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# *Long-Term Ecological Monitoring Plan for the Idaho National Engineering and Environmental Laboratory*

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*January 2004*

**Idaho Completion Project**

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## ABSTRACT

This plan presents the approach for long-term ecological monitoring at the Idaho National Engineering and Environmental Laboratory (INEEL). The approach has two objectives. The first is to verify that the objectives of each INEEL remedial action are maintained. The second is to determine that the long-term INEEL-wide ecological impact of the contamination left in place is within acceptable limits. The Operable Unit 10-04 ecological risk assessment presented in the *Comprehensive Remedial Investigation/Feasibility Study for Waste Area Groups 6 and 10 Operable Unit 10-04* was an INEEL-wide assessment with the primary purpose of assessing risk to ecological receptors from contamination released to the environment from INEEL activities, as identified by the Comprehensive Environmental Response, Compensation, and Liability Act. The Operable Unit 10-04 ecological risk assessment documented the large degree of uncertainty in the analysis of long-term ecological impacts while supporting the decision of no action with long-term monitoring that will be implemented under the *Record of Decision—Experimental Breeder Reactor I/Boiling Water Reactor Experiment Area and Miscellaneous Sites, Operable Units 6-05 and 10-04*.

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# ACRONYMS

| | |
|---|---|
| AEC | U.S. Atomic Energy Commission |
| ANL-W | Argonne National Laboratory-West |
| ARA | Auxiliary Reactor Area |
| BBS | Breeding Bird Survey |
| BLM | Bureau of Land Management |
| BORAX | Boiling Water Reactor Experiment |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFA | Central Facilities Area |
| CFR | Code of Federal Regulations |
| COC | contaminant of concern |
| COPC | contaminant of potential concern |
| CSM | conceptual site model |
| DOE | U.S. Department of Energy |
| DOE-RL | U.S. Department of Energy Richland Operations Office |
| DQO | data quality objective |
| EBSL | ecologically based screening level |
| EPA | U.S. Environmental Protection Agency |
| ER | environmental restoration |
| ERA | ecological risk assessment |
| ESER | Environmental Surveillance, Education, and Research |
| FSP | field sampling plan |
| FWS | Fish and Wildlife Service |
| HQ | hazard quotient |
| IDEQ | Idaho Department of Environmental Quality |
| IDFG | Idaho Department of Fish and Game |
| IDO | Idaho Operations Office |
| INEEL | Idaho National Engineering and Environmental Laboratory |
| INPS | Idaho Native Plant Society |
| INRA | Inland Northwest Research Alliance |

| | |
|---|---|
| JSA | job safety analysis |
| LOFT | Loss-of-Fluid Test |
| LTEM | long-term ecological monitoring |
| NA | not applicable |
| NE-ID | U.S. Department of Energy Idaho Operations Office |
| NERP | National Environmental Research Park |
| NOAA | National Oceanic and Atmospheric Administration |
| NOAEL | no observed adverse effect level |
| NODA | Naval Ordnance Disposal Area |
| NRF | Naval Reactors Facility |
| NRTS | National Reactor Testing Station |
| OSHA | Occupational Safety and Health Act |
| OU | operable unit |
| PBF | Power Burst Facility |
| PLN | plan |
| PSQ | principal study question |
| QAPjP | quality assurance project plan |
| RDX | Royal Demolition Explosive |
| RESL | Radiological and Environmental Sciences Laboratory |
| RI/FS | remedial investigation/feasibility study |
| ROD | Record of Decision |
| RWMC | Radioactive Waste Management Complex |
| SPERT | Special Power Excursion Reactor Test |
| STF | Security Training Facility |
| TAN | Test Area North |
| TNT | trinitrotoluene |
| TPH | total petroleum hydrocarbon |
| TRA | Test Reactor Area |
| TSF | Technical Support Facility |
| USC | United States Code |

| | |
|---|---|
| USFS | United States Forest Service |
| WAG | waste area group |
| WRRTF | Water Reactor Research Test Facility |

# Long-Term Ecological Monitoring Plan for the Idaho National Engineering and Environmental Laboratory

## 1. INTRODUCTION

This document outlines the surveillance and monitoring plan necessary to achieve two objectives:

1. Verification that the remedial objectives specified in Idaho National Engineering and Environmental Laboratory (INEEL) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Records of Decision (RODs) are maintained

2. Determination that contamination left in the INEEL soil and water does not have unacceptable long-term sitewide ecological impacts.

Both objectives must be achieved to ensure that the remediation is protective of ecological receptors.

This CERCLA Long-Term Ecological Monitoring (LTEM) Plan is one element of the broader monitoring responsibilities directed by U.S. Department of Energy (DOE) Order 450.1, "Environmental Protection Program." Although only CERCLA-required scope will be implemented under LTEM, this plan includes a description of the overall monitoring program required by DOE Order 450.1. A description of all DOE monitoring responsibilities was put into this document to provide a single source of reference and to assist in evaluation of the total monitoring program. The sections that include non-CERCLA descriptions are clearly labeled as non-CERCLA. Except for the sections that are specifically referred to as non-CERCLA, all of the elements in the plan are CERCLA requirements until a decision can be made about the cumulative impact of residual contamination. Because the remediation of Waste Area Groups (WAGs) 3 and 7 is not complete, the cumulative impacts cannot be fully assessed for several years.

Residual contamination will remain at the INEEL after CERCLA cleanup. Exposure to contamination, either directly or from migration of contamination through the food web, could affect occupants of the system. Long-term ecological monitoring will be implemented at the INEEL to evaluate the effectiveness of remediation (or no action) regarding the protection of the health of INEEL ecological resources from legacy contamination effects.

Based on the LTEM Plan, data will be collected in uncontaminated reference areas on and off the INEEL and in contaminated sites on the INEEL to determine if a causal relationship exists between contamination and any detected ecological effects. The *Framework for Ecological Risk Assessment* (EPA 1992) defines the environmental risk assessment (ERA) as a process for evaluating scientific information on the adverse effects of stressors on the environment. The term "stressor" is defined here as any physical, chemical, or biological entity that can induce an adverse effect. Adverse ecological effects encompass a wide range of disturbances, ranging from mortality in an individual organism to a loss in ecosystem function (EPA 1992). For this document, an ecological effect is a biological change caused by an exposure. Based on language in the *Clean Air Act* (42 USC § 7401 et seq.), a working definition of "adverse ecological effects" has been derived for use in this report. Adverse ecological effects are defined as any injury (i.e., loss of chemical or physical quality or viability) to an ecological or ecosystem component, up to and including the regional level, over long and short terms. Sampling will be directed at detecting contamination-related effects across a range of ecological organizational levels. Detecting contamination-related effects may be difficult, but the data collected from uncontaminated areas will help separate naturally occurring effects from contamination-related effects. Community- and population-level evaluations will be compared with the results of physiological effects sampling (e.g., histopathic, biochemical, and genetic changes). Links between elevated contaminant concentrations and effects (if any are observed) will be evaluated to determine possible indicators for hture trending and monitoring.

This plan will start with more focused studies at the individual WAGs and sites of concern to ensure that remedial actions at these sites have been protective of ecological receptors. Monitoring will continue at these sites to ensure that the remedies continue to be protective. This information will be supplemented with additional efforts on an INEEL sitewide level to validate the assumption of no adverse effects at that level. These additional efforts or more directed studies might be necessary throughout the 5-year activities. In addition, studies might be initiated when the results of the baseline sampling have been finalized and assessed. As the focus of sampling moves to evaluate sitewide effects, it will be important to identify the current sitewide impacts and then use appropriate methodology to determine which effects are contaminant related.

Baseline sampling will occur at all facilities identified in this plan despite whether remedial actions have occurred. Establishment of a current baseline allows the inclusion of several larger sites that could have more of an impact on an INEEL sitewide level. This will allow verification of the sitewide impact as remediation of the remaining sites occurs. If sampling preremediation provides characterization indicating that the selected remedy was protective by showing postremediation improvement, then this also supports LTEM needs.

The following paragraphs briefly discuss the major plan sections.

Section 2 provides background information on the Operable Unit (OU) 10-04 ERA and the *Record of Decision—Experimental Breeder Reactor-I/Boiling Water Reactor Experiment Area and Miscellaneous Sites* (DOE-ID 2002a). Section 2 also identifies the activities defined in the OU 10-04 ROD (DOE-ID 2002a) that will be performed under LTEM.

Section ***3*** discusses the general purposes of ecological monitoring.

Section 4 presents the data quality objectives (DQOs) for the LTEM Program. The DQOs were used to provide a systematic procedure for defining the criteria that a data collection design should satisfy (EPA 1996, 2000a, and 2000b) and were used extensively in developing this plan. The DQOs include what, when, how, and why LTEM sampling should proceed and provide a format for presenting much of the supporting information, including the INEEL site background, conceptual model, the contaminants of concern (COCs), and areas of concern. Section 4 also describes the non-CERCLA monitoring programs that collect data on and off the INEEL. The LTEM group will use data from these other non-CERCLA groups as much as possible to support monitoring goals.

Sections 5, 6, and 7 consist of the project management plan, the project documentation, and the project schedule, respectively.

# 2. OPERABLE UNIT 10-04 ENVIRONMENTAL RISK ASSESSMENT AND RECORD OF DECISION

The OU 10-04 ERA presented in the *Comprehensive Remedial Investigation/Feasibility Study for Waste Area Groups 6 and 10 Operable Unit 10-04* (DOE-ID 2001) was an INEEL sitewide assessment directed by CERCLA. The OU 10-04 ERA investigated the combined risks to ecological receptors across the INEEL from all contaminated areas. As shown in Figure 1, the OU 10-04 ERA was the third phase of the INEEL ERA approach (DOE-ID 2001). The phased approach at the INEEL used the results of the WAG ERAs and other identified supporting information as inputs to the OU 10-04 ERA. This monitoring will be Phase 4 of this approach.

To depict the effects of contamination on the INEEL environment as a whole, the OU 10-04 ERA compiled information from previous ecological risk investigations at each WAG. The OU 10-04 ERA, based on population-level endpoints and a multiple lines-of-evidence approach, concluded that less than 20% of the habitat present on the INEEL is lost to facility activities; therefore, minimal ("de minimus") risk is expected to the INEEL's plant and animal communities. However, the large number of assumptions in the assessment resulted in an equally large uncertainty in the conclusion. Facility activity at the INEEL is largely located within the flood plain or traditional riverbed of the Big Lost River and is not "typical" of INEEL habitats. It was determined that the INEEL would implement LTEM based on the multiple uncertainties, data gaps, and assumptions in the assessment. The OU 10-04 ROD states, "monitoring will ensure that expectations regarding the protectiveness of the no action approach to the INEEL-wide ERA are met" (DOE-ID 2002a).

The OU 10-04 ERA states that LTEM at the INEEL will include the following activities:

- Planning activities to develop a comprehensive surveillance and monitoring plan that supports eliminating uncertainty in the OU 10-04 ERA; allows coordination with ongoing air, soils, surface water, groundwater, and vadose zone surveillance and monitoring efforts; allows coordination with other agency activities, such as sage grouse studies; and addresses stakeholder concerns.

- Development of schedule for site walkdowns and visual inspections in the WAG areas to ensure that assumptions in the risk assessment are still applicable.

- Yearly sampling and analysis of site-specific flora and fauna for ecological contamination based on location or area-specific field sampling plans (FSPs). Approximately 10% of these samples will be taken from locations off the INEEL site for background comparison and to monitor off-Site migration of contamination by ecological receptors.

- Characterization of contaminated media (such as sample residue, sampling equipment, and personal protective equipment) generated as a result of field activities will be appropriately characterized, assessed, and dispositioned in accordance with regulatory requirements.

- An annual status report provided to the DOE, U.S. Environmental Protection Agency (EPA), and Idaho Department of Environmental Quality (IDEQ) (hereafter referred to as "the Agencies"). These annual reports will support the 5-year review.

- Selected research studies, such as measuring effects to INEEL populations or individual species, to support the development and understanding of long-term trends in the INEEL's ecology.

The uncertainty in the OU 10-04 ERA is recognized by the regulatory agencies, documented in Section 17 of the OU 10-04 Remedial Investigation/Feasibility Study (RI/FS) (DOE-ID 2001), and discussed in the OU 10-04 ROD (DOE-ID 2002a). As a result, the OU 10-04 ROD implemented a "no action with Sitewide Ecological Monitoring" to address these concerns. Note that "surveillance" and "monitoring" both generally mean "watching," but surveillance is usually focused on specific areas that are under suspicion, while monitoring is more of the overall system that gathers and evaluates the information collected from the different areas under surveillance. Appendix H2 of the OU 10-04 RI/FS (DOE-ID 2001) details the contaminant list reduction and associated rationale. The primary rationale for maintaining contaminants as contaminants of potential concern (COPCs) was a hazard quotient (HQ) above 10 for nonradionuclides and an HQ above 1 for radionuclides at more than one WAG. Contaminants with HQs below the target levels were removed from the OU 10-04 ERA COPC list, provided the COPC was not highly toxic or persistent or possibly bioaccumulative in the terrestrial environment. Many radionuclides were retained on the list because of their common presence in the environment, public concern, and the presence of large amounts in buried waste at the INEEL site. The intent of the evaluation was primarily to identify the contaminants, locations, and ultimately the receptors that most likely warrant long-term monitoring or further study.

Tables A-1 through A-7 in Appendix A present the final list of WAG ERA sites and associated COPCs that resulted from the OU 10-04 ERA. However, inconsistencies occurred in the WAG ERA data analyses. At times, the ERAs used different ecologically based screening levels (EBSLs), background data, exposure parameters, and toxicity reference values. The WAG ERA results were used as they existed in the final version for each WAG ERA except for WAG 2, which was reanalyzed with more thoroughly reviewed toxicity data; therefore, results that are more recent were used in this analysis.

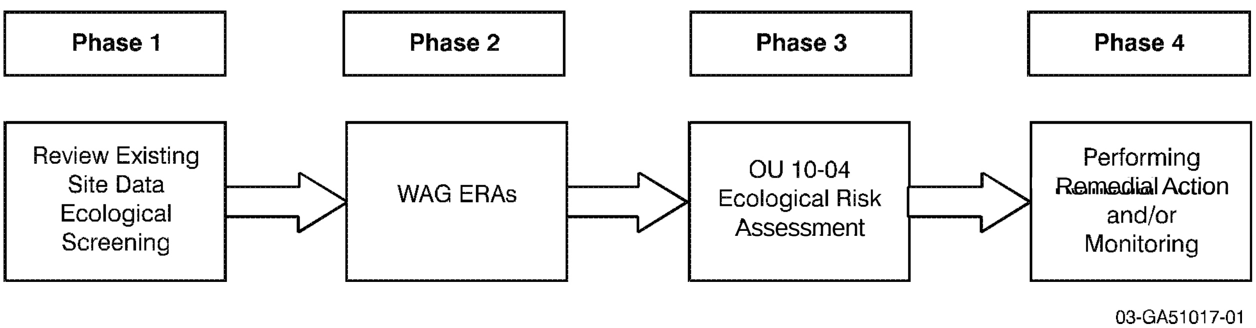


Figure 1. The Idaho National Engineering and Environmental Laboratory phased approach to ecological risk assessment.

# 3. MONITORING

Monitoring consists of repetitive measurement and observation that track the condition, status, and trends of a natural resource (DOE-RL 2001). Monitoring can occur at the community level by measuring attributes of populations of one or more species or at the population level by measuring attributes of individuals of the species comprising the population. Monitoring also can occur at the ecosystem level by measuring attributes of individual or multiple habitats or plant communities (DOE-RL 200 1). Attributes that reflect the condition of a biological resource include measuring individual health, reproductive success, population status, and habitat quality. Regular measurements of parameters of biological interest—including the abundance, distribution, or change—will be used to detect potentially harmful effects, measure progress, modify actions (if necessary), and ensure that restoration objectives are being achieved.

Monitoring is a usehl tool for environmental managers. Lee and Bradshaw (1998) state that the principal role of monitoring is to illuminate decision-making in three ways: (1) by providing an assessment of the status of resource, (2) by validating that management decisions are correctly interpreted and implemented, and *(3)* by providing improved insight into how the systems operate. Karr and Chu (1997a) state the following:

> Biological monitoring tracks the health of biological systems in much the same way that investors track the health of the United States economy. Biological monitoring will detect change in living systems, specifically, change caused by humans. To detect the effects of human activities on biological systems, biological monitoring must study human disturbance apart from disturbances that occur naturally. Biological monitoring programs need not amass information on all dimensions of natural variation, a point that scientists and managers have often lost sight of *[sic].* Rather, the goal is to track, evaluate, and communicate the condition of biological systems, and the consequences to those systems of human activities. In other words, biological monitoring identifies ecological risks—risks as important to human health and well being as the more obvious threats of toxic pollution or vector-borne disease.

