# Regulatory Overview

# Issues of Long-Term Stewardship: State Regulators' Perspectives

July 2004

Prepared by
The Interstate Technology & Regulatory Council
Radionuclides Team

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## ACKNOWLEDGEMENTS

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Members of the Radionuclides Team (listed in Appendix D) participated in the development of the regulator survey as well as the writing and reviewing of the document. We also wish to thank the organizations that made the expertise of these individuals available to the ITRC.

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## EXECUTIVE SUMMARY

For the purpose of this document, long-term stewardship (LTS) is the federally implemented institutions, controls, information, and mechanisms necessary to protect the public and environment from legacy waste deemed impractical, unsafe, or too costly to remediate to free-release standards. According to the U.S. Department of Energy's (DOE) definition, LTS includes land use controls, monitoring, maintenance, and information management.

To investigate the LTS challenges facing state regulators, the Interstate Technology & Regulatory Council's Radionuclides Team conducted a targeted survey of state regulators in the fall of 2002. The survey was developed with the intention of assessing opinions of individual state regulators involved in work with DOE sites and familiar with LTS issues. Thirty-one regulators from seven states with large DOE facilities (Colorado, Missouri, New Mexico, Ohio, South Carolina, Tennessee, and Washington) completed the survey.

The goal of the survey was to identify the areas of LTS that present challenges that would benefit from development and application of additional science (social, biological, chemical, engineering, etc.) and technology. This document presents the results of the survey of state regulator perspectives on LTS. It highlights issues and concerns identified by state regulators pertaining to LTS to assist decision makers and technology developers.

To put the results of the survey into context with other LTS efforts, three additional documents were reviewed and compared with the findings of the survey: DOE's *Long-Term Stewardship Science and Technology Roadmap (Draft)* (DOE 2002); *Environmental Cleanup at Navy Facilities: Adaptive Site Management*, developed by National Research Council (NRC 2003); and DOE's *Draft Implementation Guide for Use with DOE O.1B, Real Property Asset Management: Guidance for Transition of Long-Term Surveillance and Maintenance Function* (DOE 2004). These documents were selected because they represented federal initiatives responsible for moving the sites from cleanup to long-term management and meeting the implementation challenges of LTS. In general, the results of the survey were consistent with the perspectives of the three documents reviewed for comparison. All of the documents recognize the need for a multidimensional approach to LTS.

In the survey, state regulators indicated that they are knowledgeable about LTS technologies and challenges. They identified several areas (information management, monitoring, decision making, etc.) where they would like to improve their skills and knowledge to be better prepared for the significant challenges LTS will present. A broad collection of activities was identified as important to closing sites and conducting LTS. State regulators, as well as DOE's LTS Roadmap, recognize the need for new technologies to support better and more cost-effective cleanup and LTS efforts. Long-term treatment will require land use controls or limitations. Monitoring and data analysis systems are needed to ensure early problem detection of system failure. Human surveillance of sites during LTS is seen as mandatory. Successful information management will require the ability to access, update, store, and disseminate data across multiple generations. Land use controls require monitoring to ensure their continued effectiveness. Decision making requires early and continued public outreach and dialog to be successful. The respondents had had some experience with social science tools, such as risk perception studies,

and indicated that further development of these tools could be useful for LTS. Multifaceted communication is widely recognized as both a challenge and essential for successful LTS.

The importance of LTS is broadly recognized in the regulatory, public, technical, and federal communities. The survey and the three documents reviewed were each developed by different groups of people (state regulators, National Research Council, contractor personnel in the DOE complex, and DOE personnel) for different reasons, yet there is as much consensus as difference among the perspectives they present. All of the documents view LTS as collection of integrated activities including: communication, information management, institutional controls, and monitoring. The differences among the perspectives lie in the timing and amount of involvement of the public, the expectation for change over time, the level of confidence in intergenerational information transfer, the degree of confidence in current monitoring strategies, and the relative level of current technical and institutional readiness for LTS. This LTS survey report is intended to provide a useful basis for continuing dialog, education, and development efforts to bring the perspectives closer, facilitate the transition of sites into LTS, improve the tools available for conducting LTS, and improve the effectiveness and efficiency of LTS operations.

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# ISSUES OF LONG-TERM STEWARDSHIP: STATE REGULATORS' PERSPECTIVES

## 1. INTRODUCTION

For the purpose of this document, long-term stewardship (LTS) is the federally implemented institutions, controls, information, and mechanisms necessary to protect the public and environment from legacy waste deemed impractical, unsafe, or too costly to remediate to free-release standards. Developing successful monitoring, institutional controls, engineering controls, and maintenance activities to last for the hundreds, even thousands of years required at most U.S. Department of Energy (DOE) sites is a challenge faced by all. No processes, policies, or technologies have been evaluated against such long-term standards.

LTS emerged out of the need to address the reality that "cleanup" of federal facilities under multiple regulatory programs would not, indeed *could* not in all cases, achieve conditions deemed acceptable for unrestricted use and would therefore require some form of management far into the future. The concept of LTS is known by several different names, depending on the organization, for example "long-term stewardship," "long-term surveillance and maintenance," or "legacy management" in DOE and "long-term monitoring and surveillance" in the U.S. Department of Defense (DOD). Most federal facilities that supported the nation's defense programs will require some form of LTS to ensure protectiveness after cleanup actions are complete. Depending on the prevailing regulatory framework under which cleanup is accomplished, either the state, regional, tribal, or federal organizations will bear the responsibilities and/or authorities for LTS.

DOE defines long-term stewardship as "the physical controls, institutions, information, and other mechanisms needed to ensure protection of people and the environment at sites where DOE has completed or plans to complete 'cleanup' (e.g., landfill closures, remedial actions, removal actions, and facility stabilization). This concept of long-term stewardship includes land use controls, monitoring, maintenance, and information management" (DOE 2001a, Vol. I, p.1).

DOE is the fourth largest federal landowner, conducting its mission at 50 major sites on 2.4 million acres across the United States (DOE 2003). With DOE's mission coming to a close at many sites and with the potential to return land to the public, DOE and several states are debating how to best manage sites too contaminated for free release.

To investigate the LTS challenges facing state regulators, the Interstate Technology & Regulatory Council's (ITRC) Radionuclides Team conducted a targeted survey of state regulators from seven states with major DOE facilities. The goal of the survey was to identify the areas of LTS that present challenges that would benefit from development and application of additional science (social, biological, chemical, engineering, etc) and technology.

To put the results of the survey into context with other LTS efforts, three additional documents were reviewed and compared with the findings of the survey. These documents were selected because they represented other federal initiatives responsible for moving the sites from cleanup to long-term management and meeting implementation challenges of LTS. The DOE-sponsored *Long-Term Stewardship Science and Technology Roadmap (Draft)* (DOE 2002) was developed

to aid DOE in identifying and cost-effectively implementing knowledge and tools at DOE LTS sites. The *Environmental Cleanup at Navy Facilities: Adaptive Site Management* document was developed by the National Research Council to improve the U.S. Department of Navy's ability to close its difficult-to-remediate hazardous waste sites (NRC 2003). DOE's *Draft Implementation Guide for Use with DOE O.1B, Real Property Asset Management: Guidance for Transition of Long-Term Surveillance and Maintenance Function* (DOE 2004) provides a checklist of documentation and processes needed by sites transitioning from cleanup to LTS.

The survey and the three reviewed documents all employed different techniques for collecting information and focused on different groups of people as the primary contributors. However, the technical needs identified by the three activities are similar, as discussed in this document.

## 1.1 Purpose of this Document

This document, developed by the ITRC Radionuclides Team, presents the results of the survey of state regulator perspectives on LTS that was conducted in 2002. The document presents the survey methodology, data, results, and conclusions and compares the findings of the survey with those of three other relevant documents referenced above. These challenges and technology gaps identified by the state regulators are based on a thorough understanding of the complexities that exist not only in their own states but also DOE complex wide. It highlights issues and concerns pertaining to LTS to assist regulators, stakeholders, technology developers and DOE to understand, evaluate, and make informed decisions as they move forward and implement long-term stewardship to protect the human health and the environment.

Increasingly DOE, states, and communities are faced with the reality that successful stewardship of radioactively contaminated sites will require a combination of land use controls and stewardship technologies. This document is intended to provide a summary of LTS challenges facing states at sites contaminated with long-lived radionuclides (those possessing a half-life of about 30 years or more). In most cases, these LTS challenges will require the development of technologies and strategies not previously envisioned or utilized in standard Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)/Resource Conservation and Recovery Act (RCRA) cleanup projects. The document covers various technology needs and possible strategies to help address the challenges of protecting human health and the environment at sites with long-lived radionuclide contamination.

## 1.2 Organization of the Document

Section 2 of the document provides a brief overview of LTS issues that were considered in formulating the state survey. Section 3 describes the LTS survey conducted by the ITRC Radionuclides Team—its development, data analysis, and results. Section 4 presents a synopsis and a description of importance from an ITRC perspective of each of the following documents: the *Long-Term Stewardship Science and Technology Roadmap (Draft)* (DOE 2002), the report *Environmental Cleanup at Navy Facilities: Adaptive Site Management* (NRC 2003), and the DOE *Draft Implementation Guide for use with DOE O.1B, Real Property Asset Management: Guidance for Transition of Long-term Surveillance and Maintenance Function* (DOE 2004). Section 5 presents an integrated assessment of findings from the survey. Section 6 highlights the

major conclusions. Section 7 presents references used, and Section 8 is a bibliography of additional resources related to LTS.

## 2. OVERVIEW OF LONG-TERM STEWARDSHIP

This section is included to give readers a brief perspective on long-term stewardship in DOE and to set the stage for the LTS issues considered in the state survey. DOE is responsible for LTS at an estimated 129 sites (DOE 2001b). The residual hazards at some of those sites—notably those from radioactive materials and toxic metals—will remain potential threats to health and the environment for tens to thousands of years.

A site conducts long-term stewardship once required remediation, disposal, or stabilization activities are complete. In the case of long-term remedial actions, LTS commences when the remedy is shown to be functioning properly and operating as designed. Large, complex sites may remediate portions of the site while other parts are still performing mission-related work. Thus, specific actions that would normally be associated with LTS (such as monitoring the effectiveness of engineered controls) may start years before site closure.

The principal drivers for needing LTS at a site are a combination of the following:

- Priorities—Federal priorities do not support funding for cleanup to free-release levels.
- Long-lived contaminants—Radionuclides, chemicals, and metals are not easily or quickly broken down to safe constituents.
- Lack of technology—No further environmental benefit from remediation is attainable with current technology or asymptotic levels have been reached (e.g., groundwater and vadose zone).
- Risk—Short-term human health or environmental risks of conducting remedial activities outweigh the benefits of remediation.

The current regulatory structure (including CERCLA, RCRA, and the Uranium Mill Tailings Remediation and Containment Act [UMTRCA])[1] provides a basis for LTS of residual contaminants at sites. These statutes were primarily developed for cleanup rather than long-term management of residual contaminants and therefore do not address LTS as a specific potential phase of site management, which requires a systematic long-term approach. CERCLA, RCRA, and UMTRCA do contain elements of LTS, including post-remediation monitoring, maintenance, and periodic reviews, but none define a comprehensive system for ensuring long-term protectiveness of remedies. These statutes provide the opportunity for evaluating LTS requirements and planning during the remedy selection process rather than requiring that LTS be carefully considered during remedy development.

The compelling challenges of LTS faced by DOE, DOD, the U.S. Environmental Protection Agency (EPA), states, and communities are associated with the time frames under consideration. Many statutes and regulations assign authority and responsibility for environmental

[1] CERCLA: Title 40 of the Code of Federal Regulations (CFR) Parts 305–07, RCRA: 40 CFR 240–82, UMTRCA: 40 CFR 192.

contamination into the foreseeable future (i.e., decades), but residual contamination at many federal facilities will remain hazardous for a very long, even infinite, time. Ensuring adequately long-lived monitoring, institutional controls, engineering controls, and maintenance activities is a challenge faced by all.

## Components of Long-Term Stewardship

A regulator's view of what stewardship entails can be summarized in the following definition by one regulator in the ITRC Radionuclide Team survey: "A steward of long-lived hazards acts as a guardian, watchman, land manager, repairer, an archivist, an educator, and trustee…. [T]he range of stewardship activities requires human surveillance as well as institutional controls…."

Many aspects of long-term stewardship are intended to maintain the long-term protectiveness of the remedy. LTS components include the following:

- Physical/Engineered Controls—Implemented to treat or stabilize contamination, to physically contain or isolate waste, or to prevent access
- Institutional/Administrative Controls—Control exposure to hazardous substances by establishing governmental controls and providing legal enforcement tools
- Monitoring and Maintenance—Ongoing environmental monitoring to determine the effectiveness of the remedy, improve understanding of the contaminant interactions with the site, and support maintenance of engineered controls to guide decisions on when and how to modify LTS activities
- Information Management Systems and Repositories—Maintenance of environmental data and other information relevant to the remedy including public communication
- Periodic review of the remedy and, if need be, alteration of the remedy

<u>Physical/Engineered Controls</u>

Engineered controls are designed to treat or stabilize contamination and/or to physically contain or isolate waste or other residual hazards. Common types of engineered controls include in situ stabilization; caps or covers on residual contamination; and vaults, repositories, or engineered landfills designed to isolate waste. Contaminated water may be addressed by controls such as groundwater barriers (e.g., slurry walls, pilings), groundwater treatment systems (e.g., pump and treat, permeable reactive barriers), and surface water diversions (e.g., dams, ponds, and ditches).

Physical controls deter access to contaminated areas or preclude specific uses. Options include the following:

- fencing, walls, and other barriers;
- locks (on wellheads, buildings, fences);
- guards and security patrols; and
- signs, markers, or monuments.

Institutional/Administrative Controls

Institutional controls[2] are legally binding provisions designed to control future uses of land or resources by limiting development and/or restricting public access to a site which has residual contamination. They can include property controls such as easements and covenants; governmental controls such as zoning, permits, restrictions on land and water use, and excavation permit requirements; informational devices like deed notifications and restrictions and title transfers; and legal enforcement tools such as administrative orders and consent decrees. These controls are administrative in nature and are often implemented or enforced by off-site land use authorities (as examples, deed restrictions are generally recorded with the county while zoning ordinances are passed and enforced by municipalities).

Institutional controls also limit activities and/or access to land, groundwater, surface water, and waste disposal areas to prevent or reduce exposure to hazardous substances. These kinds of controls may be used in conjunction with other stewardship measures such as engineered controls to provide an extra layer of protection. In general, institutional controls are not intended to reduce the quantity, toxicity, or mobility of hazardous substances in the environment. They may provide for temporary or permanent restrictions.

Monitoring and Maintenance

Monitoring should provide the information needed to track conditions at the site, determine whether the selected remedies remain effective over time, provide information to decide whether remedies should be altered, and guide decisions on when to stop individual stewardship activities. Environmental elements that may require monitoring include surface water, groundwater, air, and ecological features.

Surface water is monitored to ensure that water quality, especially water leaving a site, meets applicable standards. Surface water monitoring can focus on dam integrity and operations, inflows to ponds, stream flows, water quality leaving the site, off-site water quality, and remedy performance.

The primary objectives of groundwater monitoring systems are to establish contaminant concentration trends, monitor the effects of remedial actions, and provide groundwater flow data for use in water balance and groundwater modeling. Groundwater monitoring systems may include plume definition wells, plume extent wells, plume degradation wells, boundary wells, drainage wells, performance monitoring wells, RCRA compliance wells, and water level monitoring points.

Air monitoring systems may need to measure ambient air quality, effluent air, project performance, and meteorological data. Ecology monitoring activities may include establishing the location and abundance of animal and plant species; monitoring and delineation of major vegetation communities, wetlands and other aquatic ecosystems; searching for noxious weeds;

[2] Some regulatory requirements for disposal and long-term management of radioactive waste (e.g., 10 CFR 61, 40 CFR 191) use the term "institutional controls" to include stewardship activities other than legal provisions.

determining the presence of threatened, endangered, and state special-concern species; and monitoring migratory birds.

Engineered and physical controls need periodic inspection and maintenance to ensure continued performance. Engineered control systems have finite design lives; thus, periodic monitoring of engineered controls is necessary to alert site managers to breakdowns of controls and hazardous substance releases. Maintenance of engineered controls includes routine repairs and replacement; these can be documented in operation and maintenance plans for individual engineered controls or for the site as a whole. Similarly, physical controls require periodic inspection and maintenance in the form of replacing signs, mending fences, etc.

Facilities and structures may also require monitoring. Though the usual approach to physical structures is one of remediation through deactivation, decommissioning, decontamination and dismantlement, certain structures may present a situation in which the short-term human health or environmental risks of conducting remedial activities outweigh the benefits of the remediation. In such cases, LTS or interim LTS, possibly combined with stabilization, is an option, and monitoring (or some form of modified surveillance) becomes necessary.

Monitoring and maintenance protocols may be specified in documents like records of decision or accelerated action decision documents. The effectiveness of monitoring and maintenance activities can be a major part of regular remedy reviews, such as the five-year reviews required at many Superfund sites, or inspections under RCRA/CERCLA.

Information Management

As DOE sites make the transition from cleanup to long-term stewardship, site stewards and stakeholders will need detailed information about the location and nature of residual hazards, the processes that generated them, and the engineered and institutional controls that are part of the remedy. The *National Study on Long-Term Stewardship* (DOE 2001a) identifies general considerations for information collection, storage, and retrieval including uniform criteria, data quality, public trust in the information, and the ability of future generations to readily access the information either remotely or at a centralized repository.

Management of some LTS information is governed by regulations, such as section 113(k) of CERCLA requiring the establishment of an administrative record file containing all information and documentation used in the selection of a response action. The National Archives and Records Administration (NARA 2004) also sets schedules for records retention; some records must be kept permanently while others are kept for varying periods of time (e.g., 10–75 years).

Periodic Review

EPA's *Comprehensive Five-Year Review Guidance* (EPA 2001) states that a review must be conducted at least every five years at Superfund sites "to evaluate the implementation and performance of a remedy in order to determine if the remedy is or will be protective of human health and the environment." In general, CERCLA requires a five-year review process whenever a remedial action results in contaminants remaining on site that are above "unlimited use and

unrestricted exposure" levels (CERCLA Part 121[c]). RCRA policy also requires periodic inspections and reporting.

EPA, another federal agency or department, a state, or a tribe may serve as either the lead or support agency for conducting five-year reviews. Key questions for the review are as follows:

- Is the remedy functioning as intended by the decision documents?
- Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy still valid?
- Has any other information come to light that could question the protectiveness of the remedy?

Pertinent site-specific information to be reviewed includes results from monitoring activities, operation and maintenance reports or other documentation of remedy performance, and previous five-year review reports. Changes that affect the validity of cleanup levels (e.g., standards identified as applicable or relevant and appropriate requirements [ARARs] and assumptions about contaminant characteristics and potential exposure) should also be considered. EPA guidance also states that nearby communities and stakeholders should be notified when a five-year review is conducted or even be involved in its compilation. The results of the review are provided to the local site information repository.

## 3. THE STATE REGULATORS LTS SURVEY

ITRC's Radionuclides Team was formed in 1999 to investigate innovative methods and approaches for characterization, treatment, and management of radioactively contaminated materials. The team's mission is "To facilitate cleanup of radioactively contaminated federal facilities by fostering dialogue between states, stakeholders, and federal agencies in order to increase awareness of issues and procedures at sites in other states, encourage regulatory cooperation, and share technological successes and approaches."

To investigate the LTS challenge facing state regulators, the Radionuclides Team conducted a targeted survey of state regulators in states with major DOE facilities. The focus of the survey was DOE federal facilities, Formerly Utilized Sites Remedial Action Program (FUSRAP), and UMTRCA sites under DOE jurisdiction.

### 3.1 Purpose of the LTS Survey

The goal of this survey was to identify the areas of LTS that present challenges that would benefit from development and application of additional science (social, biological, chemical, engineering, etc.) and technology. The survey results could be utilized to

- guide the future activities (training, guidance documents, technology evaluation) of ITRC Radionuclides Team in LTS,
- help the Radionuclides Team make a more informed review of the LTS documents being developed by DOE, and

- assist decision makers and technology developers.

### 3.2 Development of the LTS Survey

Members of the Radionuclide Team used standard survey development methodology to develop the survey questionnaire, which included multiple-choice graded-response, multiple selection, and short-answer questions. A focused subgroup of the team proposed and revised questions. The survey was then formatted for presentation on an Internet site so respondents could access it electronically. The decision was subsequently made to rely completely on the electronic version to facilitate data analysis. Pilot testing was conducted using five test respondents, who provided feedback that led to minor editorial changes and allowed estimation of the time required to complete the survey. Appendix B contains the final survey as presented on the Internet.

The survey was developed with the intention of assessing opinions of individual state regulators involved in work with DOE sites, targeting those familiar with LTS issues. Potential respondents were contacted through members of the Radionuclide Team based on their familiarity with and involvement in DOE oversight and LTS issues. The participation of 39 regulators from eight states (Colorado, Idaho, Missouri, New Mexico, Ohio, South Carolina, Tennessee, and Washington) with large DOE facilities was solicited via e-mail. Thirty-one regulators from seven states (all but Idaho) completed the survey, with no more than five respondents from any one state (Figure 1.). Initial contacts with potential respondents were made by telephone or e-mail. The survey was conducted over an approximately six-week period. Two follow-up e-mails were sent to encourage completion of the survey.

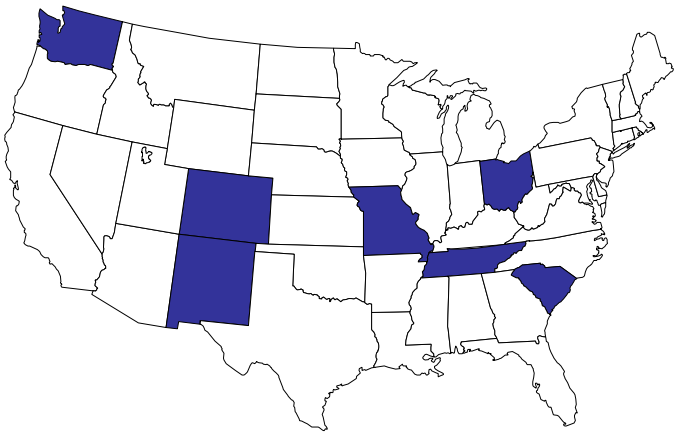

**Figure 1. States with regulators participating in the LTS survey.**

### 3.3 Survey Design

The survey was divided into seven sections—general, treatment, monitoring, information access and use, institutional controls, decision making, and path forward—described in the survey as follows:

- **Section 1: General**
  These questions addressed general issues of long-term stewardship. The purpose of this section was to understand each participant's overall familiarity with and perspective on LTS technology (Questions 10–31; see Appendix B).

- **Section 2: Treatment**
  This section addressed sites where treatment will continue into LTS (such as groundwater or leachate remediation). The purpose of this section was to identify how technology

requirements may change as sites transition from an active to a LTS mode and to understand whether treatment impacts future land use (Questions 32–44; see Appendix B).

- **Section 3: Monitoring**
  The purpose of these questions was to identify the types of monitoring activities that would benefit from additional technology (Questions 45–68; see Appendix B).

- **Section 4: Information Access and Use**
  Questions in this section were meant to help identify the roles of technology in the access and use of information for LTS (Questions 69–89; see Appendix B).

- **Section 5: Land Use and Institutional Controls**
  The purpose of these questions was to understand the role (current and potential) of science (including social) and technology in land use and institutional controls and to gather a basic understanding of the type of experience the survey participants had had with land use and institutional controls. This survey used the EPA's definition of land use and institutional controls: "**Land-use controls** include engineering controls (such as fences and signs) and institutional controls. **Institutional controls** are legally binding provisions (such as local ordinances and state and federal laws) designed to control future uses of land or resources by limiting development and/or restricting public access to a site with residual contamination" (Questions 90–123; see Appendix B).

- **Section 6: Decision Making**
  Sound decision making requires knowledge of the overall problem and an understanding of the community and physical environment potentially affected. The purpose of this section was to understand, for both aspects of the surroundings, which tools and approaches are currently being employed in the decision-making process and to identify which tools and approaches might be useful in the future (Questions 124–60; see Appendix B).

- **Section 7: Path Forward**
  The ITRC Radionuclides Team is currently considering several future projects on LTS issues. The purpose of this section was to capture input on which project would be most beneficial (Questions 161–66; see Appendix B).

The survey included 166 questions, 45 of which were short answer. The survey was estimated to take approximately one hour to complete. Each section included multiple-choice and short-answer questions, as well as an optional question allowing the responder to provide unaddressed information.

### 3.4 LTS Survey Results and Discussion

The 31 regulators from seven states with major DOE sites who responded to this survey represent approximately 80% of those contacted. The survey provides insight into the perspectives of state regulators currently involved with cleanup and LTS activities at DOE sites. Appendix C provides response data for survey questions in summary graphs and short-answer bullets. The following provides an analysis of data collected from all the survey responses and the key observations from the data (arranged by questionnaire section; question numbers in

subscripted brackets). Percentages are calculated based upon responses to each question. Throughout this section "regulator" is synonymous to "respondent."

Survey Section 1: General (Questions 10–31, see Appendix B)

- A large percentage of respondents (84%) were familiar with LTS issues. They responded as being familiar (32%) or very familiar (52%) with LTS issues. This finding reinforces the intent of the survey to contact regulators that were familiar with LTS issues *[10]*.

- The respondents were familiar with the state of the art (in terms of practice) of

  - treatment (84%) (61% familiar, 22% very familiar) *[11]*,
  - monitoring (90%) (55% familiar, 35% very familiar) *[12]*,
  - decision making (94%) (55% familiar, 39% very familiar) *[13]*, and
  - land use and institutional controls (93%) (61% familiar, 32% very familiar) *[14]*.

- The respondents added the categories of information retention, accessibility, and public involvement as the areas that they are familiar with *[15, 16]*.

- Ninety percent or more of regulators indicated that technology is critical in addressing treatment and monitoring challenges of LTS. Respondents felt that technology was important in addressing the following areas:

  - treatment (90%) (63%—major importance, 27%—moderate importance) *[17]*,
  - monitoring (97%) (67%—major importance, 30%—moderate importance) *[18]*,
  - decision making (80%) (47%—major importance, 33%—moderate importance) *[19]*, and
  - land use, institutional controls (77%) (47%—major importance, 30%—moderate) *[20]*.

- Majority of regulators (67%) agreed (27% strongly, 40% moderately) that technology limitations are affecting the ability of sites to successfully implement LTS *[21, 22]*. Some examples of major limitations in technology identified by regulators include the following:

  - information management—maintaining records, both hard copy and electronic,
  - comprehensive understanding of subsurface hydrology,
  - knowledge of long-term effectiveness and reliability of technologies,
  - long-term predictions of fate and transport of contaminants, and
  - detection and remediation of contaminants in the saturated zone.

- In the short-answer section, regulators strongly suggested that information/data management could substantially benefit from additional technology development *[21, 22, 27, 28]*.

- More than 60% of regulators indicated the areas of treatment (61%) and monitoring (61%) in LTS would substantially benefit from development of additional technology *[23, 24]*. The other two areas—decision making and land use/institutional controls—were also seen by approximately 30% of regulators as substantially benefiting from technology development *[25, 26]*.

- Sixty-six percent of regulators agreed (40% moderate, 26% strongly) that LTS is being limited by technology *[29]*.

- The major technology limitations identified by regulators include the following *(30)*:

  - groundwater treatment technologies face major limitations, such as lacking separation of contaminant (e.g., tritium), source control technologies, and removal of radionuclides;
  - technology implementation, especially the cost in a long run;
  - intruder barriers and permeable reactive barriers;
  - information management technology;
  - maintenance of institutional controls;
  - detection and remediation of dense, nonaqueous-phase liquids and strontium in groundwater; and
  - infrastructure to support treatment and monitoring.

- The regulators were in favor of investment in technology development for LTS activities. About 77% of respondents agreed (29% strongly, 48% moderately) that investments in technology development should be a high priority in addressing LTS issues *[31]*.

Survey Section 2: Treatment (Questions 32–44, see Appendix B)

- Less than 50% of respondents felt that sampling-derived water *[32]*, sampling-derived solid waste *[33]*, wastes generated during maintenance of treatment systems *[34]*, and personal protective equipment *[37]* are potential problems during LTS.

- More than 50% of regulators thought that there is potential for technical or other problems with management, treatment, or disposal of leachate and treatment-derived waste while the site is in LTS *[35, 36]*.

- Some challenges offered by the respondents in the area of managing, treating and disposing by products included maintaining the engineered controls/caps, adhering and monitoring the deed restrictions, and removing millions of pounds of metallic and oxidized uranium (in unlined trenches) from the ground, causing consideration for geologic disposal. If left in place, more hazardous and mobile daughters will over time require increasing maintenance and monitoring and land use restrictions *[38, 39, 40, 41]*.

- Most regulators were aware of a wide range of technologies applicable for small quantity of wastewater/leachate during LTS. The respondents offered the following *[42]*:

  - simple mechanical filtration to thermal destruction;
  - incinerated or solidified/stabilized and disposed;
  - coagulation, precipitation, distillation, ion exchange, solidification;
  - contaminant-appropriate technology such as ultraviolet/peroxide, air stripping, reverse osmosis, etc.;
  - treatment within existing on-site wastewater treatment facilities;

- neutralization, flocculation, filtration, evaporation;
- permeable reactive barriers, passive aeration, granular activated carbon; and
- constructed wetlands, solar evaporation.

- Long-term treatment approaches will require land use controls or limitations that extend from tens to hundreds to thousands of years (e.g., groundwater and surface water use may be restricted to protect pump-and-treat operations) *[43]*.

- Most respondents (69%) indicated that point-of-use treatment strategies (21%—never, 48%—occasionally) are generally not appropriate for LTS, or they saw a limited use of these technologies for LTS *[44]*.

Survey Section 3: Monitoring (Questions 45–68, see Appendix B)

- Respondents noted monitoring during LTS as being of major importance for the following areas (listed in descending order) *[45–53]*:

  - disposal facilities *[45]*, containment facilities *[46]*, groundwater *[47]* (>80%);
  - air *[51]*, land use controls *[48]*, and leachate *[50]* (>55%); and
  - tanks *[49]*, ecosystem *[52]* and natural events (earthquakes. etc.) *[53]* (<55%).

  It is important to note that >70% of the respondents felt that all above areas were important (moderate importance plus major importance) for monitoring during LTS.

- Individual respondents added the following categories for monitoring during LTS as being of major importance *[54, 55]*:

  - residual contamination,
  - need to monitor information systems for functionality,
  - uptake of biota and animal life (may be incorporated with ecosystem),
  - groundwater monitoring using natural attenuation of groundwater containing long-lived radionuclides, and
  - continuous remedial technique performance evaluation.

- The top five areas identified as needing additional monitoring technology (with number of 31 respondents in parentheses) are groundwater (20), disposal facilities (16), ecosystem health (16), containment facilities (15), and land use control (15). This list of needs is generally consistent with the priorities indicated for monitoring during LTS. Tanks, air, and natural events received the lowest number of selections for needing additional monitoring technology *[56]*.

- Also noted in the short-answer question was the need for developing monitoring technologies for surface water and automated monitoring with good data logging *[57]*.

- More than 70% of regulators indicated that real-time data, remote sensing and data transmission, and redundancy in monitoring are considered of importance for successful LTS monitoring *[58, 67, 68]*.

  - Seventy percent of regulators agreed either strongly (30%) or moderately (40%) that redundancy in monitoring is important for LTS success.
  - Seventy-three percent of respondents said that real-time data is important (major importance—10%, moderate importance—63%) to effectively monitor LTS systems and structures.
  - Eighty-four percent of respondents said that remote sensing and data transmission is important (major importance—27%, moderate importance—57%) to effectively monitor LTS systems and structures.

- Sixty percent of regulators thought monthly or more frequent observation of a site by personnel was important at sites that are in populated areas, while only 20% thought that such a frequency of site observation was needed in an unpopulated area. Eighty percent of regulators felt that for unpopulated areas on-site human observation was necessary on a quarterly to annual basis (Figure 2) *[63, 64]*.

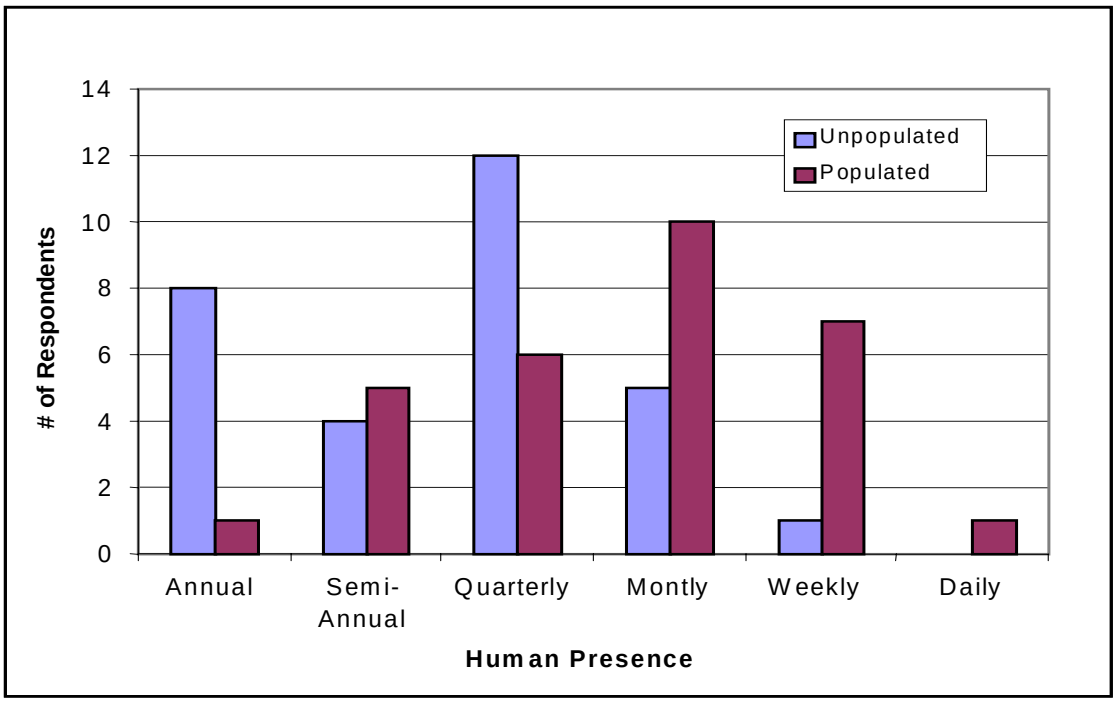


**Figure 2. Frequency of on-site human presence and observation for an effective LTS monitoring system considering populated and unpopulated areas.**

- For active treatment sites *[59]*, daily or weekly human observation was considered important by greater than 80%, while more than 68% felt that passive treatment sites *[60]* could be monitored on a quarterly or monthly basis. For sites with instrumented (an instrumented cap has sensors and monitoring systems incorporated into the design and construction of the cap) caps *[62]*, 68% would like to see quarterly or semiannual monitoring by personnel, whereas

73% thought that for sites with noninstrumented caps[61] on-site monitoring should be monthly or quarterly (Figure 3).

