantity/quality requirements driven by risks to the receptors and specific characteristics of the Service lands
- Need to determine if key receptors are being affected so appropriate action can be taken if necessary
- Need to evaluate effectiveness of remedial/mitigative actions

1 Purpose

- Intensive Service lands characterization for problem contaminants and water quality conditions to determine concentrations and distribution within several media and biological compartments and associated effects.
- Sampling should be designed to locate contaminant source (if not known), recommend mitigative/remediation measures, assess affects on the system and specific "key" receptors (T&E species and indicator species), and assess risks to humans.

Rationale

- Concentration and distribution (temporally, spatially and within multiple media and/or biotic compartments) information is necessary to locate the contaminant source (if not known) and to evaluate potential impacts to the system. This information can also be used to determine appropriate remedial/mitigative actions and associated monitoring plans.

GENERAL MONITORING RECOMMENDATIONS

Monitoring Level

4 • Establishing baseline/benchmark conditions for air:

Monthly composite and analysis of weekly, continuous air monitoring filters (for one year or enough to establish baseline conditions) and quarterly sampling and analysis thereafter (Sampling location can be at, or close to, the Service lands). If appropriate air monitoring data is not available from other air monitoring stations close to the Service lands, consideration should be given to establishing a monitoring station at the Service lands. Monitoring for the Service lands should take place once every 5 years at a minimum.

- Establishing baseline/benchmark conditions:

Initially, monthly sampling of variables to determine system variability and when the most appropriate time to sample would be. Thereafter, seasonal sampling (quarterly) or whatever is appropriate based on initial monthly sampling. A complete set of all baseline/benchmark measurements should be gathered every 3 to 5 years depending on the specific Service lands characteristics and monitoring needs. It might be necessary to identify a control site if the Service lands is disturbed or managed to the extent that baseline conditions for the area can not be assessed.

3 • Establish monitoring stations and/or contaminant assessment areas (PCAs) within primary transport pathways

- Screening for suspected contaminants
  - Monitor to assess air pathway inputs to system: air and air deposition monitoring; monitor litter, soil, sediment, and aquatic environment based on suspected contaminants and transport pathways
  - Prioritize suspected contaminants and screen the PCA for them in the optimum media and at optimum times and locations

- Frequency of sampling should be based on contaminant toxicity, media, probability of reaching area, the contaminant source characteristics, transport mechanism and pathway, etc.

2 • Select additional indicator media and bioindicators to monitor based on risk to important receptors and data needs for action level criteria

- Additional bioassessment techniques might be useful
- Temporal and spatial data resolution should be increased as necessary to adequately assess contaminant concentrations, distribution, and temporal variability within the PCA

Monitoring Level

1 • Initiate special studies as necessary

NOTE: This document does not address monitoring activities associated with Monitoring Level 1; such activities are beyond the scope of this document. At this level special studies should be initiated that includes and a more intensive investigation.

Contaminant situations that are on a lower monitoring level should not be ignored, however. Monitoring at the appropriate level of effort for other contaminants should be maintained.

APPLICABLE MONITORING LEVELS				POTENTIAL MEDIA TO MONITOR
4	3	2	1	(Also see Tables 6.2a, 6.2b, 6.2c and the BEST Detailed Plan)
Air (check to see what air monitoring is taking place near the AOI, see Appendix C - Air Monitoring)				
●	●	●	●	- Typical meteorological weather condition measurements (temperature, relative humidity, wind direction and velocity, etc.)
●	●	●	●	- Trace elements, radioactive fallout, other airborne particulates (SO_4, NO_3, HNO_3)
●	●	●	●	- NOx, SO_2, Ozone, CO
		●	●	- Organics, VOCs
Surface water (check to see what surface water monitoring is taking place up stream of the AOI, see Appendix K - Surface Water Sampling)				
●	●	●	●	- Field measurements [e.g., pH, DO, specific conductance, turbidity, true color, temperature, suspended sediments, odor (presence/absence)]
●	●	●	●	- Laboratory measurements (e.g., TOC, BOD, total-Nitrogen, coliform, etc.)
●	●	●	●	- Trace elements, TOC, nutrients, radioactivity
		●	●	- Bioassays using appropriate organisms
		●	●	- Organics, VOCs
Sediments (see Appendix I - Sediment Sampling)				
●	●	●	●	- Trace elements, radioactive fallout,
	●	●	●	- Laboratory measurements (e.g., nutrient content, cation exchange capacity, TOC, organic matter, etc.)
		●	●	- Bioassays using appropriate organisms
		●	●	- Organics, VOCs
Soil (see Appendix K - Soil Sampling)				
●	●	●	●	- Trace elements, radioactive fallout,
	●	●	●	- Field measurements [e.g., typical SCS characterization data (texture, class, pH, odor (presence/absence) etc.]
		●	●	- Laboratory measurements (e.g., macronutrient content [N (total N and nitrate, P (as phosphate), cation exchange capacity, organic matter, etc.]
		●	●	- Bioassays using appropriate organisms
		●	●	- Organics, VOCs

APPLICABLE MONITORING LEVELS				POTENTIAL MEDIA TO MONITOR (Also see Tables 6.2a, 6.2b, 6.2c and the BEST Detailed Plan)
4	3	2	1	
Subsurface water (see Appendix H - Ground Water Sampling)				
	●	●	●	- Trace elements, TOC, nutrients, radioactivity
	●	●	●	- Coliform, Nitrates
		●	●	- Bioassays using appropriate organisms
		●	●	- Organics, VOCs
Aquatic Biota and Related Variables				
				Plants
●	●	●	●	- Plankton and macrophytes (biomass, diversity, distribution)
●	●	●	●	- Specific biological indicator populations
●	●	●	●	- Chemical analysis of bioaccumulator species
		●	●	- Symptoms of stress (morphologic, behavioral, physiologic, etc.)
		●	●	- Bioassays
				Animals
●	●	●	●	- Benthic Macroinvertebrates/Fish (relative abundance, age/frequency distribution, diversity)
●	●	●	●	- Specific biological indicator populations
	●	●	●	- Chemical analysis of bioaccumulator species
		●	●	- Symptoms of stress (morphologic, behavioral, physiologic, etc.)
		●	●	- Bioassays
Terrestrial Biota and Related Variables				
				Plants
●	●	●	●	- Litter, mosses, lichen for atmospheric deposition of trace elements
●	●	●	●	- Relative abundance, age/frequency distribution, diversity (especially for sensitive species)
	●	●	●	- Chemical analysis of bioaccumulator species
		●	●	- Symptoms of stress (morphologic, behavioral, physiologic, etc.)
		●	●	- Bioassays
				Animals
●	●	●	●	- Relative abundance, age/frequency distribution diversity (especially for sensitive species)
●	●	●	●	- Reproductive success
●	●	●	●	- Specific biological indicator populations
	●	●	●	- Chemical analysis of bioaccumulator species
		●	●	- Symptoms of stress (morphologic, behavioral, physiologic, etc.)
		●	●	- Bioassays

7.1.2 Data Quality Objectives (DQO)

Establishing DQOs is a critical first stage in designing a program for monitoring contaminants in the environment. The purpose of the DQO is to provide qualitative and quantitative statements about the data such that they are of known and documented quality. This will aid in the decision making process.

The Environmental Protection Agency (EPA) developed a Data Quality Objectives (DQO) process that is applicable to Service monitoring efforts. The EPA DQO process is composed of three stages (Figure 7.1b). The first stage involves the identification of decision types. The second stage is used to identify data uses and needs. The third stage involves the design of the data collection program. Note that these three stages are interactive and iterative. They are continually reviewed and updated as decisions in each stage are revised. Development of DQO and summaries from Data Quality Objectives for Remedial Response Activities: Developmental Process (EPA 1987) are provided in Section 7.1.

Though developing the data quality requirements are generally associated with the final sampling/monitoring design, awareness of the information necessary to determine the data quality requirements will help ensure that the appropriate information is collected and then considered when monitoring designs are finalized.

The following discussion describes the DQO process. Though the process was developed for EPA remediation activities, it is applicable to development of DQOs for Service monitoring activities.

The DQO process is comprised of three stages (Figure 7.1b). The first stage involves the identification of the types of decisions to be made. The second stage is used to identify data uses and needs. The third stage involves the design of the data collection program. Note that these three stages are interactive and iterative. They are continually reviewed and updated as decisions in each stage are revised. The following summaries are from Data Quality Objectives for Remedial Response Activities: Development Process (EPA, 1987).

Stage 1: Identify Decisions to be Made

Stage 1 of the DQO process provides the foundation for Stages 2 and 3. In Stage 1, all available information on the site is compiled and analyzed. Based on the available information, a conceptual model of the site is developed. This model describes suspected sources, contaminant pathways, and potential receptors. The model assists in identifying decisions which must be made as well as deficiencies in the existing information. Stage 1 is undertaken to define the types of decisions that will be made during the investigation and involves defining program objectives and identifying and involving end-users of the data. The decision maker and all potential data users should be involved in this and all subsequent DQO stages. Stage 1 results in the specification of the decision making process and forming an understanding of why new data are needed.

Stage 2: Identify Data Adequacy

Stage 2 results in the stipulation of the criteria for determining data adequacy. This stage involves specifying the level of data certainty sufficient to meet the objectives specified in Stage 1. In Stage 2 the needs and goals of the investigation will be determined and all the important decisions which will

Stage 1

Identify Types of Decisions to be Made

- **Identify and involve ultimate data users**
- **Evaluate existing data**
- **Develop conceptual diagram of the area**
- **Specify monitoring goals and objectives**

Stage 2

Identify the Ultimate Uses/Requirements of the Data

- **Identify all potential uses of the data**
- **Identify the types of data needed**
- **Evaluate the sampling/analysis options**
- **Identify data quality requirements**
- **Identify data quantity requirements**

Stage 3

Design the Data Collection Program

- **Design program**
- **Develop data collection documentation procedures**

Figure 7.1b. Key steps in developing data quality objectives.

be based on information gathered during the monitoring effort are specified. This stage also provides for the evaluation and selection of the sampling approaches, the analytical options, and evaluation of the use of a multiple-option approach to effect a more timely or cost-effective monitoring program.

Stage 3: Design Data Collection Program

During Stage 3, the methods used to obtain and analyze data as well as the quality and quantity of data required to achieve the objectives outlined in Stage 2 will be specified. This information is then written in documents such as the work plan, quality assurance project plan, or research/management study proposal. Stage 3 results in the specification of the methods by which data of acceptable quality and quantity will be obtained.

Although there are no strict rules for determining precise requirements for data quality in relation to objectives, some simplified guidelines may be useful. The general guidelines below provide some useful considerations for developing DQO, but will not apply to all monitoring activities. The specific DQO should be determined based on the objectives, plus the relative importance of the objectives, cost considerations, Service lands considerations, and the requirements of the end-users of the data.

Detection limits are primarily a function of the analytical technique used. The medium sampled can also be important in determining detection limits. For instance, sediment samples may have more interference than water, causing the detection limits to be greater. In some cases the sampling technique used can alter detection limits.

Precision is the reproducibility of analyses under a given set of conditions. It is a quantitative measure of the variability of a group of measurements compared to their average value. It is often presented as the sample standard deviation or coefficient of variation. Precision combines both sampling and analytic factors. The precision of the analysis can be controlled to some extent, but the precision of the sampling is unique to each site. Sampling precision can be improved by standard methods and trained operators using care.

