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CHEMICAL AND RADIATION ENVIRONMENTAL RISK MANAGEMENT AT THE CROSSROADS:
Case Studies

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Chemical and Radiation Environmental Risk Management at the Crossroads: Case Studies

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Executive Summary

Driven by different statutory mandates and programmatic separation of regulatory responsibilities between federal, state and tribal agencies, distinct chemical and radiation[1] risk management strategies have emerged. While the Cold War and its legacy shaped the management of radiological risks, chemical risk management was largely spawned in the 1970s and 1980s in an era of increasing concern about the environmental hazards and an expanding public role in decision making. The separate treatment of these two fields by the scientific and regulatory communities has led to the evolution of two "cultures."

The environmental risk management challenges facing this nation today require that we break down the barriers that separate the chemical and radiation risk approaches. This process of risk harmonization is aimed at creating a consistent (but not inflexible) framework in which chemical and radiation risks can be managed to protect successfully public health and the environment and draw on the best features of each culture. As a preliminary step in the harmonization process, a workshop was held in June 1998 that brought together 40 chemical and radiation risk managers from governmental, academic, trade and tribal organizations. The workshop identified 3 key issues– decision criteria, resource allocation and institutional controls and public and stakeholder input– that were important pieces of the harmonization challenge. Workshop participants also recommended that a series of case studies be carried out to resolve or sharpen the key issues identified at the workshop.

This report evaluates six case studies– Teledyne Wah Chang Albany (Millersburg, Oregon), Chemical Waste Management and Niagara Falls Storage Site (both in upstate New York), Fernald Environmental Management Project (Fernald, Ohio) Maxey Flats Disposal Site (Fleming County, Kentucky) and Sequoyah Fuels Corporation (Gore, Oklahoma). The six sites were selected for analysis after extensive interviews with state and federal officials and stakeholders. The criteria for site selection included:

- Sites capturing the majority of issues being considered for analysis;
- Readily available information and public access to site data;
- Sites collectively covering a variety of geographical conditions; and
- Sites capturing a variety of statutes.

This report is presented in five sections. The first section reviews the development of the two risk cultures and describes the results of the Annapolis workshop. The second section identifies the case study selection methodology for the six sites and site characteristics. The third section outlines the analytical framework of the study and sources of information. The fourth section provides the research findings in four categories:

1) Human health risk characterization;
2) Decision criteria and risk management considerations;

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[1]In this report, the term radiation means radioactive materials; medical devices are not within the scope of this report.

3) Use of institutional controls; and
4) Public participation and stakeholder involvement.

Finally, the fifth section offers the study conclusions, identifying the overarching themes that were revealed by the analysis. It discusses short and long-term harmonization challenges and describes the public health goals that can serve as a basis for further harmonization.

These case studies provide examples of how chemical and radiation risks are managed and offer the opportunity to examine similarities and differences in approach and decision making. Ultimately, site specific choices indicate where and how risk management harmonization is occurring. The overarching themes that emerged were:

- Risk management approaches for both chemical and radiation hazards are generally site-specific and pragmatic, with the common goal of environmental and public health protection.

- Assumptions about future use of the site drive risk management decision making. Issues that have arisen included:
  - Identifying Institutional Controls (ICs) as important features of all future use scenarios, and revealing that their effectiveness remains unproven; and
  - Pointing out that the funding of ICs and long-term stewardship also remain unresolved.

- Public participation, input and acceptance are critical for successful risk management.
  - The case studies show that communities may support pragmatic remedies if they are provided with clear and sufficient information about site risks.

- Different approaches are used across sites to assess and manage risks. They include:
  - A variety of reasonable methods of selecting Contaminants of Concern (CoCs) that could lead to differences in remediation strategies;
  - Variability in assumptions about exposure duration and site time frame; and
  - Vastly different approaches to establishing target cleanup goals between chemical and radiation risks as well as from site to site.

It is possible to address some of the issues underlying these overarching themes, including future use scenarios, selection of CoCs, public participation and involvement, institutional controls, and the debate on risk and dose, in the near term through additional harmonization dialogues. More complicated issues such as ground water protection, and the differences between the "As Low As Reasonably Achievable" (ALARA) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) approaches would require a longer-term commitment.

There is much common ground in the management of chemical and radiation risks. Despite the differences in approach, the protection of public health is the fundamental goal at all of these sites. Three core public health objectives provide a common ground for future risk harmonization discussions:

- surveillance of site hazards and population health risks;

- coordination of agency approaches and stakeholder expectations; and
- site management and remediation to assure protection of public health.

The lessons learned from these case studies are clear. The core public health objectives apply to both chemical and radiation hazards. This common ground can provide a foundation for moving forward in the harmonization of risk management, and ultimately to a more cohesive approach to decisionmaking and protection of public health.

1.0 INTRODUCTION AND BACKGROUND

The Cold War and its nuclear legacy have had a profound effect on the management of radiation risks. Heightened concerns about radioactive fallout and public perception of the dangers of radiation have shaped the development of the radiation protection system since the 1950s. Establishing radiation limits to the public is the shared responsibility of the Nuclear Regulatory Commission (NRC), the Department of Energy (DOE), the Environmental Protection Agency (EPA), and the States. Their approaches have been guided by federal laws such as the Atomic Energy Act (AEA)[2], and the Uranium Mill Tailings Radiation Control Act (UMTRCA)[3]; evaluation of epidemiologic evidence about human health effects by the National Academy of Sciences Committees on Biological Effects of Ionizing Radiation (BEIR Reports)[4]; and consensus guidelines of national and international standard setting bodies (International Commission on Radiological Protection (ICRP)[5], National Council on Radiation Protection and Measurements (NCRP))[6].

Chemical risk management is the responsibility of a broad range of federal, state and local agencies. At the federal level, EPA has assumed a leadership role in shaping risk management approaches that have arisen from environmental statutes first enacted in the 1970s and early 1980s and their amendments. These statutory approaches have been largely media-specific, with the exception of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund)[7] and, more recently, the Food Quality Protection Act (FQPA).[8] Furthermore, chemical risk managers are typically guided by risk assessment information that is based on animal evidence as outlined in the EPA's proposed Cancer Risk Guidelines.[9] Despite the broad mandates for chemical risk management, there have been few occasions where human evidence is available (*e.g.*, asbestos, benzene) to guide risk management decisions.

Driven by differing statutory mandates and the programmatic separation of regulatory responsibilities among federal, state and tribal agencies, distinct chemical and radiation risk management strategies have emerged. The separate treatment of the two fields by the scientific and professional communities has led to the evolution of two distinct "cultures." While the separation of radiation and chemical risk management persists, from legal, regulatory, programmatic, training and

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[2] Atomic Energy Act of 1946, 42 USC §§ 2011-2021, 2022-2286i, 2296a-2296g-4; and AEA Amendments , Pub.L.No. 93-438, 88 Stat. 1233(1974), 42 USC §§ 2011-2021, 2022-2286i, 2296a-2296g-4.

[3] Uranium Mill Tailings Radiation Control Act, 42 USC §7901 *et seq.*

[4] National Academy of Sciences, Committee on the Biological Effects of Ionizing Radiation. *Health Effects on Exposure to Low Levels of Ionizing Radiation: BEIR V*. Washington, D.C.: National Academy Press, 1990; National Academy of Sciences, Committee on the Biological Effects of Ionizing Radiation. *Health Effects of Exposure to Radon: BEIR VI.* Washington, D.C.: National Academy Press, 1999; and National Academy of Sciences, Committee on the Biological Effects of Ionizing Radiation. *Health Risks of Radon and Other Internally Deposited Alpha-Emitters: BEIR IV*. Washington, D.C.: National Academy Press, 1988.

[5] *See* ICRP. *1990 Recommendations of the ICRP*. Oxford: Pergamon Press; ICRP Publication No. 60; Ann. ICRP 21 (1991): 1-201.

[6] *See* NCRP. *Comparative Carcinogenicity of Ionizing Radiation and Chemicals.* Bethesda, MD: NCRP Press, 1989. NCRP Report No. 96; and NCRP. *Research Needs for Radiation.* Bethesda, MD: NCRP Press, 1993. NCRP Report No. 117.

[7] Comprehensive Environmental Response, Compensation, and Liability Act, 42 USC §§ 9601-9675.15.

[8] Food Quality Protection Act of 1996, 21 USC §§ 321, 331, 342, and 346a.

[9] U.S. EPA Office of Research and Development. *EPA Proposed Guidelines for Carcinogen Risk Assessment.* Washington, DC: U.S. Environmental Protection Agency, April 1996.

professional practice levels, many of the major environmental risk management decisions we face today require the simultaneous evaluation and control of both radiological and chemical risks. This environmental reality requires interaction between the two cultures that can result in disagreement. A more than decade old wrangling between EPA, NRC and DOE on the issues of cleanup standards for radioactively contaminated waste sites is an example of this clash of cultures. Recognizing their differences, EPA, NRC, DOE and other federal agencies have established interagency coordinating bodies such as the Interagency Steering Committee on Radiation Standards (ISCORS).

Discussion about harmonization has continued during the last decade. The need for harmonization was also clearly articulated in a 1992 report by EPA's Science Advisory Board-Radiation Advisory Committee (SAB-RAC). According to the SAB-RAC report, harmonization does not mean that all decisions involving chemical and radiological hazards require identical treatment. Instead, it refers to fitting risk management decisions into a common policy framework aimed at aggregate risk reduction and public health protection.[10] Presently, several major developments in environmental policy are increasing the common ground between radiation and chemical risk management. The emergence of comparative risk methodologies, the growing emphasis on cumulative risk assessment and risk management and the legislative push for regulatory reform and risk-based decisionmaking provide challenges and opportunities to examine, improve and harmonize risk management strategies.

1.1 June 1998 Annapolis Workshop

In June 1998, a panel of 40 chemical and radiation risk experts and managers from governmental, academic, trade and tribal organizations came together in Annapolis, Maryland, at a workshop entitled "Addressing the Similarities and Differences in Chemical and Radiation Environmental Risk Management" to discuss perspectives on harmonizing chemical and radiation risk management approaches.[11] At the end of this meeting, participants concluded that continuing dialogue and improving interagency interaction and coordination will be crucial to the harmonization effort. Nevertheless, they recognized that the two fields lack a combined knowledge base and an understanding of each other's management processes, and that this lack of common ground poses practical barriers.

To increase the prospects for harmonization, workshop participants recommended that case studies be developed for cleanup sites at which both radioactive materials and hazardous chemical risks were addressed. Information from these case studies will help educate participants in the harmonization dialogue about their counterparts' issues, stimulate discussion, and provide a better understanding of the issues in the context of specific concerns, in order to facilitate resolution.

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[10] Science Advisory Board – Radiation Advisory Committee (SAB-RAC). "Commentary on Harmonizing Chemical and Radiation Risk-Reduction Strategies." Washington, D.C.: Environmental Protection Agency, May 1992.

[11] Locke, P.A., Tran, N.L., Burke, T.A. "Similarities and Differences in Chemical and Radiation Risk Management: Annapolis Workshop Proceedings, 1998." Washington, DC. 1998; and Tran, N.L. Locke, P.L, Burke, T.A. April, 2000. "Perspectives Chemical and Radiation Environmental Risk Management: Differences, Commonalities and Challenges." *Risk Analysis*, Vol. 20, No. 2. 163-172.

1.2 Key Issues

The case studies evaluate several key risk management issues highlighted at the Annapolis meeting. They include: decision criteria, resource allocation and public/stakeholder input.

1.2.1 *Decision Criteria*

The decision criteria in chemical risk management are fundamentally different from those used in radiation risk management. The current framework for managing public exposures to chemical carcinogens has been referred to as a "bottom-up" approach.[12] Risk is typically evaluated for each source and an acceptable risk range, usually between 10^{-4} to 10^{-6}, is established[13]. In contrast, the dominant framework for managing individual radiation exposures has been described as a "top-down" approach.[14] The top-down strategy involves aggregating risks from all sources and setting an upper bound dose limit, and then using the As Low As Reasonably Achievable (ALARA) principle to reduce the risk. NRC and DOE have consistently favored the top-down, or ALARA, approach in their standard setting and risk management practices.[15] Consistent with its chemical risk management philosophy, EPA uses a bottom-up approach, usually applying a 10^{-4} to 10^{-6} incremental lifetime target risk range in managing radiation risks. Workshop participants suggested that the rigid application of these two distinct risk management frameworks is one of the major impediments to harmonization.

Consideration for natural background also presents some challenging differences between the chemical and radiation risk management approaches. Natural background radiation exposure ranges from 0.7 to 2.5 mSv per year (excluding indoor radon).[16] To many radiation risk managers, reducing excess exposures much below 1 mSv/year is unnecessary and exceedingly difficult to monitor because it is within the natural variability of background.[17] The incremental or excess risk associated with man-made radiation sources is evaluated in the context of "total exposure."[18] In contrast, background levels of synthetic chemicals are typically considered to be *de minimis*.[19] In cases where background levels are not *de minimis*, their evaluation varies among EPA's programs. For example, under Superfund, EPA may consider background levels for the purposes of setting cleanup levels at Superfund sites (*e.g.*, naturally occurring levels of metals such as lead and chromium are considered in

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[12] Kocher, D.C. and F.O. Hoffman. "Regulation Environmental Carcinogens: Where Do We Draw the Line?" *Environmental Science & Technology* 26 (1991); and General Accounting Office. *Nuclear Health and Safety: Consensus on Acceptable Radiation Risk to the Public Is Lacking.* Letter Report, 9/19/94, GAO/ RCED-94-190. 1994.
[13] *See* 40 CFR 300.430(e)(2) (2000).
[14] Kocher, D.C. and F.O. Hoffman. "Regulation Environmental Carcinogens: Where Do We Draw the Line?" *Environmental Science & Technology* 26 (1991).
[15] General Accounting Office. *Nuclear Health and Safety: Consensus on Acceptable Radiation Risk to the Public Is Lacking.* Letter Report, 9/19/94, GAO/ RCED-94-190. 1994.
[16] Travis, C.C. *Differences in the Regulation of Chemicals and Radioactive Materials.* Center for Risk Management. Oak Ridge, Tenn.: Oak Ridge National Laboratory, 1993; and Health Physics Society. *Position Statement on Radiation Dose Limits for the General Public.* September 1992.
[17] Science Advisory Board – Radiation Advisory Committee (SAB-RAC). "Commentary on Harmonizing Chemical and Radiation Risk-Reduction Strategies." Washington, D.C.: Environmental Protection Agency, May 1992.
[18] Health Physics Society. *Position Statement on Radiation Dose Limits for the General Public.* September 1992.
[19] Science Advisory Board – Radiation Advisory Committee (SAB-RAC). "Commentary on Harmonizing Chemical and Radiation Risk-Reduction Strategies." Washington, D.C.: Environmental Protection Agency, May 1992.

cleanup goals.)[20] However, under media-specific statutes such as the Safe Drinking Water Act (SDWA), where EPA sets Maximum Contaminant Levels (MCLs) based on public health protection goals and feasibility of treatment and measurement, the MCLs for some naturally occurring inorganic substances are sometimes established below natural background levels.[21] The case studies examine the implications of these distinct risk management approaches (bottom-up versus top-down and total exposure (multi-media) versus media-specific).

1.2.2 *Resource Allocation and Institutional Controls*

The Annapolis workshop participants endorsed the idea that some level of harmonizing is desirable and potentially achievable. Issues that provide the greatest opportunities for harmonization are those of practical and common concern to both radiation and chemical risk managers. Among these is the issue of the cost of site redevelopment and long-term stewardship. In recent years, the high cost of "walk-away" cleanups has led risk managers to consider the benefits of alternative use scenarios (*e.g.*, industrial or restricted use) and the utilization of institutional controls and other in-place management tools. Institutional controls include requirements to assure that the physical barriers used to isolate residual hazardous wastes are not compromised and to warn potential users and buyers that the land is contaminated. The case studies examine the consideration of costs and the use of institutional controls in cleanup decisions.

1.2.3 *Public/Stakeholder Input*

Any kind of cost evaluation must account for public acceptability. For example, in the context of site cleanup, closure of businesses has widespread economic impact, as does restricting access to a site for an extended period of time. In practice, all risk management activities pose some costs to the affected community, ranging from direct financial impact to lifestyle and cultural change. In order for a proposed remedy to be acceptable, both its costs and benefits must be understood by the parties at risk. Effective risk management decisions must also incorporate the values and concerns of the public. The Annapolis workshop participants indicated that neither chemical nor radiation risk management has consistently incorporated public concerns. Nevertheless, this issue could serve as a vehicle for harmonization between chemical and radiation risk management approaches. The case studies evaluate the role of the public/stakeholders in decisionmaking.

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[20] 40 CFR, Part 300, *Hazard Ranking System Final Rule*. Federal Register, vol.55, number 241, pg.51590. December 14, 1990; and OSWER Directives 9355.3-01.

[21] Taylor, J.M.. *Completion of Response to the Staff Requirements Memorandum, for SECY-95-249, On Risk Harmonization White Paper and Recommendation: Memorandum to the Commissioners*. 5/17/96. U.S. Nuclear Regulatory Commission. <http://www.nirs.org/radiation/Sy96110.txt>. *See also* 40 CFR §141.11 (2000).

2.0 SITE SELECTION AND DESCRIPTIONS

2.1 Site Selection

Officials from DOE's Office of Environment Safety and Health, NRC's Division of Waste Management, the EPA, both headquarters and regional offices of Materials, Research and State Programs, and several state agencies were briefed either in person or by telephone on the scope of the project. The purpose of these briefings was to solicit their support and recommendations for sites to be included as case studies.

Based on the briefings and the recommendations received, a list of sites was generated. Subsequently, the list was shortened using the following four generic criteria:

- Whether the site captured the majority of issues being considered in the case study analysis;
- Whether data/information about the site is in the public domain and readily accessible;
- Whether the sites collectively capture adequate geographical and statutory coverage; and
- Whether a variety of statutes were used for cleanup

Briefings of members of the federal, regional and state agencies on the project and candidate sites for inclusion in the study were also conducted as the final step of the site selection process.

Six sites were chosen for inclusion in the analysis. They are:

1. Teledyne Wah Chang Albany (TWCA) Superfund site in Millersburg, Oregon;
2. Chemical Waste Management (CWM) Model City Landfill in Niagara County, New York.
3. Fernald Environmental Management Project (FEMP) in Fernald, Ohio;
4 Maxey Flats Disposal Site (MFDS) in Fleming County, Kentucky;
5. Niagara Falls Storage Site (NFSS), a DOE Formerly Utilized Sites Remedial Action Program (FUSRAP) site in Lewiston, New York; and
6. Sequoyah Fuels Corporation (SFC), NRC-licensed nuclear fuel processing facility in Gore, Oklahoma.

To narrow the scope of analysis at larger or complex sites, one or two Operable Units (OUs)[22] were selected for detailed study. At TWCA, OU2 (discussing groundwater and sediment) and OU3 (discussing surface and subsurface soil) were chosen as most helpful for examining human health risk characterization and decision criteria. At FEMP, OU5, which covers environmental media across the site, was likewise selected for analysis.

[22]Operable Unit is a term for each of a number of separate activities undertaken as part of a Superfund site cleanup.

2.2 Site Description

The six sites chosen for this study vary in size, scope, and operational history, as well as in surrounding land use, geography, geology, and topography. Environmental issues at the sites also vary widely. Both chemical and radiation materials are present at all sites with the exception of CWM, which has only chemical materials. At 1,050 acres, FEMP is the largest site. Next in size at 710 acres is CWM Model City Landfill. SFC and MFDS are of comparable acreage; each occupies approximately 280 acres. TWCA and NFSS are the two smallest sites. The TWCA site covers approximately 225 acres and the NFSS site approximately 190 acres. Table 2.2.1 summarizes the basic site characteristics. The following sections describe the sites in more detail.

Table 2.2.1: Summary of Site Descriptions

Site	Cleanup Program	Location	Size(acres)	Pop. in 5 mile radius	First Year of Operation
TWCA	Superfund[23]	Millersburg, OR	225	700	1956
CWM	RCRA-CA[24]	Lewiston & Porter, NY	710	140,000 (w/in 10 miles)	1942
FEMP	Superfund	Fernald, OH	1,050	22,900	1951
MFDS	Superfund	Fleming Cty, KY	280	663	1963
NFSS	FUSRAP (AEA)[25]	Lewiston, NY	190	140,000 (w/in 10 miles)	1944
SFC	NRC D&D (AEA)[26]	Gore, OK	280	3,103	1970

[23] Superfund, formally known as the Comprehensive Environmental Compensation, Response and Liability Act (CERCLA) was enacted in 1980. The law creates prohibitions and requirements concerning closed or abandoned hazardous substance sites, assigns liability to persons responsible for releases of hazardous substances at such sites, and establishes a trust fund to pay for remediation in cases where a responsible party cannot be identified.
[24] The Resource Conservation and Recovery Act Corrective Action program (RCRA CA) provides for RCRA facilities to address the investigation and clean up of hazardous waste pollutants released into soil, groundwater, surface water, and air. When the need for corrective measures is verified, the facility may be required to perform a Corrective Measures Study (CMS) to identify and evaluate potential remedial alternatives.
[25] The Formerly Utilized Sites Remedial Action Program (FUSRAP) addresses contamination at sites associated with Manhattan Engineering District and Atomic Energy Commission activities. The program is currently administered by the U.S. Army Corps of Engineers (USACE).
[26]NRC oversees decontamination and decommissioning (D&D) activities, which involve safely removing a facility from service and reducing residual radioactivity to a level that permits the property to be released. This action must be taken by a licensee before termination of the license.

TELEDYNE WAH CHANG ALBANY SITE

TWCA is a Superfund site located in Millersburg, Oregon, an industrial-based community two miles north of downtown Albany, Oregon. The site includes a main plant of 110 acres and a 115-acre area known as the Farm Ponds area. The main plant is organized into the Extraction area, the Fabrication area, and the Solids Storage area. The Farm Ponds area includes 2.5-acre solids storage ponds, the plant's wastewater treatment pond, and the Soil Amendment area. The Soil Amendment area has been primarily used in the past for agriculture.

Operations at the TWCA site began in 1956 when, under contract with the U.S. Atomic Energy Commission (AEC), the Wah Chang corporation reopened the U.S. Bureau of Mines Zirconium Metal Sponge Pilot Plant. The site produced primarily zirconium and hafnium sponge in addition to tantalum and niobium pilot production. TWCA was established in 1967 after Teledyne Industries, Inc. purchased the Wah Chang corporation of New York. In 1971, the site became a separate corporation, Teledyne Wah Chang Albany. Today, TWCA is an active, operating producer of zirconium metal. The facility's on-going operations are regulated under RCRA and other state and federal environmental laws.