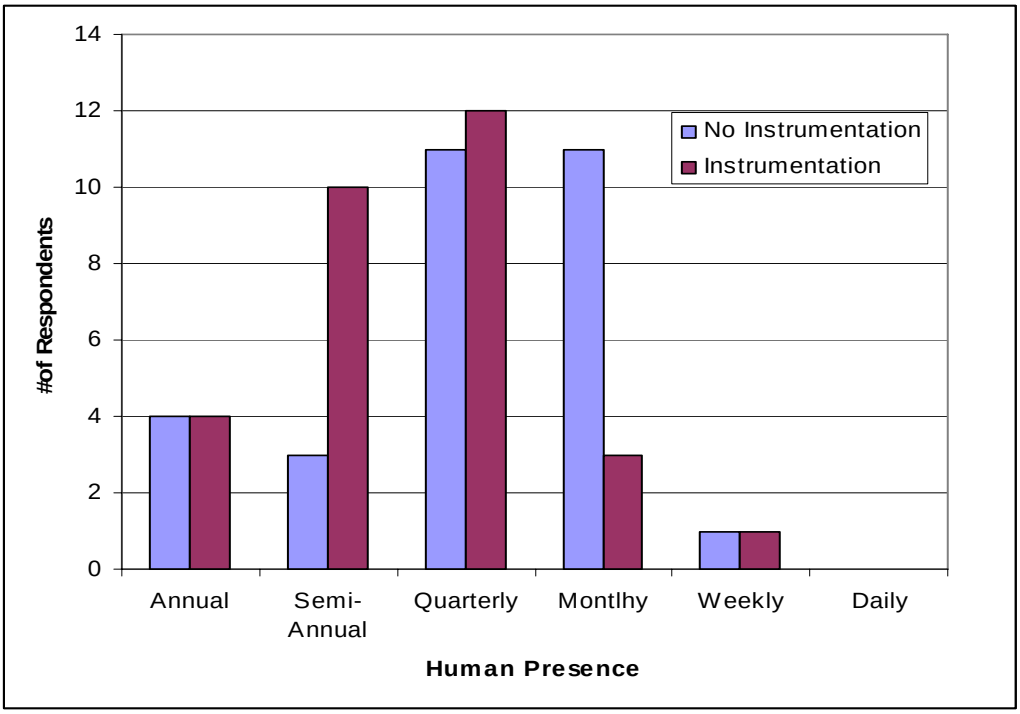


**Figure 3. Frequency of on-site human presence and observation for an effective LTS monitoring system considering cap monitoring instrumentation.**

- Situations for which regulators noted on-site human presence is needed, include vandalism, plant intrusion, animal intrusion, erosion/subsidence, and monitoring of fences. In addition, it was suggested that on-site presence of personnel is also important for public education and to minimize public concerns [65, 66].

Survey Section 4: Information Access and Use (Questions 69–89, see Appendix B)

- A high level of concern and interest was shown by regulators for the problem of maintaining institutional memory and long-term accessibility of information. The technologies currently used for information access and use include paper copies, compact discs (CDs), geographical information systems (GIS), tapes, and some electronic files. Paper is the most common current form for data and compliance documents indicated by regulators. The major limitation identified in currently used technologies is limited accessibility and long-term usability of data/records [69].

- In considering the benefit of further exploring technologies for data access, regulator responses generally fell into three levels [70–77]:

  - Web portal and CD (60%);
  - high-speed scanning, electronic data mining, paper, bar coding (ranging 20–35%); and
  - microfiche (3%).

- Respondents emphasized the need for standardization in data organization and formatting to facilitate intergenerational understanding of information and transfer of data into new forms of storage media *[78, 79]*.

- The expected modes of public access to data, identified by the majority of regulators (>90%) include Web, non-Web interactive, and CDs. In addition, greater than 80% of respondents indicated that paper and video are anticipated modes for public access of data *[80–85]*.

- Some of the innovative ideas suggested for exploring facilitation of public access to data included on-site education museum facility, mass media communication such as television, oral history/traditions, and access to knowledgeable people *[86, 87]*.

- Based on responses to the short-answer question, it seems that Colorado is the only state, of those states with regulators participating in the survey, using a centralized database of areas with LTS obligations. Colorado's database was just recently initiated after implementation of the Colorado Environmental Covenants Act in 2001 *[88]*. None of the states represented by respondents have a designated central point of contact for LTS, according to the respondents *[89]*.

Survey Section 5: Land Use Controls (LUCs) and Institutional Controls (IC) (Questions 90–123, see Appendix B)

- Eighty percent of respondents agree (strongly—23%, moderately—57%) that technology is essential to the successful utilization of land use and institutional controls *[90]*.

- Technology was seen as having a role in improving the effectiveness of land use and institutional controls items such as fences, signs, deed restrictions, zoning, easements, and lease restrictions *[90, 102–107]*.

- Respondents had most positive experience with permits, consent decrees, fences, and signs as opposed to other land use and institutional controls *[91–99]*.

    - More than 90% of the regulators had experience with signs and fences, and approximately 60% of those had had a positive experience with those types of land use/institutional controls *[91, 93]*.
    - About 85% of the regulators had experience with easements/covenants and permits/consent decrees. Positive experience was indicated by 73% for easements/covenants and 84% for permits/consent decrees *[97, 98]*.
    - About 77% of regulators had experience with deed restrictions; of those 58% had negative experiences *[94]*.
    - Regulators had the least experience with monuments (42%), zoning, ordinances and statutes (58%), building codes (39%), and lease restrictions (52%) *[92, 95, 96, 99]*.

- Some additional LUC/IC mechanisms in use include voluntary cleanup contracts/brownfields agreements, fishing advisories, and ICs on sediment disturbance *[101]*.

- The information regarding LTS must be brought to the majority of people; they will not seek it themselves. An interesting suggestion was made that public outreach may need to be more "active" in reaching people. Mass media and oral history both may play a role. Most people are not "engaged" in the decision-making process for sites, and they do not access the Web or library with the purpose of gaining that information *[87, 108, 109, 120]*.

- In terms of approaches for increasing awareness of LUCs and ICs, approximately 50% of regulators had experience; among those with experience, it was frequently (>80%) positive. These approaches included on-site museums, community education classes, and continued scientific studies, and continued government use of the sites. The two exceptions (<25% with experience) to the above finding were computer/database links for deed restrictions and multiple private industry uses for sites (nearly equivalent positive and negative experience) *[110–17]*.

- Continued government use of the sites was greatly preferred (64%) over the option of private industry uses for sites (32%) as a desirable approach to ensure LTS implementation and awareness. More than 55% of regulators thought that each of the following elements should be part of a comprehensive program to ensure long-term awareness of LUCs and ICs: on-site museum/educational facility (58%), computer/database links for deed restrictions (81%), community education (61%), and continued scientific studies (58%) *[120]*.

- Most regulators seem to view the land use restrictions in a more holistic view. They see the future restriction for land use not only related to use of land, but integrally related to use of groundwater and surface water. Access restriction was viewed as site specific, with the range of restrictions from tens to hundreds of years and in some cases even thousands of years *[122, 123]*.

- To improve awareness of LUCs and ICs, approaches suggested include multiple layered LUCs, standardization of formats for data accessibility, and continued communication with public and property owners *[123]*.

Survey Section 6: Decision Making (Questions 124–60, see Appendix B)

- To enhance inclusion of state and local values in the LTS decision-making process, the communication mechanisms/tools most used (90%) included citizen advisory boards (CABs) and public meetings. Other communication tools used frequently by regulators were local government interactions (74%), public reading rooms (74%), and focus groups (61%). The ones used less frequently were nongovernment organizations (45%), consensus building (39%), site open houses (39%), surveys (23%), training (23%), and interactive displays (16%) *[124]*.

- Of the most used communication tools, CABs were seen as the most effective (90%), followed by local government interactions (73%) and public meetings (61%). Public reading rooms, though frequently used (74%), were not seen as particularly effective (30%) *[124]*.

- Ninety percent of respondents with experience felt that CABs were an effective (48%) or very effective (41%) communication process in getting local community, tribal, and state values factored into the LTS decision-making process *[129]*.

- Seventy-three percent of respondents with experience felt that local governments were an effective (46%) or very effective (27%) communication process in getting local community, tribal, and state values factored into the LTS decision-making process *[130]*.

- Sixty-one percent of respondents felt that public meetings were an effective (46%) or very effective (14%) communication process in getting local community, tribal, and state values factored into the LTS decision-making process *[132]*.

- Sixty-two percent of respondents with experience felt that focus groups were an effective (42%) or very effective (20%) communication process in getting local community, tribal, and state values factored into the LTS decision-making process *[126]*.

- Fifty-nine percent of respondents with experience felt that site open houses were an effective (45%) or very effective (14%) communication process in getting local community, tribal, and state values factored into the LTS decision-making process *[134]*.

- Fifty-three percent of respondents with experience (only 57% had experience) felt that interactive displays were an effective (35%) or very effective (18%) communication process in getting local community, tribal, and state values factored into the LTS decision-making process *[133]*.

- Fifty-three percent of respondents with experience (only 57% had experience) felt that training was an effective (41%) or very effective (12%) communication process in getting local community, tribal, and state values factored into the LTS decision-making process *[135]*.

- Fifty-two percent of respondents with experience felt that nongovernment organizations were an effective (43%) or very effective (9%) communication process in getting local community, tribal, and state values factored into the LTS decision-making process *[131]*.

- Only 45% of respondents with experience (69% had experience) felt that consensus building was an effective (30%) or very effective (15%) communication process in getting local community, tribal, and state values factored into the LTS decision-making process *[127]*.

- Only 35% of respondents with experience (69% had experience) felt that surveys were an effective (0% very effective) communication process in getting local community, tribal, and state values factored into the LTS decision-making process *[128].*

- Only 30% of respondents with experience (93% had experience) felt that public reading rooms were effective (26%) or very effective (4%) communication processes in getting local community, tribal, and state values factored into the LTS decision-making process *[136]*.

- Newsletters, periodical articles, and Web-based mechanisms were offered as additional effective ways of communication *[125, 137, 138]*.

- For decision making for selecting land use/institutional controls, respondents had the most experience with graphical/visual presentation of data (74%) *[141]*, followed by value/judgment studies (61%) *[139]*, structured consensus building (61%) *[140]*, and public training/education (57%) *[146]*. Respondents also had the least experience with the following tools: models capable of running "what if" scenarios (45%) *[142]*, land use planning tools (48%) *[144]*, and demographics projection tools (22%) *[145]*. Respondents offered few additional approaches for decision making *[147, 148]*.

- The decision-making tool for selecting more effective LUCs and ICs expected to be the most useful was graphical/visual presentation (83%) *[151]*, followed by models capable of running "what if" scenarios (73%) *[152]*. Land use planning tools *[154]* and training *[156]* were also viewed by most (>60%) as expected to be useful. Even though most respondents have not used demographic projection tools (<25%) *[145]*, more than half of them (57%) think that this could be an effective tool for decision making *[155]*.

- Less than half of respondents (32%) had experience with simplified legal language tools *[143]*, and less than half (41%) felt they would be useful decision-making tools for selecting LUCs *[153]*.

- An average of 48% *[139, 140, 144, 145]* of the respondents had experience with social science based tools, and 56% *[149, 150, 154, 155]* of the respondents expected social science–based tools to be useful for decision making for selecting land use/institutional controls.

- Early involvement of public/stakeholders and enhanced public forums, meetings, and workshops were offered as mechanisms of improving decision making *[159]*.

- Conceptual site models are seen as a useful concept for LTS but need to be improved for effective utilization. The models need to be made more dynamic, accommodating long-term considerations of site data, land use, and contaminants *[160]*.

Survey Section 7: Path Forward (Questions 161–66, see Appendix B)

- Seventy-three percent of respondents felt that an ITRC project involving a case study/guidance document on landfill and disposal facility long-term monitoring technologies would be useful (30%) or very useful (43%) *[161]*.

- Seventy percent of respondents felt that an ITRC project involving a case study/guidance document on real-time in situ radiological contamination characterization technologies would be useful (40%) or very useful (30%) *[162]*.

- Eighty percent of respondents felt that a workshop on data retention technologies would be useful (33%) or very useful (47%) *[163]*.

- Seventy-seven percent of respondents felt that training on LTS technologies and decision making would be useful (32%) or very useful (45%) *[164]*.

## 4. RELATED FEDERAL LTS INITIATIVES AND OBSERVATIONS

To put the results of the ITRC Radionuclides Team LTS survey into context with other LTS efforts, three additional documents were reviewed and compared with survey findings. These documents were selected because they represented other federal initiatives responsible for moving the sites from cleanup to long-term management and meeting implementation challenges of LTS. The DOE-sponsored *Long-Term Stewardship Science and Technology Roadmap (Draft)* ("LTS Roadmap," DOE 2002) was developed to aid DOE in identifying and cost-effectively implementing knowledge and tools at DOE LTS sites. The *Environmental Cleanup at Navy Facilities* document (NRC 2003) was developed by the National Research Council to improve the Navy's ability to close its difficult-to-remediate hazardous waste sites. The *Draft Implementation Guide for Use with DOE O.1B, Real Property Asset Management: Guidance for Transition of Long-Term Surveillance and Maintenance Function* (DOE 2004) provides a checklist of documentation and processes needed by sites transitioning from cleanup to LTS.

### 4.1 LTS Roadmap

The content and perspectives presented in this section are based on reading the *Long-Term Stewardship Science and Technology Roadmap (Draft)* (DOE 2002). Draft documents are usually not cited in ITRC reports; however, the draft LTS Roadmap was developed during the same time frame as the survey and provides useful insight into thinking about LTS at that time. The draft LTS Roadmap was released for public comment and is publicly available at http://lts.inel.gov/st-roadmap/. It is recognized that there may be some changes in the content of the final LTS Roadmap relative to the draft, but the changes are not expected to alter its main findings.

#### 4.1.1 Purpose of the LTS Roadmap

The LTS Roadmap was developed to aid DOE in identifying, developing, and cost-effectively implementing knowledge and tools at DOE LTS sites. One of the objectives of the LTS Roadmap was to recommend "research and development (R&D) pathways to provide a system of integrated capabilities needed for DOE to influence LTS policy and best manage investments to implement an effective LTS program" (DOE 2002, p. 4). It also suggests that the planning processes at DOE will need to be comprehensive and should consider economic, ecological, social, and cultural factors surrounding each facility or parcel of land.

#### 4.1.2 Results of the LTS Roadmap

According to the document, "The Roadmap was compiled by an interdisciplinary team of subject matter experts from industry and academia, federal and state regulators, stakeholder groups, DOE national laboratories, DOE site contractors (end users), and other federal agencies" (DOE 2002, p. 4). The developers of the LTS Roadmap indicated an appreciation of the importance of LTS to other federal agencies but focused on DOE sites with the expressed intent to simplify the

development of the LTS Roadmap. Representatives from several federal agencies, including EPA, DOD, the U.S. Department of Interior (DOI), and the Nuclear Regulatory Commission were identified in the LTS Roadmap as having participated on its development and review.

The LTS Roadmap advocates a strong role for science and technology in LTS:

> …DOE needs knowledge (science) and tools (technology) beyond what it already has to ensure that planning and implementation will result in efficient and effective LTS over tens to thousands of years. In general, this means moving the LTS state-of-the-art in [Science and Technology] into the state-of-the-practice at DOE sites. Site stewards also need better information and resources to work more effectively with regulators, stakeholders, and others that influence decisions in exploring whether a new approach may work better than an accepted, or even prescribed, technology (DOE 2002, p. iii).

The LTS Roadmap advocates an iterative approach (Figure 4), starting with end state definition and moving in a cyclic manner towards the end of LTS activities (unrestricted use).

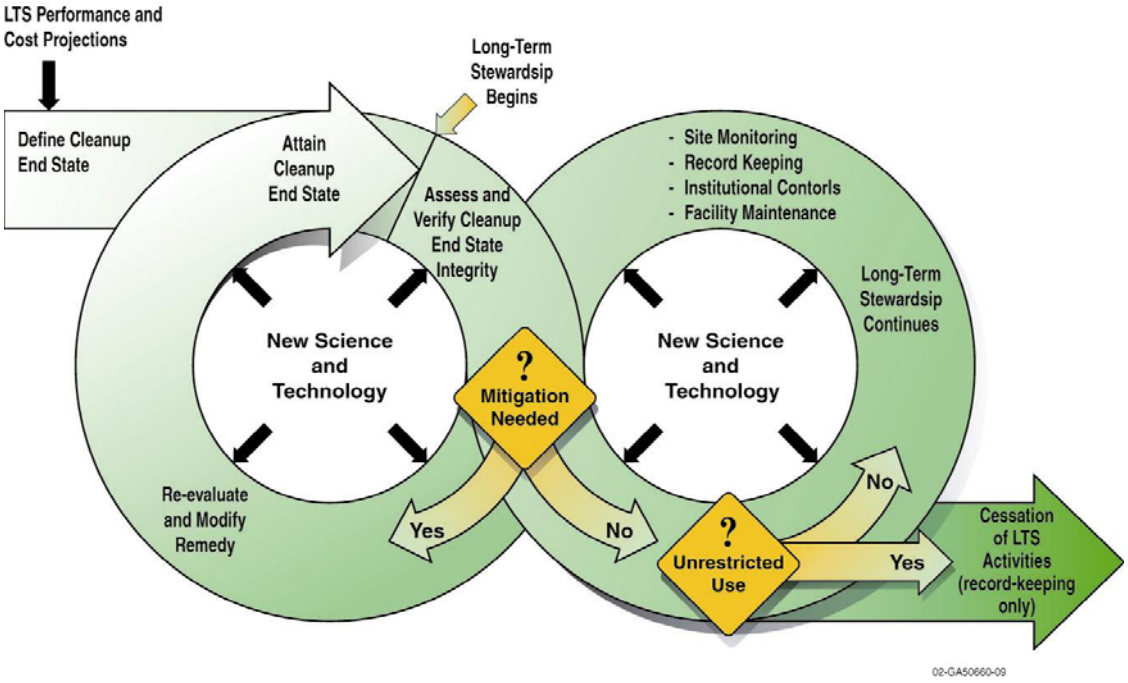


**Figure 4. Iterative approach to LTS presented in the LTS Roadmap**.
(DOE 2001a, Vol. I, p. 127)

As indicated in the LTS Roadmap, a substantial number of DOE sites are expected to transition into LTS during the 2004–12 time frame. In this LTS Roadmap, emphasis was placed on areas of research and development for the near term (2–10 years).

The LTS Roadmap recommends that LTS be viewed as a system made up of many interrelated and interacting components and activities. Four functions are identified in the LTS Roadmap as essential to the performance of LTS: containing the residual contaminants, monitoring the site and the entire LTS system, communicating within and beyond the LTS system, and managing

the system. The LTS Roadmap further identified seven capabilities it considered essential to fulfilling these four functions:

1. Site conceptualization and modeling tools
2. Contamination containment and control systems
3. Sensors and sensor systems for site monitoring
4. Preservation and communication of site information
5. Site-community relations
6. LTS system performance verification and monitoring
7. Effective and survivable land use controls

Under each key capability, the LTS Roadmap team identified one or more enhancements with associated near-term R&D targets that, if achieved, they felt would address deficiencies in existing LTS capabilities or substantially improve a capability to reduce risk, cost, or uncertainty. The goal of the team developing the LTS Roadmap was to provide an "LTS system that is resilient to human and natural forces, effective in protecting human and environmental health, and efficient in its use of national and local resources" (DOE 2002, p. 39).

The LTS Roadmap takes a broad view of science and technology and makes a case for including social sciences in its group of essential disciplines, especially when there is a regulatory or policy component. The developers of the LTS Roadmap found that when needs were prioritized and response integrated across all four working groups, many of the social issues and their resolution came out as top priorities—more important to mission accomplishment than improved monitoring hardware or engineered barrier maintenance.

According to the LTS Roadmap, the strongest proponents for resolution of social issues were the cleanup and stewardship operations personnel. They felt that their existing hardware tools and engineering methods were sufficient to perform the technical aspects of the LTS mission (though enhancements would greatly improve their effectiveness and reduce operational costs). However, they felt that some tools for community interaction, communication, legal controls, and other social issues were not sufficient. In particular, the potential inability to achieve local community acceptance of LTS goals could completely block progress.

The LTS Roadmap is intended to provide a pathway to develop the components of the overall system in a manner that would allow early implementation of portions (individual capability enhancements) of the system while other portions are still under development.

#### 4.1.3 ITRC Radionuclides Team Observations

The focus of the LTS Roadmap is identifying near-term R&D needs for LTS, and it offers some perspectives on the philosophy and functions of LTS. The LTS Roadmap defines the necessary elements of an effective and comprehensive LTS program and presents a set of pathways to develop the science and technology required for DOE to build such a program. The observations presented here are limited here to the key functions and overall philosophy described in the LTS roadmap. Some of the key observations drawn by the Radionuclide Team are summarized as follows:

- The LTS Roadmap takes a systems view of LTS, identifying management, communication, monitoring and containment as the four key functions. The LTS Roadmap also endorses defining "science" broadly, including social sciences in the disciplines required for addressing LTS. R&D needs are identified for all four key functions.

- The LTS Roadmap defines LTS from DOE's perspective and presents an iterative (not linear) stepwise approach which includes feedback or recycle loops as needed for conducting LTS that starts during remedy selection and ends with free release of the site. LTS is presented as a complex effort that will require site stewards to adapt to changes in site conditions, community values, scientific understanding, and regulatory requirements while balancing risk reduction and cost benefit over the short and long term.

- While LTS is presented and discussed as a long-term responsibility and activity, the LTS Roadmap is focused on R&D for the near term. This focus on near-term research is valuable because it would provide the tools for sites to implement a basic LTS system, but development of a longer-term view would be more useful (a point recognized by the developers of the LTS Roadmap).

- The benefits of the LTS Roadmap could also be enhanced by more substantial participation of other state and federal agencies and nongovernmental organizations with recognized expertise in LTS.

## 4.2 National Research Council: Navy Facilities and Adaptive Site Management

### 4.2.1 Summary and Background

A recent report published by the National Research Council, *Environmental Cleanup at Navy Facilities: Adaptive Site Management* (NRC 2003), describes an approach to cleanup and long-term site management that is flexible, iterative, and efficient.

According to the report, the Navy recognizes that site remedies do not always meet cleanup goals and that the effectiveness of a remedy may decrease with time. To complete its remediation tasks and meet its cleanup objectives, the Navy has recognized the need for a process for trying new remedial technologies or adjusting cleanup goals. The Navy asked the National Research Council to develop a system-oriented process to address these challenges and to facilitate decision making that is consistent with the cleanup objectives of the Navy.

The National Research Council report identified eight key objectives:

1. To protect the health and safety of those on the site and in surrounding communities,
2. To ensure the ecological viability and health of native plants and animals, and migratory species,
3. To protect and restore natural land and water resources,
4. To promote positive economic value and development in the area of the site,
5. To comply with all applicable laws and regulations governing the site and the cleanup process,

6. To promote positive participation and communication with the local community and other affected stakeholders,
7. To advance the understanding of site contamination and cleanup processes (technical, managerial and social), and
8. To accomplish each of these objectives in an affordable, cost-effective, and efficient manner (NRC 2003, pp. 48–49).

These eight objectives address the nine CERCLA criteria for remedy selection and take a holistic and context-driven approach to cleanup. Objectives 1–4 and 6–8 support a long-term view of cleanup and stewardship of a site. The objectives define science broadly, including the social sciences. Communities are asked to participate in the development of a solution rather than approval of a proposed remedy. Ecological as well as human receptors are considered in the evaluation of the environment. The document recommends advancing scientific knowledge be a component of site remediation and states that "such learning is essential if the other cleanup objectives are to be met in an effective manner" (NRC 2003, p. 52).

The National Research Council recommends an iterative approach to site cleanup and cautions against following a "highly linear, unidirectional march from site investigation to remedial action and eventually to site closure" (NRC 2003, p. 67). Instead of the usually taken linear approach, it advocates an iterative approach (a stepwise approach which includes feedback or recycle loops as needed) for cleanup and stewardship. Sites and solutions require periodic reevaluation to accommodate changes in scientific knowledge, understanding of site dynamics, economic drivers, and community values. "As sites have advanced through the restoration process, there has been a growing recognition that more iterative procedures are needed, with ongoing site stewardship and reevaluation of monitoring and remediation efforts at many sites. Because of the complexity of the subsurface environment, often incomplete identification of contaminant sources, and the long time frames required for remediation, site cleanup must not be viewed as a one-time event or an action that ends once a remedy is implemented" (NRC 2003, p. 67).

### 4.2.2 Adaptive Site Management and LTS

To address the dynamic forces from the environment, economics, community values, scientific understanding, and technology and to make progress towards cleanup, the National Research Council recommends taking an adaptive site management approach. This approach is iterative and applicable from site characterization through remediation to LTS. The principle elements of "adaptive site management" are that it

- applies at various stages of site restoration;
- applies to a wide variety of sites regardless of the contaminants being addressed or remedies envisioned;
- provides a mechanism for optimizing existing remedies, changing ineffective remedies, and refining the site conceptual model;
- formalizes the routine examination of monitoring data and how to act upon the data;
- incorporates public participation;
- recognizes uncertainty and suggests approaches to dealing with it, especially when ICs are used;

- stimulates the search for new, innovative technologies to replace older or inefficient approaches;
- stresses the need for pilot programs to test both new technologies as well as modifications of existing technologies that might enhance their effectiveness, and
- recognizes the increasing role of LTS (NRC 2003, p. 71).

Developing a comprehensive understanding of a site requires a long time. However, to be properly protective of the community and cost-effective, progress towards remediating a site must start long before a comprehensive understanding of the site is developed. Adaptive site management is a process for making responsible decisions in complex and evolving systems where knowledge is incomplete. Decisions made in this process are steps towards a goal rather than a final solution. The process of adaptive site management requires a significant amount of resources, especially in the beginning, and so is best suited for complex sites with difficult to treat contaminants that will preclude the site from going to free release in the near term.

As presented in the National Research Council report, adaptive site management has two basic steps.

- Step 1 defines and the nature of the problem at the site and includes activities such as characterization, conceptual site modeling, and risk assessment (Figure 5).
- Step 2 develops an initial remedy and then implements the remedy through a process that includes four management decision periods (Figure 6):
  1. implementation,
  2. monitoring,
  3. adaptation, and
  4. long-term stewardship.

The objective of adaptive site management, as described in the report, is to move each site to unrestricted use (site closure); the process requires iteration among the management decision periods and even Step 1 if conditions or understanding change sufficiently.

The National Research Council report also explored the technology issues associated with the Navy's remediation activities. Information management, monitoring and data analysis, treatment, land use control, and LTS were identified as areas requiring more development.

According to the report, the Navy has identified contaminated sediments and solvents and metals in groundwater and soil as its most challenging problems. In the area of treatment the report summarized technologies for remediation of organic and inorganic contaminants in soil,

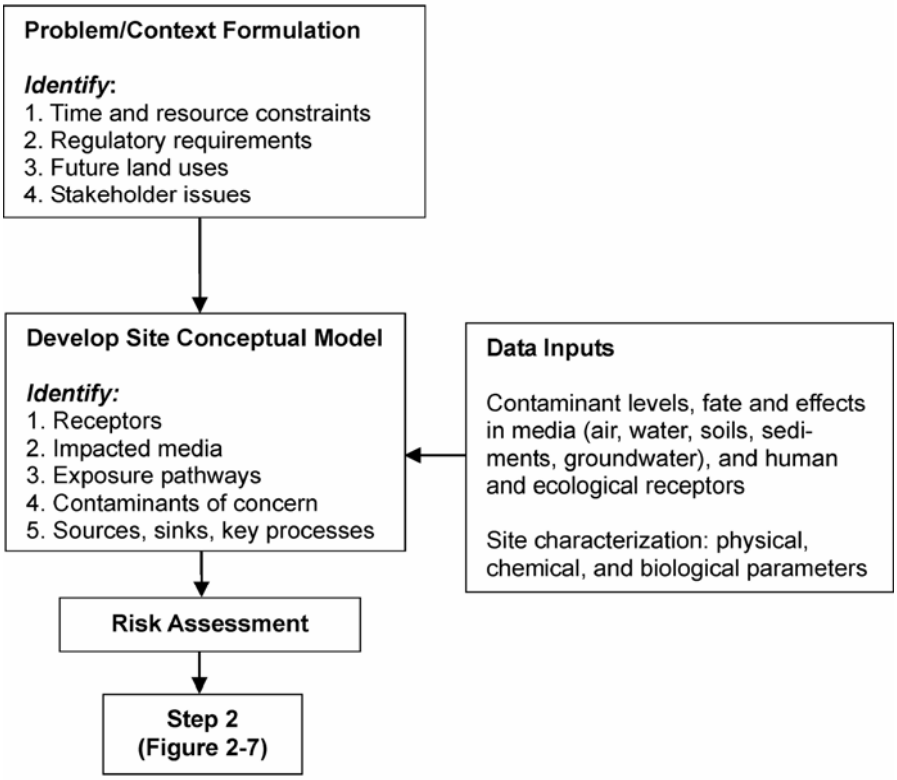


**Figure 5. Step 1 of adaptive site management: Pre-remedy selection.**
(NRC 2003, Fig. 2-5, p. 78, reprinted with permission.)

groundwater, and contaminated sediments. Technologies presented included in situ thermal, chemical, and biological approaches for source term treatment, permeable reactive barriers, natural attenuation, solidification/stabilization, phytoremediation, capping, and dredging. While many of the technologies presented are commercially available, the report identifies the need for additional research and development these technologies. The report emphasized the importance of combining technologies to address multiple or recalcitrant contaminants to develop a "treatment train" where multiple technologies could be combined to have synergistic effects on each other (NRC 2003).

Management of information was identified as a challenge. A large amount of data is produced by site remediation activities (e.g., monitoring, land use control, operations and maintenance, financial) but is frequently stored in separate systems that have no formal connection. Adaptive site management requires information from all aspects of site remediation that needs to be periodically updated for adjusting remediation activities as needed.

More effective and less costly monitoring techniques and systems are needed. Optimization of sampling strategies, direct-push probing, real time in situ monitoring, and field analytical techniques should be considered. Monitoring and data analysis are important to the decision making process and the long-term success of the remediation. Presenting data graphically over time can make trending easier and improve the accessibility of information to stakeholders. All monitoring data (including hydrogeologic, contaminant, chemical) have uncertainty associated with them, from both the measurement technique and the inherent heterogeneities of the system.

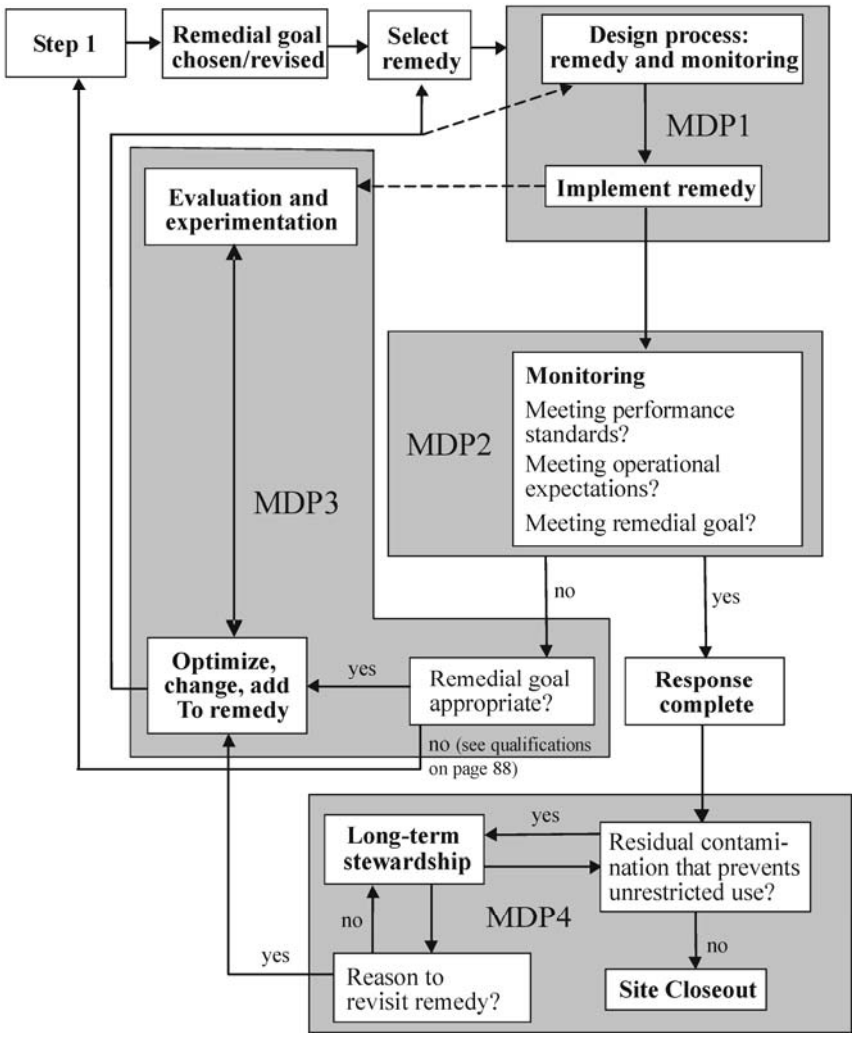


**Figure 6. Step 2 of adaptive site management process: Post-remedy selection.**
Shaded areas show the activities related to the management decision periods described in the text. (NRC 2003, Fig. 2-6, p. 82, reprinted with permission.)

This uncertainty needs to be quantified and presented to support evaluation of remedy performance.

The National Research Council report states that although LUCs are an important component of all sites that do not meet the requirements for unrestricted use, their success has been mixed. Controls need to be developed in coordination with the parties responsible for their implementation and enforcement. Records of decision need to provide sufficient detail on the LUCs so that the appropriate controls are implemented. The need for monitoring the effectiveness of LUCs is not well recognized, and techniques need to be developed to simplify this process.

The National Research Council report recognizes that all federal agencies face LTS and that a government-wide policy and approach need to be developed to properly address the issues. The

steward, or steward team, is critical to the effective implementation of LTS. From the National Research Council's perspective, the stewards should have the following:

- appropriate technical expertise,
- knowledge of developing technologies,
- ability to enforce land use controls,
- institutional longevity,
- property ownership,
- longevity of the funding source,
- ability to oversee multiple sites,
- experience in public participation and public education,
- ability to adapt to changing land use,
- institutional memory, and
- ability and authority to make decisions (NRC 2003, p. 309).

### 4.2.3 ITRC Radionuclides Team Observations

The National Research Council report develops a comprehensive and systematic approach to addressing contaminated sites. It starts with characterization, moves to cleanup, transitions to LTS, and ends with free release of a site. From the ITRC Radionuclide Team perspective, the National Research Council report presents a practical and flexible process for strengthening Navy's or any site's approach to site cleanup and LTS. The observations presented here focus on the sections of the National Research Council report dealing with LTS. The report

- sets free release as a goal for every site,
- views LTS as integral to cleanup,
- views LTS as a system of interactive parts,
- describes a broader view of science (including social, economic, biological, physical, engineering, environmental, etc.),
- presents an iterative approach for complex and difficult sites, and
- recognizes the need for additional research and development.