Accuracy is a measured comparison to a standard value. It is a function of the sampling method, field contamination, sample medium, preservation, handling, and analysis. It can be evaluated through the use of field/trip blanks and sample spikes.

Representativeness is a judgement and is a function of the sampling design and sample collection technique. To ensure representativeness, great care must be taken in the selection of samples, and one must be able to defend such selection.

Completeness is a measurement of the percent of total samples yielding valid data. Many times it is a function of Murphy's Law: anything that can go wrong will go wrong. Many problems associated with completeness can be alleviated by designing a well thought out monitoring plan that utilizes trained individuals.

Comparability of data is a judgement. It is controlled by using the same analytic techniques, the same laboratories, expressing concentrations in the same units, collecting data in the same area or under the same conditions, etc. Consider the following scenario: monitoring of a lake that has high seasonal fluctuations in depth and concentration of contaminants. One would not compare spring

measurements with fall measurements if one was interested in determining if contamination by an 'outside' source is occurring, nor would one compare the results from an exceedingly rainy year to an exceedingly dry year and still make valid conclusions.

Below are some guidelines for consideration when addressing DQO concerns for different monitoring levels:

1. Baseline and Trend Monitoring (All Monitoring Levels)

Baseline monitoring is likely the most important part of the monitoring program. It is this data that will establish action levels if such levels are not regulated by the government. Data of low quality could lead to spurious and expensive action. Low quality data could also lead to inaction even if the area is on the precipice of an environmental catastrophe.

The detection limits should be low for contaminants that are highly toxic (or detrimental in other ways) in small quantities. The sensitivity of the bioindicator should be high for these contaminants. For the contaminants that are not a problem in low concentrations, detection limits need not be so low.

Levels of precision must be set according to the intended use of the data. Generally, precision and accuracy can be moderate (as should the sample size). Low precision and accuracy can limit the use of data and may result in inappropriate decisions. High precision and accuracy may be too expensive and impractical for baseline monitoring that needs to be conducted on a continuous basis. If trends are to be detected, high precision may be necessary for some variables. If it is too expensive, some objectives may need to be ruled out.

2. Screening (Monitoring Levels 3 and 2)

Screening requires low detection limits because it is used solely to verify the presence of a contaminant. Precision and accuracy are of less importance. In other words, it is important to have a technique that can detect the contaminant at low levels, however, the accuracy of the measured value and the ability of the technique to reproduce that value from replicate samples is less important. The verification of presence or absence is the objective of screening. The number of samples used for screening depends upon the allowed probability of not finding a hot spot. That is, if it is imperative that no hot spots exist, more samples will be necessary. The size of the allowable hot spot will also affect the sample grid size and, consequently, the number of samples.

Compositing samples can save sample analysis costs; however, there is a risk of reducing contaminant concentrations within some samples to below detection limits.

3. Contaminant Concentration Determination (Monitoring Levels 2 and 1)

A reliable value for the contaminant concentration is required when there is, or could be a contamination problem. The detection limits must be low enough that the accuracy and precision remain high. If the contaminant is in a low enough concentration that it is not considered a threat, the precision and accuracy would still need to be high or you may not be able to conclude that it is low enough to not be a threat. The need for high precision and accuracy is particularly important

when the concentration is near the action level or detection limit. If the concentration is overwhelmingly large there may not be a need for high precision, the action level is clearly exceeded.

The analysis method and detection limit selected could be based on some fraction of the concentration where the contaminant is toxic to specific biota in the area (e.g., 0.1 X the LD_{50} concentration or the regulatory requirements).

4. Monitoring when Data Might be used for Litigation Proceedings
   (This could apply to all monitoring levels, but should definitely be considered for Monitoring Levels 2 and 1)

In the event that the data may be used in litigation, data quality would have to be high, as in concentration determination. It is essential that extensive QA/QC techniques, documentation and chain-of-custody protocols be followed. Typically by following a contract laboratory program (CLP) standard, the QA/QC and documentation is well defined and would be used.

7.1.3 Trend Analysis (all monitoring levels)

Trend analysis requires weekly, monthly, or yearly samples over long periods of time at fixed stations.

There are a number of nonparametric techniques available for the detection and measurement of trends. Mann-Kendall's test for trend is commonly used. It does assume that the samples are independent, though this assumption can be somewhat circumvented by a modification to the test statistic's calculation. It also assumes no seasonality or variation due to flow rate.

An estimate of the magnitude of the trend is given by Sen's procedure. There are nonparametric techniques for detecting seasonality and for deseasonalizing data. Also control charts are useful for visually detecting trends. Discussions may need to take place between statisticians, EC Specialists, and Biomonitoring Coordinators to determine what test will be used to determine that a trend is occurring.

7.1.4 Initial Data/Contaminant Distribution/Screening (Monitoring Levels 4-2)

These objectives require a short-term, intensive study. However, if contaminants are known to migrate, more long-term data is required, possibly in conjunction with the baseline monitoring.

The initial data may provide baseline measures and information necessary to establish action levels. At some point what will initiate further studies or remedial/mitigative actions must be decided. For instance, should it be when the contaminant reaches a pre-specified mean concentration, say 2 standard deviations above the mean? Will the action levels be based on the contaminants concentration in the abiotic environment, or its concentration in the tissues of organisms? These are decisions that will have to be made for each contaminant at each Service land.

7.1.5 Sampling Design (general)

In general, sample selection should be random or stratified random. Because of the large number of variables of potential interest, a single sampling design for all contaminants or variables to be monitored using a particular medium is preferred, (e.g., use a single sampling design for all water samples, a single sampling design for the sediment samples, a single sampling design for the soil samples, etc.).

The sampling design will depend upon the homogeneity of the contaminant or variable distribution throughout the PCA. If the contaminants or variables are thought to be homogeneous within the PCA, random sampling or systematic sampling over the entire PCA can be used. Reduction of estimate error may be achieved by compositing samples (this would also reduce cost), but this could also dilute individual samples that have high contaminant concentrations (hot spots).

If the distributions of the contaminants or variables are heterogeneous, that is, they have different concentrations and/or vary in different parts of the PCA, then the PCA should be divided into relatively homogeneous strata and then sampled either by random sampling or systematic sampling within each strata. Note that in the case of standing water, at a minimum, stratification by depth will likely be required. Soil and sediment may also be stratified with depth (Figure 7.1c).

The extent of stratification and subsequent sampling will vary with the objectives of the monitoring activity. If the objective is to obtain baseline data for the PCA, a more comprehensive data set is required to characterize the area. Therefore, more strata should be sampled. However, if the objective is only to verify the presence of a contaminant or observe its effect, a single location or strata within the PCA might be adequate for sampling. This location might be one that has been identified as a sink for the contaminant or one that will provide an early indication of the contaminant via an ecological response.

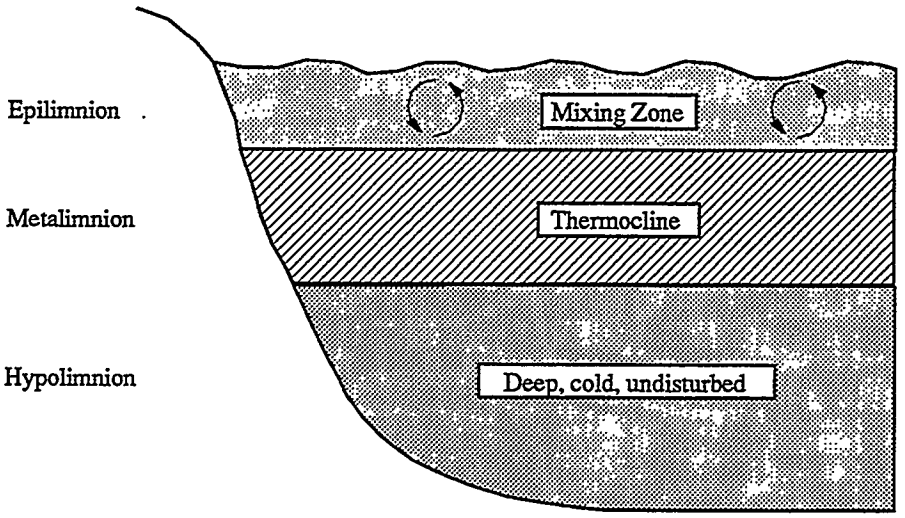
An imaginary grid of contiguous squares, rectangles or triangles can be overlaid on the surface of running or standing water, with the nodes determining sample points (Figures 7.1d and 7.1e). For simplicity, these points may determine the points in the subsurface strata also. Random number tables or other randomization techniques can be used to select the points to be sampled. If there is a potential correlation between surface and subsurface points that needs to be avoided, the same grid may be used, but reselect the sample points for the other strata.

Note that the method of selecting the PCA will bias the contaminant estimates that will result, that is, they generally will not be representative of the entire Service lands nor provide an accurate description of it (unless the contaminants are uniformly distributed). The PCA selection was based on areas that might help to determine maximum concentrations of a contaminant or show an early ecological response from contaminants. The PCA might also have been selected as a control site because it is an area that is not managed or contaminated and is therefore more representative of the natural conditions of the system.

7.1.6 QA/QC

In order for the data to meet litigative standards, appropriate quality assurance and quality control techniques should be implemented. These include startup QC to measure the ability of the laboratory to provide reliable analyses. This is conducted by Patuxent Analytical Control Facility. To continue

Stratified Standing Water



Soil Stratification

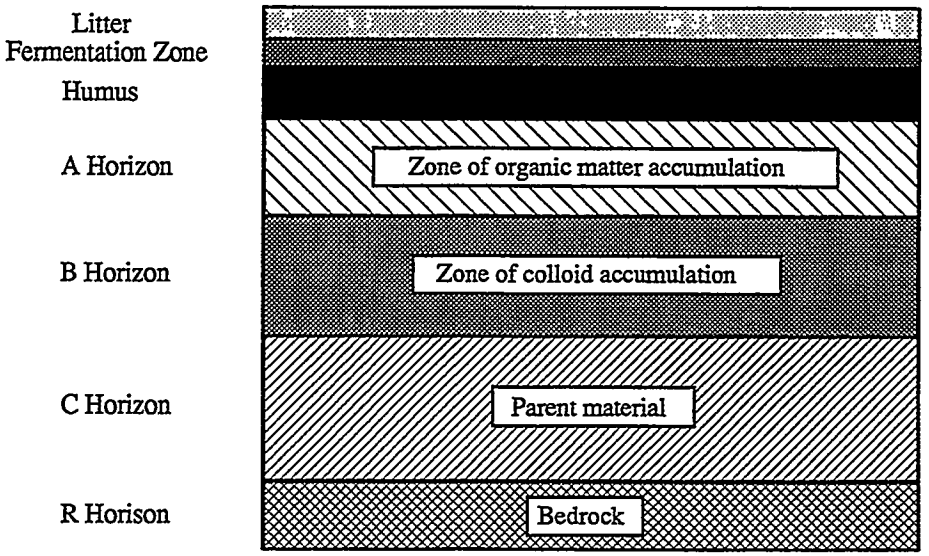


Figure 7.1c. Stratification of standing water and soil with depth.