The TWCA facility was proposed for inclusion on the National Priorities List[27] (NPL) in December 1982 due to concerns that unlined sludge ponds at the site were located in the Willamette River flood-plain, and that hazardous materials from the sludge ponds would migrate to soil, surface water, and groundwater. The site was placed on the NPL in October 1983. In 1989, EPA signed a Record of Decision (ROD) for an interim Response Action at the sludge pond to expedite cleanup. The major components of the selected remedy include: excavation and removal of sludge, partial solidification of sludge, construction of a monocell at an off-site permitted solid waste facility, transportation of solidified sludge off-site, and long-term operation and maintenance of the off-site monocell. Approximately 100,000 cubic yards of solids were transported to the monocell at Finley Buttes, a permitted solid waste facility in Boardman, Oregon. In June 1990, EPA issued a Certification of Completion for the Sludge Pond Operable Unit Remedial Action.

Based on the 1990 census, there are 29,000 residents in Albany and 700 in Millersburg. The site is approximately 20 miles south of Salem, 65 miles south of Portland, 60 miles east of the Pacific Ocean, and adjacent to the Willamette River. Portions of the TWCA site are within the river's 100-year and 500-year flood plains. Industrial facilities closest to the TWCA site include a particle board plant, a resin plant, a wood flour processing plant, and a closed plywood mill. The land to the east of the plant is used mainly for residential and commercial purposes. The land west of the Willamette River, which forms the western boundary of the plant, is used for agriculture. The land to the north of the main plant is also used for agriculture.

[27] The National Priorities List (NPL) is used by EPA as a guide under Superfund to identify those sites where further investigation and remedial action under CERCLA are most warranted. Sites are placed on the NPL through a scoring system known as the Hazard Ranking System (HRS), which assigns numerical values to factors that relate to risk, based on conditions at the site. Factors include the type of waste and potentially affected populations, and pathways considered include ground and surface water, soil, and air. *See* 40 CFR. Part 300.425.

CHEMICAL WASTE MANAGEMENT MODEL CITY

CWM is a Treatment, Storage and Disposal (TSD) facility for a variety of liquid, semi-solid and solid organic and inorganic wastes. It is currently owned and operated by Chemical Waste Management Chemical Services. Prior to 1972, the property was used for a variety of industrial purposes other than commercial hazardous waste disposal, including:

1942-43 — it was a part of the Lake Ontario Ordnance Works (LOOW) during which acidic and toxic effluents were generated and stored at the site;
1944-46 — it was used concurrently in conjunction with the Manhattan Project as part of the Northeast Chemical Warfare Depot;
1946-54 — Part of the site was used by the AEC for storage and/or burial of radioactive materials; and
1955-59 — Areas of the site were used to bury and burn wastes from the U.S. Air Force and Navy projects to develop high-energy fuels.

In 1966 the property was sold to a real estate group. In 1972, Chem-Trol Pollution Services purchased the property and began private industrial waste operations as Chem-Trol Pollution Services, Inc. Activities included reclamation of waste oils, distillation of spent solvents, aqueous waste treatment, and land disposal. Between 1972 and 1995, the ownership of the site transferred a number of times. The site has been operated by CWM since 1988. Current operations include waste receiving areas, storage and mixing, tanks, drum handling, stabilization, chemical treatment facilities, biological treatment, impoundment, and securing landfills.

The CWM site is adjacent to the Niagara Falls Storage Site (see p. 10) in a rural setting ten miles north of the City of Niagara Falls, in Lewiston and Porter, New York. The area within a one-mile radius of the facility is sparsely populated. Outside the areas zoned for industry, in both Lewiston and Porter, the land is zoned for both residential and agricultural use. There are 140,000 residents within 10 miles and 3.8 million residents within 50 miles of the facility.

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

The FEMP site, formerly known as the Feed Materials Production Center is located in southwestern Ohio, about 18 miles northwest of downtown Cincinnati. It was constructed by DOE to produce high-purity uranium metal between 1951 and 1989 in support of nuclear weapons production. The production process involved chemical and physical purification of a variety of feed materials, converting uranium compounds into uranium metal, casting the metal into various shapes, and machining the casting to specified dimensions. Some of these materials contained trace quantities of fission products (*e.g.*, technetium-99) and transuranics (*e.g.*, plutonium-239).

In March 1985, EPA issued a Notice of Noncompliance to DOE, identifying concerns about environmental impacts associated with FEMP's past and ongoing operations. Production at the facility ceased in 1989. Little remediation progress had been made since 1985 and the facility was placed on the NPL in 1989. In 1990, a Consent Decree under Superfund was signed between DOE and EPA. Amended in 1991, the Consent Decree identifies a specific schedule of compliance with the CERCLA requirements for conducting Remedial Investigation/Feasability Study (RI/FS), and preparing RODs for contamination at the site. The Ohio Environmental Protection Agency

(OEPA) participated in the RI/FS process. In 1988, DOE also entered into a Consent Decree with the state of Ohio that addressed the management of the site's groundwater pollution and hazardous wastes.

The FEMP site consists of three primary areas: the former production area, the waste storage area, and adjacent forest/pasture land. The production area is a 136-acre tract at the center of the site. The waste storage area is located west of the production area and is where all processing wastes were deposited. Contaminants from material processing and related activities were released into the environment through air emissions, water discharge, storm water runoff, and leaks and spills.

The facility is located just north of the small rural community of Fernald and lies on the boundary between Hamilton and Butler Counties. The area around the FEMP remains predominantly open and agricultural and the site itself was farmed before construction of production facilities in 1951. Residences, many of them farmsteads, are scattered around the area and a dairy farm is located just outside the southeast corner of the FEMP boundary.

Based on 1990 census estimates, the five-mile radius around the FEMP site contains approximately 22,900 people. Within five miles there are six schools that enroll 3,316 students, two day care centers that enroll about 160 children, and residences that house about 8,140 children. The eight-county Cincinnati consolidated metropolitan statistical area has a population of more than 1.7 million and a labor force of more than 920,000.

MAXEY FLATS DISPOSAL SITE

In 1962, Kentucky passed legislation enabling the state to purchase lands for the disposal of radioactive waste. The legislation called for the land to be owned and controlled in perpetuity by the Commonwealth of Kentucky. Also in 1962, the Commonwealth became the first state to sign an agreement with the federal government for the transfer of certain regulatory powers pursuant to the Atomic Energy Act, thus becoming an "Agreement State."[28] The same year, Nuclear Engineering Company, Inc. (NECO) purchased 252 acres of land in Fleming County, Kentucky, known as Maxey Flats, and submitted an application to the Kentucky Department of Health for a license to bury radioactive waste. From 1963 to 1977, NECO managed and operated the disposal of an estimated 4,750,000 cubic feet of low-level radioactive waste (LLRW) at the MFDS. Chemical waste was also buried at the site.

LLRW was disposed at the site using shallow land burial. The waste was disposed of in 46 large, unlined trenches (some up to 680 feet long, 70 feet wide, and 30 feet deep) which cover approximately 27 acres of land within a 45-acre fenced portion of the site known as the restricted areas. Hot wells were also used for burial of small-volume radioactive wastes with high specific activity. Most of the hot wells are 10 to 15 feet deep, constructed of concrete, coated steel pipe or tile, and capped with a large slab of concrete. Trench wastes were deposited in both solid and solidified liquid form. Some wastes arrived in containers such as drums, wooden crates, and concrete

[28] An Agreement State is a state that has a formal agreement with NRC to assume regulatory responsibility for certain types of nuclear materials. As of 1998, 30 states had such agreements with NRC. 1998 Annual Report (NUREG-1145, Vol. 15).

or cardboard boxes. Other wastes were disposed of loosely. Fill material (soil), typically 3 to 10 feet in thickness, was then placed over the trenches to serve as a protective cover. After 1977, six additional trenches were excavated, bringing the number of trenches at the site to 52.

In 1972, environmental monitoring by the Kentucky Department of Health indicated that water entering the trenches had become the migration pathway for radioactive contaminants, primarily tritium. Further studies confirmed tritium migration. In 1977, the Commonwealth ordered NECO to cease the receipt and burial of radioactive waste. In 1979, NECO's license was transferred to the Commonwealth and a private contractor (Westinghouse, the current site custodian) was hired to stabilize and maintain the site.

In 1984, MFDS was proposed for inclusion on the NPL and in 1986 its listing as an NPL site was finalized. Since MFDS was one of the primary disposal facilities for LLRW in the country, the list of potentially responsible parties (PRPs) included more than 650 radioactive waste generators and transporters. The generator PRPs included many private companies in the nuclear industries as well as hospitals, research institutions, and laboratories. Several federal agencies, including DOD and DOE, were also generators. The Commonwealth of Kentucky, as the site owner and a generator, is also a PRP. Some PRPs also disposed chemicals at the MFDS.

MFDS site is approximately 10 miles northwest of the city of Morehead, Kentucky and 17 miles south of Flemingsburg in eastern Fleming County. As of 1991, an estimated total of 663 persons live within 2.5 miles of the MFDS. Of these individuals, 138 are women of childbearing age and 148 are children under the age of 14. The land surrounding the MFDS is primarily mixed woodlands and open farmland. A number of residences, farms, and some small commercial establishments are located on roadways near the site.

NIAGARA FALLS STORAGE SITE (NFSS)

The NFSS is an inactive site located in Lewiston, Niagara County, New York. The current 190-acre site is part of a former 1500-acre Manhattan Engineer District (MED) site that in turn was at one time part of the LOOW. The primary use of the facility from 1944 to mid-1950s was for storage, transshipment, and disposal of radioactive wastes from several sources. Beginning in 1944, the MED used the site for storage of radioactive residues that resulted from the processing of uranium ores (pitch-blende) during the development of the atomic bomb. Additional residues were brought to the site for several years after WWII. Subsequent to MED, responsibility for the site was transferred to the AEC, the U.S Energy Research and Development Administration (ERDA), and the subsequently DOE. Corrective actions at the site have been accomplished through DOE's Formerly Utilized Sites Remedial Action Program (FUSRAP).

Historical records indicate that most materials that were stored at the site came from the following sources: Linde; Mallinckrodt Chemical Plant; University of Rochester; Knolls Atomic Power Laboratory; Union Carbide's Electrometallurgical Operations; Middlesex Sampling Plant; Oak Ridge National Laboratory; Eldorado Mining and Refining Company; and Brookhaven National Laboratory. Shipments from these organizations were primarily radioactive materials, but records indicate that non-radioactive materials were also received at the site. The primary non-radioactive contaminants expected to be found are heavy metals.

In 1982, DOE initiated interim measures to consolidate and store all radioactive materials on the site and adjacent properties. In 1986, the entire area holding the residues and waste ("Waste Containment Structure" or WCS) was covered with an interim facility cap. The cap was designed to retard radon emissions and to reduce rainwater intrusion into the residues and wastes. The remedial action was completed in 1988 and resulted in a 10-acre containment area that holds 191,000 m^3 of combined radioactive wastes and residues.

In 1986, DOE issued an ROD for remedial actions stating the Department's intent to provide long-term "in-place" management consistent with future EPA guidance and with the EPA regulation for uranium mill tailings (40 CFR 192). EPA expressed concern that the level of Ra-226 in the K-65 residues was so high that 40 CFR 192 was not applicable, and that the residues should come under the guidance given in 40 CFR 191 (Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes.) At the request of DOE, the National Research Council, Committee on Remediation of Buried and Tank Waste studied the issues of long-term storage at the site and concluded that DOE's proposed actions of replacing the interim cap with a permanent cap and of long-term site maintenance and monitoring do not address potential risks to the public for the long periods of time commensurate with the duration of potential risks. Since October 1997, the U.S. Army Corps of Engineers has assumed responsibility for the site and under the mandate of CERCLA, the Corps has been re-evaluating the entire site under the RI/FS process. To date, the Corps has completed only the RI phase of the process.

The site is approximately 4 miles south of Lake Ontario, 10 miles north of the city of Niagara Falls, and is in a rural setting. The site is bounded by the CWM facility to the north, a solid waste disposal facility (Modern Disposal) on the east and south, and a Niagara Mohawk Power Corporation right-of-way to the west. Approximately 90 percent of the population in Niagara and Erie counties receive potable water from the Niagara County Water Utility District, which is supplied by surface water intakes upstream from the site. Water from Lake Erie serves 65 percent of the population, and water from the upper Niagara River serves another 25 percent of the population. Communities north of the Niagara escarpment (the ridge of rock stretching 450 miles across Canada near the New York border), including Lewiston and Porter Townships, also receive much of their water from these sources.

SEQUOYAH FUELS CORPORATION

In 1970, the SFC began operation of a uranium conversion industrial facility north of the Interstate Highway I-40 and Oklahoma State Highway 10 in Gore, Oklahoma. SFC conducted uranium-processing operations on an 85-acre portion of the site that is commonly referred to as the "Process Area." In addition to the Process Area, SFC managed storm water and byproduct materials[29] on additional portions of its facility known as the "Industrial Area", encompassing approximately 200 contiguous acres.

[29] Byproduct material is defined in 10 CFR 30.4 as "any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material."

In 1987, SFC began operation of a process for the reduction of depleted uranium hexafluoride (DUF_6) to depleted uranium tetrafluoride (DUF_4) . SFC formally discontinued production operations in July 1993. On February 16, 1993, and July 7, 1993, pursuant to 10 CFR §40.42, SFC notified the NRC of its intent to terminate its license. SFC finalized its Decommissioning Plan (DP) in 1999. Data from this study are based on the Decommissioning Report (DP report) dated March 1999.[30] In addition to the DP report, a RCRA Facility Investigation (RFI) and the Corrective Measure Study (CMS) were carried out at the site in 1997. The scope of the CMS was limited to the evaluation of the impacts and corrective measures associated with the RCRA metals listed in 40 CFR Part 261.

[30] Decommissioning Plan, Revision 2. Sequoyah Fuels Corporation. March 26, 1999.

3.0 ANALYSIS FRAMEWORK AND INFORMATION SOURCES

3.1 Analysis Framework

For each of the selected sites, four categories of issues were closely examined in order to compare the similarities and differences in chemical and radiation risk management approaches and analyze opportunities for harmonization. The categories are:

1. Human health risk characterization;
2. Decision criteria and risk management considerations;
3. Use of institutional controls; and
4. Public/stakeholder involvement.

To examine the similarities and differences in human health risk characterization, information on source of contamination, constituents/substances of concern, exposure pathways, scenarios and assumptions, cancer and noncancer risk characterization and uncertainty are summarized for each site and compared across all six sites. In order to evaluate how sites differ in their approaches to risk management decisionmaking information on land use (that guides selection of remedies), remedy selection, target (post-remedy) cancer and noncancer risks, and balancing of cost, technical feasibility, short/long-term effectiveness, and state/public acceptance are also summarized and compared for each of the six sites.

Based upon feedback obtained at the Annapolis workshop, Institutional Controls (ICs) were suggested by participants as promising vehicles for harmonization of chemical and radiation risk management approaches. To evaluate harmonization opportunities, the following issues relating to institutional controls are examined for the six case study sites:

- Legal requirements and agency guidance;
- IC options, including potential for contaminant changes/migration, types of controls and state and local community involvement;
- Implementation and enforcement mechanisms; and
- Current implementation status.

Public involvement was similarly suggested by participants at the Annapolis workshop as a vehicle for harmonization of chemical and radiation risk management approaches. To evaluate public involvement opportunities, public involvement activities at the six case study sites are examined based on the following factors:

- History of public involvement;
- Legal requirements;
- Formal citizen groups;
- Community contact tools;
- Communication with stakeholders;
- Media relations; and
- Stakeholder involvement in decisionmaking.

3.2 Sources of Information

Publicly available documents such as RODs and RI/FS reports were used as primary sources of information for this study. Table 3.2.1 provides a summary of reports/documents that were reviewed and from which information was summarized for each case study site.

When confirmation of information and additional information was required, particularly when examining the current implementation status of ICs and public involvement, telephone interviews with state and federal regulators, remediation contractors, citizens, and local government officials and other knowledgeable parties were conducted. This report does not directly attribute specific comments to specific individuals; however, a list of persons interviewed is provided in Appendix 2. Because many of the events discussed in this report took place a number of years ago, in some cases it was necessary to rely on the recollection of interviewees.

Table 3.2.1: Reports and Documents Reviewed

Site	Documents Reviewed
TWCA	Record of Decision, Declaration, Decision Summary, and Responsiveness Summary for Final Remedial Action of Groundwater and Sediments Operable Unit. Teledyne Wah Chang Albany Superfund Site, Millersburg, Oregon. US EPA. June 10, 1994. Record of Decision, Declaration, Decision Summary, and Response Summary for Final Remedial Action for Surface and Subsurface Soil Operable Unit. Teledyne Wah Chang Albany Superfund Site, Millersburg, Oregon. US EPA. October 4, 1995. Community Relations Plan for the Teledyne Wah Chang Albany Site, Albany, Oregon. US EPA. November 1987.
CWM	Site-Wide Corrective Measures Study, Model City TSD Facility, Volume I, II and III of III. Rust Environment & Infrastructure, Amherst, New York. January 1995.
FEMP	Record of Decision for Remedial Actions at Operable Unit 5, Fernald Environmental Management Project. US DOE. January 1996. Community Relations Plan for the U.S. Department of Energy Fernald Environmental Management Project, Fernald, Ohio. US DOE. January 1995. Recommendations on Remediation Levels, Waste Disposition, Priorities, and Future Use. Fernald Citizen's Task Force. July 1995.
MFDS	Maxey Flats Nuclear Disposal, Region 04, Location: Hillsboro, KY, Operable Unit 01. US EPA. September 30, 1991. (ROD ID: EPA/ROD/R04-91/097. EPA ID: KYD980729107.) Appendix D to the Feasibility Study Report for Maxey Flats: Risk Assessment. US EPA. April 1, 1991. Draft Revised Community Relations Plan for Maxey Flats Disposal Site, Fleming County, Kentucky. Prepared for U.S. EPA by Booz, Allen & Hamilton. February 4, 1993.
NFSS	Final Environmental Impact Statement (FEIS), Long-Term Management of the Existing Radioactive Wastes and Residues at the Niagara Falls Storage Site. US DOE, Washington, DC. April 1986. (DOE/EIS-0109F) Draft Environmental Impact Statement (DEIS), Long-Term Management of the Existing Radioactive Wastes and Residues at the Niagara Falls Storage Site. US DOE. August 1984. (DOE/EIS-0109D) Safety of the High-Level Uranium Ore Residues at the Niagara Falls Storage Site, Lewiston, New York. Committee on Remediation of Buried and Tank Waste, Board on Radioactive Waste Management. Commission on Geosciences, Environment and Resources, National Research Council. Washington, DC. 1995. Site Inspection Report for the Niagara Falls Storage Site, Lewiston, New York. US DOE, Oak Ridge Operations, Tennessee. July 1992.
SFC	Decommissioning Plan, Revision 2, Sequoyah Fuels Corporation. March 26, 1999. Final Decommissioning Alternatives Study Report, Sequoyah Fuels Corporation. June 8, 1998. Draft Corrective Measures Study Report, Sequoyah Fuels Corporation. October 27, 1997.

4.0 FINDINGS

4.1 Human Health Risk Characterization

Of the six sites chosen for case studies, three are currently listed as Superfund sites and are thus managed under the process laid out in CERCLA, its implementing regulations, and guidance documents. At these sites, human health risks were typically characterized in documents such as the RI/FS. The risks at the site are first evaluated based on existing site contamination assuming that the site remains unremediated. This "baseline" human health risk information is then updated given a variety of alternative remedy options. Based on the selected remedies, the residual levels of contamination are determined and risks are re-estimated to determine residual risk post-remediation activities. Superfund-type assessments were conducted at TWCA, FEMP, and MFDS.

At the CWM and SFC sites, Superfund related assessments were not conducted. Human health risk characterization for the CWM site and the chemical components of the SFC site were carried out RCRA Corrective Measure Studies (CMS). In addition, at the SFC site, human health risk information for radioactive risks evaluated under a decommissioning plan. For the NFSS site, human health risks were characterized in 1986 using the National Environmental Policy Act (NEPA)-Environmental Impact Statement (EIS) process. At the writing of this report, current and updated risk information for NFSS based on the CERCLA RI/FS process is not yet available.

4.1.1 *Magnitude of Environmental Contamination*

Groundwater, soil, sediments, sludge, site structures, tanks, and leachate are the common primary sources of contamination found at the sites discussed in this study. Table 4.1.1 below lists selected contaminants found in all media at the six sites. For most sites, only the contaminants of concern are listed; exceptions are noted in the table. Detailed descriptions of the contamination at the sites follows.

TWCA — Waste materials from facility processes have been placed in unlined ponds on the TWCA site since 1957. These unlined sludge ponds have attracted the attention of regulatory agencies (USEPA, Oregon Department of Environmental Quality (DEQ)) and the public for many years, partly because of the presence of radioactive materials. Much of the public concern has focused on waste sludges in areas of close proximity to the Willamette River. In addition, some of the solids generated prior to 1976 were used as a soil amendment on the TWCA farm site, a portion of the Farm Ponds known as the Soil Amendment area. In 1978 TWCA changed its production process, resulting in the reduction of the amount of radioactive materials in the lime solids. Lime solids generated after 1979 are now contained in four unlined ponds located in the Farm Ponds area and these ponds are presently regulated under TWCA's existing National Pollutant Discharge Elimination System (NPDES) permit. The TWCA facility is currently classified as a hazardous waste generator under the RCRA program. The groundwater and sediments (OU2) and surface and subsurface soil (OU3) are evaluated in this case study. Contaminants at the facility itself include metals, uranium, thorium, radionuclides, ammonia, chloride, sulfates, and a variety of VOCs. Soil contamination in the Soil Amendment Area includes elevated concentrations of polychlorinated biphenyls (PCBs), hexachlorobenzene (HCB), radium, and thorium. At the plant, high concentrations of HCB, PCBs, polycyclic aromatic hydrocarbon (PAHs), radium, and thorium have been identified in the soils.

CWM — In 1986, under the RCRA corrective action program[31], a RCRA Facility Assessment (RFA) was conducted and 154 Solid Waste Management Units (SWMUs) or areas were identified at the site. From 1989 to 1992, the facility was subject to a RCRA Facility Investigation (RFI) and a final report was issued in 1993. The RFI concluded that the sources of contamination appear to be associated with past activities and releases that are unrelated to current activities. As a result of the RFI, six of the SWMUs were determined to have sufficiently high levels of contamination to require Interim Corrective Measures (ICMs). The ICMs included construction of groundwater collection/interception systems. The third phase of the RCRA corrective action program is a Corrective Measure Study (CMS) which was completed in 1995. Risk assessment information on the Model City Facility presented in this report is based on the results of the site-wide CMS. The site-wide CMS utilized three corrective action management units (CAMUs) for the purpose of facilitating remediation waste management activities. The main sources of contamination at this site included groundwater, soil sludge, and impounded water. The area within CAMU 1 is an active portion of the site; contamination consists of primarily VOCs in soils and groundwater in the Upper Tills units. The source of soil and groundwater contamination in the majority of areas in CAMU 2 related to releases from past drum handling activities, primarily VOCs. Contamination in CAMU 3 were generally limited to sediments and sludge and are both organic and inorganic compounds.

