The Rocky Flats Stewardship Toolbox: Tools for Long-Term Planning

Created by the Rocky Flats Stewardship Working Group
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Appendices

Acronyms

ARAR	Applicable or Relevant and Appropriate Requirement
CAD	Corrective Active Decision
CDPHE	Colorado Department of Public Health and the Environment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CHWA	Colorado Hazardous Waste Act
DOE	Department of Energy
EPA	Environmental Protection Agency
LTS	Long-Term Stewardship
M&M	Monitoring and Maintenance
NDAA	National Defense Authorization Act
NRC	National Research Council
RCRA	Resource Conservation and Recovery Act
RFCA	Rocky Flats Cleanup Agreement
RFCAB	Rocky Flats Citizens Advisory Board
RFCLOG	Rocky Flats Coalition of Local Governments
ROD	Record of Decision

Preamble

The Rocky Flats Stewardship Working Group convened in July 1999 at the request of the Department of Energy-Rocky Flats Field Office (DOE-RFFO). The group was tasked with beginning a public process to study and make recommendations regarding the long-term stewardship needs for Rocky Flats. This group includes representatives of the Rocky Flats Coalition of Local Governments, the Rocky Flats Citizens Advisory Board, the Colorado Department of Public Health and the Environment *(ex officio*), the Department of Energy (*ex officio*), the Colorado Attorney General's Office (*ex officio*), and members of the public. The Stewardship Working Group is engaged in evaluating DOE's stewardship assumptions, analyzing the federal government's long-term liabilities and responsibilities, and participating in national stewardship dialogues. The goal of the Stewardship Working Group is to develop the information regarding long-term stewardship to allow the community to understand and influence remedy selection and decision-making at Rocky Flats.

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Executive Summary

In its March 2001 report, "Hand-in-Hand: Stewardship and Cleanup", the Rocky Flats Stewardship Working Group outlined the importance of incorporating long-term stewardship analyses into near-term cleanup decisions. In this follow-up document, the Stewardship Working Group presents the stewardship toolbox, an analytical matrix designed to help decision-makers ensure that long-term stewardship requirements are thoroughly considered during the remedy selection process.

The toolbox is divided into six discrete components of a long-term stewardship analysis which will also become components of a long-term stewardship plan: physical controls; institutional or administrative controls; operational and performance monitoring and maintenance; information management; periodic assessment; and maintenance by a responsible controlling authority. The toolbox lays out a framework for conducting a systematic review of the long-term needs for each of these categories. This document explains how to use the toolbox and explores many of the essential elements of a comprehensive stewardship analysis.

As with "Hand-in-Hand", the toolbox focuses on Rocky Flats and does not attempt to tackle the myriad of site-specific stewardship challenges other sites will face. Nonetheless, the ideas, analyses, and supporting documentation contained in the toolbox can be broadly applied.

It is important to note that the toolbox only marginally addresses one of the most difficult issues facing stewardship analyses: cost. It is the hope of the Stewardship Working Group that DOE and other state and federal regulatory agencies will carefully revisit and improve upon how life-cycle costs are calculated so that the true costs of maintaining a given remedy may be comprehensively considered and evaluated during remedy selection.

1 Introduction

With the cancellation of the W-88 Trident Warhead program in January 1992, Rocky Flats' mission changed. The Site, which once served as a key weapons manufacturing facility during the Cold War, was to be decommissioned and cleaned up. With its extensive surface and subsurface contamination, including buried process wastes lines, trenches containing radioactive and other hazardous materials, contaminated groundwater and surface water, the challenge facing the Department of Energy (DOE) was, and remains, immense. Cleanup is progressing, and closure is within sight.

The cleanup and closure of Rocky Flats, however, will not eliminate all contamination and related risks as there are technical, fiscal, and policy constraints that will result in residual contamination remaining onsite after closure. While the total amount of contamination at closure has not been determined, DOE, the Environmental Protection Agency (EPA), and the Colorado Department of Public Health and the Environment (CDPHE) presume that engineered barriers such as caps and containment dams will be used, and institutional controls such as access restrictions will be employed for generations to come. Because of the long-lived and hazardous nature of plutonium and other contaminants onsite, the risks posed by the breakdown or malfunction of an engineered barrier or institutional control are potentially high. Consequently, one of the major challenges that has surfaced during the cleanup of Rocky Flats is incorporating long-term stewardship requirements into the remedy decision-making process.

The Rocky Flats Stewardship Working Group first addressed this issue in its 2001 report, "Hand-In-Hand: Stewardship and Cleanup". In that report, the group maintained that the key aspects of establishing, maintaining and funding long-term stewardship activities must be considered during the remedy selection process.

Additionally, the group argued that remedies should have a high degree of certainty to ensure they will meet the end-state objectives for the life of the contaminant. Based on conclusions the National Research Council (NRC) presented in its August 2000 report, "Long-Term Institutional Management of U.S. Department of Energy Legacy Waste Sites" [70], the Stewardship Working Group advised DOE to plan for uncertainty and failure of stewardship measures throughout the duration of the stewardship program. The NRC advocated, among other recommendations, using layered stewardship controls to provide a system of checks and balances. In addition, the NRC argued for some redundancy in using various controls. This advice, the Stewardship Working Group still believes, should help ensure that the long-term consequences (health and safety, budgetary, land-use, etc.) of any necessary stewardship controls are evaluated prior to the finalization of cleanup decisions.

Yet, while the theory of incorporating stewardship into remedy selection is straightforward, the details are far more complicated. What exactly should be included? What is the role of long-term stewardship when developing and analyzing remedial options? How should that analysis relate to the development of a long-term protection strategy and, in turn, the development of a long-term site stewardship plan?

To help answer these and other questions and to help facilitate the incorporation of stewardship elements into the remedy selection process, the Stewardship Working Group has developed a stewardship toolbox. The toolbox can serve to help to identify and organize the long-term elements for an effective stewardship program in order for them to be considered during remedy selection decisions. While the toolbox is not designed to address each issue a project manager will face when making cleanup decisions, it is intended to capture the essential aspects of a stewardship analysis.

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) mandates that the alternatives analysis for remedy selection consider nine evaluation criteria, including an assessment of the long-term effectiveness and permanence of a given remedy. The toolbox is not intended to circumvent or challenge the existing regulatory process. Rather, it is a tool to help project managers and others fulfill this important CERCLA requirement.

1.1 Two Challenges: Uncertainty and Cost

Two challenges that transcend stewardship considerations and are broadly applicable to remedy selection are: 1) accounting for uncertainty in the remedy selection analysis, and 2) establishing the life-cycle costs of a given remedy and related controls. Both issues are pivotally important as they directly impact the long-term effectiveness of any given remedy – and yet, despite their importance, there are no comprehensive mechanisms, including the toolbox, to address either issue. Nonetheless, cost and risk must be considered to the best extent possible throughout the remedial alternatives analysis.

Uncertainty
Remedy selection is fraught with uncertainties. For instance, will contaminants move in the environment as expected? Will the current rate of groundwater flow remain constant? Will remedies such as caps perform as designed? Will remedies be more effective than designed, or perhaps less effective? How will changes in hydrologic cycles affect passive groundwater treatment systems?

The answers to these questions are largely unknown. Yet, regardless of these and other uncertainties, project managers must select and implement remedies based on the best scientific and technical knowledge at their disposal at the time. It then becomes the stewards' responsibility to adjust the long-term stewardship plan as needed to maintain the existing remedies.

The Stewardship Working Group believes it is imperative for project managers to thoroughly consider the range of uncertainties inherent in a given remedy, including uncertainties that could affect stewardship management and responsibilities. While the toolbox does not provide the entire set of tools to evaluate uncertainty in remedy selection, the Stewardship Working Group believes that by evaluating all of the salient aspects of a comprehensive long-term stewardship strategy, project managers can begin to address and prepare for the range of uncertainties associated with a given remedy.

Cost
Another difficult aspect of developing a long-term stewardship plan concerns cost. It should be noted at the outset that the toolbox does not attempt to either quantify or qualify this factor, despite its importance as a key parameter in remedial alternative analyses.

Oftentimes the question of conducting additional remediation versus relying on stewardship controls is evaluated using a cost-benefit analysis. Yet, estimating the future costs for long-term stewardship is not an exact science. And, since the planning horizon for DOE's Environmental Management program is currently only 70 years, true life-cycle costs are often not fully considered. This timeframe, as DOE acknowledged in its "Long-Term Stewardship Study" [205], does not include the life-cycle of long-term stewardship, which may be hundreds or even thousands of years.

The challenge of accurately estimating long-term stewardship costs and incorporating them into remedy selection is great – and it is one that DOE and the other state and federal agencies must address. A cost comparison, at a minimum, should include the total project duration (measured in years), the annual operations and maintenance costs, and the total periodic costs. How DOE, state and federal regulators, and other interested parties including local governments should then weigh the costs of one remedial option versus another raises important policy questions that must be taken into consideration.

1.2 Intended Audience

One of the challenges in developing this toolbox has been designing a tool that is readily usable by different parties (i.e., DOE, regulators, local governments, community members). The challenge is rooted in the important but elemental fact that while the questions remain relatively constant for different user groups, each may have different interests and place different emphasis on many of the categories. For instance, the questions under "Controlling Authority" (Section 3.7) are generally the same for DOE, the regulators, and community members. However, considerations that would motivate one of these parties to change a remedy might not motivate another party. The DOE project manager may cite budget authority issues, land-use decision-making authority, or remedial decision authority; a regulator may be looking at enforcement or oversight authority; and the local governments and community members may be most interested in having a contact name in case the remedy fails or land use changes.

Secondly, this toolbox is focused on Rocky Flats issues and therefore does not attempt to address the broad range of issues facing other sites, including those which will pass out of federal ownership or those with a continuing DOE mission. For use at these sites, the Stewardship Working Group urges interested parties to modify the toolbox to meet that site's individual needs and conditions. To a great extent, however, the toolbox flags numerous issues that will likely be relevant at other sites.

1.3 Document Organization

Section 2 describes the toolbox, including brief descriptions of the toolbox stewardship categories, and figures illustrating, step-by-step, how a blank toolbox can be filled-in.

Section 3 outlines sets of issues and questions that should be raised for each stewardship category. The section follows the format of the toolbox and, cell-by-cell, provides guidelines for what these questions may be and what project managers should consider during the remedy analysis and selection process.

Section 4 contains examples of completed toolboxes, and Section 5 provides the document conclusion.

2 Description of the Stewardship Toolbox

As noted in the Introduction, the goal of the stewardship toolbox is to identify and organize the long-term components necessary for a stewardship program so that they may be considered and incorporated into remedy selection. Important components or tools of a stewardship program include physical controls; institutional or administrative controls; operational and performance monitoring and maintenance; information management; periodic assessment that includes continued research and development; and maintenance by a responsible controlling authority.

The toolbox is designed so that it can be applied during various stages of the cleanup project, not just during remedy selection. It can be used to develop a framework for how stewardship elements should be considered during remedy selection for individual areas of contamination. It can also be applied to the entire site to better assess the collective sitewide stewardship needs and obligations.

If project managers at Rocky Flats consider the key questions that are part of the toolbox, their analysis can also serve to raise awareness of the range of uncertainties associated with a given remedy. For instance, there are uncertainties about how long a given plume of contaminated groundwater at Rocky Flats will take to move; the rate of movement will, in turn, directly impact long-term monitoring and maintenance needs. Likewise, there are uncertainties about how long a given access restriction will be needed or exactly how long a cap will remain effective in the arid Colorado environment. In many cases, the lifetime of the contaminants will far exceed the expected design life of the proposed remedy. These uncertainties, which go to the heart and effectiveness of long-term controls, need to be flagged and considered during the remedy selection.

2.1 Stewardship Toolbox Considerations

The organization of the toolbox centers around six major categories, all of which both individually and collectively help to ensure that the chosen remedies remain protective of human health and the environment for the life of the contaminants. The six toolbox categories are as follows:

1) Physical controls: Physical controls include, but are not limited to, containment structures such as caps, water diversion and treatment systems, and access barriers such as fences, guards and signs. These controls physically reside at the site of, or in close proximity to, the actual contamination. Appendix A contains a detailed description of physical controls.
2) Institutional/Administrative Controls: This category includes governmental controls such as zoning, permits, and use restrictions; proprietary controls such as easements and covenants; legal enforcement tools such as administrative orders and consent decrees; and informational devices such as deed notices, registries and advisories. Appendix A provides detailed descriptions of institutional and administrative controls.

3) Monitoring / Maintenance: This category includes periodic monitoring and maintenance of the remedies and corresponding stewardship controls (whether physical or institutional/administrative) to ensure they continue to work as designed.
4) Information Management: A successful stewardship program is dependent on retaining all necessary records about the site's history and residual contamination. Information that must be retained should include history of the site, the contaminants of concern, the selected remedies, the use of controls along with their monitoring and maintenance records, and any other information judged necessary for succeeding generations to understand the nature and extent of the residual contamination.
5) Periodic Assessment: Periodic assessments are performed to determine whether the selected remedies and stewardship controls continue to operate as designed, and to ascertain whether new technologies might exist to eliminate remaining residual contamination in a safe and cost-effective manner.
6) Controlling Authority: Long-term protection of human health and the environment necessitates that a controlling authority be established with responsibility for overall stewardship program management and guidance.

2.2 Using the Stewardship Toolbox

One of the key characteristics of the stewardship tools is their interdependence. For example, physical controls will almost always require that the institutional/administrative controls designed to support the physical controls remain operational and functioning. Likewise, monitoring and maintenance of both the physical and institutional/administrative controls will be required to assess and ensure their performance. Information will need to be maintained about the physical and institutional/administrative controls, as well as the monitoring and maintenance records. Comprehensive periodic assessments may be conducted by examining well-kept records about stewardship controls and related monitoring and maintenance records. The controlling authority will be charged with ensuring that the stewardship controls remain in place, that they are maintained, that the necessary information is collected, and that the periodic assessment program is implemented and subsequent corrective actions are taken. As these examples show, no part of the stewardship program should be considered by itself.

The draft toolbox in Figure 1 (below) is offered as a means to organize the six stewardship categories discussed in Section 2.1. This section is meant to serve as a "how-to" for using the toolbox, while Section 3 is the heart of the toolbox. Section 3 details the stewardship questions and issues prompted by each toolbox cell.

As one starts at the top left of the toolbox and goes across, the attributes of a comprehensive stewardship program can be developed and input into the toolbox. Once the top row for a given remedy is completed (see Figure 3), the stewardship program attributes for each category should then be recorded down the first column of the toolbox (see Figure 4). By following this approach, each aspect of the stewardship program can be evaluated for additional considerations. The evaluation process should be completed for each of the succeeding rows (see Figure 5). Once information has been recorded for each of the toolbox cells, a summary of the stewardship program, by element, can be achieved by reading down the columns.

Note that some of these cells are shaded where identical categories intersect. For example, it would not be logical to capture "institutional controls necessary to maintain institutional controls". However, the center cell where the row and column "Monitoring and Maintenance" intersect is not shaded since maintenance of monitoring systems will likely occur. Additionally, some cells contain "N/A" (Not Applicable) when there are likely no applicable stewardship requirements for this cell. For example, physical controls would not be necessary to maintain the periodic assessment.

Figure 1: Blank Toolbox

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring and Maintenance*	Information Management	Periodic Assessment	Controlling Authority
Proposed/ Chosen Remedy							
Physical Controls							
Institutional / Administrative Controls							
Monitoring and Maintenance							
Information Management							
Periodic Assessment							
Controlling Authority							

*Includes operational and performance monitoring and maintenance.

An illustration using the toolbox is outlined in the steps of Figures 2 through 6 below. Please note that the information contained in Figures 2 through 6 is meant solely to be an illustration of how to use the toolbox and is not intended to be an exhaustive analysis of the stewardship program needs associated with the remedy. A more thorough analysis would identify additional program needs.

In this example, it is assumed that the selected remedy is a protective cap. The first step in developing the framework of stewardship considerations is to record the selected remedy in the appropriate cell at the upper left hand corner of the table (see Figure 2). As previously mentioned, further key questions and information captured in this cell are outlined in Section 3.

Figure 2: Step 1 in Completing Toolbox

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring and Maintenance	Information Management	Periodic Assessment	Controlling Authority
Proposed/ Chosen Remedy	Cap						

The next step is to then work towards the right in this first row, developing stewardship considerations related to the use of the cap (see Figure 3).

Figure 3: Step 2 in Completing Toolbox

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring and Maintenance	Information Management	Periodic Assessment	Controlling Authority
Proposed/ Chosen Remedy	Cap	Fences, signs	Deed, well drilling restrictions	Downstream wells; Routine maintenance	Historical contaminants, remedy documents	Is it working as designed? Is there a better option today?	Direct program; Secure funding

The first stewardship question of the toolbox falls under the category "Physical Controls". Here the question concerns whether additional physical controls are necessary to provide maximum protection of human health and environment at the cap location. One needs to consider all environmental pathways such as air transport, surface and groundwater transport, and physical intrusion. For this example, fences or signs might be appropriate because a goal is to ensure that there is no physical intrusion of the cap.

After thoroughly examining physical controls for all possible exposure pathways, the next step is to consider institutional/administrative controls related to the use of a cap. Again considering all environmental pathways, it may be determined that the groundwater pathway is of concern, necessitating deed restrictions to the property that would restrict well drilling under and in close proximity to the cap.

Continuing across the first row, the next category is monitoring and maintenance needs for the cap. The next category is information management needs, followed by details of a comprehensive periodic assessment program. Finally, a controlling authority should be identified that would be charged with planning, implementing and evaluating the stewardship program.