Stream Stratification

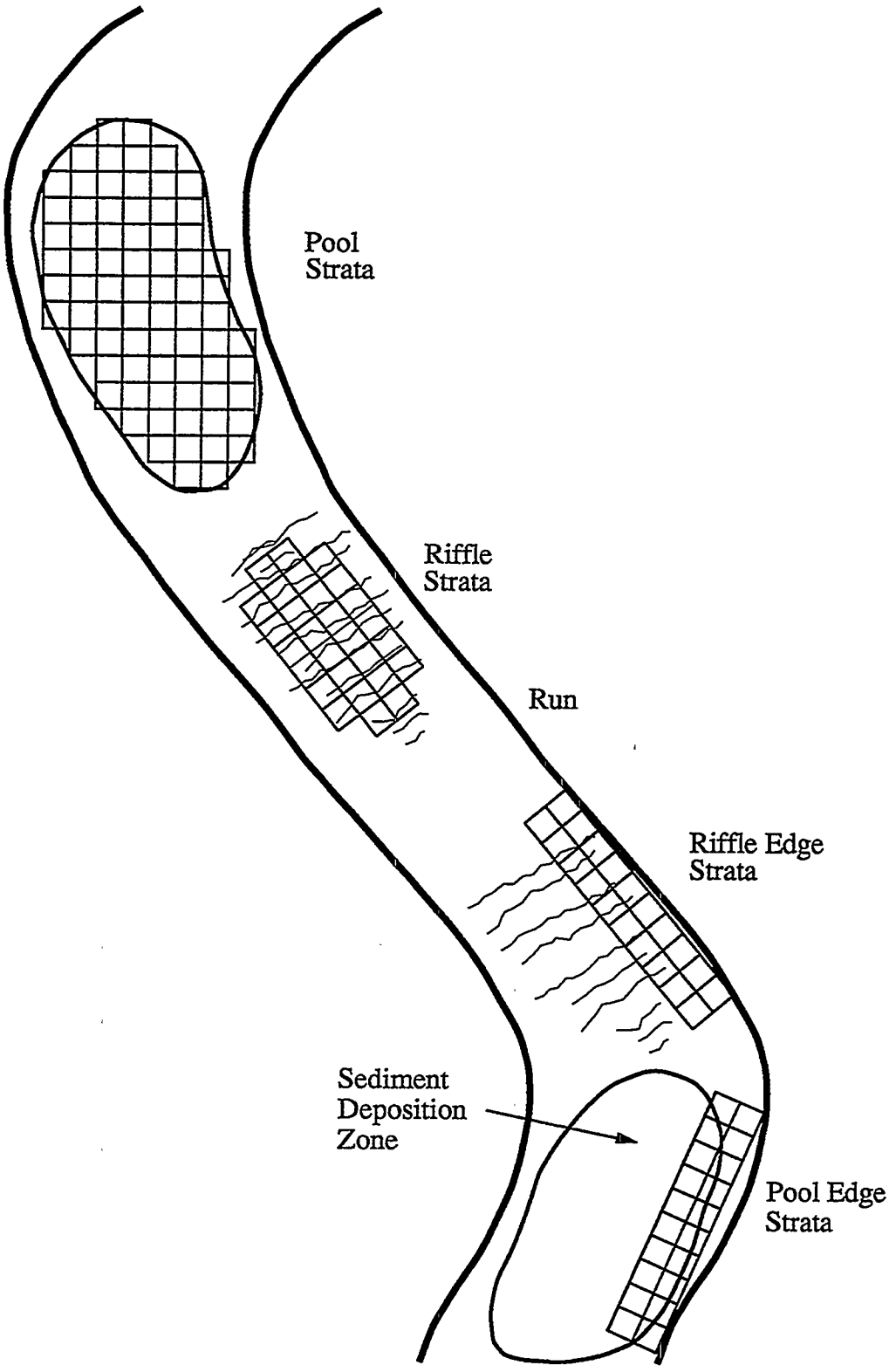


Figure 7.1d. Stream stratification - stratified random sampling grids.

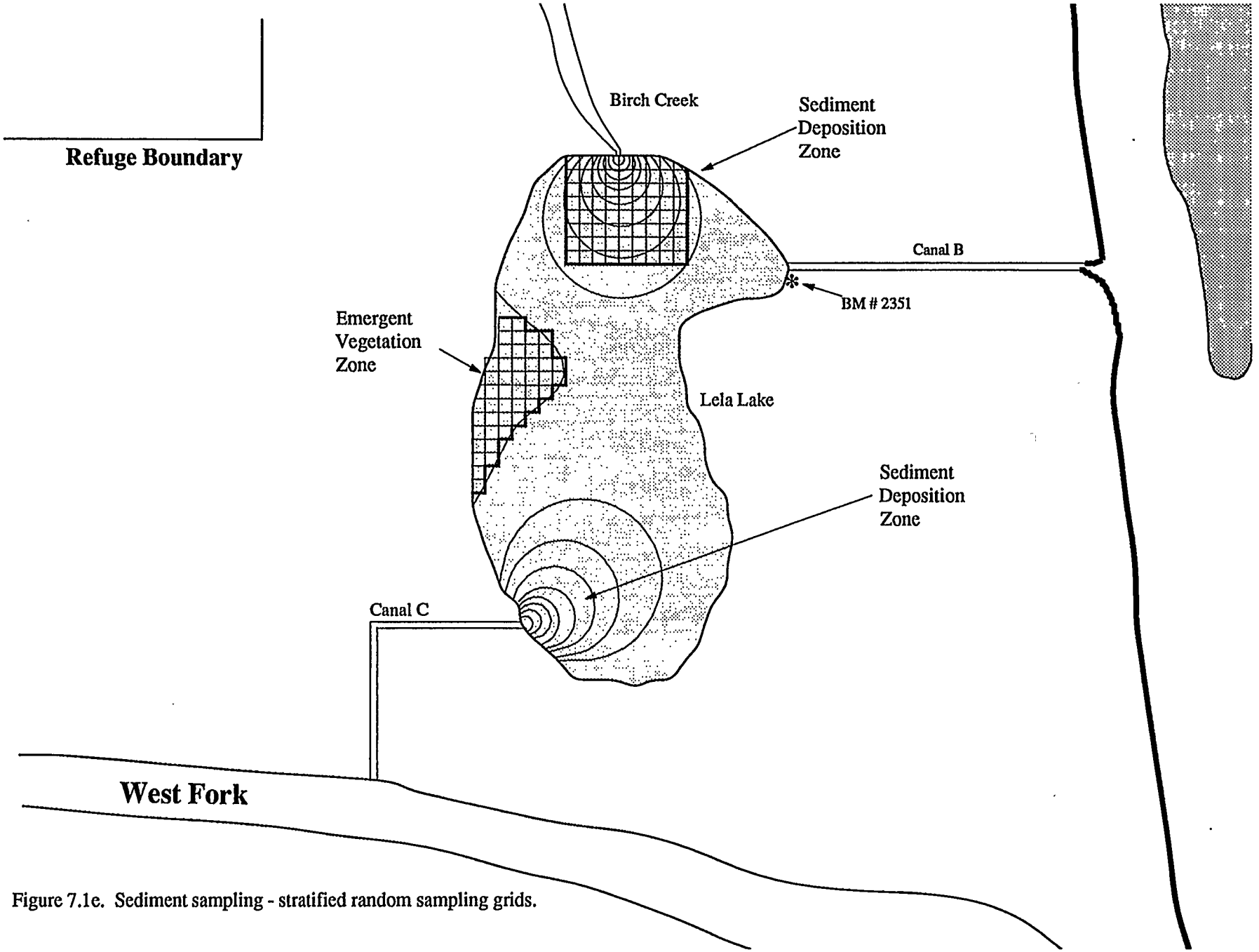


Figure 7.1e. Sediment sampling - stratified random sampling grids.

checking reliability of the analytical lab, spiked samples and control samples may be used. Sample identification, documentation, and chain-of-custody documentation are essential.

Appendix F, Documentation Guidance, Sample Handling, and Quality Assurance/Quality Control Standard Operating Procedures provides QA/QC information and procedures. This document should be reviewed and followed when addressing QA/QC issues.

7.2 Contaminant Biomonitoring Design Development

MATERIALS/INFORMATION

Worksheets WS-2.5a&b, WS-3.2, WS-4.2, WS-6.1b, WS-6.3, WS-7.2
Section 7.1.1 (Monitoring Levels)
Large scale maps of each PCA
All RFMs for the media being considered for sampling

PROCEDURES

The information compiled below will assist in writing a proposal for contaminant monitoring activities.

1. On Worksheet WS-6.1b, fill in the Contaminant Priority Level from Worksheet WS-4.2 for each listed contaminant.

2. Determine the Contaminant Monitoring Level. The contaminant monitoring level will provide an indication of the level of effort for monitoring a particular contaminant or variable (e.g., sampling frequency, the number of sample points, the number and spatial distribution of media/variables to be monitored, the types of analyses conducted, etc.). The monitoring level is based on the potential for a contaminant to reach the Service land. Use the definitions in Section 7.1.1 and the Potential Exposure Value in Worksheet WS-4.2 to determine the Contaminant Monitoring Level for each contaminant identified on Worksheet 6.1b. Record this level in the appropriate location on Worksheet WS-6.1b.

3. An important tool for developing the sampling design is a large scale map of the monitoring site with physical/biotic conditions, habitat types, orientation, scale, etc. noted. Obtain, or draw, a surface features map that provides this information and note specific areas containing the media/variables being considered for monitoring at each PCA. Identify a benchmark or permanent landmark where coordinates will be obtained for the site. Provide a scale bar, North arrow, date, sign your name. Make copies as necessary and incorporate sampling grids if one will be used as a part of the design. This map will be used to identify and document sampling locations for the PCA.

   NOTE: If a GIS map can be produced, this is preferred. Copying a USGS 7.5' topography map will also work well as a base map for drawing the monitoring site maps.

4. Determine the sampling methods to be used. For each medium/variable identified on Worksheet WS-6.1b to be sampled/measured, use the appropriate RFM, or other validated and accepted methods, and record the method to be used in the appropriate column. If an alternative method is to be used, mark the space "other" and document the procedures that will be used.

5. Discuss the monitoring design considerations listed above and the information collected in this Workbook with other EC Specialists, Biocoordinators, and/or statisticians as necessary to develop a final sampling design for each contaminant at each monitoring site.

   Use the purpose and rationale for the selected Monitoring Level to help guide the sampling design. Considerations for monitoring activities and the associated level of effort is provided in Section 7.1.1. Use this information, the BEST Detailed Plan, and other literature to assist in design development.

   Ensure that the specific objectives for monitoring are addressed when designing the monitoring plan.

6. On Worksheet WS-6.1b, complete the following for each contaminant being monitored:

   - The frequency or number of times the medium/variable will be sampled/measured per year
   - The number of samples required for each sample period

7. Using the map(s) from #4 above, locate the sample plots and/or individual sample locations for each sample type at each monitoring site. Identify each location with a number and put it in the appropriate space on Worksheet WS-6.1b.

8. Discuss the rationale for the sample design decisions made and provide any general comments that could be useful to remember in the future.