While the report presents free release of sites as an eventual goal for the Navy, the immediate goal is to contain and remove site contamination to the best degree practical given current technology and community needs. The report discusses the value of bringing technical and community experts together early so that the full range of technical, regulatory, social, and economic requirements can be identified and addressed. The interdependency of these requirements is also recognized.

The National Research Council report presents a practical and resilient approach to LTS of sites that is supportive of local communities and the environment. The report advocates involvement of the community in every step of the development of remedies and monitoring plans. The adaptive site management process described in the report, acknowledges the incompleteness of site data, and provides a system that recognizes what monitoring and technology development provide to both improve the fundamental understanding for many sites as well as the

technologies available to treat and monitor contaminants. The report also advocates for strong support of science and technology development.

## 4.3 DOE *Draft Implementation Guide for Use with DOE O.1B*

### 4.3.1 Summary

The DOE Office of Environmental Management has developed the *Draft Implementation Guide for use with DOE O.1B, Real Property Asset Management: Guidance for Transition of Long-term Surveillance and Maintenance Function* (DOE 2004), which is the guidance for transfer of sites from cleanup to long-term stewardship. The transition guidance is intended to facilitate the transition of sites from cleanup to LTS and to help ensure that adequate knowledge, procedures, and resources are provided to conduct LTS in an effective and efficient manner.

As described in the transition guidance, the transition criteria are as follows:

1. Authorities and accountabilities are assigned and documented;
2. Site conditions are accurately and comprehensively documented;
3. Emergency/contingency planning are documented;
4. Institutional controls and enforcement authorities are identified;
5. Regulatory requirements and authorities are identified;
6. Long-term surveillance and maintenance budget, funding, and personnel requirements are identified;
7. Information and records management requirements are satisfied;
8. Public education, outreach, information and notice requirements are documented and satisfied;
9. Natural, cultural and historical resource management requirements are satisfied; and
10. Business closure functions such as transfer of pensions and benefits, contract closeout or transfer, and other administrative requirements are satisfied (DOE 2004).

The transition criteria focus on what needs to be done and leaves the implementation details to the discretion of the individual sites. The intent is not to cause a comprehensive LTS document to be generated but rather to ensure that all issues are addressed and that the appropriate documents are identified and available.

Of the ten transition criteria, three (#1, #6, and #10) are outside the science and technology focus of this document and will not be discussed. The remaining seven transition criteria are within the focus of this document and are important to shaping future science and technology activities. Following is a brief description of the seven transition criteria related to science and technology.

*Transition Criterion 2: Site conditions are accurately and comprehensively documented*—This criterion provides a comprehensive inventory of the site in terms of facilities, contaminants, subsurface conditions, ecology, remedies, potential receptors, and monitoring. This is where the technical data is collected which forms a basis for transferring the site from cleanup to stewardship and which provides a baseline for future evaluations of the site. The results of any risk assessment (human and ecological) as well as the development of a long-term conceptual site model are also part of this element.

*Transition Criterion 3: Emergency/contingency planning is documented*—This criterion includes all "as-built" engineered controls, life-cycle operations and management activities, and emergency/contingency planning. The definition of "as-built" here includes documentation of the engineered system and the surrounding environment (e.g., physical and geotechnical data). Life-cycle operations and management includes surveillance and monitoring activities for both practical implementation and budgetary planning. Emergency/contingency planning includes identification of the uncertainties associated with the remaining site hazards, expected failure scenarios, and emergency response plans for those scenarios.

*Transition Criterion 4: Institutional controls and enforcement authorities are identified*—This criterion includes documenting land use assumptions (on and off site as appropriate) for each site and developing a process for managing (maintaining and altering) and enforcing land use restrictions. The preparation, collection, and organization of documents describing current status and history of the real property (such as mineral and water rights, easements, treaty rights, boundaries, property owners, deed restrictions) of the site are the other important part of this element. In addition to being identified, collected, and organized, the information must be accessible to users such as site stewards, decision makers, and the public.

*Transition Criterion 5: Regulatory requirements and authorities are identified*—This criterion includes documentation of regulatory decisions; certification of implementation of remedy and LTS activities; five-year review results; and EPA, National Priorities List, and Nuclear Regulatory Commission license status. In addition to identifying the documents, the location of the information must be described and the documents must be accessible.

*Transition Criterion 7: Information and records management requirements are satisfied*—This criterion includes identifying information transferred, providing procedures for maintaining and using the information, and specifying the location of the information to be used for LTS. In addition to meeting the needs of stewards and technical personnel, the information management system must also meet the needs of stakeholders in terms of content, longevity, and accessibility.

*Transition Criterion 8: Public education, outreach, information and notice requirements are documented and satisfied*—This criterion is focused on sites that have active community interest. The stakeholders need to be identified and the tools to disseminate information (fact sheets, email, public meetings, administrative record/information repository, etc.) need to be implemented.

*Transition Criterion 9: Natural, cultural and historical resource management requirements are satisfied*—This criterion applies to sites being transferred to nongovernmental entities. A system must be implemented to protect resources (biological, sensitive, natural, archeological, and cultural) from inappropriate or unauthorized use or access.

### 4.3.2 ITRC Radionuclides Team Observations

As sites complete their environmental restoration tasks, the land and remaining facilities will continue to be used in a variety of ways. How land ownership and responsibility for LTS will be

apportioned is not clear at this time. There are many possible options, and not all sites will use the same options. Several options are presented below for the purpose of discussion:

- In some cases the land will remain an active DOE site and be transferred from the Office of Environmental Management to another DOE office; the new DOE office will have responsibility for LTS.
- In some cases the DOE site will no longer be active but remain in DOE's and be transferred from Environmental Management to Legacy Management for LTS.
- Some DOE sites will no longer be active, but the land will be transferred to another federal agency, such as the DOI; the other federal agency may have responsibility for LTS.
- Some DOE sites will no longer be active, and the land will be transferred to or used by public/commercial enterprises; either DOE or a local entity may have responsibility for LTS.
- In many cases, the land will be managed by personnel not involved in the original site use or remediation, which will require the transfer of a large amount of complex information and legal responsibilities.

The transition guidance document is focused on helping sites identify the necessary information, procedures, and policies to transition from cleanup to LTS. With this document, DOE attempts to provide the much-needed guidance for site managers transitioning the sites from cleanup to LTS. In keeping with the Radionuclide Team's LTS survey focus on science and technology, only seven of the ten criteria are discussed here. The large volume of information and activity represented by the seven criteria described above represents a challenge to the resources of the stewards and communities responsible for these sites over the long term. The document places more emphasis on meeting the criteria initially than meeting the criteria over the long term, but both are essential to effective LTS. It seems that the focus of transitioning the site from cleanup to LTS needs to be broadened to include the requirement of procedures and institutions to update and maintain the required data over the long term. Development and implementation of new technologies could improve the effectiveness and efficiency of performing these criteria for LTS in the near and long term. Site-specific procedures for implementing LTS can be derived from this guidance.

## 5. AN INTEGRATED ASSESSMENT AND OBSERVATIONS

The findings from the LTS survey conducted by the ITRC Radionuclide Team are supported by the three related documents reviewed in the previous section: the *LTS Science and Technology Roadmap (Draft)* (LTS Roadmap) developed by DOE, the *Environmental Cleanup at Navy Facilities: Adaptive Site Management* (National Research Council) developed by National Research Council on behalf of the U.S. Navy, and the *Draft Implementation Guide for Use with DOE O.1B, Real Property Asset Management: Guidance for Transition of Long-Term Surveillance and Maintenance Function* (Transition Guidance). The major findings and some common themes for improvement of LTS implementation identified from the survey are as follows:

*1. State regulators are knowledgeable about LTS technologies and challenge.* Respondents to the survey reported that they were familiar with a range of elements of LTS, including treatment,

monitoring, decision making, information management, public involvement, and land use controls. Additionally, respondents were supportive of training and guidance development in the areas of information management, monitoring and decision making.

*2. Technology is important to addressing the challenges of LTS.* Regulators indicated that technology is important for treatment, monitoring, information management, decision making, and land use controls.

*3. Technology limitations are affecting the ability of sites to successfully implement LTS.* There are technology limitations in the areas of monitoring, information management and containment, and land use and institutional controls that limit the ability of sites to successfully implement and conduct LTS.

***4.*** *Investments are needed in technology development.* State regulators agree that investments in technology development should be a high priority in addressing LTS. This perspective is strongly echoed by the LTS Roadmap and National Research Council.

*5. Long-term treatment will require land use controls or limitations.* Sites requiring long-term treatment will have land use controls or limitations that extend from tens to hundreds to thousands of years. Land use restrictions may extend beyond the legal boundary of the site when connected systems (such as ground- or surface water, hunting, and fishing) are present.

*6. Monitoring is essential for groundwater and disposal facilities.* State regulators said that monitoring is of major importance for groundwater and disposal/containment facilities during LTS. They also felt that these areas are in need of additional technology development for monitoring. The LTS Roadmap and National Research Council support this finding and identify the need for improved data collection devices and design of sampling locations/frequency to support monitoring of groundwater and disposal/containment facilities.

*7. Monitoring of ecosystem health is important.* Ecosystem health was seen as being as important as monitoring of disposal/ containment. Monitoring of ecosystem health can support the enhancement of conceptual site models for analysis of monitoring data and future decisions about land use.

*8. Land use controls require monitoring to ensure their continued effectiveness. Monitoring and data analysis systems are needed to ensure early problem detection of system failure.* Monitoring may help mitigate the effect of breaches in land use controls caused by factors such as degradation of fences due to weather and human activity, lack of awareness of deed restrictions, and changing land use. Respondents indicated real-time data, as well as remote sensing and data transmission, are important components of effective monitoring for LTS systems and structures. This need is consistent with a growing demand for quick-turnaround data, a growing awareness of "adaptive" monitoring techniques, and a need to make the best use of currently available tools. Conceptual site models and other data analysis tools need to be enhanced to support predictive and trending analysis. The LTS Roadmap proposed R&D-oriented solutions such as enhanced modeling, enhanced sensitivity of sensors, and increased integrative capacities in sensors. The National Research Council placed more emphasis on the role of real-time monitoring in supporting the adaptive monitoring and management of sites.

*9. Effectiveness of land use/institutional controls can be enhanced by technology*. State regulators agree that technology is essential to the successful utilization of land use and institutional controls. These respondents also had highly variable experiences (positive and negative) with the use of signs, monuments, deed restrictions, zoning, building codes, and lease restrictions. Much like the survey, the perspectives in the other documents were mixed. The Transition Guidance indicated an acceptance with some confidence in land use/institutional controls. The National Research Council and LTS Roadmap expressed a low degree of confidence in the long-term effectiveness of land use and institutional controls. Both the survey and the LTS Roadmap indicated technology development might improve land use and institutional controls.

*10. Redundancy in monitoring is an effective approach to enhance confidence and data sensitivity.* State regulators said that redundancy in monitoring is important for LTS success. Environmental systems are complex and subtle changes in conditions can affect the performance of remedies. Utilizing multiple methods for data collection such as complimentary sensors or combining human and sensor surveillance can provide a more sensitive and robust monitoring system.

*11. Human surveillance is mandatory; the frequency depends on the specifics of the site*. In all cases, semiannual or more frequent visits are preferred. The degree of human surveillance desired was more strongly correlated with the type of ongoing treatment and level of instrumented monitoring than the proximity of a site to a population. Instrumentation can reduce, but not replace, human surveillance of caps. The effectiveness of human surveillance activities can be enhanced (timeliness, thoroughness, sensitivity) through development of better data analysis tools, real-time monitoring, and remote data access.

*12. Successful information management requires the ability to access, update, store, and disseminate data across multiple generations.* Records and information management are very important concerns of regulators for effective implementation of LTS. Information systems should be strengthened to improve management (including collection, organization, preservation of technical and physical integrity, and timely access) of records and information/data for current and future generations. A combination of media will likely be required to accomplish this multigenerational task and technologies from paper to digital should be employed. This finding was strongly supported in the LTS Roadmap, National Research Council, and Transition Guidance.

*13. Ensuring functional accessibility of data is a high priority.* Respondents suggested following data access technologies be further explored: Web portals, high-speed scanning, CDs, electronic data mining, and bar coding. In addition, museums, mass media, and oral traditions were identified as promising ways to facilitate public access to data.

*14. States surveyed generally did not have a centralized LTS structure.* At the time of the survey, Colorado was the only state represented by respondents that had a centralized database of LTS obligations. The Colorado Environmental Covenants Law designates the Colorado Department of Public Health and Environment as the steward to maintain a registry of all environmental

covenants and their modifications. No other state regulator reported having an identified point of contact for LTS.

*15. A comprehensive program is needed to increase awareness of land use/institutional controls.* Respondents said the following elements should be included in a comprehensive program to ensure long-term awareness of land use and institutional controls: updated computer/database links for deed restrictions, on-site museum/educational facility, continued government use of the site, and community education classes. In addition, multiple land use controls and standardization of formats for data accessibility were also identified as methods to improve awareness of land use controls. These elements are consistent with the emphasis on community involvement and communication advocated by the LTS Roadmap and National Research Council.

*16. LTS success requires active public outreach that is interactive and builds relationships.* Many people are not "engaged" in the decision-making process for sites because they do not access the Web or library with the purpose of gaining that information. The information must be brought to the majority of people. Communication tools to enhance public participation in LTS decision making require mechanisms that foster person-to-person interactions and relationships over time (such as CABs and public meetings) as opposed to "information dumping." This fact may be why CABs were seen as most effective, along with local government interactions and public meetings. Enhancing understanding the process of communication and improving the communication tools available underscore the LTS Roadmap's and National Research Council's inclusion of social sciences in the mix of disciplines required for implementing remediation and LTS.

*17. Communication is widely recognized as both a challenge and essential for successful LTS.* The effectiveness of LTS can be strengthened through open communication among all affected parties, including site owners; federal, state, local, and tribal governments; and local and regional community members. Three elements of communication were strongly identified by the survey, LTS Roadmap, National Research Council, and the Transition Guidance:

- communication, collaboration, and participation with the local community and other stakeholders during the development, implementation, and revision of an LTS plan;
- management of records and information to allow access to information/data in a timely manner and to ensure that the integrity of information is preserved; and
- transferring of an awareness of LTS issues to future generations.

*18. Like monitoring, effective communication is multifaceted.* A variety of media (e.g., paper, museum, oral tradition, digital) and both unidirectional (e.g., newsletter, television, reading room) and multidirectional (e.g., CAB or town meeting) communication modes can be used to build a functional system. Effective communication can improve understanding of site conditions among the technical, decision-making, and stakeholder communities; enhance trust between site stewards and communities; and facilitate decision making with regards to a site.

*19. Social science–based tools and studies are resources for decision making.* Respondents have experience using structured consensus building and value judgment studies. In addition

demographic projection and land use planning tools were viewed as likely to be useful and effective. There seems to be a need for further work in knowing how to integrate the results of these tools into decision making. The survey, LTS Roadmap, and National Research Council include social sciences in the mix of physical sciences required to address remediation and LTS.

*20. Citizen Advisory Boards add value.* State regulators agreed that CABs are effective communication methods for getting local community, tribal, and state values factored into cleanup and LTS decision-making processes. As sites transition into LTS, some formal mechanism, similar to the CABs should continue to play a strong role in the planning, implementation, and conduct of LTS at sites across the DOE complex. CABs should be encouraged to evolve into a structure appropriate for demands of LTS.

*21. Successful implementation of LTS requires strong stakeholder involvement.* A major theme throughout the survey responses was the importance of involvement and connection to the local stakeholders. The concept of communication and stakeholder involvement being essential to successful LTS is supported and emphasized in the Fernald CAB report *Telling the Story of Fernald, Community-Based Stewardship and Public Access to Information* (FCAB 2002). National Research Council, LTS Roadmap, and Transition Guidance all emphasized the importance of stakeholder involvement in LTS implementation.

*22. Education and guidance on LTS technologies would be beneficial.* Respondents were very supportive of future ITRC LTS projects, including a case study of landfill long-term monitoring technologies, a workshop on data retention technologies, and training on LTS technologies and decision making.

The importance of LTS is broadly recognized in the regulatory, public, technical, and federal communities. The survey and the three documents reviewed were each developed by different groups of people (state regulators, National Research Council, contractor personnel at DOE complex, and DOE personnel) for different reasons. Consequently, there are both common and differing perspectives presented within the documents. All of the documents view LTS as collection of integrated activities including communication, information management, institutional controls, and monitoring. The differences among the perspectives lies in the timing and amount of involvement of the public, the expectation for change over time, the level of confidence in intergenerational information transfer, the degree of confidence in current monitoring strategies, and the relative level of current technical and institutional readiness for LTS. This LTS survey report provides a useful basis for continuing dialog, education, and development efforts to bring the perspectives closer, facilitating the transition of sites into LTS, improving the tools available for conducting LTS, and improving the effectiveness and efficiency of LTS operations.

## 6. CONCLUSIONS

The purpose of this document is to guide the future activities of the ITRC Radionuclides Team in LTS, to help the Radionuclides Team make a more informed review of the LTS documents being developed by DOE, and to assist decision makers and technology developers addressing LTS issues. Based on the analysis in the preceding sections and comments received during

preparation of the document, the Radionuclides Team is confident that this threefold purpose has been reached. Further to this general achievement, the following specific conclusions are deduced from the analysis in this document:

1. The scope of LTS includes the management of radioactive waste disposal facilities, groundwater treatment, monitoring, information storage, and access controls. Designing and managing facilities that must safely dispose and manage wastes for hundreds, even thousands of years requires regulators and DOE to consider new technologies and strategies to address the common goal of protection. Support for development of new technologies to improve the effectiveness and efficiency of LTS is an important consideration—however, there are technology limitations in the above-mentioned areas that limit the ability of sites to successfully implement and conduct LTS.

2. LTS can be done more effectively and efficiently by integrating best-available technologies, robust administrative policies, active communication, and adaptive management principles to ensure that solutions are comprehensive, resilient, and consistent with land use requirements and scientific knowledge.

3. Awareness is key to the effectiveness of land use and institutional controls. The following approaches could aid in improving the long-term awareness and effectiveness of land use and institutional controls: computer/database links for deed restrictions, on-site museum/ educational facility, continued government use of the site, and community education classes.

4. CABs have proven to be effective communication methods for getting local community, tribal, and state values factored into cleanup decisions. It is important to have some structured local citizens group, possibly an evolution from the CABs, continue to play a strong role in the planning, implementation, and conduct of LTS at sites across the DOE complex.

5. Developing additional capabilities in monitoring sensors and systems will strengthen the ability of site stewards to detect changing conditions and potential problems early, minimize sample generated waste, and complement human surveillance activities.

6. Strengthening information systems will improve management (including collection, organization, preservation of technical and physical integrity, and timely access) of records and information/data for current and future generations. A combination of media will likely be required to accomplish this multigenerational task. Technologies from paper to digital should be employed.

7. The effectiveness of LTS can be strengthened through open communication among all affected parties including site owners, federal, state, local, and tribal governments and local and regional community members. Communication systems should be strengthened and designed to function throughout the period of LTS. A variety of media (e.g., paper, museum, digital) as well as both unidirectional (e.g., newsletter, reading room) and multidirectional (e.g., CAB or town meeting) communication modes should be used as necessary. An active

and continued public outreach is an essential and integral component of this communication effort.

8. Human surveillance of sites during LTS is important. The frequency of this human involvement will depend upon the site condition at closure. Issues affecting surveillance include monitoring complexities, land use changes, and ongoing treatment requirements.

9. While many state regulators have experience and knowledge of LTS issues and technologies, they identified several areas (information management, monitoring, decision making, etc.) where they would like to improve their skills and knowledge to be better prepared to face the significant challenges LTS will present.

10. Although criteria are being set by DOE and other federal agencies for moving sites from active cleanup to LTS, additional guidance is needed from the states' perspective that not only determines conditions for accepting a site into LTS but also ensures that the challenges identified in various aspects of technology, LTS implementation, and long-term monitoring can be met.

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# APPENDIX A

## Acronyms

## ACRONYMS

| | |
|---|---|
| ARARs | applicable or relevant and appropriate requirements |
| CAB | Citizen Advisory Board |
| CD | compact disc |
| CERCLA | Comprehensive Environmental Response, Compensation and Liability Act |
| CFR | Code of Federal Regulations |
| DOE | U.S. Department of Energy |
| DOD | U.S. Department of Defense |
| DOI | U.S. Department of Interior |
| EPA | U.S. Environmental Protection Agency |
| FUSRAP | Formerly Utilized Sites Remedial Action Program |
| GIS | geographical information system |
| IC | institutional control |
| ITRC | Interstate Technology & Regulatory Council |
| LTS | long-term stewardship |
| LUC | land use control |
| NARA | National Archives and Records Administration |
| RCRA | Resource Conservation and Recovery Act |
| R&D | research and development |
| SRS | Savannah River Site |
| UMTRCA | Uranium Mill Tailings Remediation and Containment Act |

# APPENDIX B

## LTS Survey and Respondents

# LTS SURVEY AND RESPONDENTS

## B1. CONTENTS

In August 2002, the ITRC Radionuclides Team sent the survey to state regulators working at DOE facilities. This appendix contains a full copy of the survey introduction cover page, as well as a complete listing of all survey questions and answer options.

We received responses from 31 state regulators and one tribal representative. This document covers the responses from the 31 state regulators. The responses were summarized by ITRC and are presented in Appendix C.

## B2. SURVEY INTRODUCTION PAGE

Radionuclides Survey of State Regulators' Perspectives on Technology Issues for Long-Term Stewardship

*Conducted by Radionuclides Team, Interstate Technology Regulatory Council*

The goal of this survey is to identify the areas of LTS which currently present challenges that would benefit from development and application of additional science (social, biological, chemical, engineering, etc.) and technology. The purpose of this survey is to enhance the Radionuclides Team's understanding of the technical issues surrounding LTS in order to

- guide the future activities (training, guidance documents, technology evaluation) of ITRC Radionuclides Team in LTS,
- help the Radionuclides Team make a more informed review of the LTS Science and Technology roadmap being developed by DOE, and
- influence the direction of decision makers and technology developers.

Please complete each section of the survey before submitting. Here is a brief description of the focus of each section:

- **Section 1: General**
  These questions address general issues of long-term stewardship. The purpose of this section is to understand each participant's overall familiarity with and perspective on LTS technology.

- **Section 2: Treatment**
  This section address sites where treatment will continue into LTS (such as groundwater or leachate remediation). The purpose of this section is to identify how technology requirements may change as sites transition from an active to a LTS mode and to understand if treatment impacts future land use.

- **Section 3: Monitoring**
  The purpose of these questions is to identify the types of monitoring activities that would benefit from additional technology.

- **Section 4: Information Access and Use**
  These questions help identify the roles of technology in the access and use of information for LTS.

- **Section 5: Land Use and Institutional Controls**
  The purpose of these questions is to understand the role (current and potential) of science (including social) and technology in land use and institutional controls and to gather a basic understanding of the type of experience the survey participants have had with land use and institutional controls. This survey uses the EPA's definition of land use and institutional controls: **Land use controls** include engineering controls (such as fences and signs) and institutional controls. **Institutional controls** are legally binding provisions (such as local ordinances and state and federal laws) designed to control future uses of land or resources by limiting development and/or restricting public access to a site with residual contamination.

- **Section 6: Decision Making**
  Sound decision making requires an understanding of the problem or issue being addressed and an understanding of the overall surroundings in which that problem or issue exists. The surroundings include the people or community and the physical environment. The purpose of this section is to understand, for both aspects of the surroundings, which tools and approaches are currently being employed in the decision-making process and to identify which tools and approaches might be useful in the future.

- **Section 7: Path Forward**
  The ITRC Radionuclides Team is currently considering several future projects on LTS issues. The purpose of this section is to capture your input on which project will be most beneficial.

Thank you for participating.

## B3. COMPLETE SURVEY

**1. Contact Information**
**Please enter your contact information.**
☐ By checking this box, I give the ITRC Radionuclides Team permission to contact me to clarify responses and/or ask follow-up questions to improve the results of the survey.

**2. Name _____**

**3. Agency _____**

**4. Program Office _____**

**5. Position _____**

**6. Address _____**

**7. Phone Number _____**

**8. E-mail _____**

**9. Section 1: General**
**I am affiliated with:**
○ state government ○ federal government ○ tribal ○ contractor ○ stakeholder ○ other

**10. How familiar do you feel you are with long-term stewardship issues?**
○ not familiar ○ somewhat familiar ○ familiar ○ very familiar

**11. In general, how familiar are you with the state of the art (in terms of practice, not research) in the following areas:**

**- treatment**
○ not familiar ○ somewhat familiar ○ familiar ○ very familiar

**12. - monitoring**
○ not familiar ○ somewhat familiar ○ familiar ○ very familiar

**13. - decision making**
○ not familiar ○ somewhat familiar ○ familiar ○ very familiar

**14. - land use and institutional controls**
○ not familiar ○ somewhat familiar ○ familiar ○ very familiar

**15. If you are interested in another state of the art practice, please enter it here, then rate your familiarity with it in the next question.**
_____
_____
_____

**16. In general, how familiar are you with the state of the art (in terms of practice, not research) in the area you specified in the previous question?**
○ not familiar ○ somewhat familiar ○ familiar ○ very familiar

**17. How critical is technology in addressing the challenges of LTS for the following areas:**

**- treatment**
○ not important ○ minor importance ○ moderate importance ○ major importance

**18. - monitoring**
○ not important ○ minor importance ○ moderate importance ○ major importance

**19. - decision making**
○ not important ○ minor importance ○ moderate importance ○ major importance

**20. - land use and institutional controls**
○ not important ○ minor importance ○ moderate importance ○ major importance

**21. If you have thoughts on another area in which technology is important in addressing the challenges of LTS, please enter it here, then rate the importance in the next question.**
_____
_____
_____

**22. How critical is technology in addressing the challenges of LTS in the area you specified in the previous question?**
○ not important ○ minor importance ○ moderate importance ○ major importance

**23. How much would each of these LTS areas benefit from the development of additional technology?**

**- treatment**
○ no benefit ○ some benefit ○ substantial benefit

**24.** **- monitoring**
○ no benefit ○ some benefit ○ substantial benefit

**25.** **- decision making**
○ no benefit ○ some benefit ○ substantial benefit

**26.** **- land use and institutional controls**
○ no benefit ○ some benefit ○ substantial benefit

**27. If there is another area of LTS which you think would benefit from the development of additional technology, please enter it here, then rate the level of benefit in the next question.**

_____
_____
_____

**28. What would be the level of benefit from the development of additional technology in the area you specified in the previous question?**
○ no benefit ○ some benefit ○ substantial benefit

**29. There are technology limitations affecting the ability of sites to successfully implement LTS.**
○ strongly disagree ○ moderately disagree ○ neutral
○ moderately agree ○ strongly agree

**30. If you have observed technology limitations, please give examples of some of the major limitations.**

_____
_____
_____

**31. Investments in technology development should be a high priority in addressing LTS issues.**
○ strongly disagree ○ moderately disagree ○ neutral
○ moderately agree ○ strongly agree

**32. Section 2: Treatment**
**Once a site is in LTS, to what extent do you foresee problems (technical or otherwise) in managing/treating/disposing of:**

**- sampling derived water**
○ no problems ○ limited problems ○ some problems ○ significant problems

**33.** **- sampling derived solid waste**
○ no problems ○ limited problems ○ some problems ○ significant problems

**34.** **- wastes generated during maintenance of a treatment system**
○ no problems ○ limited problems ○ some problems ○ significant problems

**35.** **- leachate**
○ no problems ○ limited problems ○ some problems ○ significant problems

**36.** **- treatment derived waste**
○ no problems ○ limited problems ○ some problems ○ significant problems

**37.** **- personal protective equipment**
○ no problems ○ limited problems ○ some problems ○ significant problems

**38. If there is another treatment by-product which you anticipate might present problems once a site is in LTS, please enter it here, then rate the problem level in the next question.**

_____
_____
_____

**39. What problem level would you anticipate in managing, treating, and disposing of the by-product you specified in the previous question?**
○ no problems ○ limited problems ○ some problems ○ significant problems

**40. If there is another treatment by-product which you anticipate might present problems once a site is in LTS, please enter it here, then rate the problem level in the next question.**

_____
_____
_____

**41. What problem level would you anticipate in managing, treating, and disposing of the by-product you specified in the previous question?**

○ no problems ○ limited problems ○ some problems ○ significant problems

**42. What technologies are you aware of for treatment of small quantities of wastewater/leachate during LTS?**

_____
_____
_____

**43. Do current long-term treatment systems require restriction in future land use at sites? What is the duration and nature of the restrictions?**

_____
_____
_____

**44. Are point of use treatment strategies (such as treatment of water removed from an aquifer for use versus treatment of the entire aquifer) appropriate for LTS?**

○ never appropriate ○ occasionally appropriate ○ frequently appropriate ○ always appropriate

**45. Section 3: Monitoring**

**How important is monitoring during LTS in each of the following areas:**

**- disposal facilities**

○ not important ○ minor importance ○ moderate importance ○ major importance

**46. - containment facilities**

○ not important ○ minor importance ○ moderate importance ○ major importance

**47. - groundwater**

○ not important ○ minor importance ○ moderate importance ○ major importance

**48. - land use control (on site and surrounding)**

○ not important ○ minor importance ○ moderate importance ○ major importance

**49. - tanks**

○ not important ○ minor importance ○ moderate importance ○ major importance

**50. - leachate**

○ not important ○ minor importance ○ moderate importance ○ major importance

**51. - air**

○ not important ○ minor importance ○ moderate importance ○ major importance

**52. - ecosystem health, change**

○ not important ○ minor importance ○ moderate importance ○ major importance

**53. - significant but unpredictable natural events (fire, rainfall, flash floods, earthquakes, tornados)**

○ not important ○ minor importance ○ moderate importance ○ major importance

**54. If there is another area for which you feel monitoring during LTS is important, please enter it here, and then rate the importance in the next question.**

_____
_____
_____

**55. How important is monitoring during LTS in the area you specified in the previous question?**

○ not important ○ minor importance ○ moderate importance ○ major importance

**56. Which of the following areas need development of additional monitoring technology (*please check all that apply*)**

☐ Disposal facilities ☐ Containment facilities ☐ Groundwater ☐ Land use control (on site and surrounding) ☐ Tanks ☐ Leachate ☐ Air ☐ Ecosystem health, change ☐ Significant but unpredictable natural events (fire, rainfall, flash floods, earthquakes, tornados)

**57. Other areas needing development of additional monitoring technology:**

_____
_____
_____

**58. Redundancy (for verification and compliance) in monitoring is important for LTS success.**

○ strongly disagree ○ moderately disagree ○ neutral ○ moderately agree ○ strongly agree

**59. To what extent is on-site human presence and observation important to an effective LTS monitoring system for the following situations:**

**- site with an ongoing active (powered) treatment system**

○ annual ○ semiannual ○ quarterly ○ monthly ○ weekly ○ daily

**60. - site with an ongoing passive treatment system**

○ annual ○ semiannual ○ quarterly ○ monthly ○ weekly ○ daily

**61. - capped site with no cap monitoring instrumentation**

○ annual ○ semiannual ○ quarterly ○ monthly ○ weekly ○ daily

**62. - capped site with cap monitoring instrumentation**

○ annual ○ semiannual ○ quarterly ○ monthly ○ weekly ○ daily

**63. - site in a populated area**

○ annual ○ semiannual ○ quarterly ○ monthly ○ weekly ○ daily

**64. - site in an unpopulated area**

○ annual ○ semiannual ○ quarterly ○ monthly ○ weekly ○ daily

**65. If there is another situation for which on-site human presence and observation is important to an effective LTS monitoring system, please enter it here, then rate the importance in the next question.**

_____
_____
_____

**66. To what extent is on-site human presence and observation important to an effective LTS monitoring system for the situation you specified in the previous question?**

○ annual ○ semiannual ○ quarterly ○ monthly ○ weekly ○ daily

**67. To what extent is real-time data important to effectively monitor LTS systems and structures?**

○ not important ○ minor importance ○ moderate importance ○ major importance

**68. To what extent is remote sensing and data transmission important to effectively monitor LTS systems and structures?**

○ not important ○ minor importance ○ moderate importance ○ major importance

**69. Section 4: Information Access and Use**

**What type of record storage/access do you currently have for data and compliance documents? For LTS activities, is there anything that you want changed?**

_____
_____
_____

**70. Which of the following technologies should be further explored to assist in data access (for reporting, entry of additional data, validation, trending):**

**- paper technology**

○ no benefit ○ some benefit ○ substantial benefit

**71. - microfiche technology**

○ no benefit ○ some benefit ○ substantial benefit

**72. - Web portal technology**

○ no benefit ○ some benefit ○ substantial benefit

**73. - high-speed scanning technology**

○ no benefit ○ some benefit ○ substantial benefit

**74. - computer disc technology**

○ no benefit ○ some benefit ○ substantial benefit

**75. - bar coding technology**

○ no benefit ○ some benefit ○ substantial benefit

**76. - electronic data mining technology**

○ no benefit ○ some benefit ○ substantial benefit

**77. - "Rosetta stone" (translation key) technology**

○ no benefit ○ some benefit ○ substantial benefit

**78. If there is another technology that should be explored to assist in data access (for reporting, entry of additional data, validation, trending), please enter it here, then rate the level of benefit in the next question.**

_____

_____

_____

**79. How much benefit would be gained by further exploring how the technology you specified in the previous question can assist in data access?**

○ no benefit ○ some benefit ○ substantial benefit

**80. In what modes do you anticipate the public having access to data from LTS monitoring and historical records:**

**- the Web**

○ no benefit ○ some benefit ○ substantial benefit

**81. - non-Web interactive**

○ no benefit ○ some benefit ○ substantial benefit

**82. - paper**

○ no benefit ○ some benefit ○ substantial benefit

**83. - CD**

○ no benefit ○ some benefit ○ substantial benefit

**84. - video**

○ no benefit ○ some benefit ○ substantial benefit

**85. - audio**

○ no benefit ○ some benefit ○ substantial benefit

**86. If there is another mode by which the public could have access to data from LTS monitoring and historical records, please enter it here, then rate the level of benefit in the next question.**

_____

_____

_____

**87. If the public had access to data from LTS monitoring and historical records via the mode you specified in the previous question, how much benefit would be gained?**

○ no benefit ○ some benefit ○ substantial benefit

**88. Does your state have a centralized listing or database of those areas with LTS obligations? If yes, please briefly describe the system. How successful (user-friendly, current) is the system in your experience?**

_____
_____
_____

**89. Does your state have a central point of contact for all LTS activities occurring within the state? If yes, in which department is the position located?**

_____
_____
_____

**90. Section 5: Land Use and Institutional Controls**
**Technology is essential to the successful utilization of land use and institutional controls.**