NFSS — The NFSS was used as a final waste storage area for radioactive residues from pitchblende processing and radium contaminated sand, soil, and building rubble. The dominant structure of NFSS is the 10-acre waste containment structure (WCS) which is enclosed within a dike and cutoff wall. All residues and wastes are consolidated in the WCS. The remedial action that was completed in 1988 and two small temporary piles and 64 drums of contaminated materials that were incorporated into the WCS when it was reopened for placement of additional materials in 1991 resulted in an estimated 195,000 m^3 (255,000 yd^3) of waste by volume.

The radionuclides and chemicals of interest in the WCS are U-238, U-235, U-234, thorium-230, radium-226, lead, barium, copper, and nickel. The primary nonradioactive contaminants expected to be found are heavy metals. Some of the drums stored in the WCS contain low concentrations of VOCs. The residues consist of the K-65 residues, the combined L-30 and F-32 residues, and the L-50 residues.[32] The wastes consist of the R-10 pile and the remaining wastes and contaminated portion of the containment system. K-65 residues contain 90 percent of structure's total activity. K-65 residues are residues remaining after uranium extraction that contain many of the uranium decay products that had been in secular equilibrium with the U-238 and U-235 isotopes. Approximately 3,510 metric tons of K-65 residues were stored in a silo, a volume of about 11,000 m^3.

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[31] CWM Model City operates under the Condition D.3 of the 6 NYCRR Part 373-2 site-wide permits and an EPA Hazardous and Solid Waste Amendments (HSWA) permit and is thus subject to corrective action requirements.

[32] K-65 residues result from the processing of ore containing 35-60 percent U_3O_8; L-30 residues result from processing of ore containing approximately 10 percent U_3O_8; F-32 residues result from processing of ore containing an unknown percentage of U_3O_8; and L-50 residues result from the processing of ore containing approximately 7 percent U_3O_8.

On-site chemicals in the vicinity of Building 401, which was used as a boron isotope separation plant, were evaluated for HRS scoring in the site-inspection report. The migration pathways for these two potential sources are groundwater, surface water, soil, and air. A soil gas survey indicated the presence of low levels of tetrachloroethene, trichloroethene, and cis-1,2 dichloroethene in the vicinity of Building 401. The presence and/or extent of contamination in groundwater is not known in this area and represents a data gap.

MFDS — Most of the waste disposed of at the MFDS was in solid form, although some container-enclosed liquid and solidified liquid wastes were accepted during the earlier years of site operation. Information on the types and quantities of chemical wastes buried at the MFDS was generally not recorded at the time of waste burial. It is suspected that xylene and toluene are the principal constituents associated with the liquid scintillation fluids that were buried at the site.

Approximately 4.8 million cubic feet of low-level radioactive waste is buried in approximately 45 acres within the site, designated as the restricted area. Of this volume, the activity of byproduct[33] material alone, has been estimated at 2.4 million curies. Because much of this material was reported as mixed fission products, the total activity from byproduct waste may be underestimated. Other wastes disposed of at the MFDS included special nuclear material (Pu, U-233 and U-235) and source material (uranium and thorium, not including special nuclear material). In addition, on-site operations generated materials which included waste from ground surface grading, trench leachate pumping, evaporator operation, and general waste handling. Approximately 27 acres within the restricted area have been used for the construction of 52 disposal trenches. The restricted area also contains storage and warehouse buildings, liquid storage tank buildings (11 20,000-gallon tanks), gravel driveway and parking area. The RI estimated that a total of approximately 2.8 million gallons of leachate are in the disposal trenches. There is a broad range of contaminant concentrations in samples collected from trenches in different parts of the restricted area. Trench materials, leachate, site structures, tanks, soil, groundwater, and ground surfaces are among the main sources of contamination. The ROD that addressed final remediation of soil was examined in this report.

Tritium is the predominant radionuclide detected in groundwater. Samples from monitoring wells contained tritium concentrations up to 2,000,000 picocuries per milliliter (pCi/ml). Other radionuclides detected included cobalt-60, carbon-14, strontium-90, radium-226, and uranium-239/240. These tritium concentrations and presence of other radionuclides indicate that the contamination was caused by trench leachate. Non-radionuclide analyses in monitoring wells indicate the presence of organics and inorganics such as benzene, toluene, xylenes, arsenic, total phenolics, and cyanide.

For soil, tritium is the predominant contaminant. Analyses also indicated that tritium has migrated from the trenches downslope. Other site-related radionuclides detected in soils at the MFDS include cobalt-60 and cesium-137, strontium-90, carbon-14, and plutonium-238 and 239. Toluene was the most widely detected chemical contaminant at the MFDS, ranging from 40 to 250

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[33] As defined in the Atomic Energy Act, 42 USC § 2014, “the term by-product material means 1) any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material, and 2) the tailing or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content.”

ppb. Other VOCs in soils include acetone and methylene chloride in low concentrations. Pesticide, PCBs, and semi-volatile contaminants were not detected in soils of the MFDS study area, with the exception of dieldrin, which was detected in a food crop study. However, this was related to farming activities rather than the MFDS site.

Tritium and radium-226 were the only radionuclides detected in the surface water samples during the RI. The principal sources of tritium are contaminated liquids that have migrated from the trenches to the hill slopes through fractured bedrock and atmospheric releases of tritium from the trenches. Analytical results from the RI indicated low concentrations of chemicals (5 to 98 ppb) in surface water. Chemical contaminants detected in surface water samples were limited to acetone, 2-butanone, chloroform, toluene, bis(2-ethylhexy)phthalate, and hexachlorobenzene. Sediment samples also revealed a high level of tritium (10 to 70 pCi/milliliter). VOCs (acetone, 2-butanone, methylene chloride, and toluene) detected in sediment samples ranged from 5 to 170 ppb.

The average gross alpha, gamma, and beta concentrations measured at the air monitoring stations around the perimeter of the restricted area were 3 to 5 times lower than the maximum concentration permitted by the Commonwealth of Kentucky regulations for individual radionuclides. The primary source of airborne radiation was the evaporation system which ceased operation in 1986.

FEMP — Production and disposal activities, wind, and runoff during 40 years of operation at this site have resulted in widespread contamination from uranium and other hazardous and radioactive chemicals on and near the site. These materials include drummed nuclear waste materials, bulk waste in pits and silos, mixed waste, and contaminated soil and debris. Because of the massive scope of contamination at this site, this study focuses on Operable Unit 5 (OU5).[34] This OU encompasses all environmental media, both on and off the FEMP property, affected by contaminants released from the FEMP site. Although OU5 has no operating history of its own, it reflects the cumulative impact of the source operable units (1, 2, 3 and 4).[35]

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[34] To promote a more structured and expeditious cleanup, FEMP's waste storage areas and the associated environmental media were segmented into five OUs.

[35] OU1 addresses the Clearwell, burn pit, and 6 other waste pits, and soil beneath the waste pits. OU2 addresses the solid waste landfill, lime sludge ponds, flyash piles and other disposal areas, and the berms, liners, and soil within the unit's boundary. OU3 addresses the former production area including structures, equipment, utilities, drums, tanks, effluent lines, wastewater treatment facilities, scrap metal piles, feedstocks, and the coal pile. OU4 addresses Silos 1, 2, 3 and 4, their berms and underlying soil and decant sump tank system, including K-65 wastes.

Table 4.1.1: Summary of Primary Contaminants

Chemicals	TWCA	CWM	FEMP	MFDS	NFSS	SFC
VOCs	acetone, benzene, chloroform, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethene, methylisobutylketone, 1,1,2,2-tetrachloroethane, tetrachloroethylene, 1,1,1-trichloroethane, trichloroethylene, vinyl chloride	benzene, carbon tetrachloride, chlorobenzene, chlororom, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethylene, ethylbenzene, methylene chloride, 1,1,2,2-tetrachloroehtane, tetrachloroethylene, trans-1,2-dichloroethylene, 1,1,1-&1,1,2-trichloroethane	benzo(a)pyrene,1,2-dichloroethane,	benzene, chloroform, 1,2-dichloroethane, toluene (most detected), trichloroethylene, vinyl choride	tetrachloroethene, trichloroethene, cis-1,2 dichloroethene (chemicals of interest for Building 401)	The following are among substances of potential concern, however, none were detected during the RFI study or selected as contaminants of concern (CoCs): benzyl chloride, 1,2 dichlorobenzene, bis (2-chloroethoxy) methane, dichlorodifluoromethane, 1,1-dichloroethane
Semi VOCs	benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, bis(2-ethylhexyl)phlathalates, chrysene, dibenzo(a,h)anthracene, hexachlorobenzene, indeno(1,2,3-cd) pyrene, PCBs, total arochlors	acrylonitrile, bis(2-Chloroethyl)ether, bis(2-ethylhexyl)phthalate, 1,2 & 1,3 & 1,4-dichlorobenze, hexachlorobenzene, hexachlorobutadiene, hexachlorocyclopentadiene, hexachloroethane, napthalene, nitrobenzene, pentachlorobenzene, phenanthrene, phenol, 1,2,	Aroclor-1254, aroclor-1260	bis(2-ethylhexyl) phlathalate, chlorobenzene		PCBs and nitrates (identified as CoCs in CMS). These are on comprehensive list of constituents, however, majority not detected during the RFI : acentonitrile, acrolein, acrylonitrile, phenols, and organic acids (benzoic acid, 2-chlorophenol, cresol, phenol, etc.
Inorganic	antimony, arsenic, barium, cadmium, chromium, copper, magnesium, manganese, mercury, nickel, thallium,thorium, uranium, zinc, zirconium	antimony, arsenic, beryllium, cadmium, chromium, copper, lead, magnesium, mercury, nickel, zinc, cyanide, selenium, silver	antimony, arsenic, beryllium, cadmium, copper, cyanide, manganese, mercury, molybdenum, silver, uranium-total, zinc	arsenic, lead, nickel	barium, copper, lead, nickel	arsenic (identifed as CoC in CMS) antimony, arsenic, beryllium, lead, nickel, selenium, thallium, cadmium (identified as CoPC in CMS; not detected during RFI)
Radiation	radium-226,radium-228, radon-222		cesium-137, radium-226, radon-222, strontium-90, technetium-99, thorium-228, thorium-232, uranium-234/235/236/238	americium-241, carbon-14, cobalt-60, iodine-129, cesium-137, plutonium-238, plutonium-239, radium-226, radon-222, strontium-90, thorium-232, tritium (H3) (predominant)	uranium-238, uranium-235, uranium-234, thorium-230, radium-226 (predominant in K-65 residues), radon-222	natural uranium, thorium-230, radium-226

Total uranium concentrations in surface soil within FEMP boundary typically ranged from 10-100 mg/kg (background is 3.7 mg/kg). Radium-226 and thorium are limited to the former process areas and waste storage areas. The predominant inorganic contaminants are cadmium and beryllium. VOCs and semivolatile organics and PCBs are within the boundary of uranium contamination. Uranium is the predominant contaminant in off-site soil generally in the 5-6 mg/kg range. The estimated affected area of soil (both on and off-site) with uranium above background is approximately 7,907 acres or 12.4 square miles with about 1.7 to 9.3 million cubic yards of soil requiring remediation.

SFC — There are over 5 million cubic feet of contaminated materials at this site, including sludge and soil contaminated with natural uranium, thorium-230 and radium-226; solid wastes, *i.e.*, scrap metal, drummed wastes, empty drums, pallets, and solid wastes buried on-site in the 1970s and 1980s; and facility equipment and structural materials. Among the main sources of contamination were raffinate sludge, calcium fluoride sludge, sediments from various process impoundments, buried and stored solid waste, contaminated soils and sludges. Uranium concentrations in soil exceeding 35 pCi/gram have been found at 31 feet below the process area. Soils containing thorium and radium are found in areas where raffinate sludge was managed. Groundwater on the site is contaminated by uranium; an impermeable layer of sandstone prevents the contamination from migrating vertically. Heavy metals such as arsenic, lead, and antimony are found at various concentrations in soil, sediments, and groundwater.

4.1.2 *Selection of Constituents of Concern (CoCs) and Consideration of Background*

Cleanup sites are usually contaminated with a large number of constituents. Selection of "indicator" substances or constituents of concern (CoCs) from the large list of site constituents is often undertaken to reduce the number of contaminants involved in the analysis. Selection of CoCs is the first step in characterizing a site's potential risks. Among the six sites examined, a variety of screening approaches were used to select CoCs. In general, the screening process is based on one or both of the following two criteria: 1) naturally occurring levels and 2) health risk screening levels. Differences exist in the health risk criterion used to determine CoCs at these sites. In addition, different approaches were employed to select chemical and radionuclide CoCs. Because this study is limited in scope, we could not evaluate whether different CoC approaches have an impact on the site risk characterization and risk management decisions. Table 4.1.2 summarizes the selection of CoCs and consideration of background.

Table 4.1.2 Selection of Constituents of Concerns and Consideration of Natural Background

Sites	Criteria for Selection of Constituents of Concern (CoCs)		Consideration of Natural Background	
	Chemicals	**Radiation**	**Chemicals**	**Radiation**
TWCA	Sample-specific approach CoCs > natural background, CoC risk > 10^{-6} and HI > 0.1	Sample-specific approach Soil: CoC > 5 pCi/g (UMTRCA standard); Groundwater: CoC >0.2 pCi/1 (agriculture) or CoC >0.68 pCi/1 (industrial)	Substances with concentrations less than natural background levels are excluded from further analysis	Remedial decisions were based on cancer risks in excess of background (from gamma) (see section 4.1.4)
CWM	Medium media-specific approach For each medium, CoCs contributed 99 percent of the total risks (risk = concentration times toxicity factors, q*)	NA	Consider natural background for inorganics in soil, arsenic, copper, mercury, nickel, selecnium and zin.	NA
FEMP	Total site risk approach 1LCR > 10^{-7} & III > 0.1; Hypothetical on-site farmer scenario CoCs contributed 99 percent of total cancer and non-cancer risks to "park-user" and "off-site farmer/child"	Total site risk approach Cancer risks from exposure to background radiation in the range of 10^{-10} to 10^{-4} CoCs were selected based on whether they contributed 99 percent of total cancer and non-cancer risks to "park-user" and "off-site farmer/child"	Cancer risk & Hqs are calculated for background in soil, groundwater (GW), surface water (SW), and sediment and compared with risks and Hqs calculated for areas of high concentrations. The baseline risk assessment calculates all site-related risks without separating the contribution from natural background, when, in fact, the contribution from background for some constituents may yield an ILCR>10^{-4} or an HI>1. CoC selection included a statistical comparison to background and in many cases site concentration only slightly greater than natural background.	
MFDS	Media-specific approach Well data used to select CoCs Relative ranking of substances based on concentration, physical and toxicological characteristics CoCs > water quality criteria or RfD	Media-specific approach Data from 4 media (soil, GW, SW, air) used to select CoCs Omit constituents < natural background Rank Impact Sum (IS=max. Conc x toxicity) Incorporate physical characteristic and re-rank IS to select CoCs	Not discussed in selection of CoCs	Omit constituents with concentration less than natural background selection of CoCs
NFSS[36]	NA	NA	NA	NA
SFC	Concentrations of inorganics compared with the background values, and if greater than background, then compared against benchmarks for selection as CoCs. Industrial benchmarks where IC to be implemented. Arsenic is the only CoC in GW, sludge, sediments.	Selected based on potential to contribute the dose, historical information and findings of site investigations Natural uranium and associated transformation products, thorium-230, radium-226	Soil inorganics background levels considered in corrective measure study (i.e., concentration less than background eliminated) Background values for organic constituents assumed Non-Detected	Not explicitly discussed

[36] Documents review for this report were prepared under NEPA (1986 EIS), and were subject to a subsequent review by the NAS (1995). Selection of CoCs was not discussed. Such discussion will be available under the CERCLA process currently being conducted at this time. Information from the CERCLA process is, however, not available at the writing of this report.

TWCA — For the selection of chemical CoCs, two screening methods were used. Chemicals were selected as CoCs when: 1) concentrations were greater than naturally occurring levels; and 2) concentrations resulted in a higher risk than the health risk screening level of 10^{-6} (cancer) and hazard index (HI)>0.1 (noncancer).[37] The health-based screening criterion was applied to substances with available dose-response information such as the reference dose (RfD) and cancer slope factors (q*). For radionuclides in soil, CoCs were selected based on the Uranium Mill Tailings Radiation Control Act (UMTRCA) standard of 5 pCi/g.[38] For radiation levels in groundwater, radionuclides were selected as CoCs if the maximum concentration was greater than 0.2 pCi/l (farmpond agricultural area) and 0.68 pCi/L (main plant industrial area). In addition, as part of the radiological survey conducted by TWCA, risks associated with gamma radiation and radon and the result of radium contamination in the site soil were also evaluated.

CWM — The EPA Risk Assessment Guidelines for Superfund (RAGS) concentration-toxicity screen test was used to select CoCs at this site (risk factor = concentration x toxicity). Chemicals that contributed 99 percent of the cumulative risk were included as CoCs. CoCs were selected separately for groundwater, soil, sludge, and impoundment water. There were no radionuclides at this site

MFDS — To select chemical indicators (CoCs) for further analysis, information on chemical concentration, physical (organic partition factor, K_{ow}), and toxicological characteristics were combined to establish relative ranking of potential CoCs. The health-based criteria were based on Region 5 EPA's Health Effects Assessment, evaluations by EPA's Carcinogen Assessment Group, EPA's RfDs, and EPA's Health Effects Documents. To select CoCs, well concentrations were compared to health-based adjusted water quality criteria or EPA's RfD. Chemicals without health-based criteria and those with concentrations below criteria levels were eliminated from consideration. Eleven indicator chemicals were chosen: benzene, bis(2-ethylhexyl) phthalate, chlorobenzene, chloroform, 1,-dichloroethane, toluene, trichloroethylene, vinyl chloride, arsenic, lead, and nickel.

Radionuclide CoCs were selected for 4 contaminated media (groundwater, surface water, soil, and air). Concentrations that could be attributed only to background for that medium were excluded. Two criteria were used to select a radiation indicator. First an impact sum (IS)[39] was calculated and the IS of potential indicators were compared. Second, other physical characteristics were examined to determine whether they affected the ranking established by the IS value. Based on this approach, twelve radionuclides were chosen as CoCs: tritium, carbon-14, cobalt-60, strontium-90, technetium-99, iodine-129, cesium-137, radium-226, thorium-232, plutonium-238, plutonium-239, americium-241.

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[37] Hazard Index is the sum of more than one hazard quotient for multiple substances and/or multiple exposure parthways.

[38] The UMTRCA standard of 5 pCi/g is set out in the regulations implementing the Uranium Mill Tailings Radiation Control Act, 40 CFR §192.12 (2000).

[39] The impact sum factor is largest of concentration-toxicity (CT) products for various environmental media for each radionuclide, and represents the relative total impact associated with the contaminated media. CT values were calculated for each media by multiplying the media concentration of the radionuclide by an ingestion dose conversion factor.

FEMP — Because of multiple chemical contaminants present, to ensure that no significant chemical CoCs were ignored, the screening risk levels to a hypothetical on-site farmer were set at 10^{-7} for cancer risks and a HI of 0.1 for noncancer risks. For radionuclides, the screening risk level range was set at increased lifetime cancer risks from exposure to background radiation of 10^{-4} to 10^{-10}. Any constituents with risks less than these screening levels were omitted from further analysis.

To identify the major contaminants driving risk, a process was implemented to determine the total risk to the "target receptors" (user of undeveloped park and off-site adult farmer/child scenarios). Chemicals and radionuclides that contributed 99 percent of total cancer and noncancer risks were selected as CoCs. Ten radionuclides (cesium-137, radium-226, radon-222, strontium-90, technetium-99, thorium-232, uranium-234, uranium-235/236, uranium-238), 12 inorganic chemicals (antimony, arsenic, beryllium, cadmium, copper, cyanide, manganese, mercury, molybdenum, silver, uranium-total, zinc), and four organic chemicals (aroclor-1254, aroclor-1260, benzo(a)pyrene, 1,2-dichloroethane) were ultimately chosen as major constituents of concern for OU5.

The baseline risk assessment then calculated all site-related risks without distinguishing between natural background and human-made contamination. In fact, the contribution to risk from natural background concentrations for certain contaminants may yield an incremental lifetime cancer risk greater than 10^{-4} or an HI exceeding 1. External radiation, specifically from radium-226, thorium-228, and radium-228, is the primary pathway for background (natural) cancer risks from radionuclides and their short-lived progeny present in soil. Generally, the concentrations of these constituents on-site present a risk level which is approximately one order of magnitude greater than that of background (natural) concentrations. On-site risks for uranium-234, uranium 235/236, and uranium-238 were approximately two orders of magnitude greater than those of natural background. Risk from arsenic in soil at background (natural) concentrations exceeded 10^{-4}. Background (natural) concentrations of beryllium in soil present a potential risk of 10^{-5}. The highest representative concentrations of beryllium and arsenic on-site demonstrate risks equivalent to the risks associated with background (natural) concentrations of these constituents.

Hazard quotients (HQs)[40] were calculated for naturally occurring concentrations of inorganics in soil based on representative concentrations calculated from site-specific background soil samples. HQs for mercury and zinc exceeded 0.1, HQ for cadmium exceeded 1. Calculated background risks appear to be very significant factors when determining risk levels from soil and sediment because background risks for many contaminants are similar to risks from the human-made contamination at the site. In contrast, on-site surface and groundwater risks are considerably greater than background risks and are not likely to be naturally occurring. Based on these results, background risks from surface and groundwater are, for the most part, less significant than for the other media.

SFC — Radiation CoCs are the radionuclides that have potential to pose a hazard to humans or the environment and are evaluated in the derivation of site-specific cleanup levels, *i.e.*, acceptable

[40] The Hazard Quotient is a ratio of a single substance exposure level over a specified time period to a reference dose for the same substance derived from a similar exposure period.

site-specific derived concentration guidelines levels (DCGL)[41]. They were chosen based on historical information and findings of the site investigations. SFC's radiological CoCs for soil, surface water, sediment, and groundwater were natural uranium and associated decay products, thorium-230, and radium-226. Additionally, the potential chemical CoCs are arsenic, barium, fluoride, PCBs, and nitrate. Since these chemicals do not fall under the NRC's regulatory authority, the EPA and Oklahoma Department of Environmental Quality will be responsible for final determination for these contaminants.