As one begins to develop information along the first row of the table, it is important to record the same information down the first column, so that the interdependent considerations of the stewardship program can be identified and recorded (see Figure 4).

Figure 4: Step 3 in Completing Toolbox

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring and Maintenance	Information Management	Periodic Assessment	Controlling Authority
Proposed/ Chosen Remedy	Cap	Fences, signs	Deed, well drilling restrictions	Downstream wells; Routine maintenance	Historical contaminants, remedy documents	Is it working as designed? Is there a better option today?	Direct program; Secure funding
Physical Controls	Fences, signs						
Institutional / Administrative Controls	Deed, well drilling restrictions						
Monitoring and Maintenance	Downstream wells; Routine maintenance						
Information Management	Historical contaminants, remedy documents						
Periodic Assessment	Is it working as designed? Is there a better option today?						
Controlling Authority	Direct program; Secure funding						

Next, the toolbox allows one to consider the stewardship issues for the physical controls (fences and signs) that are required to support the use of the cap. Likewise, the institutional/ administrative controls may require some form of monitoring, information management, periodic assessment, and a controlling authority (see Figure 5). Following the example in Step 2, one will fill in the toolbox for each of the controls identified in the vertical column.

Figure 5: Step 4 in Completing Toolbox

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring and Maintenance	Information Management	Periodic Assessment	Controlling Authority
Proposed/ Chosen Remedy	Cap	Fences, signs	Deed, well drilling restrictions	Downstream wells; Routine maintenance	Historical contaminants, remedy documents	Is it working as designed? Is there a better option today?	Direct program; Secure funding
Physical Controls	Fences, signs		Deed requirements	Routine inspections, maintenance and repairs	Inspection and maintenance records	Have controls provided necessary protection?	Direct program; Secure funding
Institutional / Administrative Controls	Deed, well drilling restrictions	N/A		Periodic review of records	Keep records on file	Have controls provided necessary protection?	Direct program; Secure funding
Monitoring and Maintenance	Downstream wells; Routine maintenance						
Information Management	Historical contamin-ants, remedy documents						
Periodic Assessment	Is it working as designed? Is there a better option today?						
Controlling Authority	Direct program; Secure funding						

After completing an assessment of each cell in the table, the components of a comprehensive stewardship program should be apparent. There may be blank cells in the table (see Figure 6).

Figure 6: Step 5 in Completing Toolbox

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring and Maintenance*	Information Management	Periodic Assessment	Controlling Authority
Proposed/ Chosen Remedy	Cap	Fences, signs	Deed, well drilling restrictions	Downstream wells; Routine maintenance	Historical, contaminants, remedy documents	Is it working as designed? Is there a better option today?	Direct program; Secure funding
Physical Controls	Fences, signs		Deed requirements	Routine inspections, maintenance and repairs	Inspection and maintenance records	Have they provided necessary protection?	Direct program; Secure funding
Institutional / Administrative Controls	Deed, well drilling restrictions	N/A		Periodic review of records	Keep records on file	Have they provided necessary protection?	Direct program; Secure funding
Monitoring and Maintenance	Downstream wells; Routine maintenance	N/A	N/A	Maintenance of the cap monitoring systems	Keep records on file	Is the periodicity proper? Are things functioning?	Direct program; Secure funding
Information Management	Historical, contamin-ants, remedy documents	N/A	N/A	Periodically assess which documents or info can get rid of		Is the proper info being kept?	Direct program; Secure funding
Periodic Assessment	Is it working as designed? Is there a better option today?	N/A	N/A	N/A	Need to keep records of assessment		Direct program; Secure funding
Controlling Authority	Direct program; Secure funding	N/A	N/A	N/A	Need to keep records of controlling authority's actions	Need to provide independent external oversight	

*Includes operational and performance monitoring and maintenance.

Again, cost is a key consideration for any remedy selection/stewardship decision. It will be important for the project manager to identify the cost associated with each element of the stewardship program by assigning a cost value to each stewardship element. The cost information will help inform the remedy selection process.

Other examples using the stewardship toolbox are included in Section 4.

3 Stewardship Alternatives Analysis Using the Toolbox

Section 2 described how to read and use the toolbox. This section contains the heart of the toolbox – the issues project managers, community members, regulators, and other interested parties should consider as part of a comprehensive stewardship analysis during remedy selection. It describes in detail the questions one should ask about each of the toolbox categories and provides the basis for recognizing and identifying which issues to address in each of the cells.

The Stewardship Working Group has not tried to capture every issue but instead has focused on the key ones. By discussing the issues raised and answering the questions posed in the toolbox, the group believes affected parties will be better prepared to comprehensively address stewardship issues. One should work through each section of the toolbox and address the questions and issues, recognizing that some may not be relevant and others may be applicable.

There are three primary uses for the questions and issues raised in the following sections (3.1-3.7).

1) As described in Section 2, the toolbox is designed as an analytical matrix. It serves to recognize, organize, and incorporate long-term stewardship considerations into remedy selections. It is the Stewardship Working Group's hope and expectation that project managers and other interested parties will use the toolbox in this way. The process of filling in the matrices and addressing the questions and issues posed will likely raise other issues that should be incorporated into the stewardship analysis.

2) As some reviewers of prior drafts of the toolbox have commented, the questions and issues raised in the following pages can also be used as a stewardship checklist. So long as the following issues are addressed, discussed in a public forum, and included in the stewardship analyses and remedial decision-making, then the intent and goals of the toolbox are served.

3) There is also great value in using the questions and issues raised in this document as discussion trigger points. To the extent that the goal is to better educate an interested party and not develop remedial actions, filling out the matrices then becomes a secondary consideration.

Regardless of how one uses the toolbox, the common parameter for all is that it can be adapted to site-specific needs and thus serve to expand and deepen a stewardship dialogue. The Stewardship Working Group urges all readers to modify the toolbox and use it in a way that fits their own needs.

For those using the toolbox as designed (see #1 above), consider each cell in the toolbox as a drawer (see Figure 7). Most of these drawers will contain a set of questions that focus on the remedy's long-term stewardship requirements. The following sections follow the format of the toolbox and, cell-by-cell, provide guidelines for what these questions may be. If the list of questions is being used to evaluate a remedy selection, the evaluator must determine if the following questions and issues have been adequately addressed and identified in the decision document. The information collected on the remedy's long-term stewardship requirements can then be transferred to a site's long-term stewardship plan.

Figure 7: Toolbox with Numbered Cells

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring and Maintenance*	Information Management	Periodic Assessment	Controlling Authority
Proposed/ Chosen Remedy	A1	B1	C1	D1	E1	F1	G1
Physical Controls	A2	B2	C2	D2	E2	F2	G2
Institutional / Administrative Controls	A3	B3	C3	D3	E3	F3	G3
Monitoring and Maintenance	A4	B4	C4	D4	E4	F4	G4
Information Management	A5	B5	C5	D5	E5	F5	G5
Periodic Assessment	A6	B6	C6	D6	E6	F6	G6
Controlling Authority	A7	B7	C7	D7	E7	F7	G7

*Includes operational and performance monitoring and maintenance.

3.1 Proposed/Chosen Remedy

When utilizing the toolbox to assess a stewardship scenario, one must begin by examining the proposed remedy. In the proposed/chosen remedy description (cell A-1), the problem being addressed by the remedy must be fully described so that the long-term stewardship attributes of the remedy can be adequately defined. (The long-term stewardship attributes are addressed in the toolbox rows 2 through 7.)

Each remedy is developed to mitigate a specific problem. A remedy is selected for its ability to accomplish one or more of the following:

- eliminate the contamination source;
- block a potential contaminant pathway; and/or
- protect a specific receptor from the contamination.

In order to accurately define a given problem, one must understand the media that serves as the contamination source (surface soil, subsurface soil, groundwater, surface water), the potential contamination pathways (air, groundwater, surface water) and the likely receptors (users of the property, consumers of the air, groundwater or surface water, etc.).

Also, since similar remedies may be used for different purposes, one needs to specify the purpose of the remedy to help ensure that it functions as intended. For example, a cap may be used to:

- prevent direct human contact with surface contamination; and/or
- prevent infiltration of precipitation (precipitation would cause contamination in surface soil to infiltrate groundwater); and/or
- prevent erosion of contaminated soil into surface water.

Conversely, a given contamination problem may be addressed through different approaches. For example, direct human contact with surface soil contamination could be mitigated by any or all of the following methods:

- removing the contaminated soil;
- capping the contamination; and/or
- erecting a fence around the contaminated area.

It is important to remember the proposed/chosen remedy may contain several layers of controls. For example, a cap may be fenced and require signs warning of the residual hazards, and include a provision in the Corrective Action Decision/Record of Decision (CAD/ROD) allowing only limited access to the cap. A groundwater remediation project may include a drilling restriction and require the area to be fenced and signed.

The remedy description should include general information about the contamination, specifics about how the remedy accomplishes the intended purposes, and information necessary to understand how the remedy would be applied to the problem. Examples of the information likely to be needed are presented below.

Information about the Contamination (Cell A1)

- Location of contamination onsite
- Description of contamination (contaminants, media, potential transport pathways)

Information about the Proposed/Chosen Remedy (Cell A1)

- What is the proposed remedy (e.g., cap, groundwater barrier, soil removal plus cover, etc.)?
- What is the purpose of the remedy (e.g., the remedy prevents contamination from reaching surface water)?
- What is the level of cleanup? (Will the remedy allow for unrestricted use of the area of contamination?)
  - Cleanup to protect a future user:
    - Soil action level - tier I or above (restricted use)
    - Soil action level - tier II (restricted use)
    - Soil action level - tier II and ALARA, but above unrestricted use (restricted use)
    - Unrestricted use
    - Background
  - Cleanup to protect water quality

Note: The question of soil action levels is Rocky Flats specific. For sites that do not utilize this system, the key issue is whether or not the area is cleaned to a level that would allow for unrestricted use.

- If the remedy does not allow for unrestricted use, then which activities are restricted?
- Additionally, will the remedy plus stewardship controls protect a future resident to 1×10^{-6} risk level?
- What are the performance requirements of the remedy (e.g., for an evapotranspiration cap the performance requirement would be that the cap be able to transpire x times the annual precipitation, where x>1)?
- What is the legal and regulatory guidance driving the selection and application of the remedy?
  - Resource Conservation and Recovery Act (RCRA)
  - Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)
  - Rocky Flats Cleanup Agreement (RFCA)
  - Applicable or Relevant and Appropriate Requirements (ARARs)
  - Other (e.g., Departmental policies and guidance)
- What are the applicable engineering details?
- What are the performance data on similar remedies, and what do those data suggest about designing, implementing, and maintaining the given remedy? Has the effectiveness of the given remedy been addressed?
- What are the uncertainties associated with implementing the given remedy?
- What are the life-cycle costs for designing, implementing, and maintaining the given remedy?
- Has the anticipated lifetime of the given remedy been addressed?
- Have the specific plans for maintaining the given remedy, including a contingency plan should the remedy fail, been addressed?
- What are the plans for decommissioning the given remedy?

Filling in the vertical column
As described in Section 2, as one begins to develop information along the horizontal row of the table, it is important to record the same information down the first column, so that the interdependent considerations of the stewardship program can be recorded (see Figure 7, page 9).

3.2 Physical Controls

What are physical controls: Physical controls are the primary barriers used to limit unauthorized access to contaminants and to limit exposure to hazards that exist on the site after remediation is complete. These controls "physically" reside at the site of, or in close proximity to, the actual contamination, and may include containment structures such as caps (also referred to as engineered controls), and access barriers such as fences. Once these systems are in place, it is essential that they function as designed for the anticipated lifetime of the contaminant. When designing a physical control, decision makers must ensure that all stewardship responsibilities are addressed. Stewardship responsibilities may include monitoring and maintenance, and information management, both of which are described in Section 3.4 and Section 3.5, respectively.

Controls may be necessary for caps, covers, passive and active barriers, pump and treat systems, monitored natural attenuation, soil removal above unrestricted use, and subsurface contamination left in place. The following physical controls may be used as part of the remedial action to limit access to the given remedy and areas of residual contamination:

- Fences
- Signs/Markers
- Guards
- Other

Why physical controls are important: As noted in Section 3.1, a remedial action can protect human health and the environment through eliminating the source, eliminating the pathway, and/or eliminating the receptor by keeping the receptor away from the source. Physical controls can thus serve as one of the mechanisms to keep contaminants from moving to the receptor or the receptor from getting to a source. The purpose of physical controls is, in short, to control the contamination, prevent access, or both.

Objective of this part of the toolbox: The objective of this section is to identify the physical controls that will be used to implement the remedy. This objective includes ensuring the physical controls are maintained over the life of the contaminants.

Issues to consider:

1. Physical controls are a key component of implementing and maintaining a remedy;
2. Physical controls can be used in conjunction with institutional controls to provide protection in the case of failure. For instance, DOE may install a sign that states there is a drilling restriction. In this case, the sign (a physical control) is part of implementing the use restriction (an institutional control). The physical control is not "layered" with the institutional control but is rather part of implementing the institutional control.
3. It is important to identify the physical controls necessary to maintain, protect, and allow access to monitoring and maintenance systems.

General Questions/Issues (apply to all cells)

- How long will the physical controls have to be in effect?
- What are the regulatory requirements regarding the use and management of the physical controls?
- How will the physical controls be incorporated into the RFCA decision-making process and at what point(s)?
- How and where are the physical control requirements documented (e.g., in the decision document)?
- Have the life-cycle costs of all of these physical controls been included in the cost estimates? How do these costs compare to other remedial options?

Physical Controls Necessary to Maintain the Remedy (Cell A2 and B1)

- What physical controls will be used as part of the remedy or to maintain the remedy (e.g., a fence around a cap)?
- What are the performance requirements of the physical controls?

Physical Controls Necessary to Maintain the Institutional/Administrative Controls (Cell B3)

- It is highly unlikely there will be any information for this cell. The converse, institutional/administrative controls necessary to maintain physical controls (cell C2), is absolutely necessary whenever physical controls are used. Nonetheless, it is important to remember that physical controls and institutional controls are often used in tandem to provide additional protection in case of failure or malfunction.

Physical Controls Necessary to Protect the Monitoring and Maintenance Systems (Cell B4)

- What physical controls (fences, signs, security, etc.) are necessary to protect and allow access to monitoring and maintenance systems?

Physical Controls Necessary to Maintain the Information Management Systems (Cell B5)

- It is highly unlikely there will be any information for this cell. The converse, information management systems necessary to maintain physical controls (cell E2), is absolutely necessary whenever physical controls are used.
- The type of information that could fall under this category is ensuring that the information is accessible, retrievable, and secure.

Physical Controls Necessary to Maintain the Periodic Assessments (Cell B6)

- It is highly unlikely there will be any information for this cell. The converse, periodic assessments of the physical controls (cell F2), is absolutely necessary whenever physical controls are used.

Physical Controls Necessary to Maintain a Controlling Authority (Cell B7)

- It is highly unlikely there will be any information for this cell. The converse, controlling authorities necessary to maintain and assess physical controls (cell G2), is absolutely necessary whenever physical controls are used.

Physical Controls – Essential Questions

- Which physical controls will be included as part of the remedy:
  - Fences?
  - Signs?
  - Other?
- How long will the controls be necessary?
- What will be the anticipated lifecycle costs of these controls?
- Have the specific plans for reporting failure, including a contingency plan should the controls fail, been addressed?
- How often will the controls need to be inspected?
- Has the Site identified who will perform the surveillance and the routine inspections?

3.3 Institutional/Administrative Controls

<u>What are institutional/administrative controls</u>: As described in Section 2, on a broad scale this category includes governmental controls such as zoning, permits, and use restrictions; proprietary controls such as easements and covenants; legal enforcement tools such as administrative orders and consent decrees; and informational devices such as deed notices,

registries and advisories. In most contexts, these controls work in tandem with physical controls to serve as an additional layer of protection.

Why institutional/administrative controls are important: Institutional and administrative controls are, among other things, an important means to: 1) prevent activities that would cause contaminants to move (e.g., preventing people from driving on or disturbing contaminated areas), and 2) eliminate the ability of people to access materials (e.g., drilling restriction). In both cases the controls help prevent people from conducting an activity that would cause the movement of materials, and/or prevent people from coming into contact with materials. Institutional and administrative controls are also designed to ensure that proper monitoring and maintenance take place, as an effective stewardship program needs an administrative mechanism that ensures specific activities are implemented so that the remedy remains effective.

Objective of this part of the toolbox: The objective of this section is to identify the institutional/administrative controls necessary to implement the components of a remedy or related stewardship controls.

Issues to consider:

1. It is important that information about the controls (e.g., purpose of the controls) is complete, maintained, and accessible;
2. Institutional controls may be necessary to ensure that physical controls remain in use (e.g., the CAD/ROD may specify that a fence be kept around a cap);
3. The regulators may decide to identify institutional controls that would serve to mandate specific monitoring and maintenance requirements, or alternatively limit access to a monitoring station;
4. Institutional controls may also provide that information about residual contamination and final remedies be easily accessible and widely disseminated to all responsible parties;
5. Institutional controls may be used to establish the parameters for periodic assessments or to identify the responsible party to assess the institutional controls; and
6. Institutional controls will likely establish who will maintain and oversee the various stewardship controls.

Ancillary considerations:
The NRC recommends that project managers take into account the fact that physical controls fail, and thus stresses the importance of layering multiple controls to plan for uncertainty and fallibility [70].