A comprehensive surveillance (observing) and monitoring (tracking changes) program should provide the following to determine if the remedies have been effective and if contamination left in place has unacceptable INEEL sitewide impacts:

- Reliable information on status and trends in the biota
  - Requires baseline information to initiate (i.e., contaminant and population)
  - Requires multiple sampling events to detect trends
- Ability to identify populations and species at risk
  - Requires characterization of populations and species at risk (i.e., population inventory)
  - Requires characterization of the risk factors (i.e., contaminant concentrations)
- Indicators of the factors causing the observed trends
  - Requires multiple endpoints (i.e., effects and concentrations)

    - Some may be more sensitive than others (i.e., range of effects)

- Tools for forecasting hture trends based on alternative policy and management decisions

    - Identify the most sensitive components of the monitoring program

    - Reduce the overall cost of the monitoring program.

In addition, the LTEM Program is designed to provide the following:

- The data by which to address the concerns raised in the OU 10-04 ROD (DOE-ID 2002a) (see Section 2)

- A means to ensure that the assumptions made in the OU 10-04 ERA concerning the extent of contamination from INEEL activities are correct

- A baseline to monitor the contamination remaining at the WAGs (for ecological concerns)

- A baseline of biotic and contaminant characteristics that can be used to support evaluation of hture activities at the facilities

- A means to address certain Native American concerns about the impact of INEEL activities on ecological receptors

- A means to ensure that remediation activities at the INEEL are effective

- A means to verify ERA assumptions concerning INEEL sitewide risk

- An evaluation of the sagebrush steppe dependent species and the sagebrush steppe habitat itself

# 4. DATA QUALITY OBJECTIVE PROCESS

The EPA developed the DQO process to help INEEL managers decide what type, quality, and quantity of data will be sufficient for environmental decision-making. The process allows decision-makers to define their data requirements and acceptable levels of decision errors during planning, before any data are collected. The outputs of the DQO process can be used to develop a statistical sampling design and to effectively plan field investigations that can stand up to rigorous review.

It is the goal of EPA and the regulated community to minimize expenditures related to data collection by eliminating unnecessary, duplicative, or overly precise data (EPA 1993). At the same time, it is necessary to collect data of sufficient quantity and quality to support decision-making. A tradeoff results from the desire to limit decision errors and the cost of reducing decision errors. Reducing decision errors can be costly, because more samples and more analyses are required. One of the goals of the DQO process is to help decision-makers strike the best balance between acceptable limits on decision errors and the cost of meeting those decision error limits. The DOE Environmental Management Program considers the DQO process to have application for designing optimized short- and long-term environmental monitoring (Grumley 1994).

The DQO process follows guidelines from the EPA that help formulate the study objectives and ensure that the data will meet the objectives (EPA 1994, 2000a, and 2000b). The DQOs for planned field activities will be hrther detailed in each yearly FSP and the *Quality Assurance Project Plan for Waste Area Groups I, 2, 3, 4, 5, 6, 7, 10, and Inactive Sites* (DOE-ID 2002b).

## 4.1 Step 1: State the Problem

The problem is that residual contamination that could be accessible to ecological receptors will remain at the INEEL after CERCLA remediation for human health. The overall objectives of the LTEM Program are to develop an integrated approach to ecological surveillance and monitoring that verifies the remedial objectives specified in INEEL CERCLA RODs are maintained for ecological receptors and that determines if contamination left in the INEEL soils and water has unacceptable long-term sitewide ecological impacts. To meet these objectives, the LTEM Program will initially collect ecologically focused data near identified CERCLA sites of concern.

Focusing sampling near the sites of concern serves several purposes. The data will validate that CERCLA remedies (or no action decisions) were effective and remain effective for ecological receptors. In addition, if no contaminant bioaccumulation or adverse effects are evident at these “worst case” sites, then the data also will reduce the uncertainty in the ERA assumption that no sitewide ecological risks exist. The LTEM effort also will support baseline characterization and help determine the natural variations in biotic populations and communities. Finally, the compiled information will support more inclusive 5-year reviews for the WAGs and will help decision-makers direct hture LTEM site-specific and sitewide efforts.

### 4.1.1 Site Characteristics

Appendix B presents an overview of INEEL site characteristics, including climate, meteorology, plants, wildlife (including sensitive and threatened and endangered species), and current and hture INEEL land use. The Bureau of Land Management (BLM) classifies INEEL land as industrial and mixed use (DOE-ID 1991). Approximately 2% (4,600 ha [11,400 acres]) of the INEEL site is used for building and support structures totaling 279,000 $m^2$ (3,000,000 ft’) of floor space and supporting infrastructure operations. The remaining INEEL land—which is largely undeveloped—is used for environmental research, ecological preservation, sociocultural preservation, grazing, and some forms of recreation

(DOE-ID 1997). The INEEL is considered an ecological treasure and is possibly the largest intact expanse of sagebrush steppe habitat in the United States.

The early grazing history of the INEEL site is not well documented; however, it is known that the area was used extensively for spring/fall sheep grazing (Anderson and Holte 1981). The site also was crossed by a trail used for moving large herds of cattle to eastern markets during the late 1870s (AEC 1966). This competition for forage resulted in severe overgrazing before 1950 (Harniss and West 1973). In “Vegetation Development over 25 Years without Grazing on Sagebrush-dominated Rangeland in Southeast Idaho,” Anderson and Holte (1981) discuss the removal of INEEL lands from grazing. Initiated during World War II, 700 $km^2$ (270 mi’) was closed to grazing for use as a Navy gunnery range. In 1950, grazing was excluded from 445 $km^2$ (172 mi’) of the south-central portion of the INEEL, and in 1957, an additional 240 $km^2$ (93 mi’) was closed to livestock use (Harniss and West 1973).

Several wildlife species are found only or primarily in sagebrush *(Artemisia tridentata)* habitats throughout their range. About 100 bird, 70 mammal, and 23 amphibian and reptile species in the Great Basin rely to some degree on sagebrush habitat for shelter and food. Some species are sagebrush obligates—such as the sagebrush lizard (*Sceloporus graciosus)*, pygmy rabbit *(Brachylagus idahoensis)*, pronghorn *(Antilocapra americana)*, sage sparrow *(Amphispiza belli)*, brewer’s sparrow *(Spizella breweri*), sage grouse, and sagebrush vole *(Lemmiscus* curtatus)—and cannot survive without high-quality sagebrush habitat and its associated perennial grasses and forbs. The loggerhead shrike *(Lanius ludovicianus)* is a species highly associated with sagebrush. Other species depend on sagebrush for a significant portion of their diet. For example, pronghorns depend on sagebrush for nearly 90% of their diet (Lipske 2000).

In 1975, the INEEL was designated as a National Environmental Research Park (NERP); it is one of only two parks in the United States that allows comparative ecological studies in sagebrush steppe ecosystems (DOE-ID 1997). The NERP’s primary objective is to provide research on and education about environmental consequences of energy and weapons development. The INEEL also is designated as a National Important Bird Area by the American Bird Conservancy and the National Audubon Society and as irreplaceable land in the Columbia Basin Ecoregion by the Nature Conservancy.

On July 17, 1999, the Sagebrush Steppe Ecosystem Reserve was created at the INEEL. This reserve conserved 30,000 ha (74,000 acres) of unique habitat in the northwest portion of the INEEL and contains some of the last sagebrush steppe ecosystem in the United States. This action recognized that the INEEL has been a largely protected and secure facility for 50 years and that portions are valuable for maintaining this endangered ecosystem.

### 4.1.2 Long-Term Ecological Monitoring Plan Conceptual Site Model

Conceptual site models (CSMs) are used during risk assessments to assist in understanding the relationships among hazards, environmental transport mechanisms, exposure pathways, and, ultimately, human and ecological receptors. Projects often use flow charts to depict CSMs; however, the LTEM effort has a somewhat different purpose and developed pictorial presentations. The CSM presented in Figures 2 and 3 attempts to express the multiscale aspects across time and space of the LTEM Program and addresses the possible exposures at different levels of ecological organization. The top level of Figure 2 illustrates engineered caps and existing facilities in a sitewide view, including residual hazards, how hazards have been contained, and how exposure pathways have been blocked. The second level of Figure 2 relates the abiotic and biotic components of the INEEL with the residual contamination remaining at the areas of concern or study areas. This level more clearly presents the pathways and exposures to the individual organisms in the ecosystem. Food and soil ingestion are the likely major

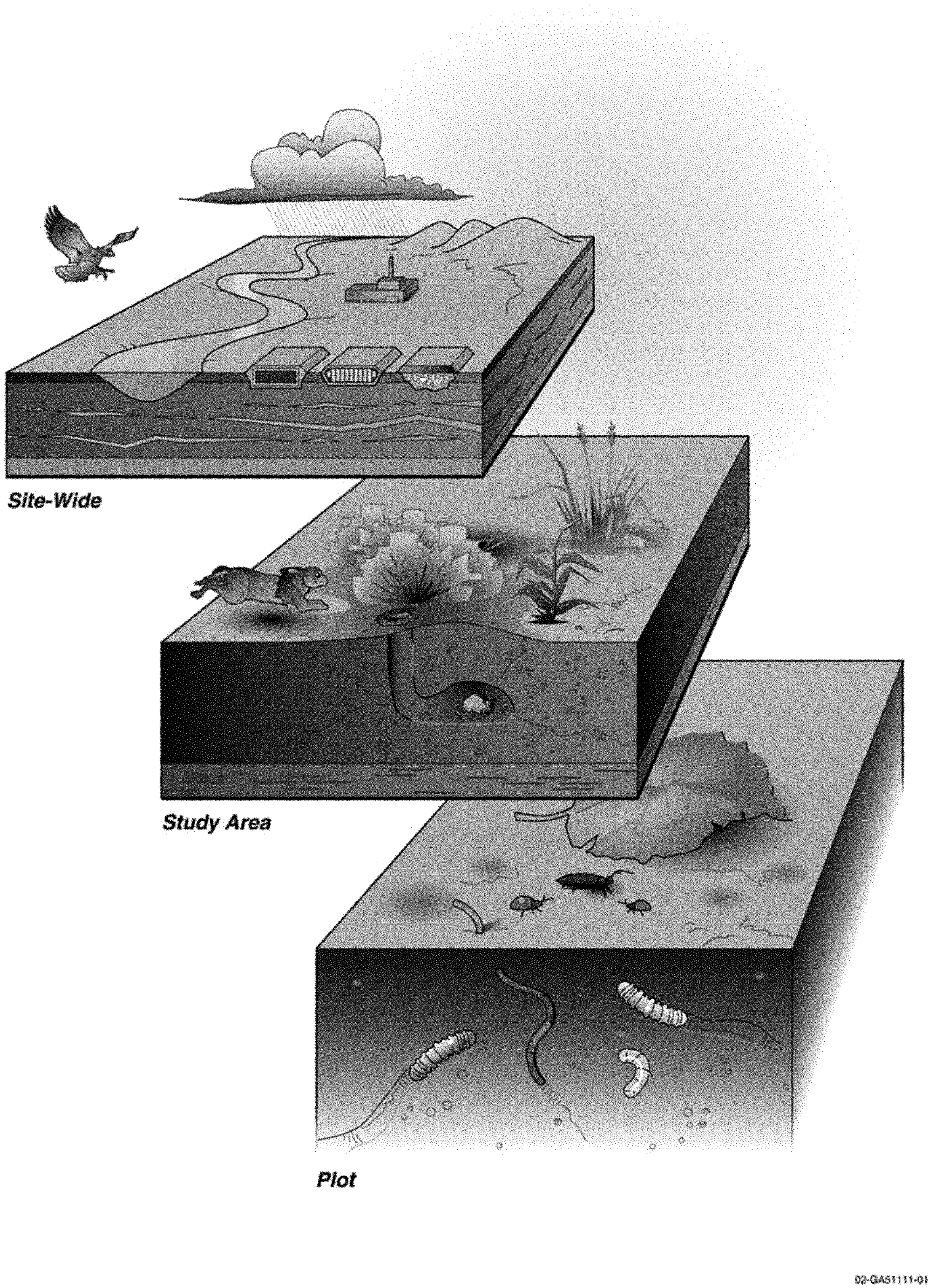


Figure 2. Current conceptual site model presenting ecological scales under evaluation.

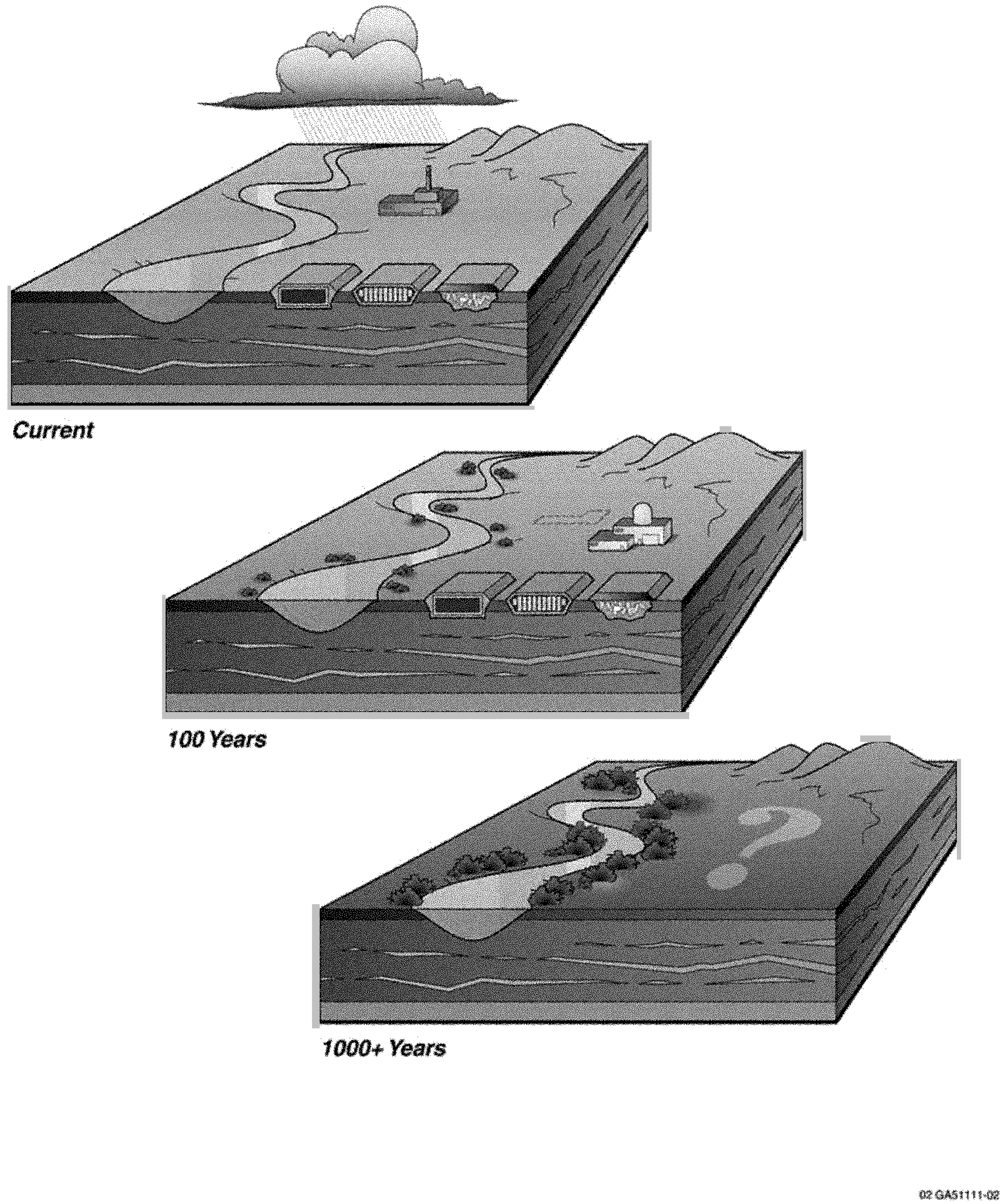


Figure 3. Conceptual site model presenting the temporal scale of long-term ecological monitoring.

pathways of concern. The third level of the CSM describes the finer ecological level where effects are more likely to be detected. This is also the primary level where it may be possible to identify biological markers (biomarkers) and biological indicators (bioindicators).

Figure *3* depicts the temporal scale inherent in the LTEM. The top level is the current timeframe. After 100 years, the second level assumes that old facilities have been decommissioned and new facilities have been constructed. During that time, some breaching of buried waste caps might have occurred, but the environment and associated indicators of change should remain the same. However, as presented in the third level, what will be occurring 1,000 years in the hture is much more difficult to predict. Changes in climate over that timeframe could significantly affect the receptors (e.g., additional rainfall could provide a permanent lake in the Big Lost River Sinks area). Current knowledge does not allow modeling that far into the hture.