○ strongly disagree ○ moderately disagree ○ neutral ○ moderately agree ○ strongly agree

**91. Please indicate your experience with each of the following land use and institutional controls:**

**- signs**
○ negative experience ○ no experience ○ positive experience

**92. - monuments**
○ negative experience ○ no experience ○ positive experience

**93. - fences**
○ negative experience ○ no experience ○ positive experience

**94. - deed restrictions**
○ negative experience ○ no experience ○ positive experience

**95. - zoning, ordinances, statutes**
○ negative experience ○ no experience ○ positive experience

**96. - building codes**
○ negative experience ○ no experience ○ positive experience

**97. - easements, covenants**
○ negative experience ○ no experience ○ positive experience

**98. - permits, consent decrees**
○ negative experience ○ no experience ○ positive experience

**99. - lease restrictions**
○ negative experience ○ no experience ○ positive experience

**100. If you have had experience with another land use and institutional control, please enter it here, then rate your experience in the next question.**

_____
_____
_____

**101. Please indicate your experience with the land use and institutional control you specified in the previous question.**

○ negative experience ○ no experience ○ positive experience

**102. Can technology improve the effectiveness of each of the following land use and institutional controls (*For example, a fence that signals when it is pushed down*.):**

**- signs**
○ no role ○ limited role ○ significant role

**103. - fences**
○ no role ○ limited role ○ significant role

**104. - deed restriction**
○ no role ○ limited role ○ significant role

**105. - zoning**
○ no role ○ limited role ○ significant role

**106.** **- easements**
○ no role ○ limited role ○ significant role

**107.** **- lease restrictions**
○ no role ○ limited role ○ significant role

**108. If there is another land use and institutional control whose effectiveness could be improved by technology, please enter it here, then rate the role technology could play in the next question.**

_____
_____
_____

**109. Please indicate what role technology could play in improving the effectiveness of the land use and institutional control you specified in the previous question.**
○ no role ○ limited role ○ significant role

**110. Please indicate your experience with each of the following approaches to increasing awareness of land use and institutional controls.**

**- on-site museum/educational facilities**
○ negative experience ○ no experience ○ positive experience

**111.** **- computer/database links for deed restrictions**
○ negative experience ○ no experience ○ positive experience

**112.** **- school programs**
○ negative experience ○ no experience ○ positive experience

**113.** **- community education classes**
○ negative experience ○ no experience ○ positive experience

**114.** **- continued scientific studies**
○ negative experience ○ no experience ○ positive experience

**115.** **- multiple public uses for sites**
○ negative experience ○ no experience ○ positive experience

**116.** **- multiple private industry uses for sites**
○ negative experience ○ no experience ○ positive experience

**117.** **- continued government use of sites**
○ negative experience ○ no experience ○ positive experience

**118. If you have experience with another approach to increasing awareness of land use and institutional controls, please enter it here, then rate your experience in the next question.**

_____
_____
_____

**119. Please indicate your experience with the approach to increasing awareness of land use and institutional controls that you specified in the previous question.**
○ negative experience ○ no experience ○ positive experience

**120. Which of the following elements should be included in a comprehensive program to ensure long-term awareness of land use and institutional controls? (*Please select all that apply*)**
☐ On-site museum/educational facility ☐ Computer/database links for deed restrictions ☐ School programs ☐ Community education classes ☐ Continued scientific studies ☐ Multiple public uses for sites ☐ Multiple private industry uses for sites ☐ Continued government use of sites ☐ Other

**121. If you checked "Other" above, please enter the element that should be included.**

_____
_____
_____

**122. If possible, provide examples of land use and institutional controls that have or have not been effective.**

_____
_____
_____

**123. How can the processes/activities associated with ensuring awareness of land use and institutional controls be improved or simplified?**

_____
_____
_____

**124. Section 6: Decision Making**

**Which of the following communication processes do you currently use to get local community, tribal, and state values factored into the LTS decision-making process?**

☐ Focus groups ☐ Consensus building ☐ Surveys ☐ Citizen Advisory Boards ☐ Local governments ☐ Nongovernment organizations ☐ Public meetings ☐ Interactive displays ☐ Site open houses ☐ Training ☐ Public reading rooms ☐ Other

**125. If you checked "Other" above, please enter the name of the communication process.**

_____
_____
_____

**126. Please rate the effectiveness of each of the following communication processes in getting local community, tribal, and state values factored into the LTS decision-making process.**

**- focus groups**
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience

**127. - consensus building**
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience

**128. - surveys**
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience

**129. - citizen advisory boards**
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience

**130. - local governments**
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience

**131. - nongovernment organizations**
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience

**132. - public meetings**
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience

**133. - interactive displays**
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience

**134. - site open houses**
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience

**135. - training**
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience

**136. - public reading rooms**
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience

**137. If you would like to rate the effectiveness of another communication process in getting local community, tribal, and state values factored into the LTS decision-making process, please enter it here, then rate its effectiveness in the next question.**

_____
_____
_____

**138. Please rate the effectiveness of the communication process you specified in the previous question in getting local community, tribal, and state values factored into the LTS decision-making process.**

○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience

**139. What is your experience with these approaches to decision making for selecting land use/institutional controls (e.g. zoning):**

**- inclusion of value/judgment studies (e.g. risk perception/community values)**

○ no experience ○ little experience ○ some experience ○ substantial experience

**140. - structured consensus building process**

○ no experience ○ little experience ○ some experience ○ substantial experience

**141. - graphical/visual presentation of data**

○ no experience ○ little experience ○ some experience ○ substantial experience

**142. - models capable of running "what-if" scenarios**

○ no experience ○ little experience ○ some experience ○ substantial experience

**143. - simplified legal language templates**

○ no experience ○ little experience ○ some experience ○ substantial experience

**144. - land use planning tools**

○ no experience ○ little experience ○ some experience ○ substantial experience

**145. - demographics projection tools**

○ no experience ○ little experience ○ some experience ○ substantial experience

**146. - public training/education programs**

○ no experience ○ little experience ○ some experience ○ substantial experience

**147. If you have experience with another approach to decision making for selecting land use and institutional controls, please enter the approach here, then rate your experience in the next question.**

_____
_____
_____

**148. Please indicate your experience with the approach to decision making that you specified in the previous question.**

○ no experience ○ little experience ○ some experience ○ substantial experience

**149. To improve the decision-making process for selecting more effective land use and institutional controls, please rate the potential usefulness of these tools:**

**- inclusion of social science expertise**

○ not useful ○ somewhat useful ○ useful ○ very useful

**150. - formalized consensus building**

○ not useful ○ somewhat useful ○ useful ○ very useful

**151. - graphical/visual presentation of data**

○ not useful ○ somewhat useful ○ useful ○ very useful

**152. - models capable of running 'what if' scenarios**

○ not useful ○ somewhat useful ○ useful ○ very useful

**153. - simplified legal language building blocks**

○ not useful ○ somewhat useful ○ useful ○ very useful

**154. - land use planning tools**

○ not useful ○ somewhat useful ○ useful ○ very useful

**155. - demographics projection tools**

○ not useful ○ somewhat useful ○ useful ○ very useful

**156. - training**

○ not useful ○ somewhat useful ○ useful ○ very useful

**157. If you would like to comment on the potential usefulness of another tool for improving the decision-making process, please enter it here, then rate its usefulness in the next question.**

_____
_____

_____

**158. Please rate the potential usefulness of the tool you specified in the previous question.**

○ not useful ○ somewhat useful ○ useful ○ very useful

**159. How would you improve on existing processes?**

_____
_____
_____

**160. Are existing conceptual site models (as per used in CERCLA) sufficient for long-term analysis of site data? If not, what changes should be made to make conceptual site models a useful tool for monitoring LTS sites?**

_____
_____
_____

**161. Section 7: Path Forward**

**Please rate the potential usefulness of ITRC projects:**

**- Case Study/Guidance document on landfill and disposal facility long-term monitoring technologies**

○ not useful ○ somewhat useful ○ useful ○ very useful

**162. - Case Study/Guidance document on real-time in situ radiological contamination characterization technologies**

○ not useful ○ somewhat useful ○ useful ○ very useful

**163. - workshop on data retention technologies for LTS**

○ not useful ○ somewhat useful ○ useful ○ very useful

**164. - training on LTS technologies and decision making**

○ not useful ○ somewhat useful ○ useful ○ very useful

**165. If you have an idea for another project for the ITRC Radionuclides Team, please enter it here, then rate its usefulness in the next question.**

_____
_____
_____

**166. Please rate your expectation of the usefulness of the project you specified in the previous question.**

○ not useful ○ somewhat useful ○ useful ○ very useful

# APPENDIX C

## ITRC Analysis of Responses to LTS Questionnaire

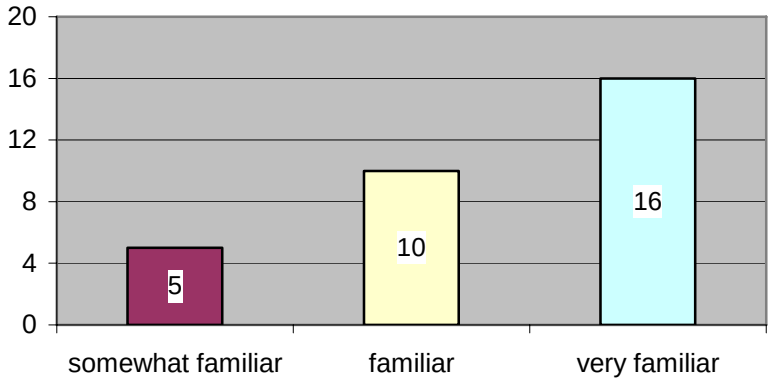
## ITRC ANALYSIS OF RESPONSES TO LTS QUESTIONNAIRE

This appendix summarizes the response to each question from the questionnaire filled in by state regulators, except for Questions 1–9, which were requests for personal data from the state regulators. The question is first given, and then the data is summarized.

The survey responses were compiled by the ITRC Radionuclides Team. Three styles of data compilation are used in this appendix. The answers to quantitative questions are presented as graphs, showing the number of respondents giving each answer. Answers to qualitative questions are listed as bulleted items. The number of responses to each question is provided. In some instances two questions are tightly related and require write-in response to the first and then quantitative judgment on the next (e.g., Questions 15 and 16, where respondents are asked to enter a state of the art practice and then rate their familiarity with it). In these cases, the two questions are listed consecutively, and the answers are then paired together as bulleted items. These paired questions also give the number of responses to each.

### SURVEY SECTION 1: GENERAL (QUESTIONS 10–31)

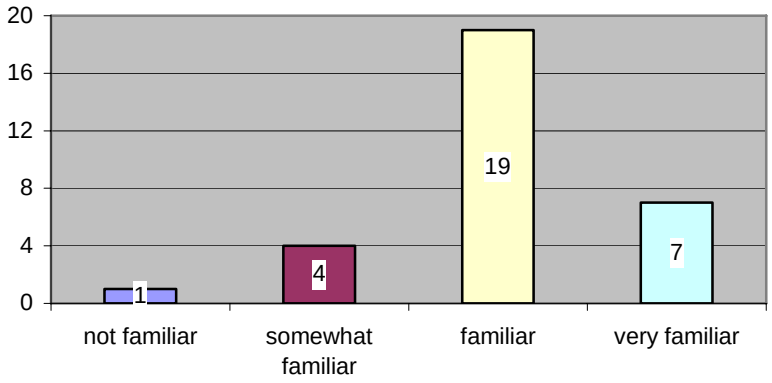
**Question 10. How familiar do you feel you are with long-term stewardship issues?**
○ not familiar ○ somewhat familiar ○ familiar ○ very familiar



**Question 11. In general, how familiar are you with the state of the art (in terms of practice, not research) in the following areas:**

**- treatment**

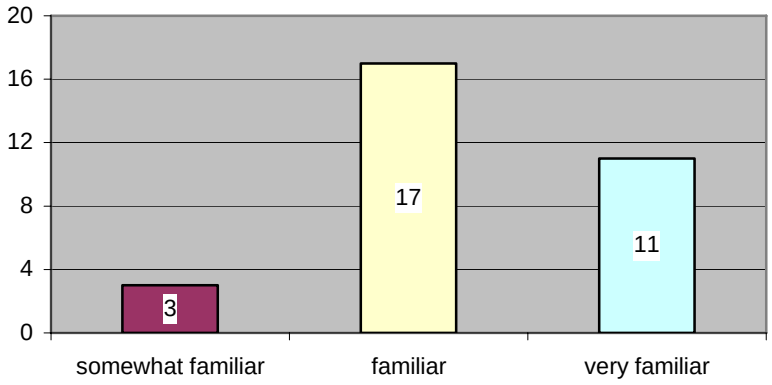
○ not familiar ○ somewhat familiar ○ familiar ○ very familiar



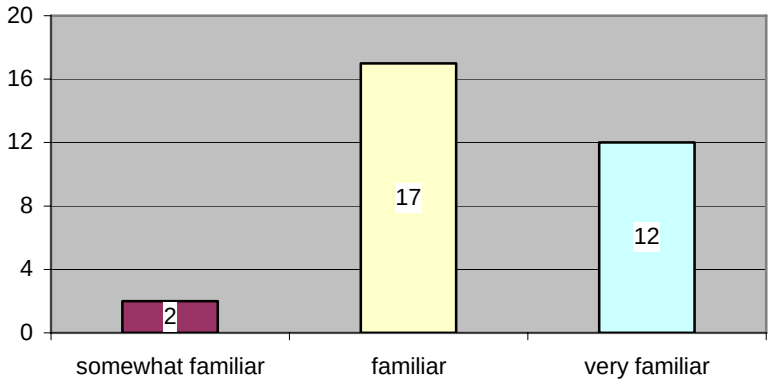

**Question 12. In general, how familiar are you with the state of the art (in terms of practice, not research) in the following areas:**

**- monitoring**

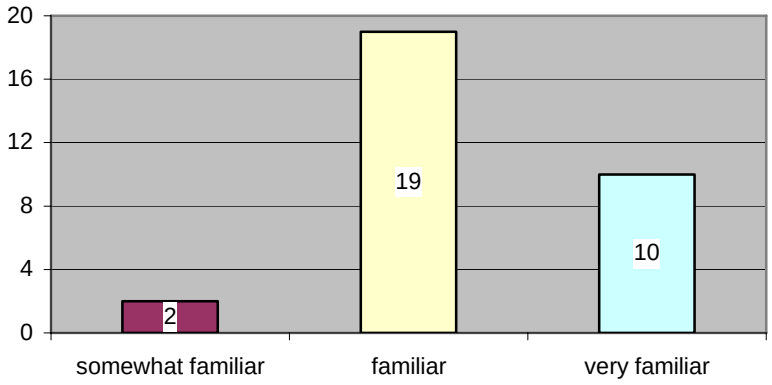
○ not familiar ○ somewhat familiar ○ familiar ○ very familiar



**Question 13: In general, how familiar are you with the state of the art (in terms of practice, not research) in the following areas:**
**- decision making**
○ not familiar ○ somewhat familiar ○ familiar ○ very familiar




**Question 14: In general, how familiar are you with the state of the art (in terms of practice, not research) in the following areas:**
**- land use and institutional controls**
○ not familiar ○ somewhat familiar ○ familiar ○ very familiar




**Question 15. If you are interested in another state-of-the-art practice, please enter it here, then rate your familiarity with it in the next question.**
- See answers to following question for state-of-the-art practices

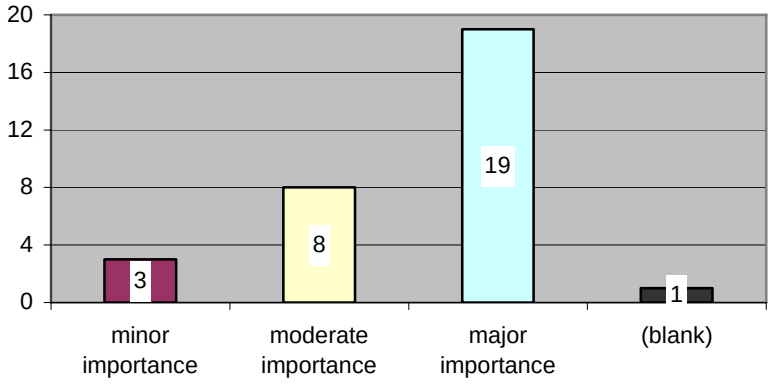
**Question 16. In general, how familiar are you with the state of the art (in terms of practice, not research) in the area you specified in the previous question?**
○ not familiar ○ somewhat familiar ○ familiar ○ very familiar
- Characterization – very familiar
- Funding, communication/public involvement – familiar
- In situ vitrification – familiar

- Funding – not familiar
- Site information management and accessibility – familiar
- Information retention and management – familiar
- Public involvement – familiar
- Information storage and management. – somewhat familiar
- Examination of ancient artifacts and cultures to determine how to produce lasting records and artifacts for the extreme future. – familiar

**Question 17. How critical is technology in addressing the challenges of LTS for the following areas:**

**- treatment**

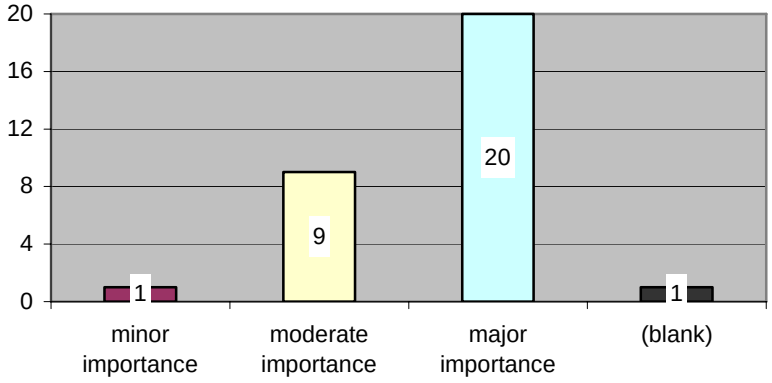
○ not important ○ minor importance ○ moderate importance ○ major importance




**Question 18. How critical is technology in addressing the challenges of LTS for the following areas:**

**- monitoring**

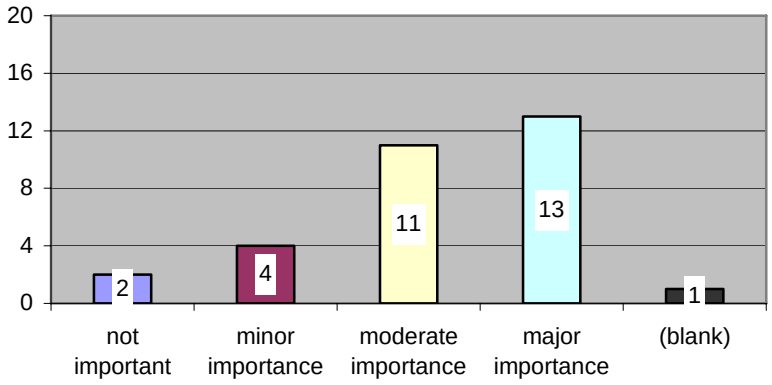
○ not important ○ minor importance ○ moderate importance ○ major importance



**Question 19. How critical is technology in addressing the challenges of LTS for the following areas:**

**- monitoring**

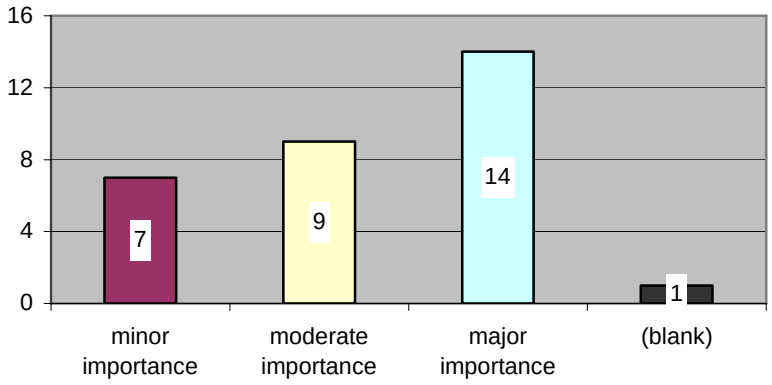
○ not important ○ minor importance ○ moderate importance ○ major importance




**Question 20. How critical is technology in addressing the challenges of LTS for the following areas:**

**- land use and institutional controls**

○ not important ○ minor importance ○ moderate importance ○ major importance



**Question 21. If you have thoughts on another area in which technology is important in addressing the challenges of LTS, please enter it here, then rate the importance in the next question.**

- See answers to following question for responses to this question

**Question 22. How critical is technology in addressing the challenges of LTS in the area you specified in the previous question?**

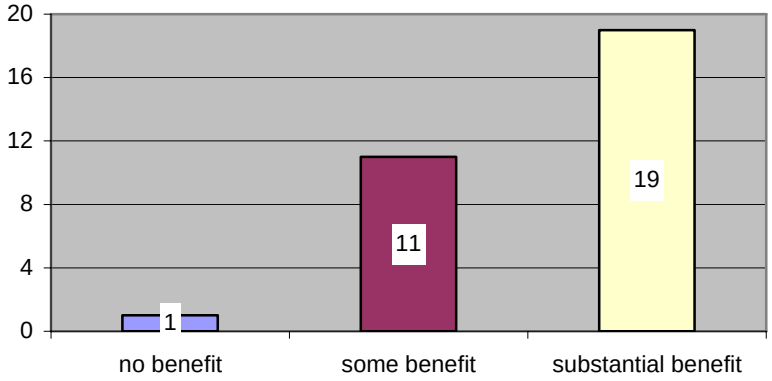
○ not important ○ minor importance ○ moderate importance ○ major importance

- Data management (which might be part of institutional controls above – major importance
- Long-term information management – moderate importance
- Data management and accessibility – major importance
- Funding for long term – moderate importance
- Information retention and management – moderate importance
- Information retention and access – major importance
- Site data retention and management – major importance
- Information management – major importance
- Public involvement and outreach – major importance
- Inventions (new ways of remediating, unknown previously) – major importance
- Information storage and management – major importance
- Balance between remediation, attenuation, institutional controls, and natural resource damages. Leaving perpetual care wastes in unsuitable geology and demographics. – moderate importance
- Records/data management – major importance
- Remote-sensing automated reporting monitoring programs – (not rated)
- Blending technology with administrative challenges – major importance

**Question 23. How much would each of these LTS areas benefit from the development of additional technology?**

**- treatment**

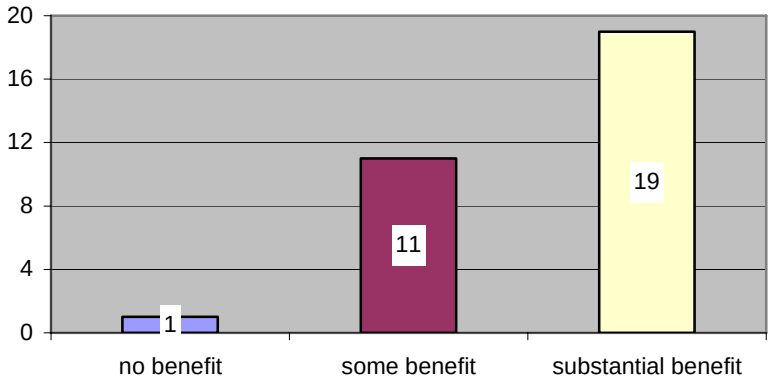
○ no benefit ○ some benefit ○ substantial benefit



**Question 24. How much would each of these LTS areas benefit from the development of additional technology?**

**- monitoring**

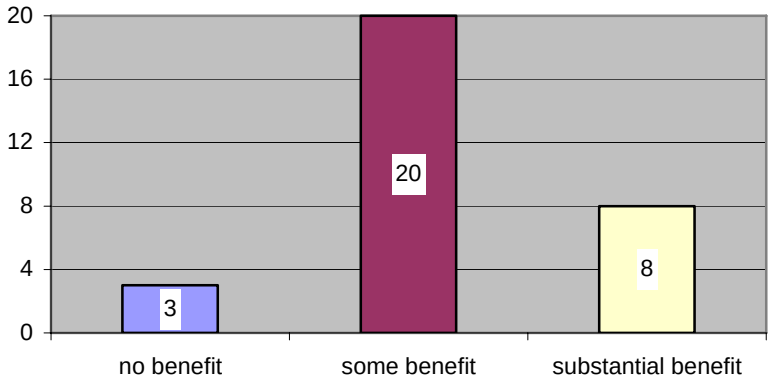
○ no benefit ○ some benefit ○ substantial benefit




**Question 25. How much would each of these LTS areas benefit from the development of additional technology?**

**- decision making**

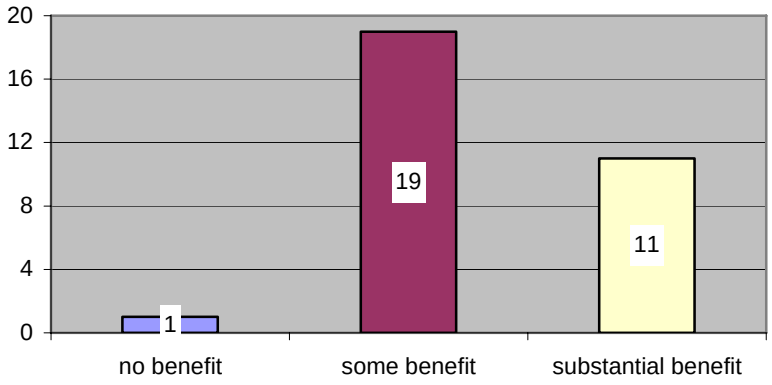
○ no benefit ○ some benefit ○ substantial benefit



**Question 26. How much would each of these LTS areas benefit from the development of additional technology?**

**- land use and institutional controls**

○ no benefit ○ some benefit ○ substantial benefit




**Question 27. If there is another area of LTS which you think would benefit from the development of additional technology, please enter it here, then rate the level of benefit in the next question.**

- See answers to following question for responses to this question

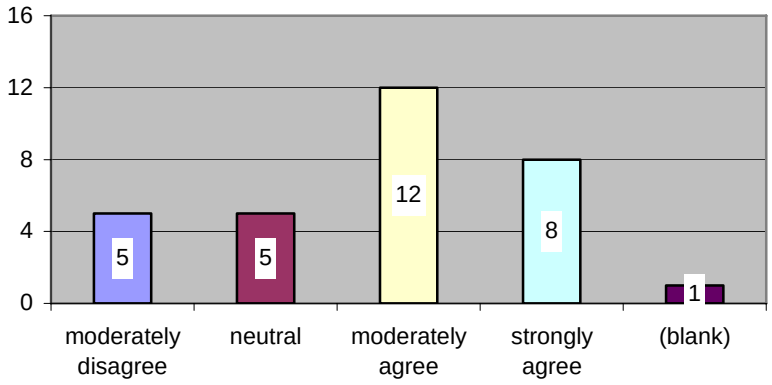
**Question 28. What would be the level of benefit from the development of additional technology in the area you specified in the previous question?**

○ no benefit ○ some benefit ○ substantial benefit

- Data management – substantial benefit
- Long-term information management – some benefit
- Data management – substantial benefit
- Information retention and management – some benefit
- Data retention and management – substantial benefit
- Information management – substantial benefit
- The time and money to clean a site – substantial benefit
- Remediation of soil and groundwater, especially the groundwater – substantial benefit
- Information storage and management – substantial benefit
- Records/data management – substantial benefit
- Internet-based interactive GIS – some benefit
- Mass communication. Robots to patrol and inform. – substantial benefit

**Question 29. There are technology limitations affecting the ability of sites to successfully implement LTS.**

○ strongly disagree ○ moderately disagree ○ neutral
○ moderately agree ○ strongly agree



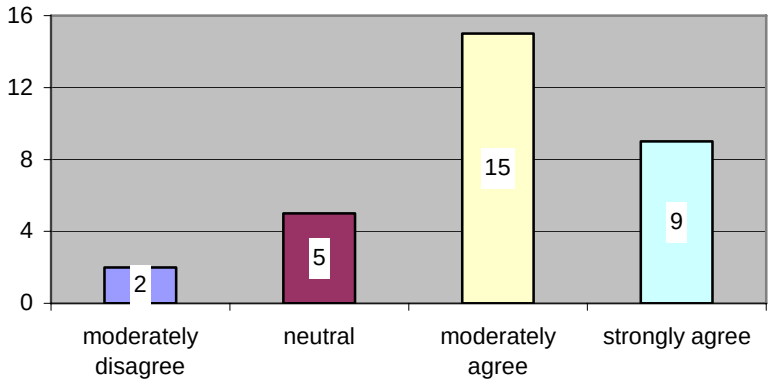

**Question 30. If you have observed technology limitations, please give examples of some of the major limitations.**

- In treatment, technologies for groundwater treatment that will have to continue for years after sight closure, when there may not be personnel and $ to continue O&M.
- The cost of implementing the technology appears to be a limitation for facilities more than the effectiveness of the technology.
- Intruder barriers, ability to predict contaminant mobility over a long period of time, D&D of radioactive facilities (i.e., reactors, radioactive waste storage tanks).
- One major problem is how to maintain records, both hard copy and electronic, for extremely long periods of time. Paper and tape records have a limited life span, and various forms of electronic medium are in technologies that become outdated.
- Removal of radionuclides from groundwater, assurance that institutional controls will be maintained.
- One major issue to be considered is the cost-benefit ratio for technology limitations. In other words, there might be a technology to address the problem but is cost prohibiting.
- Pump-and-treat systems that limit spread of contaminants but have decreasing recovery rates; monitoring wells affected by changing water table; information not compatible with GIS or in obsolete electronic formats; lack of technology to separate and remove certain contaminants from groundwater (e.g., tritium).
- Detection and remediation technologies for dense, nonaqueous-phase liquids; strontium in groundwater; etc.
- Limitations no, but the opportunity exists to develop improved monitoring methods that will provide more confidence in the long-term protectiveness and potentially reduce overall LTS costs.
- Source control technologies for groundwater often do not work. I think source removal and placement into engineered disposal and, when appropriate, geological disposal works best. Time will tell however.

- Most technologies that will be used or needed for LTS have no proven track record over the long term. This is especially true in the areas of treatment and monitoring. In addition, the infrastructure to support the continued success of the technology (maintenance, protection against the elements, vandalism, etc.) is uncertain.
- Permeable reactive barrier – observed hydraulic problems with a system designed to capture a nitrate+uranium plume; a system designed to treat for decades had immediate problems.
- As LTS may also apply to small nonradioactive sites, some sites do not have very large resources.
- Groundwater investigations in karst to know that systems are dynamic and change on time scales as short as a human life time and what will come to be on geologic time scales.