9. **IF** an overview worksheet is desired that summarizes all the monitoring sites and associated contaminants/water quality parameters being monitored, complete Worksheet WS-7.2.

   a. List the contaminants, indicator, variables, or water quality parameters down the 1st column.
   b. List the monitoring site identification numbers across the top.
   c. Using one Worksheet WS-6.1b at a time, put the monitoring level for each contaminant/variable for that site in the column under the appropriate monitoring site number. Complete this for each monitoring site.
   d. In the "Overall Contaminant Monitoring Level" column, put the lowest number in that row. This will give an indication of the contaminant's risk and the level of effort for monitoring this contaminant, (e.g., contaminant X has a monitoring level of 2, indicating that it is likely present, however no problems have been documented at this time).
   e. In the last row at the bottom of the worksheet, record the lowest number in the column. This will provide an indication of the risk from contaminants at this monitoring site and the level of effort for monitoring at this site, (e.g, this monitoring site has a monitoring level of 1, indicating that contaminant problems have been identified here and an intensive monitoring effort is likely being implemented here).
   f. In the last column of the last row record the lowest number in the last row. This indicates whether the Service lands has any contaminant problems at present and the status at the worst

case monitoring site. A 2 would indicate that the Service lands has a least one monitoring site that has identified and least one contaminant as present or likely present. The monitoring activities associated with this level would provide information regarding contaminant spatial, temporal, and media distribution. They would also help identify if and where effects were occurring.

9. If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

WS-7.2 INDEX TO MONITORING SITES AND CONTAMINANT MONITORING LEVELS Page __ of __

	Contaminants or Water Quality Parameters Being Monitored (WS-4.2)	Monitoring Site Numbers (WS-6.1a)																		Overall Contaminant Monitoring Level
		TS27.5S	IS05M	IS07M																
1	Arsenic	1	2	2																1
2	Cadmium	1	2	2																1
3	Lead	1	2	2																1
4	Mercury	1	2	2																1
5	Selenium	1	2	2																1
6	Aldrin	2	2	3																2
7	p,p'DDT	2	2	3																2
8	p,p'DDE	2	2	3																2
9	Dieldrin	2	2	3																2
10	Nitrate+Nitrite as N	2	2	3																2
11	Total Phosphorus	2	2	3																2
12	Ammonia	2	2	3																2
13	Temperature	3	2	3																2
14	pH	3	3	3																3
15	Conductivity	3	3	3																3
16	Dissolved Oxygen	2	2	3																2
17	Salinity	2	3	3																2
18	Alkalinity	3	3	3																3
19	Hardness	3	3	3																3
20	Total Suspended Solids	2	3	3																2
	Monitoring Level for Monitoring Sites	1	2	2																SL Monitoring Level
																				1

7.3 Implementing Biomonitoring Activities

7.3.1 Logistic Considerations for Monitoring Activities.

In addition to the technical requirements, the logistical requirements associated with monitoring need to be considered. Below are some of the considerations that will need to be addressed prior to implementing monitoring activities for the Service land. Worksheet WS-7.3 is provided to document some of the funding and personnel requirements for the monitoring program.

The information collected for Worksheet WS-7.3 will help determine funding requirements for the monitoring activities. If funding is not available for conducting all the planned monitoring activities documented on the worksheets, a reevaluation of the monitoring strategy will be required. Priorities will need to be further evaluated for focusing monitoring activities.

The following considerations should be addressed to determine funding needs:

Personnel Requirements

- Are the personnel required to implement the contaminant monitoring activities available?
- Are there plans to hire additional personnel?
- How many additional personnel are needed?
- Estimate costs for additional personnel ($K).
- Are personnel appropriately trained to conduct monitoring activities?
- Are there special requirements for handling highly toxic samples?
- Are personnel trained in handling and shipping procedures?

Sampling/Sample Processing Requirements

- Are the required equipment/materials available?
- Are the necessary materials available for sample processing?
- Are packaging and shipping materials available?
- Are sufficient funds available for sample analysis?

7.4 Additional Information Requirements

This concludes the activities associated with development of a monitoring strategy for the Service land. The following information should now be documented:

- Management goals and objectives for the Service lands (WS-2.1)
- Existing information relevant to contaminants and monitoring (WS-2.2a)
- Field reconnaissance information (WS-2.2b)
- Monitoring assessment considerations for the Service lands (WS-2.3)
- Information regarding off-Service land areas important to trust resources (WS-2.4a, WS-2.4b)
- Monitoring goals for the Service lands (WS-2.6)
- Public outreach workshop input (WS-2.7)
- Contaminant transport mechanisms and pathways associated with the Service lands (WS-3.1.2a-d, WS-3.1.3)
- Potential contaminant sources and associated contaminants within the AOI (WS-3.2)
- Key species for the Service lands (WS-3.4)
- Key physical and biotic associations between the contaminant sources and key species (conceptual model, Section 3.5)

- Toxicity data for trust resources using the Service lands (WS-4.1) and a priority list of contaminants associated with the Service lands (WS-4.2)
- Monitoring objectives for the Service lands (WS-5)
- An index to all monitoring sites (WS-6.1a)
- A list of PCA(s), reference monitoring sites, the associated contaminants and variables to monitor, the appropriate media to sample, and index period to monitor them (WS-6.1b)
- A map of each PCA with notes regarding its physical/biotic variability (Section 7.2)
- The sampling methods to be used and equipment, personnel, and resources requirements (WS-6.1b, WS-7.3)
- Training requirements (WS-7.3)

Document additional information required to complete this Workbook on Worksheet WS-1. Other information not addressed by this Workbook that is relevant to implementing contaminant monitoring activities should be discussed in the box provided. Worksheet WS-1 is a part of the Workbook Summary discussed at the beginning of the workbook. The Workbook Summary contents are discussed in Section 1.

Example: Minidoka National Wildlife Refuge March 22, 1993

WS-7.3 LOGISTIC CONSIDERATIONS AND COSTS FOR MONITORING ACTIVITIES Page __ of __

Monitoring Site #	TS27.5S		Project #	001-93-R1-14614	Date	3-25-93
Project Title/Description	Reconnaissance Investigation of Water Quality, Bottom Sediment, and Biota Associated with the Minidoka NWR					

	Contaminant, Water Quality Parameter, or Biotic Variable Being Monitored (WS-6.1b)	Medium to be Collected for Sample Analysis (WS-6.1b)	Personnel or Training Needed? (7.3)	Total # of Samples per Year (WS-6.1b)	Type of Analysis (7.2)	Analysis Cost per Sample (7.3)	Total Sample Analysis Costs	Total Materials Costs	Total Equipment Costs	Total Training Costs	TOTAL COSTS
1	Trace elements	tissue/sediment	Y	4	Metal Scan (Method determined by EPA approved lab)	225	900	30			930
2	Trace elements	water	Y	4	Metal Scan (Method determined by EPA approved lab)	185	740	30			770
3	Organochlorines	water/tissue/ sediment	Y	4	OC Scan (Method determined by EPA approved lab)	375	1,500	60		100	1,660
4	Grain Size	Sediment	Y	4	Grain Size test	45	180	25			205
5	Total Organic Carbon	Sediment	Y	4	TOC	40	160	25			185
					GRAND TOTAL		3,480	170	0	100	3,750

Personnel/Training Needs:	Training for sampling technique, sample preservation, and sample shipment
Material/Equipment Needs:	Metals (500 ml HDPE bottles), OCs (1000 ml amber glass with septums), Grain Size (250 ml HDPE), TOC (125 ml borosilicate glass).
Other Comments:	There will be additional travel expenses.

8. DATA EVALUATION AND RECOMMENDATIONS

8.1 Evaluating Monitoring Data

An extensive amount of effort and expense is required for a comprehensive monitoring program. This includes sample design, collection, and analysis. The next task involves converting the raw data into useful information that can be used to assess the status and trends of contaminants and provide input to management decisions. This conversion process was reviewed by the National Research Council (NRC 1990) in an evaluation of "The Role of Marine Environmental Monitoring". Although this is focused on the monitoring of marine systems, several points are worth consideration for FWS monitoring activities.

Numerous sources of expertise are available within the Service that can assist data analysis. Expertise can be accessed through the Service's Research Centers, Division of Environmental Contaminants, other governmental agencies, universities, and special interest groups.

Conversion of monitoring data into relevant information involves a range of activities including data management, statistical analysis, predictive modeling, and fate and effects research. Each of these activities is discussed in this section.

8.1.1 Data Management

The major function of data management activities is to provide easy access to the collected data and related information (e.g., historical trends data, research data, model outputs, data summaries). Because of the amount and complexity of the data that are collected by most monitoring programs and the variety of reports and analyses that are produced, a computer-assisted data management system is usually essential.

To define and select the appropriate data management system, data managers should determine the:

- expected amount of data
- long-term uses of the data
- existing data management capabilities
- number, background, and relationships among data users
- types of analyses to be conducted
- quality assurance/quality control and report requirements.

This information can help ensure that a system with the required capacity and degree of access necessary is available. If the DQO process described earlier was followed, these issues should have been considered.

Monitoring data are frequently not incorporated into a data management system until most data collection is complete. At this point, there may not be enough time or money to create an adequate data management system. This situation lessens the utility of the monitoring data to scientists within and outside the Service. Data management activities are as important to the success of monitoring programs as the collection of data. Therefore, they should be included as a necessary component of the monitoring program. Reports that summarize the types, amount, and quality of data should be prepared and distributed to potential users on a regular basis.

The Service is developing the Environmental Contaminants Data Management System (ECDMS). This will be a central location to store monitoring data. If the ECDMS or another system is used, the monitoring data and relevant model results should be included in both raw and reduced form to eliminate costly reanalysis. In addition, information on the site characteristics, the personnel responsible for data collection and storage, and a brief description of sampling methods, data format, quality control procedures, and how to access the data should be components of each data set.

8.1.2 Data Analysis and Assessment

The goals of analysis activities are to summarize and simplify the collected data, test for change and differences, generate hypotheses, determine the consequences of observations, and evaluate the uncertainty associated with conclusions drawn from the data. Analysis programs should be developed prior to data collection. This development should include both statistical testing and modeling to ensure that the analysis approach is appropriate to the sampling design and the sampling methods.

Support to develop analysis programs is available through the various FWS Research Centers (e.g., Columbia, Patuxent). Service personnel at these Centers can help select and design statistical analysis procedures.

Successful analysis programs cut across institutional and media boundaries; partition spatial and temporal variations into their major sources (natural and human induced); are based on an understanding of linkages among physical, chemical, and biological attributes; use standard verified modeling approaches, statistical packages, and analysis/data management packages; state and determine the consequences of assumptions inherent in the sampling design and analysis approach; evaluate the sensitivity of analyses to assumptions; and summarize analysis results using easily understood graphs, maps, and tables.

Numerous publications are available to help identify the most appropriate test, conduct the test, and interpret the results (e.g., Green, 1979). Predicting the responses of complex ecological systems to human activities and assessing their status and trends with reliability are a difficult problem. Simulation models are an assessment tool that can be used to describe environmental complexities while allowing these complexities to be used in forecasting the consequences of environmental change. Simulation models are based on essential system attributes.

Development of predictive models and the interpretation and synthesis of monitoring data and model outputs can be a useful tool to help develop management strategies for Service lands. Models may not be warranted for all cases, but should be discussed between the EC Specialists, Regional Biocoordinators, and Research personnel. In many cases they can help identify how current conditions can develop into future problems. Using models can be a good anticipatory management tool. Research and information from the literature are the basic elements in developing predictive models, and the interpretation and synthesis of monitoring data and model outputs. These are important processes for establishing cause-effect relationships. Correlations and relationships identified during the analysis of monitoring data (e.g., Cairns, Dickson, and Maki, 1978; Smith, Bernstein, and Cimberg, 1988; Holland, Shaughnessy, and Hiegel, 1986) can be an important source of ideas for future experiments and measurements. Monitoring programs (e.g., irrigation drainwater studies) have been significantly enhanced by a close association with ongoing research programs designed to understand the fate and effects of discharged wastes. Many times research results on or adjacent to Service lands will need to be reviewed to determine if information from the programs can be transferred effectively.