In instances where land use controls are used, a number of questions arise. For example, is the land use control enforceable against a subsequent owner or user? Who enforces what against whom? If the property remains in federal ownership, does the state have enforcement rights? Is the relied upon control valid in the jurisdiction? If so, are there common law defenses to address? Where are deed restrictions registered? Is the deed language clear? Are the site real property personnel involved in designing the institutional controls, and are these controls built into the planning process? In considering these questions, one must recognize there is significant debate over the legality of such controls on federal land and, in turn, the political challenges in enforcing many of these institutional controls.

Finally, for many DOE sites, DOE and the regulators must coordinate land use controls with offsite land use authorities. Although "The Rocky Flats National Wildlife Act of 2001" mandates continued federal ownership, state law creates a statutory environmental covenant that serves to enforce use restrictions imposed in connection with remediation of contaminated sites.

General Questions/Issues (apply to all cells)

- What are the regulatory requirements guiding the use and management of the institutional controls?
- How will the institutional controls necessary to maintain the activities/use restrictions identified in Section 3.1 be enforced?
- Have the institutional controls been included in the appropriate decision document (e.g., the CAD/ROD)?
- How long will these controls have to be in effect?
- Have the life-cycle costs of all of these controls been included in the cost estimates? How do these costs compare to other remedial options?

Institutional Controls Necessary to Maintain the Remedy (Cell A3 and C1)

- What institutional controls will be used as part of the remedy to implement and maintain the given remedy?
- What are the performance requirements of the institutional controls?

Institutional Controls Necessary to Maintain the Physical Controls (Cell C2)

- What are the institutional controls necessary to maintain physical controls such as fences, signs, and security?
  - Provision in long-term stewardship plan or other regulatory requirement
  - Deed requirements
  - Written notification to agency
  - State of Colorado environmental covenant

Institutional Controls Necessary to Maintain the Monitoring and Maintenance Systems (Cell C4)

- What institutional controls will be used to ensure protection of and access to monitoring and maintenance systems?

Institutional Controls Necessary to Maintain the Information Management Systems (Cell C5)

- Are provisions in place to ensure the information management system is maintained? The final CAD/ROD may serve as the control that would necessitate the use and substance of the information management system.

Institutional Controls – Essential Questions

- What controls are included as part of the remedy?
- What controls are needed to maintain physical controls such as fences?
- What regulatory requirements drive the use of institutional controls?
- Do the stewardship documents include relevant information about the controls?

Institutional Controls Necessary to Ensure the Periodic Assessments Are Performed as Designed (Cell C6)

- Are controls established to ensure periodic assessments, such as the CERCLA five-year review, are conducted?

Institutional Controls Necessary to Ensure a Controlling Authority is Identified, Established, and Maintained (Cell C7)

- Are institutional controls in place to ensure there is a controlling authority to conduct stewardship activities? The control could be the final regulatory documents.

3.4 Monitoring and Maintenance

What is monitoring and maintenance: There are two distinct types of monitoring. Performance monitoring includes the review to ensure the remedy continues to be effective based on the output (e.g., water quality results) or impact (e.g., a treatment system working as designed) of the given remedy. Operational monitoring entails examining the effectiveness of the mechanics of the remedy (e.g., Is there oil in the engine? Are there iron filings in the passive groundwater treatment systems?). Operational monitoring also informs the regulators whether an action needs to be taken (e.g., Is the cap eroding such that it will need to be fixed?). Maintenance includes taking the steps necessary to keep the remedy effective; maintenance can be both preventative and corrective. The goal of monitoring and maintenance (M&M) is to ensure that the remedy remains effective until such time as it is no longer needed or a better remedy is developed and implemented. Toward this end, the lead agency will monitor both the remedy, as well as the physical, institutional, and administrative controls necessary to ensure that the remedy remains effective.

Why monitoring and maintenance are important: M&M are an essential part of implementing the remedy and are necessary to keep the remedy effective. Based on current knowledge of remedial technologies, some remedies will fail before the contamination has depleted. Therefore, it should be expected that monitoring and maintenance will reveal remedial failure, thereby necessitating corrective actions. A contingency plan should likewise be maintained and be ready for implementation should a control fail or not work as designed.

Objective of this part of the toolbox: The objective is to ensure that both the remedies (e.g., caps or water containment systems) and the controls used in conjunction with and in protection of the remedies are operating as designed. Monitoring and maintenance considerations include, but are not limited to, how often the remedy will be inspected and/or replaced, who will perform the performance and operational monitoring and periodic maintenance, and where these monitoring and maintenance requirements are captured.

Issues to consider:

1. Physical controls, like engineered controls such as caps and water containment systems, must be monitored and maintained so that the regulators know that the controls are operating as designed and performing their given function;
2. Institutional controls also need to be monitored and maintained as part of both implementing the remedy and ensuring their long-term effectiveness;

3. Monitoring systems need to be maintained; and
4. Information about remedies and controls will also need to be maintained.

General Questions/Issues (issues apply to all of the cells)

- Where will M&M be required?
  - M&M of the remedy, often referred to as an engineered control (e.g., containment structure); and/or
  - M&M of the controls necessary to maintain the remedy (e.g., a fence around a cap)
- What is the purpose of the monitoring?
  - To ensure that the remedy remains protective and is performing as designed (performance monitoring); and/or
  - To ensure that the remedy is operating as designed (operational monitoring).
- How will the M&M requirements be incorporated into the RFCA decision-making process and at what point(s)?
- What are the regulatory requirements for monitoring and maintenance?

Monitoring and Maintenance Needs to Maintain the Remedy – General Questions (Cell A4 and D1)

- How often will the remedy:
  - need to be inspected?
  - require replacement or repair?
- What are the anticipated performance and operational monitoring requirements and maintenance needs?
- Will the remedy require decommissioning?

Monitoring and Maintenance Requirements to Maintain the Remedy – Remedy and Media Specific (Cell A4 and D1)

Additional monitoring and maintenance issues may arise based on the individual remedy. The following tables provide examples of some of these M&M requirements linked to specific remedy options. These lists are by no means exhaustive. For instance, they focus on an area or control-specific monitoring and do not address the current ambient monitoring program.

Cap:

Performance Monitoring	Operational Monitoring	Maintenance
Inspections Groundwater monitoring	Leachate monitoring Cap integrity Vegetation	Vegetation management Rodent control Pipe/valve testing and repair Well replacement Berm/cover repair

Cover over contaminated soil:

Performance Monitoring	Operational Monitoring	Maintenance
Inspections Groundwater monitoring	Cover integrity Vegetation	Vegetation management Rodent control Well replacement Cover repair

Soil removal to levels above unrestricted use:

Performance Monitoring	Operational Monitoring	Maintenance
Inspections	Vegetation Erosion	Vegetation management Erosion management Rodent control

Subsurface contamination left in place:

Performance Monitoring	Operational Monitoring	Maintenance
Inspections Groundwater monitoring Effluent sampling	Vegetation Erosion Sediment levels Groundwater monitoring Dam integrity	Vegetation management Erosion management Rodent control Well replacement Sediment removal Bank stabilization Pipe/valve testing and repair

Monitored natural attenuation:

Performance Monitoring	Operational Monitoring	Maintenance
Inspections Groundwater monitoring		Well replacement

Groundwater barrier, collection and passive treatment:

Performance Monitoring	Operational Monitoring	Maintenance
Inspections Groundwater monitoring Effluent monitoring	Groundwater monitoring Effluent monitoring	Well replacement Treatment media replacement Structure repair/replacement

Surface water impoundment and settling:

Performance Monitoring	Operational Monitoring	Maintenance
Effluent sampling	Sediment levels Groundwater monitoring Dam integrity	Sediment removal Well replacement Bank stabilization Pipe/valve testing and repair

Monitoring and Maintenance Necessary to Maintain the Physical Controls (Cell D2)

- Wherever physical controls are used, they will have to be monitored and maintained. What are the monitoring and maintenance requirements to ensure the effectiveness of the physical controls? Periodic inspection of signs, and repair and replacement as necessary? Other?

Monitoring and Maintenance Necessary to Maintain the Institutional/Administrative Controls (Cell D3)

- What maintenance requirements are needed to ensure the institutional/administrative controls remain in place and operate as designed? Periodic review of records? Periodic review of performance monitoring data? Other?
- What are the contingency plans in case records are not maintained or accessible?

Maintenance Necessary to Maintain the Monitoring Systems (Cell D4)

- What maintenance requirements are needed to ensure the monitoring systems perform as designed?

Monitoring and Maintenance Necessary to Maintain the Information Management Systems (Cell D5)

- Does the document recognize, and identify if possible, the need for system upgrades, repairs, and replacements?

Monitoring and Maintenance Necessary to Ensure Periodic Assessments Are Performed as Designed (Cell D6)

- It is highly unlikely there will be any information for this cell. The converse, periodic assessment of the monitoring and maintenance systems (cell F4), is absolutely necessary whenever controls will be used.

Monitoring and Maintenance Necessary to Ensure the Maintenance of a Controlling Authority (Cell D7)

- It is highly unlikely there will be any information for this cell. The converse, controlling authority to ensure the monitoring and maintenance systems operate as designed (cell G4), is absolutely necessary whenever controls will be used.

M&M – Essential Questions

- What operational and performance monitoring will be included as part of the remedy?
  - How often will the remedy be inspected?
  - Will the remedy require decommissioning?
- What will be the scope of the monitoring program for the physical and institutional controls?
- What maintenance will be conducted as part of the remedy?
- What information will need to be retained and periodically assessed?

3.5 Information Management

What is information management: As DOE transitions from cleanup to long-term stewardship, the agencies will need detailed information about the remedies and residual contamination. DOE will thus need to establish mechanisms for the collection, retrieval, and storage of information needed for long-term stewardship.

Why information management is important: Information management goes to the heart of a successful stewardship program. Such systems are vital to the long-term management of a site in the future, years after the site has closed and the individuals with institutional knowledge have died. It is crucial that future generations have access to information, and that they are made aware that the information exists. Prior to closure, the existing information management system must act as an interim repository for long-term stewardship documents and related needs. This information will then eventually transfer to the site's long-term stewardship plan.

Objective of this part of the toolbox: The objective is to ensure that the information management systems contain the necessary information about the remedies, their implementation, and residual contamination, and that provisions are in place to ensure access by DOE, regulators, and community members to the necessary information.

Issues to consider:

1. Information management is a pivotal element of implementing a remedy;

2. Information about both the remedy and the controls needs to be retained to ensure the effectiveness of the remedy; and
3. Information about the institutional controls must be maintained to ensure that there is a robust periodic review of the information. The information must also be comprehensive and retrievable.

General Questions/Issues (apply to all cells)

- Do the decision documents suggest what type of information will need to be maintained in order to ensure the effectiveness of the remedy and controls?
- What are the criteria for identifying critical information?
- How and where will non-critical records be managed?
- Will there be a records archive and tracking system?
- Will local information centers or reading rooms continue to exist after closure, and if so, is there a funding mechanism to guarantee their continued existence?
- How will very old records that may be critical to future generations be preserved?
- How will future generations be made aware that the necessary information exists?
- What are the regulatory requirements guiding information management?
- Are provisions in place to ensure information about the remedy and related controls is easily accessible and widely disseminated to all responsible and interested parties?

Information Management Systems as Part of the Remedy (Cell A5 and E1)

- Does the remedy identify the long-term record keeping requirements?
- Do the decision document and subsequent regulatory documents list the critical documents pertaining to the selected remedy that must be retained?
- What information about the remedy will need to be maintained?

Information Management Necessary to Maintain the Physical Controls (Cell E2)

- What information about the physical controls will be needed in order to ensure their long-term effectiveness?
- Is that information easily accessible?

Information Management Necessary to Maintain the Institutional Controls (Cell E3)

- What information about the institutional controls will be needed?
- Is that information easily accessible to ensure the long-term effectiveness of the control?

Information Management Necessary to Maintain the Monitoring and Maintenance Systems (Cell E4)

- Where are the M&M requirements captured?
  - The long-term monitoring plan (Integrated Monitoring Plan)
  - Long-Term Stewardship Plan
- An effective M&M plan could require access to the following information:
  - Long-term monitoring plan
  - Monitoring and maintenance data, records and reports
  - Discharge permits
  - Monitoring and maintenance contract

Information Management Necessary to Ensure the Periodic Assessments Are Performed as Designed (Cell E6)

- The following information needs should also be addressed:
  - Who will periodically assess which documents are no longer needed?
  - What will be the guidelines for document disposal?
  - Who will perform the yearly analytical data review/report?
- How will the site, and future stewards, ensure the information will be in a retrievable format that is updated along with current technology?
- Has the site prepared a five-year review inspection checklist that identifies the records that must be reviewed?

Information Management Necessary to Ensure the Maintenance of a Controlling Authority (Cell E7)

- What information will be needed to ensure a controlling authority remains?

Information Management – Essential Questions

- What information will be needed to implement the remedy?
- What information about residual contamination will need to be maintained?
- What information about physical and institutional controls will be needed by the stewards?
- What information will be reviewed during the periodic assessments?
  - Performance monitoring data?
  - Operational monitoring data?
  - Engineering designs?
  - Other?
- How will information be accessed and made available to the stewards and future generations?

3.6 Periodic Assessment

What is a periodic assessment: The CERCLA five-year review process is required for all Superfund sites that leave residual contamination behind after closure. The EPA "Comprehensive Five-Year Review Guidance," dated June 2001 [208], describes the format of the five-year review and suggests mechanisms that can be implemented through the five-year review process to assure the protectiveness of the remedy. DOE is responsible for conducting the five-year reviews and then EPA issues a finding of concurrence or non-concurrence. RCRA also requires periodic assessment.

This periodic assessment would include actions such as evaluating monitoring and maintenance records, looking at how information records are being maintained, verifying regulatory compliance, and determining whether land use assumptions are still valid. An important part of managing the assessment program is to develop and be ready to implement contingencies in the event of failed performance of either the remedy or its associated controls.

Why periodic assessments are important: The periodic assessment is necessary to validate the original remedy assumptions and ensure the remedy remains effective. The assessment should also determine if the remedy and associated long-term stewardship controls remain the most effective option available based on new research and development.

Objective of this part of the toolbox: The objective is to identify the scope and elements of the periodic review.

Issues to consider:

1. Physical controls, like engineered barriers, must be periodically assessed to determine their effectiveness;
2. Institutional controls and the information management systems must likewise be periodically assessed to determine their effectiveness; and
3. Periodic assessment of the monitoring and maintenance systems and associated output is essential to implementing the remedies.

General Questions/Issues (apply to all cells)

- Will the remedy be inspected regularly?
- What are the regulatory requirements regarding periodic assessments?
- Will the review include an assessment of new laws, regulations, and standards?
- Will the review provide procedures for recalculating the risk or the risk assessment if standards, land use assumptions, or site conditions change significantly?
- Will the review include procedures for evaluating the exposure assumptions?
- Will the review include interviews with local government and community members?
- Will the review include public hearings and opportunities for comment?
- Will EPA provide local governments and citizens with copies of their status reports and, if so, how will these reports be disseminated?
- Will the review include an assessment of new research and technologies that could be applied?

Periodic Assessment of the Remedy (Cell A6 and F1)

- Does the regulatory document adequately specify the objectives and goals of the remedy?
- What is the scope of the periodic remedy review?
- Will the review assess the effectiveness of the remedy in performing its intended functions (e.g., reducing groundwater contamination)?
- Have the relevant agencies identified the parameters that ensure the remedy is operating correctly?
- Is the remedy effective and protective?
- Is the remedy functioning as intended?

Periodic Assessment of the Physical Controls (Cell F2)

- What is the scope of the periodic review of the physical controls?
- Will the review assess the effectiveness of the controls in performing their intended functions (e.g., restricting access)?

Periodic Assessment of the Institutional Controls (Cell F3)

- Do the remedy and subsequent regulatory documents adequately specify the objectives and goals of the institutional controls?
- Do the guidelines include procedures for maintaining and modifying, as necessary, institutional controls if standards, land use assumptions, or site conditions change significantly?

- Do the regulatory documents, including the final CAD/ROD and long-term stewardship plan, specify procedures for reevaluating the remedy if institutional controls fail?

Periodic Assessment of the Monitoring and Maintenance Systems (Cell F4)
- Are the monitoring and maintenance systems effective and operating as intended?
- How often will their effectiveness be assessed?
- Will the periodic assessment include an evaluation of whether the stewards should reduce the scope of the monitoring program?

Periodic Assessment of the Information Management Systems (Cell F5)
- Will the review assess the effectiveness of the information management systems?

Periodic Assessment of the Effectiveness of the Controlling Authority (Cell F7)
- Will the periodic assessment include an evaluation of the effectiveness of the controlling authority?

Periodic Assessment – Essential Questions
- What is the frequency and scope of the review?
- What are the procedures for reporting the findings of the review?
- Will the assessment include an evaluation of whether the stewards should reduce the scope of the monitoring program after closure?

3.7 Controlling Authority

What is controlling authority: Long-term protection of human health and the environment requires that clear lines of authority and responsibility exist for implementing and overseeing long-term actions stewardship activities. A controlling authority will monitor the long-term stewardship program, making sure that activities such as routine monitoring and maintenance are conducted on schedule, that unfavorable conditions are corrected, and that funding for program implementation is secured.

Key participants in this process at Rocky Flats include the following:
- The DOE is the party responsible for the environmental contamination at Rocky Flats and has responsibility for cleanup, including the implementation of any measures required to ensure protection of human health and the environment from this contamination (primarily under CERCLA, RCRA and the Colorado Hazardous Waste Act [CHWA]). DOE is also the Lead Federal Agency under CERCLA, and is thus responsible for ensuring that CERCLA requirements are met for long-term remedies.
- The EPA has responsibility for overseeing DOE's implementation of CERCLA and must concur on DOE's adherence to CERCLA requirements for long-term remedies.
- The CDPHE oversees DOE's implementation of the long-term requirements under RCRA and CHWA and has direct enforcement authority for RCRA/CHWA requirements. In addition, CDPHE may comment on DOE's implementation of the long-term requirements of CERCLA.