**Question 31. Investments in technology development should be a high priority in addressing LTS issues.**

○ strongly disagree ○ moderately disagree ○ neutral
○ moderately agree ○ strongly agree



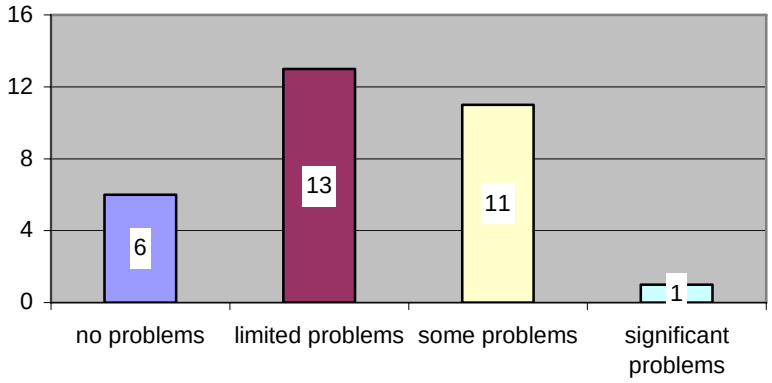
## SURVEY SECTION 2: TREATMENT (QUESTIONS 32–44)

### 32. Section 2: Treatment

**Once a site is in LTS, to what extent do you foresee problems (technical or otherwise) in managing/treating/disposing of:**

**- sampling-derived water**

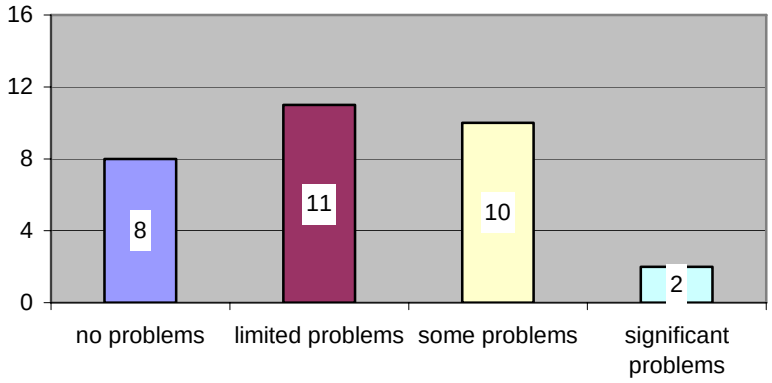
○ no problems ○ limited problems ○ some problems ○ significant problems




**Question 33. Once a site is in LTS, to what extent do you foresee problems (technical or otherwise) in managing/treating/disposing of:**

**- sampling-derived solid waste**

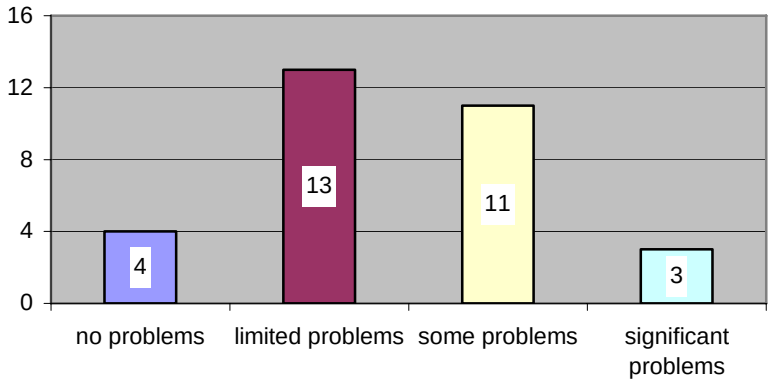
○ no problems ○ limited problems ○ some problems ○ significant problems



**Question 34. Once a site is in LTS, to what extent do you foresee problems (technical or otherwise) in managing/treating/disposing of:**

**- wastes generated during maintenance of a treatment system**

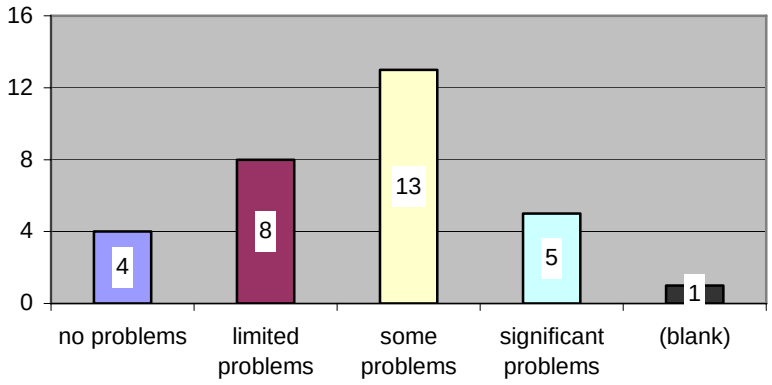
○ no problems ○ limited problems ○ some problems ○ significant problems




**Question 35. Once a site is in LTS, to what extent do you foresee problems (technical or otherwise) in managing/treating/disposing of:**

**- leachate**

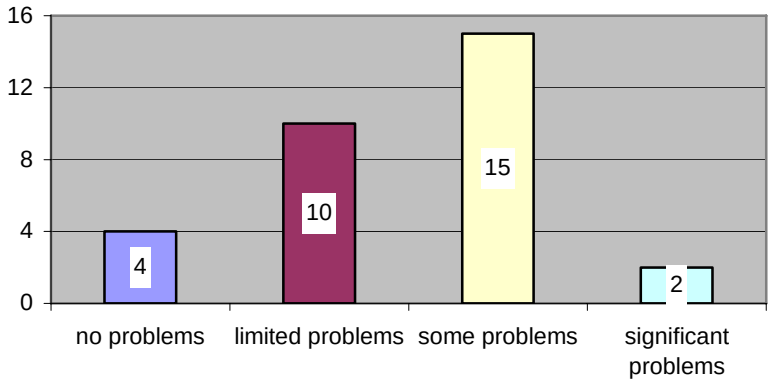
○ no problems ○ limited problems ○ some problems ○ significant problems



**Question 36. Once a site is in LTS, to what extent do you foresee problems (technical or otherwise) in managing/treating/disposing of:**

**- treatment-derived waste**

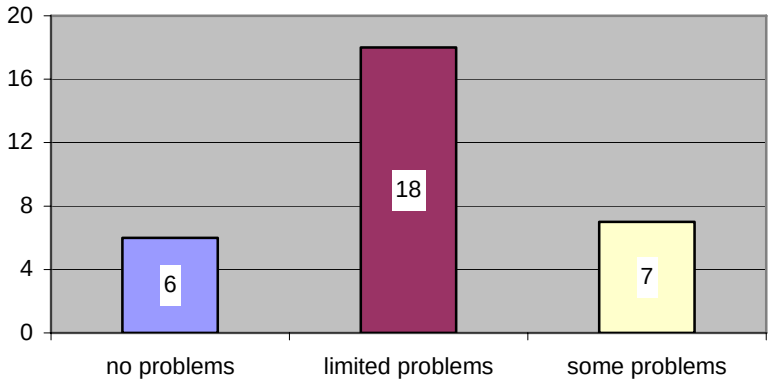
○ no problems ○ limited problems ○ some problems ○ significant problems




**Question 37. Once a site is in LTS, to what extent do you foresee problems (technical or otherwise) in managing/treating/disposing of:**

**- personal protective equipment**

○ no problems ○ limited problems ○ some problems ○ significant problems




**Question 38. If there is another treatment by-product which you anticipate might present problems once a site is in LTS, please enter it here, then rate the problem level in the next question.**

- See answers to following question for responses to this question

**Question 39. What problem level would you anticipate in managing, treating, and disposing of the by-product you specified in the previous question?**

○ no problems ○ limited problems ○ some problems ○ significant problems

- Maintenance of engineering controls (e.g., cap) – significant problems
- The by-product of treating groundwater...clean groundwater where does it go and how long does the system last – limited problems

- 40 million lbs of metallic and oxidized uranium in unlined trenches. In the event that this material is removed from the ground, the quantity alone should likely cause consideration for geologic disposal. If left in place, over time more hazardous and mobile daughters will require increasing maintenance and monitoring, and land use restrictions, if anyone still remembers to do it. – significant problems
- (No by-product specified) – some problems
- (No by-product specified) – limited problems

**Question 40. If there is another treatment by-product which you anticipate might present problems once a site is in LTS, please enter it here, then rate the problem level in the next question.**

- See answers to following question for responses to this question

**Question 41. What problem level would you anticipate in managing, treating, and disposing of the by-product you specified in the previous question?**

○ no problems ○ limited problems ○ some problems ○ significant problems

- Adhering and monitoring the deed restrictions – significant problems
- (No by-product specified) – limited problems

**Question 42. What technologies are you aware of for treatment of small quantities of wastewater/leachate during LTS?**

- Insertion into larger facility treatment systems, pump and haul for off-site disposal.
- The liquid could be pretreated to meet publicly owned treatment works' acceptance criteria or incinerated or solidified/stabilized and disposed. Depending on the contaminants and volume, the facility may want to construct their own treatment system using a contaminant-appropriate technology such as ultraviolet/peroxide, air stripping, reverse osmosis, etc.
- A way to minimize well purge water. Savannah River Site (SRS) uses a tank that holds the purge water until sample collected, then puts purge water back in well. Should look for technologies to reduce investigative-derived waste rather than searching for new treatment technologies. Currently treatment utilizes traditional wastewater treatment technologies.
- None.
- Depends on the waste and the regulations and disposal options in place when the waste is generated.
- Ranges from simple mechanical filtration to thermal destruction.
- Coagulation, precipitation, distillation, ion exchange, solidification.
- Treatment within existing on-site wastewater treatment facilities.
- Neutralization, flocculation, filtration, evaporation.
- The best alternative is off-site disposal to a permitted facility.
- Some sort of reactive barrier/ion exchange and treatment wetlands.
- Passive treatment, local recycling facilities, local waste treatment facilities.
- Evaporation with collection of off-gases.
- Batch processing by acidification, flocculation, and then neutralization.
- Limited quantity to treat/deal, may not be cost-effective.
- Constructed wetlands, solar evaporation.
- Existing process treatment systems at the Oak Ridge facilities.

- This depends in a large part what is in the leachate.
- Permeable reactive barriers; passive aeration; granular, activated charcoal.
- For hazardous waste sites, there are a number of currently available, off-the-shelf waste water treatment techniques readily available for the treatment of these wastes.
- Standard wastewater batch/continuous treatment technologies. These can be very waste stream/contaminant dependent.
- Incineration dilution.
- Leachate will be taken to a publicly owned treatment works for treatment and disposal under the current plans.
- Depends on the nature of the leachate, wastewater and contaminants. In general it may be a question of feasibility of on-site vs. off-site treatment and the relative costs of each. Many treatments may work at both large and small scale but it depends on what is being treated.

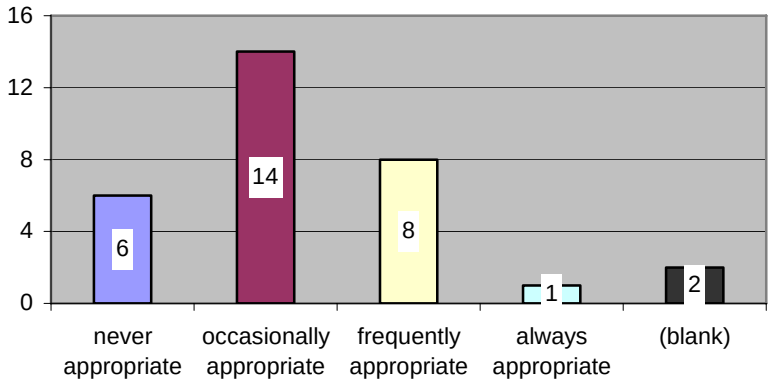
**Question 43. Do current long-term treatment systems require restriction in future land use at sites? What is the duration and nature of the restrictions?**

- Yes, particularly in regard to groundwater treatment. Require well drilling/potable water restrictions during period of treatment. Also in our case some springs would have to be restricted from use due to contamination.
- The restrictions require that the land use remain the same until the facility demonstrates that an alternate land use would be safe.
- I'm not aware of any treatment systems having land use restrictions. I am familiar with groundwater use restriction put in place as a component of a groundwater corrective action system. Restrictions are in an enforceable agreement (permit, order, record of decision), and restrictive covenants are placed on deed of land to be transferred.
- Capped waste, groundwater contamination may require land use restrictions for 100+ years.
- Yes. Depends on the nature of contamination and the residuals left after treatment.
- Yes, forever. Land disturbance, incompatible uses.
- Yes. At least 200 years.
- Yes. The duration can sometimes be lengthy. The department currently believes that institutional controls at certain SRS waste units can be maintained for up to 100 years. The remediation systems at some waste units will exceed this time period. Plans must be made for these waste units to be sure that the remediation system can be maintained beyond this time period (e.g., documentation within record of decision, human intruder barriers over hot spots within waste unit).
- Yes. Ex situ may have emissions, safety issues, and waste such as sludges or filters. Possible limitations on construction. In situ may have drilling/water use restrictions, but surface use may not be restricted.
- Depends of the nature of the remedial action. For example: for groundwater there could be groundwater well drilling prohibition for as long as the groundwater is above maximum contaminant limits.
- Presumably uses that extract groundwater adjacent to the site (thus pulling contaminants outward) or add surface water (e.g., irrigation) may need to be restricted to protect pump and treat or passive permeable barrier systems.
- Obviously they limit access to the treatment system and potentially the area being treated. Most durations are seen as very long term (>30 years).

- Yes. Access restrictions required for treatment works, physical structures. Access required for maintenance and monitoring.
- Unknown at present. Oak Ridge will undoubtedly require restriction of land use in certain areas. Some of these restrictions will have to be permanent.
- At Hanford, work is in progress to determine land use scenarios at various portions of the site. The most challenging task is the groundwater for which site use will be restricted to industrial and other limited purpose use only for a long period of time!
- At most of our sites restrictions should already be in place.
- Yes. I would guess a lot of DOE land in Oak Ridge will have land use and groundwater restrictions in perpetuity. Even the Clinch Rivers and Tennessee Rivers will have consumption advisories on fisheries for the foreseeable future. You keep mentioning "treatment systems." I am not certain the term is at all applicable in our most difficult cases. The horse is out of the barn as far as treatment can be considered.
- Some do, and the duration and nature would vary. The starting point in cleanup decisions had been to limit the need for LTS and associated restrictions, but in many cases that is not feasible, and in other cases it is not practical. Most typical are limitations on future uses.
- Yes, but the duration and nature of the restrictions depend on what the treatment system is.
- Yes. The site (Rocky Flats) with be operated by the U.S. Fish and Wildlife Service, but the long-term treatment facilities will be operated, and probably owned, by DOE in perpetuity.
- Yes. The duration of the restrictions is dependent on the remedial technique employed: more aggressive remedies result in shorter duration use restrictions, less aggressive methods require longer time frames.
- At Hanford, 10,000 years.
- Yes in RCRA. No in voluntary cleanup. In RCRA the initial duration is 30 years.
- Yes, forever billion plus years pumping of groundwater.
- Yes, potentially thousands of years.
- Long-term treatment systems do require restrictions in land use. At minimum, restrictions are necessary to restrict inadvertent or unauthorized access to treatment equipment or areas where damage may occur or people be exposed to chemicals. Restrictions will be different based on type of treatment facility and whether treatment is in situ or ex situ. Duration is as necessary.

**Question 44. Are point-of-use treatment strategies (such as treatment of water removed from an aquifer for use versus treatment of the entire aquifer) appropriate for LTS?**

○ never appropriate ○ occasionally appropriate
○ frequently appropriate ○ always appropriate

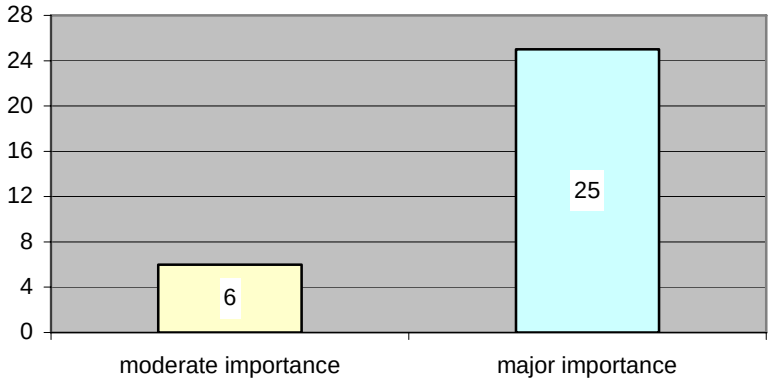



## SURVEY SECTION 3: MONITORING (QUESTIONS 45–68)

**Question 45. Section 3: Monitoring**
**How important is monitoring during LTS in each of the following areas:**

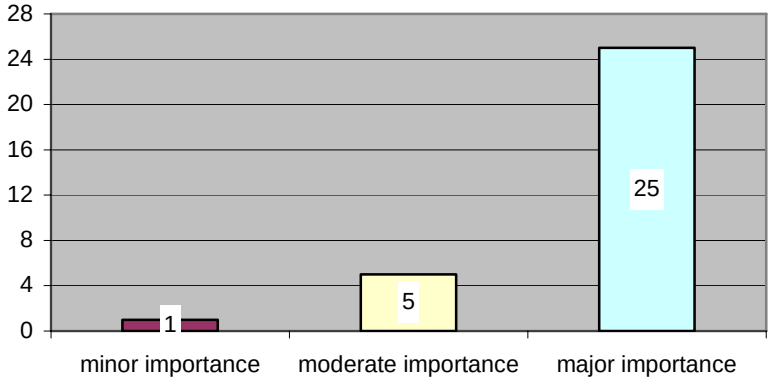
**- disposal facilities**

○ not important ○ minor importance ○ moderate importance ○ major importance



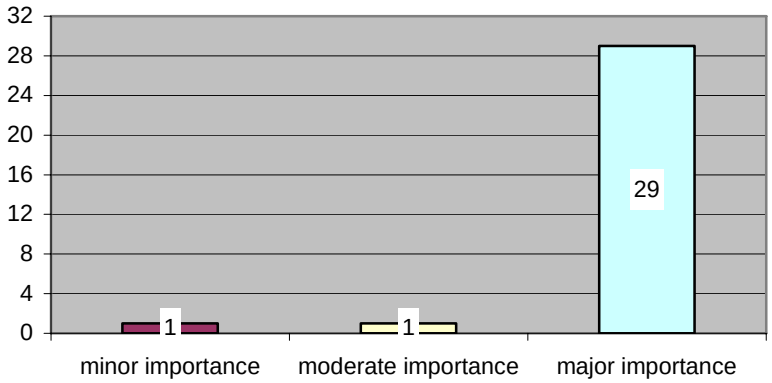
**Question 46. How important is monitoring during LTS in each of the following areas:**
**- containment facilities**

○ not important ○ minor importance ○ moderate importance ○ major importance



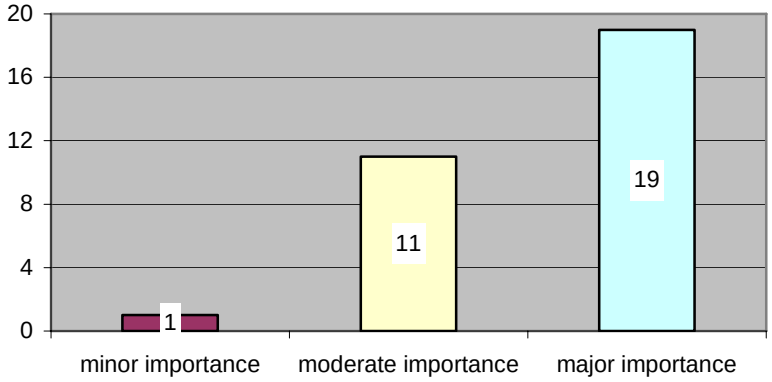

**Question 47. How important is monitoring during LTS in each of the following areas:**
**- groundwater**

○ not important ○ minor importance ○ moderate importance ○ major importance



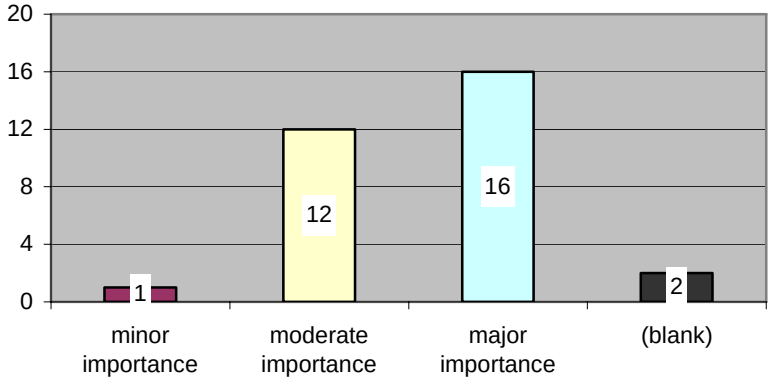
**Question 48. How important is monitoring during LTS in each of the following areas:**
**- land use control (on site and surrounding)**

○ not important ○ minor importance ○ moderate importance ○ major importance




**Question 49. How important is monitoring during LTS in each of the following areas:**
**- tanks**

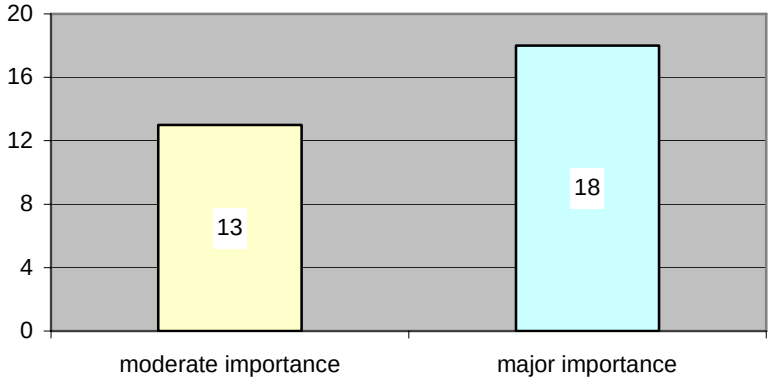
○ not important ○ minor importance ○ moderate importance ○ major importance



**Question 50. How important is monitoring during LTS in each of the following areas:**

**- leachate**

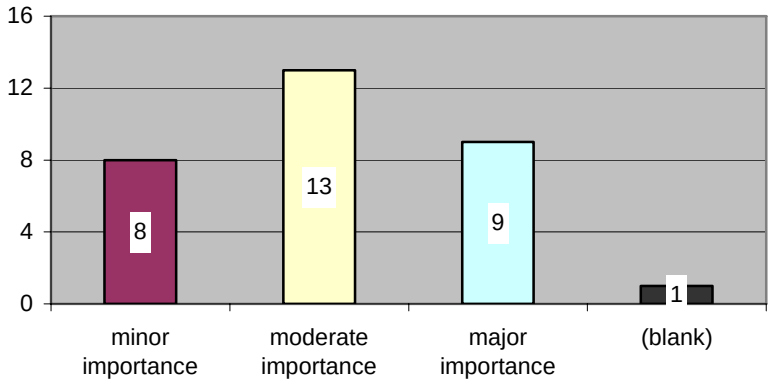
○ not important ○ minor importance ○ moderate importance ○ major importance




**Question 51. How important is monitoring during LTS in each of the following areas:**

**- air**

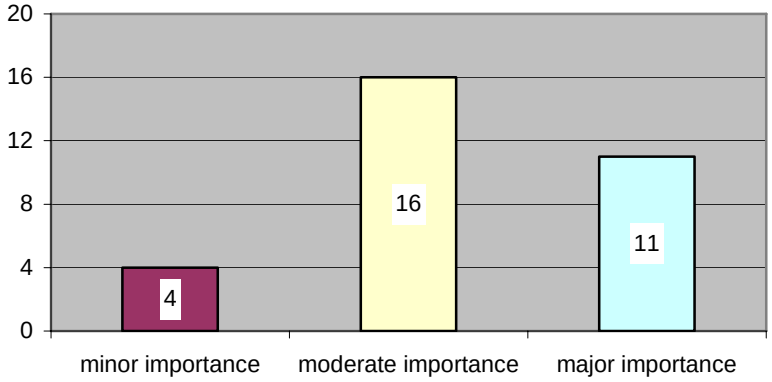
○ not important ○ minor importance ○ moderate importance ○ major importance



**Question 52. How important is monitoring during LTS in each of the following areas:**

**- ecosystem health, change**

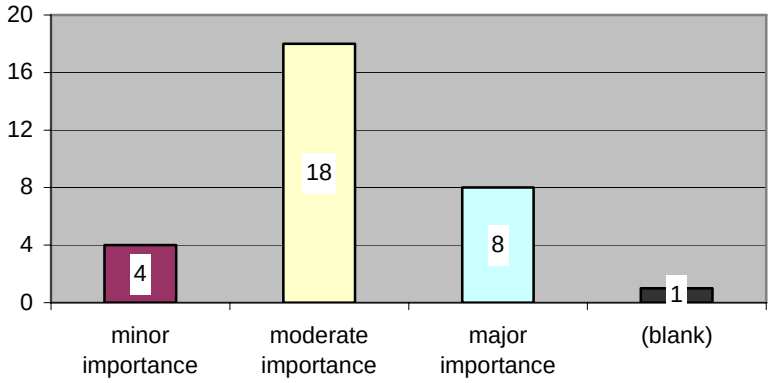
○ not important ○ minor importance ○ moderate importance ○ major importance




**Question 53. How important is monitoring during LTS in each of the following areas:**

**- significant but unpredictable natural events (fire, rainfall, flash floods, earthquakes, tornados)**

○ not important ○ minor importance ○ moderate importance ○ major importance




**Question 54. If there is another area for which you feel monitoring during LTS is important, please enter it here, and then rate the importance in the next question.**

- See answers to following question for responses to this question

**Question 55. How important is monitoring during LTS in the area you specified in the previous question?**

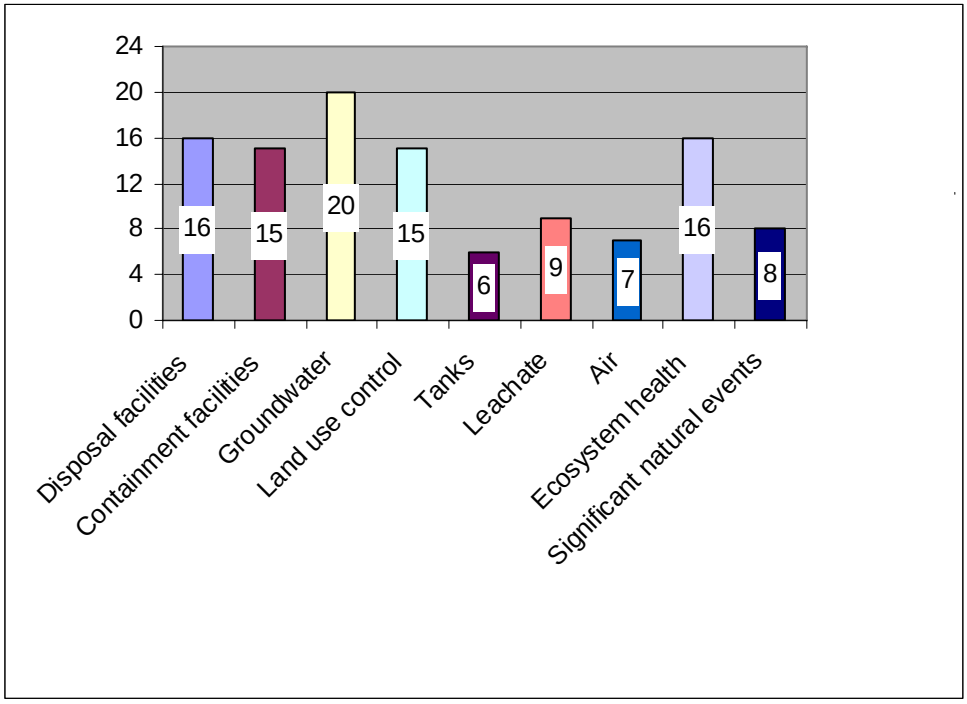
○ not important ○ minor importance ○ moderate importance ○ major importance

- Residual contamination – major importance
- Need to monitor information systems for functionality – major importance
- Uptake of biota and animal life (may be incorporated with ecosystem) – major importance
- Groundwater monitoring using natural attenuation of groundwater containing long-lived radionuclides. – major importance

- Continuous remedial technique performance evaluation – major importance
- Communication – major importance
- I left the question above on tanks blank because I have no idea what they have to do with long-term stewardship. Tank usage is in the same category as container storage, waste piles, staging areas, and other temporary use structures that I am not sure have much role in LTS – no rating

**Question 56. Which of the following areas need development of additional monitoring technology (*please check all that apply*)**

☐ Disposal facilities ☐ Containment facilities ☐ Groundwater ☐ Land use control (on site and surrounding) ☐ Tanks ☐ Leachate ☐ Air ☐ Ecosystem health, change ☐ Significant but unpredictable natural events (fire, rainfall, flash floods, earthquakes, tornados)

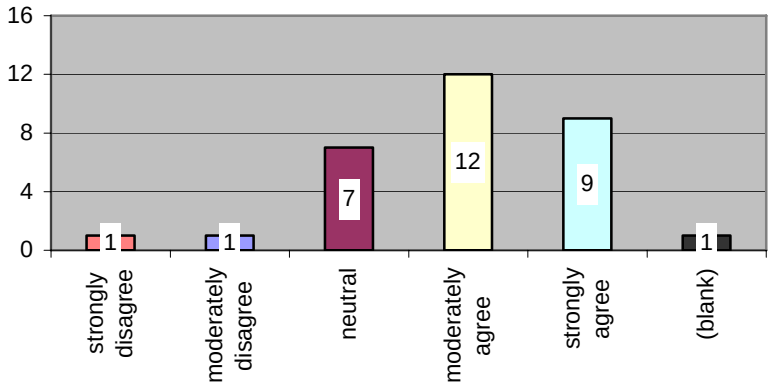



**Question 57. Other areas needing development of additional monitoring technology:**

- Surface water.
- All of these have existing monitoring technologies. New technologies can improve the effectiveness and potentially reduce costs.
- Automated monitoring with telemetry or good data logging will be valuable in the future. The ability to gather large amounts of information with just a few people as budgets shrink will be important.
- Record keeping.

**Question 58. Redundancy (for verification and compliance) in monitoring is important for LTS success.**

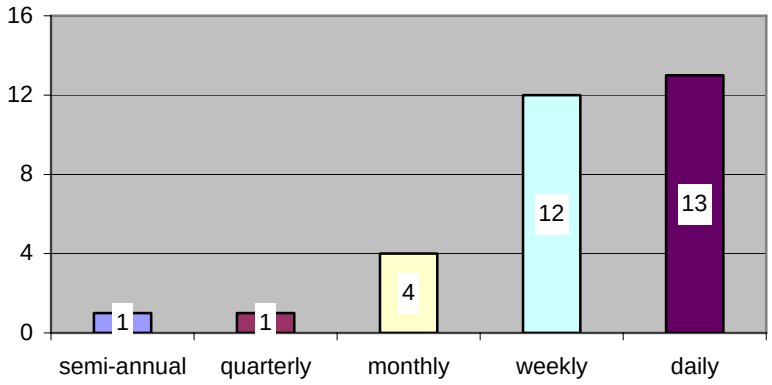
○ strongly disagree ○ moderately disagree ○ neutral
○ moderately agree ○ strongly agree




**Question 59. To what extent is on-site human presence and observation important to an effective LTS monitoring system for the following situations:**

**- site with an ongoing active (powered) treatment system**

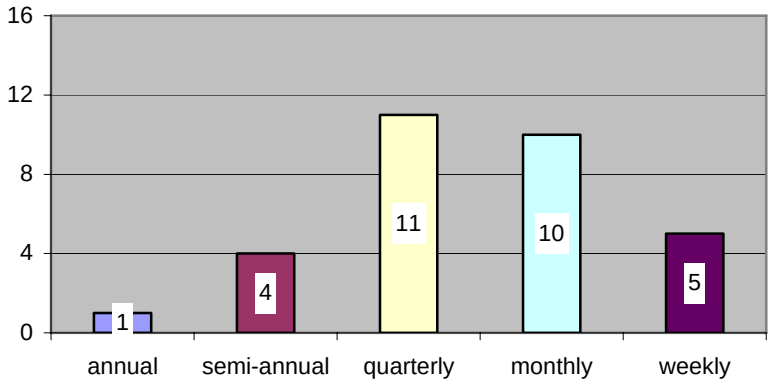
○ annual ○ semiannual ○ quarterly ○ monthly ○ weekly ○ daily



**Question 60. To what extent is on-site human presence and observation important to an effective LTS monitoring system for the following situations:**

**- site with an ongoing passive treatment system**

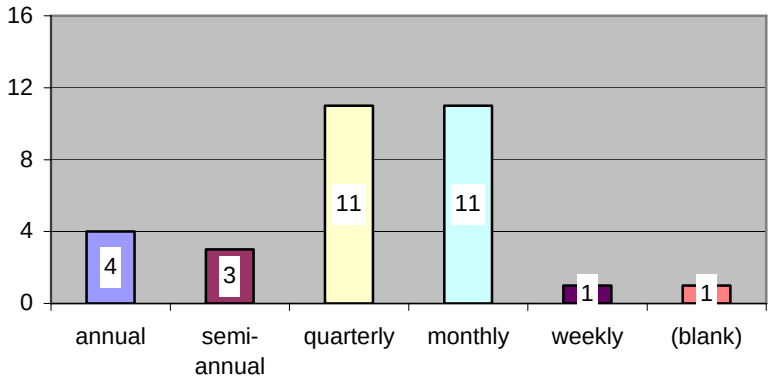
○ annual ○ semiannual ○ quarterly ○ monthly ○ weekly ○ daily




**Question 61. To what extent is on-site human presence and observation important to an effective LTS monitoring system for the following situations:**

**- capped site with no cap monitoring instrumentation**

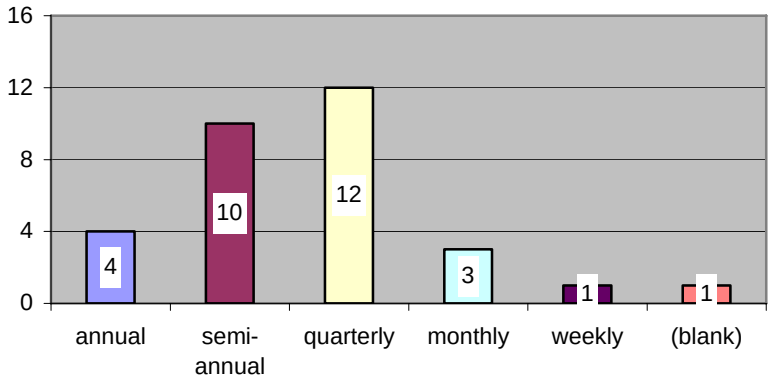
○ annual ○ semiannual ○ quarterly ○ monthly ○ weekly ○ daily



**Question 62. To what extent is on-site human presence and observation important to an effective LTS monitoring system for the following situations:**

**- capped site with cap monitoring instrumentation**

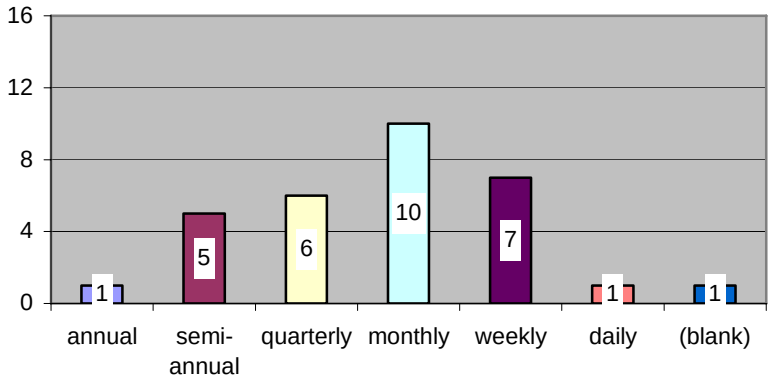
○ annual ○ semiannual ○ quarterly ○ monthly ○ weekly ○ daily




**Question 63. To what extent is on-site human presence and observation important to an effective LTS monitoring system for the following situations:**

**- site in a populated area**

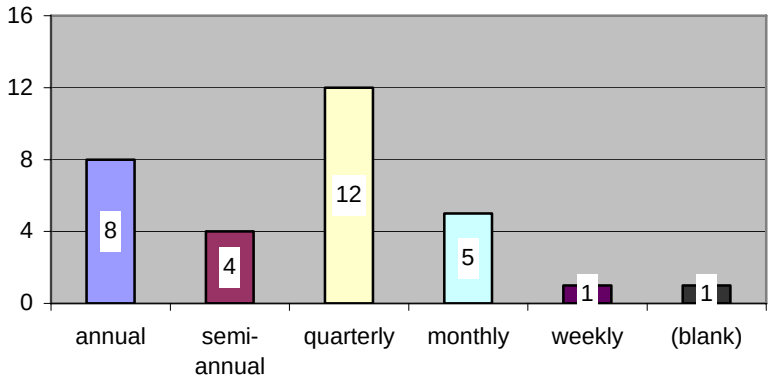
○ annual ○ semiannual ○ quarterly ○ monthly ○ weekly ○ daily



**Question 64. To what extent is on-site human presence and observation important to an effective LTS monitoring system for the following situations:**

**- site in an unpopulated area**

○ annual ○ semiannual ○ quarterly ○ monthly ○ weekly ○ daily




**Question 65. If there is another situation for which on-site human presence and observation is important to an effective LTS monitoring system, please enter it here, then rate the importance in the next question.**

- See answers to following question for responses to this question

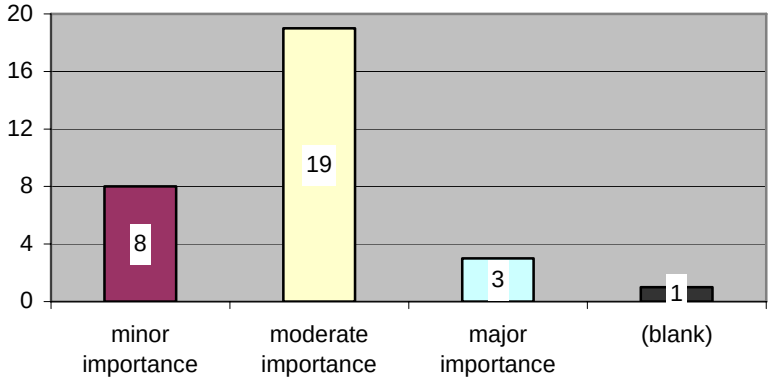
**Question 66. To what extent is on-site human presence and observation important to an effective LTS monitoring system for the situation you specified in the previous question?**

○ annual ○ semiannual ○ quarterly ○ monthly ○ weekly ○ daily

- Vandalism, plant intrusion, animal intrusion, erosion/subsidence – weekly
- Site with physical restrictions (i.e., fence), or erosion control – annual
- On-site presence is important for public education and understanding. This helps to eliminate public concerns and limits surprise issues. – monthly
- Chain-link or other fences separating the public from contaminated areas – weekly
- With regard to Questions 59–64, the monitoring frequency is dependent on the many factors noted. However, monitoring frequency may also be adjusted based on past performance and trends in observations. Less frequent monitoring may be necessary if conditions are stable and predictable and the opportunity for harm is low. – (no rating)
- Human interaction on a site can be based on system monitoring criteria tied to alarm and dial-up – (no rating)
- #63 & #64 are unanswerable because too much variability in situations—cannot generalize—frequency of monitoring may only have a small correlation with whether the site is in a populated area. Depends on nature of contaminants, pathways, concentrations, type of activities, etc. Many of the questions suffer from this problem—so much depends on site-specific conditions that generalization results in inaccurate answers. Should add an additional answer to say it depends on site-specific information. Same explanation goes for question #67 & 68 below—may be important or not. – (no rating)

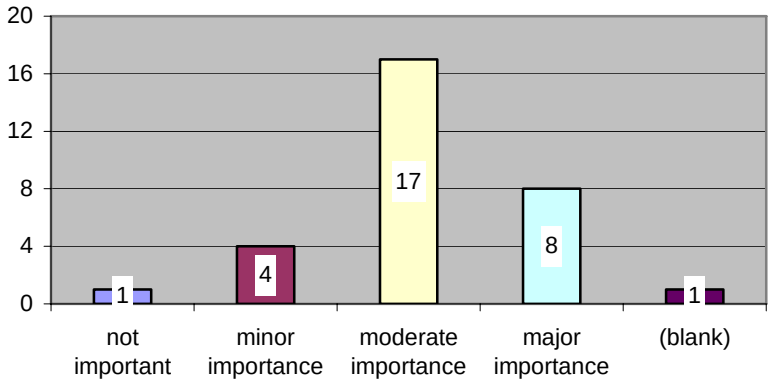
**Question 67. To what extent is real-time data important to effectively monitor LTS systems and structures?**

○ not important ○ minor importance ○ moderate importance ○ major importance




**Question 68. To what extent is remote sensing and data transmission important to effectively monitor LTS systems and structures?**

○ not important ○ minor importance ○ moderate importance ○ major importance




**SURVEY SECTION 4: INFORMATION ACCESS AND USE (QUESTIONS 69–89)**

**Question 69. Section 4: Information Access and Use**

**What type of record storage/access do you currently have for data and compliance documents? For LTS activities, is there anything that you want changed?**

- Paper, electronic and microfiche.
- Currently, we have mostly paper records. We are setting up an electronic database for monitoring data. For LTS, we need GIS in addition to the databases.
- Paper records and traditional paper filing system. Not sure I have the solution, but it doesn't seem that paper records would be the best for long-term stewardship.
- Records include hard paper copies, CDs, tapes and electronic files.
- Paper filing system.