Resources allocation for analysis activities are frequently not commensurate with those for data collection. For example, results from the monitoring program for assessing the condition of the Chesapeake Bay found that far too little attention and resources were directed at data analysis and synthesis relative to the investment made to collect the data. **Data should not be collected unless a commitment is made at the outset that support for analysis activities will be appropriate for data collection.**

One method to address the above problem is to use a phased analysis approach. In such an approach, the data collected early in the monitoring program are used to develop and refine analysis methods, classify the data into spatial and temporal components, determine the adequacy of the sampling design and methods, define the status and its relationship to historical conditions, and develop a preliminary understanding of links between components and processes.

8.1.3 Presenting Results

The results of a monitoring program should be disseminated to a range of audiences and at several technical levels. Monitoring programs that produce only technical reports that only summarize data and scientific findings are not likely to show the public or decision makers that the information is essential to better environmental protection or management decisions. Useful management information is produced only when it is delivered to managers and decision makers in a usable, accessible form.

The different reports should consider the target audience, discuss what the current information means, the analyses that remain to be completed, why additional data collection and analyses are needed, and the management decisions to be made using the information.

8.1.4 Using Monitoring Results for Management of Service Lands

Management plans should be designed to predict the future effects of management decisions. The planning process for environmental contaminant issues should answer the following questions:

- What is the present condition of the ecosystem? What are the current contaminant problems and the sources of these problems? How widespread and significant are they?
- What will be the condition of the ecosystem in 10-15 years, given projected uses and current approaches to managing these problems?
- What should be the condition of the ecosystem, based on present or projected future environmental quality expectations?
- What can be done and what are the tools needed to achieve the desired results?

The answers to these questions should lead to development of a set of actions to achieve some future level of environmental quality. One of the key steps is to determine what environmental data are needed to support effective actions within the management plan.

Assessment of trends in environmental indicators and ultimate effects of those trends can provide significant insight for managers. For example, trends of specific contaminant levels in estuaries can be used to determine the most appropriate targets for actions and to assess their effectiveness.

Management of the environment and the associated monitoring programs must consider the risks and uncertainties inherent in most actions. Monitoring is limited in terms of its ability to quantify changes and to identify their causes. These limitations should be stated upfront, understood, and incorporated in the decision-making process.

The reality of an imperfect understanding of ecosystems indicates that monitoring should be used as an opportunity to increase and refine this understanding. Data and information derived from monitoring programs should be used to check, validate, and refine the assumptions, models, and the understanding on which the monitoring is based. This iterative feedback can increase predictive ability, reduce uncertainty, and ultimately reduce the monitoring effort needed. Risk-free decision making is not achievable, and monitoring should be viewed as a way of reducing uncertainty, not of eliminating it.

8.2 Assessing the Need to Implement Actions

This section provides a brief discussion and some considerations to address when determining when to implement additional contaminant monitoring, or related activities. Specific actions and their implementation criteria should be established for the Service lands and individual PCAs. The refuge personnel, the EC Specialist, and other Service Contaminants and Research personnel should be involved in this task.

After data analysis and an assessment of the contaminant and ecosystem status at the Service lands or PCA, a decision needs to be made regarding how to respond to identified contaminants and/or to variables responding to a contaminant.

Potential responses range from:

- No change in current monitoring activities
- Increase the number of media and/or variables being monitored
- Increase the spatial and temporal resolution of monitoring for a contaminant or variable
- Initiate special studies
- Initiate mitigative and/or remediation activities.

The extent of the response will depend on:

- Relevant regulations
- Potential affects on human health
- Confidence in the data
- If a trend has been identified and its significance
- The toxicity of the contaminant to key species
- The risk to the ecosystem
- Potential consequences of inaction
- The extent (distribution, concentration, and/or effect) of the contamination or ecosystem response
- Established action levels and how they were determined.

Specified activities should be implemented in response to action levels (AL) that have been established to address potential contaminant concerns at the Service land. Criteria for establishing action levels will vary for different areas, but will generally reflect the following considerations:

- Regulatory limits

- Contaminant characteristics
  - toxicity
  - persistence in the environment
  - mobility
  - bioavailability, bioaccumulation, biomagnification
  - synergistic effects

- Key species
  - sensitivity
  - probability of exposure
  - importance to the system or management goals
  - habitat and ecosystem condition requirements

- Contaminant source characteristics
  - ability to control releases
  - flux rates
  - location
  - temporal aspects of release

- Contaminant transport mechanism
  - transport medium
  - temporal variability

- Service land or PCA abiotic characteristics - air, sediment, soil, water (e.g., pH, temperature, conductivity, chemistry, etc.)

- Difficulty in mitigating or remediating contaminant effects if released (e.g., the more difficult, the lower the AL should be)

- How the implemented actions will affect current monitoring activities

An example of a method for addressing contaminant concentrations and associated actions is provided in Table 8.2a.

A different method could be developed for ecological variables that are measured as a part of the monitoring program. In this method enough baseline data for the variable would be necessary to establish a mean at the PCA. Once this has been determined, action levels could be established. An example is shown in Table 8.2b.

It is important to note that the specific variable being measured and the characteristics of the Service lands will determine the mean, standard deviation (SD), and other factors that will need to be considered for this method. That is, the actual limits for each monitoring level may vary with each variable, at each Service land or monitoring site. Additionally, the conditions at the Service lands could already be stressed, or affected in other ways, consequently the means that have been established for the area might not represent those of an area with more desirable conditions. Use of control sites for such situations will help minimize this potential bias.

Another potential method (Table 8.2c) is to consider minimum populations, habitat area, productivity, or other conditions necessary to maintain (or enhance) the ecosystem. These values could be used to establish action levels for the Service lands by using a percentage of the desired value to establish the

Table 8.2a. Example of Action Levels for Contaminant Concentrations.

Criteria[a]	Action
[ ] < DL or [ ] is within natural levels for the area NOTE: (in this case the element or substance would not meet the definition of a contaminant)	Monitoring Level 4 Activities
DL < [ ] < .1R	Monitoring Level 3 Activities
.1R < [ ] <.5R	Monitoring Level 2 Activities
.5R < [ ]	Monitoring Level 1 Activities
[a] Where: [ ] = the concentration DL = the detection limit R = the regulatory limit or a [] where effects are thought to occur in important species (if the contaminant is bioaccumulated or biomagnified, this value should be reduced to consider this effect)	

NOTE: This example is used for illustrative purposes only, the values selected are arbitrary and should not be used unless they are reviewed and determined to be appropriate for the contaminant selected.

value ranges for each monitoring level. It will be difficult to determine what the actual requirement values are until the appropriate data are available, but if this method is suitable for the Service land, obtaining this data should be included as a part of the monitoring program. Information from the literature can also be used to establish these values.

The information compiled for prioritizing the contaminants to monitor is directly applicable to establishing action levels and should be reviewed for this task. Many of the considerations used are the same and many of the toxicity values can be used for this effort.

Table 8.2b. Example of Action Levels for Ecological Parameters.

Criteria[a]	Action
V < 2 SD from the mean parameter value	Monitoring Level 4 Activities
2 SD < V < 2.5 SD from the mean parameter value	Monitoring Level 3 Activities
2.5 SD < V < 3.5 SD from the mean parameter value	Monitoring Level 2 Activities
V > 3.5 SD from the mean parameter value	Monitoring Level 1 Activities

[a] Where: V = the measured value
SD = the standard deviation for the parameter being measured.

NOTE: This example is used for illustrative purposes only, the values selected are arbitrary and should not be used unless they are reviewed and determined to be appropriate for the parameter selected.

8.3 Evaluating the Monitoring Program

Any monitoring activities should be evaluated on a regular basis to determine if they are addressing the objectives of the monitoring program. If they are not, then actions should be taken to address the shortcomings. The review should also evaluate the specific monitoring goals and objectives to determine if the monitoring data are providing the information necessary to make appropriate management decisions.

A review of the contaminant and environmental variable data, and a reassessment of the components that were used to develop the monitoring program should take place each year. Below is a list of considerations to be addressed before beginning each monitoring cycle. These questions should be answered for the entire Service lands as well as for each individual PCA. Given the probability that some of the conditions or management goals will change, and that additional information regarding contaminant toxicity will become available, partial reassessment of the Service lands will likely be necessary.

- Review the information compiled for the Workbook (Appendix B) and update as necessary.
  - Are there sections in the Workbook that were not completed previously (see WS-1) ?

Table 8.2c. Example of Action Levels Based on Desired Ecological Conditions.

Criteria[a]	Action
$V \geq .9R$	Monitoring Level 4 Activities
$.9R > V > .8R$	Monitoring Level 3 Activities
$.8R > V < .7R$	Monitoring Level 2 Activities
$.7R \geq V$	Monitoring Level 1 Activities

[a] Where: V = the measured value
R = the value required (desired) to maintain the ecosystem

NOTE: This example is used for illustrative purposes only, the values selected are arbitrary and should not be used unless they are reviewed and determined to be appropriate for the ecological condition selected.

  - Have any management goals, AOIs, contaminant sources, contaminants, transport pathways, key species, contaminant priorities, etc., changed for the Service lands?
  - Have any monitoring goals changed for the Service lands?
  - Has additional relevant information become available?

- Are the goals and objectives for the overall Service lands monitoring program being addressed?
- Does the information generated from the monitoring data address management decision needs?
- Is the data collected appropriate for the specified PCA goals and objectives?
- Does the data collected provide the information required to answer questions or test hypotheses about the contaminant conditions and/or ecosystem health status at the Service lands or any off-Service land areas being monitored?
  - Would other media or variables provide better information than those selected?
  - Can the spatial or temporal components of the monitoring activities be improved?
- Will the data or additional information collected over the previous year affect the contaminant monitoring activities for the coming year(s)?
- Should new activities be implemented to enhance current monitoring efforts (e.g., new special studies, sample another medium or new locations, increase temporal resolution, etc.)?

- Can any monitoring activities be reduced or discontinued as a result of new information, techniques, or a change in goals and objectives, etc.?

- Should the monitoring design be changed? This may result from the availability of new techniques or from new information about the characteristics of the monitoring sites, the contaminant sources, the contaminants, or receptors, etc. **It is important to "calibrate" new methods and/or techniques with those used previously. This will allow comparison of the new data with that collected using the old methods.**

- Are sampling equipment, materials, and storage space available.

- Will personnel be available at the appropriate time for sampling and sample processing?

- What funding resources are available for the coming year?

- Is more support needed for monitoring activities (sample collection and analysis, data analysis, etc.)?

Each year there should be an evaluation of the monitoring activities and associated data to discuss potential improvements to the monitoring activities. Worksheet WS-8.3 is provided to document the results, interpretations, and recommendations for future activities.

Adjustments in the monitoring program for the Service lands may need to be made after completing this evaluation. The Workbook should be updated with new information and can be used for continuation or revision of the monitoring activities. A new monitoring proposal for the coming year should be submitted with the justification for any changes in the monitoring program. If significant changes are recommended to the monitoring strategy, some overlap of the new and old activities may be necessary to allow for comparison of data.