Why a controlling authority is important: Long-term protection of human health and the environment necessitates that a controlling authority be established. With responsibility for overall program management and guidance, the controlling authority helps ensure stewardship controls remain protective.

Objective of this part of the toolbox: The objective is to ensure that clear lines of authority are established and that the role of each entity is clearly identified. This section is also designed to ensure the long-term stewardship program goals are implemented.

Issues to consider:

1. A separate external authority not affiliated with the entity responsible for overall management of the stewardship program should oversee the implementation of the stewardship plan;
2. This external authority should provide independent verification that the overall stewardship program is meeting its goals; and
3. The clear assignment and acceptance of responsibility to both create and maintain the stewardship controls must be established.

Controlling Authority as Part of the Remedy (Cell A7 and G1)

- Who will direct the long-term stewardship program, and who else will be involved in direct oversight of program?
- Who will secure funding for the long-term stewardship program?

Controlling Authority Necessary to Maintain and Assess the Physical Controls (Cell G2)

- Who will ensure that physical controls are monitored and maintained, and that data are collected, analyzed, and distributed according to the long-term stewardship plan?

Controlling Authority to Maintain the Institutional Controls (Cell G3)

- Who has clear assignment and acceptance of responsibility to both create and maintain the institutional controls?
- Who will be responsible for coordinating institutional controls and ensuring the controls are working?
- What will be the role, if any, of state and local agencies in providing oversight of these controls?

Controlling Authority to Ensure the Monitoring and Maintenance Systems Operate Properly (Cell G4)

- Who will be responsible for coordinating the monitoring and maintenance systems and ensuring all system needs are being met?
- What will be the role, if any, of state and local agencies in monitoring the remedies?

Controlling Authority to Ensure Information Management Systems Operate Properly (Cell G5)

- Who will be responsible for coordinating and

Controlling Authority – Essential Questions

- Who will be the primary stewards?
- Who will direct the program including:
  - Ensuring that the remedies are performing as designed?
  - Coordinating the monitoring and maintenance?
  - Coordinating and maintaining information systems?
  - Ensuring adequate funding?
- What are the regulators assuming about the role of local governments?
- What opportunities will there be for community involvement, including independent external oversight of the program?

maintaining the information management systems?
- What information will be maintained and where will it be housed?

Controlling Authority to Ensure the Periodic Assessments Are Performed as Designed (Cell G6)
- Who will be responsible for coordinating federal and state assessments?

4 Examples of Completed Toolboxes

The following completed toolboxes provide examples of the type of long-term activities that may be required for different remedy alternatives. The information contained in these examples is not meant to suggest that the issues identified are exhaustive. Rather, these examples are illustrative of the type of information that needs to be considered and included in the toolbox and corresponding analysis. It is assumed that additional stewardship program needs will be added as a thorough analysis of the stewardship program is undertaken.

Example 1: Surface Water Impoundment and Settling

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring & Maintenance*	Information Management	Periodic Assess-ment	Controlling Authority
Proposed/ Chosen Remedy	**Surface water impound-ment and settling**	Signs, fences, security	Access restrictions	Effluent sampling, sediment levels, groundwater monitoring, dam integrity, sediment removal, well replacement, bank stabilization, pipe/valve testing & repair	Pond and contaminant location	Effective-ness of ponds in contain-ing sediment	CAD/ROD (DOE, EPA, CDPHE); Direct program, and secure funding
Physical Controls	Fences, signs, security		CAD/ROD, LTS Plan	Periodic inspection, repair or replace access, fences, signs	Inspection records, repair/replace -ment records	Effective-ness of controls in restricting access	DOE; Direct program, and secure funding
Institu-tional / Admini-strative Controls	Access restrictions	N/A		Periodic inspection and update/replace implementing documents or systems	Record of restrictions and responsibili-ties for implementing	Effective-ness of controls in restricting access	DOE, property manager, records manager
Monit-oring & Mainten-ance	Effluent sampling Sediment levels, groundwater monitoring, dam integrity Sediment removal, well replacement, bank stabilization, pipe/valve testing & repair	Protect sampling station, provision for access	Provisions for access	Update/repair sampling station and access, inspections	Sampling results and interpretation, record of referral to maintenance, reporting to State Engineer, record of inspections, repair and replacement, record of sediment removal and disposal, program description	Effective-ness of sampling, monitor-ing and mainten-ance program	DOE, DOE contractor; Direct program and secure funding

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring & Maintenance*	Information Management	Periodic Assess-ment	Controlling Authority
Informa-tion Manage-ment	Pond and contaminant location	Access-ibility, retriev-ability and security	CAD/ROD; Accessibility, retrievability and security	Information updates, system upgrade, repair and replacement, including user tools		Effective-ness of informa-tion accessibil-ity, retrieva-bility and security	DOE, EPA, CDPHE; Direct program and secure funding
Periodic Assess-ment	Effectiveness of ponds in containing sediment	N/A	Institutionalize requirement, and ensure assessment occurs	Review and concurrence, institutionalize process (checklist, etc.)	Compile, maintain and announce record, trigger for corrective action		DOE, EPA, CDPHE; Direct program and secure funding
Control-ling Author-ity	CAD/ROD (DOE, EPA, CDPHE); direct program, secure funding	N/A	Institutionalize authority (CAD/ROD)	N/A	Keep records of controlling authority's actions, ensure a controlling authority remains	Effective-ness of authority; Provide independ-ent external oversight	

*Includes operational and performance monitoring

Example 2: Cap

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring and Maintenance*	Information Management	Periodic Assess-ment	Controlling Authority
Proposed/ Chosen Remedy	**Cap**	Signs, fences, security	Surface (limited) and subsurface access restrictions	Inspections, groundwater monitoring, leachate monitoring, cap integrity, vegetation management, rodent control, pipe/valve testing & repair, well replacement, berm/cover repair	Cap and contaminant location	Effec-tiveness in contain-ing waste/ contam-ination	CAD/ROD (DOE, EPA, CDPHE); Direct program, and secure funding
Physical Controls	Cap, signs, fences, security		CAD/ROD, LTS Plan, land use controls	Periodic inspection, repair or replace access, fences, signs, and erosion or rodent damage, vegetation management	Inspection records, repair/replace -ment records	Effec-tiveness of controls in restrict-ing access	DOE; Direct program, and secure funding
Institu-tional / Adminis-trative Controls	Surface (limited) and subsurface access restrictions	N/A		Periodic inspection and update/replace implementing documents or systems	Record of restrictions and responsibili-ties for implementing	Effec-tiveness of controls in restrict-ing access	DOE, property manager, records manager
Monitor-ing and Mainten-ance	Inspections, groundwater monitoring, leachate monitoring, cap integrity, vegetation management and rodent control, pipe/valve testing & repair, well replacement, berm/cover repair	Provision for access, protect sampling station;	Provision for access	Update/repair sampling station and access, inspections	Sampling results and interpretation, record of referral to maintenance, record of inspections, repair and replacement, program description	Effec-tiveness of samp-ling & inspec-tion and monitor -ing & mainten -ance program	DOE, DOE contractor; Direct program, and secure funding

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring and Maintenance*	Information Management	Periodic Assess-ment	Controlling Authority
Informa-tion Manage-ment	Cap and contaminant location	Access-ibility, retriev-ability and security	CAD/ROD; Accessibility, retrievability and security	Information updates, system upgrade, repair and replacement, including user tools		Effec-tiveness of informa-tion access-ibility, retriev-ability and security	DOE, EPA, CDPHE; Direct program, and secure funding
Periodic Assess-ment	Effective-ness in containing waste/ contamina-tion	N/A	Institutionalize requirement	Review and concurrence, institutionalize process (checklist, etc.)	Compile, maintain and announce record, trigger for corrective action		DOE, EPA, CDPHE; Direct program, and secure funding
Control-ling Authority	CAD/ROD (DOE, EPA, CDPHE); Direct program, secure funding	N/A	Institutionalize authority (CAD/ROD)	N/A	Keep records of controlling authority's actions, ensure a controlling authority remains	Effec-tiveness of author-ity, provide indepen-dent external over-sight	

*Includes operational and performance monitoring.

Example 3: Cover Over Contaminated Soil

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring & Maintenance*	Information Management	Periodic Assess-ment	Controlling Authority
Proposed/ Chosen Remedy	**Cover over contamin-ated soil**	Signs, fences, security	Surface (limited) and subsurface access restrictions	Inspections, groundwater monitoring, cover integrity, vegetation management, rodent control, well replacement, cover repair	Cover and contaminant location	Effec-tiveness in contain-ing waste/ contam-ination	CAD/ROD (DOE, EPA, CDPHE); Direct program, and secure funding
Physical Controls	Cover, signs, fences, security		CAD/ROD, LTS Plan, land use controls	Periodic inspection, repair or replace access, fences, signs, erosion or rodent damage, vegetation management	Inspection records, repair/replace -ment records	Effec-tiveness of controls in restrict-ing access	DOE; Direct program, and secure funding
Institu-tional / Adminis-trative Controls	Surface (limited) and subsurface access restrictions	N/A		Periodic inspection and update/replace implementing documents or systems	Record of restrictions and responsibili-ties for implementing	Effec-tiveness of controls in restrict-ing access	DOE, property manager, records manager
Monitor-ing and Mainten-ance	Inspections, groundwater monitoring, cover integrity, vegetation management and rodent control, well replacement, cover repair	Provision for access, protect sampling station	Provision for access	Update/repair sampling station and access, inspections	Sampling results and interpretation, record of referral to maintenance, record of inspections, repair and replacement, program description	Effec-tiveness of sampl-ing & inspec-tion and monitor -ing & mainten -ance program	DOE, DOE contractor; Direct program, and secure funding

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring & Maintenance*	Information Management	Periodic Assess-ment	Controlling Authority
Informa-tion Manage-ment	Cover and contaminant location	Access-ibility, retriev-ability and security	CAD/ROD; Accessibility, retrievability and security	Information updates, system upgrade, repair and replacement, including user tools		Effec-tiveness of informa-tion access-ibility, retriev-ability and security	DOE, EPA, CDPHE; Direct program, and secure funding
Periodic Assess-ment	Effective-ness in containing waste/con-tamination	N/A	Institutionalize requirement	Review and concurrence, institutionalize process (checklist, etc.)	Compile, maintain and announce record, trigger for corrective action		DOE, EPA, CDPHE; Direct program, and secure funding
Control-ling Authority	CAD/ROD (DOE, EPA, CDPHE); direct program, secure funding	N/A	Institutionalize authority (CAD/ROD)	N/A	Keep records of controlling authority's actions, ensure a controlling authority remains	Effec-tiveness of author-ity, provide indepen-dent external over-sight	

*Includes operational and performance monitoring.

Example 4: Soil Removal to Tier I Level

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring & Maintenance*	Information Management	Periodic Assess-ment	Controlling Authority
Proposed/ Chosen Remedy	**Soil removal to Tier I level**	Signs, fences, security	Surface (limited) and subsurface access restrictions	Inspections, vegetation & erosion management, rodent control	Contaminant location	Effec-tiveness in contain-ing contam-ination	CAD/ROD (DOE, EPA, CDPHE); Direct program, and secure funding
Physical Controls	Signs, fences, security		CAD/ROD, LTS Plan	Periodic inspection, repair or replace access, fences, signs, erosion or rodent damage, vegetation management	Inspection records, repair/replace -ment records	Effec-tiveness of controls in restrict-ing access	DOE; Direct program, and secure funding
Institu-tional / Adminis-trative Controls	Surface (limited) and subsurface access restrictions	N/A		Periodic inspection of implementing documents or systems, update/replace documents or systems	Record of restrictions and responsibili-ties for implementing	Effec-tiveness of controls in restrict-ing access	DOE, property manager, records manager
Monitor-ing and Mainten-ance	Inspections Vegetation & erosion management and rodent control	Provision for access	Provision for access	Update/repair access, inspections	Inspection reports, record of referral to maintenance, record of inspections, repair and replacement, program description	Effec-tiveness of inspec-tion and mainten -ance program	DOE, DOE contractor; Direct program, and secure funding
	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring & Maintenance*	Information Management	Periodic Assess-ment	Controlling Authority

Information Management	Contaminant location	Accessibility, retrievability and security	CAD/ROD; Accessibility, retrievability and security	Information updates; system upgrade, repair and replacement, including user tools		Effectiveness of information accessibility, retrievability and security	DOE, EPA, CDPHE; Direct program, and secure funding
Periodic Assessment	Effectiveness in containing contamination	N/A	Institutionalize requirement	Review and concurrence, institutionalize process (checklist, etc.)	Compile, maintain and announce record, trigger for corrective action		DOE, EPA, CDPHE; Direct program, and secure funding
Controlling Authority	CAD/ROD (DOE, EPA, CDPHE); direct program, secure funding	N/A	Institutionalize authority (CAD/ROD)	N/A	Keep records of controlling authority's actions, ensure a controlling authority remains	Effectiveness of authority, provide independent external oversight	

*Includes operational and performance monitoring.

Example 5: Subsurface Contamination Left in Place

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring & Maintenance*	Information Management	Periodic Assess-ment	Controlling Authority
Proposed/ Chosen Remedy	**Subsurface contamina-tion left in place**	Signs, fences, security	Surface (limited) and subsurface access restrictions	Inspections, groundwater monitoring, erosion and vegetation management, rodent control, well replacement	Contaminant location	Effec-tiveness in contain-ing contam-ination	CAD/ROD (DOE, EPA, CDPHE); Direct program, and secure funding
Physical Controls	Signs, fences, security		CAD/ROD, LTS Plan, land use controls	Periodic inspection, repair or replace access, fences, signs, erosion or rodent damage, vegetation management	Inspection records, repair/replace -ment records	Effec-tiveness of controls in restrict-ing access	DOE; Direct program, and secure funding
Institu-tional / Adminis-trative Controls	Surface (limited) and subsurface access restrictions	N/A		Periodic inspection of implementing documents or systems, update/replace documents or systems	Record of restrictions and responsibili-ties for implementing	Effec-tiveness of controls in restrict-ing access	DOE, property manager, records manager
Monitor-ing & Mainten-ance	Inspections, groundwater monitoring vegetation &erosion management and rodent control, well replacement	Provision for access, protect sampling station	Provision for access	Update/repair sampling station and access, inspections	Sampling results and interpretation, record of referral to maintenance, record of inspections, repair and replacement, program description	Effec-tiveness of sampl-ing & inspect-ion and monitor -ing & mainten -ance program	DOE, DOE contractor; Direct program, and secure funding

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring & Maintenance*	Information Management	Periodic Assess-ment	Controlling Authority
Informa-tion Manage-ment	Contaminant location	Access-ibility, retriev-ability and security	CAD/ROD; Provision for access	Information updates, system upgrade, repair and replacement, including user tools		Effec-tiveness of inform-ation acces-sibility, retriev-ability and security	DOE, EPA, CDPHE; Direct program, and secure funding
Periodic Assess-ment	Effective-ness in containing contamin-ation	N/A	Institutionalize requirement	Review and concurrence, institutionalize process (checklist, etc.)	Compile, maintain and announce record; trigger for corrective action		DOE, EPA, CDPHE; Direct program, and secure funding
Control-ling Authority	CAD/ROD (DOE, EPA, CDPHE); direct program, secure funding	N/A	Institutionalize authority (CAD/ROD)	N/A	Keep records of controlling authority's actions, ensure a controlling authority remains	Effec-tiveness of author-ity, provide indepen-dent external over-sight	

*Includes operational and performance monitoring.

Example 6: Monitored Natural Attenuation of Groundwater

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring & Maintenance*	Information Management	Periodic Assess-ment	Controlling Authority
Proposed/ Chosen Remedy	**Monitored Natural Attenuation of Ground-water**	Signs, security	Subsurface access restrictions	Inspections, groundwater monitoring, well replacement	Contaminant location	Contam -inant immo-bility	CAD/ROD (DOE, EPA, CDPHE); Direct program, and secure funding
Physical Controls	Signs, security		CAD/ROD, LTS Plan	Periodic inspection, repair or replace access, signs signs	Inspection records, repair/replace -ment records	Effec-tiveness of controls in restrict-ing access	DOE; Direct program, and secure funding
Institu-tional / Adminis-trative Controls	Subsurface access restrictions	N/A		Periodic inspection of implementing documents or systems, update/replace documents or systems	Record of restrictions and responsibili-ties for implementing	Effec-tiveness of controls in restrict-ing access	DOE, property manager, records manager
Monitor-ing & Mainten-ance	Inspections, groundwater monitoring, well replacement	Provision for access, protect sampling station	Provision for access	Update/repair sampling station and access, inspections	Sampling results and interpretation, record of referral to maintenance, record of inspections, repair and replacement, program description	Effec-tiveness of sampl-ing & inspec-tion and monitor -ing & mainten -ance program	DOE, DOE contractor; Direct program, and secure funding

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring & Maintenance*	Information Management	Periodic Assess-ment	Controlling Authority
Informa-tion Manage-ment	Contaminant location	Access-ibility, retriev-ability and security	CAD/ROD; Accessibility, retrievability and security	Information updates, system upgrade, repair and replacement, including user tools		Effec-tiveness of informa-tion access-ibility, retriev-ability and security	DOE, EPA, CDPHE; Direct program, and secure funding
Periodic Assess-ment	Contaminant immobility	N/A	Institutionalize requirement	Review and concurrence, institutionalize process (checklist, etc.)	Compile, maintain and announce record, trigger for corrective action		DOE, EPA, CDPHE; Direct program, and secure funding
Control-ling Authority	CAD/ROD (DOE, EPA, CDPHE); direct program, secure funding	N/A	Institutionalize authority (CAD/ROD)	N/A	Keep records of controlling authority's actions, ensure a controlling authority remains	Effec-tiveness of author-ity, provide indepen-dent external over-sight	

*Includes operational and performance monitoring.