### 4.1.3 Summary of the Operable Unit 10-04 Ecological Risk Assessment

The OU 10-04 ERA, which began in 1995 and ended in 2001, was a complex process that addressed a very large facility that overlaps various ecosystems (DOE-ID 2001). The OU 10-04 ERA investigated the combined risks to ecological receptors across the INEEL from all contaminated areas. To depict the effects of contamination on the INEEL environment as a whole, the OU 10-04 ERA compiled information from previous ecological risk investigations at each WAG. The OU 10-04 ERA summarized and assessed the results of the ERAs for WAGs 1 through 10. From this initial WAG ERA summary, a combination of professional judgment and HQ levels (looking primarily at HQs greater than 10) was used to narrow the focus to the most common contaminants.

The OU 10-04 ERA, based on population level endpoints and a multiple lines-of-evidence approach, concluded that less than 20% of the habitats present on the INEEL are lost to facility activities; therefore, minimal ("de minimus") risk is expected to INEEL's diverse plant and animal communities. However, limited data were collected to support the ERA, and it had a number of associated uncertainties, data gaps, and assumptions related to specific plant and animal species, specific habitats, and specific characterization data. In addition, this approach was not intended to address the loss of an individual species or the species' habitat.

Risk to ecological receptors was evaluated primarily based on modeled exposure using extensive assumptions concerning movement and concentration of contamination in the ecosystem. Recent evaluation of the limited ERA-focused sampling data indicates that this modeling might not be conservatively based (VanHorn 2002). Conservativism of the modeling input parameters is a major assumption of the risk assessment. Although past investigations indicate that extensive exposure to ecological receptors has occurred, very limited effects data have been collected at the INEEL. Recent genetic screening studies suggest that effects could be occurring on the INEEL site (Stormberg and Cook 2002). Given these multiple uncertainties, it cannot be concluded with confidence that ecological receptors are adequately protected from past and current activities at the INEEL.

The OU 10-04 ERA suggested that contamination at levels of concern remains at some of the various WAGs (DOE-ID 2001). The LTEM will provide decision-makers with the empirical data needed to ensure the continued protection of INEEL ecological resources from effects of legacy contamination.

Evaluation of the sagebrush steppe dependent species and the sagebrush steppe habitat itself is one focus of the LTEM. In 1995, the National Biological Service listed the Sagebrush Steppe Ecosystem as a critically endangered ecosystem. This ecosystem has experienced a greater than 98% decline since European settlement. This decline has affected many dependent species such as the sage grouse, which is being considered for threatened and endangered listing. The LTEM will collect data to evaluate population and community parameters and to characterize exposures and effects in the ecosystem. This information will allow INEEL environmental managers to more adequately address potential impacts of activities on sagebrush steppe species that might become listed in the future.

One of the activities mandated by the OU 10-04 ROD (DOE-ID 2002a) (see Section 2) is the reduction in the OU 10-04 ERA uncertainties. These uncertainties include the following:

- Lack of adequate effects data for both plants and animals
- No evaluation of reptile, amphibian, and soil fauna
- Lack of focused characterization data to address ecological issues in both the contaminated media and in the biota
- Incomplete characterization of both sensitive species and habitats.

The following subsections discuss these uncertainties.

***4.1.3.1 Lack of Adequate Effects Data.*** A major concern for long-term monitoring is that the ERA lacked adequate effects data to support the exposure estimates. For example, when chronic effects data for ecological receptors in arid ecosystems were lacking, the ERA used laboratory data for taxonomically distant species. This might have over- or underestimated effects in the environment. In addition, because plant and animal toxicity data for a number of contaminants were lacking, the ERA may have over- or underestimated risks for some ecological receptors. A major emphasis of the LTEM sampling will be to detect effects.

***4.7.3.2 No Evaluation of Reptile, Amphibian, and Soil Fauna.*** The OU 10-04 ERA did not address reptiles, amphibians, or soil fauna. Rattlesnake (*Crotalus viridis lutosus*) hibernacula on the INEEL have been investigated in the past, and the Idaho State University is currently performing monitoring surveys of reptiles and amphibians. However, these studies provided very little support to the OU 10-04 ERA effort. The LTEM will include additional field studies for distribution, abundance, or other ecological parameters of ecosystem health for reptiles and amphibians. The collection of soil fauna community (e.g., insects, spiders, nematodes, and beetle larvae) data will be part of LTEM sampling.

***4.7.3.3 Lack of Focused Characterization Data.*** Other areas of uncertainty and data gap issues identified in the OU 10-04 ERA included the lack of focused characterization data in both contaminated media and biota to address ecological issues. In most cases, this lack was the result of little or marginal sampling data. This lack required extensive modeling at some sites. For some sites, analytes were limited to only radionuclides (e.g., Boiling Water Reactor Experiment [BORAX] -02 and -08). Sampling for organic contaminants was often not performed due to budget constraints or lack of historical records that would have indicated the necessity for such sampling. For the purposes of the OU 10-04 ERA, it was assumed that contamination had not spread either off the WAGs or off the INEEL site. A limited, retrospective air-modeling effort performed for the remediation activities at the Warm Waste Ponds tended to confirm this assumption. However, the modeling did not address all the potential contaminants, and uncertainty remains. Because limited biotic characterization was performed, risk estimates were based primarily on extensive modeling. In addition, because environmental sampling data were obtained primarily to assess human health risks rather than ecological risk, the analytical results might not have adequately represented ecological exposure and risk. Some site-specific data were used to develop plant and animal uptake factors. As a result, the assessment required extensive use of literature-derived values that might have either over- or underestimated risk.

The OU 10-04 ROD (DOE-ID 2002a) activities specifically include yearly collections and analyses of flora and fauna samples. This activity is an important part of the LTEM and will address many of the uncertainties and data gaps in the OU 10-04 ERA. This will also establish a baseline for the WAG or other study areas, verify the assumptions concerning contaminant characterization, and validate modeling of contaminant movement from the potentially impacted sites into the INEEL regional food web. Effects data also will be collected to reduce the uncertainty in the OU 10-04 ERA concerning possible effects to receptors at various taxonomic levels.

***4.1.3.4 Incomplete Characterization of Sensitive Species and Habitats.*** Certain INEEL areas provide unique habitats for the diverse plants and animals that occur at the INEEL site (EG&G Idaho 1993). These sensitive biological resource areas have been identified as having significant value for supporting sensitive and/or unique plant and wildlife species and communities. They include areas along the Big Lost River and Birch Creek, which are riparian and wetland communities that support a great variety of species. The northern area of the INEEL is an important wintering area for pronghorn and sage grouse, but sage grouse habitats are likely to exist across the INEEL.

The OU 10-04 ERA did not address the major wetlands, primarily the Big Lost River and the associated Big Lost River Sinks, including Birch Creek and the Little Lost River (DOE-ID 2001). The Big Lost River Sinks is a unique area; during periods of high water flow, this area can contain over 800 ha (1,977 acres) of wetlands. These wetlands are dominated by stands of common spike rush *(Eleocharispalustris)* and perhaps the most extensive stands of western wheatgrass *(Agropyron smithii)* in the state (IDFG 1999). The Big Lost playa supports a large Great Basin spade-foot toad (*Spea intermontana*) population and is recognized as an important waterfowl area. Many questions remain regarding the plant and animal biota of the Big Lost River Sinks and the area'sgeneral ecology (IDFG 1999). Since this area has little or no historical contaminant or other characterization data available, it was identified as an area of uncertainty in the OU 10-04 ERA. The spreading areas near the Radioactive Waste Management Complex (RWMC) also can be considered wetlands, but past characterization data show that they were uncontaminated and were not a source of uncertainty in the OU 10-04 ERA.

Currently, every 90 days, the U.S. Fish and Wildlife Service (FWS) provides an update to the list of threatened and endangered or other species of concern on the INEEL in a letter to a U.S. Department of Energy Idaho Operations Office (NE-ID)"representative (currently Stoller, Inc.). It appears that no currently listed threatened and/or endangered species (such as species of concern and watch species as described by other federal agencies or the State of Idaho) with critical habitat on the INEEL have been documented at the INEEL site. Species identified by the FWS as possibly present on the INEEL use the site on a transitory basis (e.g., during migration). The potential exists for undocumented threatened and endangered species at the INEEL, because comprehensive surveys of species and habitat have not been completed. Present knowledge regarding listed and sensitive species at the INEEL is based in large part on surveys ranging up to 25 years old (Stoller 2002).

The listing of a species, such as the sage grouse (and the associated critical habitat that is known to exist on the facility), would require action on the part of the INEEL. This may include modifying this plan to include more emphasis on the species and habitats identified.

Section 7 of the Endangered Species Act directs federal agencies to use their legal authorities to carry out conservation programs for listed species. It also requires these agencies to ensure that any actions they fund, authorize, or carry out are not likely to jeopardize the survival of any threatened and

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a. The abbreviation NE-ID signifies that the U.S. Department of Energy Idaho Operations Office (which was abbreviated DOE-ID before October 1, 2003) reports to the DOE Office of Nuclear Energy, Science, and Technology.

endangered species or to adversely modify its designated critical habitat (if any). When an agency finds that one of its activities might affect a listed species, it is required to consult with the FWS to avoid jeopardy. If necessary, "reasonable and prudent alternatives," such as project modifications or rescheduling, are suggested to allow completion of the proposed activities. Where a federal action may jeopardize the survival of a species that is proposed for listing, the federal agency is required to confer with the FWS (although the recommendations resulting from such a conference are not legally binding) (FWS 1999).

As part of the OU 10-04 effort, biological surveys were conducted at all of the WAGs (except for WAG **8)** in the summer of 1997. These surveys evaluated habitat for sensitive species (DOE-ID 2001, Appendix H7), but limited compensatory adjustments were made for these receptors in the risk estimates. Annual walkdowns of these WAG areas will ensure that the previous evaluation still reflects the situation at these sites. The Naval Reactors Facility (NRF) conducted their own ERA using a different approach than other WAGs. This is documented in the *Final NRF Comprehensive Remedial Investigation/Feasibility Study WasteArea Group 8 Naval Reactors Facility Idaho Falls, Idaho—Volume I ơ 3—Part I, Remedial Investigation Report* (NRF 1997).

### 4.1.4 Project Assumptions

Several assumptions could affect the execution of the planned LTEM activities. A basic assumption in developing this plan is that no resident sensitive or threatened and endangered species are year-round residents on the INEEL site; thus, the endpoint accepted in the OU 10-04 ERA will remain applicable. If a species such as sage grouse becomes listed as a species of special status, this plan will need to be reevaluated.

Another assumption is that ecological risk from exposure to contaminants will decline as those contaminants are removed from the environment during the completion of the remediation projects and as those contaminants decay. The OU 10-04 directs this monitoring to only evaluate those contaminants that are already present from CERCLA activities. However, continuing operations and placement of new missions could introduce new contaminants to the environment, which might require inclusion in the monitoring for completeness and to ensure continued protection of ecological receptors.

### 4.1.5 Schedule

Monitoring for ecological receptors is present in the lifecycle baseline until 2068. The first phase of the sampling, as presented in this LTEM Plan, will take *5* years. This effort will be directed at identifying species and effects for long-term monitoring. The results of this 5-year sampling will recommend either the collection of more focused information or the implementation of some type of monitoring. Section 7 presents a schedule of this 5-year sampling effort.

## 4.2 Step 2: Identify the Decision

Decision statements are developed by combining principal study questions (PSQs) and alternative actions. The PSQs are derived from the problem statements. As shown in Table 1, alternative actions are developed for the PSQ to indicate what action will be taken as the PSQ is answered and how the data will be used to guide hture surveillance and monitoring. Note that the purpose of decision-making at this level is not to revisit ROD decisions about whether cleanup was necessary but to ensure that the remedial activities (or decisions of no hrther action) remain protective of ecological receptors.

Table 1. Principal study questions and alternative actions.

| # | Principal Study Question | # | Alternative Action |
|---|---|---|---|
| 1 | Do yearly site-specific sampling data or associated studies indicate a difference in contamination levels or effects as compared with the reference sites? | 1 | Yes—In addition to continuing the site-specific monitoring and surveillance required to verify that the remedial objectives specified in INEEL CERCLA RODs are maintained for ecological receptors, collect supplemental data to help determine if the difference could result in unacceptable long-term INEEL sitewide ecological impacts. Search the literature and compare detected concentrations with thresholds above which deleterious effects have been observed. Then, determine the relative potential of the contaminant's concentration to cause adverse ecological effects. Evaluate if the difference would have potential ecological relevance. Evaluate if positive correlation exists between contaminants and effects, and identify indicators. Determine if a threatened and endangered species at the INEEL has become listed and if it could be affected. |
| | | 2 | No—Continue site-specific monitoring and surveillance at an appropriate level for trending, ensuring that the remedy remains ecologically protective and supporting 5-year reviews. Continue evaluating site-specific data for potential INEEL sitewide impacts. Evaluate locations/reasons for sitewide data collection. |

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
INEEL = Idaho National Engineering and Environmental Laboratory
ROD = Record of Decision

The decision statements are similar whether the answer to the PSQ is yes or no. If the answer is yes, LTEM will still complete everything that is required for a no answer. For example, in both cases, site-specific monitoring and surveillance will continue for trending, for ensuring the remedy remains ecologically protective, and for supporting 5-year reviews. However, for a yes answer, supplementary data will be required to help determine if the difference is a potential sitewide issue, if the difference has ecological relevance, and if a positive correlation exists between contaminants and effects, thereby allowing the possible identification of biomarker/bioindicators. The approach is expected to be iterative and to involve the decision-makers.

After observing a difference in contaminant concentrations, one of the first steps would be to search the literature and compare detected concentrations with thresholds above which deleterious effects have been observed. Long-term ecological monitoring would use the search results to help determine the relative potential of the contaminant's concentration to cause adverse ecological effects and to determine the type and quantity of additional data collection. This additional data collection would be included as an associated (or research) study.

Ecological relevance might not be immediately apparent, and its determination will rely in part on the expertise and professional judgment of the LTEM team, as well as that of the regulators and other stakeholders (such as the public). Generally, an effect is considered ecologically relevant if it is being exerted above the level of the individual (e.g., population, community, or ecosystem level); however, any effect in a threatened and endangered species is considered ecologically relevant. When reasonable scientific evidence gives good reason to believe that residual contamination is harmful to ecological receptors, the INEEL should act to prevent additional harm.

Detecting whether an effect is caused by CERCLA contaminant exposure is important to the assessment. Impacts unrelated to CERCLA contamination will be managed under some other aspect of laboratory oversight.

## 4.3 Step 3: Identify Inputs to the Decision

In the DQO process, it is important to identify existing data and to determine whether they are applicable to the problem statement. Based on this assessment, it is then necessary to determine if new data need to be collected.

### 4.3.1 Existing Documentation and Guidance

The following documents report the major efforts relevant to the LTEM goals performed to date, provide discussion on the uncertainty in the OU 10-04 ERA, and provide data compiled to support the ERA effort at the INEEL:

- *Guidance Manual for Conducting Screening-Level Ecological Risk Assessments at the INEL* (INEL 1995). This document presents a consistent approach for performing the individual WAG ERAs and presents a path forward for developing the OU 10-04 approach.

- *Approach and Data Gap Identification for OU 10-04 INEL-Wide Ecological Risk Assessment Technical Memorandum* (INEL 1996). This document lists data gaps and recommends how to fill the gaps.

- *Work Plan for Waste Area Groups 6 and 10 Operable Unit 10-04 Comprehensive Remedial Investigation/Feasibility Study* (DOE-ID 1999). Appendix C2 of the OU 10-04 Work Plan (DOE-ID 1999) finalizes the data gap analysis initiated in the Technical Memorandum (INEL 1996). Appendix D of the OU 10-04 Work Plan (DOE-ID 1999) summarizes the phased approach to the OU 10-04 ERA at the INEEL. It also documents the receptors and parameters used in the WAG ERA risk assessments.

- The *Comprehensive Remedial Investigation/Feasibility Study for Waste Area Groups 6 and 10 Operable Unit 10-04* (DOE-ID 2001) contains the OU 10-04 ERA (Section 17) and the associated information assessed in support of this effort. Appendixes H1 through H12 of the document present several significant compilations (white papers and other contributions) supporting the OU 10-04 ERA (DOE-ID 2001).

### 4.3.2 Existing Data

Published and unpublished ecological research that was pertinent to scoping and to conducting ERAs at the INEEL was compiled and evaluated in Appendix C of the *Guidance Manual for Conducting Screening-Level Risk Assessments at the INEL* (INEL 1995). Over 300 research papers, dissertations, theses, technical reports, and popular articles have been published on a broad array of ecological subjects (Appendix C, INEL 1995). Numerous radioecology and descriptive ecology studies were included that the INEEL conducted since its establishment as the National Reactor Testing Station (NRTS) in 1948 (Markham 1973; DOE-ID 1987; and DOE-ID 1991). Many of these non-CERCLA studies were conducted for the INEL Radiological and Environmental Sciences Laboratory (RESL) and represent the efforts of numerous scientists from academic institutions, government agencies, and private-sector firms.