As part of the initial screening process during the CMS, the concentrations for each constituent (mainly metals) in each media were compared with facility-specific background values. Contaminants that were within the facility background values were eliminated from further evaluation. If constituents were greater than facility background levels, comparison to a series of "benchmark values" was made to determine if action was warranted. For metals in soil, human EPA Region 6 health criteria established for residential and industrial soils were applied for benchmark screening purposes. Benchmark values for groundwater were based on the SDWA MCLs and the EPA Region 6 Human Health Screening levels for tap water. If constituents exceeded the benchmark screens, they were considered to be a CMS CoC and were further evaluated for corrective measure alternatives. Antimony, arsenic, beryllium, lead, nickel, selenium, and thallium were detected in various media at SFC. Based on the industrial benchmark screening criterion only arsenic in sludge and sediments was considered a CoC. Arsenic is also the only CoC in the terrace and the shallow bedrock groundwater system at the facility. There were no CoCs identified in the soil media, deep bedrock groundwater system or drainage sediment.

<u>NFSS</u> — This site is not discussed here because the NEPA process was used during the site evaluation in 1986 and no CoC determination was made. At the writing of this report, information from the CERCLA process evaluation was not available.

4.1.3 *On-Site and Off-Site Exposure Scenarios*

To characterize the potential for human health risks associated with a site, a set of assumptions about the use of the site and the hypothetical individuals who might come into contact with a site's contaminated media are postulated. Generally, current and future use of the sites and the surrounding areas formed the basis for the identification of exposure points and exposure pathways which in turn establish the framework for the risk assessment. Both on- and off-site exposure assessment and risk characterization are examined in this study. Tables 4.1.3a and Table 4.1.3b summarize assumptions about the on- and off-site exposure scenarios at the sites.

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[41] Derived concentration guideline levels (DCGL) have been developed as concentrations of residual radioactivity in soils that are equivalent to the radiological criterial. Radiological criteria for termination of a site license are provided in term of dose to an "average" member of a group of individuals "reasonably" expected to receive the greatest exposure to residual radioactivity for "any applicable" set of circumstances (Decommissioning Plan for Sequoyah Fuels Facilty. Revision 2. March 1999.).

ASSUMPTIONS OF FUTURE SITE USE

There is a common theme among the six sites with regard to future land use. For all sites, it is assumed by regulators that once contaminated, the likelihood of returning the contaminated sites to unrestricted use is low to non-existent. With the exception of a portion of the SFC facility, there is no plan to return these sites to unconditional residential use. For all sites institutional controls and long-term site stewardship will play an important role. Institutional controls are "non engineered instruments such as administrative and/or legal controls that minimize the potential for human contamination by limiting land or resource use . . ."[42] Long-term stewardship is a broader concept, encompassing "all engineered and institutional controls designed to contain or to prevent exposures to residual contamination and waste, such as surveillance activities, record-keeping activities, inspections, groundwater monitoring, ongoing pump and treat activities, cap repair, maintenance of entombed building or facilities, maintenance of other barriers and containment structures, access control, and posting signs."[43] Development of effective long-term stewardship programs will be necessary to ensure the future protectiveness of the remedies at all of the sites.

The use of the FEMP site will be restricted, including recreational, industrial, and undeveloped parks, with measures to prevent human intrusion. The MFDS site is essentially abandoned and permanent institutional controls will be implemented to prevent site access. Both the CWM and TWCA sites will remain active industrial sites in the foreseeable future. The majority of the TWCA site is industrially zoned; although the Soil Amendment Area is currently used for agricultural purposes, the property is zoned for industrial use, and in the future the site may be used for industrial purposes. For the SFC facility, the remediation plan calls for restricted access to an on-site disposal cell and the creation of a buffer zone. The remainder of the site would be released without any restriction. The future of NFSS beyond the 300-year plan for temporary storage of radioactive wastes remains uncertain as there is currently no agreement on the future long-term storage of the K-65 residues currently stored at the site. In its hazard ranking assessment, it was assumed that NFSS would remain inactive.

ON-SITE EXPOSURE ASSUMPTIONS

Human receptors — Assumptions about potential human receptors at these sites are driven by the assumption of future land use, as described above. Given that the CWM and TWCA are to remain actively operating facilities, the human receptors included in the exposure and risk characterization are primarily workers. This approach would be less conservative than if the properties were used for residential purposes. Residential exposure may be higher than worker exposure because residential exposure is likely to be for as much as 24 hours per day, rather than eight hours per work day used for worker exposure.

Potential human receptors that were evaluated at the FEMP site included workers and trespassing youth under current land use assumptions and recreational adults and seniors under

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[42] A. *Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups.* September 2000. EPA 540-F-00-005.

[43] U.S. DOE. *Report to Congress on Long-Term Stewardship.* Release No. R-01-025. January 19, 2001.

future land use assumptions. At the MFDS site, because of the "site abandoned" assumptions and proposal for permanent institutional controls to prevent human access, potential human receptors were limited to site intruders for various scenarios including trespassers, construction, and agriculture.

At the SFC site, human access to the area within the institutional control boundary (ICB) of the on-site disposal cell is restricted. It was assumed that a failure to prevent such access would occur and a residential farmer could enter the area within the ICB. It was further assumed that the residential farmer would not disturb the disposal cell. As part of the selected remedies at the FEMP site, an on-site disposal cell will be constructed. Assumptions about possible future failures to prevent human intruders within the restricted zone were not evaluated for the FEMP site.

Consideration of human receptors at NFSS appear to be limited to 10 on-site workers and possible human intruders. Specific attention to children and elderly as receptors were only found in the assessment at FEMP.

Routes of exposure — Although chemical contamination is present at all six sites, analysis of potential human exposure to chemicals was found for only three sites– TWCA, CWM, and FEMP. Exposure pathways for chemicals typically include soil ingestion, dermal contact, and inhalation. In contrast, with the exception of CWM where radiation is not an issue, all five sites considered external exposure to radiation (*i.e.*, direct gamma radiation). Inhalation of radon was considered at TWCA, FEMP, and NFSS. At MFDS additional routes of exposure to on-site radiation were examined, including ingestion of contaminated crops, inhalation, and skin absorption of airborne tritiated water vapor. At SFC, inhalation of dust and ingestion of contaminated food (grown on-site) were pathways analyzed by the site risk assessors. With the exception of the TWCA site, on-site exposure to chemically or radiologically contaminated drinking water was not considered.

Duration of exposure — In general, consistency exists in the assumption about the duration of exposures for workers. A reasonably maximum exposure (RME) duration of 25 years and an average duration of 9 years were used at the TWCA, CWM, and FEMP sites. Differences exist, however, in the residential scenarios. At the TWCA site, a 30-year exposure duration was assumed for the RME adult residents and a worst case scenario of 70 years was assumed at the MFDS site. At the FEMP site, a range of exposure durations was assumed depending on the type of receptors, with the worst case scenario being 70 years. At the SFC site, it appeared that exposure duration of 30 years for residential farmer scenario was used in the computer code (RESRAD) for dose assessment (Appendix G of the Decommissioning Plan). Comments received from NRC at the review of the draft report, however, contradict this fact and suggest that NRC's radiation dose limit is based on an "annual" dose and does not require a 30-year exposure duration. NRC further indicated in its review that the dose limit is based on an "average member of the critical group" and not a "reasonably maximum exposed individual."

Table 4.1.3a: Assumptions in Health Hazard Assessment — future site use, human receptors, exposure routes and duration (on-site)

Sites	Future Site Use	Human Receptor Scenarios	Routes of Exposure		Exposure Duration
			Chemicals	Radiation	
TWCA	Remains an active operating facility in future. Current site use is industrial except for the Soil Amendment area (located within the Farm Ponds Remedial area which is is currently used for agricultural purposes	Soil: current/future farm worker and future residents at Farm Ponds area; trench workers at Plant area; GW: current/future farm worker and future residents at Farm Pond area; future workers at Plant area	Incidental ingestion, contact, inhalation	Direct exposure to external radiation and inhalation of radon gas	Worker: 25 yrs RME; 9 yrs average Resident: 30 yrs RME; 9 yrs average residents
CWM	Remains a RCRA TSD facility	Current on-site workers and future construction workers	Ingestion, dermal contact, inhalation	N/A	On-site worker: 25 yrs RME; 9 yrs average Construction worker: 1 yr
FEMP	Restricted use, including recreational, industrial, undeveloped park with measures to prevent human intrusion On-site disposal cell with restricted access and buffer zone	On-site trespassing youth, workers under current land use and recreational adults and seniors under future land use There was no assumption about human intruders at the disposal cell	Soil ingestion, dermal contact, inhalation	Direct exposure to external radiation; food and water ingestion, inhalation	_Current land use —on-site_ Worker/visitor: 25 yrs Trespasser: 12 yrs (youth) _Future land use—on-site_: Recreational adult: 38 yrs Recreational senior: 14 yrs Recreational youth: 12 yrs Recreational child: 6 yrs Avg. farmer: 70 yrs RME child : 6 yrs
MFDS	Site is abandoned and permanent institutional controls are put in place to prevent site access.	On-site intruders: trespasser, discovery, construction, agriculture Off site: farmer/ child	Not discussed in ROD	Ingestion of contaminated crops, inhalation, direct gamma radiation, inhalation and skin absorption of airborne tritiated water vapor	Short term only — 70 yrs Assumed 100 and 500 yrs of site institutional controls before a person occupies site
NFSS	Temporary storage for 300 years; long-term disposition unknown	10 on-site workers; resident intruders	Limited assessmen via Hazard Ranking System	Direct exposure to external radiation and inhalation of radon gas	Action period: 10 years Monitoring/Maintenance Period: 10-200 years
SFC	Restricted access to ICB area (on-site disposal cell and buffer zone); the remainder of site unrestricted release	Residential farmer with access to area within ICB but would not disturb the disposal cell	N/A	Direct exposure to external radiation, inhalation of dust and ingestion of contaminated food (grown on-site); DW not considered	Maximum reasonably exposed individuals (30 yrs exposure duration; adult RME). 66 percent indoor, 12 percent outdoor, 22 percent away. Max. 50 percent diet from site, 100 percent milk from site

There are clear differences between chemical and radiation risk management approaches in the relevant duration considered in calculations of risk and exposure. In the case of chemicals, 70 years was the typical time period used in evaluating risks at Superfund sites while 30 years was used for RCRA sites. In the case of radiation, a time frame exceeding 70 years and up to 1000 years was considered. In managing radiation risks, long-term horizons are necessary due to the possibility that risks, whether calculated for 30 or 70 years of exposure, might be higher in the future than at present. This is possible because of transit times in groundwater or ingrowth of radioactive progeny that are more dangerous than the original radionuclides. For example, pure uranium is not very hazardous, however, over time at equilibrium more hazardous radium and radon isotopes would occur. Similar behavior can occur with chemicals, however most, but not all, chemical degredation would result in less hazardous products.

Because of the presence of long-lived radionuclides at the MFDS site, additional assessment beyond the typical 70-year time frame was considered. Consideration of a 500-year time frame showed that tritium, strontium-90 and radium-226 levels would exceed the drinking water limits in water extracted from wells located at the base of the hill slopes during the initial part of the 500-year time frame, before tritium and strontium-90 have decayed away. For on-site exposure scenarios, MFDS considered two other durations beyond the 70-year time frame. The first scenario assumed that occupancy of the site occurred after 100 years of institutional controls. The second scenario assumed occupancy after 500 years of institutional controls. At the current levels of contamination (baseline, without any remediation), the average case lifetime fatal cancer risk for the intruder-agriculture scenario was approximately $1x10^{-2}$ (excluding radon exposure). If a 100-year period of ICs is assumed before a person constructs and occupies a home on-site (*i.e.*, intruder-agriculture scenario) the dose decreases and the longer-lived radionuclides such as radium-226, thorium-232, and plutonium-238 become the significant radionuclides. In these longer-lived scenarios, tritium and strontium-90 no longer contribute to the dose because they have decayed away. Also, after 100 years, cesium-137 will have about 10 percent of its original activity (*i.e.*, 90 percent loss). The dose associated with an intruder-agricultural scenario decreases by a factor of 3, to 7.2 rem/year, making the lifetime fatal cancer risk approximately $4x10^{-2}$ (not including radon exposure). After a 500-year period of ICs, the dose and risk slightly decrease further to 5.1 rem/year and lifetime fatal cancer risk of 3.1×10^{-2}, not including radon exposure. The reason for the small decrease is that the dose from drinking water is dominated by very long-lived radionuclides. If <u>uncontaminated</u> sources of water are used, the dose is approximately 600 mrem/year. This dose is primarily due to direct radiation whose major contributer is radium-226.

At NFSS, due to long-lived activities of K-65 residues, the final disposition of this waste is undetermined. Current conditions at NFSS are only intended for a duration of 300 years. Exposure durations used in the site's health assessment are based on 10-year construction period and a 10- to 200-year period of maintenance and monitoring. Similarly, the disposition of long-lived K-65 residues at Fernald remains uncertain. DOE pilot tests of vitrification technology proved unsuccessful due to increased costs and technical uncertainties. In May 1999 DOE completed Proof of Principle (POP) testing for new remediation technologies, and intends to select a new remedial technology and amend the ROD for OU4 by the end of 2001. DOE has not changed its intention to dispose K-65 wastes off-site, as indicated by the requirement that the technologies tested for POP produce a final waste meeting waste acceptability requirements at an off-site disposal facility.

For sites contaminated with both longer lived radionuclides and persistent chemicals, one could reasonably argue that although attention is not given specifically to the persistent chemicals beyond the 70-year duration, accounting for long-lived radionuclides would indirectly handle persistent organic compounds. This argument cannot be made for sites where only chemical contaminants are present, (*i.e.*, CWM). For sites where persistent compounds exist, it is assumed that chemical concentrations will be the same at the time of site investigation, throughout the assumed human exposure duration, (*e.g.*, 30-70 years).

OFF-SITE[44] EXPOSURE ASSUMPTIONS

With the exception of the MFDS and FEMP facilities, off-site exposure and risks received limited consideration. Groundwater as drinking water is the only pathway that received some considerations for off-site exposures across all six sites. However, this off-site exposure pathway was often eliminated based on the assumption that local groundwater was not suitable and/or not currently used as drinking water.

At the TWCA site, groundwater flows in the westerly direction below the site toward the Willamette River. Because this water resource is not currently used as drinking water by TWCA or the surrounding communities, assessment of this off-site exposure pathway was not conducted.

At the NFSS and CWM sites, municipal water supplies most of the residential and agricultural needs in the surrounding communities. Lake Erie and the upper Niagara River are the primary sources of municipal water with intake upstream from both sites. Groundwater in the area is saline and not suitable as drinking water. In the case of the CWM site, it was determined that no evidence existed of contaminated on-site groundwater migrating off-site. At the NFSS site, the WCS is surrounded by monitoring wells, and radiological and nonradiological parameters are routinely measured. The continuous monitoring indicates that there has been no release of radiological and non-radiological contaminants from the WCS. Surface water and sediment samples are also collected quarterly along the surface water and runoff pathway leaving the site as part of the site environmental monitoring program. No release has been detected for the surface water overland/flood migration pathway and groundwater to surface water migration pathway. Both sites eliminated groundwater as a pathway of off-site exposure.

At the SFC site, it was determined that drinking water is not an applicable pathway for several reasons. First, there is no existing drinking water well near or down-gradient from the facility that could be impacted. The few drinking water wells near the plant are up-gradient or so far removed that future impact due to the migration of contaminants is not possible. Second, limited yield of groundwater wells is typical throughout this part of the country and potable water systems rely on surface water. Finally, local areas with higher water yield are affected by current site features. Once removed during the decontamination and deconstruction, the higher water output would also be eliminated.

[44] Off-site exposures include air releases off-site and water release and/or migration off-site.

At the MFDS site, the results of the baseline risk assessment revealed that for the off-site exposure pathways, tritium is the critical radionuclide and the well water pathway is by far the dominant off-site pathway. The Maxey Flats region has a public water supply system that operated by the Flemming County Water Association. The water supply system was extended to serve essentially all residents in the vicinity of the site in 1985, thus reducing the likelihood of off-site exposure through the use of well water. Furthermore, groundwater resources in the area are very limited, with residential supplies typically available only in the valley bottoms. Groundwater quality in the area is generally low, although prior to the extension of the public water system in 1985, water was typically obtained from shallow dug wells which reportedly supplied sufficient quantities of water for household use.

At the FEMP, the Great Miami Aquifer is the major source of drinking water which underlies the entire 1,050-acre site. It has also been determined that 0.062 percent of the Aquifer is contaminated with levels of uranium above background.

OFF-SITE RELEASE AND RECEPTORS

At the TWCA, CWM, NFSS, and SFC sites, limited to no risk characterization for off-site receptors was carried out. At the TWCA site off-site release and risks to off-site receptors were not discussed. At the CWM site off-site risks from exposure due to current site conditions were considered negligible based on site's perimeter air monitoring. Air monitoring stations are also located throughout the NFSS site and its WCS. Monitoring results showed that the WCS is in compliance with the Radon National Emission Standard for Hazard Air Pollutant (NESHAP) of 20 $pCi/m^2/s$.[45] Thus, off-site risks were not considered at the NFSS site based on site monitoring program results. Off-site public safety risks were characterized for the SFC site during the decontamination and deconstruction (D&D) period but not post D&D.

Detailed off-site releases and receptors were evaluated at both the MFDS and FEMP sites. At the FEMP facility, wind, soil erosion, particulate emissions, volatile emissions, root uptake and soil grazing cattle, leaching-infiltration, and surface water runoff are among the many off-site release mechanisms that were considered in the health assessment. Farmers, children, sensitive sub-populations (including children in grades K-8, 9-12, and "senior" citizens), meat consumers and surface water users were among the off-site receptors evaluated. Inhalation, ingestion of foods, drinking water, soil/sediments, dermal contact, and direct exposure to radiation are among the routes of exposures for these off-site receptors. Similar to on-site scenarios, the residential exposure duration for RME is 70 years for adults and 6 years for children.

To evaluate the potential for off-site exposure at the MFDS site, it was assumed that the site was abandoned and no measures were put in place to control or mitigate site releases. Approximately 10 percent of rainwater was assumed to penetrate deep into the trenches and leach radionuclides from the waste. The contaminated rainwater was also assumed to percolate down into the strata underlying the trenches and migrate laterally beneath the trenches to the MFDS hillslopes.

[45] NESHAP for Radon Emissions from Department of Energy Facilities, 40 CFR § 61.192 (2000).

Table 4.1.3b: Assumptions About Site, Water Resources, Extent of Off-Site Contamination and Off-Site Exposure Scenarios

Sites	Assumptions / Current Water Use	Off-Site Contamination	Receptors
TWCA	Site uses Willamette River for industrial use. Ground water is not used by site and surrounding area as drinking water (DW).	GW: Flows in westerly direction below site to Willamette river. Off-site assessment not conducted.	Off-site assessment was not conducted.
CWM	Municipal water supplies for most of Niagara City for both residential and agricultural use. Four percent rely on private wells for drinking water (1980 census). Intake of public water supply on the Niagara is about 10 miles upstream from site. Groundwater is saline (TDS>10,000 mg/l), not considered a source of drinking water. (See NFSS)	GW: It is unlikely that contaminated groundwater has migrated off-site. No evidence of chemical release into environment or off-site migration (1993 RFI); Groundwater potentiometric contours for water level data indicated that contaminant lateral migration is minimal; vertical migration is limited to the Upper Tilt unit.	GW &SW: Limited residential use of groundwater and nearby streams, pathways excluded from HHE. Air: Perimeter monitoring showed airborne off-site exposure risks due to current site conditions are considered to be negligible and not included in HHE.
FEMP	The Great Miami Aquifer is the major source of drinking water. It underlies the entire 1,050-acre site.	GW: 0.062 percent of Great Miami Aquifer contaminated above background levels of uranium. *Off-site release mechanisms:* wind, soil erosion, particulate emissions, volatile emissions, root uptake, soil grazing cattle, leaching-infiltration, surface water runoff.	*Receptors:* Farmers and children; sensitive sub-populations (K-8, 9-12, "senior" citizens); meat consumers; surface water users. *Exposure Routes*: Inhalation, ingestion of foods, DW, soil/sediment; dermal contact, direct radiation. *Exposure duration (current/future land use)*: RME adult farmer: 70 yrs RME child: 6yrs
MFDS	Public water supply installed in 1985. Assumed site was abandoned and no measures in place to control/mitigate site release.	*Off-site release mechanisms:* Rainwater penetrates trenches & leaches contaminants. Contaminated rainwater percolates down into underlying strata & migrates to hillslopes. At hillslopes, contaminated water partially evaporated/partially transported downhill. Evapotranspiration — tritiated water becomes airborne & transported to off-site receptor location. Off-site creek and surface water receiving runoff from site are contaminated w/tritium and hazardous chemicals.	*Receptors:* children; adults *Exposure Routes:* Inhalation of tritium; ingestion of contaminated food, water, direct radiation, child ingestion of soil/sediments. *Exposure duration:* 70 yrs, 500 yrs *Exposure pathways:* Surface water, evapotranspiration, deer, sediment, well water, soil erosion, trench sump.
NFSS	Lake Erie and upper Niagara River are primary source of public water supplies; groundwater use is primarily agricultural and very small number of private wells; local groundwater not suitable for municipal water supply. (see CWM)	Based on site monitoring program, no release to the surface water from land/flood migration pathway and groundwater to surface water migration pathway.	Air: 9676 persons within 3-4 miles, no sensitive environment. Soil: inactive site/no resources, no sensitive environment; 990 persons within 0.5 to 1 mile distance. GW: 2.8 miles to Four-Mile Creek, 500 yr floodplain, fishery production, no sensitive environment.
SFC	DW is not an applicable pathway. No existing DW wells near or down-gradient from facility that could be impacted. The few DW wells near plant are up-gradient or so far removed that future impact due to migration of contaminant is not possible. Limited yield of GW wells is typical throughout this part of Oklahoma; potable water distribution systems rely on surface water and their sources. Localized areas at SFC w/higher water yield affected by site feature. It is assumed that once these features are removed during D&D, the higher output will also diminish.	Due to low yield and quality and abundance of inexpensive surface water, it is assumed unlikely that a viable drinking water well would be established. GW pathway was not considered as potential exposure pathway. CMS: GW flow and mass transport of arsenic was simulated via computer program. Dissolved arsenic movement is predicted to be very low, approx 3-6 times slower than GW velocity. Concentration of arsenic expected to exceed 70 ug/L until approximately 1000 years into the future.	Not evaluated

From here, the contaminated water was assumed partially to evaporate and partially to be transported down the hillslopes to the valley. As a result of evapotranspiration, tritiated water becomes airborne and transported off-site to receptor locations. Another pathway is that without erosion controls, surface and hillslope soil will be transported to the alluvial valley. The erosion pathway would consist of a subset of pathways including direct radiation from living on contaminated alluvium, ingestion of contaminated surface water and vegetables grown in contaminated alluvium, and the ingestion of beef and milk obtained from cattle and milk cows raised on water obtained from the creek and fodder from the contaminated alluvium plain. In summary, at the MFDS site, off-site exposure pathways included surface water, evapotranspiration, deer, sediment, well water, soil erosion, and trench sump. Children and adults are the off-site receptors. Inhalation of tritium, ingestion of contaminated food, water, soil/sediment and direct exposure to radiation are among the routes of exposure for these off-site scenarios. Similar to the on-site assessment, a short-term 70-year time frame and long-term 500-year time frame were considered.