Example 7: Groundwater Barrier, Collection and Passive Treatment

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring & Maintenance	Information Management	Periodic Assess ment	Controlling Authority
Proposed/ Chosen Remedy	**Ground-water barrier, collection and passive treatment**	Signs, fences, security	Subsurface access restrictions	Inspections, effluent and groundwater monitoring, well replacement, treatment media replacement, pipe and structure repair/ replacement	Contaminant location	Contam -inant removal	CAD/ROD (DOE, EPA, CDPHE); Direct program, and secure funding
Physical Controls	Signs, fences, security		CAD/ROD, LTS Plan	Periodic inspection, repair or replace access, signs and fences	Inspection records, repair/replace -ment records	Effec-tiveness of controls in restrict-ing access	DOE; Direct program, and secure funding
Institu-tional / Administr ative Controls	Subsurface access restrictions	N/A		Periodic inspection of implementing documents or systems, update/replace documents or systems	Record of restrictions and responsibilitie s for implementing	Effec-tiveness of controls in restrict-ing access	DOE, property manager, records manager
Monitor-ing & Mainten-ance	Inspections, effluent and groundwater monitoring, well replacement, treatment media replacement, pipe and structure repair/ replacement	Provision for access, protect sampling station	Provision for access	Update/repair sampling station and access, inspections	Sampling results and interpretation, record of referral to maintenance, record of inspections, repair and replacement; program description	Effec-tiveness of sampl-ing & inspec-tion and monitor -ing & mainten -ance program	DOE, DOE contractor; Direct program, and secure funding

	Proposed/ Chosen Remedy	Physical Controls	Institutional / Administrative Controls	Monitoring & Maintenance	Information Management	Periodic Assess ment	Controlling Authority
Informa-tion Manage-ment	Contaminant location	Access-ibility, retriev-ability and security	CAD/ROD; Accessibility, retrievability and security	Information updates, system upgrade, repair and replacement, including user tools		Effec-tiveness of inform-ation access-ibility, retriev-ability and security	DOE, EPA, CDPHE; Direct program, and secure funding
Periodic Assess-ment	Contaminant removal	N/A	Institutionalize requirement	Review and concurrence, institutionalize process (checklist, etc.)	Compile, maintain and announce record, trigger for corrective action		DOE, EPA, CDPHE; Direct program, and secure funding
Control-ling Authority	CAD/ROD (DOE, EPA, CDPHE); direct program, secure funding	N/A	Institutionalize authority (CAD/ROD)	N/A	Keep records of controlling authority's actions, ensure a controlling authority remains	Effec-tiveness of author-ity, provide indepen-dent external over-sight	

*Includes operational and performance monitoring.

5 Conclusion

As Rocky Flats and other sites around the country grapple with long-term stewardship responsibilities and options, the Rocky Flats Stewardship Working Group encourages project managers to utilize the tools presented in this report and in "Hand-In-Hand: Stewardship and Cleanup." The Stewardship Working Group members have spent a great deal of time investigating how best to assess stewardship requirements and remedy options. The ideas contained within these reports, while not exhaustive, are a very thorough account of the issues surrounding long-term stewardship planning. The Stewardship Working Group will continue to develop the ideas and tools presented here and advocate for the best possible decisions for the long-term health and safety of the surrounding communities.

The Stewardship Working Group also encourages DOE to continue to develop strategies for addressing the myriad of unresolved issues relating to uncertainty and cost estimation. Without improvements in this area, many already difficult decisions will be made without complete information and may need to be revisited, at additional cost, at a future date.

APPENDIX A

DESCRIPTION OF STEWARDSHIP CONTROLS

Physical and Institutional Stewardship Controls

The toolbox defined processes for determining appropriate considerations associated with long-term remedies. This appendix provides additional detail and discussion about those considerations. Over time, additional knowledge will be gained that may change some of this discussion.

These considerations are grouped by physical controls and institutional controls. Within each section and as available, the discussion covers a description, technical aspects, public acceptance, whether the item was included in the Rocky Flats Stewardship Cost Estimate provided to Congress in 2000, advantages and disadvantages, and case study information. Sections not considered applicable to Rocky Flats are also noted. Items addressed are as follows:

Physical Controls
I. Caps, Covers, and Liners
II. Subsurface Barriers
III. Access Deterents
IV. Ponds and Ditches

Institutional Controls
I. Governmental Controls
II. Proprietary Controls
III. Enforcement Tools
IV. Informational Devices
V. Planning Systems

The research compiled in Appendix A was conducted and written by John McCartney (CDPHE). Although the research in Appendix A was commissioned by the Stewardship Working Group, it has not been subjected to any Stewardship Working Group review and therefore does not necessarily reflect the views of the Working Group, and no official endorsement should be inferred. We provide it because we believe it adds important value to any stewardship dialogue.

References cited in Appendix A can be found in Appendix C, the Long-Term Stewardship Bibliography.

Physical Controls

Physical controls are the primary barriers to limit unauthorized access to contaminants and to limit exposure to hazards that exist on the site after remediation is complete. These controls "physically" reside at the site of or in near proximity to the actual contamination, and may include containment structures such as caps (also referred to as engineered controls), and access barriers such as fences.

I. Caps, Covers, and Liners

A. Soils

1. Materials

- Different soil types have different strength and hydraulic behaviors. Soil is composed of solid particles which do not fit together in a completely contiguous mass. The spaces between particles, called pores, may be filled with liquid (water, leachate, oil) and/or gas (air, landfill emissions). This combination of three phases causes the soil to act as a unique material.
- Sand and gravel are made from large particles (two millimeters to several centimeters in diameter), and rely on gravity to hold the soil mass together. Water is able to flow through the pore spaces very easily. The large sizes of the particles imply that shear forces may be resisted by both the roughness of the particles and their interlocking geometry. Sand (and all other soils) does not have any tensile strength.
- Clays, which consist of much finer particles, behave in a plastic manner because there is adhesion between the particles. Clays are the end product of weathering processes, thus individual solid particles are often smaller than 2 micrometers (colloid size). A unique property of clay minerals is their electrically negative charge. The particles attract positively charged material, which is often found in electrolyte rich groundwater. Films of water form over the clay particles, creating an adhesive mass. Because of these tightly bonded particles, water flow is impeded through the clay matrix, resulting in a much lower hydraulic conductivity than larger grained soils. Clays do not have a very high shear strength compared to sands and gravels.

2. Applications

- Clay is often used as a hydraulic barrier because of its ability to restrict the flow of water from one area to another. Water will still pass through the soil, but the rate and volume of the water flow are insignificant. These hydraulic barriers used in landfill applications are often called Compacted Clay Liners (CCL). A unique property of compacted clay is that the soil will "shrink" as water is removed by evaporation, causing the soil to crack. This is a limitation of using CCLs in arid regions.
- Sand is often used as engineering backfill because of its high shear strength. Sand has also been used as a drainage layer, because water may flow laterally through the soil with little impedence.

B. Geosynthetics

1. Materials

- The use of geosynthetics, including continuous, woven, or non-woven synthetic polymers in cap-liner systems, is a relatively new technology.

2. Types and Applications
   - Geomembranes act as hydraulic barriers, geotextiles act as filters, protection layers and soil enforcements; geonets act as drainage layers; geogrids act as soil reinforcements; geosynthetic clay liners (GCLs) act as a composite soil-geosynthetic hydraulic barrier; geocells act as erosion controls; wick drains act as vertical drains; and geopipes act as drainage conduits. There are several other types and applications of geosynthetics being investigated, and their presence is an asset to geotechnical and geoenvironmental design.
   - Although many of these applications (hydraulic barrier, protection layers, drains) may be accomplished using soil materials, geosynthetics tend to be more consistent in their properties and expected performance and more readily available than specific soils like clay, and require less vertical space in a landfill allowing more waste to be contained. However, geosynthetics may be more costly and prove to be more difficult to place properly in the field than soils used for these applications.
   - In landfills, the main uses of geosynthetics are for hydraulic barriers, drainage layers, protection layers, reinforcements and erosion controls. Hydraulic barriers limit the flow of liquid into and out of the landfill, where hazardous materials generated from the waste must be isolated. Drainage layers allow any liquid generated by or passed through the waste to be collected, or may act as leakage detection layers. Protection layers protect other geosynthetics from sharp or heavy objects that may be present in a landfill, increasing the puncture resistance and bearing capacity. Reinforcement layers provide tensile strength to a cover or liner, resisting slope failures and allowing covers to function under differential settlement of the underlying waste. Erosion layers provide a lasting stabilization to surface soils that would otherwise be eroded by surface water flow or wind.
   - The performance of a specific geosynthetic may be susceptible to chemical, biological and UV degradation, construction damage, and time dependent stress-strain behavior. For this reason, geosynthetics used in a landfill design must be made from polymers or configurations selected to resist the (expected) chemical and biological composition of the contained waste or leachate and should not be left in direct sunlight. Placement in the field should be done with adequate quality control and quality assurance.
   - Geosynthetics can be used for a wide range of functions in a cap system, such as horizontal or vertical barriers for limiting seepage into the contaminated waste, filters, leachate drains, soil reinforcement and erosion control of soil above the waste.

C. RCRA Subtitle D and C Cap-Liner Systems

1. RCRA Subtitle D
   - This regulation applies to new municipal solid waste (MSW) landfills.
   - The regulations provide sighting resistance for the landfills which include proximity limits to airports, floodplains, seismic zones, wetlands, and unstable

areas. In addition, the regulations provide minimum design criteria for MSW landfills and require long-term financial obligations from the landfill owner.

- Landfill owners are required to monitor the landfill's hydraulic performance at at least one point of compliance for 30 years following closure. The owner must also prove that he is financially able to cover the costs of a landfill failure throughout the life of the landfill.
- Liner Design: Composite liner with a CCL (hydraulic conductivity greater than 10^{-7} cm/s) at least 0.6 meters deep, overlain by a geomembrane which is overlain by a soil/geosynthetic protection and drainage layer.
- Cover/Closure Design: CCL (hydraulic conductivity greater than 10^{-5} cm/s) or material with equivalent hydraulic performance of the liner. This is a contested requirement, and typically depends on the state's approval of the cover. The CCL is covered by an erosion protection layer with vegetation.

2. RCRA Subtitle C
    - This regulation supplies prescribed designs for new hazardous waste (HW) landfills. The information included is similar to RCRA Subtitle D, except for the landfill design requirements, which are stricter.
    - The same long-term requirements are made for the landfill owner, but monitoring requirements and financial obligations may be greater, depending on the situation.
    - Liner Design: Double composite liner with each layer being similar to the single composite layer required by RCRA Subtitle D.
    - Cover/Closure Design: Composite CCL and HDPE equivalent to the RCRA Subtitle D liner system. This is typically overlain by an erosion protection layer and vegetation.
3. Technical Aspects
    - RCRA C and D caps are designed to function for 1000 years, but a conservative estimate of their lifetime is 200 years [181, pg. 13].
    - When these caps are used for hazardous material, they must be designed according to the guidelines set forth by RCRA Subtitle C, or prove that they are equivalent [107, pg. 27].
4. Public Acceptance
    - The Rocky Flats Citizens Advisory Board (CAB) believes that low-level waste containment systems such as cap-liner systems are not acceptable long-term solutions. If used, the CAB suggests monitoring these systems every five years and replacing or refurbishing the system after 200 years [105, pg. 9].
    - Covers can have many different aesthetically pleasing finishes, making them a good solution for a "natural" look in a wildlife refuge.
    - The use of caps, barriers or pumping in containment systems to prevent additional migration of contaminants may achieve design criteria, but they also imply a need for monitoring, maintenance, repair and replacement activities. All of these factors contribute to the life-cycle cost of a system, so they should be appropriately weighed in comparing remedies and long-term physical containment [205, pg. 6].
5. Rocky Flats Stewardship Cost Estimate

- The cost estimate assumes that RCRA type caps will be used at five disposal sites totaling 90 acres on the site. The Rocky Flats Cost Estimate does not identify the original cost of a RCRA type double lined HDPE barrier system as a stewardship cost, but as a cleanup cost. DOE assumes that there will be no maintenance or replacement of any barrier systems within the next 70 years, but annual erosion repair is estimated to be about $17,000 total for the five systems. There will also be noxious weed control in the disposal cells equal to about $37,000 per year total for the five cells.
- It is important to note that the National Defense Authorization Act (NDAA) submittal says that non-RCRA evapotranspiration caps will be used at Rocky Flats, while the cost estimate assumes RCRA type covers. This discrepancy may be due to older policies at the time of the cost estimate.

D. Evapotranspiration (ET) Alternative Covers

1. Technical Aspects

- These waste cover systems are useful in arid climates where the potential evaporation combined with the movement of water through plants (evapotranspiration) greatly exceeds the annual precipitation. They function by taking advantage of a natural water balance – water infiltrates from the surface from precipitation or melting snow, and is then stored in the soil until it evaporates from the surface or transpires through the vegetative cover.
- The goal is of an ET cover is to avoid water percolation into the underlying waste. In addition, an increased amount of water storage in the soil layer from growing year to growing year should be avoided, but storage should never be so low as to cause wilting of the vegetative cover.
- Evaporation is the dominant water removal process in the top few centimeters of the soil cover, while transpiration via root uptake is the dominant water process throughout the remainder of the soil profile.
- These barriers use loam, a loose silty soil, combined with natural grasses and forbs. The plant roots must be able to drain a section of soil about two meters deep, but must not grow so deeply as to infiltrate the underlying waste. A layer of dense gravel placed beneath the loose soil serves to protect the underlying waste from plant root and burrowing animal infiltration [153; 152].
- Surface cracking, animal infiltration and local settlement of the loose soil has been shown to be a problem, but has only been seen to be a superficial problem, with no significant effect on the water balance of the ET cover. The silt-loam soil has less volumetric change (than clay soils) when water is removed from the soil matrix, so less cracking is apparent in arid climates. It is anticipated that cracking in silt-loam soils will be self-healed when water enters the soil and that extensive vegetation will help limit cracking [152].
- Depending on the thickness and permeability of the silt-loam cover, ET barriers can also effectively control radon gas emissions (*Id.*).

2. Public Acceptance

- These covers are not included in the prescriptive covers listed in Subtitle C of RCRA, but they are acceptable if they can be shown to be "RCRA Equivalent". In other words, equivalent percolation performance must be demonstrated by comparative analysis, and a field test must be conducted [152].

3. Rocky Flats Stewardship Cost Estimate
   - It is assumed that ET covers will be used as caps at Rocky Flats but they are not currently included in the stewardship cost estimate. The ET cover will likely require less initial funding than RCRA Subtitle C prescriptive covers as they have lower potential material, construction and quality control costs. Nevertheless, costs due to regulatory compliance should not be ignored. Long-term costs of ET covers are believed to be significant.
4. Case Studies
   - ET covers were being tested at the Rocky Mountain Arsenal site for regulatory compliance (September 2000-September 2001). There are four test plots, each with different initial soil compaction characteristics and soil depths. Beneath the soil, a lysimeter collects all of the percolated water that passes through the soil barrier without being evaporated or absorbed by the vegetative cover (*Id.*).
   - Idaho National Engineering and Environmental Laboratories has been conducting studies for the past fifteen years on the proper plant cover to be used in ET covers to ensure proper water balance. The plant species are evaluated on transpiration properties throughout the growing season (via leaf-area index analysis), ability to withstand drought, ability to form diverse and stable stands, and resilience to weed infiltration and wildlife foraging.
   - Vegetation control is essential, the importance of which can be learned from the Burrell, Pennsylvania uranium mill tailings disposal cell. Plant roots and their effect on soil particle arrangement has increased the cell's hydraulic conductivity from the regulatory level of 10^{-7} cm/s to 10^{-5} cm/s, which is not sufficient to control groundwater flow according to RCRA Subtitle C. Control with herbicides and other chemicals may not be the best solution though, as these are usually hazardous themselves and may seep into the groundwater [147, pg. 5].

E. Other Alternative Cover Systems

1. Capillary barriers
   - Capillary barriers use the soil mechanics concepts of capillary suction and unsaturated flow to prevent water from percolating into a waste layer. These covers typically perform very well in arid climates, but do not perform well in areas where snow banks form on the ground or where there is a large amount of precipitation.
2. Geosynthetic clay liner barriers
   - Geosynthetic clay liner barriers provide several advantages over compacted clay liners such as ease in placement, less cracking potential due to volumetric shrinkage and freeze-thaw cycles and lower product costs if there is not a local clay to use in a CCL. The main disadvantage of GCLs is the specific clay used in the product is known to have the lowest shear strength of all clays.