The results of this research were considered an important resource for conducting ERAs at the INEEL. They were assembled, organized, and evaluated as part of developing the *Guidance Manual for Conducting Screening-Level Ecological Risk Assessments at the INEL* (INEL 1995). However, the previous research was primarily done to address specific research questions and has limited relevance to an ERA, or their relevance might not be immediately obvious to risk assessors. Therefore, the literature evaluation presented in Appendix C of the Guidance Manual (INEL 1995) was conducted to assemble, organize, and summarize the available reports in a format useful for risk assessment of site-related contamination. The ecological literature and data considered to be the most critical to ERA at the INEEL were emphasized and later assessed in the OU 10-04 ERA (DOE-ID 2001).

Many radioecology studies conducted by RESL are unpublished or are available only in annual summary reports. The only data set with sufficient duration to determine temporal and spatial trends at the INEEL is the RESL soil data. The samples from which these data were derived have been collected as part of a routine surveillance program since about 1970. Permanent sampling grids were established by RESL around nine facilities, and each grid is resampled on a rotating basis approximately every 7 years. All facilities have been sampled at least twice. Soil samples are collected from two depths: 0 to 5 cm (0 to 2 in.) and 5 to 10 cm (2 to 4 in.). These data were verified to be appropriate for use in environmental restoration (ER) risk characterization efforts in the *Compilation and Evaluation of the Idaho National Engineering Laboratory Radiological and Environmental Sciences Laboratory Surface Soil Sample Data for Use in Operable Unit 10-06 Baseline Risk Assessment* (Jessmore, Lopez, and Haney 1994).

### 4.3.3 Non-CERCLA Monitoring Programs at the Idaho National Engineering and Environmental Laboratory

Although LTEM will collect the data necessary to meet the stated objectives, data collected under non-CERCLA monitoring efforts also may support the LTEM effort. The LTEM Program will coordinate and communicate with non-CERCLA programs to help ensure that integration of sampling and data can occur to eliminate redundancy and minimize the cost.

At the INEEL, non-CERCLA environmental (especially ecological) monitoring and surveillance are currently conducted by two primary groups with different but complementary goals. The two groups are the Environmental Monitoring Program and the Environmental Surveillance, Education, and Research (ESER) Program. Program management for both groups is consistent with the requirements of DOE Order 450.1, "Environmental Protection Program."

The Environmental Monitoring Program monitors environmental media and facility effluents to assess the effects of INEEL operations on the environment, to protect public health, and to demonstrate compliance with federal, state, and local regulations. This non-CERCLA program is divided into three major areas: (1) program management, (2) compliance monitoring, and (3) environmental surveillance. The environmental surveillance portion conducts radiological sampling of air, water, soil, and limited biota and performs ambient radiation monitoring on the INEEL site and at selected off-Site locations.

The ESER—which is also non-CERCLA—collects samples of air, water, food, and soil and measures direct radiation. The ESER performs off-Site surveillance for radionuclides, including sample collection and analysis of air, water, soil, milk, wheat, lettuce, potatoes, and tissue samples (domestic livestock and wildlife). The ESER also collects waterfowl and mourning dove samples from waste disposal ponds and selected off-Site reference areas as well as selected tissues from game animals accidentally killed on INEEL roads. These are evaluated for potential radionuclide exposures to members of the public who might consume these game animals. Yellow-bellied marmots, or rockchucks (*Marmota flaviventris*), are sampled for radionuclide concentrations in the RWMC area due to a potential concern to Native American people in the area.

Currently, ESER publishes the INEEL's Annual Site Environmental Report each year for the DOE. The Site Environmental Report summarizes environmental data, information, and regulations and highlights major environmental programs and efforts. A brief section will be added to this report describing the LTEM Plan's monitoring activities.

The following subsections present an overview of the monitoring efforts' history (other than groundwater) and more detail on the current monitoring activities at the INEEL.

***4.3.3.1 History of Monitoring at the Idaho National Engineering and Environmental Laboratory*.** In 1949, the predecessor to DOE, the U.S. Atomic Energy Commission (AEC), selected the Naval Proving Ground in the Upper Snake River Plain of Idaho to become a research facility called the National Reactor Testing Station (NRTS). The NRTS mission was to develop peaceful applications of nuclear energy. By the end of 1951, a reactor at the NRTS became the world's first nuclear reactor to produce usable electricity. Over the years, the INEEL (formerly called the NRTS) assembled 52 reactors, associated research centers, and waste-handling areas. The NRTS was renamed the Idaho National Engineering Laboratory in 1974 and the INEEL in January 1997. Only two reactors are operating today, with most activities on the INEEL centered on ER and waste management activities.

Achievements in nuclear technology, however, had a price. Operations left behind a legacy of environmental contamination. Along with later efforts in cleanup and reclamation, the INEEL instituted environmental monitoring and surveillance in 1949 that continues today. The following paragraphs briefly discuss the history of environmental monitoring on the INEEL.

Created in 1949 to support the NRTS, the Air Resources Laboratory Field Research Division of the National Oceanic and Atmospheric Administration (NOAA) completed some of the earliest environmental monitoring on the INEEL. The division's task was to develop a basic understanding of the regional meteorology and climatology, with a focus on protecting the health and safety of workers and nearby residents using meteorological measurements and transport and dispersion models. One of the first studies examined how local meteorology affected iodine deposition and subsequent uptake into the food chain. To that end, a "mesonet" (a small network of monitoring stations) was deployed to acquire meteorological data for the upper Snake River Plain. Over the years, NOAA has added stations to the mesonet and updated its technology to enhance understanding of various meteorological regimes. Their data are available in near real time via the Internet at **http://www.noaa.inel.gov/windvector/.**

In 1949, the Health and Safety Division of the AEC's Idaho Operations Office (IDO) collected numerous samples to determine the prereactor radionuclide background in soil, plants, and animals at the site (Singlevich et al. 1951). The IDO collected and analyzed a large number of samples of on- and off-Site groundwater, air filters, and rabbit bones and off-Site milk and direct radiation. The analytical results were reported in quarterly reports. In 1959, the IDO noted that trace amounts of various isotopes were dispersed by the NRTS into the natural environment. Their analytical results showed that in almost all cases, the values that were stated represented the present detection limit of that particular measurement.

In 1959, the first of several aerial radiological surveys of the INEEL was performed under the direction of the IDO in an attempt to determine the extent of both natural and manmade radioactivity. Subsequent aerial surveys performed in 1965, 1974, 1982, and 1990 focused mainly on characterizing facilities and associated regions of the INEEL site (EG&G RECO 1976). These data were used to identify possible plumes that could be evaluated during the OU 10-04 ERA.

In 1970, RESL established a routine soil sampling and monitoring program for radionuclides in the surface soils near INEEL facilities and off the INEEL. Establishing sampling grids around the facilities, RESL sampled the grids extensively between 1970 and 1975. In 1976, RESL established a rotating 7-year schedule for sampling the INEEL facility grids. In addition, every 3 years, RESL conducted direct gamma-radiation surveys around the INEEL facilities using hand-held instruments. In 1970, RESL began sampling locations outside the INEEL to establish regional background radionuclide concentrations. These off-Site locations were sampled extensively from 1970 through 1978, after which a biennial sampling program was initiated. Eventually, RESL included biological sampling in its program, which included extensive studies of radionuclide-contaminated areas and transport by biota from these areas. These studies were evaluated and summarized during the OU 10-04 ERA process (DOE-ID 2001). Many of these studies found levels and transport of radionuclides from various sites at levels of concern that precipitated remedial action. The RESL Program continued on- and off-Site monitoring through 1993.

***4.3.3.2 Current Monitoring at the Idaho National Engineering and Environmental Laboratory.*** In 1989, the Idaho Legislature established a comprehensive state oversight program for the INEEL. In 1990, Idaho became the first state in the nation to negotiate a 5-year agreement with DOE to provide funding for independent environmental oversight and monitoring of a DOE facility within its borders. Over the years, the INEEL Oversight Program has developed an effective non-CERCLA monitoring network to help evaluate the effects of the INEEL on public health and the environment. The INEEL Oversight Program maintains an independent environmental surveillance program designed to verify and supplement INEEL monitoring programs. More information about the INEEL Oversight Program is available on the Internet at **http://www.oversight.state.id.us/about/index.htm.**

On January 1, 1994, NE-ID (formerly called DOE-ID) transferred the responsibility for on-Site environmental surveillance from RESL to the prime INEEL contractor. The Environmental Monitoring Program covers on-Site non-CERCLA monitoring. The Environmental Monitoring Program monitors environmental media and facility effluents to assess the effects of the INEEL operations on the environment, to protect public health, and to demonstrate compliance with federal, state, and local regulations. The program compares monitoring data with regulatory criteria to verify compliance with regulations and permits. The program also compares data to voluntary protection criteria to assess potential environmental impacts and to protect public health. In addition, the program evaluates trends over time by comparing data from the current year to past monitoring data. The trend evaluation identifies changes that might indicate loss of control, unplanned releases, or ineffectiveness of pollution prevention programs.

The Environmental Monitoring Program is divided into three major areas: (1) program management, (2) compliance monitoring, and (3) environmental surveillance. The Environmental Monitoring Program management area includes all necessary documentation to ensure that all collected data meet the specific program's DQOs. The management area includes activities such as document control for technical procedures, records management, program manuals, required training (Occupational Safety and Health Act [OSHA], Radiation Worker, etc.), configuration management (program management plan), and program management and oversight. Program management also includes self-assessment activities by a quality engineer and support from safety and industrial hygiene professionals.

Compliance monitoring under the Environmental Monitoring Program consists of drinking water, storm water, effluent, and groundwater monitoring. The Environmental Monitoring Program compares analytical results either with permit limits or with other criteria to determine compliance and to assess the impacts of operations on the environment.

The Environmental Monitoring Program's environmental surveillance program conducts radiological sampling of air, water, soil, and biota and performs ambient radiation monitoring both at the

INEEL site and at selected off-Site locations. The program also conducts ambient air monitoring for $NO_x/SO_2$.

Generally, samples are shipped off-Site for analyses, with the exception of radiochemistry analyses (which are performed by the Radiation Measurements Laboratory) and bacteriological analyses (which are performed by the Industrial Hygiene Laboratory).

On April 11, 1994, NE-ID transferred all non-CERCLA off-Site environmental surveillance, land management, environmental education, ERA support, and ecological and radioecological research functions to a private contractor under the ESER. The ESER is operated consistent with the requirements of DOE Order 450.1 to satisfy the following non-CERCLA program objectives:

- To verify compliance with applicable environmental laws and regulations and with commitments made in official DOE documents
- To characterize and define trends in the physical, chemical, and biological condition of environmental media in the INEEL vicinity
- To assess the potential radiation dose to members of the public from INEEL effluents.
- Services provided by ESER include the following:
- INEEL off-Site surveillance, including sample collection and analysis of air, water, soil, milk, wheat, lettuce, potatoes, and tissue samples (domestic livestock and wildlife) for radionuclides
- Wildlife habitat and vegetation surveys, studies, and research on and near the INEEL
- INEEL sitewide research concerning endangered species, pollutants in the environment, and revegetation
- Ecological, radioecological, and innovative research within INEEL boundaries
- Environmental education concerning ecological issues around the INEEL.

The objectives of ESER are to sample media representing pathways of contaminants (chiefly radioactive) from the INEEL to people near the INEEL site, obtain radiological analyses for these samples, and report and interpret the results of these analyses for the public. Yearly, ESER collects over 2,000 samples of air, water, foodstuffs, and soil and measures direct radiation over an area of nearly 23,000 $km^2$ (9,000 $mi^2$) in southeast Idaho. Quarterly and annual surveillance reports are available through the Stoller ESER website: http://www.stoller-eser.com/.

### 4.3.4 Coordination with Other Monitoring and Ecological Study Programs

The INEEL has many ongoing CERCLA and non-CERCLA monitoring activities that may or may not overlap LTEM activities.

Monitoring, as part of CERCLA activities, at each of the WAGs is ongoing and documented in both the RODs and their associated operations and maintenance plans. The LTEM Program will evaluate the plans across the INEEL site to maximize coordination and minimize any duplication of data collected for postremedial characterization, institutional controls, and other CERCLA-related activities. The evaluation will result in a matrix of what data are being collected (where and when) sitewide and may require yearly updating until decisions and cleanups are finalized across the INEEL under CERCLA.

Other related activities also will be evaluated and discussed for applicability. For example, during the summer of 2002, a Science Action Team evaluated biotic intrusion into the Central Facilities Area (CFA) landfills. This information and the resultant reports will provide valuable input to LTEM.

Other associated research by various groups is ongoing and in development at the INEEL. Communication between the groups performing these activities will minimize duplication and allow coordination of effort. Some of the non-CERCLA groups that have activities that may support the LTEM effort include the Inland Northwest Research Alliance (INRA), the Sagebrush Steppe Ecosystem Reserve, the ESER Program, and the Laboratory Directed Research and Development.

The INRA is a consortium of eight research universities dedicated to fostering collaborative research and educational partnerships in the inland northwest. The INRA was formed to facilitate the leveraging of new research and national partnerships between the member institutions and the private sector, federal agencies, and federal laboratories.

In 1999, DOE signed an agreement with BLM, the FWS, and the Idaho Department of Fish and Game (IDFG) to establish the INEEL Sagebrush Steppe Ecosystem Reserve. The reserve includes approximately 74,000 acres of high-desert land in the northwest part of the INEEL. This was part of a complexwide effort by DOE to identify, protect, and conserve environmentally significant parcels of land in partnership with federal and state agencies. The agreement chartered the BLM to develop a management plan to protect this unique habitat. The DOE and BLM will work together with the Shoshone-Bannock Tribes, the FWS, the IDFG, and the public in the development and management of this plan.

As discussed in Subsection 4.3.3, the ESER Program's primary responsible is off-Site non-CERCLA monitoring for the INEEL. However, ESER personnel also perform some non-CERCLA sampling and research on the INEEL site. For example, they conducted sampling in 2002 for contamination characterization of the Big Lost River Sinks. This information will be used to direct associated studies developed for further characterization of this area. This information is a valuable resource that could provide supporting information when significant baseline data have been collected.

### 4.3.5 Data Obtained under Long-Term Ecological Monitoring

To support the overall objective of the LTEM Program in providing an integrated approach to CERCLA ecological surveillance and monitoring as directed by the OU 10-04 ROD (DOE-ID 2002a), the LTEM Program will collect ecologically focused data near identified sites of concern. As previously discussed, focusing sampling near the sites of concern serves several purposes. Primarily, the data will validate that the CERCLA remedies (or no action decisions) were effective and remain effective for ecological receptors, and the data will help determine if contamination left in the INEEL soils and water has unacceptable long-term sitewide ecological impacts. Sampling in the next 5 years also will be evaluated for possible modification of this plan to better address sitewide issues and provide a more comprehensive evaluation.

The focused sampling will be performed as three different but interrelated efforts:

- Yearly sampling, which will include both the contaminant characterization and effects sampling
- Associated studies, which will be directed by the results of the first sampling effort
- Annual walkdowns.

**4.3.5.1 Yearly Sampling.** Yearly sampling refers to data types collected annually, although the location at which data are collected may vary. Sampling to obtain additional data is necessary because characterization of contaminant concentrations representing ecological concerns is inadequate, and effects data are generally not available. Therefore, yearly sampling will provide the information needed to verify that the remedial objectives specified in INEEL CERCLA RODs are maintained for ecological receptors and to determine if contamination left in the INEEL soils and water has unacceptable long-term sitewide ecological impacts. The evaluation will include the assessment of reference areas (Subsection 4.3.5.1.3) and will provide a baseline by which to judge the data obtained from areas potentially affected by INEEL site-related contamination. The areas of concern (Table 2) will be sampled on a rotational basis based on the COCs, which are considered ecological stressors. The yearly sampling is summarized in Table 3 and will be directed at the following:

- Determining if organisms have been exposed to contaminants, primarily by measuring concentrations in the abiotic and biotic media

- Determining the hazard or effect of contaminants on organisms and populations (bioindicators).

Ecological stressors are physical, chemical, or radiological agents that have direct (e.g., through metabolic pathways) and indirect (e.g., through changes in food or habitat availability) effects on organisms. The INEEL has a large number and variety of site-related and naturally occurring stressors (including contaminants) that receptors are subjected to in the environment. The LTEM Program will use a range of field assessment studies, combined with the evaluation of contaminant concentrations in the surrounding media, to evaluate the effects of site-related stressors on ecological receptors. Multiple measures are needed to help identify and separate site-related impacts from those changes caused by natural or other anthropogenic stressors. Measures of exposure and measures of effects are key components in an ERA for predicting adverse ecological effects due to contaminants in the environment (EPA 1998). They are equally useful in predicting adverse effects under LTEM. These measures include responses at different levels of biological organization, measures of ecosystem and receptor characteristics, as well as measures of exposure (i.e., analytical data for abiotic media and nutrient concentrations).