4.1.4 *Hypothetical Baseline Risks*

Baseline risks are cancer and noncancer risks associated with existing contamination at a site prior to implementation of cleanup strategies. Approaches to assess baseline risks varied among the six sites examined. The focus of the risk assessment at the MFDS, SFC, and NFSS sites cancer risk associated with radiation. The risk assessments at TWCA and FEMP sites address cancer and noncancer risks from both chemical and radiation exposures. The focus of the CWM site risk assessment is cancer and noncancer risks from chemical exposures.

In terms of cancer risks, site-wide cumulative risks (*i.e.*, adding risks from all constituents of concern and all pathways of exposure) were assessed at FEMP, MFDS, and NFSS sites. Only sample- and media-specific cancer risks were evaluated at TWCA and CWM sites. Even more different is the SFC site where only total effective dose equivalents (TEDE) were derived. While the most extensive and inclusive risk assessment was carried out at the FEMP site, the MFDS site is the only site for which probabilistic exposure and risk assessment using the Monte Carlo techniques was conducted. The baseline cancer risks for the six sites are summarized in Table 4.1.4a.

At all six sites, noncancer risks were not evaluated for radiation exposure. For noncancer risks due to chemical exposure, on-site noncancer risks were evaluated in the form of hazard indices (HIs) at the TWCA, CWM, and FEMP sites. Off-site noncancer risks were presented only in the case of the FEMP site. At the NFSS site, noncancer risks were evaluated with the HRS. While potential for noncancer risks from chemical exposures exist at the MFDS and SFC sites, no such assessment seems to have been carried out. The baseline noncancer risks for the six sites are summarized in Table 4.1.4b.

The following sections describe the baseline cancer and noncancer risks associated with the six sites in more detail.

CANCER RISKS

TWCA — Assessment of site-wide cumulative cancer risks (all pathways and all CoCs) was not carried out. Rather, sample-specific risk assessments were conducted to characterize geographic distribution of risks and sources of risks. The argument to justify this sample-specific approach is that it allows more accurate delineation of risks from specific contaminant source areas. This approach also enables retention of information on the geographic distribution of risk throughout the study area.

On-site risks from exposure to chemical and radionuclide contamination (excluding gamma and radon) were generally low. Levels of radiation and chemicals detected in soil samples were estimated to result in cancer risk ranges of 10^{-4} to 10^{-6}. For surface soils, chemicals with the most significant contribution to site risks were PCBs, hexachlorobenzene, and PAHs. For sub-surface soils, the most significant contributions came from PCBs and radionuclides. Similar risk ranges due to both types of contaminant were also found in groundwater samples. Volatile organics and arsenic were the main contributors to risks in groundwater samples. However, arsenic levels in groundwater were well below the current MCL (50 ppb).[46]

Estimated excess cancer risks from modeled radon concentrations in future buildings were estimated to exceed 10^{-4}. This level of radon cancer risk was calculated under both industrial (2.2 x 10^{-3}) and residential scenarios (8.4 x 10^{-3}).

Naturally occurring levels of radionuclides create significant gamma radiation risks. The background risk level for the main plant (1.6 x 10^{-4}) and the reference risk level for the Soil Amendment Area (1.9 x 10^{-4}, industrial scenario and 1.7 x 10^{-3}, residential scenario) were considered in evaluating site contaminant related risks. Total excess lifetime cancer risks (risks including background or reference levels), and incremental excess lifetime cancer risks (risks in excess of background) were both provided. However, remedial decisions were based on the latter. Incremental excess lifetime cancer risks due to gamma exposure were in the range of 10^{-4} to 10^{-6}.

CWM — Similar to TWCA, site-wide cumulative cancer risks were not evaluated. On-site risks were characterized for specific contaminated media (*i.e.*, soil and sludge). Furthermore, only worker exposure scenarios were postulated in the evaluation. Workers' cancer risks due to exposure to chemical contamination in soil and sludge were estimated to be in the range of 10^{-5} to 10^{-11}.

FEMP — A large number of factors were incorporated into the baseline risk assessment at the FEMP site. Both on- and off-site cumulative cancer risks were estimated under a variety of assumptions about current and future site use and site access controls. For the purpose of this report, risks relating to the current site use with access controls and the most likely future site use with access controls are summarized.

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[46] 40 CFR § 141.11 (2000).

Table 4.1.4a: Baseline On-Site and Off-Site Cancer Risks

Sites	On-Site Cancer risks		Off-site Cancer Risks	
	Chemicals	**Radiation**	**Chemicals**	**Radiation**
TWCA	Soil: 10^{-5} (3/58 samples) - 10^{-6} (7/58 samples) GW:10^{-4} (2/19 samples) - 10^{-6} (8/19 samples); VOCs & arsenic are main contributors to risks; but As < MCL (50 ppb)	Soil: 10^{-4} (1/44 samples) - 10^{-6} (39/44 samples) Radon: 2.2 x10^{-3} (industrial scenario); 8.3x10^{-3} (residential); gamma 10^{-3} to 10^{-4} GW: 10^{-6} (7/9) - 10^{-4} (1/9 samples)	Not evaluated	Not evaluated
CWM	Soil: on-site worker: 6x10^{-8} - 4x10^{-11} construction worker: 2x10^{-5}- 2x10^{-6} Sludge: on-site worker: 2x10^{-6} - 3x10^{-7} construction worker: 3x10^{-6} - 8x10^{-6}		Not evaluated, GW exposure pathway considered incomplete	Not evaluated, GW exposure pathway considered incomplete
FEMP	*Current land use w/access controls:* 10^{-4} - 10^{-7} (workers); 10^{-6} -10^{-7} (trespassing youth); *Future land use w/access controls:* recreational receptors: 10^{-5} - 10^{-7} (wildlife reserve); 10^{-5} - 10^{-6} (developed park)	*Current land use w/access controls:* 10^{-3} - 10^{-6} (workers); 10^{-5} - 10^{-6} (trespassing youth); *Future land use w/access controls:* recreational receptors: 10^{-4} - 10^{-7} (wildlife reserve); 10^{-5} - 10^{-6} (developed park)	*Current land use w/access controls:* Adult RME 10^{-2}-10^{-3} Child RME 10^{-3}- 10^{-9} Meat eaters10^{-4} -10^{-6} *Future land use w/access controls:* Farmer: 10^{-5} to 10^{-3} Child: 10^{-5} to 10^{-9} Household use of Great Miami River: 10^{-5}	*Current land use w/access controls:* Adult RME 10^{-4} Child RME 10^{-4}-10^{-5} Meat eaters 10^{-4}-10^{-5} *Future land use w/access controls:* Farmer 10^{-3} to 10^{-5} Child: 10^{-4} to 10^{-7} Household use of Great Miami River: 10^{-4}
MFDS	Not evaluated	Assume site abandoned, no action taken to control release Trespasser--73mrem/yr; Construction worker -- 3.2 rems or risk 1.2 x 10^{-4} Adult farmer – 1x10^{-2} (Avg) , 4x10^{-1} (upper) (exclude radon); Site resident's radon exposure 50 WLM/yr (lifetime lung cancer risk of 1) *100yrs IC before occupancy:* Construction worker -- 320 mrem, 1.2x10^{-2} Adult farmer – 7.2 rem/yr or 4 x 10^{-2} (exclude radon) *500 yrs IC before occupancy:* Adult farmer – 5.1rem/yr or 3x10^{-2} (exclude radon)	Not evaluated	Assume site abandoned, no action taken to control release *Groundwater:* During 70 yr timeframe: >MCLs for tritium, strontium-90; >4 mrem/yr MCL for beta activity; Over the 500 yr timeframe: >MCLs for tritium, strontium-90, radium-226. *Risks (fatal lifetime cancer risks):* Tritium is the critical radionuclide contribute up to 50 percent dose/risk; Wellwater is the dominant pathway; soil erosion contributes to the remaining radiation dose. Each year of exposure: Avg: 3x10^{-5} (75mem/yr); Upper: 1.7x10^{-3} (4300mrem/yr); Prolonged exposure: 1x10^{-3} (Avg), 6x10^{-2} (upper); exceeding MFDS remediation goal 25 mrem/yr;
NFSS	HRS score for WCS is zero; HRS score is .553 for on-site chemicals -- low values for potential targets w/in the target distance for the various pathways	Workers: 1.3x10^{-3}(10 yr action period); no significant dose during M&M period Resident intruders: 8000 rem/yr worst case; radon exposure above normal range	Not evaluated	General Public: risk of 10^{-7} (10 year action and 10-200 yrs M&M period
SFC	Not evaluated	Not risks but look at exposure to all radionuclides and all pathways and compared with TEDE 25mrem/yr; 100 mrem/yr (if IC failed)	Not evaluated	Not evaluated

Under current site use and access controls, for on-site receptors (*e.g.*, workers and trespassing youth) total cancer risks due to radiation exposure were slightly higher than risks due to chemical exposures. While worker's risks due to chemical exposure were in the range of 10^{-4} to 10^{-7} and trespassing youth's risks from 10^{-6} to 10^{-7}, risks due to radiation exposures were in the range of 10^{-3} to 10^{-6} and 10^{-5} to 10^{-6} for workers and trespassing youth, respectively. For off-site receptors, chemical exposures resulted in wider ranges of cancer risks than radiation exposures. While the lower bounds of risks associated with chemical exposure in off-site receptors (10^{-9}) were much lower than the lower bounds of risks associated with radiation exposure (10^{-5}), the upper bounds of chemical cancer risks (10^{-2}) were much higher than the upper bounds in the case of radiation exposures (10^{-4}).[47] The carcinogens primarily driving the risk are isotopes of uranium, radium, and thorium; strontium-90; technetium-99; and arsenic, beryllium, 1,1-dichloroethene, and 1,2-dichloroethane.

Although a variety of future site uses were postulated in the ROD, this report presents risk information related to the most likely future site use, specifically, a wildlife reserve or undeveloped park with site access controls in place. Cancer risks to on-site recreational receptors given these future hypothetical use were similar to workers and trespasses under the current site use assumption. Cancer risks due to chemical exposures were in the range of 10^{-5} to 10^{-7} and 10^{-4} to 10^{-7} due to radiation exposure. For off-site receptors, farmers' cancer risks due to radiation exposure were the greatest, 10^{-3} to 10^{-5}. Household use of the Great Miami River water would also result in a high cancer risk of 10^{-4}.

MFDS — This is the only site where the Monte Carlo method was used to characterize distributions of exposure and risks. However, risks were characterized for only radionuclides and not for chemical contaminants. Several assumptions about the site were made for the risk estimation. The first set of risk estimates assumed that site was abandoned and no action was taken to control the release of radioactive materials. Under this assumption and assuming that the trespasser frequents the site once per week for an approximately one hour visit, his/her dose would be approximately 73 mrems/year. It was also estimated that on-site construction workers would receive a lifetime dose of 3.2 rems which is equivalent to lifetime fatal cancer risks of 1.2×10^{-3} (most of the dose and risk are due to direct radiation, primarily from cobalt-46, cesium-137, and radium-226).

Cancer risks were also estimated based on the assumptions that ICs were implemented for 100 years and 500 years before site occupation. Under the assumption of occupation after a 100-year period, the dose and risks of a hypothetical on-site construction worker were estimated to decrease by an order of magnitude (320 mrems or 1.2×10^{-4} lifetime fatal cancer risks). However, after a period of 500 years, the construction workers' dose and risk decrease slightly by less than a factor of 2 to 210 mrem. Direct radiation is still the major contributor to dose and radium-226 is still the dominant radionuclide.

For the on-site agriculture scenario, the lifetime fatal cancer risk to a hypothetical adult farmer is extremely high. For each year a person lives on-site, the lifetime fatal cancer risk is in the 4×10^{-1} to 1×10^{-2} range (excluding radon). Prolonged exposures (many years) would result in a lifetime risk of cancer approaching 1. The exposure to radon was estimated to be 50 working level months (WLM) per year, corresponding to a lifetime risk of fatal lung cancer of close to 1. After a 100-year institutional control period, dose and risk to an on-site adult farmer decreases slightly to 7.2 rem/yr or lifetime fatal cancer risk of 4×10^{-2}. Even when assuming that site-occupation after a 500-year period during which ICs were in place, the lifetime fatal cancer risk for the adult farmer remains at a high level of 3×10^{-2} or exposure to 5.1 rem/year (excluding radon). The reason for this high risk is that the dose from drinking water is dominated

[47] It is suspected that the more conservative assumptions in the off-site exposure scenarious (*i.e.*, residential) contributed to off-site chemical risks being higher than on-site risks.

by radium-226, a very long-lived radionuclide. Given the persistently high risks far into the future, it is apparent that maintenance and monitoring should be implemented and funded in perpetuity.

For off-site cancer risk, it was assumed that site is abandoned and no action is taken to control releases. Well water is the dominant pathway of exposure and tritium is the critical radionuclide contributing 50 percent of the average annual dose of 75 mrem/yr. For each year of exposure at the average annual dose, the lifetime fatal cancer risks would be $3x10^{-5}$ and the upper bound risk would be $1.7x10^{-3}$ (or exposure to 4,300 mrem/yr. The lifetime cancer risks from off-site pathways from prolonged exposure (many years of exposure) would be approximately $1x\ 10^{-3}$ (average case) and $6\ x\ 10^{-2}$ (upper bound case.) The well water pathway contributes the highest dose and risk and soil erosion contributes the remaining dose and risk. In both the average and upper bound estimates of off-site exposure, the MFDS remediation goal of 25 mrem/yr would be exceeded for the entire site.

Two different periods, 70 and 500 years, were used to estimate levels of contamination in the groundwater. During the 70-year timeframe, the MCLs for tritium and strontium-90 would be exceeded. In addition, the 4 mrem/yr MCL for beta activity would be exceeded. Over the 500-year period, tritium, strontium-90 and radium-226 would exceed the drinking water limits in water extracted from wells located at the base of the hillslopes during the initial part of the 500 year time frame, before tritium and strontium-90 have decayed away.

NFSS — On-site workers' risks due to exposure to radionuclides were estimated for two different periods: action and maintenance periods. For the 10-year action period during site construction and remediation, workers' risks were estimated to be approximately $1.3x10^{-3}$. Workers were not exposed to a significant radiation dose during the maintenance period of the site. For site resident intruders, the worst case was estimated to be about 8000 rem/year and radon exposure was above the normal (background ?) range. For off-site risks, only risk due to exposure to radionuclides was found. It was estimated that the general public is exposed to cancer risks of 10^{-7} during the 10 year action period and 10 to 200 year periods during maintenance and monitoring. More recent risk assessment information from the CERCLA RI process conducted by the Corps of Engineers was not available at the writing of this report.

SFC — In July 1997, the NRC adopted new regulations that establish radiological criteria for license termination. Under these criteria, a site will be considered acceptable for license termination if the residual activity is reduced to ALARA and the TEDE to an average member of the critical group does not exceed 25 mrem/yr.[48] In addition, if the ICs fail, the TEDE would not exceed 100 mrem/yr. Based on these radiological criteria and using RESRAD computer code, DCGLs for natural uranium, thorium-230 and radium-226 in soils were derived for both inside and outside the SFC's Institutional Controls Boundary (ICB). Although these dose limits can be converted into cancer risks via conversion factors, these conversions from dose to risks were not provided in the SFC's Decommissioning Plan.

Occupational and public safety issues were explicitly considered in the Decommissioning Plan. The potential radiological impacts on the safety of the public are principally related to the hazards associated with atmospheric release of radioactive materials during decommissioning, from both planned tasks and from accidents. Public doses were predicted based on planned D&D activities. All estimates were less than 0.9 mrem/yr. Accidental scenarios were also assessed. No adverse radiological consequences were postulated from any of these activities.

[48] 10 CFR § 20.1403 (2000).

Table 4.1.4b: Noncancer Risks

Sites	On-Site Noncancer Risks		Off-Site Noncancer Risks	
	Chemical	**Radiation**	**Chemical**	**Radiation**
TWCA	Soil: all areas and all samples HI<1 GW: HI>1 for many samples and all exposure scenarios; Primary chemicals are 1,1 DCE, 1,1,1, TCA, MIBK, magnesium, manganese, ammonia, fluoride, nitrate.	Not evaluated	Not evaluated	Not evaluated
CWM	Soil: on-site construction workers HI<1	Not evaluated	Not evaluated	Not evaluated
FEMP	*Current land use w/access controls:* 0.045<HI<5.4 (workers); 0.068<HI<1.8 (trespassing youth); *Future land use w/access controls:* 0.049<HI<1.6 (wildlife preserve); 0.07<HI<1.7 (developed park);	Not evaluated	*Current land use w/access controls:* Adult RME: 2.3<HI<50; Child: 14<HI<260 Meat consumers: 7<HI<9.9 *Future land use w/access controls:* .031<HI<37 (farmer) .079<HI<150 (child)	Not evaluated
MFDS	Not evaluated in ROD[49]	Not in ROD	Not evaluated in ROD	Not evaluated in ROD
NFSS	Potential health hazard posed by toxic materials such as lead and barium were not addressed adequately in EIS and subsequent studies and documentation.	Not evaluated		Not evaluated
SFC	Not evaluated	Not evaluated	Not evaluated	Not evaluated

[49] May be evaluated in other documents but not summarized in ROD.

NONCANCER RISKS

TWCA — Similar to on-site cancer risks, noncancer risks were estimated for all samples. Soil samples in all areas had hazard index less than one (HI<1). For many of the groundwater samples, the HI was found to be greater than one for assumed exposure scenarios. The primary chemicals detected in groundwater are 1,1-DCE, 1,1,1-TCA, MIBK, magnesium, manganese, ammonia, fluoride, and nitrate. Off-site risks were not evaluated for TWCA.

CWM — Only risks to on-site construction workers were examined and HI was determined to be less than one.

FEMP — A variety of on-site and off-site exposure scenarios were considered to estimate noncancer risks due to chemical exposures. For current land use assuming access controls, the hazard index for workers ranges from 0.045 to 5.4; for trespassing youth the HI ranges from 0.068 to 1.8. Under the assumption of future site use as a wildlife preserve, a recreational receptor would have a hazard index ranging from 0.049 to 1.6; and 0.07 to 1.7 under the assumption of future site use as a developed park. Off-site cancer risks were also estimated for an adult farmer, child, and meat consumer. Assuming current land use patterns and site access controls in place, the child exposure scenario would result in the highest hazard index range (14<HI<260). Under the future land use assumptions (*i.e.*, wildlife preserve or developed park), the child's HI range would decrease. Nevertheless, the upper bound of the HI would still be quite high (0.079<HI<150). Uranium, antimony, arsenic, and cadmium are the dominant chemicals contributing to the risk associated with non-carcinogenic health effects.

NFSS — On-site risks due to presence of chemical contamination were evaluated with the HRS. The HRS score for the waste containment structure (WCS) was zero. For on-site chemicals, the HRS score was 0.553[50].

4.1.5 *Uncertainties*

Uncertainties exist in the exposure and toxicity assessments and subsequently the risk characterizations for all six sites. In general, uncertainties associated with exposure are not quantified in the assessments that were reviewed in this report. Rather, qualitative discussions about exposure uncertainties are provided, with the exception of the MFDS site. At MFDS, Monte Carlo simulation was conducted.

Toxicity as a source of uncertainities was quantified for the Fernald site. The magnitude of toxic uncertainties found at the FEMP site would also be applicable to the other sites. For toxicity assessment, all sites face uncertainties in the reliance on animal data for chemical toxicity and thus could overestimate risks by reliance on slope factors that describe upper 95 percent confidence limit on cancer risks for chemical carcinogens. In the case of the FEMP site, it was suggested that cancer risks may have been overestimated by two or more orders of magnitude for chemical carcinogens. In

[50] The higher the HRS score, the greater the risk from the contamination. Under Superfund, sites with HRS scores greater than 28.50 are proposed for inclusion on the NPL.

contrast, cancer risks from radiation exposure are based on "best estimates," and could underestimate risks by one order of magnitude according the assessment at the FEMP site. For the TWCA site, it was indicated that chemical cancer risks were underestimated due to lack of toxicity information for some chemical contaminants.

In general, the major sources of uncertainties for all sites are the assumptions about exposure pathways, receptors, and fate and transport models used to calculate point estimates. These uncertainties lead to bias in both directions, and hence could result in over- and under-estimates of risks. At the TWCA site, the assumption about workers exposed to groundwater that is currently only zoned for industrial use was listed as a source of uncertainty. In addition, since samples were directed and nonrandomly selected, the sample-specific approach could over-estimate risks for suspected areas and under-estimate risks for missed hot-spots. Another source of uncertainty which could lead to underestimation of risk is that chemical concentrations in environmental media will remain constant over the assumed exposure periods. As TWCA is an active, operating facility, leaks or spills of hazardous materials from pipes and structures could pose additional risks. This source of uncertainty is also true for the CWM site. The assumption that chemical concentrations will remain constant over the exposure period may also lead to overestimation because compounds may degrade or disseminate over time. This source of uncertainty is applicable to all sites at which risk assessment for chemical contaminants were conducted.

At the FEMP site, there were less analytical data for chemical than radiological parameters. This introduced low to moderate uncertainty in the selection of substances of concern and the subsequent calculation of exposure point concentrations for organics, particularly in soil. The cumulative uncertainty from all source at FEMP, including site data, exposure parameters, fate-transport models, toxicity assessment and risk characterization, were estimated to result in an overestimation of risks by two or more orders of magnitude.

The cumulative impacts of uncertainties on the results of the exposure and risk assessments were judged to be minor because the majority of the risk for most receptors (particularly the on-site receptors) is attributable to exposure to uranium, thorium and radium and their progeny in the subsurface soil and groundwater. The relative contribution from this group of radionuclides to the total risk is so great, in most instances, that the total risk would not change significantly if most of the other constituents were added or deleted from the list of constituents selected for evaluation in the baseline risk assessment.