3. Case Studies for Cap/Liner Systems
    - In early 1995, CSX Railroad began an expansion project for their rail lines, which are located near the Canal Ridge Road/Mullins toxic dump site near Cincinnati, Ohio. The city of Cincinnati informed CSX Railroad about the presence of the toxic dump located near the rail line in late 1994. The company conducted numerous soil borings, and reported both strong petroleum odors and liquid sludge, but still believed that they were not working on the dump site. Excavation commenced, and metal drums containing chromium, lead and vinyl chloride were encountered. In July of 1995, the Ohio Environmental Protection Agency made five investigations of the site, and ordered CSX to collect and contain waste-laden water leaking out of the excavation. The company complied, but not until October, during which time the water was leaking into a nearby sewer inlet. The contractor for CSX claimed that it obtained all permits thought to be needed. Construction stopped and limited contaminant migration controls were put in place, but the immediate health hazard had not been identified at the time of the article, as there were no human receptors living near the site [50, pg. 1-2].
    - The existence of institutional controls may greatly change the effectiveness of a designed cap/liner system. At the Industri-Plex site in Woburn, Massachusetts, the institutional controls being developed by the EPA and the Primary Responsible Parties are performance standards intended to guide the way in which operators and owners are permitted to breach and restore the cap. These controls were put in place to ensure that industrial reuse of the high-value property is not limited by the existence of residual contamination. Many local commentators have criticized this institutional control plan as it is not directly linked with the remedy, which may hinder the remedy's effectiveness to provide adequate protection for human health and the environment [90, pg. 55].

II. Subsurface Barriers

A. Slurry Walls

1. Technical Aspects
    - A slurry wall is a vertical barrier of bentonite clay and soil that prevents the horizontal flow of groundwater [107, pg. 27].
    - Permeability tests are required to ensure the contaminated groundwater will not dissolve the bentonite and adversely affect the quality of the barrier (*Id.*).
    - These barriers may also help by diverting uncontaminated water away from the contaminant source [70, pg. 35].
2. Public Acceptance
    - These controls have been used for many years, and are quick and functional. The cost depends on the depth of the barrier, the equipment required, and any admixtures added to enhance the properties of the barrier (*Id.*).
3. Rocky Flats Stewardship Cost Estimate
    - DOE did not include slurry walls as a component in the control of groundwater flow at the Rocky Flats.

B. Permeable Reactive Barriers (PRBs) and Passive Treatment Walls

1. Technical Aspects
    - These barriers are both a long-term remedy, passively treating contaminated groundwater, and a physical control, containing the contaminated groundwater to a certain known area.
    - PRBs rely on a chemical slurry barrier that is permeable to normal groundwater, but not to specific contaminants such as volatile organic compounds. Adhesive forces between the chemicals in the slurry and the contaminants stop contaminant movement. The contaminants can then be removed, and the reactive chemicals can be reused [181, pg. 7].
    - This solution will stop only selected water-soluble contaminants, but will not stop all possible sources of groundwater contamination (*Id.*). Continuous monitoring is necessary to ensure proper functioning.
2. Public Acceptance
    - The cost of these systems is one-fourth that of pump and treat systems because of the lower amount of maintenance required (*Id.*). Because the effectiveness in treatment and containment of wastes by both this system and pump and treat systems is unknown, communities may favor passive treatment walls solely because of their lower costs.
3. Rocky Flats Stewardship Cost Estimate
    - The three passive barrier walls at Rocky Flats make up a significant portion of the stewardship cost estimate for physical controls. The systems require replacement of the iron filings (used as the reactive chemical) every ten years. The replacement cost for each wall is $67,200 per wall, or $201,600 to replace all of the walls, and the replacement time is about one week per wall. While the new filings only cost $40 per cubic yard, the disposal cost of the used filings (which are considered low level wastes) will be about $3,000 per cubic yard. Each load of used filings must be sampled to ensure there are no higher-level wastes.

III. Access Deterrents

A. Fences

1. Technical Aspects
    - Fences and walls provide a warning to the presence of a restricted area, and prevent accidental access to the area [107, pg. 28].
2. Public Acceptance
    - Fences may be considered a stigma to the community.
    - Fences might not be publicly accepted in a natural setting, but may be accepted in an industrial area (*Id.*).
3. Rocky Flats Stewardship Cost Estimate
    - For the perimeter of the site, a four-strand wire fence is believed to provide adequate warning and protection. The bottom strand is smooth and the other three are barbed. There will be 5 ½ -foot steel posts spaced every sixteen feet, but every fifth post will be a wood post. There will be horizontal wooden braces every 330 ft or wherever there is a terrain change. There are about 21,000 meters (13 miles) of perimeter that need to be fenced at a unit cost of

about $4.00 per meter, equaling a total replacement cost of $84,000. DOE assumes total replacement of the fence every 50 years.
    - Because a higher level of security is required for disposal cells, a six-foot chain-link fence with three strands of barbed wire on top will be used. There will be about 5,400 meters of fencing for all five cells, with a cost of about $41.00 per meter, equaling a total replacement cost of $221,400. DOE assumes total replacement of the fence every 50 years.
    - Vandalism repairs were also considered, estimated to cost about $3,300 per year for all fences, supports, and gates.
4. Case Study:
    - DOE Grand Junction Long-Term Surveillance and Maintenance office has reported numerous problems with vandalism of the fencing at the 100 or more sites that it manages. It reports that 60 feet of chain link fence were stolen from one of the sites and had to be replaced [146, pg. 5].
    - These physical access controls may still not deter a determined trespasser. The Bureau of Land Management reported an incident in which two men ignored a fence around a closed mine near Virginia City, Nevada. The two men were found in the mine within 75 feet of the mine entrance, asphyxiated from carbon dioxide poisoning. Human intrusion to a contaminated site is less likely to occur when there is layering of multiple institutional controls combined with active management of a site [205, pg. 49].

B. Guards and Security Systems

1. Technical Aspects
    - Depending on the frequency of patrols or checkpoints, guards can effectively prevent human access to a dangerous site.
    - Guards may be a good monitoring control by checking to see that fences and signs are maintained, and making sure that there are no visible signs of contamination.
2. Public Acceptance
    - Guards draw public attention that something is dangerous at a site. This perception may lower local real estate and property values, but may also boost public awareness.
3. Rocky Flats Stewardship Cost Estimate
    - Weekly exterior inspection of perimeter fence by a subcontracted security force will cost about $7,800 per year.
    - Interior inspection of disposal cells and monitoring wells will be done by monitoring personnel, requiring about 200 hours per year at a unit cost of $45.00 per hour. The disposal cell surveillance is more thorough and frequent than the perimeter surveillance.
    - The cost estimate also includes an annual inspection by DOE personnel, compilation of an inspection and monitoring report, and compilation of stakeholder presentation materials, which cost $3,200, $22,500 and $14,000 per year, respectively.
4. Case Study
    - At the Oak Ridge Reservation in Oak Ridge, Tennessee, the Department of Energy Office of Inspector General found that a subcontracted security firm,

Wackenhut Inc., had a contract in place that did not limit worker overtime hours. This contract allowed the security firm to maximize its profits by hiring several part-time guards and having the full-time guards work more overtime. The security company maximized overtime worked by hiring more full-time guards. This contract could have led to $8.1 million being spent for avoidable overtime, and may force the Department to pay $3.2 million in excessive award fees on the contract [170, pg. 3-6].

C. Signs and Markers

1. Technical Aspects
   - Signs are good warning mechanisms, and have varying lifetimes and effectiveness depending on the material from which the sign is made.
   - Signs require at least annual monitoring for operational effectiveness, and frequent maintenance or replacement if problems are noted.
2. Public Acceptance
   - Signs are passive devices that rely on an individual realizing the importance of the warning and acting in a manner that is in his or her best interest.
3. Rocky Flats Stewardship Cost Estimate
   - For the perimeter of the site, DOE assumes that 150 signs posted at the corners and every 500 feet will be required for adequate notice of the potential hazards on the site. The signs will be aluminum with a yellow reflective coating. It is assumed that each sign will be replaced every 25 years, and that fifteen percent of the signs will require replacement each year because of vandalism. Each sign is estimated to cost $49.00 plus $7.00 per hour for installation.
   - For the disposal cells, DOE assumes that 50 signs will be required for adequate notice of the potential hazards in the cell. The signs will be aluminum with a yellow reflective coating. It is assumed that each sign will be replaced every 25 years, and that fifteen percent of the signs will require replacement each year because of vandalism. Each sign is estimated to cost $49.00 plus $7.00 per hour for installation.
4. Case Study
   - Concrete and metal markers have been used at many sites where cover systems hold radioactive waste. The signs often identify the type, volume, and radioactivity of material when it was buried. These markers will last for many years, but there are still problems with corrosion and visibility [154, pg. E.1-3].
   - Signs were used at the Oak Ridge Reservation site in Tennessee, and several metal signs did not last longer than five years because of vandalism and wear. It is not uncommon for signs to be stolen or obliterated by bullet holes, especially in remote locations [76, Reference Pictures].

IV. Ponds and Ditches

1. Technical Aspects
   - On sites with contaminated soil or groundwater, surface water must be collected and stored as there is a potential that a contaminant may move into the surface water. Ditches are often used to collect and transport surface

water to a holding pond, where heavy particles will settle out. Ditches are important if the surface water on the site has a potential to move offsite.
- These ponds may be lined with a low hydraulic conductivity clay, or with a double layer of HDPE geomembranes.
- It may be important to remove the sediments from these ponds on a regular basis to ensure that any eroded contamination is safely removed.

2. Public Acceptance
   - The public may see accessible ponds and ditches as dangerous, so fences or a surface barrier may be warrented.
3. Rocky Flats Stewardship Cost Estimate
   - DOE estimates that it will cost about $3,200 per year for the equipment and operator to remove pond and ditch sediments.

Institutional Controls

The different types of institutional controls have different aspects that work to solve different problems over different spans of time. The choice of institutional controls must be made on a site-specific basis so that their effectiveness is maximized. The complexity involved in the different aspects of institutional controls magnifies the importance of selecting a control to accomplish a specific task. If many specific tasks must be accomplished, then a combination of controls must be used to achieve this; there is no institutional control that applies to every situation.

I. Governmental Controls

Description

- Governmental controls use the authority of the government to either limit the activities that a landowner may undertake or limit the size and location of the structure on the property [191, pg. 11].
- These controls are generally the most effective and accepted of the institutional controls (*Id.*).
- Because neither the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) nor the Resource Conservation and Recovery Act (RCRA) specifically authorizes the EPA to regulate land use in a comprehensive manner, the EPA must rely on state or local governments to establish such controls [191, pg. 37].
- Governmental controls usually work well because they require no negotiation, which is useful when there are many interested parties with conflicting needs [191, pg. 44].
- Governmental controls may not work well because the EPA and the state, which are the lead remedial agencies, are not the parties responsible for their implementation and enforcement. A contractual agreement between the remedial agency and the responsible party (usually the municipality) may be useful [191, pg. 44].
- The effectiveness of governmental controls depends directly on the willingness and capability of the governmental entity to inspect and enforce the control [192, pg. 12].
- The US Nuclear Regulatory Commission (NRC) recommends that governmental controls be used when there are any long-lived radionuclides present at a site. The NRC assumes that government institutions will last longer than private institutions [198, pg. 3].
- Governmental controls are generally direct controls, as the government creates them for a specific purpose [83, pg.3].
- A report by the International City/County Management Association pointed out the importance of working closely with local governments and the need to increase the Association's level of expertise with respect to institutional controls. It has been identified that 75% of local governments presently do not have experience implementing institutional controls related to hazardous waste sites. The report also mentioned that the majority of institutional controls implemented by local governments could be breached without their knowledge [205, pg. 49].

A. Zoning

[Zoning is not applicable to Rocky Flats, except for minerals, as the site will remain in federal ownership and incorporation into a municipality is prohibited.]

1. Purpose

- Zoning is the breakdown of a municipality into areas of compatible use, such as industry, commercial, or residential [83, pg. 4]. It also regulates building size and features.
- Exclusionary zoning is the most probable zoning control that would be used for contaminated sites, because it allows only specified uses within the zone and excludes all others (*Id.*).

2. Specific Zoning Controls
    a. Overlay District
        - This control involves overlaying a new zoning classification and imposing a new set of regulations on previously zoned areas [191, pg. 38]. The overlay district may include the development of a Historical Preservation Zone or an Environmentally Sensitive Area.
        - This overlay district will not change the existing regulations, but will require the submittal and approval of a development plan in order to obtain permits (*Id.*).

    b. Rezoning
        - Rezoning include map and language amendments. Map amendments change the use of a particular parcel by showing changed circumstances or mistakes on the existing map. Language amendments change the text of an ordinance by obtaining a declaratory judgement action [104, pg. 2].
        - The Board of Adjustments for the city and county may grant variances from the literal enforcement of zoning regulations (*Id.*).
        - Rezoning that is inconsistent with a comprehensive plan may be attacked as spot zoning (*Id.*).

    c. Transferable Development Rights (TDR)
        - TDRs are used to transfer development rights from an environmentally sensitive area to more appropriate areas. TDRs have been used in the past to limit residential overcrowding in some areas and encourage growth in other areas [191, pg. 40].
        - TDRs can be used to reduce the risk of takings, if there is developable land to give to the owner of the development rights (*Id.*).

    d. Performance Zoning
        - This method of zoning establishes criteria to control the effects of landowner activity or building at a site, such as pollution, waste removal, water use, glare, dust, vibrations, *etc*. This type of zoning limits the use of the land to those that conform to these criteria [111, pg. 12].

    e. Zoning with Other Types of Controls
        - Most often, a violation of a zoning law is reported by a neighbor [42, pg. 18]. An informational device directed at the public explaining why there is a severe zoning restriction on the property will help to ensure the public watches for any blatant violations.
        - This informational device also helps the public nature of zoning by forcing representatives in the local government to be aware of the community's desire to maintain the law, and thus decreases the chances that the law will be repealed for short-term gains [83, pg. 4].

3. Advantages for Long-Term Control
   - This method of allocating land use has been widely used since 1916, so it is known to work effectively as long as it is monitored and enforced. It will not require changes to the current legal system or new statutory authority (*Id.*).
   - Zoning is implemented through processes that are highly public, allowing for substantial public involvement (*Id.*).
   - Zoning can be very flexible, so any changes at the site can result in a change to the zoning law (*Id.*). As described below, this flexibility also has a downside.
   - Zoning regulations must bear a reasonable, substantial relationship to the health, safety, morals, or welfare of the public [104, pg. 1].
4. Disadvantages for Long-Term Control
   - Zoning laws are different in every municipality [83, pg. 4].
   - Zoning is oriented to avoid conflict. A request for a change is less likely to be approved if neighbors object. On the other hand, a general public agreement about a proposed change may prevent a zoning board from denying the change [83, pg. 5].
   - Zoning laws are meant to be flexible so that an individual landowner is not forced into hardship by maintaining the requirements of the law. Municipalities differ in what is accepted as a sufficient hardship to grant a variance to the requirements [83, pg. 4].
   - Zoning is not static but responds to the land market, and is a part of maintaining the vitality of communities [83, pg. 5].
   - Some argue zoning is contrary to the freedom of choice, in which a person has the option to make the decision whether or not to subject himself to a risk or nuisance without government interference (*Id.*).
   - Zoning has been used to keep intensive land uses (industrial) away from less intensive land uses (residential) but not the reverse. Zoning laws used in the remedial context must stipulate this reverse restriction [191, pg. 38].
5. Responsible Party for Enforcement
   - The zoning laws are made in accordance with state, not federal, statutes, and is enacted and enforced by local governments [2, pg. 20].
   - Local government is usually the best candidate for zoning enforcement because of proximity to the site, resulting in effective monitoring. In addition, it has police power to enforce zoning in the interest of public safety, and usually mirrors the interests of the people living around the site [83, pg. 4].
   - Another agency should oversee the actions of the local government to guard against short-term interests of the landowner (*Id.*).
6. Case Study
   - Arguably, the most well known failure of institutional controls is the Love Canal site near Niagara Falls, New York. The site consists of a landfill containing 21,000 tons of highly toxic chemical wastes generated by the Hooker Plastics and Chemical Corporation, which closed in the early 1950's. At closure, zoning restrictions were placed on the area forbidding residential use, and Hooker placed a deed notice on the property deed when it transferred the land to the Board of Education in 1953. The deed notice included a "hold

harmless" clause that stated that "the Board of Education had been advised by the Hooker Chemical Company that the premises described above have been filled to the present grade level thereof with waste production resulting from the manufacture of chemicals". Despite all of these controls, the Board of Education built a school directly on top of the landfill, and many houses were constructed adjacent to the site. By the summer of 1978, contamination had migrated to the basements of the houses, and was seeping into the schoolyard. This case was the first evidence that institutional controls such as zoning and deed notices have serious limitations in providing long-term protection of human health and the environment [90, pg. 65].

B. Local Permits

[With the exception of permits to mine, local permits are not applicable to Rocky Flats, as the entire site will remain in federal ownership and incorporation into a municipality is prohibited by law.]