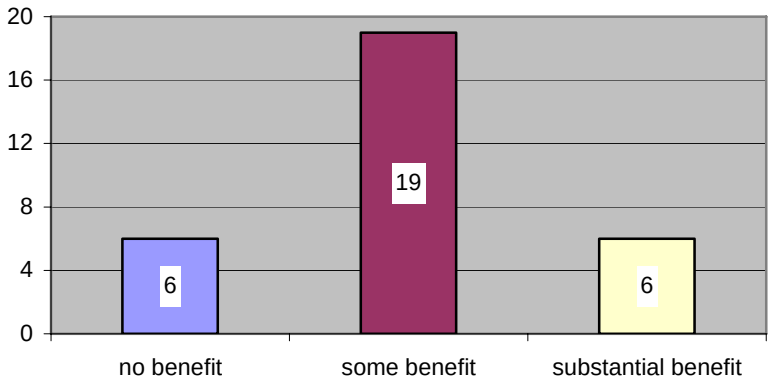
- SRS is an active site with on-site records and individuals knowledgeable about site records and history. When the site is closed, this situation likely will change.
- Administrative record files (paper, electronic), Web, microfilm.
- GIS, CD, paper copy for administrative record. As technology progresses, the information would need to be entered in the new media.
- Paper copy and electronic format index.
- The facility has hard-copy storage with electronic records management system. Regulatory documents (hard copy) are available at NMED offices and UNM Library Government Reading Room. Some information on environmental restoration sites was available on the Sandia internal web, but was pulled off after Sept. 11 events. Data and compliance docs should eventually be available in layers on a Web-based information management system. Management responsibility should be shared by DOE and the local government.
- We have both paper filing and archives and also electronic data archives. Would prefer electronic data storage system that can be retrieved easily through time.
- Administrative record—hard copy in multiple locations. Not all monitoring data included. Some GIS based information not generally accessible to the public. Should have accessible, current GIS-based information on prior uses and contamination, cleanup/treatment/ stabilization actions, engineered facilities, institutional controls, monitoring and maintenance assignments, periodicity, results, reviews and audits.
- Standard paper filing system. Some letters and photos electronic. Assume DOE will maintain the record to support LTS.
- Presently hard-copy storage.
- Current systems have limited accessibility. Need a distributed, semiautomatic data presentation capability, layered above a limited access database and application structure.
- Paper technology needs to transition to GIS/electronic database system.
- File and data records per case, easily accessible.
- Paper and computerized records at a central location. Data stored should be redundant in that there should be more than one copy and that the format should be long-lived.
- Central data management system, quarterly monitoring reports. For LTS, remote access data directories should be available for the citizens/interested public.
- DOE and state paper records. For LTS, possibly hundreds to thousands of years or much longer, records must be kept. The evolution of language must be considered. At least eliminate acronyms. The documents must be physically and electronically archived safely and in a manner which will withstand time. As well, English that we can understand easily ("modern") is only about 500–800 years old. Most of us, by nature, are temporal provincials, who examine time frames outside our own lifetimes only infrequently. Only scholars are adept at interpreting ancient writing and even then taking years of deciphering. We should perhaps look to the past to find successful methods to use for the future. I think historians and anthropologists may be the source for future success in transferring information to the people that live in the future.
- An adequate information management system has not been fully designed at this point.
- Paper files.
- Administrative Record + 3 Records Centers for hard copies; Internet access for data and compliance documents. A permanent long-term records preservation, storage and retrieval system needs to be developed.

- We presently employ paper documentation, with large data sets perhaps stored electronically (CD).
- Hard copy files.
- Behind the times, disjointed and tedious data. Redundant data on stable media in open source–based electronic applications.
- Storage of records is a concern. At this point many of the records associated with one of the DOE sites in Missouri will be relocated to Grand Junction, Colorado. This information will no longer be easily accessible to the majority of individual who need to know. Other options must be considered to allow easy access or retrieval of information.
- Paper, microfiche/film, some electronic. Should go to more electronic or bulk media storage of information for more ready access. Backup critical information in multiple formats.

**Question 70. Which of the following technologies should be further explored to assist in data access (for reporting, entry of additional data, validation, trending):**

**- paper technology**

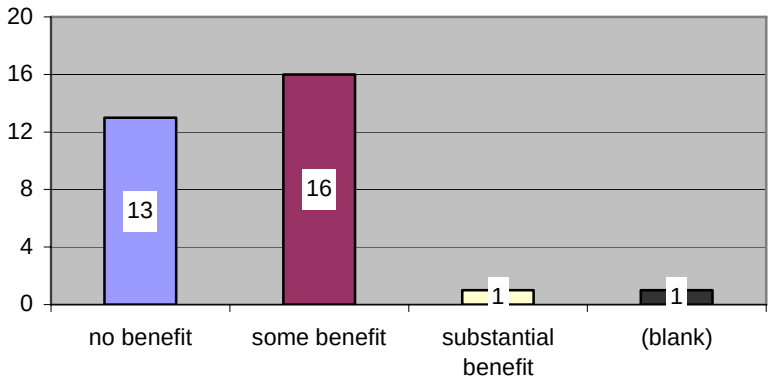
○ no benefit ○ some benefit ○ substantial benefit




**Question 71. Which of the following technologies should be further explored to assist in data access (for reporting, entry of additional data, validation, trending):**

**- microfiche technology**

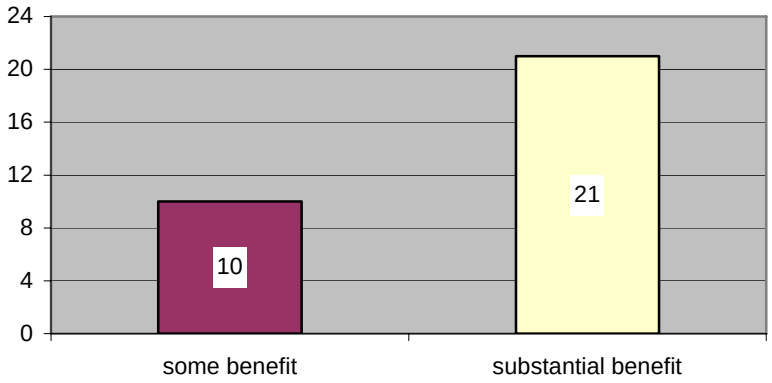
○ no benefit ○ some benefit ○ substantial benefit



**Question 72. Which of the following technologies should be further explored to assist in data access (for reporting, entry of additional data, validation, trending):**

**- Web portal technology**

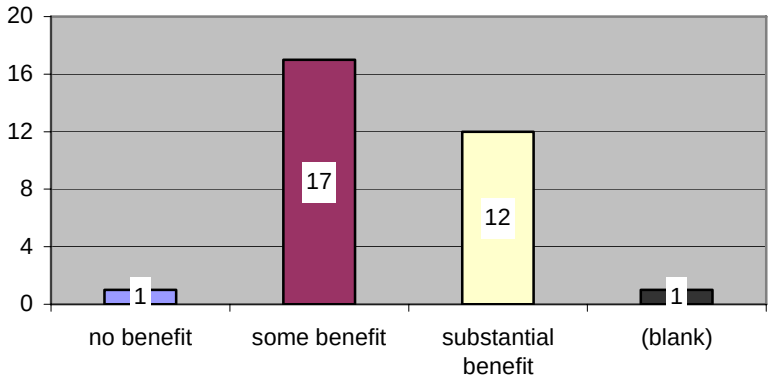
○ no benefit ○ some benefit ○ substantial benefit




**Question 73. Which of the following technologies should be further explored to assist in data access (for reporting, entry of additional data, validation, trending):**

**- high-speed scanning technology**

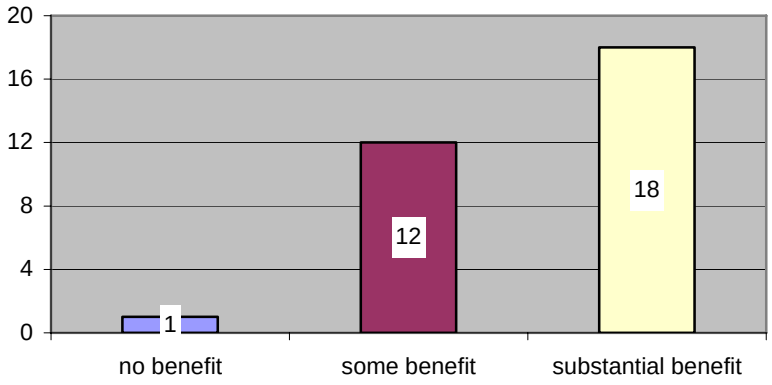
○ no benefit ○ some benefit ○ substantial benefit



**Question 74. Which of the following technologies should be further explored to assist in data access (for reporting, entry of additional data, validation, trending):**

**- computer disc technology**

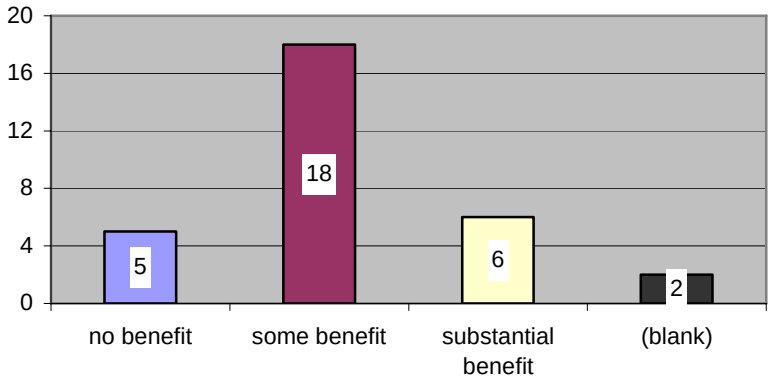
○ no benefit ○ some benefit ○ substantial benefit




**Question 75. Which of the following technologies should be further explored to assist in data access (for reporting, entry of additional data, validation, trending):**

**- bar coding technology**

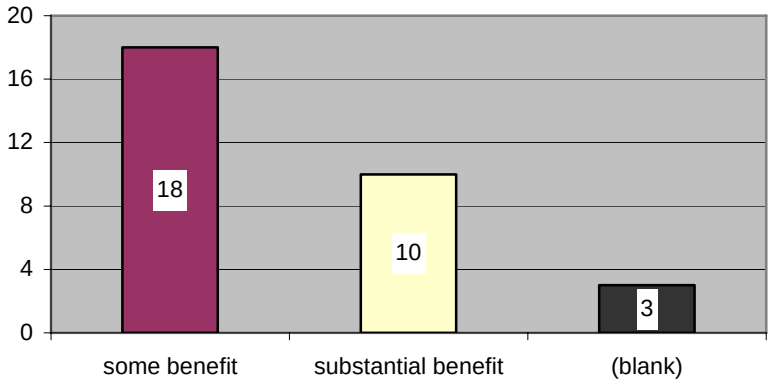
○ no benefit ○ some benefit ○ substantial benefit



**Question 76. Which of the following technologies should be further explored to assist in data access (for reporting, entry of additional data, validation, trending):**

**- electronic data mining technology**

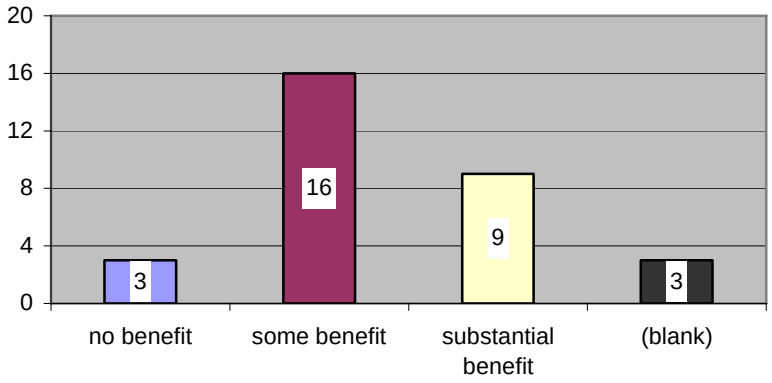
○ no benefit ○ some benefit ○ substantial benefit




**Question 77. Which of the following technologies should be further explored to assist in data access (for reporting, entry of additional data, validation, trending):**

**- "Rosetta stone" (translation key) technology**

○ no benefit ○ some benefit ○ substantial benefit




**Question 78. If there is another technology that should be explored to assist in data access (for reporting, entry of additional data, validation, trending), please enter it here, then rate the level of benefit in the next question.**

- See answers to following question for responses to this question

**Question 79. How much benefit would be gained by further exploring how the technology you specified in the previous question can assist in data access?**

○ no benefit ○ some benefit ○ substantial benefit

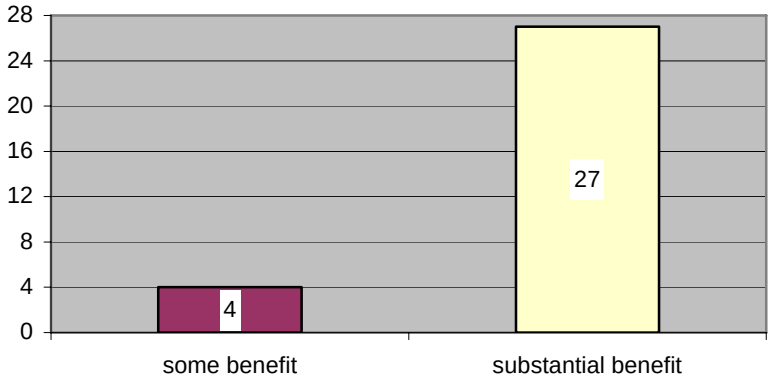
- Standards for data formats and data access. Or at least, standards and requirements for moving to new technologies so no data becomes inaccessible because of an outdated format. – substantial benefit
- Automated software/database system upgrade. – substantial benefit

- If use electronic storage media must find a way to continuously update it to ensure technology doesn't become obsolete and the data irretrievable. – substantial benefit
- If a professional data management company is used, their interests. – substantial benefit
- No technology specified. – substantial benefit
- The items 70 through 77 seem to deal with the hardware "aspects" of technology. I think the emphasis should be on the standardization for files maintenance and formatting, whether electronic or other. As well the "Rosetta Stone" concept applies to all records. For example, an acronym list is a simple Rosetta Stone, needed to interpret government documents even in real time. Rosetta Stones for the future will have to account for etymology and technology as well as acronyms. To a degree we are creating artifacts for the future with an intended purpose. – substantial benefit
- News or mass communication abilities. – substantial benefit

**Question 80. In what modes do you anticipate the public having access to data from LTS monitoring & historical records:**

**- the Web**

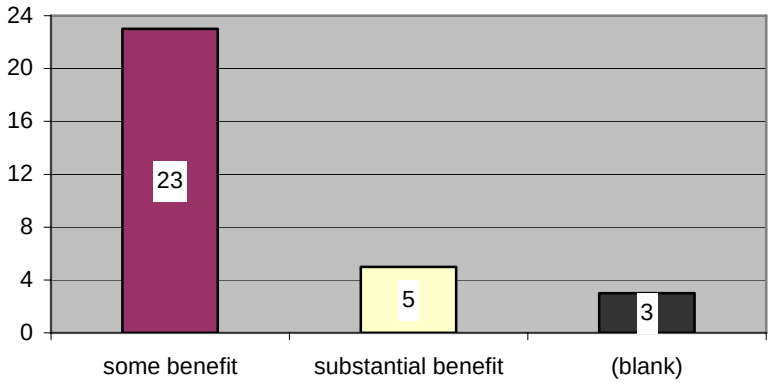
○ no benefit ○ some benefit ○ substantial benefit



**Question 81. In what modes do you anticipate the public having access to data from LTS monitoring & historical records:**

**- non-Web interactive**

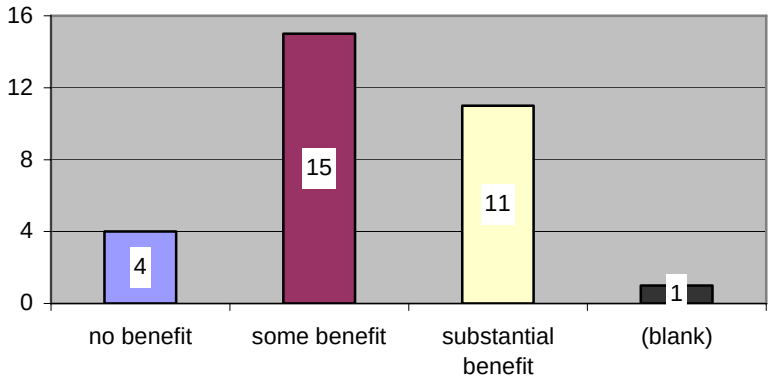
○ no benefit ○ some benefit ○ substantial benefit




**Question 82. In what modes do you anticipate the public having access to data from LTS monitoring & historical records:**

**- paper**

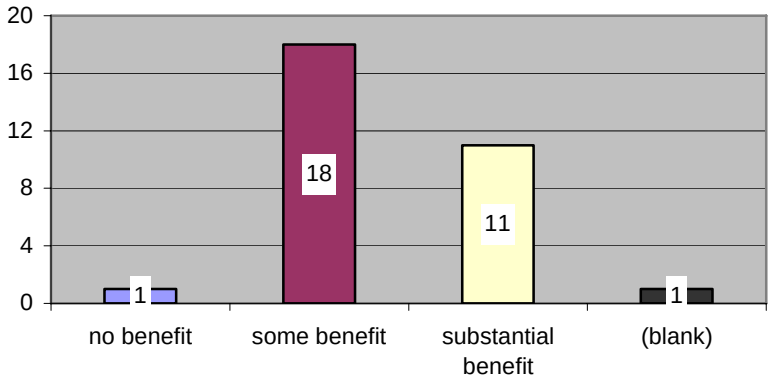
○ no benefit ○ some benefit ○ substantial benefit



**Question 83. In what modes do you anticipate the public having access to data from LTS monitoring & historical records:**

**- CD**

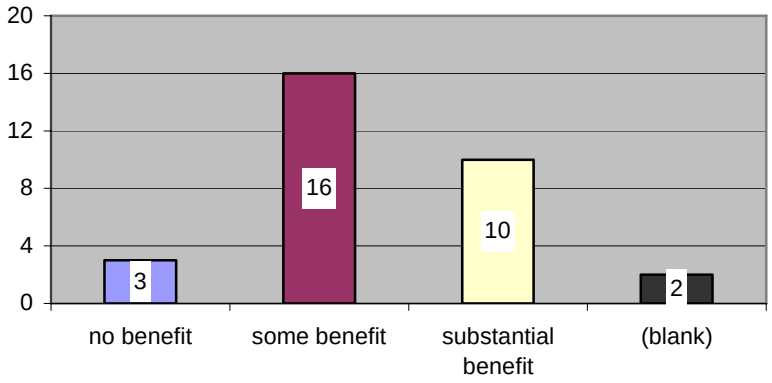
○ no benefit ○ some benefit ○ substantial benefit




**Question 84. In what modes do you anticipate the public having access to data from LTS monitoring & historical records:**

**- video**

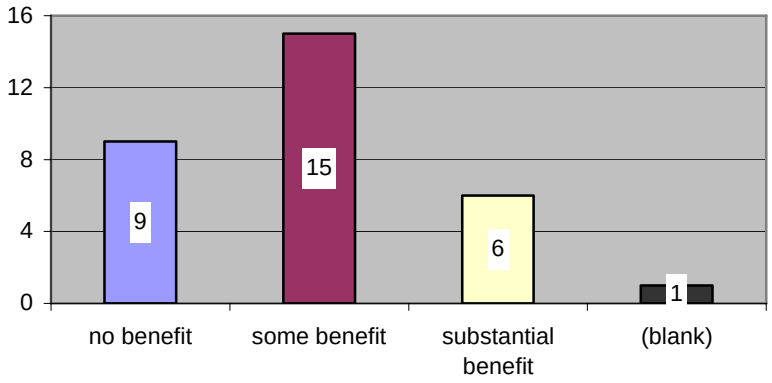
○ no benefit ○ some benefit ○ substantial benefit



**Question 85. In what modes do you anticipate the public having access to data from LTS monitoring & historical records:**

**- audio**

○ no benefit ○ some benefit ○ substantial benefit




**Question 86. If there is another mode by which the public could have access to data from LTS monitoring and historical records, please enter it here, then rate the level of benefit in the next question.**

- See answers to following question for responses to this question

**Question 87. If the public had access to data from LTS monitoring and historical records via the mode you specified in the previous question, how much benefit would be gained?**

○ no benefit ○ some benefit ○ substantial benefit

- (No mode specified) – some benefit
- Who knows what the state-of-the-art data storage media will be when SRS closes. But I'm sure it won't be CDs or even DVDs. – (no rating)
- Public meetings or presentations. – substantial benefit
- (No mode specified) – some benefit
- Oral history. – some benefit
- I think the best way to keep the public informed and to retain knowledge for LTS is to have an on-site education/museum facility where records are maintained and education is continuous. – substantial benefit
- Access to knowledgeable people. – substantial benefit
- Electronic transfer/modem. – some benefit
- The public that needs information presented clearly are often the ones without access to computer technology. As well a great many people simply are not in the "loop" with no time for family life and tracking environmental issues. I think mass media communications especially TV shows help a lot. From then the oral communication can grow, and a great amount of information is passed between friends and neighbors. I think information campaigns on closure sites are valuable to get an "oral tradition" kicked off and an oral history started in the communities as well as increased interest. – substantial benefit
- Mass communication. – substantial benefit

**Question 88. Does your state have a centralized listing or database of those areas with LTS obligations? If yes, please briefly describe the system. How successful (user friendly, current) is the system in your experience?**

- No (11 respondents)
- To a certain degree. An state institutional control covenants law that was passed last year requires that this division maintains records on sites with residual contamination where such an environmental covenant has been granted.
- Restrictive covenants on deeds and typical regulatory files. No statewide listing system.
- REGISTRY. The system provides a brief history/issues/status of the site and is review on an annual basis.
- Yes, to the extent that they remain on our state's hazardous sites list.
- Not to my knowledge.
- No, not for all sites in one data base. But for an individual site you can get that information easily through FOIA.
- No such system in Ohio.
- We have recently started a system based on our environmental covenant law. Too soon to tell how well it works.
- No, the filing system is only as good as you reference it.
- Not yet!
- Good question.
- The Colorado Environmental Covenants Act (2001) created registry of all properties which require use restrictions. The format and access for this registry have not yet been finalized, to my knowledge.
- Yes. Documents received are entered into a database for easy identification and recovery. Staff find it easy to use. Not available for public access. Questions should be directed to: Cris Pretko in the Records Center, 303-692-3312
- Not at this time.
- Maybe ORIES? OK as far as friendly. State has IRIS system that is not operational at this time.
- Not comprehensive. Some exists in separate systems.

**Question 89. Does your state have a central point of contact for all LTS activities occurring within the State? If yes, in which department is the position located?**

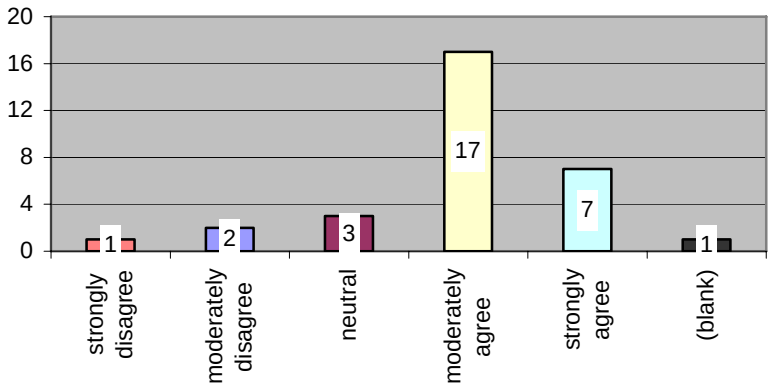
- No (16 respondents)
- For all practical purposes, this division is the central point concerning long-term stewardship of contaminated sites, although to my knowledge that hasn't been established by statute.
- not really
- None officially designated. Designee of either DOE Oversight or Hazardous Waste Bureau Chiefs most likely (for DOE sites).
- No central LTS contact. We have centralized dealings with DOE but no one specifically for LTS. And certainly not one for all LTS issues in the state.
- LTS is a new concept with this state and no centralized location is in place with the exception of Superfund sites.
- Possibly the TDEC Division of Superfund in Nashville.
- Not yet!

- For Superfund Statewide. Frank Grubbs with the Division of Superfund.
- Probably Ohio EPA would be the primary central point of contact for the State of Ohio, but a centralized system has not been created.
- Department of Public Health & Environment
- No. LTS activities are project specific and handled by individual project managers. Records are centrally located and the individual responsible for their management is Cris Pretko in the Records Center, 303-692-3312.
- Don't know.

**SURVEY SECTION 5: LAND USE CONTROLS (LUCS) AND INSTITUTIONAL CONTROLS (IC) (QUESTIONS 90–123)**

**Question 90. Section 5: Land Use and Institutional Controls**
**Technology is essential to the successful utilization of land use and institutional controls.**

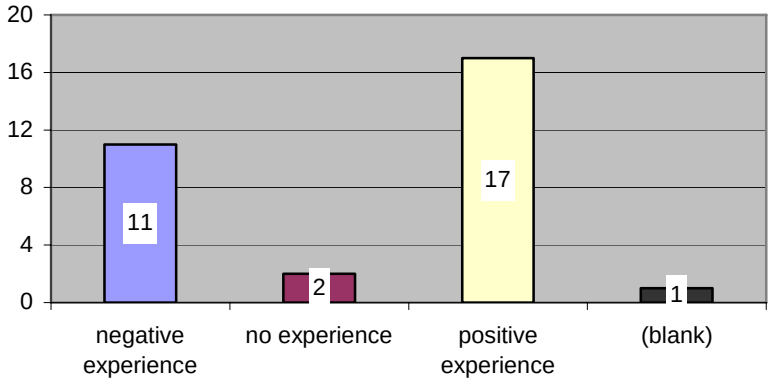
○ strongly disagree ○ moderately disagree ○ neutral
○ moderately agree ○ strongly agree




**Question 91. Please indicate your experience with each of the following land use and institutional controls:**

**- signs**

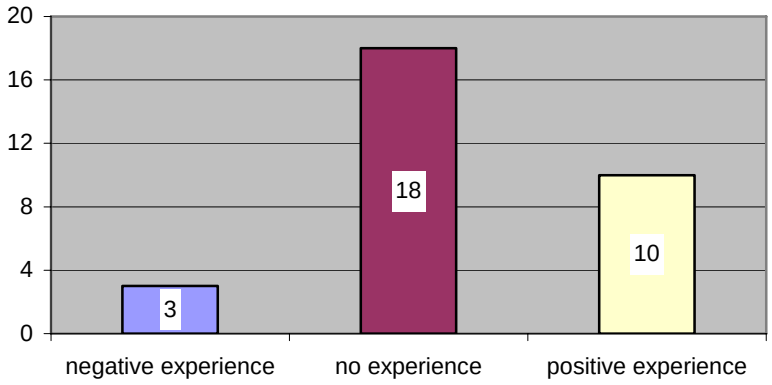
○ negative experience ○ no experience ○ positive experience



**Question 92. Please indicate your experience with each of the following land use and institutional controls:**

**- monuments**

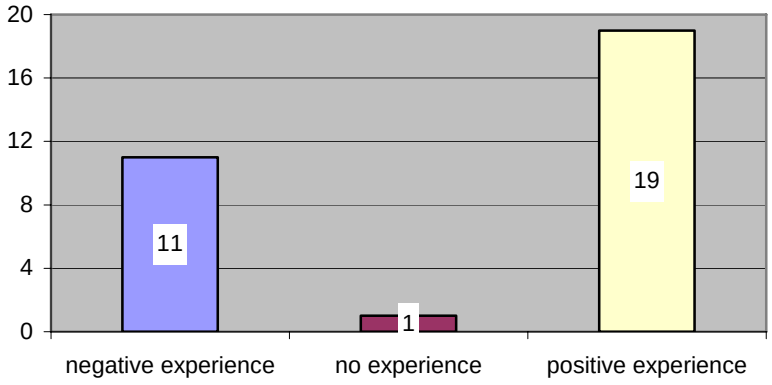
○ negative experience ○ no experience ○ positive experience




**Question 93. Please indicate your experience with each of the following land use and institutional controls:**

**- fences**

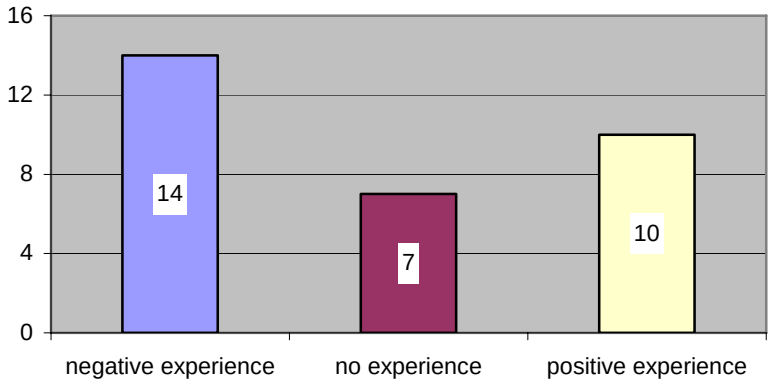
○ negative experience ○ no experience ○ positive experience



**Question 94. Please indicate your experience with each of the following land use and institutional controls:**

**- deed restrictions**

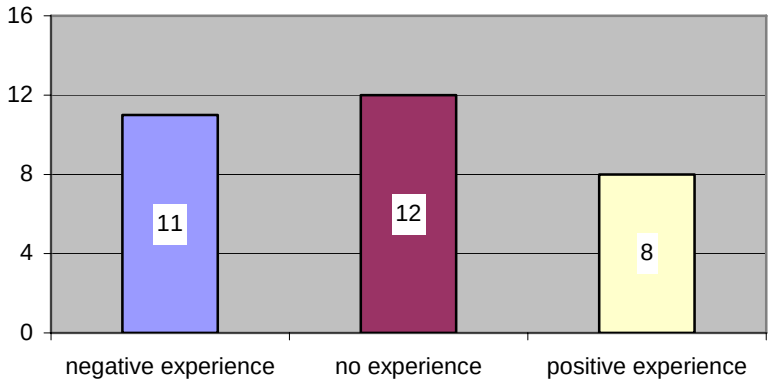
○ negative experience ○ no experience ○ positive experience




**Question 95. Please indicate your experience with each of the following land use and institutional controls:**

**- zoning, ordinances, statutes**

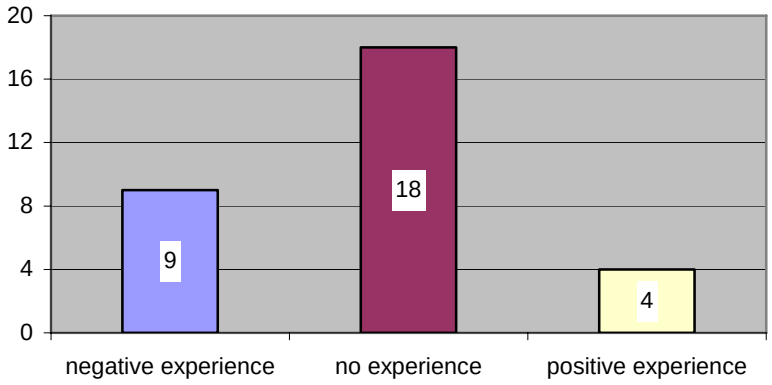
○ negative experience ○ no experience ○ positive experience



**Question 96. Please indicate your experience with each of the following land use and institutional controls:**

**- building codes**

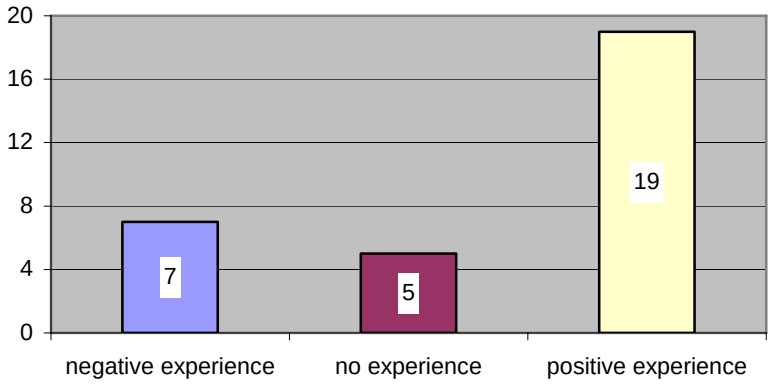
○ negative experience ○ no experience ○ positive experience