At the MFDS site the transit time for water for many radionuclides is much longer tahn the several years that were assumed due to the radionuclide binding coefficients. Also, the magnitude of retardation for some of the radionuclides may have been overestimated. In addition, the detection of plutonium in the groundwater migrating away from the trenches suggests that plutonium is more mobile than would be indicated by the high K_d[51] values assumed in the risk assessment. These factors could lead to underestimation of risks. On the other hand, the likelihood of all exposure pathways is low and doses from plant and deer ingestion were likely overestimated, leading to overestimates of

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[51] K_d: soil/water partition coefficient.

total risks. In terms of risk characterization, the impacts from tritium in the early part of the 500-year time frame are added to those from radium-226 which are seen at the end of the time frame. It could be argued that this summing of all radiation exposure at the 500-year time frame is unrealistic and could lead to overestimation of risks. At SFC, there are uncertainties associated with the source terms and exposure scenarios specified in the RESRAD computer model and code.

4.2 Decision Criteria

4.2.1 *Future Land Use and Selected Remedy*

At all six sites, the assumptions about future site use determined the corresponding level of site cleanup efforts and selected remedies. Restricted use of sites, including industrial and recreational uses, were the common themes at TWCA, CWM, and FEMP. Both the MFDS and NFSS sites were assumed to be closed to the public and appeared to contemplate no future site use other than as a hazardous waste disposal site. Portions of the SFC site will be released for unrestricted use, but the remainder will be subject to restricted access with legally enforceable institutional controls. Institutional controls are also common to all sites and cleanup remedies. Nevertheless, SFC is the only site among the six evaluated that considered the possible failure of institutional controls. The following sections describe the selected remedies at these sites given the assumed future site use scenarios in more detail. Table 4.2.1 provides a summary of future land use and selected remedies.

TWCA — It was determined that the industrial scenario would be the most appropriate for evaluating the need for remedial action on the main plant, and the industrial and farm worker scenarios were selected as the most appropriate for deciding the need for remedial action for the Soil Amendment area. Risks from exposure to chemicals and radionuclides in surface and subsurface soils were deemed to be acceptable and thus no cleanup was required for these constituents. This determination was based on the assumption of industrial use of the main plant and agricultural (workers) or industrial use for the Soil Amendment area. For surface gamma radiation, cleanup would be needed where risks exceeded acceptable risk levels. To reduce site risks a combination of source remediation and institutional controls will be implemented at the site.

The June 1994 ROD indicates that deed restrictions and institutional controls on land and groundwater use will be implemented for both the main plant and Farm Ponds area. The objective is to ensure that the property and groundwater are used only for purposes appropriate to the cleanup levels achieved.[52] Active groundwater extraction for identified hotspots and source areas at the site (about 35 on-site wells) and slope erosion protection to prevent contaminated fill material from entering the creek would be implemented. For contaminated soil, materials exceeding the gamma action level will be excavated and transported to an off-site disposal site. A facility maintenance plan will be established to incorporate information on areas where future buildings must be constructed using radon resistant construction methods and areas with sub-surface PCB

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[52] Deed restrictions may not be sufficient to ensure that this objective is met. *See* Pendergrass, John. *Sustainable Redevelopment of Brownfields Using Institutional Controls to Protect Public Health*. 29 ELR 10243.

Table 4.2.1: Future Land Use and Selected Remedy

Sites	Future Site Use Scenarios	Selected Remedy
TWCA	-Industrial land use scenario for the Main plant -Industrial & farm worker scenarios for Soil Amendment area (Farm pond area).	Combines source remediation with institutional controls to reduce risks. *Groundwater (GW) & sediments:* Source reduction, GW extraction, slope erosion protection, removal of sediments in portions of surface water remedial sector, flushing of source material in the feed makeup area. *Soil:* 1) Excavate materials exceeding gamma radiation action level and transport to off-site disposal.; 2) establish facility maintenance plan to incorporate information on areas where future buildings must be constructed using radon resistant construction methods and areas with sub-surface PCB and radiation contamination which do not pose a risk if not disturbed (this is available to future site purchasers and government). Site-wide: Institutional controls and monitoring and deed restrictions. However, in 1999, it was discovered that gamma contamination in soil is more widespread than previously thought. Over 20 percent of site is contaminated with gamma radiation at levels exceeding the site cleanup standard (*i.e.*, 20microroetgen/hr over background). The selected remedy based on institutional control requiring land use consistent with current industrial zoning is no longer relevant since inhouse radiation program would be required for any future industrial operator at this site.
CWM	Assumed existing zoning controls and heavy industrial use of site in the future. Site remains as a RCRA TSD facility	Institutional controls to prevent future worker exposures and ongoing groundwater monitoring to prevent off-site migration. Limited ground and soil removal and treatment.
FEMP	-Contaminated materials in consolidated waste management area -Use of the remaining areas as recreational, industrial, or undeveloped park	Site-wide: Excavate and consolidate contaminated materials in on-site disposal (waste management) area. Off-site disposal of soil not meeting waste acceptance criteria. Institutional controls under federal government ownership with measures to prevent human intrusion.
MFDS		Natural subsidence/initial cap and final engineered soil cap with synthetic liner/horizontal flow barrier — Excavate trenches, demolition and on-site disposal of structures; extraction/solidification/on-site disposal of trench leachate; install initial cap of clay and periodic maintenance and replacement; management of surface water runoff; monitor runoff and subsidence; procure buffer zone. Institutional controls to restrict use of site with monitoring/maintenance in perpetuity.
NFSS	Temporary storage site up to 300 years	DOE controls 10 acre Waste Containment Structure (WCS) & buffered zone, total 39 acres; maintains longer controlled access area; performs surveillance/monitoring for an uncertain period following installation of the WCS permanent cap and site closure. Institutional controls under DOE indefinite, thus not required to postulate and design against an inadvertent intruder. (ROD 9/86)
SFC	Unrestricted release portions of the facility and releasing the remainder with legally enforceable institutional controls	D&D and place resulting wastes in on-site disposal cell within the institutional control boundary. GW: Remove and treat contaminated terrace groundwater to remove uranium and other contaminants (required by other regulatory agencies) . Reliance on natural attenuation of the uranium in contaminated bedrock groundwater; nitrate present in the alluvial groundwater system due to previous leaks, GW model shows nitrate will flush into the R.S. Kerr Reservoir. Concentration expected to drop to current DW water standard (10mg/l) in 200 yrs. Restrictions on installation of DW wells in this groundwater system will be imposed. Rate of contaminant entering the river will result in maximum in stream concentration of nitrate about 0.003 mg/l which is below the normal background level. Post remediation GW monitoring for uranium, arsenic and nitrate CMS —- approx 500 cf of PCBs contaminated gravel/sand/soil will be removed in conjunction with facility decommissioning.

and radiation contamination which do not pose a risk if not disturbed. This facility maintenance plan will be available to future site purchasers and the government authorities. Action to control radon exposure was also required for the entire Soil Amendment area and for areas on the main plant where surface and subsurface soil radium-226 concentration exceed 3 pCi/gram. These areas could exceed the action level for radon of 4 pCi/liter if buildings are constructed on the site in the future. No further cleanup action is required to address risks from ingestion of surface and subsurface chemical and radionuclide contamination.

In 1999 it was discovered that gamma contamination in soil is more widespread than previously determined. Over 20 percent of the site is contaminated with gamma radiation at levels exceeding the site cleanup standard (*i.e.*, 20 microroetgen/hr over background). The additional radionuclide contamination that was discovered is buried under 6 to 12 inches of material. Surface gamma levels are at background. While surface readings are not above the cleanup level, they would be if the materials were brought to the surface. Therefore, the selected remedy based on institutional controls requiring land use consistent with current industrial zoning is no longer relevant since an in-house radiation program would be required for any future industrial operator at this site. EPA needs to develop a remedy to address the discovered buried materials. At the writing of this report, no clear solution has been developed to address this issue.

CWM — The site is assumed to remain a TSD facility. Existing industrial zoning controls and heavy industrial use of site is assumed to remain in the future. The main purpose of the selected alternatives for all 3 CAMUs (1, 2, and 3) is to monitor the migration and natural attenuation of subsurface contaminants while informing current and future site workers as to the levels and locations of contaminated media. The following are the selected corrective measure alternatives for CAMU 1, 2 and 3:

CAMU 1: Under the limited action alternative, the contaminants in groundwater will remain in place. However, institutional controls will be implemented to allow for the natural attenuation and monitoring of contaminated groundwater and the possible removal of PCB contaminated soil, if these media have a PCB concentration above 25 mg/kg. Among the components of the institutional controls are an awareness program for facility personnel; continuation of the existing facility groundwater sampling program; maintenance and/or updating of existing facility procedures and protocols for the identification and safe excavation, handling, and storage of contaminated sub-surface soils; and allowance for continual natural attenuation of organic compounds.

CAMU 2: The selected remedy of groundwater extraction and treatment, and environmental monitoring will include the removal and treatment of contaminated groundwater from the Upper Tills unit south of the PCB Warehouse.

CAMU 3: Under the selected remedy, the contaminant of concern will remain in place and institutional controls similar to those under the selected alternative for CAMU 1 (except for groundwater monitoring) will be implemented. In additional, impoundment water and sludges will be pumped and treated.

FEMP — Land use objectives are an integrated component of the cleanup strategies outlined in the FEMP's ROD. The selected remedy for the site is the establishment of a consolidated waste management area with restricted use of the remaining areas of the property. The restricted use will include either recreational, industrial, or undeveloped park. Site-wide, all contaminated soils will be excavated and contaminated materials will be consolidated in an on-site disposal area referred to as the waste management area. Contaminated soil not meeting the on-site waste acceptance criteria will be shipped to an off-site disposal facility. The disposal facility will remain under the continued ownership of the federal government (DOE) with measures taken to prevent human intrusion. The remaining areas made available for use will have institutional controls applied to ensure that the restricted land use (non-farming) will be maintained. An ongoing environmental monitoring program will be put in place.

The selected remedy for the FEMP site consists of these key components:

- Excavation of soil and sediment exceeding final remediation goals/levels and placement of excavated material into an on-site engineered disposal facility;
- Perched water zone presenting an unacceptable threat (*i.e.*, having a cross-media impact to the Great Miami Aquifer that would produce concentration in groundwater exceeding the MCLs) to the underlying aquifer will be excavated with the contaminated soil. Excavated subsurface soil will be placed in an on-site disposal facility;
- Areas of the Great Miami Aquifer exceeding final remediation levels will be restored through extraction methods. Modeling suggests that the extraction well system will be required for up to 27 years to fully attain the final remediation levels.
- Collection/treatment of storm water/wastewater during the implementation of site-wide remedial actions to minimize impact on the regional aquifer;
- Construct and operate a treatment facility for site discharges;
- Measures to minimize environmental and cultural impacts;
- Institutional controls/monitoring, including continued access controls at the site during the remediation period, alternate water supplies to affected residential and industrial wells, continued federal ownership of the disposal facility and necessary buffer zone, and deed restriction to preclude residential and agricultural uses of the remaining region of the FEMP property. Additionally, proper notifications will be provided before the transfer of any federal real property which is known to contain potential for human exposure to contaminated soil and groundwater during the implementation of site-wide remedial actions, and to contaminated materials contained in the on-site disposal facility.
- An institutional control plan focused on specifying short-term (during remedy implementation) and long-term institutional control measures to be applied at the site will be developed during the remedial design to complement the final land use plan. DOE is working with the local communities during the remedial design to establish this final land use and ownership for the FEMP property. In 1999 DOE developed a draft master plan for post-remedial public use of the site, detailing a variety of options relating to the recreational activities to be permitted on the site.
- Long-term environmental monitoring will also be conducted as part of the selected remedy.

MFDS — The objectives of the remedial action at the MFDS site are to minimize infiltration of rainwater and groundwater into trench areas and migration from the trenches; stabilize the site so that the engineering cap requires minimal care and maintenance over the long term; minimize mobility of wastes; promote site drainage and minimize erosion; implement institutional controls to permanently prevent unrestricted use of the site; and implement a site performance and monitoring program.

The key components of the cleanup strategy include natural subsidence, initial cap and final engineered soil cap with synthetic liner and horizontal flow barrier. Excavation of trenches, demolition of structures and on-site disposal, extraction, solidification and on-site disposal of trench leachate were among the cleanup actions. An initial clay cap was installed over the trench disposal area to prevent infiltration of precipitation, which must be maintained and replaced periodically. Management of surface water runoff, monitoring of runoff and subsidence were implemented. A buffer zone was also procured. The period of natural subsidence is estimated to take approximately 35 to 100 years. A final multilayer cap will be installed at the completion of natural subsidence. Future use of this site will be greatly restricted through institutional controls, with monitoring and maintenance in perpetuity. The cleanup strategy will include four phases: initial closure period (22 months); interim maintenance period (35-100 years); final closure period (10 months); and custodial maintenance period (in perpetuity).

Numerous supporting bases for the natural subsidence as a key component of cleanup strategy were provided in the ROD. The proposed long-time period will largely eliminate the potential problem of future subsidence that has existed with remedies that involved stabilizing trenches by mechanical means and placement of a final cap within a few years. The natural stabilization alternative will reduce the redundancy of efforts necessary to construct and maintain the final cap. Natural stabilization does not disrupt intact metal containers such as 55 gallon drums and therefore provides an extra measure of protection to prevent movement of radionuclides to the hillsides. Additional benefits of the natural stabilization alternative will be the opportunity for continued data collection and analyses, and the ability to take advantage of technological advances during the stabilization period.

NFSS — Based on the September 1986 ROD, because this site will serve as a nuclear waste storage site (for up to 300 years), the site is under the government's institutional controls indefinitely. For this reason, it was determined by DOE that it is not required to postulate and design against an inadvertent intruder (in contrast to the approach taken at the FEMP and MFDS sites). The situation at NFSS has since changed since the USACE took responsibility for the site in 1997. The future of this site is unknown at the writing of this report. The Corps is currently revaluating site risks and alternative remedies under the mandates of CERCLA.

SFC — Based on the final Decommissioning Plan, portions of the facility would be released for unrestricted use. The remainder of the site will be released with legally enforceable institutional controls that provide reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the community does not exceed 25 mrem (0.25 mSv) per year. In the event that institutional controls fail to restrict access to the site, the postulated dose will not exceed 100 mrem/yr. This is the only site among the six that considered the failure of institutional controls as a selected remedy.

Under the site D&D plan, the remedy includes dismantling facility equipment and structures; remediation of sludges, impoundments, buried wastes and some impacted soils, and placement of resulting waste materials in an on-site, engineered disposal cell. Under the institutional controls plan a fenced institutional control boundary around the disposal cell will be established. Additional monitoring wells will be installed and a long-term monitoring plan will be developed. Natural attenuation of contaminants in the shallow bedrock groundwater system will be monitored. An agreement will be established with an appropriate institution for long-term security, monitoring and maintenance of the disposal site, including the establishment of a trust fund for financing these activities.

Actions to mitigate contaminated groundwater included the removal and treatment of terrace groundwater to remove uranium and other pollutants. Natural attenuation of the uranium in contaminated bedrock groundwater will be instrumental in lowering levels of radioactivity. There was evidence of nitrates present in the alluvial groundwater system due to previous leaks. In addition, groundwater modeling shows that nitrate will flush into the R.S. Kerr Reservoir. However, nitrate concentration is expected to drop to current drinking water standards (10 mg/l) in 200 years. Restrictions on installation of drinking water wells in this groundwater system will be imposed. The rate of nitrate entering the river is estimated to result in maximum in-stream concentration of nitrate of about 0.003mg/L which is below the normal background level. Post remediation groundwater monitoring for uranium, arsenic, and nitrate will be implemented. Finally, according to the CMS, approximately 500 cubic feet of PCB-contaminated gravels and soil will be removed in conjunction with facility decommissioning.

4.2.2 *Target Post-Remediation Risk/Cleanup Goals*

Target post-remediation risk goals (henceforth "target risk goals") are the residual cancer and noncancer risks that remain on- and off-site after implementation of the selected remedies. While target risk goals were established for the FEMP, TWCA, and MFDS sites, only cleanup goals meeting the radiological criteria of 25 mrem/yr and 100 mrem/yr were used at the SFC site.[52] Cleanup goals for the CWM site were determined based on corrective action criteria for various contaminated media. Based on DOE's assessment (under NEPA-EIS), the NFSS site will remain an interim storage site, and as such no target post-remediation risk goals were found. Risks to on-site workers and nearby residents during the 300-year interim storage periods were previously described under the baseline risks section. However, the disposition of this site could change depending on the outcomes of current Corps of Engineers' CERCLA activities at this site. The following sections described the target risk goals at the following five sites: TWCA, FEMP, MFDS, SFC, and CWM. Tables 4.2.2a and 4.2.2b summarize the target post-remediation cancer and noncancer risk goals, respectively.

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[52]Using EPA's risk coefficient of 7.6×10^{-7} per mrem (EPA-402-R-93-076, June 1994), exposure to 100 mrem/yr for 70 years translates to a lifetime cancer risk of 5×10^{-3}. Without consideration of ALARA, this radiological criterion is less stringent than the typical risk range of 10^{-4} to 10^{-6} for chemical carcinogens.

TARGET CANCER RISK/CLEANUP GOALS

As previously described in the baseline risk assessment section, cancer risks are primarily based on the assessment of radiation exposure at the MFDS and SFC sites. At the FEMP and TWCA sites cancer risks from both radiation and chemicals were evaluated. However, these sites differ in their risk management approaches.

Cumulative (Site-Wide) Target Cancer Risk Goals

Cumulative target cancer risk goals were calculated for both on- and off-site scenarios at the FEMP and MFDS sites. At both sites, the target lifetime fatal cancer risks to residents are less than 10^{-4} for all on- and off-site exposure scenarios. However, at the MFDS site, according to the baseline risk assessment, risks to site intruders were estimated to be at 10^{-2} after 100 and 500 years of institutional controls when no actions are taken. Given that the selected remedy will rely on natural subsidence and institutional controls, it is not entirely clear how these risks would be mitigated to a level below 10^{-4} for the residential intruder scenarios within and beyond these time frames. An additional cleanup goal of 15-20 ppm of uranium-total was also established for on-site exposure to a user of an undeveloped park at the FEMP site. This goal is based on the cumulative exposure to this recreational receptor.

At the SFC site, there were no target post D&D risk goals. Instead, DCGLs for soil were derived to meet radiological criteria determined to be 25 mrem/yr for unrestricted release (TEDE) with specified cleanup goals (CG), and 100 mrem/yr for restricted release with cleanup goals based on 25 mrem/yr. In areas where radium and thorium are not currently present, the uranium DCGLs will be used as the cleanup goal. In areas where radium and thorium are also present, they will be considered in combination to ensure that the dose criteria are met, (*i.e.*, the sum of ratios of concentration to respective DCGL will not exceed one).

Medium-Specific (Source) Target Cancer Risk/Cleanup Goals

Target risk/cleanup goals for specific contaminated media, (*e.g.*, soil, ground and surface water) were not derived for the MFDS site. Ground and surface water target risk goals were established at the TWCA and FEMP sites, but not at the SFC site. Target risk/cleanup goals for soil are available for the TWCA, SFC, and FEMP sites. Corrective action criteria were available for groundwater and soil for the CWM site.

Groundwater:

Differences exist between the TWCA and FEMP sites in terms of target risk goals for groundwater. The MCLs are the cleanup goals for both sites when MCLs are available. If MCLs do not exist, 10^{-6} is the selected risk goal at the TWCA site and 10^{-5} risk is the target risk at the FEMP site. At the FEMP site, residential off-site receptors were used in deriving target risk goals and a less conservative on-site receptor (worker exposure) scenario was used at the TWCA site. The ROD for the TWCA site indicates that contaminated groundwater in exceedance of MCLs, cancer risk of 10^{-6} or noncancer risk of HI > 1 for residential scenario will be prevented from migrating off the TWCA site. In addition, at the FEMP site, a level of 20 ppb for uranium-total was also established for groundwater.

For groundwater at CWM, the CMS indicates that area public and private water supplies would be unlikely to be affected under current and future site conditions. And since there were no exposure points, groundwater was considered to be an incomplete exposure pathway. Also, based on contaminant transport modeling, contaminant concentrations at the site boundary will not exceed groundwater protection limits (7 NYCRR Part 703.5, 40 CFR Part 264.94). As such, it was assumed that groundwater contamination detected within the confines of the site's boundary poses no significant risk to human health or the environment. Corrective action criterion for contaminated groundwater within the site boundary was chosen to be 100 mg/l total volatile organic compound. This level is consistent with the informal criterion previously used at the facility. It was further stated in the CMS that the NYSDEC and USEPA recognize that the purpose of the existing ICMs is not aquifer restoration. Aquifer restoration is not considered a reasonable goal because of technical impracticability of remediating areas with groundwater in geologic units with $1x10^{-6}$ cm/sec hydraulic conductivity. Instead of aquifer restoration, the existing ICMs restrict contaminant migration by providing an additional barrier (*e.g.*, extraction wells and trenches).

Surface Water:

Differences exist between the TWCA and FEMP sites in their risk goals for surface water. Again, the MCLs are the cleanup goals for both sites when MCLs exist. However, 10^{-6} is the stated risk goal at TWCA and risks of 10^{-6} to 10^{-4} were the target ranges for the FEMP site. In addition, a uranium-total level of 530 ppb were also established for surface water at the FEMP site.

Treated wastewater from the CWM facility is ultimately discharged into the Niagara River, located approximately 3.1 miles west of the site, in accordance with the Facility NYSPDES permit limits. There have been minor and sporadic exceedences of these standards at the facility. Additionally, monitoring has been conducted at eight surface water monitoring points on the site. Thus, corrective action criteria for surface water/sediments have not been developed at this site.

Soil:

Target risk/cleanup goals for soil varied across the TWCA, SFC, FEMP, and CWM sites. TWCA adopted a 10^{-4} to 10^{-6} target cancer risk range for on-site chemical constituents in soil. For radium-226, a soil level of 3 pCi/g (equating to a total radon concentration of approximately 4 pCi/L) is the target cleanup goal. According to EPA's regional office, the radon remediation action level used for TWCA coordinated the EPA's radon program voluntary residential standard of 4 pCi/L with the CERCLA industrial risk range. The background radium concentration at TWCA was approximately 1 pCi/gram (equating to a radon level of 1.3 pCi/L.) Assuming continuous exposure to 4 pCi/L radon, the total lifetime cancer risk would be approximately 10^{-3}. Taking background level into consideration, an increase life cancer risk above background levels is in the upper 10^{-4} risk range, which is consistent with the CERCLA industrial risk range.[53] For soil gamma levels, 20 microroentgen/hour over background is the target cleanup level. If one was to apply the same default assumptions of continuous lifetime exposure at the 20 microroetgen/hour level (albeit unrealistic but analogous to the case of chemical hazards) and using EPA's risk coefficient, a lifetime cancer risk of up to 10^{-2} would be assumed. NESHAP levels were applicable to all off-site emissions from soils.