1. Purpose
   - Permits are issued by the government to a land user who would like to perform a certain activity, informing the potential user of any restrictions before the activity is authorized [192, pg. 12].
   - At hazardous waste sites, permits can be used to restrict the construction of new wells, limit soil excavation of contaminated subsurface soils, or limit the ability to alter a cap [42, pg. 2].
   - "Miss Utility" permit systems are used in several states which require excavation companies to contact a central agency before beginning work to find out about the location of buried utilities [191, pg. 41].
   - For federally owned sites, permits, licenses, and leases may be issued by the controlling federal agency to restrict activities by land users [191, pg. 88].
2. Advantages for Long-Term Control
   - A site can take advantage of existing permit restrictions and apply them to site-specific situations [192, pg. 12].
   - Permits are effective at preventing future users from undertaking an inappropriate activity [188, pg.27].
3. Disadvantages for Long-Term Control
   - Permits will not prevent current inappropriate activities (*Id.*).
   - Permits have a narrow focus, so they will not prevent all possible activities that could harm human health and the environment [192, pg. 12].
   - Requirements may be changed at any time by the local government (*Id.*).
   - Permits may not be required for government-based construction.
4. Responsible Party for Enforcement
   - Permits are usually the responsibility of the local government (*Id.*).
5. Case Study
   - A Building Permit Survey system has been in place for 25 years at the Uranium Mill Site in Grand Junction. This system forces builders to search the Colorado Department of Public Health and Environment (CDPHE) records for information on uranium mine tailings on the property, then check to see if tailings still remain. The use of permits eventually failed because a

project to build a recreational path through the site was carried out by the city itself, which was not required to obtain a permit [34, pg. 13].
- A "miss-utility" program (called "One Call for Brownfields") is being used in Portland, Oregon   This program uses the format of the Oregon Utility Notification Center, which allows excavation contractors to call in to find where the subsurface utility lines run at a site. The Notification Center then works with the Oregon Department of Environmental Quality to notify the contractor if he is working in a contaminated area and where any caps or subsurface contaminants are located. This program is also a good method of finding if any construction on the city's Brownfields is taking place of which the regulators may not be aware. The pilot project was a success, with over 200 calls on eight Brownfield sites in eight months [56, pg. 1-9].

C. Tailored Ordinances

[Tailored ordinances are not applicable to Rocky Flats, as the entire site will remain in federal ownership and incorporation into a municipality is prohibited by law.]

1. Purpose
    - Tailored ordinances are placed on access or use of certain areas, such as a ban on fishing or swimming [192, pg. 13].
    - They are based on the police power of the local government [207, pg. 14].
2. Advantages for Long-Term Control
    - They can take advantage of existing permit restrictions by applying them to site-specific situations [192, pg. 13].
3. Disadvantages for Long-Term Control
    - These controls must be communicated through a posting of the ordinance. Postings alone may not be effective in preventing incidental contact with the contamination (*Id.*).
4. Responsible Party for Enforcement
    - Local governments are responsible for enforcement of ordinances (*Id.*).
5. Case Study
    - At the Cannons Engineering site in Bridgewater, Massachusetts, the town of Bridgewater used an ordinance to enter into a Declaration of Restrictions with the EPA that limited future municipal uses of the site. The ordinance worked, but there were limitations on recording the Declaration because the State of Massachusetts uses the name of the property owner to search for the Declaration, instead of the site name and location [37, pg. 21].

D. Land Use Planning or Siting Restrictions

1. Purpose
    - Siting restrictions can be used to prevent certain land uses to areas that are prone to natural hazards, such as flood plains or fault lines [42, pg. 2], and may also be applied to a highly contaminated area.
    - California requires an environmental impact review of proposed construction or other activities approved by state or local governments [84, pg. 6]. The review might be a good check to ensure that any new construction plans will not affect the physical controls on a site, or will not be in danger of releasing subsurface contamination at the site.

- Several restrictions exist for developing in a floodplain, which are laid out by the US Army Corps of Engineers or the Federal Emergency Management Agency [84, pg. 7]. The long-term stewardship plan for land use at a contaminated site and a floodplain may contain similar restrictions.

2. Advantages for Long-Term Control
   - There are often set laws for siting restrictions at all levels of government, and there are agencies that have successful management systems laid out (*Id.*).
3. Disadvantages for Long-Term Control
   - Site restrictions usually apply to new construction, so current laws may not apply to existing structures (*Id.*).
4. Responsible Party for Enforcement
   - For a normal siting restriction, the state or local government would take responsibility for enforcement and monitoring [192, pg. 13].
5. Case Studies
   - At the Mound Site near Miamisburg, Ohio, the DOE established an Interim Land Use Policy, because the DOE had not yet released control of the land to the local government, but wanted to lay out land use controls for companies subletting the land. The policy identified fifteen categories of authorized uses, established performance standards including avoidance of hazards and pollution, laid out requirements pertaining to radioactive waste, and required a risk assessment of the sublessees' work. This policy was enforced by prohibiting a business from receiving a lease or conveyance without being issued a "Certificate of Appropriateness" by a committee [35, pg. 25].

E. Groundwater Use Restrictions

1. Purpose
   - These restrictions are directed at limiting or prohibiting certain uses of groundwater, and may be implemented by establishing groundwater management zones, or by capping or closing wells according to the state well permitting system [191, pg. 42].
   - Several states include water use restrictions in their regular construction permits or in a deed restriction for sites surrounding contaminated water [83, pg. 5].
2. Advantages for Long-Term Control
   - These restrictions can take advantage of existing water use restriction laws, and apply them to the specific site situation [192, pg. 13].
   - Provision of an alternate source of drinking water strengthens compliance with groundwater use restrictions. In addition, a water testing program will help groundwater well users determine if their water is contaminated [46, pg. 41].
3. Disadvantages for Long-Term Control
   - These water use restrictions vary from state to state in technicalities. The use of groundwater restrictions must be checked to ensure that an individual state's guidelines for using these restrictions are not too vague or too specific for a hazardous waste site [192, pg. 13].

4. Case Study
    - At the Paducah Gaseous Diffusion Plant in Paducah, Kentucky, DOE created a zone delineating an area of contaminated groundwater, which extended through a residential neighborhood. Any resident within this zone was eligible for a free hookup to city water sources, on the condition that they close all wells and promise not to use groundwater on their property. This control failed at one property, where a lessee used contaminated groundwater for eleven years, because his landlord did not want to give up the water rights for the property, which extended much further than the DOE's zone. There was no contingency for renters in DOE's plan, so the family suffered multiple health problems over the years [65, pg. 1].

II. Proprietary Controls

Description

- Proprietary controls are related to the intricacies of owning private property. Private property owners have certain rights and responsibilities that have been established over time in the common law system specific to each state [83, pg. 6]. A proprietary control involves one owner exerting his rights to control the land use of another owner.
- The proprietary control itself should contain, at minimum, the following information as recommended by the NRC [198, pg. 5]:
  1. A legal description of the property affected
  2. The name(s) of the current owner(s) as reflected in public land records and the conditions of payment for the property interest
  3. The parties who can enforce the control and are responsible for payment
  4. A statement of the hazard posed by the contamination on the site and the nature of the restriction, limitation or control
  5. The duration of the control, or conditions that would allow an end to the control
  6. Permission for regulators to monitor compliance with controls
  7. Permission to install and maintain physical controls
  8. The location of the public copy of the final radiation status report
  9. The name of owners and enforcers so that any changes in the future do not limit the power of the control
- Development of new proprietary controls is a function of state law [191, pg. 18-19]. Relatively little state or federal government staff time would be needed to administer a proprietary interest (depending on the owner of the rights), but periodic site visits are necessary for high risk sites [84, pg. 4].
- Most propriety controls can be written in a way that restrictions can be passed onto subsequent owners (i.e. it "runs with the land") [83, pg. 9].
- Deed restrictions encompass all enforceable instruments such as easements and covenants, but are not a specific control tool alone [191, pg. 9].

A. Easements

1. Purpose
    - An easement is a conveyance of a property right from a principal landowner to another party, which gives the second party rights with regard to the first party's land [192, pg. 15]. It may be given freely, or may be sold by the owner of the property [84, pg. 3].

- An affirmative easement allows the holder to enter upon or use another's property for a particular purpose, such as checking groundwater monitors or checking for compliance with other controls [192, pg. 15].
- A negative easement imposes limits on how the principal landowner can use his property (*Id.*). This type of easement is more useful for an institutional control, as it is prohibitive in nature [191, pg. 21].
- An easement "in gross" is held by a party who does not own an adjacent parcel of land. A government agency such as the EPA may hold the easement but not fully own the property [192, pg. 15].
- An appurtenant easement is held by the owner of a neighboring property, and is much easier to enforce than an "in gross" easement because the restrictions directly benefit the neighbor.
- The most important part of writing an easement is to state its intent and scope clearly so that its purpose is not questioned or misinterpreted over time [191, pg. 21].

2. Specific Types of Easements
   a. Conservation Easements
      - This easement limits uses of the property to those that are compatible with the conservation of natural resources, environmental values, scenery, or other specified purposes. These easements are binding on future users of the property, and may be held by land trusts, charities, or government agencies (*Id.*).
      - These easements are generally used to protect open space, not to limit exposure to dangerous contaminants [83, pg. 9].
      - Another method of creating a conservation easement would be to have a land trust or charitable institution buy the development, natural resource, and water rights on the property [84, pg. 3].

   b. Hazardous Waste Easements
      - This easement would be similar to a conservation easement, but would be used primarily to limit human and ecological exposure to contaminants [83, pg. 9].
      - State laws govern property rights, thus the development of a hazardous waste easement should be enacted at the state level. This easement has been enacted in only three states. Still, the method of drafting a model or uniform law and encouraging states to adopt it has worked in almost every state (*Id.*).
3. Case Study
   - At the Mound Site near Miamisburg, Ohio, the DOE polluted an offsite city owned area with plutonium. The DOE obtained an easement to clean up the land by gaining ownership of the land for five years. The DOE was required to pay $4.6 million to the city for damages, but the easement served its purpose by restricting access to the public during cleanup [35, pg. 26].

B. Covenants

1. Purpose
   - A covenant is a promise made by one landowner to another, in connection with a conveyance of property, generally agreeing to refrain from using the property in a certain manner [191, pg. 24].
   - In a minority of the states, including Colorado, a covenant is not a legal interest in a property, but a binding contract. In other states, a covenant is both an interest in the property and a binding contract. A covenant must "touch and concern the land", not the owners, to be binding [85, pg. 1].
   - As an example, if a federal agency transfers real property to a non-federal entity, CERCLA Section 120(h) requires the agency to include a covenant asserting that all remedial action necessary to protect human health and the environment from any hazardous substances has taken place [190, pg. 1].
   - This covenant also states that any action which disturbs or contributes to existing contamination makes anyone involved in that action a PRP (*Id.*).
2. Advantages for Long-Term Control
   - Covenants can serve as an institutional control when remediated property is transferred from one owner (such as the DOE) to another (a developer or private individual) [192, pg. 16].
3. Disadvantages for Long-Term Control
   - Covenants have different formal requirements than easements that make them less flexible and effective in enforcing the restrictions over the long term [191, pg. 24].
   - Covenants are only binding on subsequent owners when notice is given to the subsequent owner, there is a clear statement of intent to bind future owners, the agreement "touches and concerns" the land, and there is vertical and horizontal privity between the parties. Horizontal privity means that only a contract party may claim relief for a breach in contract, while vertical privity means that each party in a distribution chain only has a contract with the party ahead of him or her in the chain [192, pg. 16].

C. Restrictive Covenants

1. Purpose
   - A restrictive covenant is similar to zoning in that it prohibits specific types of development or construction on a property. Restrictive covenants are different in that zoning is a policing mechanism while a restrictive covenant relies on private controls [84, pg. 4].
   - Rather than being between two parties, like the covenant explained above, a restrictive covenant is usually a promise between a group of landowners in a certain area (*Id.*). There is no central enforcer, but the landowners enforce each other using state courts.
2. Advantages for Long-Term Control
   - Restrictive covenants are usually between multiple landowners, and can be enforced by and against each other [83, pg. 6].
   - A restrictive covenant will run with the land if it is between several neighboring landowners, placed by mutual consent, or initially created by a developer (*Id.*).

3. Disadvantages for Long-Term Control
    - Restrictive covenants are usually intended to benefit the included parties rather than the public [83, pg. 6]. The interests of a single party may be forced upon the other landowners, putting the public and environment at risk.
4. Case Study
    - At the Mound Site near Miamisburg, Ohio, the DOE is considering several deed restrictions that still may be put in place when it transfers its property to the city of Miamisburg. One will restrict use to industrial buildings, one will prevent the installation of potable water wells until the groundwater can be proved to be at acceptable standards, another will restrict any excavation on the site, one will monitor all contaminated soil transported from the site to avoid spreading contaminants to the community, and a final restriction will allow regulatory agency access to the site. These restrictions are to be enforced both by the regulatory agency and by mutual monitoring by the different site users [35, pg. 29].
    - The DOE Oak Ridge Operations Office in Oak Ridge, Tennessee transferred land to a local community with deed restrictions prohibiting the use of groundwater because there is a contaminant plume that might eventually migrate into the area. DOE did not conduct regular monitoring to ensure the deed restriction was being enforced and discovered that the community later drilled groundwater wells to irrigate a golf course. DOE then mandated immediate removal and threatened a reversion of property interest [205, pg. 47].

D. Reversionary Interest

1. Purpose
    - A reversionary interest is created when a landowner deeds property to another landowner, but the deed specifies that the property will revert to the original owner under specified conditions. This control places a condition on the transferee's right to own and occupy the land [191, pg. 17].
2. Advantages for Long-Term Control
    - This control is binding on any subsequent purchasers in the chain of title (*Id.*). It is still important to keep any new owners informed of the condition on their ownership so that this control does not need to be unnecessarily enforced.
3. Disadvantages for Long-Term Control
    - The effectiveness of a reversionary interest is based on the future owners complying out of fear that the original owner will reclaim the property if a restriction is violated (*Id.*).
4. Case Study
    - At the Mound site near Miamisburg, Ohio, the DOE is using lease controls, which can be considered a form of reversionary interest. This institutional control binds both the development corporation and its sublessees to avoid releasing any new contamination or disturbing existing contamination. The penalty for violations is loss of the lease and a return of the land to DOE. This control is working fairly well, but there has been one incident of a copper discharge in the site's wastewater that could not be traced to DOE or the

sublessee. In addition, all lease controls would become invalid if the property were sold by the development corporation [35, pg. 24].

E. State Use Restrictions

1. Purpose
    - State statutes provide owners of contaminated property with the authority to establish use restrictions specifically for contaminated property [192, pg. 18].
    - Colorado has passed Bill 01-145, Concerning the Enforceability of Environmental Real Covenants, which establishes a state program for controlling land uses in areas with residual contamination [12a].

F. Governmental/Proprietary Control Hybrids (Wildlife Refuge)

1. Purpose
    - When the land in question is owned by a government agency, it may be transferred to another government agency for management, or an act may be passed to protect the area. The land ownership by the government constitutes the proprietary control while the act constitutes the governmental control [16, pg. 7].
    - In the case of the Rocky Mountain Arsenal and Rocky Flats, the enabling legislation specifies that the contaminated portions of the sites remain in the control of the Department of Defense or DOE, respectively [138a].
2. Advantages for Long-Term Control
    - At the Arsenal, any conveyance of property is subject to perpetual restrictions, including a ban on residential or industrial use, and the use of groundwater [16, pg. 7].
    - The Arsenal protects endangered species of animals, and provides guaranteed open space in the future (*Id.*).
    - The Department of Interior and the U.S. Fish and Wildlife Service, which are responsible for maintaining wildlife refuges, have long-term land controls of their own which have been shown to work (*Id.*).
    - Creating a wildlife refuge is a public proceeding, which means there could be tremendous public scrutiny of proposed uses (*Id.*)
3. Disadvantages for Long-Term Control
    - Refuge management is not responsible for managing the site contamination, and may not have the tools to implement restrictions. Agencies responsible for implementing restrictions may not be on site, and may be unable to obtain funding for implementation of long-term activities.
4. Case Study
    - Under the Rocky Mountain Arsenal National Wildlife Refuge Act of 1992, legislation was enacted to create a wildlife refuge on that site (*Id.*). The site cleanup has been proceeding successfully because the Army, the EPA, and the Bureau of Fish and Wildlife Services are cooperating on several projects. A benefit of government ownership is the ability to use many different experimental physical controls, such as ET covers.
    - DOE is carrying out preservation activities at Idaho National Engineering and Environmental Laboratory, Savannah River, Oak Ridge, Los Alamos, Lawrence Livermore National Laboratory, and Rocky Flats [205, pg.35].

- The Rocky Flats Wildlife Refuge Bill of 2001 establishes a refuge at Rocky Flats after the completion of cleanup activities. The definition of what land will be transferred will be determined in the Memorandum of Understanding between DOE and DOI, to be drafted by December 2002. By June 2002, the Department of the Interior must establish a Comprehensive Planning Process that would involve the Rocky Flats Coalition of Local Governments, the Rocky Flats Citizens Advisory Board and others.

G. Historic Preservation

1. Purpose
    - The National Historic Preservation Act (NHPA) is a consultation and mitigation mechanism to protect historic resources [84, pg. 6].
    - This act establishes the National Register of Historic Places (NRHP) and protects properties "eligible" for the Register, whether or not they have been registered in the past (*Id.*).
2. Advantages for Long Term Control
    - Either the contaminated sites could be preserved for their historical significance in the Cold War, or the Act could be used as a template for protecting Superfund sites after cleanup (*Id.*).
    - Consultation may provide a good warning device for enforcement agencies such as the EPA (*Id.*).
3. Disadvantages for Long Term Control
    - Consultation is not effective as an institutional control in preventing changes in land use (*Id.*).
4. Case Studies
    - The NRHP has listed a massive crater that was created by a nuclear explosive excavation experiment in New Mexico and another unspecified highly polluted site. The nomination process is difficult and time consuming because there is no central agency to research and record the necessary information to gain eligibility. The landowner has the responsibility to complete the nomination process and, if accepted, maintain the site according the NHPA's guidelines [31, pg. 2].
    - Cemeteries are historically preserved institutions that have existed almost as long as man has existed. They utilize monitoring and maintenance, passive physical controls such as fences and tombstones, institutional access restrictions, and burial records. Experience shows that cemeteries still are vandalized or built over (examples are Pere-Lachaise cemetery in Paris). Many have a historical governmental or religious institution meant to protect them over many generations. They may have large costs as well, such as Arlington Cemetery, which has a budget of $11 million a year, while others have a perpetual care trust fund to avoid falling into neglect [92, pg. 34].