If additional work remains to be done on this task or additional information is required, document these needs on Worksheet WS-1.

WS-8.3	DOCUMENTATION OF MONITORING RESULTS AND INTERPRETATION			Page __ of __
Monitoring Site Number	TS27.5S	Project Number	001-93-R1-14614	
Purpose & Objectives	Quantify water quality, trace metals, organochlorines, and nutrients in order to assess impact on the refuge			

	Contaminant, Water Quality Parameter, or Biotic Variable Monitored	Line of Evidence	Results	Interpretation of Results	Recommendations and Rationale for Future Activities
1	Mercury (sediment)	4-Chem.	0.5 mg/kg dry weight	Concentration is considered elevated, exceeding the state's 90th percentile value of 0.32 mg/kg dry weight	Continued monitoring is recommended. Increased concentrations may pose detrimental to biota.
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
15					

Lines of Evidence

1. Biomarker/organism health 2. Bioassay or toxicity testing 3. Population or community indices 4. Chemical Analysis

9. WORKSHEETS

WS-P	Workbook Revision Worksheet
WS-1	Status of Information for Workbook
WS-2.1	Management Goals and Objectives for These Service Lands
WS-2.2a	Existing Contaminant and Monitoring Information
WS-2.2b	Field Reconnaissance Data Worksheet
WS-2.3	Assessment Considerations for the Service Lands Biomonitoring Activities
WS-2.4a	Index to Local Off-Service Land Areas Important to Trust Resources
WS-2.4b	Assessing Local Off-Service Land Areas Important to Trust Resources
WS-2.5a	Federal Laws Relevant to Monitoring
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Workbook Revision Worksheet WS-P

Use this worksheet to document suggested revisions (make a copy for your files) and send it to:

U.S. Fish and Wildlife Service
Division of Environmental Contaminants
4401 North Fairfax Drive, Room 330
Arlington, VA 22201

Commentor's Name		Phone	
Address			
Section to be revised		Page (s)	
Paragraph number(s) (1 = paragraph at very top of page)		Line number(s)	
Suggested Revision:			
References (if applicable):			

WS-1	STATUS OF INFORMATION FOR WORKBOOK	Page of
Section #	Discussion of status and information still needed for each section	
2.1		
2.2		
2.3		
2.4		
2.5		
2.6		
2.7		
3.1		
3.2		
3.3		
3.4		
3.5		
4.1		
4.2		
5.		
6.1		
6.2		
6.3		
7.1		
7.2		
7.3		
7.4		
8.		

WS-2.1	MANAGEMENT GOALS AND OBJECTIVES FOR THESE SERVICE LANDS Page __ of __
1	
2	
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WS-2.2a	EXISTING CONTAMINANT AND MONITORING INFORMATION				Page __ of __
	Ref. Material or Contact, Affiliation, & Phone #	Cont. Source *	Cont. Category *	Brief Description of Information	Relevance to Monitoring (location, species, reference site, time of year, etc.)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

WS-2.2b	FIELD RECONNAISSANCE DATA WORKSHEET				Page __ of __
Personnel on Trip				Date	

	Area Visited (Name/Specific Location)	UTM Coordinates X (long)	Y (lat)	Habitat/Land Use	Flora/Fauna Present	Description	Comments Relevant to Monitoring
1							
2							
3							
4							
5							
6							
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8							
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10							
11							

WS-2.3 ASSESSMENT CONSIDERATIONS FOR THE SERVICE LANDS BIOMONITORING ACTIVITIES

Rank	Assessment Considerations	Group Code*	Description and Comments Regarding Importance to Monitoring Activities
	Amphibians	AM	
	Anadromous fishes	AF	
	Catadromous fishes and invertebrates	CA	
	Raptors	RA	
	Seabirds	SB	
	Shorebirds	SH	
	Waterfowl	WF	
	Other aquatic birds	QB	
	Other migratory birds	MB	
	Other resident birds	RB	
1	Federally listed threatened & endangered, or candidate species (including research)	ES	
	Exotic/Pest Species	XS	
	Other freshwater species	FW	
	Macroinvertebrates	MI	
	Mammals - Marine	MM	
	Mammals - Terrestrial	MT	
	Marine organisms other than mammals (including invertebrates)	MR	
	Plants-aquatic (food/cover, native habitats, etc.)	AP	
	Plants-terrestrial (food/cover, native habitats, etc.)	TP	
	Reptiles	RE	
	State listed or candidate species	SL	

WS-2.3 ASSESSMENT CONSIDERATIONS FOR THE SERVICE LANDS BIOMONITORING ACTIVITIES

Rank	Assessment Considerations	Group Code*	Description and Comments Regarding Importance to Monitoring Activities
	Wildlife/other resident species	RW	
	Other species	OT	
	On-Site Pest Management Activities	PM	
	Biodiversity		
	Geographic location of the area (feeding/staging area, good climatic conditions, breeding area, etc.)		
	Recreational activities (consumptive and nonconsumptive)		
	Research (for other than T&E species)		
	Economic uses (grazing, haying, mining, logging, oil)		
	Other (e.g. wilderness, subsistence, military)		
	Previous baseline or reference monitoring		
	Documented or suspected contaminant concerns		
	Other:_____		
	Other:_____		

GENERAL HABITATS/COMMUNITIES ON THE SERVICE LANDS

Upland Formations			
	Agricultural Lands	AG	
	Tundra	T	
	Forest (>50' trees)	F	
	Woodland (<50' trees)	W	
	Scrubland (<31'-multibranched)	S	
	Grassland	GR	
	Desertland (<12" precip.)	D	

WS-2.3 ASSESSMENT CONSIDERATIONS FOR THE SERVICE LANDS BIOMONITORING ACTIVITIES

Rank	Assessment Considerations	Group Code*	Description and Comments Regarding Importance to Monitoring Activities
	Other Uplands: _____	OU	
	Other Uplands: _____	OU	
	Other Uplands: _____	OU	
	Wetland/Aquatic Formations		
	Wet Tundra	WT	
	Swampforest/Riparian	SF	
	Swampscrub/Riparian	SS	
	Freshwater Marshland	FM	
	Strandland (beach)	ST	
	Saltflats/Mudflats	SM	
	Submergent Aquatic	SA	
	Managed Wetlands	MW	
	Lake/Pond/Impoundment	L	
	Riverine	RS	
	Marine	M	
	Estuarine	E	
	Other Wetlands: _____	OW	
	Other Wetlands: _____	OW	
	Other Wetlands: _____	OW	

WS-2.4a INDEX TO LOCAL OFF-SERVICE LAND AREAS IMPORTANT TO TRUST RESOURCES

Page __ of __

Off-Service Land Area		Description of Area and Importance to Service Land Monitoring
Area Name		
Location		
Contact and Phone #		
Status*		
Area Name		
Location		
Contact and Phone #		
Status*		
Area Name		
Location		
Contact and Phone #		
Status*		
Area Name		
Location		
Contact and Phone #		
Status*		
Area Name		
Location		
Contact and Phone #		
Status*		
Area Name		
Location		
Contact and Phone #		
Status*		

* Status Ranking:

1 Known contaminant sources and documented contamination problems and/or habitat degradation.

2 Known contaminant sources and contaminant presence, no documented contaminant problems or habitat degradation.

3 Known contaminant sources, suspected contaminant presence, no documented contaminant problems or habitat degradation.

4 No known contaminant sources other than global atmospheric input and no known habitat degradation.

WS-2.4b ASSESSING LOCAL OFF-SERVICE LAND AREAS IMPORTANT TO TRUST RESOURCES

Area Name					
Distance and Direction from Service Lands					
UTM Coordinates (centroid)	UTM Zone		X (Long.)		
			Y (lat.)		
General Description					
Contact or Agency			Phone #		
Monitoring Activities Relevant to this Area					

Assessment Considerations	Description and Comments Regarding Importance to Monitoring Activities
Amphibians	
Anadromous fishes	
Catadromous fishes and invertebrates	
Raptors	
Seabirds	
Shorebirds	
Waterfowl	
Other aquatic birds	
Other migratory birds	
Other resident birds	
Federally listed threatened & endangered, or candidate species (including research)	
Exotic/Pest Species	
Other freshwater species	
Macroinvertebrates	
Mammals - marine	
Mammals - terrestrial	
Marine organisms other than mammals (including invertebrates)	

WS-2.4b ASSESSING LOCAL OFF-SERVICE LAND AREAS IMPORTANT TO TRUST RESOURCES

Area Name	
Plants - aquatic (food/cover, native habitats, etc.)	
Plants - terrestrial (food/cover, native habitats, etc.)	
Reptiles	
State listed or candidate species	
Wildlife/other resident species	
Other species	
On-Site Pest Management Activities	
Biodiversity	
Geographic location of the area (feeding or staging area, good climatic conditions, breeding area, etc.)	
Recreational activities (consumptive and nonconsumptive)	
Research (for other than T&E species)	
Economic uses (grazing, haying, mining, logging, oil)	
Other (e.g. wilderness, subsistence, military)	
Previous Baseline or Reference Monitoring	
Documented or Suspected Contaminant Concerns	
Other	

UPLAND FORMATIONS	
Agricultural Lands	
Tundra	
Forest (>50' trees)	
Woodland(<50' trees)	
Scrubland (<31'- multibranched)	
Grassland	

WS-2.4b ASSESSING LOCAL OFF-SERVICE LAND AREAS IMPORTANT TO TRUST RESOURCES	Page __ of __
Area Name	
Desertland (<12" precip)	
Other Uplands _____	
Other Uplands _____	
WETLAND/AQUATIC FORMATIONS	
Wet Tundra	
Swampforest/Riparian	
Swampscrub/Riparian	
Freshwater Marshland	
Strandland (beach)	
Saltflats/Mudflats	
Submergent Aquatic	
Managed Wetlands	
Lake/Pond/Impoundment	
Riverine	
Marine	
Estuarine	
Other Wetlands _____	
Other Wetlands _____	
Other Wetlands _____	

WS-2.5a FEDERAL LAWS RELEVANT TO MONITORING Page __ of __		
X	Federal Laws	Comments/Relevance to Monitoring Strategy
	Anadromous Fish Conservation Act (AFCA) - 1965	
	Clean Air Act (CAA) - 1970	
	Clean Water Act (CWA) - 1977	
	Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Superfund) - 1980	
	Endangered Species Act - 1973	
	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) - 1947	
	Federal Water Pollution Control Act (FWPCA) - 1977	
	Fish and Wildlife Act - 1956	
	Fish and Wildlife Coordination Act (FWCA) - 1934	
	Marine Mammal Protection Act - 1972	
	Marine Protection, Research, and Sanctuaries Act - 1972	
	Migratory Bird Treaty Act (MBTA) - 1918	
	National Environmental Policy Act (NEPA) - 1970	
	Oil Pollution Act - 1990	
	Refuge System Administration Act	
	Resource Conservation and Recovery Act (RCRA) - 1976	
	River and Harbor Act - 1899	
	Surface Mining Control and Reclamation Act - 1977	
	Toxic Substances Control Act (TSCA) - 1976	
	Water Quality Act - 1987	