No target cancer risks for chemical constituents in soil were calculated at the SFC site. Compared to the TWCA site, a slightly lower target cleanup goal for radium-226 in on-site soil was established. For unrestricted release of the site, the soil cleanup level for radium-226 was initially established at 1.8 pCi/g based on the radionuclide criteria of 25 mrem/year TEDE. This level was further lowered to set a target cleanup goal of 1 pCi/g for unrestricted release. For restricted release, the level was initially established at 7.2 pCi/g based on the 100 mrem/yr TEDE criterion and subsequently lowered to a cleanup goal of 1.8 pCi/g. Thus, for both restricted and unrestricted release scenarios, the on-site soil cleanup goals for radium at the SFC site are lower than the 3 pCi/g cleanup goal at the TWCA site.

Cleanup goals for natural uranium and thorium-230 in on-site soils were also established for both the unrestricted and restricted use of the SFC site. Similar to the approach used in establishing cleanup levels for radium-226, levels were initially established based on the 25 mrem/yr and 100 mrem/yr TEDE criteria for unrestricted release and restricted release, respectively. These levels were subsequently lowered to determine the target cleanup goals for natural uranium and thorium-230. As a result, the cleanup goal for natural uranium in soil was set at 35 pCi/g for unrestricted release and at 110 pCi/g for restricted release. For thorium-230, cleanup goal was set at 5 pCi/g for unrestricted release and 12 pCi/g for restricted release.

Target cleanup risk goals at the FEMP site were established for both on-site and off-site soils. For on-site soil, a target risk goal of 10^{-6} was established for each contaminant under the assumption of future site use as an undeveloped park at which the hypothetical receptor is a recreational user. Final remediation levels for uranium-total were also established based on the ALARA goal: 50 ppm (leachable form) and 82 ppm (less leachable form). A target risk range of 10^{-4} to 10^{-6} cumulative risk from all contaminants was also established. For off-site soil, an ILCR goal of 10^{-4} to 10^{-5} for each contaminant for the resident farmer scenario was established. The target risk goal for off-site uranium exposure to a resident farmer was determined to be 3.5×10^{-5}. In addition, a final remediation level of uranium of 50 ppm was established.

Based on the HHEs, at the CWM site the potential cancer risks posed by surface and sub-surface soils are well below acceptable levels for current site workers. However, a corrective action level for PCB contaminated surface soils of 25 mg/kg was established for consistency with the PCB Spill Cleanup Policy (40 CFR Parts 761.120-761.139). This cleanup level was determined in

[53] It was noted that when using the risk coefficient from the 1995 Health Effects Summary Tables (EPA-540/R-95-036) and standard assumptions about inhalation rates, continuous exposure to radon level at 4 pCi/L would translate to a lifetime cancer risk exceeding 10^{-2}.

consideration of these factors: that access to the site is restricted by fencing, that deed restrictions exist for the site, and that the current and future use of the site will most likely be industrial.[54]

Some conclusions on target cancer risk goal are:

- A great deal of harmonization in the approaches to managing chemical and radiation risk appeared to have taken place at the FEMP site. The comprehensive assessment of cumulative and pathway-specific risks and cleanup goals reflects this harmonization effort. In addition, its comprehensiveness in addressing both on-site and potential off-site exposures ensure that surrounding population is protected from unwarranted risks post site closure.

- The dose criterion approach at SFC resulted in lower soil cleanup goals for radium-226 than the substance and medium-specific approach utilized at TWCA. Since cumulative cancer risks were not described in the RODs for the TWCA site, it cannot be ascertained whether cumulative risks to an on-site receptor (*i.e.*, workers) would exceed the 10^{-3} risk that are typically considered acceptable for worker's risks, or the risk ranges of 10^{-4} to 10^{-6} for a hypothetical resident farmer residing in the portion of the site where such activities could take place.

- Medium-specific target risk or cleanup goals were not prepared at the MFDS site. However, based on the baseline risk assessment, the MCLs for tritium, strontium-90 and beta activity were exceeded during the 70-year timeframe. Over the 500-year timeframe, the MCLs for tritium, strontium-90, and radium-226 would still be exceeded.

TARGET NONCANCER RISK GOALS

As previously described in the baseline assessment section, noncancer risks were only available for chemical exposures and such assessments were only conducted at three of the six sites: TWCA, CWM, and FEMP. At the CWM site, under the assumption that site will continue to be of industrial use and remain a TSD facility, it is assumed that risks to future construction workers will be mitigated by health and safety protocols and the use of personal protective equipment. Furthermore, it was argued that activities involving excavation of contaminated sludges may result in higher risks than leaving the materials in place. For the groundwater pathway, it was assumed that area public and private water supplies were unlikely to be affected under the current and future site conditions. Thus, it was concluded that the groundwater pathway is an incomplete exposure pathway and no human health risks would be expected. Cumulative impact of chemical exposures from all pathways were not considered in the corrective measure study.

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[54] U.S. EPA has recommended action levels for PCB contaminated Superfund sites (EPA, August 1990). The generic action level for residential areas is 1 mg/kg (10^{-5} excess cancer risk). For industrial areas, there are two action levels: 10 mg/kg for non-restricted access areas and 25 mg/kg for restricted access areas.

Table 4.2.2a: Target Post-remediation Cancer Risk Goals

Sites	Target Post-Remediation Cancer Risks			
	Soil Sediment Sludge	Groundwater	Surface Water	Cumulative Cancer Risks
TWCA	On-site: Chemicals: 10^{-4} to 10^{-6} (worker); Radium-226 < 3 pCi/g (this level could result in 4 pCi/L radon if buildings built here); Gamma: 20 micro-roetgen/hr over background. Off-site: ARAR (NESHAPs)	On-site: MCL or 10^{-6} risk goal (workers)	MCL or 10^{-6} risk goal	NA -- sample specific approach for spatial distribution analysis.
SFC	Unrestricted release: U-natural: 110 pCi/g, CG 35 pCi/g Th-230: 12 pCi/g, CG 5pCi/g Ra-226: 1.8 pCi/g, CG 1pCi/g Restricted: U-natural: 440 pCi/g, CG 110 pCi/g Th-230: 48 pCi/g, CG 12 pCi/g Ra-226: 7.2 pCi/g, CG 1.8 pCi/g	Not considered	Not considered	DCGLs for soil meeting radiological criteria TEDE 25 mrem/yr for unrestricted release with specified cleanup goals (CG), 100 mrem/yr for restricted release with cleanup goals based on 25 mrem/year . In areas where radium and thorium are also present, they are considered in combination to ensure that the dose criteria is met, *i.e.*, the sum of ratios of concentration to respective DCGL will not exceed one.
FEMP	On-site: 10^{-6} risk for each contaminant (undeveloped park recreational user); Final remediation levels for uranium, ALARA goal: 50 ppm (leachable form) and 82 ppm (less leachable form) 10^{-4} to 10^{-6} cum.risk for all contaminants. Off-site: 10^{-4} to 10^{-5} risk for each contaminant (3.5 x 10^{-5} for uranium) (resident farmer); Final remediation level of uranium: 50 ppm	MCLs or 10^{-5} target risks (resident farmer per each constituent); Total Uranium 20 ppb	MCLs or 10^{-6} to 10^{-4} target risks for each constituent (recreational user); uranium-total 530 ppb	On-site: 2.1 x 10^{-5} (undev.park user) 10^{-6} (trespassers in the disposal facility area) Off-site: 10^{-5} (farmer)
MFDS	Not available	Not available	Not available	On-site: less than 10^{-4} (intruder) Off-site: less than 10^{-4} (residential farmer)
CWM	On-site: contaminants concentration in sub-surface soils contribute to cancer risks to future workers within acceptable ranges defined by EPA (10^{-4} to 10^{-6}); Assumed risks to future construction workers above 10^{-6} mitigated by health and safety protocols and PPE. Off-site: not evaluated	On-site: 100mg/L for TVOC Off-site: Assumed area public and private water supplies unlikely to be affected under the current and future conditions at site. GW pathway is an incomplete exposure pathway.	Not considered	Not evaluated
NFSS	Not available	Not available	Not available	Not available

At the TWCA site, noncancer risks were characterized for specific soil and water samples to establish the spatial distribution of risks to target the cleanup effort. Based on the sample assessment, all soil samples had hazard indices of less than one. In the case of groundwater, remediation of groundwater extraction in the Feed Makeup area and at areas where site contaminant concentrations substantially exceed noncancer HI of 1 for workers.

At the FEMP site, both the on-site and off-site target noncancer risk goals were based on HI = 1. The assessment demonstrated that the site remedy for the FEMP will result in a total HI of 0.05 for the user of the undeveloped park from all pathways of exposure. Noncancer target risk goals were also established for individual contaminated medium. A hazard quotient of 0.2 was established for each chemical constituent in on-site soil and less than 1 in off-site soil. For ground and surface water, the MCL is the target goal. In cases where there is no established MCL, a HQ of 0.2 for individual chemical constituent is used as the cleanup target goal. While drinking water was assumed to estimate the hazard quotient for groundwater pathway, the recreational user scenario was used in the case of surface water pathway.

Risks associated with the MFDS site are primarily due to potential exposure to radionuclides rather than the very low concentrations of chemical constituents detected at the site. However, it was suggested that measures taken to contain radionuclides within the site would also be effective in containing the chemical constituents, thus, the implementation of additional treatment process to remove the minor fraction of chemical constituents was deemed as unnecessary.

For sub-surface soil at the CWM site, the hazard index for the reasonable maximum exposure under the future construction worker scenario exceed 1 (CAMU 2). However, remedial activities involving excavation could have resulted in higher risks than leaving contaminated soil in place. Since the CWM site was assumed to remain as a TSD facility in the foreseeable future, it was assumed that risks to future on-site construction workers will be mitigated by safety protocols and personal protective equipment.

4.2.3 *Issues of Balancing*

The Comprehensive Environmental Response, Compensation, and Liability Act (or Superfund), that was initially passed by Congress in 1980 and amended in 1986, is aimed at cleaning up sites contaminated by hazardous substances (including radiation).[55] The National Oil and Hazardous Substances Contingency Plan (40 CFR Part 300) is the regulatory strategy promulgated to implement Superfund.[56] Nine remedy selection criteria that have a substantial bearing on risk management, grouped into three categories, are set out in the NCP.[57] They are:

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[55] With regard to radiation, however, CERCLA provides for certain exemptions, including radon that is naturally occurring in homes.

[56] Rodgers, W.H. Environmental Law. 2d ed. pocket part. St. Paul, Minn.: West Publishing Company, 1994.

[57] 40 CFR §300.430 (e)(9)(iii) (2000).

Table 4.2.2b: Target Post-Remediation Noncancer Risk Goals

Sites	Target Post-Remediation Noncancer Risks			
	Soil, Sediment, Sludge	**Groundwater**	**Surface Water**	**Cumulative Noncancer Risks**
TWCA	HI < 1 (workers)	HI < 1 or MCLs (workers)	Not evaluated	Not evaluated
CWM	On-site: Assumed risks to future construction workers exceeding HI>1 mitigated by health and safety protocols and PPE. 25 ppm for surface soil PCBs.	Assumed area public and private water supplies unlikely to be affected under the current and future conditions at site. GW pathway is an incomplete exposure pathway. No human health risks are expected. On-site: 100mg/L for TVOC	None established; assumed no significant risk to human health or environment.	Not evaluated
FEMP	On-site: HQ = 0.2 for each subs. HQ<1 for all subs. (undeveloped park) Off-site: HQ = 0.2 for each subs. HQ<1 for all subs. (residential)	MCLs or HQ = 0.2 for individual constituents (drinking water)	MCLs or HQ = 0.2 for individual constituents (recreational use)	On-site: goal of HI=1 (recreational users and trespassers in disposal facility). [Assessment showed HI =0.05 for under park user] Off-site: HI=1 (farmer)
MFDS	Not evaluated	Not evaluated	Not evaluated	Not evaluated
NFSS	Not evaluated	Not evaluated	Not evaluated	Not evaluated
SFC	Not evaluated	Not evaluated	Not evaluated	Not evaluated

Threshold Criteria:

- Overall protection of human health and environment; and
- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs), unless a waiver can be justified

Primary Balancing Criteria:

- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility or volume through treatment
- Short-term effectiveness in protecting site workers and community
- Ease or difficulty of implementability; and
- Costs

Modifying Criteria:

- State acceptance; and
- Community acceptance.

In this study, the threshold criteria are examined in the context of target post remediation risk/cleanup goals as described in previous section. To streamline the analysis, compliance with ARARs was evaluated in the context of the target post-remediation cleanup goals for ground and surface water and soil, also as described in previous section. Some of the sites evaluated in this study were not characterized and will not be cleaned up under CERCLA. In order to compare across the studied sites, the CERCLA balancing and modifying criteria were combined and reconstituted into the following five key balancing criteria:

- Time horizon of selected remedies, *i.e.*, long-term effectiveness and permanence
- Considerations of short-term risks to workers and community
- Scientific/technical limitations and implementability
- Costs
- State and community acceptance

These five balancing criteria are examined across six sites and discussed in the text that follows. They are also summarized in Table 4.2.3.

TIME HORIZON OF SELECTED REMEDIES, *I.E.*, LONG-TERM EFFECTIVENESS AND PERMANENCE

This criterion evaluates the ability of a remedial alternative to maintain reliable protection of human health and the environment over time, once cleanup goals have been achieved. The discussion here will focus on the long-term outlook of the residual risks (if any) on- and off-site, post implementation of cleanup strategies.

Table 4.2.3: Balancing Issues

Sites	Time Horizon	Short-Term Risks	Scientific/Technical Limitations	Cost	State & Community Acceptance
TWCA				$110,000 for total capital cost for soil remediation; $7.5 million for GW/sediment remediation.	The state accepts the proposed remedy; community offered little comment on remedy.
CWM	30 years	No health risks to general pub-lic. Minimal risks to workers.	Technically feasible, implementable and reliable.	Overall total is $ 940,000	Community acceptance not considered in selection of corrective action. Corrective action comlies with NYSDEC corrective measure plan requirements.
FEMP	Long-term residual risks of contaminated soil remaining in an on-site disposal facility. Up to 1000 years protection for disposal cell.	22 to 27 years to implement, short-term risks associated with construction, operation of treatment facilities and materials transport.	Uncertainty associated with 27 years duration required to attain GW remediation levels for uranium and several other contaminants. Access to some off-site soil may be difficult.	$580 million (net present worth). Cost of selected remedy is less 1/3 of the cost of meeting cleanup levels associated with full unrestricted use.	State acceptance of selected remedy with stipulations. Community generally accepts selected remedy with reservations about on-site disposal.
MFDS	22 months initial closure; 35-100 years interim maintenance period (natural subsidence); 10 months final closure; Custodial maintenance period (IC) in perpetuity.	Significant maintenance required during the 35-100 yrs of natural subsidence period.	Easy to implement because of continuation of current operations.	$33.5 million; least costly of the 7 alternatives outlined in ROD.	Kentucky generally endorsed the selected remedy. Community favors the selected remedy with inclusion of features in RODs.
NFSS	50 years expected life of WCS interim cap. 100-1000 years expected life of final cap Not adequate because half life of radium-226 (1600 years) & thorium-230 (77,000 years) are longer than expected life of cap.		Uncertainties in local geological and hydrological dynamics, future land/water use, demographics, physiCoChemical behavior and potential public risks argue against leaving the K-65 residues at NFSS permanently. Present and future interactions of adjacent disposal sites w/ NFSS pose added uncertainties.	There are large differences in estimated costs for managing residues for off-site disposal at NFSS and at the Fernald site — approx 100 million dollars difference.	Neither the state nor the public supported the proposed alternative in the FEIS.
SFC	Institutional controls in perpetuity. Short-term worker and public risks due to D&D activities.		Solidification of sludge and soil to limit mobility, leaching and inhibit radon emissions.	Directed cost of D&D approx. $23 million.	Public: Cherokee Nation preferred unrestricted release; concerns about unremediated GW, required 1000 year monitoring, sufficient trust fund for IC.

TWCA — A major component of the selected remedies is the reliance on perpetual deed restrictions and other institutional controls on land and groundwater use. The long-term effectiveness of these ICs is unknown, and can only be ascertained over time with adequate monitoring and maintenance of the institutional controls plan. Under the current plan of the selected alternative, the impacts of potential contamination from uninvestigated areas, and from ongoing operations at the TWCA facility will be further investigated. This provides some assurance that future risks will be investigated and mitigated. The approach recognizes that as an active site, ongoing operations at the site may impact the effectiveness and permanence of remedial actions. Furthermore, the recent discovery of more extensive gamma radiation-contaminated soil renders the selected risk management approach less than permanent for the time being.

FEMP — Long-term residual risks arise from contaminated soil that will remain in an on-site disposal facility. Engineering measures and institutional controls are proposed to ensure the long-term performance of the remedy and the protection of human health and environment over time. These measures and controls will be adequate to provide reliable, long-term protection for up to 1000 years. While the selected site remedy for soil does not offer as high a degree of long-term effectiveness and permanence as the off-site disposal alternative, it was deemed to significantly reduce the risks from the contaminated material through excavation and placement in an engineered on-site disposal facility. By combining all of the remediation waste into one disposal location, it can be managed more effectively over the long term. DOE intends to dispose the high-level K-65 wastes off-site and continues to evaluate remedial options that will allow for off-site disposal.

MFDS — After the final cap has been constructed, the custodial maintenance period will begin at this site. Site monitoring, surveillance and five year reviews will be performed during the custodial maintenance period. The completion of the custodial maintenance period will initiate the institutional control period which must be maintained for at least 100 years following site closure. In addition, the perpetual maintenance fund will ensure that institutional control activities, including fencing and other activities to control access to the MFDS, periodic surveillance, custodial care, and filing of notices, survey plats, and deed restrictions will accomplish the goal of preventing inadvertent intrusion onto the MFDS and provision of custodial care in perpetuity. The fund will also provide for collection and analysis of samples and data. Time is the primary means by which the toxicity of radionuclides would be reduced. Toxicity would be reduced by decay of the radionuclides to concentrations at which they no longer present a threat to human health and the environment. Budgeting for these items is, however, contingent on the state's biennial budget process.

NFSS — A 50-year expected life of WCS interim cap and 100 to 1000 years expected life for the final cap. These durations were deemed not adequately protective since the half life of radium-226 is 1600 years and that of thorium-230 is 77,000 years. The future status at this site is unknown at the present time.

SFC — Institutional controls will be used in perpetuity due to the presence of an on-site disposal cell and buffer zone surrounding the cell. Cleanup of the rest of the site is permanent and will result in the unrestricted release of site use.

CWM — For all three CAMUs, it is assumed that the components of selected alternatives will be continued for 30 years. Awareness training and groundwater level monitoring programs are essential components of the operation and maintenance requirements. For CAMU 2, the groundwater extraction is presumed to continue for 30 years. Removal of impoundment water and sludges will be the most cost effective method of remediating CAMU 3.

CONSIDERATIONS OF SHORT-TERM RISKS TO WORKERS AND COMMUNITY

The short-term effectiveness criterion focuses on the period of time needed to put into place mechanisms to achieve longer-term protection of human health and the environment, and address the adverse impact that can occur during remedial construction and remedial action until cleanup goals are met.

TWCA — The estimated time to implement groundwater and sediment cleanup activities is one year. The short-term risks to human health are primarily those associated with dust and air emissions resulting from sediment excavation, debris handling and off-site disposal. These risks could be minimized by control of air emissions during construction. Workers on-site may be exposed to acidic groundwater in certain areas while construction activities are conducted, and will be required to wear protective clothing. Since the site is a restricted access industrial plant, the nearby community should not be impacted by construction activities.

FEMP — It will take approximately 22 to 27 years to implement the selected remedy at this site. Short-term risks will be created by construction, operation of treatment facilities and material transport. However, because the majority of the contaminated soil to be excavated is present on property within an area under DOE access and control, there will be little opportunity for public exposure to the contaminants during the remedial activity. The exposure potential to remediation workers will be managed in accordance with the health and safety plan. The on-site disposal plan will provide more short-term effectiveness and will be easier to implement than off-site disposal.

MFDS — The estimated implementation time of the selected remedy at this site included 22 months for the initial closure period; 35 to 100 years for the interim maintenance (natural subsidence) period following the initial closure period; and 10 months for the final closure period following the interim maintenance period. Significant maintenance activities will be required during the 35 to 100-year maintenance period. A buffer zone adjacent to the existing MFDS site property boundaries will be acquired to protect environmentally sensitive areas such as the hillslopes from detrimental logging to prevent further erosion. Signs will be posted to warn potential trespassers of the presence of site contaminants. Fences were constructed to prevent access to the capped trench disposal area. This approach will provide the greatest short-term effectiveness of the several alternatives evaluated for the MFDS site because it will achieve initial capping of the trench disposal area earlier than any other alternative and with less exposure of site workers to radiation.

SFC — There will be some short-term worker and public risks due to D&D activities.

CWM — There will be no health risks to the general public off-site, and minimal risks to construction workers during installation of selected actions mitigated through personal protective equipment.

SCIENTIFIC / TECHNICAL LIMITATION AND IMPLEMENTABILITY

This evaluation addresses the performance of selected treatment technologies to permanently and significantly reduce risks and the technical and administrative feasibility of implementing the selected remedy.

TWCA — For groundwater, extraction and treatment for resource recovery will be employed to reduce contaminant volume and flushing will be used to reduce toxicity. Groundwater extraction and treatment and monitoring systems are readily implementable as a proven technology and process services and equipment are readily available. However, implementation is difficult because of the extensive material handling requirements associated with sediment excavation and removal; pilot testing of flushing techniques prior to full scale implementation and sediment removal will require determination of potential ecological impact prior to implementation. The recent discovery of much more soil with gamma levels above the cleanup goal than had been anticipated calls into question the current remedial action plans. The selected remedy of ICs requiring future land use consistent with current industrial zoning is not appropriate without further action. A new course of action has not yet been identified.

FEMP — Uncertainty is associated with the 27-year time period required to attain ground- water remediation levels for uranium and several other contaminants. Access to some off-site soil may be difficult. The major tradeoffs that provide the basis for selection of on-site disposal are short-term effectiveness, implementability, and cost.