**Question 97. Please indicate your experience with each of the following land use and institutional controls:**

**- easements, covenants**

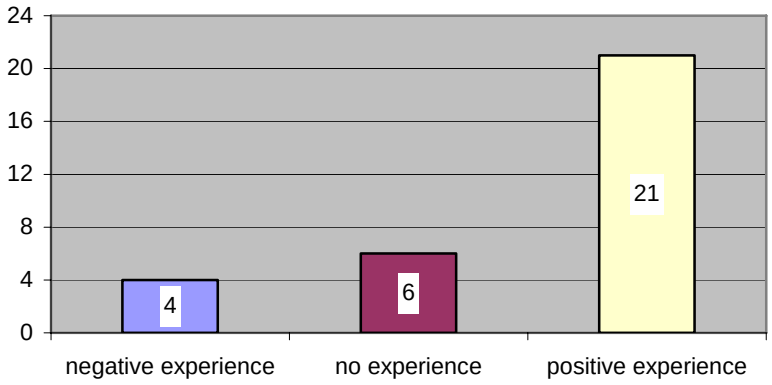
○ negative experience ○ no experience ○ positive experience



**Question 98. Please indicate your experience with each of the following land use and institutional controls:**

**- permits, consent decrees**

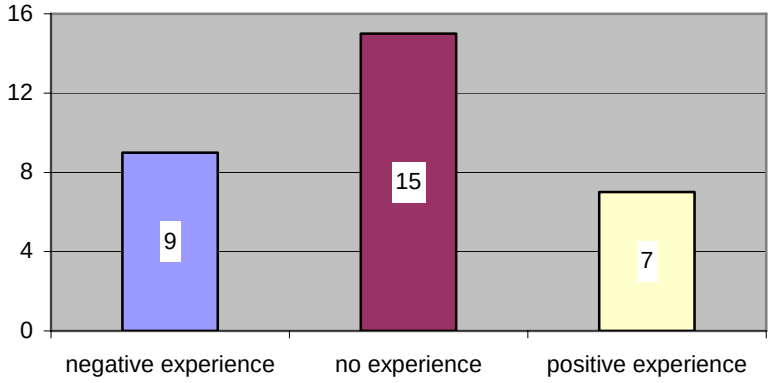
○ negative experience ○ no experience ○ positive experience




**Question 99. Please indicate your experience with each of the following land use and institutional controls:**

**- lease restrictions**

○ negative experience ○ no experience ○ positive experience




**Question 100. If you have had experience with another land use and institutional control, please enter it here, then rate your experience in the next question.**

- See answers to following question for responses to this question

**Question 101. Please indicate your experience with the land use and institutional control you specified in the previous question.**

○ negative experience ○ no experience ○ positive experience

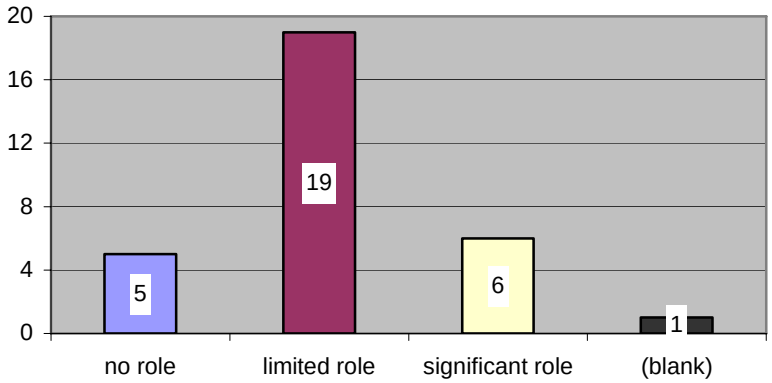
- Voluntary cleanup contracts or Brownfields agreements. – positive experience
- REGISTRY. – positive experience
- All of the above have their uses and limitations, but can be effective layers of protection. – (rating not applicable)

- Fishing advisories and ICs on sediment disturbance in Watts Bar Reservoir and tributaries. – positive experience

**Question 102. Can technology improve the effectiveness of each of the following land use and institutional controls (*For example, a fence that signals when it is pushed down*):**

**- signs**

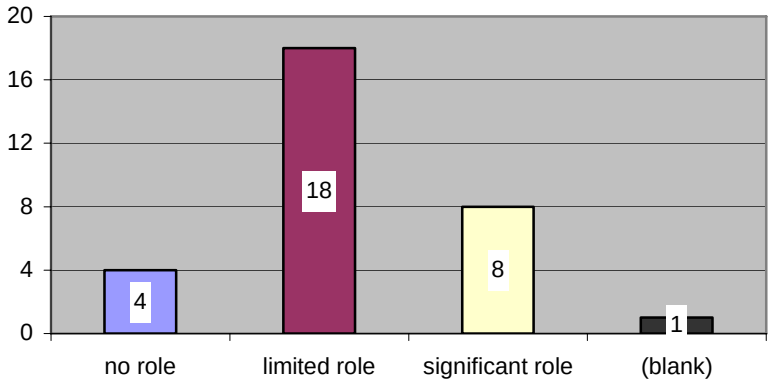
○ no role ○ limited role ○ significant role




**Question 103. Can technology improve the effectiveness of each of the following land use and institutional controls (*For example, a fence that signals when it is pushed down*):**

**- fences**

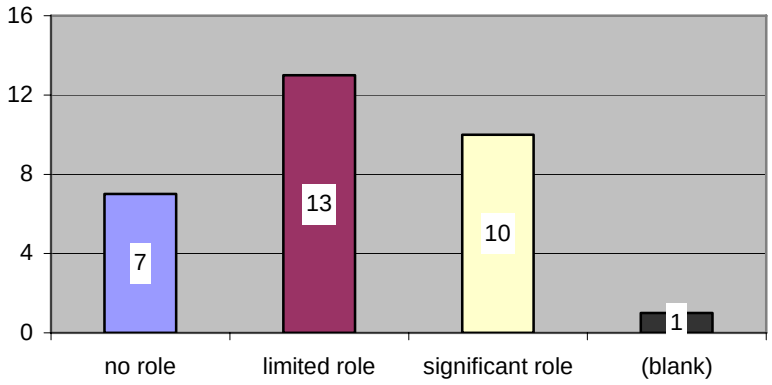
○ no role ○ limited role ○ significant role



**Question 104. Can technology improve the effectiveness of each of the following land use and institutional controls (*For example, a fence that signals when it is pushed down*):**

**- deed restriction**

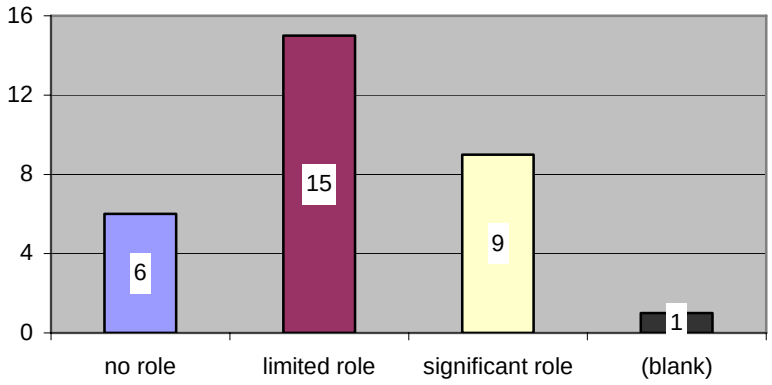
○ no role ○ limited role ○ significant role




**Question 105. Can technology improve the effectiveness of each of the following land use and institutional controls (*For example, a fence that signals when it is pushed down*):**

**- zoning**

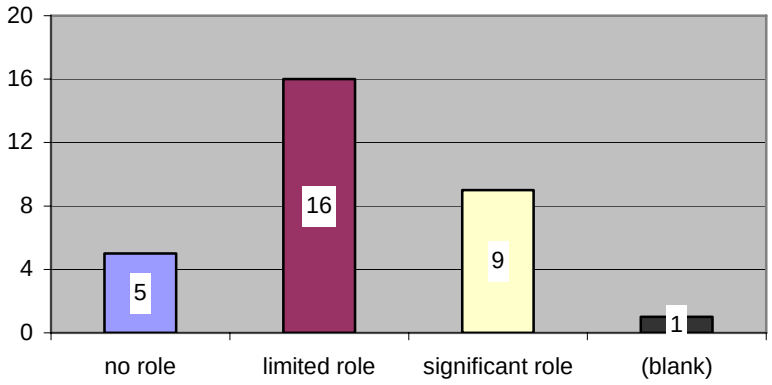
○ no role ○ limited role ○ significant role



**Question 106. Can technology improve the effectiveness of each of the following land use and institutional controls (*For example, a fence that signals when it is pushed down*):**

**- easements**

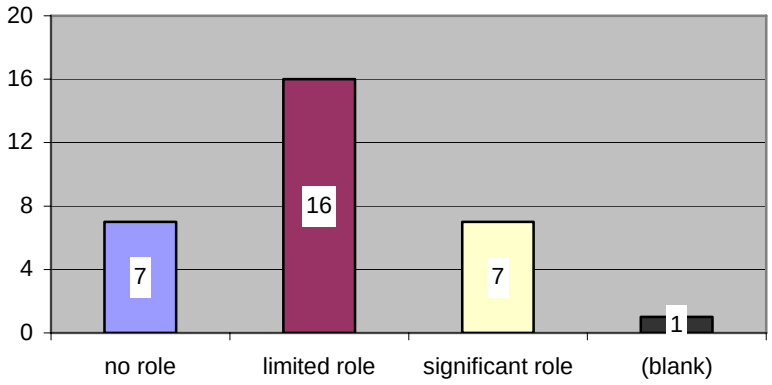
○ no role ○ limited role ○ significant role




**Question 107. Can technology improve the effectiveness of each of the following land use and institutional controls (*For example, a fence that signals when it is pushed down*):**

**- lease restrictions**

○ no role ○ limited role ○ significant role




**Question 108. If there is another land use and institutional control whose effectiveness could be improved by technology, please enter it here, then rate the role technology could play in the next question.**

- **See answers to following question for responses to this question**

**Question 109. Please indicate what role technology could play in improving the effectiveness of the land use and institutional control you specified in the previous question.**

○ no role ○ limited role ○ significant role

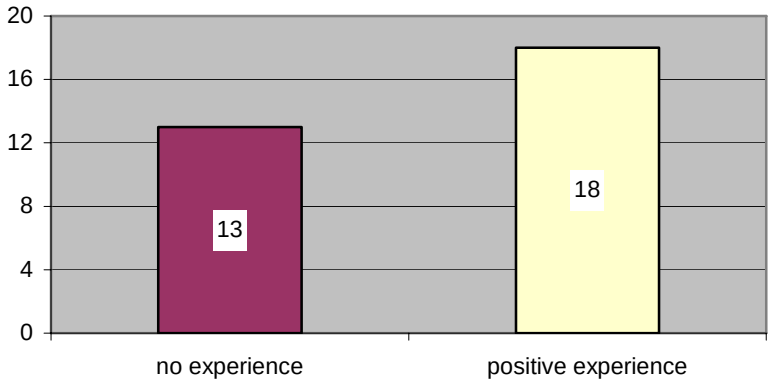
- Add the electronic coordinates of the area where the land use controls are necessary to the database (one call program) that contain easements and restrictive covenants. So if a person calls to have someone check for water lines, gas lines, etc., they would also be notified that an area of the property exists where land use restrictions exist. – significant role

- Oral history of Native Americans (tribal nations). – limited role
- Use of such a system as Call Before You Dig seem to have shown some level of effectiveness over time. – significant role
- Land use controls that work with wildlife. For example to keep deer and geese from being contaminated and becoming a pathway to humans. I am not certain that Oak Ridge cleanups will eliminate contamination in wildlife. Currently harvested game is screened and confiscated if found to be contaminated. – significant role
- Yeah, develop a technology that removes greed from people in power. – significant role

**Question 110. Please indicate your experience with each of the following approaches to increasing awareness of land use and institutional controls.**

**- on-site museum/educational facilities**

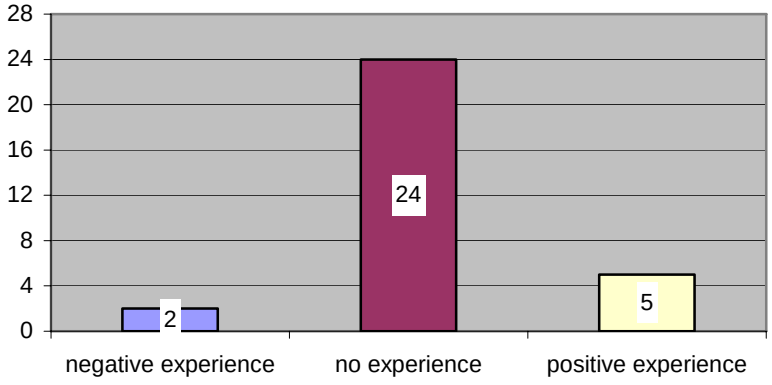
○ negative experience ○ no experience ○ positive experience




**Question 111. Please indicate your experience with each of the following approaches to increasing awareness of land use and institutional controls.**

**- computer/database links for deed restrictions**

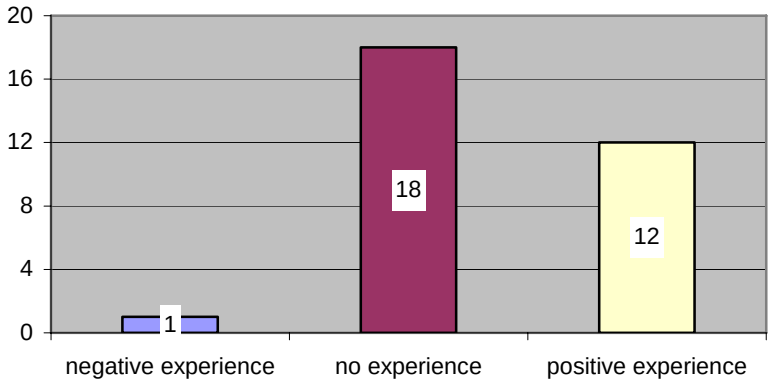
○ negative experience ○ no experience ○ positive experience



**Question 112. Please indicate your experience with each of the following approaches to increasing awareness of land use and institutional controls.**

**- school programs**

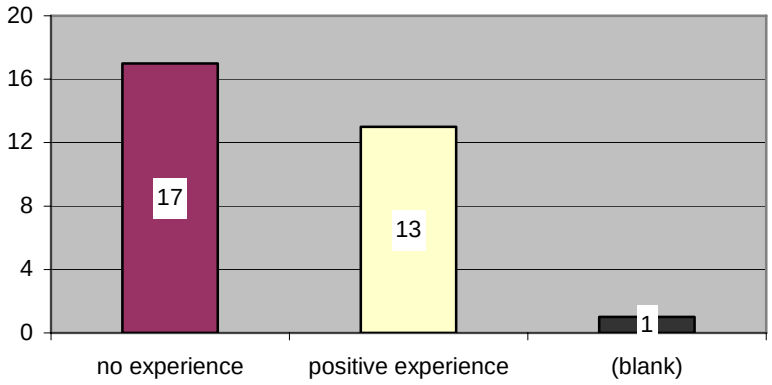
○ negative experience ○ no experience ○ positive experience




**Question 113. Please indicate your experience with each of the following approaches to increasing awareness of land use and institutional controls.**

**- community education classes**

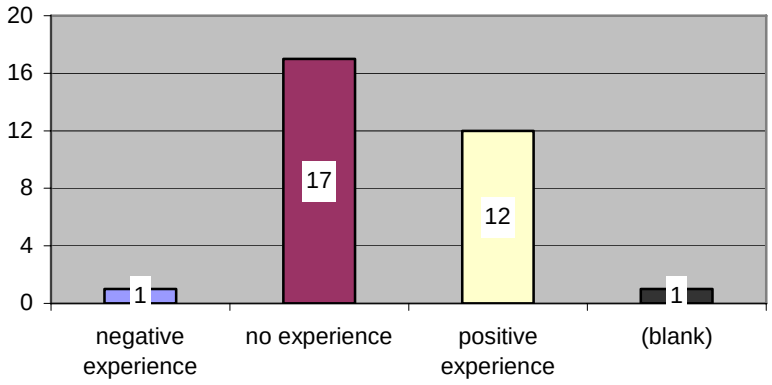
○ negative experience ○ no experience ○ positive experience



**Question 114. Please indicate your experience with each of the following approaches to increasing awareness of land use and institutional controls.**

**- continued scientific studies**

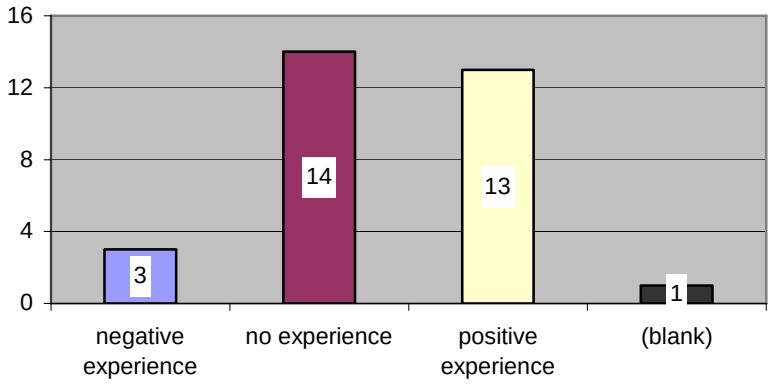
○ negative experience ○ no experience ○ positive experience




**Question 115. Please indicate your experience with each of the following approaches to increasing awareness of land use and institutional controls.**

**- multiple public uses for sites**

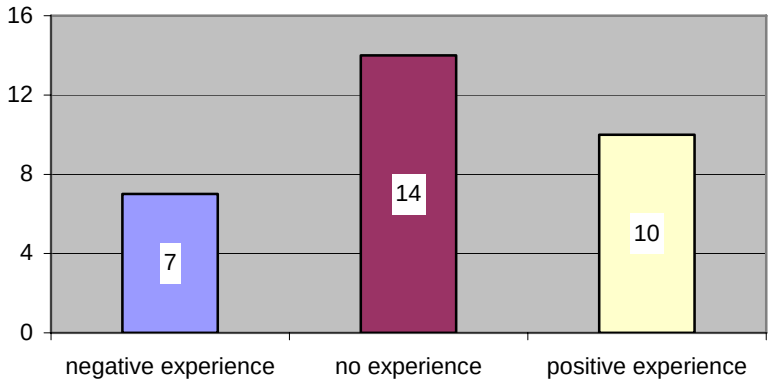
○ negative experience ○ no experience ○ positive experience



**Question 116. Please indicate your experience with each of the following approaches to increasing awareness of land use and institutional controls.**

**- multiple private industry uses for sites**

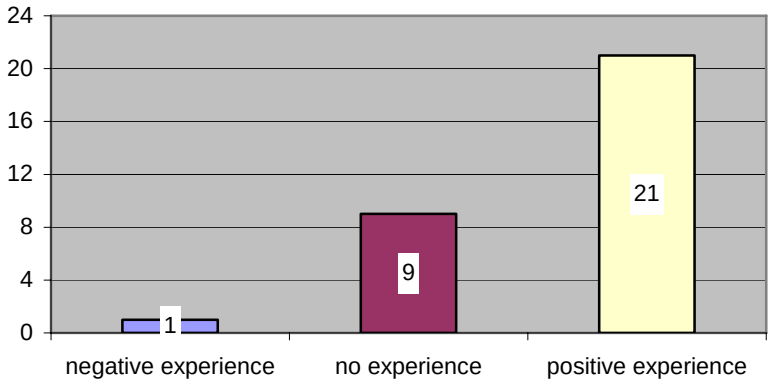
○ negative experience ○ no experience ○ positive experience




**Question 117. Please indicate your experience with each of the following approaches to increasing awareness of land use and institutional controls.**

**- continued government use of sites**

○ negative experience ○ no experience ○ positive experience




**Question 118. If you have experience with another approach to increasing awareness of land use and institutional controls, please enter it here, then rate your experience in the next question.**

- See answers to following question for responses to this question

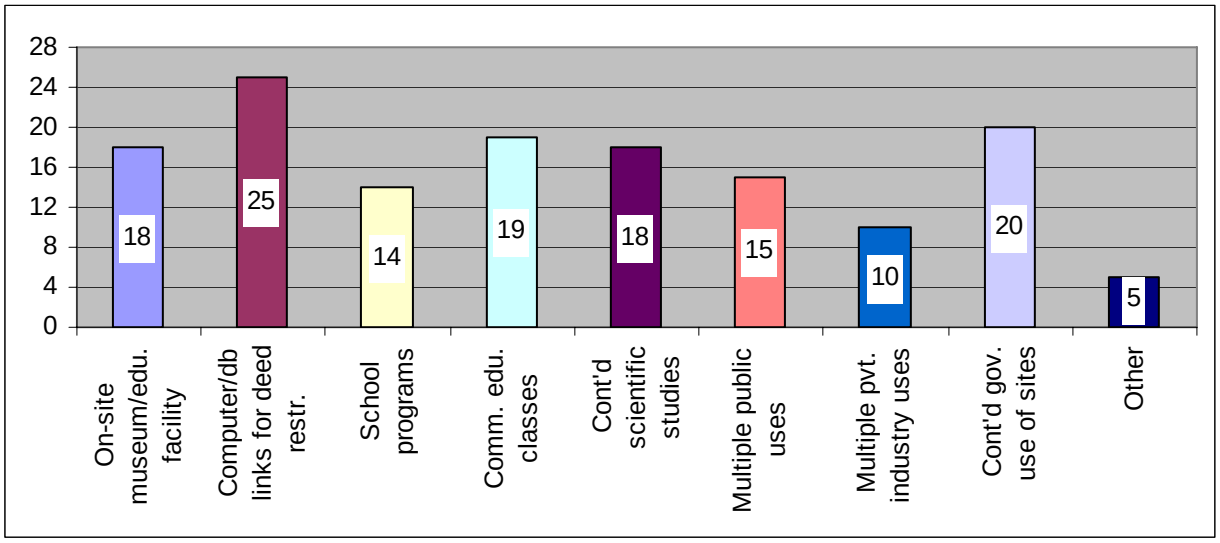
**Question 119. Please indicate your experience with the approach to increasing awareness of land use and institutional controls that you specified in the previous question.**

○ negative experience ○ no experience ○ positive experience

- Tribal use of lands. – positive experience
- Public meetings to discuss land use and future development. – positive experience
- Getting EPA involved by sharing data. – positive experience

**Question 120. Which of the following elements should be included in a comprehensive program to ensure long-term awareness of land use and institutional controls? (*Please select all that apply*)**

☐ On-site museum/educational facility ☐ Computer/database links for deed restrictions ☐ School programs ☐ Community education classes ☐ Continued scientific studies ☐ Multiple public uses for sites ☐ Multiple private industry uses for sites ☐ Continued government use of sites ☐ Other




**Question 121. If you checked "Other" above, please enter the element that should be included.**

- Adding site information to the one call system as I described above.
- Note: The elements needed depend on the size and type of site. For example, continued government use/presence are needed at large sites like SRS.
- Continued tribal use of lands.
- Community awareness needs to be stressed through a variety of communication strategies over time. Local responsibility for communications with external oversight.
- TV programs and announcements on TV like the antismoking or -drug spots.
- Computer/database links for government agencies on limitations that are more than deed restrictions, e.g., ties to planning and zoning processes, building permits

**Question 122. If possible, provide examples of land use and institutional controls that have or have not been effective.**

- The experience I have had is with deed restrictions and zoning controls at the local government level and they have been a disaster. Land that was used for "dumps" within 10 years had been built over with all associated problems. Zoning ordinances fall to political and economic pressures. Fencing and signs are torn down and require continual replacement. Once land passes through a few owners, restrictions are lost or misunderstood. Due to court backlogs judicial system places very low priority on taking violators to court so legal options are limited.
- Colorado passed a law that created an environmental covenant as a mechanism for enforcing land use restrictions. Since deed restrictions and zoning cannot be enforced by the

environmental agency and can be changed without their concurrence, the environmental covenant is a more reliable way to control future land use.

- At sites where remedies have not yet been selected. Very few sites have interim land use controls that are in place until remedy is selected.
- I've certainly heard of cases in other states with land use controls have failed. It is too early to determine whether our new state environmental covenants law will prove to be effective. We believe that it will be effective.
- Signs are ignored.
- Fences and signs that are not routinely monitored and repaired.
- Signs to prevent fishing and/or trespassing are typically destroyed or removed
- Effective: Environmental covenants tied to deed. Federal government control (access or management).
- The land use controls effectiveness will be available in next 5–10 years as it is too early to see the effectiveness.
- Oak Ridge has a pretty good list of failed LUCs. If I remember right from stolen signs to within a couple months of transfer with a deed restriction against use of groundwater wells were drilled on site.
- Controls are only good when actively monitored and maintained (e.g., fences and signs fall down and are breached)
- Signs and fences are seen to be effective for only a short period of time!
- Security personnel and fences are effective; everybody stays out.
- I am aware of examples of failures of virtually every type of land use or institutional controls. I believe that the best chance to have them succeed is through several layers of redundancy.
- Too early to tell.
- Environmental covenants.
- Not useful: deed restrictions, zoning.
- Have not: Giving away land. Footprint reduction.
- Deed restrictions with no enforceability.

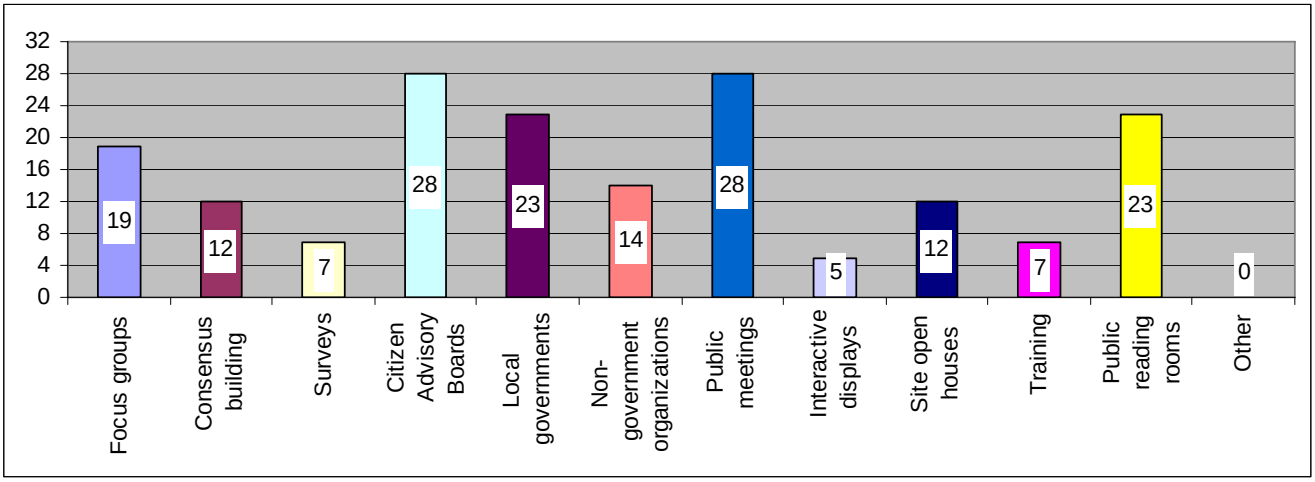
**Question 123. How can the processes/activities associated with ensuring awareness of land use and institutional controls be improved or simplified?**

- Adequate funding to maintain a physical presence and operating and maintenance. Dedicated government or "monument" style controls to continue to provide education and information on hazards.
- There has to be legal mechanisms in place that can make institutional controls enforceable.
- Standard formats for data and data accessibility.
- State statutes authorizing enforcement of land use restrictions.
- Definitely need layers of land use controls. Also the conflict of interest between development folks and those trying to implement LUCs presents a difficult challenge.
- Involve the public and users of the land as much as they will allow!
- Determine land use suitability and a percentage to be released for recreational, industrial, and residential purposes.
- Continuous education and a combination of various tools identified by the above questions.
- Use of layers can improve the probability of success.

- Maintenance of deed restrictions so they do not expire and periodic mailings to property owners so they are reminded. Short-term hazards are suitable for fences for a few years in the case of attenuation sites. Perpetual sites should simply be cleaned up and wastes treated and/or geologically disposed and separated from the biosphere.
- They can be improved by assuring that there are multiple protections and multiple methods of awareness.
- Layered or redundant methods that are integrated into many approaches.
- Central (state-wide) registry of current land use controls.
- It cannot be. You must do some work, maybe a considerable amount of work. Having funding and support to do LTS.
- Data access.

## SURVEY SECTION 6: DECISION-MAKING (QUESTIONS 124–160)

**Question 124. Section 6: Decision Making**
**Which of the following communication processes do you currently use to get local community, tribal, and state values factored into the LTS decision-making process?**
☐ Focus groups ☐ Consensus building ☐ Surveys ☐ Citizen Advisory Boards ☐ Local governments ☐ Nongovernment organizations ☐ Public meetings ☐ Interactive displays ☐ Site open houses ☐ Training ☐ Public reading rooms ☐ Other

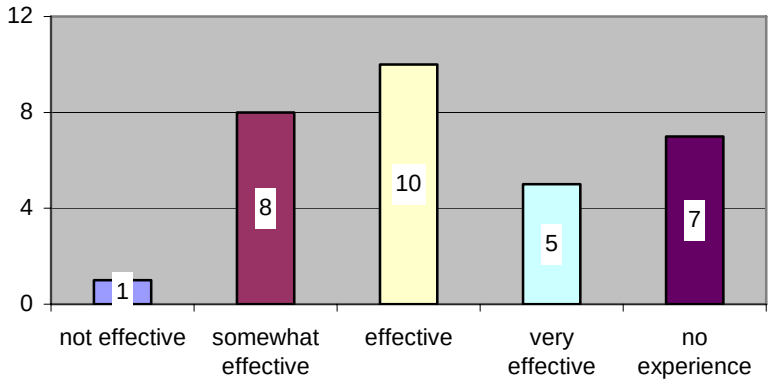



**Question 125. If you checked "Other" above, please enter the name of the communication process.**
- Newsletters, articles in periodical magazines.