WS-2.5b STATE AND LOCAL LAWS RELEVANT TO MONITORING

State/Local Laws	Comments/Relevance to Monitoring Strategy

WS-2.6	MONITORING GOALS FOR THE SERVICE LANDS Page __ of __
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15	

WS-2.7 PUBLIC OUTREACH WORKSHOP PARTICIPANTS Page __ of __			
	Participant Name, Address, Phone #	Affiliation	Discussion Comments/Concerns/Interests
1			
2			
3			
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14			
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16			
17			

WS-3.1.2a	SURFACE WATER TRANSPORT PATHWAYS TO THE SERVICE LANDS		
	Watercourse Name	Location Where It Enters SL	Description/Comments
1			
2			
3			
4			
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15			

WS-3.1.2b SUBSURFACE WATER TRANSPORT PATHWAYS TO THE SERVICE LANDS		
	Subsurface Watershed Location and Area Where It Enters the Service Lands	Description/Comments
1		
2		
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13		

WS-3.1.2c	AIR TRANSPORT PATHWAYS TO THE SERVICE LANDS	
Wind Direction	**General Area Where Inputs Enter Service Lands**	**Description/Comments** (common contaminants from atmospheric inputs)
Global/Regional Inputs (sources > 160 km) - all wind directions	Throughout the SL; inputs would also be transported to the SL via SW runoff	Gases - CO_2, H_2S, CH_3SCH_3, COS, NH_3/N_2O, HNO_3/NO_3 Particulates - trace metals (e.g., Hg, Pb, Cu, Cr, Fe), sulfates, nitrates, benzene-soluble organics, radioactive fallout
Regional Inputs (sources > 50 km, but < 160 km distance) - most wind directions	Throughout the SL; inputs would also be transported to the SL via SW runoff	<u>As above plus:</u> Gases - SO_2 Chlorinated hydrocarbons (pesticides and others) Organophosphate pesticides
In the Space to the Right Identify Specific Regional Sources and Potential Contaminants for the Service Lands		1. 2. 3. 4. 5. 6.
Local Inputs (sources < 50 km distance)	Likely throughout the SL, however, some areas might be more affected than others; SW runoff in some drainages might receive more input than others	<u>As above plus:</u> Gases - CO, NO/NO_2, Ozone Halogens Hydrocarbons (Table 7 - Air RFM) Particulates - specific local inputs (note what could be carried on dust/soil particles)
Wind Direction	**NA for Not Applicable**	**Identify Local Inputs from Each Wind Direction**
N		
NE		
E		
SE		
S		
SW		
W		
NW		

WS-3.1.2d	BIOTIC TRANSPORT PATHWAYS TO THE SERVICE LANDS		
	Species or Species Group Name	Habitats/Locations Used Extensively on SL	Description/Comments (likely locations of exposure, distance (L,R,G)*, and contaminant)
1			
2			
3			
4			
5			
6			
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11			
12			
13			

NOTE: These descriptions are for guidance to provide an approximate location (distance) where exposure might occur

* G = Global/Regional exposure; occurs further than 160 km from the Service lands border
R = Regional exposure; occurs between 50 km and 160 km from the Service lands border
L = Local exposure; occurs within 50 km of Service lands border

WS-3.1.3	TRANSPORT PATHWAYS WITHIN AND/OR MOVING OFF THE SERVICE LANDS	Page __ of __
Transport Mechanism		Description and Relevance to Monitoring
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

WS-3.2 **CONTAMINANT SOURCE DOCUMENTATION WORKSHEET** Page __ of __

	Contaminant Source Name, Location and/or Address, Key Contact, and Phone #	UTM Coordinates (Centroid) X (Long)	Y (Lat)	Cont. Source*	Associated Contaminants and/or Affected Water Quality Parameters	Cont. Category*	Transport Mechanism(s) (A, SW, SSW, B)	Specific Pathway(s) to the Service Lands	Sensitive Key Species Group*	Comments Relevant to Monitoring
1										
2										
3										
4										
5										
6										
7										
8										

* Use codes from Table 1 at the end of the Workbook.

WS-3.4	KEY SPECIES IDENTIFICATION WORKSHEET				Page ___ of ___
Key Species or Species Group Name	Habitat Code*	Ecol. Compartment **	Primary Food Source	Primary Exposure Media***	Comments Relevant to Monitoring: (sensitivity, pathway, temporal considerations, exposure location, etc.)
1					
2					
3					
4					
5					
6					
7					
9					
10					
11					
12					
13					

* Use Habitat Group Codes from WS-2.3.
** P - Primary producer 1 - 1st order consumer (herbivore) 2 - 2nd order consumer (carnivore) 3 - 3rd order consumer or greater O - omnivore
D - Detritivore/Decomposer
***A = Air, SW = Surface Water, SSW = Subsurface Water, S = Soil, SE = Sediments, AN = Animal, PL = Plant

WS-4.1	REFERENCES FOR TOXICITY VALUES						Page __ of __
Contaminant or Water Quality Parameter							
Regulatory Limits, if applicable	Freshwater		Marine		Other		

Key Species (WS-3.4)	Species Used for Toxicity Testing	Acute Toxicity (mg/kg, ppm)		Threshold for Chronic/Sublethal Effects (mg/kg, ppm)	Type of Effect	Exposure Method (oral, dermal, aquatic, etc.)	References	#
		LD50	LC50					

CONTAMINANT PRIORITIZATION WORKSHEET

Contaminant or Water Quality Parameter (WS-3.2)	Reg. Lim. Y/N	Bio-acc. Y/N	Bio-mag. Y/N	Syn. Eff. Y/N	Terat Eff. Y/N	Carc. Eff. Y/N	Key Species/Species Groups/Habitat (WS-3.3)															Overall Risk: Tox = (H,M,L) Expos = (1,2,3)	Cont. Prior. Level (H,M,L)	Will Monitor (Y/N)
	Overall Sensitivity of Species, Group, or Habitat																							
	Primary Habitat(s) Where Exposure Occurs																							

WS-5 MONITORING OBJECTIVES FOR THE SERVICE LANDS Page __ of __		
	Monitoring Objective	Contaminant Issue/Location/Rationale
1		
2		
3		
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7		
8		
9		
10		
11		
12		
13		
14		

WS-6.1a	INDEX TO MONITORING SITES		Page __ of __
PCA or Reference Site			
Monitoring Site #		Monitoring Level	
Location and General Description			
Monitoring Issues and Rational for Selecting this Site			
Monitoring Site #		Monitoring Level	
Location and General Description			
Monitoring Issues and Rational for Selecting this Site			
Monitoring Site #		Monitoring Level	
Location and General Description			
Monitoring Issues and Rational for Selecting this Site			
Monitoring Site #		Monitoring Level	
Location and General Description			
Monitoring Issues and Rational for Selecting this Site			
Monitoring Site #		Monitoring Level	
Location and General Description			
Monitoring Issues and Rational for Selecting this Site			
Monitoring Site #		Monitoring Level	
Location and General Description			
Monitoring Issues and Rational for Selecting this Site			
Monitoring Site #		Monitoring Level	
Location and General Description			
Monitoring Issues and Rational for Selecting this Site			
Monitoring Site #		Monitoring Level	
Location and General Description			
Monitoring Issues and Rational for Selecting this Site			

WS-6.1b	MONITORING ACTIVITIES FOR MONITORING SITES										Page __ of __
Monitoring Site Number				UTM Coordinates	X (Long)				Y (Lat)		
Project Number											
Specific Purpose & Objectives											
	Contaminant or Water Quality Parameter to Monitor (WS-4.2)	Medium to Sample (6.2)	Variable & Line of Evidence (6.2)	When to Sample: Month/Time (6.3)	Cont. Monit. Level (7.2)	Cont. Priority Level (WS-4.2)	Sampling Method (7.2)	# of Samples/ Sample Period (7.2)	Frequency (# Times) Per Yr. (7.2)	Sample Plot # (7.2)	Comments/Rationale for Decisions
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											

Lines of Evidence

1. Biomarker/organism health 2. Bioassay or toxicity testing 3. Population or community indicies 4. Chemical Analysis

WS-6.3	INDEX PERIOD CONSIDERATIONS FOR MONITORING				Page ___ of ___
Monitoring Site #				Date	
Contaminant, Water Quality Parameter, or Biotic Variable(s) Being Monitored	Transport Mechanism or Exposure Medium (A, SW, SSW, SO, SE, AN, PL)	Most Important Index Period Considerations	Optimum Time to Sample	Selected Time to Sample	Comments: Provide rationale for the optimum and/or selected sampling time
1					
2					
3					
4					
5					
6					
7					
8					
9					

1. Transport/Exposure Mechanism Codes

A = Air
SW = Surface water
SSW = Subsurface
SO = Soil
SE = Sediments
AN = Animal
PL = Plant

2. Index Period Considerations

1 Storm events (pulses of contaminants)
2 Wet vs. dry periods/seasons
3 Temperature affects (DO, respiration, etc.
4 Agricultural activities (fertilizers, amount and type of Pesticides, aerial spraying)
5 Turnover period and stratification of standing water
6 Biotic activities (life cycle, peak population numbers, hormonal cycles, migration, exposure potential, etc.)
7 Wind or storm intensity
8 Wind direction
9 Stagnation events
10 Dryness (resuspension of particulates)

WS-7.2 **INDEX TO MONITORING SITES AND CONTAMINANT MONITORING LEVELS** Page __ of __

	Contaminants or Water Quality Parameters Being Monitored (WS-4.2)	Monitoring Site Numbers (WS-6.1a)																				Overall Contaminant Monitoring Level
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
	Monitoring Level for Monitoring Sites																					SL Monitoring Level

WS-7.3	LOGISTIC CONSIDERATIONS AND COSTS FOR MONITORING ACTIVITIES	Page __ of __

Monitoring Site #			Project #		Date	
Project Title/Description						

	Contaminant, Water Quality Parameter, or Biotic Variable Being Monitored (WS-6.1b)	Medium to be Collected for Sample Analysis (WS-6.1b)	Personnel or Training Needed? (7.3)	Total # of Samples per Year (WS-6.1b)	Type of Analysis (7.2)	Analysis Cost per Sample (7.3)	Total Sample Analysis Costs	Total Materials Costs	Total Equipment Costs	Total Training Costs	TOTAL COSTS
1							0				0
2							0				0
3							0				0
4							0				0
5							0				0
6							0				0
7							0				0
8							0				0
					GRAND TOTAL		0	0	0	0	0

Personnel/Training Needs:	
Material/Equipment Needs:	
Other Comments:	

WS-8.3	DOCUMENTATION OF MONITORING RESULTS AND INTERPRETATION		Page __ of __
Monitoring Site Number		Project Number	
Purpose & Objectives			

	Contaminant, Water Quality Parameter, or Biotic Variable Monitored	Line of Evidence	Results	Interpretation of Results	Recommendations and Rationale for Future Activities
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					

Lines of Evidence

1. Biomarker/organism health 2. Bioassay or toxicity testing 3. Population or community indicies 4. Chemical Analysis

10. GLOSSARY

Accuracy

Accuracy is a measurement of bias in a measurement system. Accuracy is assessed by the use of field/trip blanks and matrix spikes since inaccuracy can be the result of field contamination, preservation, handling, sample matrix and analysis. Random sampling alleviates inaccuracy that could be caused by the sampling design.

Area of Interest (AOI)

The Service lands and the surrounding air and watershed (ground and surface) that affect, or have contaminant sources that could affect, the biotic and abiotic resources of the service lands.