Sampling is designed to optimize the possible development of biomarkers, bioindicators, or both to support hture monitoring efforts. A biomarker is a response of an organism to a stressor that is not linked to an adverse physiological effect but is indicative only of exposure. Biomarkers and bioindicators can be useful in identifying areas for hrther investigation, but their presence in itself does not indicate adverse effects are occurring. Bioindicators are physiological or ecological variables that are considered adverse effects due to exposure. A bioindicator is an anthropogenically induced response in a biomolecular, biochemical, or physiological parameter that has been causally linked to biological effects at one or more of the organism, population, community, or ecosystem levels of biological organization. As shown in Figure 4, those measurements that are easier to understand usually cannot be as easily related to ecological relevance. With increasing ecological significance comes a lack of sensitivity to shifts in any one stressor. It may be fairly easy to understand and measure a biochemical response to exposure to a single contaminant under laboratory conditions; however, changes in field populations, and the relationship between a bioindicator and a contaminant or other stressor level, may be very difficult to understand.

Table 2. Locations identified for monitoring.

| Facility, Area, or Site Name | Associated WAG | Included in LTEM | Comments | Suggested Initial Sampling Year |
|---|---|---|---|---|
| TAN | 1 | Yes | This site will be considered two areas of concern since it is so widely spread. | 2005 |
| TRA | 2 | Yes | — | 2003 |
| Idaho Nuclear Technology and Engineering Center | 3 | Yes | Location of the new INEEL CERCLA Disposal Facility. This will be sampled in Fiscal Year 2004 to ensure that a recent background of contaminant levels in the soil can be obtained. | 2004 |
| CFA | 4 | Yes | — | 2006 |
| ARA and Stationary Low-Power Reactor No. 1 | 5 | Yes | Permanently buried radioactive waste site; surrounding soil contaminated with radionuclides and metals. | 2007 |
| BORAX and Experimental Breeder Reactor | 6 | Yes | Permanently buried radioactive waste site; surrounding soil contaminated with radionuclides and metals. | 2007 |
| RWMC | 7 | Yes | The RWMC is currently under evaluation for remediation and was not evaluated in the OU 10-04 RI/FS (DOE-ID 2001); however, the RWMC will be included in the monitoring plan for completeness. Transects to the major windrows outside the fences will be sampled to obtain a baseline in the current timeframe. | 2006 |
| NRF | 8 | Yes | Need to evaluate monitoring needs at this site based on the results of the NRF ERA and remedial actions. Sampling needs to be coordinated with NRF personnel to support the monitoring effort. | 2007 TBD" |
| ANL-W | 9 | Yes | Need to evaluate monitoring needs at this site based on the results of the ANL-W ERA, current sampling and monitoring. Sampling needs to be coordinated with ANL-W personnel to support the monitoring effort. | 2006 TBD" |
| Big Lost River Sinks | NA | Yes | Sensitive habitat designated as wetlands. Since the river flows by and through a number of CERCLA sites, the possibility exists that contamination was deposited in Big Lost River Sinks sediment. Need to ensure that an appropriate baseline is being given to the Sagebrush Steppe Reserve. Stoller has collected data in this area, and they will be evaluated to determine whether further evaluation is required. | 2005 |
| Ordnance Areas (will be grouped into three larger areas based on location) | 10 | Yes | Ordnance sites have soil contamination and chunks of TNT/RDX present. Areas of concern from the presence of significant habitat, uncertainty in characterization, or known contamination within the Naval Proving Ground. | 2003 2004 2005 |
| Aquatic Sites of Concern | NA | Yes | Several pond areas identified as CERCLA sites at the INEEL have not been remediated (such as TSF-07). These ponds will be evaluated for baseline for future monitoring and effects to ecological receptors using data collected for other monitoring and for the specific purpose of this plan. | 2004–2007 |

Table 2. (continued).

| Facility, Area, or Site Name | Associated WAG | Included in LTEM | Comments | Suggested Initial Sampling Year |
|---|---|---|---|---|
| Aquatic Reference Area | NA | Yes | Reference areas are required to provide a comparison of unimpacted and impacted conditions. | 2004–2007 |
| Terrestrial Reference Areas (three) | NA | Yes | Reference areas are required to provide a comparison of unimpacted and impacted conditions. At least two reference areas (preferably three) will be sampled—one on-Site and one in an area off-Site that is determined to have minimal impact. | 2003–2007 |

a. TBD = to be determined based on coordination with NRF and ANL-W personnel.
ANL-W = Argonne National Laboratory-West
ARA = Auxiliary Reactor Area
BORAX = Boiling Water Reactor Experiment
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
ERA = ecological risk assessment
INEEL = Idaho National Engineering and Environmental Laboratory
LTEM = long-term ecological monitoring
NA = not applicable
NRF = Naval Reactors Facility
RDX = Royal Demolition Explosive
RWMC = Radioactive Waste Management Complex
TAN = Test Area North
TNT = trinitrotoluene
TRA = Test Reactor Area
TSF = Technical Support Facility

Table 3. Yearly sampling summary.

| | Media | | | | |
|---|---|---|---|---|---|
| | Soil | Plants | Mammals | Invertebrates | Avian |
| Concentration Sampling | Contaminant concentration at 0 to 6 in. and 6 to 24 in. and physical characteristics | Contaminant concentration in nonrooting portions of plants" | Contaminant concentration in whole body | May be collected as part of associated study if required | Concentration as determined for aquatic only (not yearly) |
| Effects Sampling | NA | Population/ communities (determined by quantitative sampling) | Population/ communities (determined by live trapping methods) | Population/ communities (determined by microscopic examination) | Population/ communities (observational counts) |
| | NA | Plant bioassay | Histopathic examination, body weight to organ weight ratio | Soil fauna bioassay | Egg and fledgling weight and other measures for aquatic only (not yearly) |

a. There is some concern that only those plants that are exceptional at hyperaccumulating will move contaminants up to the shoots and leaves. It is more likely that the majority of plants that can accumulate contaminants (especially metals and radionuclides) will concentrate them in the roots. Many organisms consume root material. Therefore, as an associated study in Fiscal Year 2004, the concentration in the roots will be compared to the concentration in the nonrooting portion of the plants.

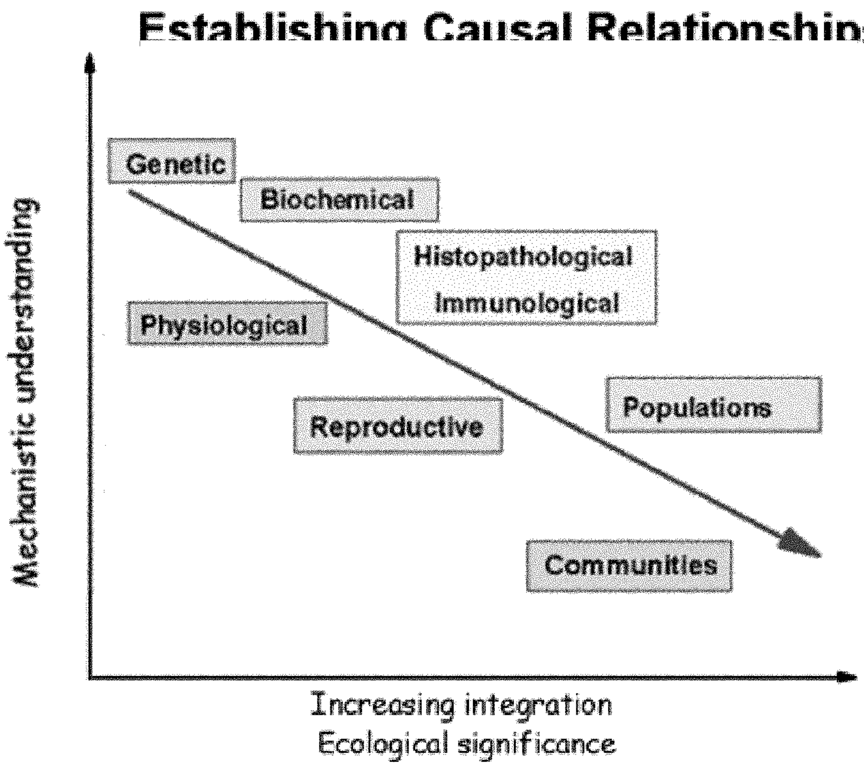


Figure 4. Establishing causal relationships (ORNL 2002).

As shown in Table 4, measurement endpoints (or bioindicators) at the cellular level—such as enzymes, DNA damage, stress proteins, and selected blood chemistry—are the most sensitive to changes in contaminant concentrations; however, these are less ecologically significant, because they are not linked to adverse effects on the organism, population, or community until a defined level of change has been reached. This is because animals can survive and reproduce even though organ system function is somewhat impaired. Thus, while these endpoints are the most sensitive to impact and relatively easy and inexpensive to measure, additional effort is required to establish ecological relevance. The least sensitive endpoints are population and community-based parameters, sex ratio, food-web alterations, and trophic-level relationships. Data for these indicators are often difficult to interpret due to the lack of sensitivity to environmental stresses. For example, normal fluctuation in these indicators introduces high levels of variability that can obscure more subtle contaminant-related effects. However, subtle contaminant-related effects can be enough to force a local population into extinction when it would have otherwise survived the forces of natural variability. Multiple years of data are required for the results to be definitive. Organism-level responses may provide a pivotal point through which mechanistic understanding and the ecological consequences of stressors can be linked. Although it may be difficult to accomplish, ideally an effective monitoring and surveillance plan at the INEEL would be able to properly relate endpoints at a more ecologically significant level to the less ecologically relevant but more sensitive and rapidly responding endpoints (i.e., biomarkers).

Table 4. Sensitivity of bioindicators to contaminant exposure (ORNL 2002).

| Most Sensitive | Moderatelv Sensitive | Least Sensitive |
|---|---|---|
| Detoxification enzymes | Selected histopathologies | Population-level parameters |
| DNA damage | Immune system indicators | Community-level parameters |
| Bile metabolites | Bioenergetics (lipids) | Alterations in sex ratios |
| Antioxidant enzymes | Condition indices | Food-web alterations |
| Selected blood chemistries | Growth | Trophic-level relationships |
| Stress proteins | Reproductive parameters | |

Terrestrial and aquatic reference selection will be documented in the yearly FSPs. The criteria that will be applied in order to obtain appropriate, representative reference areas are as follows:

- **Soil type and geology.** Because many of the potential COCs are naturally occurring (i.e., metals and some radionuclides), it is important to attempt to match the soil type and geology of the reference area to that of the site as closely as possible. If the soil type and geology are comparable, significant elevation of naturally occurring contaminants in soil or tissue relative to reference area concentrations is more likely to be related to INEEL site activities, because soil type and geology affect the variability of inorganics in soil media. However, it may not be possible to attain a complete match because of extraneous circumstances such as land use or lack of appropriate soil types in accessible areas unimpacted by the INEEL. Soil conservation service maps or other sources of soil type and geology will be used to address this criterion.

- **Habitat.** This variable affects the animal populations that occur. When addressing community or population effects caused by site-specific contamination, areas of similar habitat are preferred. However, it is accepted that habitat encompasses many different facets, including access to food of the right quality, in the right quantities, and at the right time; access to water and shelter; and size of the area, depending on the species of concern. Therefore, although matching habitat would be desirable, it might be impossible.

- **Location with respect to the site-related windblown plumes.** The reference area(s) must be outside the direct influence of INEEL-related contaminants to be considered appropriate controls.

- **Access.** In the event the other criteria are met, this criterion is important, because it determines whether sampling can legally occur.

As shown in Table 2, terrestrial reference area sampling will be divided between two terrestrial areas. One location in the central-eastern section and one location in the western section of the INEEL site will be sampled. These areas have been determined to be more representative of the pristine ecosystem at the site due to the exclusion of grazing and lack of other disturbances. A site reconnaissance occurs before finalizing reference area selection to verify representativeness.

***4.3.5.1.1*** Yearly Sampling for Contaminant Characterization — Yearly sampling will be performed to characterize contaminant levels. Metal, radionuclide, or munitions concentrations in soil and tissues will be analyzed yearly at several WAGs. Not all WAGs will be sampled contiguously; however, contaminant data will be obtained annually.

Data will be collected from various media in potentially contaminated sites to compare with similar data collected from uncontaminated background/reference areas. Radionuclides, trinitrotoluene (TNT)/Royal Demolition Explosive (RDX), and metals are the primary COCs on the INEEL. Plants, soil fauna, birds, and mammals are likely to be exposed to contaminants in soil and possibly dietary items. Ingestion of soil during feeding and grooming as well as ingestion of dietary items are likely to be the major pathways of concern. Thus, sampling of soil and dietary items will be performed.

Inhalation is not an exposure pathway that is typically evaluated in ERAs. However, identification of depositional areas where contaminants were available through several exposure routes, such as soil ingestion and plant uptake, was evaluated in the OU 10-04 ERA. The OU 10-04 ERA evaluated the possible windblown movement of contamination from the sites of concern. Air monitoring data are collected by the Environmental Monitoring Program and the ESER Program and will be evaluated for significant effects. However, it is felt that the collection of surface soil will provide an indication of contamination from windblown sources.

Abiotic and biotic media will be collected in the same area to obtain chemical and radiological data. This will be done in conjunction with collection of health and population effects. The abiotic and biotic sampling for chemical analysis and effects information will, therefore, be collocated spatially and contiguously to the greatest extent possible in order to minimize sources of variability.

Aquatic areas of concern include currently active waste ponds and the Big Lost River Sinks. Active waste ponds might provide a source of contamination in the environment for selected receptors using the pond; however, only a few ponds that are considered CERCLA sites remain on the INEEL site. All waste ponds are permitted. Any waste pond that is designated as a CERCLA site will ultimately be remediated, and the source of the water will be eliminated. These waste ponds are considered an attractive nuisance in this environment, and the banks of most of these waste ponds are maintained to minimize this interaction.

Only ponds designated as CERCLA sites will be evaluated under LTEM. Both abiotic (i.e., sediments and surface water) and biotic media will be collected; however, this effort will be limited to one biotic receptor. Barn swallows will provide a species that would be representative of the exposure to sensitive species, such as bats, that might be feeding on insects hatching from the sediment at the pond bottom.

The data types that are being considered for collection under the LTEM are discussed in more detail in Appendix C. The exact types of data, number of samples of each medium at each plot, time of sampling, number of sampling events, transect and plot locations, statistical design, and schedule will be presented in the yearly FSP following optimization of the study design and coordination with other programs. Abiotic and biotic samples will be collected for chemical and/or radiological analysis from a concentration gradient along permanent transects in order to collocate contaminant concentrations in abiotic and biotic media. Temporal and spatial collocation of samples helps minimize variables that can confound a contaminant monitoring study, aids in statistical interpretation of data, and assists in determining if observed effects are site related or due to naturally occurring variables.

The purpose of collecting abiotic media samples is to determine if there has been a release from the areas of concern and to identify and quantify transport or migration of the release. The LTEM Program will monitor changes in abiotic media concentrations and/or radiological activity over time as well as changes in spatial variability. Comparison to reference area data will be made to identify if measured concentrations or activity are above ambient levels. Data will be collected for surficial soils (0- to 2-in. depth), surface water, and sediments. Measurements of soil chemical and physical characteristics that might be important to contaminant characterization also will be collected. In addition, any air monitoring data collected under other programs will be evaluated in the LTEM. Contaminant effects will be distinguished from natural effects by comparing multivariate data with reference area data.

The purpose of collecting biotic media samples is to determine if there is uptake by biota at the areas of concern and to identify and quantify the potential for biological transport or migration of contaminants. Bioaccumulative contaminants have the potential to enter local food chains and concentrate with each trophic level. Thus, by sampling plants and animals in close contact with contaminated media, the potential for uptake and bioaccumulation can be measured, as well as the potential for exposure to higher trophic-level consumers that might feed on plants or animals associated with contaminated media. Collection of tissue may provide a direct measure of exposure and can possibly be linked statistically with health effect information and concentrations or activity in abiotic media. Biological samples for chemical analysis will be collected from the plots along each transect in conjunction with abiotic media samples.

***4.3.5.1.2*** Yearly Sampling for Effects—The LTEM is designed to determine if adverse effects to plants and wildlife are occurring on the INEEL, verify that INEEL sitewide impacts to ecological receptors are minimal, and reduce the uncertainty in the OU 10-04 ERA conclusions. To fulfill these objectives, one LTEM focus area is sampling and analyzing indicator species of plants and wildlife both in potentially contaminated INEEL site areas and in uncontaminated off-Site locations. The data from the potentially site-impacted areas will be compared to the reference area data to determine if adverse effects exist and can be detected. If the data indicate no difference between potentially affected areas and reference areas, then the data verify that impacts to ecological receptors are minimal and reduce the uncertainty in the OU 10-04 ERA conclusion.

The types of effects data that will be evaluated annually are as follows:

- Measures of effects on the plant community, including community structure, diversity, and biomass
- Measures of effects on the soil fauna community, including community structure, diversity, and biomass
- Measures of physiological responses in small mammals, including histopathology and body weight relative to organ weight changes
- Laboratory toxicity bioassays, whereby many variables can be controlled to isolate the effects of contamination.