**Question 126. Please rate the effectiveness of each of the following communication processes in getting local community, tribal, and state values factored into the LTS decision-making process.**

**- focus groups**

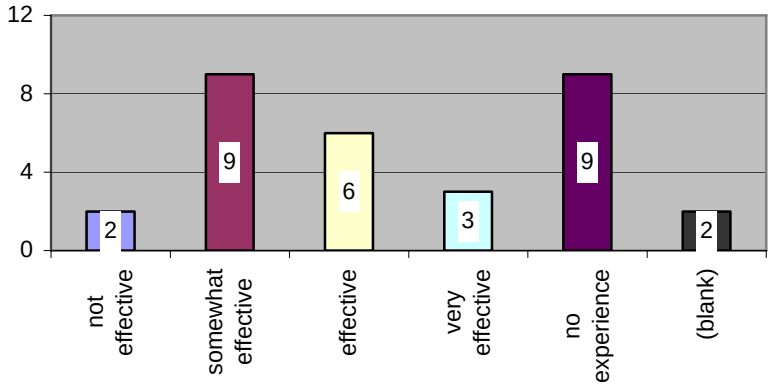
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience




**Question 127. Please rate the effectiveness of each of the following communication processes in getting local community, tribal, and state values factored into the LTS decision-making process.**

**- consensus building**

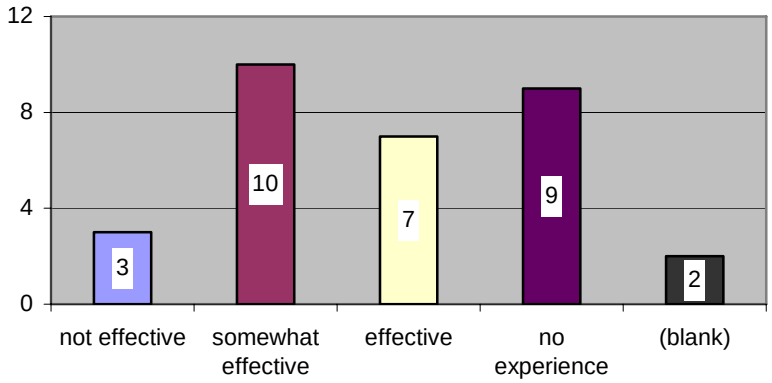
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience



**Question 128. Please rate the effectiveness of each of the following communication processes in getting local community, tribal, and state values factored into the LTS decision-making process.**

**- surveys**

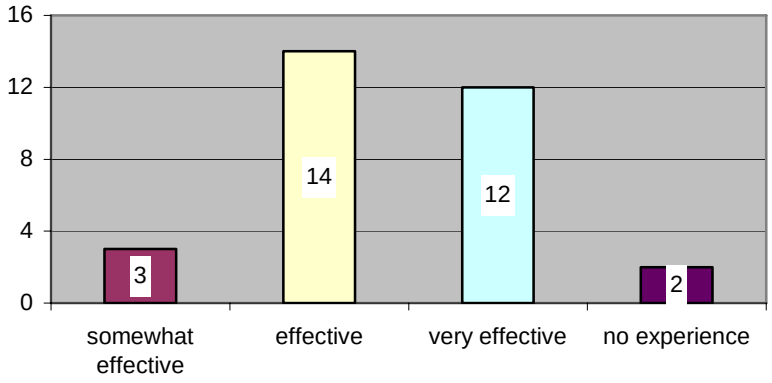
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience




**Question 129. Please rate the effectiveness of each of the following communication processes in getting local community, tribal, and state values factored into the LTS decision-making process.**

**- citizen advisory boards**

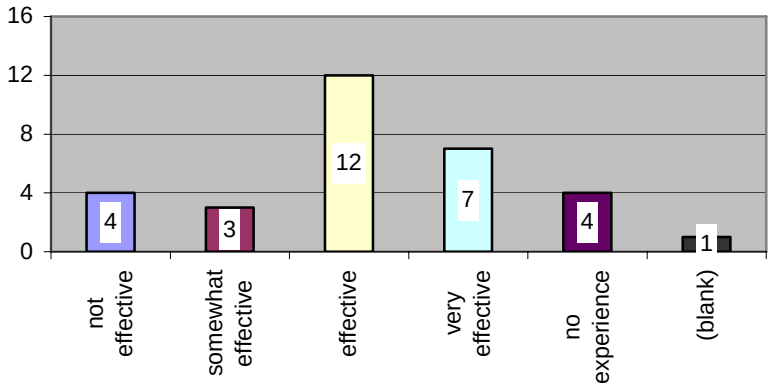
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience



**Question 130. Please rate the effectiveness of each of the following communication processes in getting local community, tribal, and state values factored into the LTS decision-making process.**

**- local governments**

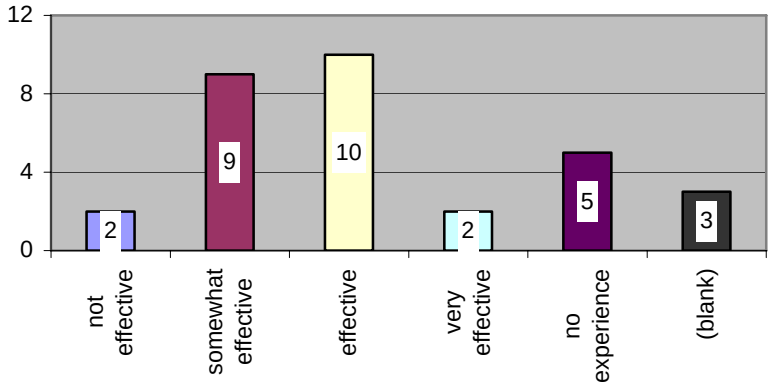
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience




**Question 131. Please rate the effectiveness of each of the following communication processes in getting local community, tribal, and state values factored into the LTS decision-making process.**

**- nongovernment organizations**

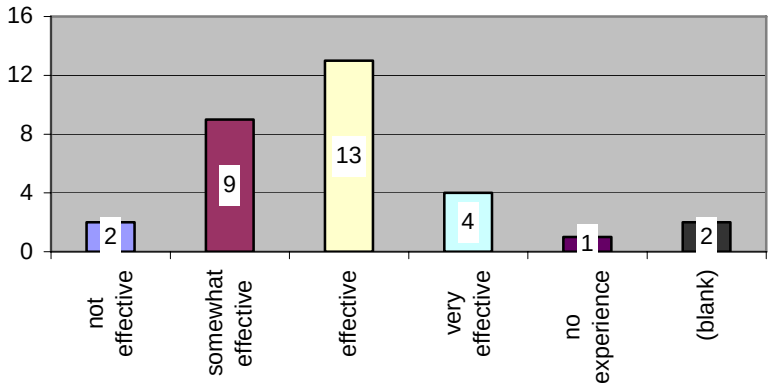
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience



**Question 132. Please rate the effectiveness of each of the following communication processes in getting local community, tribal, and state values factored into the LTS decision-making process.**

**- public meetings**

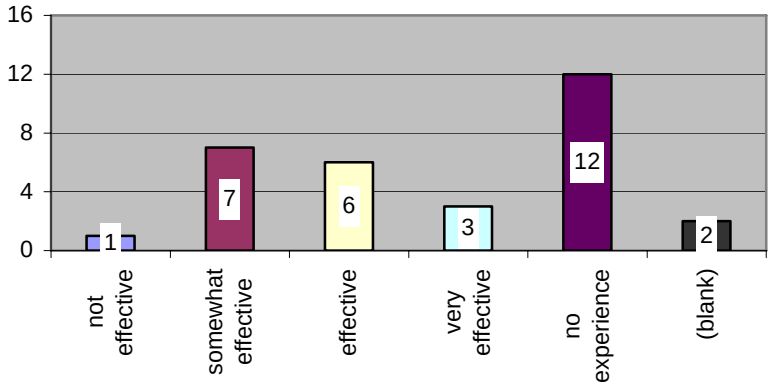
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience




**Question 133. Please rate the effectiveness of each of the following communication processes in getting local community, tribal, and state values factored into the LTS decision-making process.**

**- interactive displays**

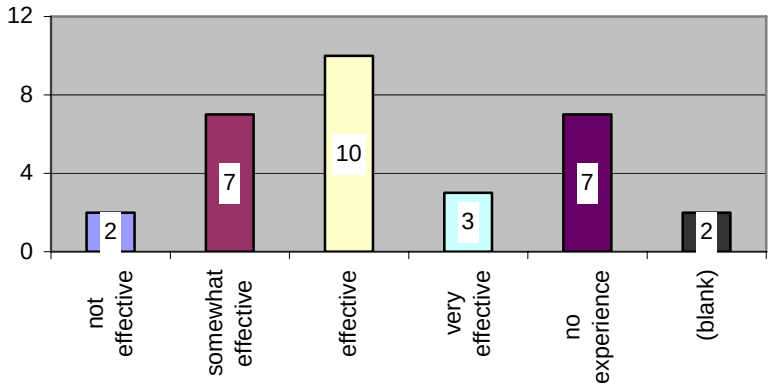
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience



**Question 134. Please rate the effectiveness of each of the following communication processes in getting local community, tribal, and state values factored into the LTS decision-making process.**

**- site open houses**

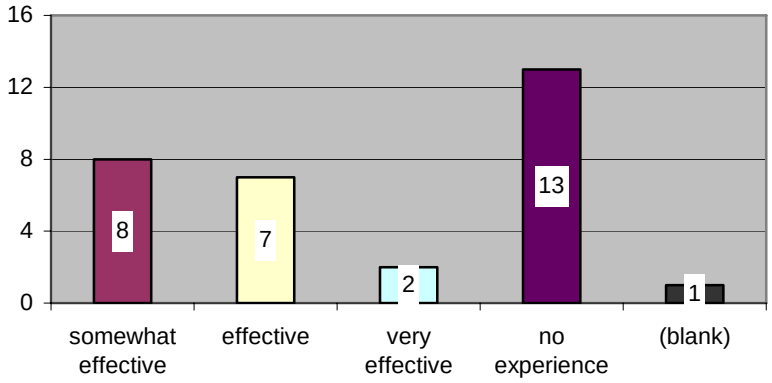
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience




**Question 135. Please rate the effectiveness of each of the following communication processes in getting local community, tribal, and state values factored into the LTS decision-making process.**

**- training**

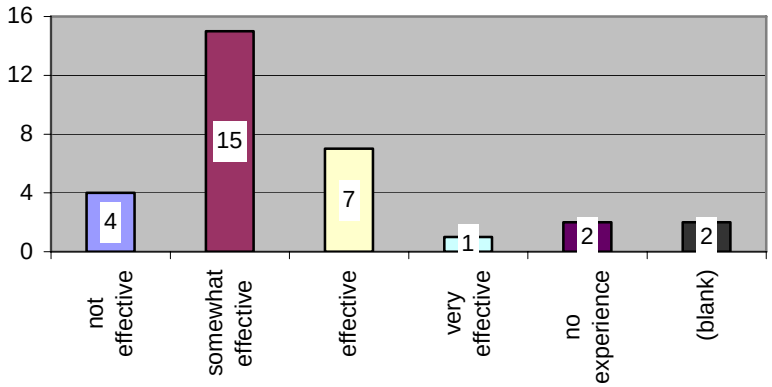
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience



**Question 136. Please rate the effectiveness of each of the following communication processes in getting local community, tribal, and state values factored into the LTS decision-making process.**

**- public reading rooms**

○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience




**Question 137. If you would like to rate the effectiveness of another communication process in getting local community, tribal, and state values factored into the LTS decision-making process, please enter it here, then rate its effectiveness in the next question.**

- See answers to following question for responses to this question

**Question 138. Please rate the effectiveness of the communication process you specified in the previous question in getting local community, tribal, and state values factored into the LTS decision-making process.**

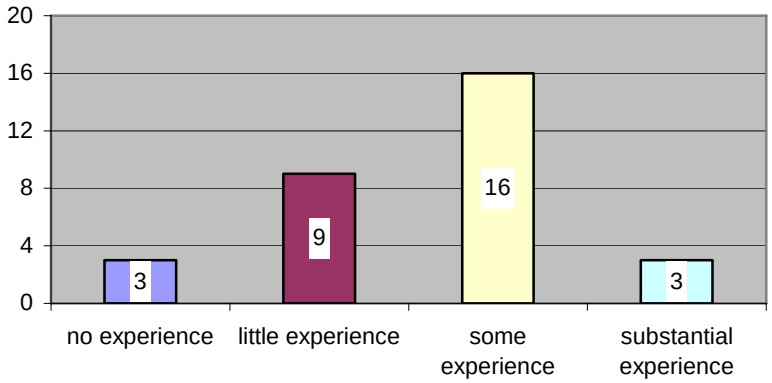
○ not effective ○ somewhat effective ○ effective ○ very effective ○ no experience

- See question 125. – effective
- Web-based information. – somewhat effective
- Getting community values factored into the process is not a function of communicating with stakeholders; we can do that already. The hard part is getting the decision makers, particularly DOE, to value community values. – (no rating)
- Web sites dedicated to the subject. – effective

**Question 139. What is your experience with these approaches to decision making for selecting land use/institutional controls (e.g. zoning):**

**- inclusion of value judgment studies (e.g. risk perception/community values)**

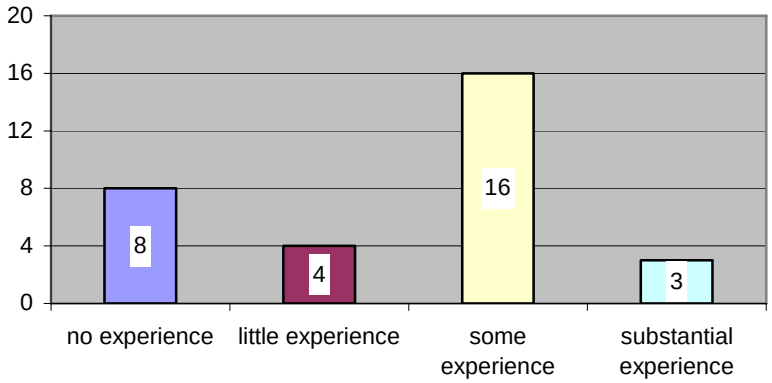
○ no experience ○ little experience ○ some experience ○ substantial experience




**Question 140. What is your experience with these approaches to decision making for selecting land use/institutional controls (e.g. zoning):**

**- structured consensus-building process**

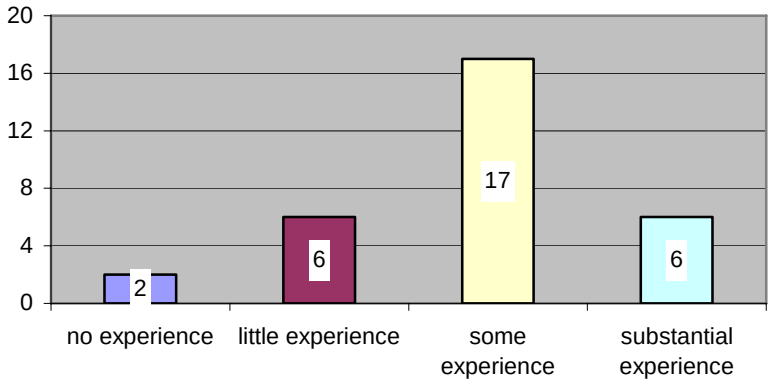
○ no experience ○ little experience ○ some experience ○ substantial experience



**Question 141. What is your experience with these approaches to decision making for selecting land use/institutional controls (e.g. zoning):**

**- graphical/visual presentation of data**

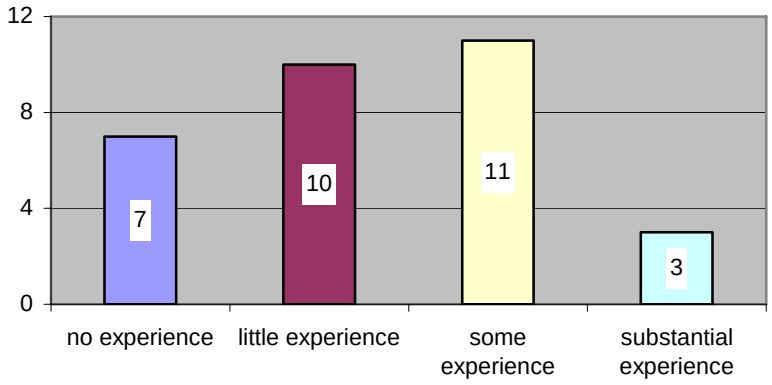
○ no experience ○ little experience ○ some experience ○ substantial experience




**Question 142. What is your experience with these approaches to decision making for selecting land use/institutional controls (e.g. zoning):**

**- models capable of running "what-if" scenarios**

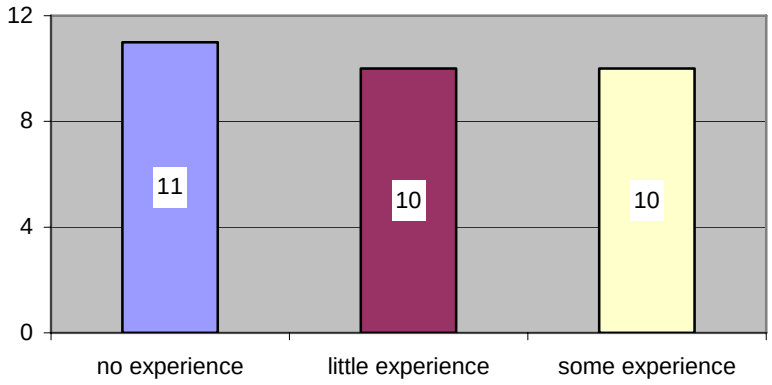
○ no experience ○ little experience ○ some experience ○ substantial experience



**Question 143. What is your experience with these approaches to decision making for selecting land use/institutional controls (e.g. zoning):**

**- simplified legal language templates**

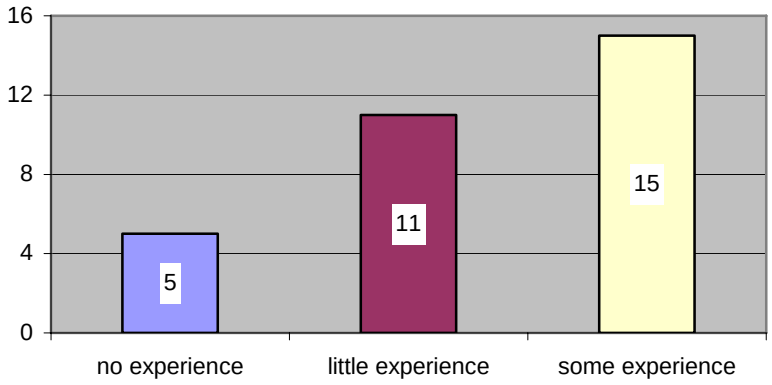
○ no experience ○ little experience ○ some experience ○ substantial experience




**Question 144. What is your experience with these approaches to decision making for selecting land use/institutional controls (e.g. zoning):**

**- land use planning tools**

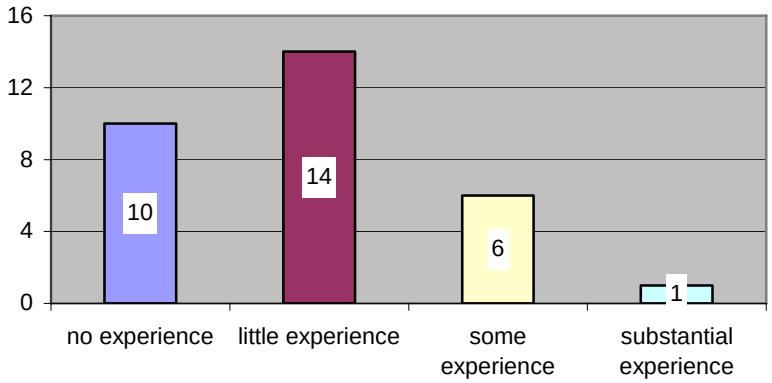
○ no experience ○ little experience ○ some experience ○ substantial experience



**Question 145. What is your experience with these approaches to decision making for selecting land use/institutional controls (e.g. zoning):**

**- demographics projection tools**

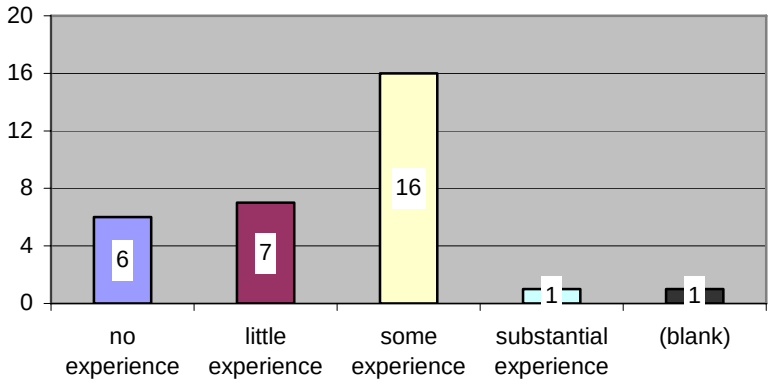
○ no experience ○ little experience ○ some experience ○ substantial experience




**Question 146. What is your experience with these approaches to decision making for selecting land use/institutional controls (e.g. zoning):**

**- public training/education programs**

○ no experience ○ little experience ○ some experience ○ substantial experience




**Question 147. If you have experience with another approach to decision making for selecting land use and institutional controls, please enter the approach here, then rate your experience in the next question.**

- See answers to following question for responses to this question

**Question 148. Please indicate your experience with the approach to decision making that you specified in the previous question.**

○ no experience ○ little experience ○ some experience ○ substantial experience

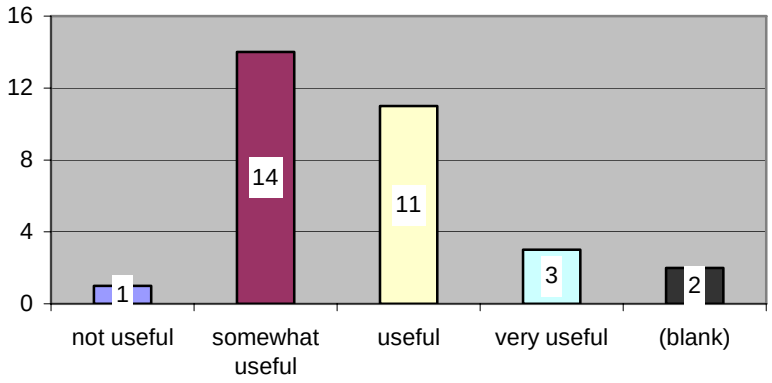
- Risk Assessments. Could be the same #142. – some experience
- Decision making is performed as part of the remedy decision process. Selecting ICs is a function of what you can apply that might work in your circumstances. In general, ICs don't

work, so layering is an attempt to guess at what set of ICs will work in combination. – (no rating)

**Question 149. To improve the decision-making process for selecting more effective land use and institutional controls, please rate the potential usefulness of these tools:**

**- inclusion of social science expertise**

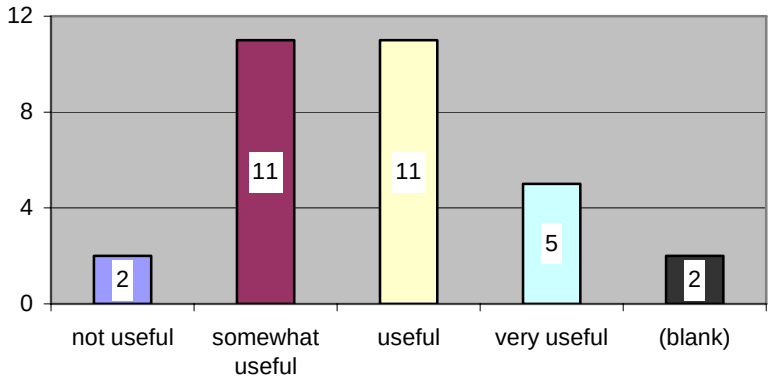
○ not useful ○ somewhat useful ○ useful ○ very useful




**Question 150. To improve the decision-making process for selecting more effective land use and institutional controls, please rate the potential usefulness of these tools:**

**- formalized consensus building**

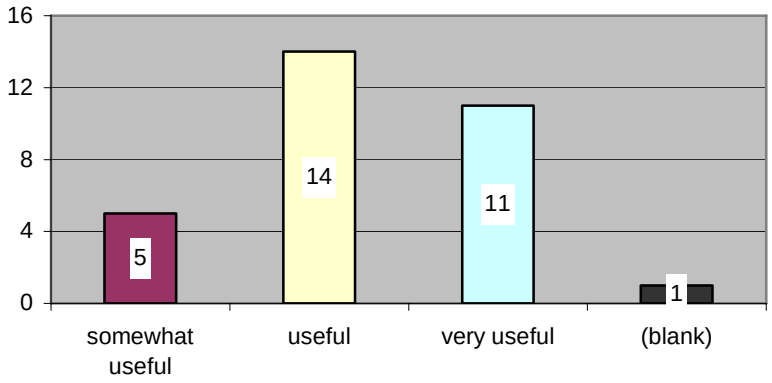
○ not useful ○ somewhat useful ○ useful ○ very useful



**Question 151. To improve the decision-making process for selecting more effective land use and institutional controls, please rate the potential usefulness of these tools:**

**- graphical/visual presentation of data**

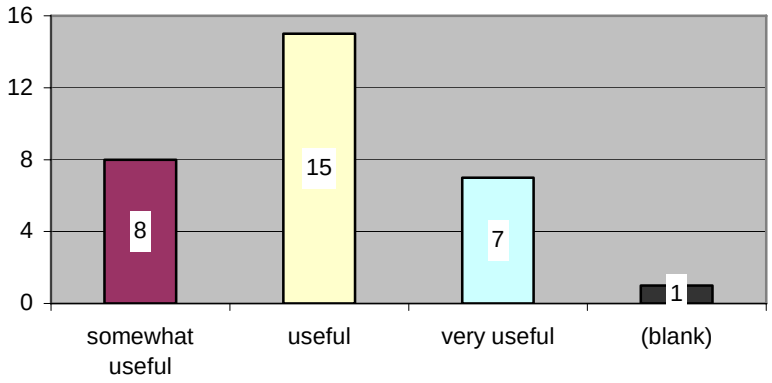
○ not useful ○ somewhat useful ○ useful ○ very useful




**Question 152. To improve the decision-making process for selecting more effective land use and institutional controls, please rate the potential usefulness of these tools:**

**- models capable of running "what-if" scenarios**

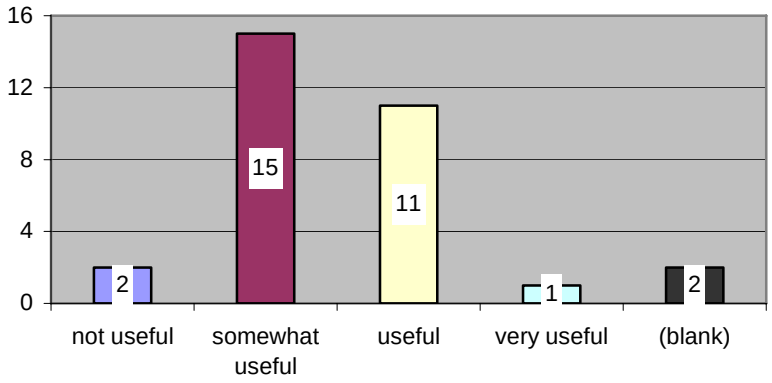
○ not useful ○ somewhat useful ○ useful ○ very useful



**Question 153. To improve the decision-making process for selecting more effective land use and institutional controls, please rate the potential usefulness of these tools:**

**- simplified legal language building blocks**

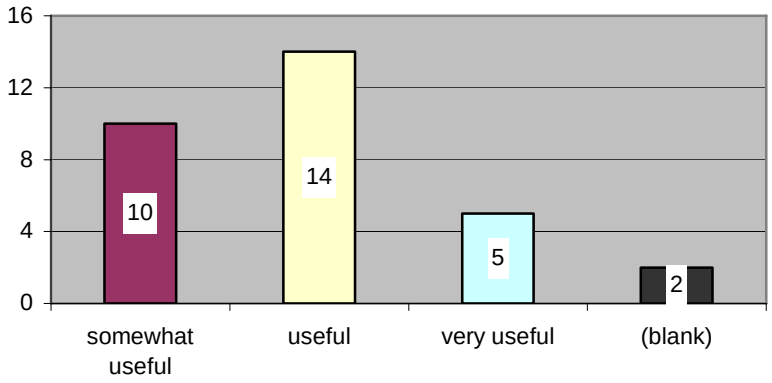
○ not useful ○ somewhat useful ○ useful ○ very useful




**Question 154. To improve the decision-making process for selecting more effective land use and institutional controls, please rate the potential usefulness of these tools:**

**- land use planning tools**

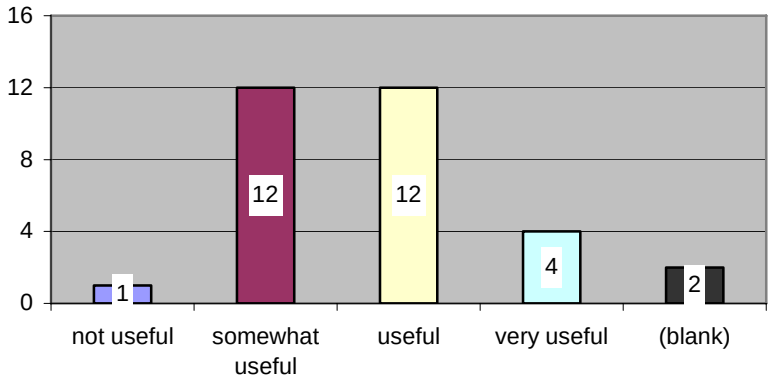
○ not useful ○ somewhat useful ○ useful ○ very useful



**Question 155. To improve the decision-making process for selecting more effective land use and institutional controls, please rate the potential usefulness of these tools:**

**- demographics projection tools**

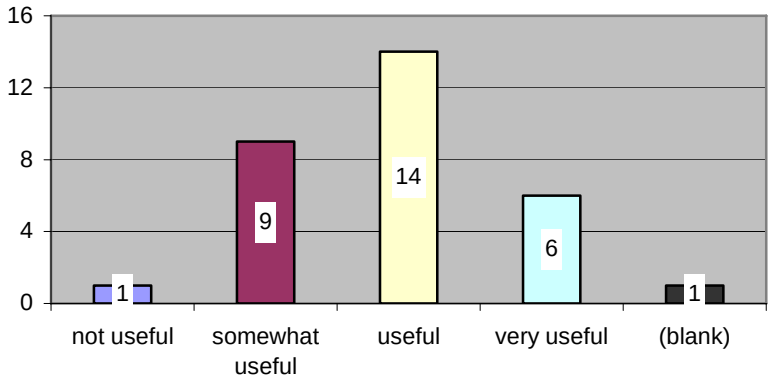
○ not useful ○ somewhat useful ○ useful ○ very useful




**Question 156. To improve the decision-making process for selecting more effective land use and institutional controls, please rate the potential usefulness of these tools:**

**- training**

○ not useful ○ somewhat useful ○ useful ○ very useful




**Question 157. If you would like to comment on the potential usefulness of another tool for improving the decision-making process, please enter it here, then rate its usefulness in the next question.**

- (no responses)

**Question 158. Please rate the potential usefulness of the tool you specified in the previous question.**

- (no responses)

**Question 159. How would you improve on existing processes?**

- Have no idea.
- Additional training.

- More political debate and possible legislation regarding large sites, such as SRS. Should the federal government always own and manage these sites?
- Involve the public to a greater extent.
- At present citizens (committees) make decisions on land use prior to any real site investigations required by CERCLA. Seems you could save time and evaluate land usage once it undergoes NFI through EPA.
- More public presentation and public workshops.
- Early involvement of the public and stakeholders into the remedy selection process is a key issue. Bring LTS issues into these discussions.
- As cleanup winds up in Oak Ridge and land uses are finalized, a better plan is needed for residual risk assessment and communication.
- I think LTS decision making needs to be organized in a way that makes the decision-making process easier. There are many interrelated parts that can't be evaluated or considered in a vacuum. In addition the responsible entity needs to understand their long-term responsibility for leaving materials in place and the need to provide the resources for participation by other partners in the LTS solution. Appropriate long-term funding mechanisms are needed.
- Make it so isn't needed.

**Question 160. Are existing conceptual site models (as per used in CERCLA) sufficient for long-term analysis of site data? If not, what changes should be made to make conceptual site models a useful tool for monitoring LTS sites?**

- Need a broader focus than typical site models. Need to somehow be able to work in social and cultural value issues.
- There is a lot of variability in CERCLA conceptual site models. But if done right with adequate visual displays, then they are useful.
- It depends on the remedy.
- Conceptual site models are useful for LTS, but will need to be updated regularly.
- Yes, however it is impossible to represent all possible conditions. Trying to do this with a CSM usually renders it ineffective (too complicated) for the likely scenario.
- Not sure. Current CSMs seem to be adequate.
- The models do not predict very long-term perspective at this time. Increase in population and its variations, future anticipated used of the land, control effectiveness, and transfer of responsibility are the areas that need further attention.
- Need to address potential failure mechanisms and data gaps. This allows you to develop response plans that can be implemented upon recognition of problems.
- Presently yes, but we all know that situations change and therefore effectiveness of models is dependent on adequacy and sufficiency of information. Most sites do not have enough data for effective models.
- Involved parties do not effectively utilize conceptual models in problem definition, assessment and decision making.
- Conceptual models are fine if they continue to be correct. Once information changes, the model it should be updated.
- Most likely not sufficient for long-lived rads.
- Actually the CERCLA conceptual models aren't too bad. The problem is getting people to take the long-term consideration of risk seriously. Some people think that taking care of our

own generation is probably good enough. Also considering the NRDA damages along with cleanup and ICs sometimes sobers up the responsible party and the public enough that a decision for cleanup is made. Perhaps all the affecting variables should be added in for full life-cycle costs, up-front, both fiscal and environmental costs, including NRDA.

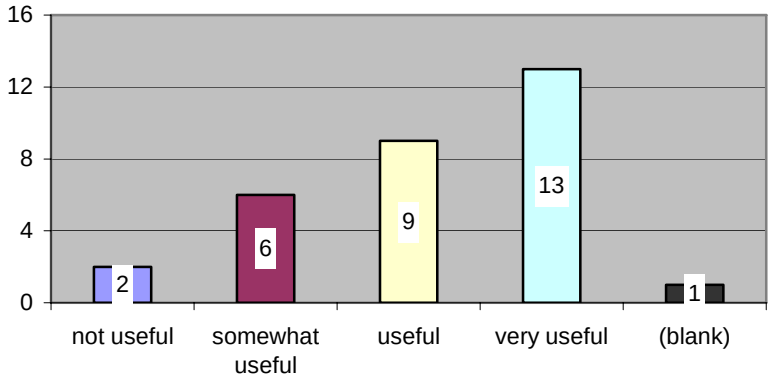
- I am not an expert on CERCLA process, but I have not seen anything that approaches the rigor needed for a truly long-term protective system.
- Yes, if the models aren't restricted to one or two scenarios.
- We have found them fairly useful to demonstrate viability and differences among potential exposure pathways.
- No experience with site models for long-term analysis of site data.
- NO! Groundwater path way in conduit flow.

**SURVEY SECTION 7: PATH FORWARD (QUESTIONS 161–166)**

**Question 161. Section 7: Path Forward**
**Please rate the potential usefulness of ITRC projects:**

**- Case Study/Guidance document on landfill and disposal facility long-term monitoring technologies**

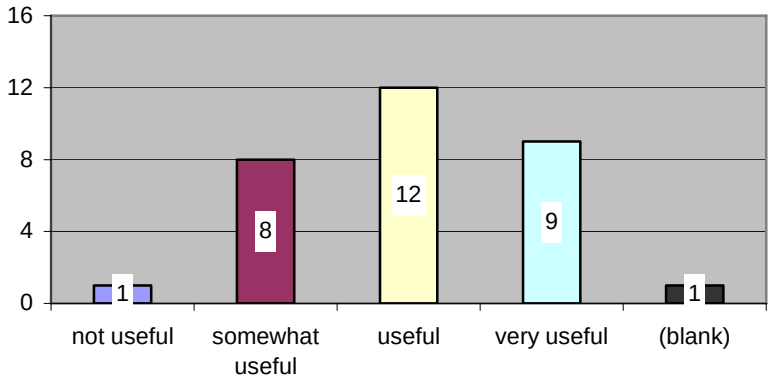
○ not useful ○ somewhat useful ○ useful ○ very useful



**Question 162. Please rate the potential usefulness of ITRC projects:**

**- Case Study/Guidance document on real-time in situ radiological contamination characterization technologies**

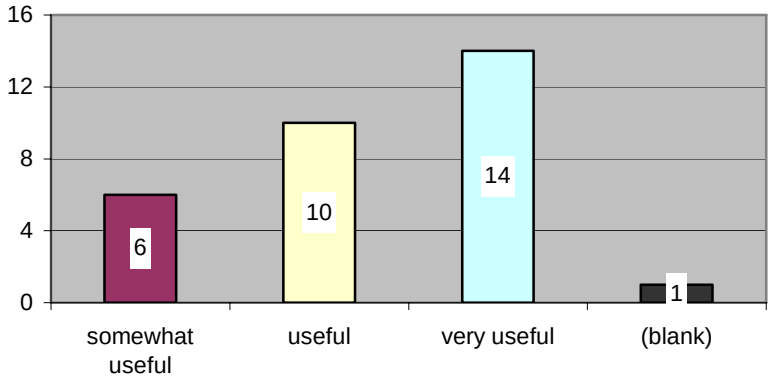
○ not useful ○ somewhat useful ○ useful ○ very useful




**Question 163. Please rate the potential usefulness of ITRC projects:**

**- workshop on data-retention technologies for LTS**

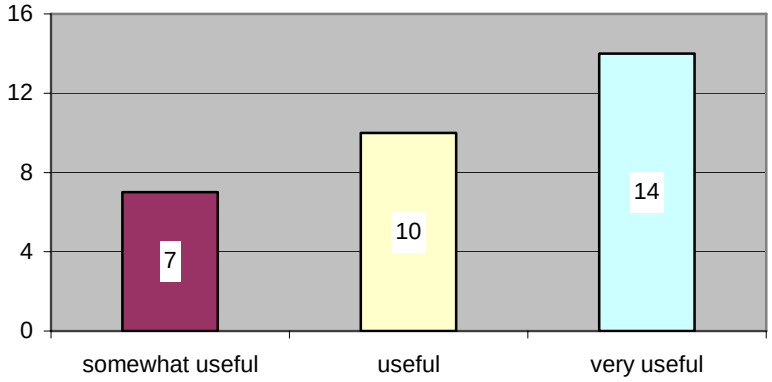
○ not useful ○ somewhat useful ○ useful ○ very useful



**Question 164. Please rate the potential usefulness of ITRC projects:**

**- training on LTS technologies and decision making**

○ not useful ○ somewhat useful ○ useful ○ very useful




**Question 165. If you have an idea for another project for the ITRC Radionuclides Team, please enter it here, then rate its usefulness in the next question.**

**Question 166. Please rate your expectation of the usefulness of the project you specified in the previous question.**

○ not useful ○ somewhat useful ○ useful ○ very useful

- Intruder barriers. Integration of LTS site GIS data with public utility databases. Technologies to notify people they are approaching a restricted area (GIS Alert system). – useful
- I did not like questions #91–#99, because there was no "neutral experience" option. – (no rating)
- Look at technologies that support LUCs if they exist. – useful
- Robotic controls. – useful
- (No project specified) – useful
- This survey is very difficult to answer in a multiple-choice format where there are not enough choices or the answers provided give a skewed perception of the situation. The questions about monitoring related to proximity to population are particularly troubling—if they are answered as written, there are many assumptions on conditions that go into the response. I can see those particular answers being used out of context. Some of the other questions also may provide opportunities for out-of-context uses. There should have been some places to provide comments on the responses to questions. – (no rating)

# APPENDIX D

## ITRC Contact List, Fact Sheet, and Product List

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