Baseline Conditions

The "natural" environmental conditions existing in an area (i.e, prior to human interference). These conditions generally do not exist in the world today, especially on service lands which are generally managed. However, hypothesizing these conditions for the service lands or locating a "control area(s)" is useful to provide conditions/variable values for comparison studies.

Benchmark Monitoring

This is sampling/monitoring to establish an initial data set (the benchmark) from which future data can be compared to assess status and trends.

Bioaccumulation

Net uptake of a material by an organism from food, water, and respiration. The accumulation of a chemical by an organism from food or water that is ingested. In animal toxicological investigations this is also referred to as the body burden.

Bioassay

A standardized procedure to determine the effects of an environmental variable or substance on living organisms. This procedure involves exposure of variable to organisms and measurement of mortality, health, reproduction, etc. under controlled conditions. A method for determining the relative toxicity (or other biological activity) of a substance by observing its effects on a suitable organism under controlled conditions.

Bioassessment

Evaluation of an environmental variable or substance using a biological condition or response. An evaluation of the biological condition of a (waterbody) using biological surveys and other direct measures of resident biota (in surface waters).

Biodiversity

A conceptual term referring to the variety and variability among living organisms and the ecological complexes in which they occur; diversity can be defined as the number of different items and their relative frequencies. For biological diversity, these items are organized at many levels, ranging from complete ecosystems to the chemical

structures that are the molecular basis of heredity. Thus, the term encompasses different ecosystems, species, genes, and their relative abundance (OTA 1987).

Biomonitoring

The use of a biological entity as a detector, and its response as a measure, to determine environmental conditions. The essential component is that changes can be measured in the organism(s) response to changes in environmental conditions.

This is similar to contaminant monitoring, however, this monitoring approach focuses on the use of organisms and biotic response indicators to detect the presence of stressors and/or to estimate ecosystem health. The approach includes the use of biological indicators as measurement tools. These include biomarkers, biodiversity, community and population indices, bioassays, landscape indices, etc. as variables for monitoring the status and trends of ecosystem health.

Biomarker

An indicator of cellular or physiological processes that signal events in biological systems or samples. A biological marker of effect may be an indicator of an endogenous component of the biological system, a measure of the functional capacity of the system, or an altered state of the system that is recognized as impairment or disease. A biological marker of exposure may be the identification of an exogenous substance within the system, the interactive product between a xenobiotic compound and endogenous components, or other event in the biological system related to the exposure (NRC 1987).

Biosurvey

Consists of collecting, processing, and analyzing representative portions of a resident (aquatic) community to determine the community structure and function.

Comparability

Comparability expresses the confidence with which one data set can be compared to another. Factors affecting comparability include the use of standard field and analytical techniques, reporting of results in the same units, and data collection activity.

Completeness

Completeness is a measure of the amount of valid data obtained from a measurement process required to achieve a particular statistical level of confidence resulting from that measurement process. It is often expressed as a percentage. It is achieved by minimizing the amount of missing data.

Contaminant

A substance that exists at an unnatural concentration for the area and can potentially affect the physical and/or biologic characteristics of the area.

Characterization

The documentation of essential traits (Hunsaker 1990).

Contaminant Biomonitoring	The use of biomonitoring tools in addition to other (abiotic) monitoring tools (e.g., residue analysis, water quality parameters such as DO, pH, BOD, etc.) for monitoring the status and trends of contaminants and their effects.
Contaminant Monitoring	A long-term (>5 years), systematic, and repetitive sampling program, that includes sample collection, analysis, and data interpretation designed to track the status and trends of the concentrations and/or the effects of contaminants.
Contaminant Problem	A situation resulting from identified contaminants, an event negatively impacting trust resources, or where a trigger level for a contaminant(s), environmental variables, or bioindicator has been reached. This would result in a Monitoring Level 1 ranking for the area or contaminant.
Contaminant Sampling or Survey	The short-term collection of contaminant data or abiotic/biotic measurements, generally in response to a specific incident or suspected problem.
Contaminant Sources	Cities, industries, landfills, storage tanks, areas, events, etc. That contain and release contaminants to the environment.
Ecological Risk Assessment	The application of a formal framework to estimate the effects of human action on a natural resource and to interpret the significance of those effects in light of the uncertainties identified in each component of the assessment process. Steps in the framework include initial hazard identification, exposure assessment, dose response assessment, and risk characterization (Hunsaker 1990).
Ecosystem	A local complex of interacting plants, animals, and their physical surroundings which is generally isolated from adjacent systems by some boundary, across which energy and matter move; examples include a watershed, an ecoregion, or a biome (Hunsaker 1990).
Environmental Indicators	A collective term for response, exposure and habitat, and stressor indicators (Hunsaker 1990).
Impact	A change in the chemical, physical, or biological quality or condition of a (waterbody) caused by external sources.
Indicator	A characteristic of the environment that, when measured, quantifies the magnitude of stress, habitat characteristics, degree of exposure to the stressor, or degree of ecological response to the exposure.
Indicator Medium/Variable	An indicator medium or variable is a substance and/or ecological attribute where the contaminant, or its effects, can be measured or

	observed soon after its introduction into the system and/or it will be found in the greatest concentration relative to other media in the system. An optimum medium or variable will be effective and efficient at quantifying the contaminant or its effects. It will also satisfactorily address the specific goals and objectives of the monitoring effort. Indicator media/variables can be either abiotic or biotic. A monitoring program generally will include measurements of both.
Index (indices)	Mathematical aggregation(s) of indicators or metrics; one example is the Index of Biotic integrity (IBI), which combines several metrics describing fish community structure, incidence of pathology, population sizes, and other characteristics (Hunsaker 1990).
Index Period	Sampling period that yields the maximum amount of information during the year, which may vary from one indicator or resource class to another (Hunsaker).
Indicator	A characteristic of the environment that, when measured, quantifies the magnitude of stress, habitat characteristics, degree of exposure to the stressor, or degree of ecological response to the exposure (Hunsaker 1990).
"Key" Species/Habitats	Key species and/or habitats are defined in this manual as biota and environments crucial to the maintenance of the ecosystem. This definition includes the key species plus the physical/biological conditions necessary for their survival. Also included are those species identified by the service as being important (e.g., threatened/endangered, migratory game species, etc.). These species might not be crucial to the ecosystem, but are considered a trust resource and therefore of concern.
Landscape	The fundamental traits of a specific geographic area, including its biological composition, physical environment, and anthropogenic or social patterns.
Landscape Characterization	The documentation of principal components and patterns of landscape structure, including attributes of the physical environment, biological composition, and cultural patterns.
Landscape Ecology	The study of the distribution patterns of communities and ecosystems, the ecological processes that affect those patterns, and changes in pattern and process over time (Forman and Godron 1986).
Landscape Indicator	A characteristic of the environment, calculated from remotely sensed data, used to describe spatial distribution of physical, biological, and cultural features across a geographic area (Hunsaker 1990).

Medium	The type of material being sampled (e.g., air, water, sediment, soil, biota, etc.)
Method	A framework composed of one or more techniques.
Monitoring	A repetitive sampling or checking effort designed to track status and trends.
Non-point Sources	Contaminant sources that do not have an identifiable location where the contaminants are released into the environment (e.g. run-off, global inputs, erosion, transportation, etc.)
Parameter	A measure that describes or characterizes a (statistical) population (e.g., a measure of biological or physical attributes; biomass, relative abundance, temperature, dissolved oxygen, etc.). A characteristic element
Point Sources	Contaminant sources that have an identifiable location where the contaminants are released into the environment (e.g. an effluent pipe, irrigation water return ditch, stack, etc.)
Pollutant	A substance (contaminant) or an alteration in the physical environment (low do, eutrophication, suspended sediments) that is negatively affecting the resource. This could be a direct or an indirect effect on the resource.
Potentially Contaminated Area (PCA)	An area that has been identified to establish a sampling station(s) or sampling grid to assess contaminant concentrations or specific biotic/abiotic variables. Ideally this is a location where the investigator would observe the contaminant or its effects soon after it moves onto service lands or other areas of interest. There may be a number of PCAs depending on the contaminants and their sources, transport pathways, and receptor characteristics.
Precision	Precision is the reproducibility of analyses under a given set of conditions. It is a quantitative measure of the variability of a group of measurements compared to their average value. It is often presented as the sample standard deviation or coefficient of variation. Precision combines both sampling and analytic factors. The precision of the analysis can be controlled to some extent, but the precision of the sampling is unique to each site. Sampling precision can be improved by standard methods and trained operators using care.
Receptor	The biotic and abiotic components of the environment that receive, absorb, adsorb, or accumulate contaminants.

Reference Site	An area that approximates "natural" or baseline conditions for the variable(s) being studied, often used as a control for comparative studies.
Region	Any extensive geographic area that generally corresponds in size to EPA administrative Regions III through X (e.g., physiographic regions, ecoregions, major river basins) (Hunsaker 1990).
Regional Reference Site	One of a population of benchmark or control sites that, taken collectively, represent an ecoregion or other broad biogeographic area; the sites, as a whole, represent the best ecological conditions that can be reasonably attained, given the prevailing topography, soil, geology, potential vegetation, and general land use of the region (Hunsaker 1990).
Representativeness	Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. It is a qualitative parameter. Representativeness is achieved by making certain that sampling locations are selected properly and a sufficient number of samples are collected. It can be assessed to some extent by the use of co-located samples.
Service Lands	Those lands and aquatic resources managed by the U. S. Fish and Wildlife Service. This includes National Wildlife Refuges, Service facilities (administration and others), easements, waterfowl production areas, coordination areas, wildlife extension areas, fish hatcheries, fish and wildlife research areas, etc.
Significant Concentrations/ Levels/Numbers/etc.	Numerical values of a contaminant or variable that are within a range that is considered high enough (or low enough) to be a concern. These values could be the same as the trigger levels.
Sink	A receptor that concentrates a contaminant more than other components of the system.
Sample Site/Station/ Point/Location	The precise geographical location where a sample is collected; e.g., address, reach, coordinates, etc.
Source-Receptor Relationships	The temporal, spatial, physical and biotic interactions that affect the exposure and risk from contaminants to the receptor.
Special Case Studies	The short-term collection of data in response to a specific incident or identified contaminant problem.

Stressor	Measurements used to provide information on human activities or externalities that can cause stress in ecological entities; three general categories include: hazard indicators, management indicators, and natural process indicators. Examples are the incidence of fertilizer application, which can increase nutrient concentrations in lakes; incidence of dredging/filling, which can diminish availability of wetland habitat; and climatic fluctuations, which can promote damage by pathogens (Hunsaker 1990).
Threshold	The value for a particular response indicator used to distinguish nominal from subnominal ecological condition (Hunsaker 1990).
Transport Mechanism	The media that physically moves a substance from one location to another. This includes air, water (surface and subsurface), and biota.
Transport Pathway	A location or feature (e.g. A stream, corridor, portion of an aquifer, wind direction, or biota) that can be identified as the carrier for contaminants from a specific source to a receptor.
Trigger Levels	These are contaminant concentrations, environmental variable values, biotic index values, or symptoms that, would induce actions to study, mitigate, or remediate the cause, and/or its effects. These trigger levels would be established for each area based on its physical and biotic characteristics and the potential contaminant sources and associated contaminants.
Variable	A characteristic of interest about each individual element of a population or sample.

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