H. Liability Following Property Transfer

1. Purpose

- Section 3158 of the National Defense Authorization Act of 1998 allows the Secretary of Energy to hold harmless a person or entity to whom property has been transferred against any claim for injury related to the release or threatened

release of a contaminant as a result of DOE activities at a defense nuclear facility [205, pg. 65].
- This exemption does not apply if that the person or entity knowingly contributed to any such release (*Id.*).
- CERCLA states that anyone who contributes to the contamination at a site may be held liable as a PRP [195]. This liability includes waste that is transferred from one property to another. An implication of this liability may be that sites will store waste onsite rather than accept a share of the responsibility of a failure at a site to which they transferred waste.
- EPA may grant an agreement "not-to-sue" if a person reuses a contaminated site while following any restrictions placed on the site (*Id.*)

III. Enforcement Tools

Description

- Oversight and regulatory agencies such as the EPA and the state have the power to enforce laws and agreements, whose violation could affect public safety, health, and the environment.
- Enforcement authority is used to prohibit a party from using land in certain ways or from carrying out certain activities at a specified property [191, pg. 46].
- Enforcement tools are generally easier to regulate than governmental and proprietary controls, as the agency is not dependent on a third party (*Id.*).
- Enforcement tools are typically binding only on the original signatories of the agreement or binding only parties to whom it is issued in the case of a Unilateral Administrative Order (*Id.*).
- These controls are best suited for short-term control in which the property is not likely to change hands or the contamination is short-lived [191, pg. 51].

A. Administrative Orders

1. Purpose
    - An order directly restricting the use of property by a named party. This order can also be used to restrict the use of land by a non-liable party [191, pg. 18].
2. Advantages for Long-Term Control
    - EPA has broad scope of authority to issue orders to protect public health and the environment through Section 106 of CERCLA (*Id.*).
    - These controls can be implemented without the execution of any further property instruments (*Id.*).
    - The order may include provisions for the bound parties to notify the agency of any potential purchaser so that the agency may reissue the order (*Id.*).
    - This control does not require the agreement of the landowner, although it is advantageous to have consent in the long run (*Id.*).
    - Unilateral orders can be easily modified in the event that the control situations change (*Id.*).
3. Disadvantages for Long-Term Control
    - Orders do not bind subsequent owners or parties who are not named (*Id.*).
    - An order to restrict a non-liable party may result in a claim for compensation under Section 106(b) of CERCLA (*Id.*).

4. Case Study
    - The Uranium Mine Tailings Radiation Control Act program was carried out by the DOE in Grand Junction, Colorado, in a similar manner to an administrative order. The DOE worked to remove uranium mine tailings from thousands of sites in the city that had used the tailings as fill. The program was based on the compliance of the landowners, allowing them to choose if they wanted the tailings removed from their property. Many accepted the offer, but 200 out of 5000 declined the cleanup, exemplifying the limitations of a voluntary order [188, pg. 30].

B. Consent Decrees

1. Purpose
    - A consent decree is signed by a judge and documents the settlements of an enforcement case. The purpose of restricting land use is the same as an administrative order (*Id.*).
2. Advantages for Long-Term Control
    - A consent decree can be used to require the landowner to file a separate instrument conveying a proprietary control such as an easement or covenant to the EPA or a third party (*Id.*).
    - A consent decree can be used to require the landowner to notify successors-in-title of the consent degree and its conditions, and also to notify the EPA of any new ownership (*Id.*).
3. Disadvantages for Long-Term Control
    - Consent decrees are not binding on subsequent property owners (*Id.*).
    - Consent decrees cannot be used against federal agencies (*Id.*).
    - The Institutional Controls Workgroup for the EPA believes it is not good practice to rely exclusively on the terms of a consent decree for a long-term land use control. A settlement between the PRP and the EPA does not bind other parties. Consent decrees are most effective in forcing the PRP to institute other long-term controls [191, pg. 49].
4. Case Studies
    - The EPA often requires local governments to place an ordinance on a property as part of a Superfund consent decree, and has held the municipality liable when the municipality failed to strictly enforce the terms of the ordinance. The EPA has in at least one case used its broad authority under a consent decree to assess stipulated penalties against a municipality for failing to obtain a permit under its own ordinance. This threat of liability may make local governments refuse to accept the terms of the consent decree [20, pg. 3].
    - This threat may be avoided if the EPA provides the local government or reuse organization with a covenant not to sue in the consent decree. At the Denver Radium Site, the EPA provided Home Depot (the reuse organization) such a covenant because of the benefits the company may bring to the community [138, EPA, pg. 2].
    - At the Industri-Plex site in Woburn, Massachusetts, a custodial trust was developed by the PRPs to handle the site's redevelopment and some cleanup. The custodial trust has been able to function successfully in creating private/public partnerships because of a consent decree from the EPA which

effectively severed liability for the trust's redevelopment activities. There are two reasons, however, why this consent order may not be in the best interests of public health and the environment. For one, the EPA is using the site as an example of national initiative that aims to establish the beneficial reuse of Superfund sites, and is therefore considering less stringent institutional controls [90, pg. 63]. Second, the Industri-Plex site is in a high-value area, thus the PRPs are more interested in the future use of the site than in the cleanup and long-term control processes [90, pg. 54].

C. Comprehensive Five-Year Review

1. Purpose
    - The CERCLA five-year review process is required of all National Priority List sites that leave residual contamination behind after closure. The National Contingency Plan, as implemented in 40 CFR 300.430(f)(4)(ii), states:

      The five-year review must include an assessment of every possible factor that may influence the long-term protection of human health and the environment. The CERCLA five-year review should contain three elements:
      Compliance monitoring,
      Performance monitoring, and
      Review of the land use and exposure assumptions.
    - The five-year review must include an assessment of applicable new and modified state, federal, or local laws; an assessment of the land use controls, the functionality of the physical controls; the functionality of the monitoring, maintenance, and monitoring; the functionality of the information management systems; a reevaluation of the baseline conditions, cleanup levels, exposure assumptions, future land use assumptions; and any other factors that may impact the protectiveness of the remedy and associated stewardship controls.
    - Executive Order 12580 establishes the requirements for conducting five-year reviews at DOE sites. DOE is responsible for conducting the five-year reviews and EPA issues a finding of concurrence or non-concurrence.
2. Advantages for Long-Term Control
    - The entity responsible for the remedy also has the direct responsibility for routine reevaluation of the remedy effectiveness.
    - Scheduled reviews can affirm the adequacy of monitoring and O&M, and can reevaluate new information or technologies.
3. Disadvantages for Long-Term Control
    - The entity responsible for the remedy also has the direct responsibility for routine reevaluation of the remedy effectiveness.
    - As the lead agency, DOE is only required to obtain concurrence from EPA and to notify the state agency or the public regarding the review. Thus, external oversight or enforceability is lacking.

IV. Informational Devices

Description

- Informational devices are tools that often rely on public record systems, used to provide public information about risks and contamination [192, pg. 22].
- Informational devices are passive controls, and as long as the information exists and is available, it may effectively discourage inappropriate land users from acquiring the property (*Id.*).
- Informational devices are an easy control to implement as there are no conveyances or negotiations necessary (*Id.*).
- These controls have no effect on a property owner's legal rights regarding the future of the site, and may actually discourage improper uses of the site by creating a perceived liability risk (*Id.*).

A. Deed Notices

1. Purpose
    - A deed notice is an informational document filed in public land records that alerts anyone searching the records to important information about the property (*Id.*). This information may include where the site is located, what kinds of contaminants are present, and what the risks of exposure are, and describe undesirable activities on the site [192, pg. 22]
2. Advantages for Long-Term Control
    - A deed notice may discourage inappropriate land use by alerting the public about dangers.
3. Disadvantages for Long-Term Control
    - Deed notices are not traditional real estate interests, so proper practice in using them is not well established. There are variations from state to state on how the notice will be recorded if it is available, how it should be drafted, and who is entitled to revoke it (*Id.*).
    - It is important to obtain the property owner's consent prior to filing the notice to avoid the risk of claims for slander of title (*Id.*).
    - For a non-owner of a contaminated property, the information is not easily noticed unless a deed search is done.
4. Longevity
    - This informational control will last as long as the public land records last. Its effect is non-enforceable so it will retain its passive sense through perpetuity.

B. Public Education

1. Purpose
    - Public education can be carried out through meetings, information packets, public service announcements, children's education, etc.
2. Advantages for Long-Term Control
    - Information can be memorialized into each generation of local residents. The communities will understand other institutional controls, and know where contamination is located and how to avoid being contaminated
3. Disadvantages for Long-Term Control
    - If the public forgets or the source of information is eliminated or inaccessible, then the public education will fail.

- People have to be willing to learn for this control to work.

4. Case Studies
   - "Pb Possum" children's coloring books, by Annabelle Fuhr, are a good way for children to find out about avoiding contamination [191, pg. 125].
   - At the Cannons Engineering site in Bridgewater, Massachusetts, the EPA held public education sessions, but because the Site was located in an industrial area, the public did not see a risk of exposure and stopped attending [191, 23].

V. Planning Systems

Description

- These devices are institutional controls that are an integral part of stewardship, but do not fit into the categories of restricting access or informational devices.

A. Planning Systems

1. Purpose
   - Planning systems can be considered an informational basis for controls, a template or protocol for actions, and an informational reference. Thus, these controls may fit into the categories as parts of governmental, proprietary and enforcement controls, or may not fit into a category at all.
2. Aspects of Long-Term Control
   - A planning system is a way to ensure future decisions will be consistent with currently known concerns, such as the protection of human health and the environment, by not breaching physical controls at contaminated sites.
   - These planning systems first compile all useful and relevant information on a subject of concern (such as groundwater contamination), and then develop a future course of action. It should be constantly updated with any new information, and old or irrelevant information should be discarded.
3. Examples of Planning Systems
   a. Environmental Master Plan (EMP)
      - This is a plan used on the state or county level that integrates land use controls and controls on new development in a particular type of site. For instance, an EMP may be written to forbid any future development on all uranium mining sites in a state or county [37, pg. 53].

   b. Base Master Plan
      - This is the plan for land-use consistent with a ROD for a closed military base. The EPA stresses that these are not dependable devices because they are only used for construction projects and can easily be changed by a commanding officer [191, pg. 84].

   c. Geographic Information Systems (GIS)
      - Federal facilities are beginning to develop extensive computerized databases that track land uses and restrictions on properties. GIS can be a very useful institutional control as it is a visual device. A ROD may specify that a site must be marked on these maps [191, pg. 86].
      - In Commerce City, Colorado and Emeryville, California, local governments are setting up environmental information databases that include locations of soil and groundwater contamination. The databases include GIS maps that show properties with historical contamination such

as brownfields and properties that have land use restrictions. The annual costs for Commerce City are $170,000 and $36,000 for Emeryville [111, pg. 33].

APPENDIX B

REGULATORY AUTHORITY TABLE

Environmental Regulatory Authorities for Selected Major DOE Facilities

(As of February 6, 2001)

Statute[1] State/Facility	RCRA			CERCLA	CAA[2]	SDWA[3]	CWA	TSCA
	BA	**CA**	**MW**					
CA/LBNL	CA	CA	CA	*CA	CA (EPA Rad NESHAP)	Joint CA and EPA (UIC)	CA (except sludge)	EPA
CA/LLNL	CA	CA	CA	EPA	CA (EPA Rad NESHAP)	Joint CA and EPA (UIC)	CA (except sludge)	EPA
CO/RF	CO	CO	CO	EPA	CO (EPA Rad NESHAP)	Joint CA and EPA (UIC)	EPA	EPA
ID/INEEL	ID	ID	ID	EPA	ID (EPA Rad NESHAP)	ID (UIC)	EPA	EPA
IL/Argonne	IL	IL	IL	*IL	IL (EPA Rad NESHAP)	IL (UIC)	IL (except pretreatment and sludge)	EPA
KY/Paducah	KY	KY	KY	EPA	KY (EPA Rad NESHAP)	EPA (UIC)	KY (except sludge)	EPA
NM/LANL	NM	NM	NM	**NM	NM (EPA Rad NESHAP)	NM (UIC)	EPA	EPA
NM/Sandia	NM	NM	NM	*NM	NM (EPA Rad NESHAP)	NM (UIC)	EPA	EPA
NM/WIPP	NM	NM	NM	*NM	NM (EPA Rad NESHAP)	NM (UIC)	EPA	EPA
NY/BNL	NY	NY	NY	EPA	NY (including Rad NESHAP)	EPA (UIC)	NY (except pretreatment and sludge)	EPA
NY/WV	NY	NY	NY	*NY	NY (including Rad NESHAP)	EPA (UIC)	NY (except pretreatment and sludge)	EPA
NV/NTS	NV	NV	NV	***NV	NV (EPA Rad NESHAP)	NV (UIC)	NV (except pretreatment and sludge)	EPA
OH/Portsmouth	OH	OH	OH	*OH	OH (EPA Rad NESHAP)	OH (UIC)	OH (except sludge)	EPA

OH/FEMP	OH	OH	OH	EPA	OH (EPA Rad NESHAP)	OH (UIC)	OH (except sludge)	EPA
SC/SRS	SC	SC	SC	EPA	SC (including Rad NESHAP)	SC (UIC)	SC (except sludge)	EPA
TN/ORR	TN	----	TN	EPA	TN (including Rad NESHAP)	EPA (UIC)	TN (except sludge)	EPA
TX/Pantex	TX	TX	TX	EPA	TX (EPA Rad NESHAP)	TX (UIC)	TX (except sludge)	EPA
WA/Hanford	WA	WA	WA	EPA	WA (process to gain Rad NESHAP authority has begun but EPA will have authority until process complete)	WA (UIC)	EPA	EPA

Key

Endnotes

1. Under a number of environmental statutes EPA can delegate/authorize a State to manage particular aspects of an environmental program. In those instances where a State has not been delegated/authorized to manage a particular environmental program, EPA manages the program. There are also some environmental programs that EPA does not or cannot delegate/authorize the State to manage. Therefore, depending upon the statute EPA could retain authority over the entire program, delegate/authorize the State to manage some programs, or delegate/authorize the State to manage all programs.

2. A key regulatory program of the Clean Air Act (CAA) is the requirement that States develop State implementation plans (SIPs), which when complied with would enable all areas in the State to attain and maintain the National Ambient Air Quality Standards for criteria pollutants (sulfur dioxide, particulate matter, nitrogen dioxide, carbon monoxide, ozone and lead). All of the States in the table have SIPs approved by EPA (with some exceptions to certain provisions identified in 40 CFR Part 52 for each State). There are other regulatory programs established under the CAA in which EPA must approve State rules and requirements for implementing the program. One example of such a program is the State air operating permit program and the corresponding EPA regulations in 40 CFR Part 70. In addition, there are CAA regulatory programs for which States have the discretion to request approval from EPA to run the program. An example of such a program is the Radionuclide National Emission Standards for Hazardous Air Pollutants (NESHAP) program (40 CFR Part 61, Subpart H). Only a few states have been delegated authority by EPA to run the Radionuclide NESHAP program and these states are identified in the table. Additional data collection is needed to develop a comprehensive list of state programs approved by EPA.

3. All the States in the table have been granted primacy by EPA for the public water system program under the SDWA. A separate delegation is needed from EPA for a State to implement the Underground Injection Control program. The table lists those States that have been given full authority or joint authority by EPA.

Statute Abbreviations
RCRA = Resource Conservation and Recovery Act
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CAA = Clean Air Act
SDWA = Safe Drinking Water Act
CWA = Clean Water Act
TSCA = Toxic Substances Control Act

Facility Abbreviations
Argonne = Argonne National Laboratory
BNL = Brookhaven National Laboratory
FEMP = Fernald Environmental Management Project
Hanford = Hanford Site
INEEL = Idaho National Engineering and Environmental Laboratory
LANL = Los Alamos National Laboratory
LBNL = Lawrence Berkeley National Laboratory
LLNL = Lawrence Livermore National Laboratory
Paducah = Paducah Gaseous Diffusion Plant
Pantex = Pantex Plant
Portsmouth = Portsmouth Gaseous Diffusion Plant
NTS = Nevada Test Site
RF = Rocky Flats
Sandia = Sandia National Laboratory
SRS = Savannah River Site
WIPP = Waste Isolation Pilot Plant
ORR = Oak Ridge Reservation
WV = West Valley Demonstration Project

RCRA Abbreviations
BA= State has Basic Authorization from EPA to run its basic RCRA Program
CA= State has specific Corrective Action Authorization to run the corrective action program
MW = State has specific Mixed Waste Authorization to regulate mixed waste

Other Abbreviations
EPA = U.S. Environmental Protection Agency
Rad = Radionuclide
NESHAP = National Emission Standards for Hazardous Air Pollutants
UIC = Underground Injection Control Program

Symbol Definitions
* = site not on the National Priorities List under CERCLA, but environmental remediation activities are conducted under State RCRA authority.
** =site not on the National Priorities List under CERCLA, but environmental remediation activities are conducted under State RCRA authority. However, CERCLA guidelines for remediation are followed for remediating project sites that contain hazardous substances not covered by RCRA.
*** = site not on the National Priorities List under CERCLA. However, to address environmental restoration activities for different parts of the site, NTS entered into an agreement with the State of Nevada and DOD pursuant to CERCLA 120 (a)(4) which provides that state law shall apply to removal and remedial actions for federal facilities not on the NPL and RCRA 3004 (u) which governs continuing releases at permitted facilities.
---- = State believes that it has adopted a rule that is analogous to the federal rule, but EPA has not yet authorized the state program

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APPENDIX C

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