***4.3.5.2*** Associated (Research) Studies. Associated studies are data collection efforts or research studies that are not necessarily performed on an annual basis. Specific studies will be used to investigate the applicability of other measures of effects triggered by the results of initial sampling and to address other issues of concern as they are identified. The need for additional studies, or research, was identified in the OU 10-04 ROD (DOE-ID 2002a). These studies will be used to evaluate responses from different COPC and receptor combinations that are identified as the program progresses. Some potential associated studies have been identified and are discussed below (more detail is included in Appendix C). One associated study has been chosen for Fiscal Year 2004 and is presented below. However, all possible associated studies have not all been (and cannot be) identified yet and will depend on circumstances and observations in the hture.

The study is designed to assess chronic cumulative effects from radionuclides by measuring the microsatellites' mutation rate of burrowing mammals. This effort would support the establishment of a baseline and has potential use as a genetic marker for ecological receptors for long-term evaluation of caps over buried waste sites and other remaining contamination at the INEEL. During collection for population sampling, deer mice will be harvested. Appropriate samples will be delivered to a qualified laboratory for analysis of microsatellites' mutation rate.

Molecular techniques provide a powerful tool with potentially significant application for evaluating the impacts of environmental contaminant exposure on faunal and floral populations. More specifically, molecular tools have been applied to studies of environmental and molecular toxicology to answer questions on acute and chronic exposure to radiation and other hazardous constituents produced by anthropogenic activities (Grinikh and Shevchenko 1992; Abramov, Fedorenko, and Shevchenko 1992; Zainullin et al. 1992; Sugg et al. 1996). Genetic markers can provide a rapid means to test for the presence or damaging effects of toxicants. For example, Shevchenko et al. (1992) investigated genetic disorders in mice exposed to radiation in the vicinity of Chernobyl; Kovalchuk et al. (2000) reported mutation rates in wheat DNA that are six times higher than in unexposed control groups. Researchers have been evaluating changes in microsatellites mutation rates in alligators that have been exposed to contaminants at the Savannah River Site.[b]

The rationale behind using quantification of microsatellites mutation rate relies on the fact that these loci (the positions in a chromosome of a particular gene or allele) are selectively neutral and not expressed (i.e., do not have a phenotypic [visible properties of an organism that are produced by the interaction of the genotype and the environment] expression), which makes them ideal candidates for studies of mutation rate. One of the advantages of using "mother/offspring analysis" is that direct mutations occurring from the mother to the offspring are identifiable, with the mother serving as a direct yardstick, or control, for the offspring. This eliminates temporal problems, such as accumulation of mutations through time. The theoretical foundation for this approach relies on the fact that replication slippage is the major mechanism causing mutations, that these types of mutations are nonexpressed genetic changes, and that microsatellites' alleles are inherited by offspring from their parents. With a parent/offspring approach, mutations can be observed as changes in alleles between the mother and the offspring.

The fact that the mother can be used as an internal control for changes in mutation rate provides a test of the mutation hypothesis. Furthermore, mutation rate can be estimated from samples that have not been exposed to contaminants; that rate can be compared with the value obtained from samples that have been exposed. Since the rate of mutation is analyzed between parent and offspring, the issues of time of exposure or accumulation of mutations are not critical.

Preliminary data have been obtained on the microsatellites' mutation rate for deer mice (*Peromyscus maniculatus*) collected at the INEEL. The data suggest significant differences in the mutation rate of samples from the study areas in comparison with control samples (Stormberg and Cook 2002). These mutations, while not directly linked to adverse health effects, can be inferred to be representative of the mutation frequency on other regions of the genome. Pregnant mammals (i.e., deer mice) and their offspring will be evaluated for mutation rate differences under the LTEM Program.

This is a highly cost-effective method of determining elevated exposure to radiation, which identifies trends over time. However, there is no direct link with health effects at this point, since available microsatellites' markers have not been tested for linkage to expression genes. Comparison to the population data and other information collected within the plots may be used to address this limitation.

Other studies for hture consideration were identified in the OU 10-04 ROD (DOE-ID 2002a) and associated comments. These studies will address issues that are identified based on the proposed yearly sampling or that are considered important to the INEEL characterization. These studies include the following:

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b. Telephone conversation from Angelica I. Stormberg, INEEL, to T. C. Glen, Savannah River Ecology Laboratory, July 2003.

- Evaluation of amphibian and reptile populations potentially impacted by INEEL historic activities. No data exist for amphibian and reptile populations at WAG or munitions locations.

- Reevaluation of the Breeding Bird Survey (BBS) data to compare the routes near facilities to other routes and off-Site surveys. The BBS analysis was used as a primary basis for the decision that no effects have occurred at the INEEL site. However, the analysis did not use proximity to potential source areas and should be reevaluated to support the assumptions made in the risk assessment.

- Grazing issues and data that were not analyzed by proximity to potential source locations.

- Areas of concern where elevated levels of contamination have been identified may be selected for additional effect studies on the selected species or higher trophic levels. Specifically, sites appropriate for further evaluation of TNT/RDX concentrations in soil and associated ecological impacts will be evaluated.

***4.3.5.3 Walkdowns.*** The LTEM Program will conduct regular seasonal site walkdowns and inspections in the areas of concern and over broad areas of the INEEL site. The intention of walkdowns is to record general information of biological interest, including the species observed, number of individuals, and habitat quality.

As part of the OU 10-04 ERA, walkdowns were used to gather information on the presence or absence of species of concern and the habitat that would support them. The walkdowns were performed at or in close proximity to the WAGs (DOE-ID 2001). For the OU 10-04 ERA, this information (based on professional judgment) was used to evaluate risk based on the presence or absence of habitat that could support species of concern.

Walkdowns will initially be important, because remedial activities could eliminate or create desirable habitats for sensitive species. The walkdowns will help identify these changing situations and help ensure that sensitive species are protected. However, walkdowns have limits. Because observations occur at gross levels, it is difficult to detect trends until the impact is significant.

These walkdowns will follow the procedure documented in Appendix H7 of the OU 10-04 ERA (DOE-ID 2001). Nighttime walkdowns also will be performed but will be limited to wildlife observations and will support the information gathered during the day. The walkdowns will occur at approximately the same date each year and will collect the same information annually, including:

- Date and conditions under which the surveys were conducted

- Area encompassed by the surveys (Global Positioning System mapping, where practical)

- Global Positioning System locations for observed habitat, sign, and species sighted (where practicable)

- Habitat description, the proximity to WAG or site, and an estimate of whether contaminated sites or areas are within the home range of members of the species in question

- Species presence and abundance, current site use, past site use (historical sightings or surveys), and anticipated site use (professional judgment)

- An estimated site or area population (where possible)

- Size

- Substrate (gravel, asphalt, lawn, etc.)
- Natural or manmade features that entice wildlife (water, lights, etc.)
- Proximity to areas or sites of facility activity
- Presence and availability of food or prey
- Availability of nesting, roosting, or resting habitat
- Signs of wildlife use
- Prior history, known sightings, or use.

### 4.3.6 Historical Data Regarding Contaminants of Concern and Areas of Concern

As discussed in Subsection 4.1.3, the OU 10-04 ERA effort identified and assessed areas of concern and COCs. This information was used to identify areas of concern (see Table 2) and COCs (see Table *5)* for LTEM. During LTEM sampling, the results of the OU 10-04 ERA will be used to direct the locations of sampling at each area of concern. In addition, this information will indicate contaminants that might be of concern for sampling. The results of the OU 10-04 ERA, in combination with this initial sampling effort and an evaluation of future activities at each facility, will direct the designation of indicators at each area and the COCs. The COCs were identified at each WAG in the OU 10-04 ERA and are included in Table *5*.

## 4.4 Step 4: Define the Boundaries of the Study

The primary objective of this step in the DQO process is to define the scale of decision-making by clearly describing the what, when, and where parameters of the study. This includes the populations of interest and the spatial and geographical boundaries. The populations of interest for the LTEM include flora and fauna and media such as water and soil. The spatial scale describes the physical area to be studied and generally indicates where the samples will be taken. The geographical boundaries define the area to which the decision statements will apply. The boundaries are discussed below.

### 4.4.1 Population of Interest

***4.4.1.1 Flora and Fauna.*** Some of the considerations for selecting organisms to be evaluated for monitoring and assessment are abundance, biogeographic distribution, population stability, life-history characteristics, habitat specialists versus generalists, mobility, ecological importance, and economic and social importance. The rationale for selecting each of the sampling efforts is discussed below. However, based on the outcome of sampling during the next *5* years, additional species may be identified and evaluated.

A wide variety of small mammals and birds provide key food sources for INEEL raptors, mammalian carnivores, and reptilian carnivores, as shown by the INEEL food web presented on Figure *5*. Two animal carnivores representing major linkages between primary and secondary consumers and higher predators will be collected for tissue analyses. A preliminary food web analysis has resulted in consideration of the deer mouse (*Peromyscus maniculatus*).

The deer mouse is a major prey item for both secondary and tertiary consumers. Deer mice will be collected and used to represent several important linkages in the food chain, because they are omnivorous, widespread, and relatively easy to collect.

Table 5. Operable Unit 10-04 contaminants of potential concern summarized from the waste area group ecological risk assessments (DOE-ID 2001).

| COPCS | WAG 1 | WAG 2 | WAG 3 | WAG 4 | WAG 5 | WAG 8[a] | WAG 9 | WAGs 6 and 10 |
|---|---|---|---|---|---|---|---|---|
| ***Inorganics*** | — | — | — | — | — | — | — | — |
| Arsenic[b] | X | X | — | X | X | X | X | — |
| Antimony[b] | X | — | — | — | — | — | — | — |
| Barium | X | X | X | X | — | — | X | — |
| Cadmium | X | X | X | X | X | — | X | — |
| Chromium (111) | X | X | X | X | — | — | X | — |
| Chromium (VI) | — | — | X | — | — | — | X | — |
| Cobalt | X | — | — | X | X | — | — | — |
| Copper | X | X | — | X | X | — | X | X |
| Cyanide[b] | X | — | — | — | — | — | X | — |
| Lead | X | X | X | X | X | X | X | X |
| Manganese | X | — | — | X | X | — | X | — |
| Mercury | X | X | X | X | X | X | X | — |
| Nickel | X | — | X | X | X | — | X | — |
| Selenium | X | X | X | X | X | — | X | — |
| Silver | X | X | — | X | X | — | X | — |
| Strontium | — | — | X | — | — | — | — | — |
| Thallium | X | X | — | — | X | — | — | — |
| Vanadium | X | — | — | X | X | — | X | — |
| Zinc | X | X | — | X | X | — | X | X |
| ***Organics*** | — | — | — | — | — | — | — | — |
| 1,3-Dinitrobenzene | — | — | — | — | — | — | — | X |
| 2,4-Dinitrotoluene | — | — | — | — | — | — | — | X |
| 2,6-Dinitrotoluene | — | — | — | — | — | — | — | X |

Table 5. (continued).

| COPCS | WAG 1 | WAG 2 | WAG 3 | WAG 4 | WAG 5 | WAG 8" | WAG 9 | WAGs 6 and 10 |
|---|---|---|---|---|---|---|---|---|
| 2-Amino-4,6-dinitrotoluene[c] | — | — | — | — | — | — | — | X |
| 4-Amino-2,6-dinitrotoluene[c] | — | — | — | — | — | — | — | X |
| RDX | — | — | — | — | — | — | — | X |
| HMX" | — | — | — | — | — | — | — | X |
| 1,3,5-Trinitrobenzene[c] | — | — | — | — | — | — | — | X |
| 2,4,6-Trinitrotoluene | — | — | — | — | — | — | — | X |
| 4-Methyl-4-hydroxy-2-pentanone | — | — | X | — | — | — | — | — |
| 2-Methylnaphthalene | X | — | — | — | — | — | — | — |
| Polychlorinated biphenyls, including Aroclors-1248, -1254, and -1260[d] | X[d] | X[d] | X[d] | X[d] | X[d] | — | X[d] | — |
| TPHs | X | — | — | X | — | — | — | |
| Xylene[b] | — | — | — | — | — | — | — | |
| ***Radionuclides"*** | — | — | — | — | — | — | — | — |
| Am-241, Co-60, Cs-134, Cs-137, Eu-152, Eu-154, Pu-238, Pu-239, Pu-2391240, Sr-90, U-235, U-238, and Tritium | NA | NA | NA | NA | NA | — | NA | NA |

a. Significant uncertainty exists in the screening-level ecological risk assessment (NRF 1997).
b. Retained due to toxicity and common occurrence as a contaminant at CERCLA sites.
c. No sites with HQ >10 for this contaminant; however, it may be a potential COC for postremediation confirmation sampling at ordnance sites.
d. Retained due to environmental persistence and potential for bioaccumulation.
e. Radionuclides were retained for the OU 10-04 and not screened for HQs >10.
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
COC = contaminant of concern
COPC = contaminant of potential concern
NA = not applicable
NRF = Naval Reactors Facility
OU = operable unit
RDX = Royal Demolition Explosive
TPH = total petroleum hydrocarbon
WAG = waste area group

Based on area-specific considerations, other mammals may be collected in the future, and the list of sampled species may be expanded as monitoring proceeds. For example, cottontails represent both a widespread primary consumer and a major prey item in INEEL large raptor and mammal diets, including the coyote *(Canis latrans)*, bobcat (*Felis rufus*), badger (*Taxidea taxus)*, and sensitive species, such as the ferruginous hawk *(Buteo regalis*) and golden eagle (*Aquila chrysaetos*). The Townsend's ground squirrel (*Citellus townsendii*) represents a second common herbivore and a primary dietary item for carnivorous species. Because the ground squirrel can be more easily collected through trapping than the cottontail, the ground squirrel has potential as an equivalent to the cottontail. Black-tail jackrabbits (*Lepus californicus*) ordinarily would replace the cottontail as primary prey; however, huge cyclic jackrabbit populations have not recovered since their decline in the mid-1980s. If and when black-tail jackrabbit (or other species) populations escalate, LTEM will evaluate collecting them for analyses, because their presence in large numbers could mean a change in contaminant migration patterns.

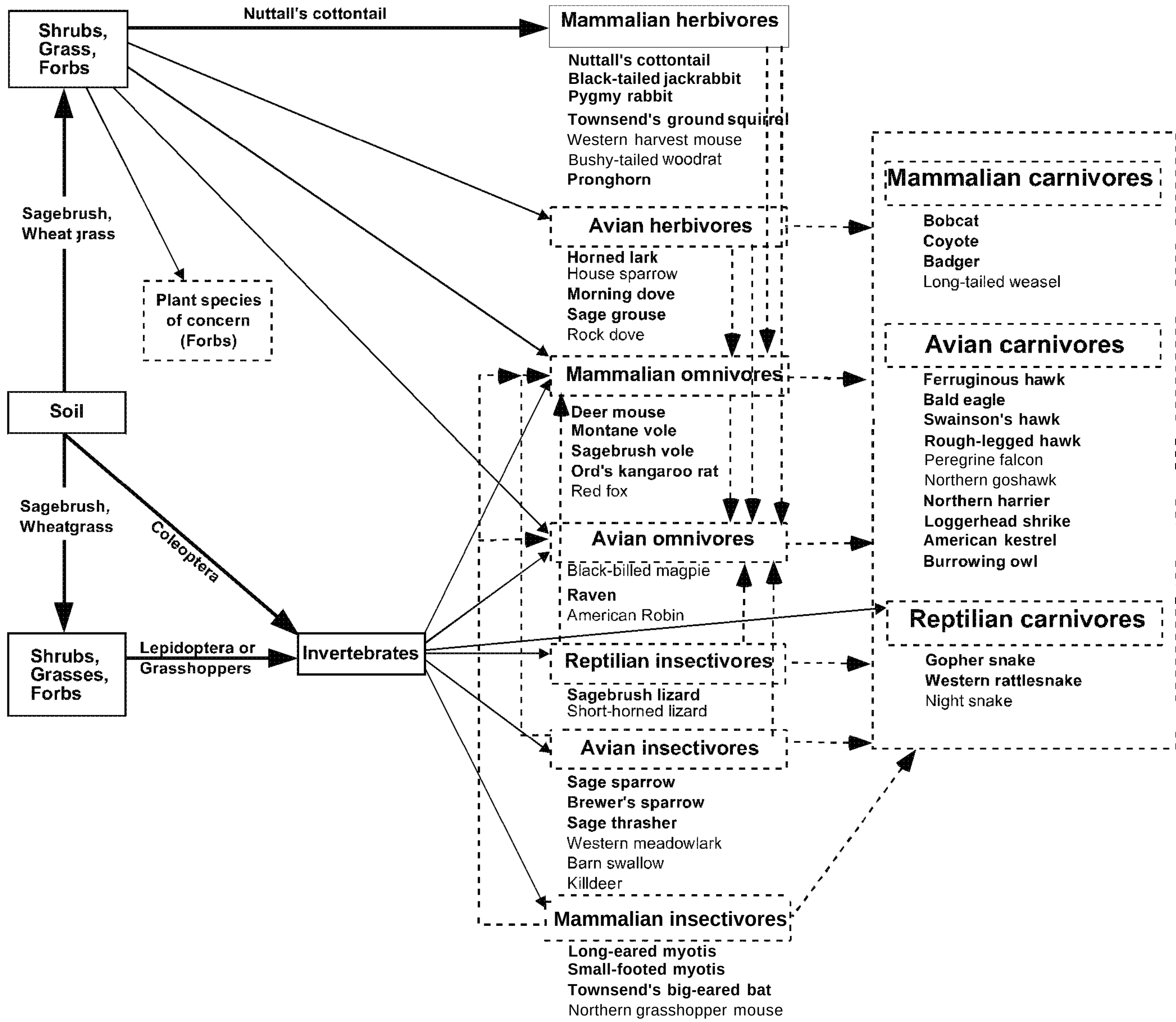
Plants represent the major linkage in the transfer of soil-borne contaminants to primary consumers and higher trophic levels, as shown in Figure 5. Two types of vegetation representing functional plant types (i.e., shrubs, grasses, and forbs) will be collected for chemical analysis. A review of dietary information for herbivorous and omnivorous INEEL wildlife species has resulted in consideration of the following individual plant species and/or types:

- Sagebrush *(Artemisia tridentata)* (alternative—winterfat[*Krascheninnikovia lanata*])
- Wheatgrasses *(Agropyron cristatum* [preferred], *Elymus lanceolatus, Pascopyrum smithii,* etc.).

Sagebrush is the shrub most commonly used by INEEL primary consumers, including the pronghorn, sage grouse, black-tailed jackrabbit, Nuttall's cottontail, and pygmy rabbit. In addition, sagebrush is an important component in the diets of avian and mammalian omnivores and herbivorous insects. Wheatgrasses are most widely used and are significant components in the diets of jackrabbits, cottontails, birds, and small mammals. *Agropyron* is the most commonly identified genus in the dietary studies examined, with cheat grass *(Bromus tectorum)* being the second most common. Few studies identify all grass dietary items to species. Overall, forbs represent a smaller dietary component for INEEL major primary consumers than do shrubs and grasses. Evaluation of available herbivorous and omnivorous dietary data indicates that tansy mustard (*Descurainia pinnata)*, white-stemmed globemallow (*Sphaeralcea munroana*), and milk vetch *(Astragalus* spp.) are most commonly used by herbivorous mammals and insects. Sagebrush and wheatgrass will be the focus of the monitoring; however, other plants may be considered and included as an associated study. For example, it is known that milk vetches *(Astragalus* spp.) are natural hyperaccumulators of metals, especially selenium. In areas of elevated selenium, it may be possible to use this species as an indicator.

Soil fauna—including nematodes, Collembola, and mites—have been considered useful bioindicators for environmental monitoring programs because of their role in essential ecological functions of soil, including nutrient cycling and decomposition. Microinvertebrates play multiple roles in regulating decomposition through grazing, debris fragmentation, and excretion. In addition, decomposition rates can serve as indicators of toxic effects on ecosystem processes. The movements of macroinvertebrates are limited, thus spatially associating them with environmental contaminant levels. For this reason, soil fauna will be evaluated as a bioindicator under the LTEM Program.

Avian species are common at the INEEL, yet little quantitative ecotoxicological information exists. Most species on the INEEL site are migratory; therefore, exposure is typically for a shorter duration than for resident mammals, plants, and invertebrates. However, migratory birds are protected under the Migratory Bird Treaty Act, and the presence of raptors and sage grouse raises the concern that




03-GA50006-02

Figure 5. Simplified Idaho National Engineering and Environmental Laboratory food web.

contaminants could cause adverse effects in birds. Barn swallows (*Hirundo rustica*) are likely to be among the more highly exposed bird species due to their feeding habits around contaminated waste ponds and use of contaminated sediments to build nests. Therefore, barn swallows were selected as appropriate receptors to evaluate exposure at waste ponds (as identified at each area of concern). If elevated levels of contaminants are measured in soil and/or plants from upland areas in initial sampling, an upland bird species also may be considered for sampling.

As the sampling progresses, indicators of bioaccumulation through the food web may focus on sampling other higher trophic-level organisms to obtain verification of movement into the food web and to evaluate possible effects to these organisms. Higher trophic species would include species such as the badger and coyote.

Species identified as sensitive by federal or state listing also may be addressed. Species and sensitive areas are of concern under the CERCLA process and require protection. Currently, several INEEL species are being considered for federal threatened and endangered listing (for example, sage grouse). The OU 10-04 ERA assumed a population level endpoint (DOE-ID 2001), so further evaluation of possible impacts to these species on an individual level might be required.

***4.4.1.2 Soil.*** Soil samples will be collected from the surface to no more than 0.61 m (2 ft) below ground surface and consist of composites from locations within the sampling plots that correspond to plants from which vegetation samples are collected. This depth is anticipated to concentrate sampling and analytical efforts on the depth most likely to pose a source of contamination to plant roots and ingestion/physical exposures for surface dwelling and burrowing animals. Historical data collected at the INEEL include sampling depths of approximately 5, 10, and 15 cm (2, 4, and 6 in.) and additional data for soil depths up to 3.1 m (10 ft).

### 4.4.2 Spatial Scale

Overall, the INEEL site encompasses a land area of approximately 227,840 ha (569,600 acres), with approximately 2% (4,560 ha [11,400 acres]) encompassed by 659 buildings and 2,000 support structures (WAGs 1 through 9) (DOE-ID 1994). Waste Area Groups 1 through 9 are spatially distributed across the INEEL site, separated by distances as small as 3 km (2 mi) and as great as 48 km (38 mi). There are currently 437 sites of contamination at the INEEL, with approximately 160 radionuclides and 100 organics and metals identified as contaminants. Contaminated sites vary in size from a few square meters to several hundred hectares, with widely differing habitat.

The CERCLA definition of the site encompasses only the area within INEEL boundaries (DOE-ID 1999). Currently, regional issues (regional being the large geographic area that has natural boundaries important to ecological concepts) beyond the INEEL boundary are not addressed. However, as the LTEM matures, it will be necessary to include a regional evaluation of this facility. The regional evaluation of INEEL resources is critical, because the INEEL maintains several declining ecosystems, and this could affect risk management decisions and direct long-term monitoring.

Sampling will be focused on areas of concern identified in the OU 10-04 ERA (DOE-ID 2001) and in this plan. These areas were identified as being of concern—due to residual contaminant concentrations in surface or subsurface soil, buried waste, or sensitive habitat—to be adequately addressed during monitoring. However, as sampling progresses, more effort will be placed on understanding impacts at a sitewide level. This understanding will be used to direct LTEM to validate the assumptions of limited risk at a sitewide level.

***4.4.2.1 Temporal Scale.*** The initial sampling effort is planned to occur over a 5-year period. Initial sampling results will be used to determine bioindicators, biomarkers, and a baseline. This information will be used to define the extent of hture efforts. Since residual and buried waste will remain at the INEEL long into the hture, it is anticipated that associated ecological monitoring will be required to ensure protectiveness of the remedies and to evaluate possible failure of any waste containment. It is proposed that the intensity of sampling will be reduced to periodically sampling selected indicators based on increased understanding of the system that will emerge from current sampling efforts.

## 4.5 Step 5: Develop Decision Rule

Decision rules are "if…then" statements that describe the actions that will be taken in response to the results of data collection. This project has two main objectives for data collection. The first is to verify that the remedial objectives specified in INEEL CERCLA RODs are maintained for ecological receptors. The second is to determine that contamination left in the INEEL soils and water does not have unacceptable long-term sitewide ecological impacts. Two decision rules support these two main objectives:

1. If yearly sampling or associated studies do not indicate a difference or a trend at known areas of possible contamination in an area surrounding the WAG or other area of concern (as compared with the reference areas), then continue site-specific monitoring and surveillance at an appropriate level for trending, for ensuring the remedy remains ecologically protective, and for supporting the 5-year reviews.

2. If yearly sampling or associated studies indicate a difference or a trend at known areas of possible contamination in an area surrounding the WAG or other area of concern (as compared with the reference areas), then in addition to site-specific monitoring and surveillance, supplementary data (see Subsection 4.3.5) will be required to help determine if the difference is a potential INEEL sitewide issue, if the difference has ecological relevance, and if a positive correlation exists between contaminants and effects (allowing the possible identification of biomarker/bioindicators).

The assumption related to the first decision rule is that if no difference in contaminant concentrations are detected at the "worst case" sites in comparison with the reference areas, then it is unlikely that sitewide ecological risks exist and most of the monitoring efforts will focus on verifying that the remedies remain effective. The assumption related to the second decision rule is that the mere detection of a contaminant concentration difference does not mean an adverse effect in an ecological receptor has occurred. As mentioned, one of the first steps after detecting an elevated contaminant concentration would be to search the literature and compare detected concentrations with thresholds above which deleterious effects have been observed. The LTEM Program would use the search results to help determine the relative potential of the contaminant's concentration to cause adverse ecological effects and to help determine the type and quantity of additional data collection.

## 4.6 Step 6: Specify Tolerable Limits on Decision Errors

There are two null hypotheses, one for the analytical data types and one for the effects data types. The data collected under LTEM will have components that contain both statistical and nonstatistical design aspects. In general, the null hypothesis ($H_0$) for each of the analytical data types states: concentrations in biotic or abiotic media exceed that of the reference area(s). The alternative hypothesis (HA) states: concentrations in biotic or abiotic media are the same as those of the reference areas. The null hypothesis ($H_0$) for the effects data types states: effects in biotic media are different from those of the reference area(s). The alternative hypothesis (HA) states: effects in biotic media are not different from those of the reference area(s). Use of conservative estimates of parameters measured (e.g., 95th percent upper confidence limit concentrations for soils) should minimize the potential for error. The decision errors associated with these hypotheses are summarized in Table 6.

Table 6. Decision errors associated with long-term ecological monitoring hypotheses.

| Decision Based on Sample Data | True Condition | |
|---|---|---|
| | $H_0$ is True | $H_A$ is True |
| Decide $H_0$ is true | Correct | Decision error<br>*false acceptance, Type II)* |
| Decide $H_A$ is true | Decision Error<br>*false rejection, Type I)* | Correct |

False acceptance of either of the above null hypotheses would result in a moderate consequence of possible wasted cost and effort of supplemental data collection and evaluation. There is a low likelihood of a more severe consequence involving reevaluation of a ROD and site remediation. False rejection of either of the above null hypotheses would result in excess potential for adverse effects to ecological receptors. The consequences of a false rejection may range from low to severe, and the actual consequences are difficult to predict. Based on previous evaluations, most effects to receptors are expected to be localized in a small area.

## 4.7 Step 7: Optimize the Sampling Design

The approach used for the initial 5 years of the LTEM sampling is a staged approach. Although these areas could be sampled in one large effort, a significant increase in support staff and equipment would be required. The staged approach for collecting this type of information will use existing resources more efficiently. A staged approach allows the interpretation and redirection of the sampling, if necessary. It allows more in-depth individual studies to evaluate techniques to detect effects or exposure for receptor contaminant combinations on selected areas (skinning the hide, etc.). In addition, this approach will provide an indication of the natural variation in populations over time caused by climate stressors that would not be apparent in a one-time effort.

The design for characterization of contaminant concentration in the abiotic and biotic media will include 10 samples at each area. The majority (number to be determined in the yearly FSP) will be (1) random plot areas established by use of strata surrounding the source area and (2) selected biased plot areas from known areas of soil contamination. This maximizes the likelihood that some adverse effects will be detected. To obtain an average, a minimum of three samples is required. If there are no differences between the plot areas, the data can be combined to improve statistical power for comparison to the reference area or other WAG data.

The areas of concern and the proposed rotational schedule are listed in Table 2. As the INEEL ER process and the initial sampling as part of LTEM continue, additional areas may be identified. These will be added as necessary.

# 5. PROJECT MANAGEMENT

The organizational structure and interfaces are documented in Plan (PLN) –881, "Environmental Restoration Long-Term Stewardship Project Execution Plan." The Project Execution Plan presents the project roles and should be used to identify specific responsibilities within this structure.

# 6. PROJECT DOCUMENTATION

This section discusses the documentation and the sequence that it is developed with the LTEM Program. Documentation is designed to provide the approach for evaluation by the Agencies and stakeholders, to direct sampling, and to provide summaries of sampling.

## 6.1 Long-Term Ecological Monitoring Plan

This LTEM Plan summarizes the results of the OU 10-04 ERA, discusses the associated issues, defines goals of LTEM, presents the DQOs for the overall project, and defines activities to be conducted.

## 6.2 Field Sampling Plan

The quality assurance project plan (QAPjP) and the FSP constitute the sampling and analysis plan for a sampling effort. Each year, a new FSP will be developed to direct field sampling at facilities, areas, and sites identified in Table 2. The yearly FSP also will direct the walkdowns and any additional sampling identified during the year. Additional research activities and directed studies will be identified and discussed. The objectives and methodologies of these activities will be included in the FSP. Each FSP will be a stand-alone document that includes the sampling objectives, the sample locations and frequency, sample designation, sampling equipment, and sample handling and analysis. In addition, it will present the data management and data validation, sample size requirements, sample preservation and storage, chain-of-custody and shipping requirements, transporting samples, holding times, handling and disposition of investigation-derived waste, data needs and requirements, and sample location and frequency.

The FSP will reviewed by NE-ID and the final FSP will be sent to NE-ID for transmittal to the EPA and IDEQ.

### 6.2.1 Quality Assurance Project Plan

The referenced QAPjP (DOE-ID 2002b) includes procedures designed to ensure sample integrity, precision, and accuracy in the analytical results, as well as representativeness and completeness of environmental data. The QAPjP is not an attachment to this work plan but is available through the administrative record. The QAPjP (DOE-ID 2002b), written in accordance with RI/FS guidance (EPA 1988), discusses the following elements:

- INEEL ER description
- Project organization and responsibility, including the names of individuals responsible for ensuring that the environmental data collected are valid
- Quality assurance objectives for data, including required data precision, accuracy, representativeness, completeness, and allowed usage of data
- Sample custody procedures and documentation
- Calibration procedures and frequency
- Analytical procedures with references to applicable standard operating procedures
- Data reduction, validation, and reporting procedures
- Internal quality control procedure description or reference

- Performance and system audits
- Preventive maintenance procedures
- Specific routine procedures used to assess data accuracy, precision, and completeness
- Corrective action procedures
- Quality assurance reports, including results of system and performance audits and assessments of data accuracy, precision, and completeness.

### 6.2.2 Waste Management

Waste generated during field activities will be appropriately managed under CERCLA. The FSP will discuss whether the waste will include nonhazardous and nonradioactive waste, hazardous and radioactive (mixed) waste, radioactive waste, or hazardous waste and will reference the appropriate INEEL documents that direct waste management.

### 6.2.3 Sample Analysis and Data Validation

Sample analysis and data validation tasks and the methods and protocols that will be used in analyzing samples will be described in an FSP each year. The data will be validated to the levels of analytical method data validation called for in the FSP and as defined by the appropriate INEEL documentation. Validated data are entered in the Integrated Environmental Data Management System and uploaded to the Environmental Restoration Information System.

## 6.3 Job Safety Analysis

After approval of the LTEM Plan, the job safety analysis (JSA) document will be developed in conjunction with the yearly FSP. The JSA, which will be a stand alone document, will detail health and safety measures for field activities. In addition, the JSA will discuss personal protective equipment, medical surveillance requirements, and applicable safety procedures. The JSA will include the elements described in the *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (NIOSH 1985) and "Hazardous Waste Operations and Emergency Response" (29 CFR 1910.120).

## 6.4 Sampling and Data Documentation

The Sample and Analysis Management organization (formerly the Sample Management Office) provides the LTEM Program with analytical data validation that compares the analytical results with the requirements established by the analytical method. Validation involves evaluation of all sample-specific information generated from sample collection to receipt of the final data package. Data validation is used to determine if analytical data are technically and legally defensible and reliable. The final product of the validation process is the validation report. The validation report communicates the quality and usability of the data to decision-makers. The validation report contains an itemized discussion of the validation process and results. Copies of the data forms annotated for qualification are attached to the report. The limitations and validation reports for the long-term ecological monitoring sampling conducted at the INEEL will be delivered to NE-ID for transmittal to the EPA and IDEQ in accordance with Section 19.1 of the *Federal Facility Agreement and Consent Order for the Idaho National Engineering Laboratory* (DOE-ID 1991b).

Non-quality-assured data results generated by LTEM project activities will be made available upon request.

## 6.5 Annual Letter Reports

Each year, the LTEM Program will generate a letter report that will include a summary of the year's activities, a summary of the results, and a preliminary data assessment and interpretation. This letter report will reference appropriate documents to reduce the size of the report. Any available research or directed study results will be summarized in this letter report and results will be included as attachments.

## 6.6 Five-Year Report

The LTEM Program is performing monitoring to verify that the remedial objectives of the CERCLA RODs are maintained for ecological receptors and to determine if contamination left in the INEEL's soil and water is having unacceptable long-term ecological impacts. This initial plan directs the collection of data over 5 years to provide the baseline in abiotic and biotic media needed to adequately monitor and trend in the future. The 5-year report will summarize and assess the 5 years of data collected across the facilities, areas, and sites. Based on the results of this assessment, a new plan for long-term monitoring will be developed. This updated plan will provide the direction for hture monitoring and/or additional evaluation. Based on the results of the 5-year data assessment, the ultimate goal is to develop a streamlined monitoring program for hture monitoring.

## 6.7 Other Written Communications

Two types of reports explained in this subsection will be prepared for this project: (1) routine reports and (2) event reports. Each of these is discussed below.

### 6.7.1 Routine Reports

Weekly and monthly reports will be issued to the NE-ID project manager. Reports will contain a summary of work in progress, planned work, problems encountered, results of any change control board or internal change board actions, work stoppages, anticipated schedule variances, work completed, key position changes, status of subcontracts, corrective action plans, audits performed, and earned value reports.

### 6.7.2 Event Reports

Unusual events may be within the scope of DOE Order 232.1A, "Environment, Safety, and Health Reporting." If such events occur, notifications will comply with this order. Unusual events outside the scope of DOE Order 232.1A will be reported as follows:

- Minor problems will be reported to the site supervisor and, if necessary, to the safety representative
- Radiological health and safety problems that cannot be corrected on the INEEL site will be reported to the site supervisor or the health and safety officer.

## 6.8 Community Relations

Community relation activities for any LTEM report will be guided by the INEEL *Community Relations Plan* (DOE-ID 1995). This plan is a guide to public involvement and community relations at the INEEL. It was developed to involve the community in the environmental cleanup decision-making process, and it will be used as a guide for eliciting and addressing stakeholder concerns about LTEM. Copies of the *Community Relations Plan* (DOE-ID 1995) may be reviewed at the information repositories or by calling the INEEL's toll-free number: 1-800-708-2680.

# 7. LONG-TERM ECOLOGICAL MONITORING SCHEDULE

The LTEM plan is designed to help verify that the remedial objectives of the CERCLA RODs are maintained for ecological receptors and that the contamination left in place does not have unacceptable long-term ecological impacts. Table 2 presents the proposed schedule for the first 5 years of baseline sampling. The term “suggested initial sampling year” in Table 2 anticipates that sampling locations and dates may change based on sampling results, events, and changing conditions at the INEEL. After 5 years, the 5-year data collected will be evaluated. The LTEM plan will be updated, and the monitoring schedule beyond this timeframe will be developed.

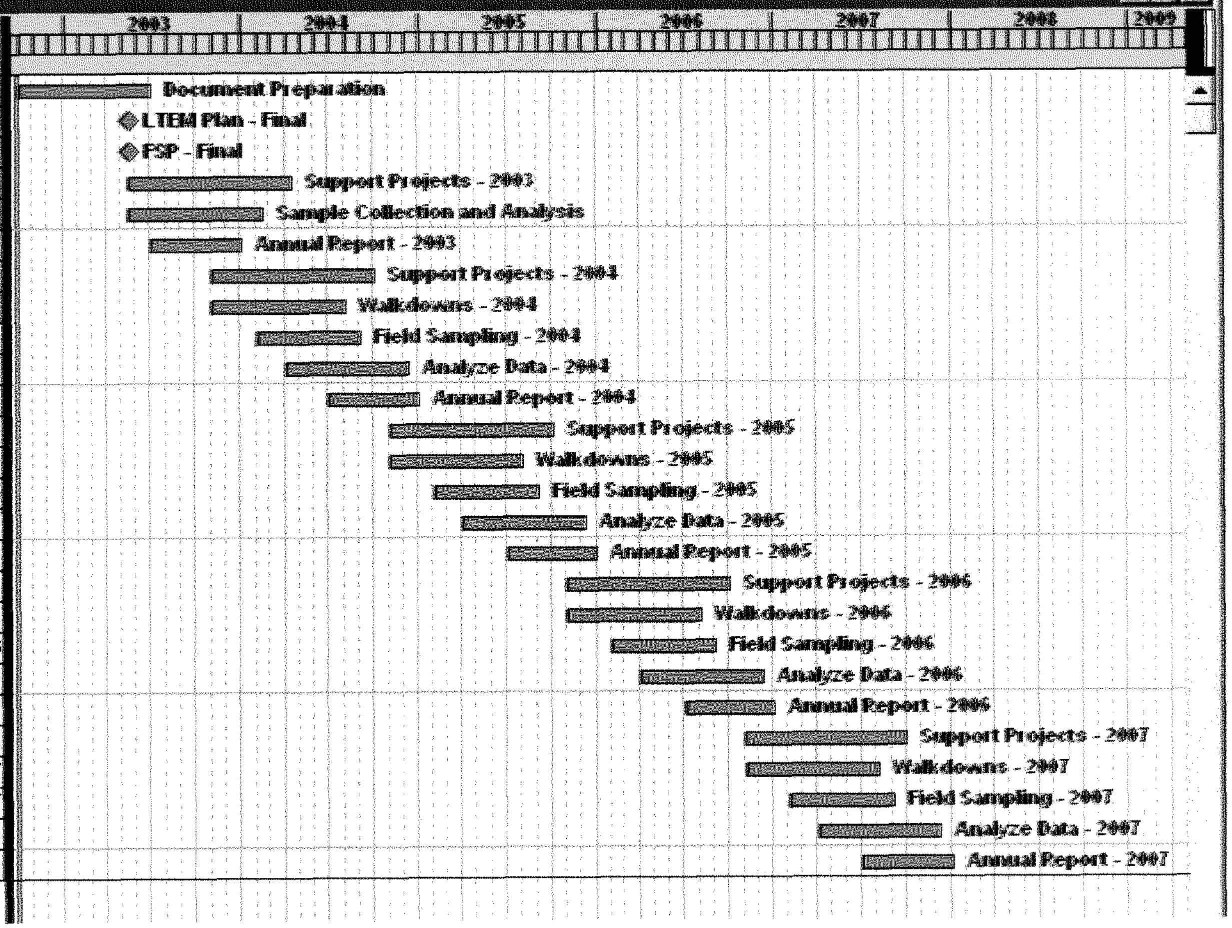
Table 6 presents a sample of the planned schedule of yearly activities, including walkdowns. The actual date the activities take place will be highly dependent on weather and on the availability of technical and analytical services. The “Support Project” shown in Table 6 and discussed in Subsection 4.3.5.2 pertains to CERCLA-funded data collection efforts on research studies that are not necessarily performed annually. Various portions of the ecological monitoring are planned for completion each fiscal year as follows:

- 1st–2nd quarter—FSP; first walkdown
- 2nd–3rd quarter—Annual status letter report
- 3rd–4th quarter—Second walkdown; field sampling
- 4th–1st quarter—Limitations and validation transmittals.

Table 7. Proposed fiscal year long-term monitoring schedule.[a]

ECOM

| Activity ID | Activity Description | Orig Dur | Early Start | Early Finish |
|---|---|---|---|---|
| 110 | Document Preparation | 195 | 01OCT02 | 30JUN03 |
| 120 | LTEM Plan - Final | 0 | 15MAY03 | |
| 125 | FSP - Final | 0 | 15MAY03 | |
| 135 | Support Projects - 2003 | 237 | 16MAY03 | 12APR04 |
| 155 | Sample Collection and | 195 | 16MAY03 | 12FEB04 |
| 190 | Annual Report - 2003 | 132 | 01JUL03 | 31DEC03 |
| 195 | Support Projects - 2004 | 239 | 03NOV03 | 30SEP04 |
| 200 | Walkdowns - 2004 | 196 | 03NOV03 | 02AUG04 |
| 210 | Field Sampling - 2004 | 151 | 03FEB04 | 31AUG04 |
| 220 | Analyze Data - 2004 | 180 | 02APR04 | 09DEC04 |
| 240 | Annual Report - 2004 | 132 | 01JUL04 | 31DEC04 |
| 245 | Support Projects - 2005 | 240 | 01NOV04 | 30SEP05 |
| 250 | Walkdowns - 2005 | 195 | 01NOV04 | 29JUL05 |
| 260 | Field Sampling - 2005 | 150 | 03FEB05 | 31AUG05 |
| 270 | Analyze Data - 2005 | 180 | 01APR05 | 08DEC05 |
| 300 | Annual Report - 2005 | 131 | 01JUL05 | 30DEC05 |
| 310 | Support Projects - 2006 | 239 | 01NOV05 | 29SEP06 |
| 320 | Walkdowns - 2006 | 195 | 01NOV05 | 31JUL06 |
| 330 | Field Sampling - 2006 | 150 | 03FEB06 | 31AUG06 |
| 340 | Analyze Data - 2006 | 180 | 03APR06 | 08DEC06 |
| 370 | Annual Report - 2006 | 130 | 03JUL06 | 29DEC06 |
| 380 | Support Projects - 2007 | 238 | 01NOV06 | 28SEP07 |
| 390 | Walkdowns - 2007 | 195 | 06NOV06 | 03AUG07 |
| 400 | Field Sampling - 2007 | 151 | 02FEB07 | 31AUG07 |
| 410 | Analyze Data - 2007 | 180 | 02APR07 | 07DEC07 |
| 440 | Annual Report - 2007 | 131 | 02JUL07 | 31DEC07 |




a. Presented from FY-03 activities.
FSP = field sampling plan
FY = fiscal year
LTEM = long-term ecological monitoring

# 8. GLOSSARY

**Absolute density ($N_a$):** This is a precise quantitative measure of the numbers of individuals (e.g., rabbits: n $km^{-2}$; snails: n $m^{-2}$; bacteria n $mm^{-3}$). This is possible only when the area or volume can be defined accurately and individuals can be detected and counted accurately.

**Abundance:** Population size **(N)** is usually expressed as **density (=** number/area or number/vol).

In an empirically defined population, the data can be extrapolated to a conceptual population by assuming that density in the area under study is representative of the density throughout the entire population. Changing density then reflects changing abundance (i.e., population **growth).**

**Assemblage:** An association of interacting populations of organisms in a given water body. Examples of assemblages used for biological assessments include algae, amphibians, birds, fish, reptiles and amphibians, macroinvertebrates (insects, crayfish, clams, snails, etc.), and vascular plants.

**Attribute:** A measurable component of a biological system (Karr and Chu 1997b).

**Biological assessment (bioassessment):** Using biomonitoring data of samples of living organisms to evaluate the condition or health of a place (e.g., a stream, wetland, or woodlot).

**Biological criteria (biocriteria):** Numerical values or narrative expressions that describe the condition of aquatic, biological assemblages of reference sites of a given aquatic life use designation.

**Biological indicator (bioindicator):** An anthropogenically induced response in biomolecular, biochemical, or physiological parameters that has been causally linked to biological effects at one or more of the organism, population, community, or ecosystem levels of biological organization. Bioindicators are usually used to reflect effects of stressors on biological systems at higher levels of organization. They can be used to indicate contaminant exposure, help identify the mechanisms of toxicity, provide an early warning of impending environmental damage, and provide early indications of environmental recovery/remediation. Bioindicators are important in linking cause (stressor) to ecologically relevant effects.

**Biological integrity:** "...the ability of an aquatic ecosystem to support and maintain a balanced, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats within a region." (Karr and Dudley 1981)

**Biological marker (biomarker):** Biomarkers are generally used to indicate exposure of organisms to contaminants at lower levels of biological organization, while bioindicators are typically used to reflect effects of stressors on biological systems at higher levels of organization. The increased mutation of microsatellite alleles in deer mice would be considered a biomarker.

**Biological monitoring (biomonitoring):** Sampling the biota of a place (e.g., a stream, a woodlot, or a wetland).

**Biota:** The plants and animals living in a habitat.

**Community:** All the groups of organisms living together in the same area, usually interacting or depending on each other for existence.

**Composition (structure):** Composition is a calculated attribute rather than one that is directly collected in the field. It is the proportion of various plant species in relation to the total of a given area. Composition may be expressed in terms of relative cover, relative density, relative weight, etc.

Composition has been used extensively to describe ecological sites and to evaluate rangeland condition. To calculate composition, the individual value (weight, density, and percent cover) for a species or a group of species is divided by the total value of the entire population.

**Cover:** An important vegetation and hydrologic characteristic, cover can be used in various ways to determine the contribution of each species to a plant community. In addition, cover is important in determining the proper hydrologic function of a site. This characteristic is very sensitive to biotic and edaphic forces. For watershed stability, some have tried to use a standard soil cover, but research has shown each edaphic site has its own potential cover.

Generally, cover is referred to as the percentage of ground surface covered by vegetation. However, numerous definitions exist. It can be expressed in absolute terms (square meters/hectares) but is most often expressed as a percentage. The objective being measured will determine the definition and type of cover measured.

1. Vegetation cover is the total cover of vegetation on a site.
2. Foliar cover is the area of ground covered by the vertical projection of the aerial portions of the plants. Small openings in the canopy and intraspecific overlap are excluded.
3. Canopy cover is the area of ground covered by the vertical projection of the outermost perimeter of the natural spread of plants' foliage. Small openings within the canopy are included. It may exceed 100%.
4. Basal cover (area) is the area of ground surface occupied by the basal portion of the plants. Ecologists and range managers typically use a height close to the ground (e.g., about 2.5 cm [1 in.]); foresters typically use "breast height" (e.g., 1.4 m [4.5 ft]).
5. Ground cover is the cover of plants, litter, rocks, and gravel on a site.

**Density:** Density has been used to describe characteristics of both floral and faunal communities.

For plants, however, comparisons can only be based on similar life form and size. This is why density is rarely used as a measurement by itself when describing plant communities. For example, the importance of a particular species to a community is very different if there are 1,000 annual plants per acre versus 1,000 shrubs per acre. It should be pointed out that density was synonymous with cover in the earlier literature. Density is the number of individuals per unit area. The term refers to the closeness of individual plants to one another.

Density:

1. Number of individuals/unit area
2. Absolute density—count or number of all individuals in a unit area (or surface)
    a. Indicates exact numbers (at least in principle)
    b. For example, insects/square meter

3. Relative density—numbers of individuals related to other numbers in time or space

    a. Often related to method used in sampling

    b. Can only be used for comparisons

    c. For example, insects/10 sweeps

4. Both types of estimates are important.

**Diversity:** A combination of the number of taxa (see taxa richness) and the relative abundance of those taxa. Various diversity indices have been developed to calculate diversity.

**Ecological integrity:** The condition of an unimpaired ecosystem as measured by combined chemical, physical (including physical habitat), and biological attributes.

**Ecological risk assessment:** An evaluation of possible adverse effects to ecological receptors from stressors (usually chemical) in the environment.

**Ecoregion:** Regions defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, and other ecologically relevant variables.

**Frequency:** One of the easiest and fastest methods available for monitoring. It describes the abundance and distribution of species and is useful to detect changes over time. Frequency is one of the most commonly used indicators for monitoring vegetation.

Frequency has been used to determine land condition, but only limited work has been done in most communities. This makes the interpretation difficult. The literature has discussed the relationship between density and frequency, but this relationship is only consistent with randomly distributed plants (Greig-Smith 1983).

Frequency is the number of times a species is present in a given number of sampling units. It is usually expressed as a percentage.

**Functional groups:** A means of dividing organisms into groups, often based on their method of feeding (e.g., shredder, scraper, filterer, predator), type of food (e.g., fruit, seeds, nectar, insects), or habits (e.g., burrower, climber, clinger).

**Functions:** The roles that ecosystems serve (e.g., wetlands), which are of value to society or the environment.

**Habitat:** The sum of the physical, chemical, and biological environment occupied by individuals of a particular species, population, or community.

**Herpetiles:** Reptiles and amphibians.

**Index (plural = indices or indexes):** An integrative expression of site condition across multiple metrics. An index of biological integrity is often composed of at least seven metrics (Karr and Dudley 1981).

**Index of Biological Integrity:** An integrative expression of the biological condition that is composed of multiple metrics. Similar to the Dow Jones Industrial Index used for expressing the condition of the economy.

**Macroinvertebrates:** Animals without backbones that can be seen with the naked eye. Includes insects, crayfish, snails, mussels, clams, fairy shrimp, etc.

**Metric:** An attribute with empirical change in value along a gradient of human influence (Karr and Chu 1997a).

**Reference site (off-Site):** An area not subject to the source-related contamination that is representative of the expected ecological conditions and integrity of potentially impacted sites of the same type and region.

**Relative density ($N_r$):** This is some index of biological activity of the population that is known or assumed proportional to the absolute density (i.e., $N_r = cN_a$). Assuming the value of "c" is constant (although) usually unknown, proportional changes in $N_r$ should be identical to those in N,.

**Taxa (singular = taxon):** A grouping of organisms given a formal taxonomic name such as species, genus, and family.

**Taxa richness:** The number of distinct species or taxa that are found in an assemblage, community, or sample.

**Wetland:** Areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support and, under normal circumstances, do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (Cowardin et al. 1979).

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