MFDS — The treatment of site wastes would not be practical due to the nature and volume of waste involved. Other than exhumation and off-site disposal of the contaminated media at the site, a significant reduction in volume at the MFDS is not currently attainable. Exhumation and off-site disposal, while physically possible, would result in unacceptably high doses to site workers. In addition, due to the activity of some wastes present at the site and the volume of waste involved, no present commercial low-level waste facility would likely accept the waste. Thus, excavation and off-site disposal would not be feasible due to the lack of facilities that could accept the volume and activity of waste present at the MFDS and the greater risk to human health and environment that would be associated with such activities. The implementability, reduction of toxicity, mobility or volume, state acceptance and community acceptance weighed heavily in favor of a selected remedy for natural subsidence and stabilization. The natural stabilization process at the MFDS allows the materials to subside naturally to a stable condition prior to installation of a final engineered cap. With uncertainty, it was estimated that the stabilization process could take up to 100 years.

NFSS — Uncertainties in local geological and hydrological dynamics, future land/water use, demographics, physiCoChemical behavior and potential risks to the public argued against leaving the K-65 residues permanently at NFSS. Present and future interactions of adjacent disposal site (CWM) posed added uncertainties. The future of this site is presently unknown.

SFC — Solidification of sludge and soil will limit mobility and leaching, and inhibit radon emissions.

CWM — Selected corrective actions for all three CAMUs were considered technically feasible, implementable, and reliable. For CAMU 2 and 3, the removal and treatment of contaminants from soil and groundwater will reduce toxicity, mobility, and volume.

COSTS

TWCA — Total capital costs of $110,00 for soil remediation and $7.5 million for groundwater and sediment remediation were estimated for this site. The $7.5 million is the present worth cost for a 30-year period. The present worth costs were determined by summing the estimated capital costs and estimates of the discounted operation and maintenance (O&M) costs over the projected lifetime of the remedial alternative. Estimated present worth costs of $7.5 million were based on a 30-year life of the remedial alternative using a discount rate of 5 percent. The following assumptions were also made: groundwater extraction will be carried out at 35 on-site wells; approximately 15 environmental evaluations beneath buildings and structures will be conducted; and approximately 3600 cubic yards of sediment will be removed from site. The $110,000 cost for soil remediation does not include operation and maintenance costs. This cost could increase significantly depending on what is to be done about the recent discovery of more extensive radium-226 contamination at the site.

FEMP — The cost of the selected remedy is presented in three different estimates: total cost, present worth cost, and total cost with escalation. The total cost of the remedy ($840 million) represents the total amount, in constant 1995 dollars, necessary to implement the selected remedy assuming no escalation or inflation occurs over the life of the remedy. The present worth cost ($580 million) represents the total estimated present worth cost of the remedy assuming a discount rate of 2.8 percent. The present worth costs represent the sum of money which must be placed into a bank at the onset of remedial activities at an interest rate of 2.8 percent to progressively pay for the entire scope and duration of remedial actions. The total cost with escalation ($2.11 billion) represents the total estimated cost of remedial actions assuming that funding is provided on an annual basis and an annual escalation rate of 3.7 percent prevails throughout the duration of the remedy. The selected remedy is less 1/3 of the cost of meeting cleanup levels associated with full unrestricted use.

MFDS — The present worth cost of the selected remedy will depend on the period assumed for interim maintenance. The selected remedy has the lowest present worth total cost of any alternative regardless of the duration of the interim maintenance period. Based upon a 4 percent discount rate, the cost estimate is $33,553,000. Approximately $23,910,000 of this amount was attributed to the construction cost and $9,643,000 was associated with operation and maintenance costs. The actual discount which will be used to establish the MFDS trust fund was not determined at the time the ROD was completed. Furthermore, the cost estimate assumed a 10 percent contingency and installation of a north cutoff wall. The actual contingency factor employed in the establishment of the MFDS trust fund may be higher than 10 percent. The necessity of a horizontal flow barrier and type of barrier will be determined during the interim maintenance period; therefore the cost estimate is subject to change.

NFSS — The estimated cost of ultimate off-site disposal of K-65 residues at this site was approximately $100 million more than that at Fernald. There are currently no accurate cost estimates for this site due to uncertain future of site and final disposition of K-65 residues.

SFC — The estimated direct cost of D&D is approximately $23 million.[58]

CWM — Total cost based on Present Worth Analysis in 1995 dollars for CAMU 1, limited action alternative is $180,000; for CAMU 2, groundwater extraction and treatment and environmental monitoring alternative is $270,000; CAMU 3, source removal and treatment alternative is $470,000. Overall total is $940,000.

STATE AND COMMUNITY ACCEPTANCE

A detailed description of community acceptance of selected remedies based on phone interviews can be found in Section 4.4 of this report. This section represents a summary of information provided in documents (*i.e.*, RODs) reviewed by the researchers.

TWCA — The state accepted the proposed excavation remedies, determining that they met the Oregon cleanup rule preference for permanent remedies. The state also accepted the 20 microroentgen/hr > background as the cleanup standard for gamma radiation. Public comment on the ROD addressing groundwater largely supported the facility, expressing concern over the remedial actions EPA would require. Although opportunity to comment was provided on the ROD addressing soil, there was no public comment received on this remedial action.

FEMP — The state accepted the selected remedy with stipulations; the community generally accepted the remedy with reservations about on-site disposal. Some members of the local community are personally opposed to on-site disposal and expressed a preference for off-site disposal of contaminated soil, regardless of cost and implementability considerations. Other members of the community expressed an understanding of the proposed remedy and the prudence of taking a balanced approach to site cleanup, noting the disproportionate costs, implementability concerns, and transportation safety concerns associated with full off-site disposal. In general, the public was in general agreement to restore the Great Miami Aquifer to full beneficial use.

MFDS — State acceptance and community acceptance weighed heavily in favor of the selected remedy for natural subsidence and stabilization. The Commonwealth of Kentucky generally endorsed the selected remedy. The community favors the selected remedy of natural subsidence with inclusion of a number of features that were included in the RODs and RD/RA consent decree.

NFSS — The state and the public do not support leaving wastes at the site permanently. The site is only an interim storage facility.

[58] According to NRC's sources, the gross costs including other costs incurred by SFC in addition to the direct cost are approximately $87 million (NRC comments, November 2000).

SFC — The Cherokee Nation prefers a release of the site with no restrictions on site use. It is concerned about unremediated groundwater, the requirement for a 1000-year monitoring program, and the creation and maintenance of a sufficient trust fund for institutional controls.[59]

CWM — Remediation at this site does not appear to consider public input in the selection of corrective measures. The selected alternative was in compliance with New York State Department of Environmental Conservation (NYSDEC) corrective measure plan requirements.

4.3 Institutional Controls

4.3.1 *Defining Institutional Controls*

According to EPA, institutional controls (ICs) "are non engineered instruments such as administrative and/or legal controls that minimize the potential for human contamination by limiting land or resource use; are generally to be used in conjunction with, rather than in lieu of, engineering measures such as waste treatment or containment; can be used during all stages of the cleanup process to accomplish various cleanup-related objectives; and should be "layered" (*i.e.*, use multiple ICs) or implemented in a series to provide overlapping assurances of protection from contamination."[60] The Environmental Law Institute defines ICs as "legal or institutional mechanism[s] employed at industrial or similar sites to ensure that such sites will continue to be used for industrial or other purposes that are compatible with the cleanup, while triggering a review of the need for further cleanup if the user proposes to put the site to residential use or to another use for which the residual contamination might present unacceptable risks."[61]

ICs are put into place at sites where complete remediation is not possible or feasible. They are meant to limit human activity at or near facilities where hazardous substances, pollutants, or contaminants exist or will remain on-site. Examples of institutional controls include land and resource (*e.g.*, water) use and deed restrictions, well-drilling prohibitions, building permits and well-use advisories, and deed notices.[62] Where residual contamination remains and potentially hazardous exposures are possible, ICs may be implemented to limit exposure to contaminants of concern.[63]

In this study, the following issues relating to institutional controls are examined across six studied sites:

i. Legal requirements or guidance

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[59] NRC's regulations do not specify an explicit value of 1000 years for the monitoring program and monitoring is not required when doses are below 100 mrem/yr TEDE.
[60] U.S. EPA. *Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups.* September 2000. EPA 540-F-00-005.
[61] Environmental Law Institute. *Institutional Controls in Use.*. September 1995.
[62] "Policy on Management of Post-Removal Site Control," OSWER Directive 9360.2-02 (Cited in "Optimization and Institutional Controls, Institutional Controls Report." Cohen & Associates, Under EPA Contract No. 68D70073, Work Assignment No. 1-5. February 17, 1998. McLean, Virginia.).
[63] Environmental Law Institute. *Protecting Public Health at Superfund Sites: Can Institutional Controls Meet the Challenge?* May 2000.

ii. Institutional control selection, including:
    -Type of controls
    -Anticipated duration
    -Layering of controls
    -Public and local government involvement

iii. Implementation and enforcement of ICs, including:
    -Current status
    -Agency authorities and inter-agency coordination
    -Funding
    -Monitoring of engineering barriers
    -Maintenance and distribution of IC records
    -Incorporation of community education

4.3.2 *Legal Requirements or Guidance*

Institutional controls have been explicitly embraced in many federal and state environmental statutes and regulations, and by radiation protection standard-setting bodies (10 CFR 60 and 61). EPA, DOE, and NRC have promulgated regulations and/or guidance pertaining to the use of institutional controls for radiation protection. Some of these are briefly reviewed below.

CERCLA

Under CERCLA, EPA is directed to permanently reduce risks to hazardous substances to levels that fully protect human health and the environment. To accomplish this, when appropriate, EPA has prescribed the use of ICs at some Superfund sites. When these substances remain on-site above levels allowing for unrestricted use, EPA must review the remedial action at least every five years to ensure that the remedy remains protective.[64]

EPA's regulations governing remedy selection more specifically refer to institutional controls. EPA states that it expects to use institutional controls "such as water use and deed restrictions to supplement engineering controls as appropriate for short- and long-term management to prevent or limit exposure to hazardous substances, pollutants, or contaminants. Institutional controls may be used . . . where necessary, as a component of the completed remedy."[65] However, ICs cannot serve as the sole remedy in place of active measures unless active measures are determined not to be practicable through the remedy selection analysis.

Remedy selection under Superfund requires an assessment of alternatives against nine evaluation criteria. The nine criteria are 1) overall protection of human health and the environment; 2) compliance with ARARs; 3) long-term effectiveness and permanence; 4) reduction of toxicity, mobility, or volume through treatment; 5) short-term effectiveness; 6) implementability; 7) cost; 8) state acceptance; and 9) community acceptance. All alternatives must meet the first two criteria to be considered for analysis. Criteria three through seven are the primary balancing criteria. Most of

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[64] 40 CFR §300.430(f)(4)(ii) (2000).
[65] 40 CFR §300.430(a)(1)(iii)(D) (2000).

the balancing criteria address the reliability or feasibility of the remedy, which may include an IC program. This is most specifically addressed in the assessment of long-term effectiveness, which calls for EPA to consider the "adequacy and reliability of controls such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste."[66] In particular, EPA must consider uncertainties associated with land disposal and the need to replace technical components (*e.g.*, cap or treatment system) of the alternative.

CERCLA §120(h) establishes the requirement that, when transferring real property on which hazardous substances were either stored for one year, known to have been released, or disposed of, the federal government must disclose certain information to the transferee. The provision requires that the deed of each property to be transferred contain information on the type and quantity of the hazardous substances, the dates of storage, release, or disposal, and a description of remedial action taken. The statute also specifies that the deed contain a covenant indicating that remedial actions needed to protect human health and the environment have been taken prior to the date of the property transfer. This requirement may be waived if the administrator of the appropriate federal agency and the governor of the state find that the intended use of the property will be consistent with protection of human health and the environment, and that the deed provides for any necessary restrictions on the use of the property. The federal government is responsible for conducting any additional remedial actions, and the deed must allow for remedial activities to be conducted by the federal government following the transfer, if needed.

The regulations implementing CERCLA §120(h) are promulgated at 40 CFR Part 373, Reporting Hazardous Substance Activity When Selling or Transferring Real Property. The regulations specify that reporting applies any time that the United States enters into any contract for the sale or transfer of real property on which an applicable amount of hazardous substances were stored, released, or disposed of. The regulations require that the federal government provide notice specifying the type of hazardous substance, additional information about the substance, and details of the storage, release, or disposal. The regulations further specify that the notice read, "The information contained in this notice is required under the authority of regulations promulgated under section 120(h) of the Comprehensive Environmental Response, Liability, and Compensation Act." The regulations do not specifically require that restriction on land use be noted on the deed or other document.

RCRA

In governing the disposal of hazardous wastes, RCRA requires treatment to reduce the likelihood of migration of hazardous constituents prior to the disposal on land, unless it can be demonstrated that migration of will not occur. The statute specifies minimum technology requirements, including leachate collection systems and groundwater monitoring for hazardous waste landfills. Additionally, the regulations promulgated under RCRA for post-closure care of a hazardous waste landfill require 30 years of post-closure care that includes at least monitoring and maintenance activities. The post-closure period may be extended by the EPA Regional Administrator. Security measures, including 24-hour surveillance or physical barriers and signage,

[66]40 CFR §300.430(e)(9)(iii)(C)(2) (2000).

are required if hazardous wastes may remain a source of exposure following closure, or if access by the public will pose a health hazard. Post-closure activity at the site must not be allowed to disturb the integrity of the final cap unless the Regional Administrator finds that such activity is necessary for the proposed use of the property and will not increase the threat to human health or the environment, or if such an activity is necessary to a reduce a threat to human health or the environment.[67] After closure of the facility, the operator must submit to the local land use authority information on the type of wastes disposed at the site and their location. A notation must be recorded on the deed or other instrument normally examined during property transfer that the property has been used to manage hazardous wastes, including information on the type of wastes disposed and their locations, and a notation that the use of the property is restricted.[68]

RCRA-permitted facilities are explicitly designed to be protective for 30 years. In the case of RCRA-permitted facilities and CERCLA sites where hazardous material is left at the site, these regulations often require maintenance and monitoring as a means to ensure long-term protectiveness.

LAND DISPOSAL OF LLRW

Under provisions of the Low Level Radioactive Waste Policy Act of 1985,[69] NRC is responsible for determining licensing criteria for the disposal of commercially generated low-level radioactive waste. Institutional controls concepts were formally incorporated into low-level waste management in 10 CFR Part 61.7 due to concern that persons might occupy a licensed low-level radioactive waste disposal site in the future and engage in normal pursuits without knowing that they were receiving radiation exposure. These "normal" pursuits were defined to include excavating some of the waste when building a home on the site and using the site for agricultural purposes. These persons were referred to as "inadvertent intruders." Protection for such intruders involves two principal controls: institutional controls over the site after operations terminate, and disposing of the waste in such a manner that provides some form of intruder barrier.[70]

Both of these concepts are incorporated into the licensing requirements for land disposal of radioactive wastes as set forth in 10 CFR Part 61. Specifically, higher activity/long-lived waste, which could pose a threat after 100 years of institutional controls following the termination of operations, are required to be placed in disposal units that are specifically designed against an inadvertent intruder. Other, lower activity/shorter-lived waste can be disposed of in waste-disposal units that do not contain intruder barriers. However, the type and quantity of radioactive waste materials that may be disposed in this manner is limited such that, after a period of institutional control, assumed to be 100 years, the radioactivity has decayed to a point that it no longer represents an unacceptable hazard to an inadvertent intruder. An unacceptable hazard is defined as an exposure exceeding 500 millirems per year (mrem/yr). A 100-year period was selected because it was deemed to be a time

[67] 40 CFR §§264.117 and 114 (2000).
[68] 40 CFR §264.119 (2000).
[69] 42 U.S.C. §2201 *et. seq.*
[70] "Optimization and Institutional Controls, Institutional Controls Report." Cohen & Associates, Under EPA Contract No. 68D70073, Work Assignment No. 1-5. February 17, 1998. McLean, Virginia.

period during which there is a high likelihood that institutional knowledge and associated institutional mechanisms can be relied upon to preclude inadvertent intrusion.[71]

However, there are differences in the degree to which the various statutes and regulations rely upon institutional controls for the management of hazardous materials that remain hazardous for very long periods of time. An evaluation of selected statutes[72] and their implementing EPA regulations and guidelines with respect to institutional controls by Cohen and Associates[73] came to the following general conclusions:

- The use of ICs is accepted for long-term protection from environmental pollution in conjunction with engineered barriers.
- NRC's ICs program for long-term radiation protection is significantly different than EPA's program for long-term non-radiation hazard protection. NRC assumes that institutional controls are not permanent and requires fail-safe measures like dose-caps or intruder barriers. EPA assumes that ICs will be functional for the future and that failure will not occur.[74]
- EPA promulgates media-specific standards for long-term protection of air, water, and soil while NRC employs a single, higher dose standard from all pathways, including groundwater.

Legal requirements at each site vary. At all sites, both state and federal laws effect the choice and implementation of ICs. The laws pertaining to institutional control requirements at the FEMP and MFDS sites are discussed below.

At FEMP, DOE Orders 5400.5 and 435.1 (replaces DOE Order 5208.2A), CERCLA §120(h), and Ohio Municipal Soil Waste Rules and Ohio Hazardous Waste Interim Standards provide requirements for DOE's management of the FEMP in the future. State law primarily addresses the on-site disposal facility while federal laws address both the disposal facility and the remainder of the site. CERCLA §120(h) creates disclosure requirements for transfer of any land that contains, or once contained, contamination.

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[71] *Ibid.*

[72]Atomic Energy Act, Clean Air Act, Comprehensive Environmental Response, Compensation and Liability Act, Safe Drinking Water Act, Resource Conservation and Recovery Act, Uranium Mill Tailings Radiation Control Act) and their implementing EPA regulations and guidelines(40 CFR 190, the Uranium Fuel Cycle; 40 CFR 191, High level and TRU Waste disposal; 40 CFR 192, Uranium and Thorium Mill Tailings Disposal; 40 CFR 61, National Emissions Standards for Hazardous Air Pollutants; 40 CFR 300, the National Contingency Plan (NCP) addressing uncontrolled hazardous waste sites; 40 CFR144-146, the Underground Injection Control Program covered by SDWA; 40 CFR 257-268, Solid Waste Disposal under RCRA.

[73] "Optimization and Institutional Controls, Institutional Controls Report." Cohen & Associates, Under EPA Contract No. 68D70073, Work Assignment No. 1-5. February 17, 1998. McLean, Virginia.

[74]However, in EPA's *Site Manager's Guide to Identifying, Evaluating, and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups*, EPA states, ". . . limitations in ICs may lead to reevaluation and adjustment of the remedy components . . . . At some sites, remedy contingencies may protect against uncertainties in the ability of ICs to provide the required long-term protectiveness." September 2000. EPA 540-F-00-005.

DOE's Radioactive Waste Management Order (435.1 (formerly 5820.2a)) and DOE's Radiation Protection of the Public Order (5400.5) govern both the disposal facility and the remainder of the site, should DOE lease or sell the land outside of the disposal facility. DOE Order 435.1 requires that the Department file the location and use of the facility with the local land use and zoning authorities, and establish institutional controls pursuant to DOE 5400.5; the order also provides waste acceptance criteria and construction and monitoring requirements. DOE Order 5400.5 governing the release of restricted land allows for private or government ownership or lease of such land with restrictions such as deed restrictions or zoning, monitoring, inspection, and radiological safety measures during certain activities. Restrictions on land use must be clear to the future landowner or lessee through notification, land records, or other methods.

Ohio laws specify a number of requirements for property use restrictions and deed notation that will provide assurance that a future user of a hazardous waste disposal site will be informed of the nature of the site. The regulatory requirements include that:

- Future use of the property must not be allowed to disturb the integrity of the cap without approval from the Director of OEPA.[75]
- Access to the landfill must be restricted by the owner.[76]
- The owner must file with the board of health, the county recorder, the local zoning authority and OEPA a survey plat of the landfill and information describing the size and type of waste disposed in the facility.[77]
- The owner must record a notation on deed or other instrument examined during the title search indicating that the land has been used to manage hazardous wastes and that its use is restricted.[78]

The state's regulations also specify requirements for monitoring and leachate management.

At MFDS, both the federal government and the Commonwealth of Kentucky have promulgated regulations governing the land disposal of radioactive wastes (10 CFR 61 and 902 KAR 100:022). The regulations with regard to institutional controls, which both federal and Commonwealth regulations require. The primary requirement for institutional controls is in 40 CFR §61.59 and 902 KAR 100:022 27, which prohibit land disposal of radioactive waste found on sites not owned by the federal or state government. The regulations call for the governmental land owner to carry out an institutional control program to physically control access to the disposal site, as well as to conduct environmental monitoring, surveillance, and minor custodial care. The site must have a buffer zone between the disposal site and boundary of the property, and monitoring must be designed to provide an early warning of releases before they leave the site. The period during which the controls must be administered will be determined by the appropriate agency (in Kentucky, the Cabinet of Health Services) but institutional controls may not be relied upon for

[75] OAC 3745-66-17(C) (1999).
[76] OAC 3745-68-10(D)(5) (1999).
[77] OAC 3745-27-11(H)(5)(a) and OAC 3745-66-16 (1999).
[78] OAC 3745-27-119(H)(5)(b) and OAC 3745-66-19(B) (1999).

more than 100 years. In addition, the regulations require that the facility design ensure protection of public health in case of inadvertent intrusion following the active institutional control period.

Because of the hazardous constituents of some of the waste disposed of during site operations (specifically, liquid scintillation vials which contain xylene and toluene), disposal of the solidified trench leachate is regulated by the Commonwealth's hazardous waste disposal law, as delegated by EPA under RCRA. The regulations require that the operator of the site:

- file a survey plat with the local zoning authority indicating the location and dimension and contents of landfill cells,[79]
- conduct post-closure care for at least 30 years following closure, including monitoring and maintenance,[80]
- maintain security measures to control access to the site if necessary to protect public health,[81]
- record a notation on the deed to the facility that will notify a potential purchaser that the land has been use to manage hazardous wastes, that its use is restricted, and that a survey plat and information has been filed with the local zoning authority.[82]

4.3.3 *Institutional Control Selection*

This section discusses the types of institutional controls identified for potential use at the six sites, as well as other issues associated with the choice of institutional controls, including the anticipated duration of controls, the use of different types of controls to provide redundancy, and the involvement of local governments and stakeholders in the IC development process.

TYPES OF CONTROLS

The institutional controls proposed at the six sites include government ownership, maintenance and monitoring, and deed or other use restrictions. Government ownership of a site may serve as an institutional control by restricting activities or access through the property rights of the government property owner. Use of maintenance and monitoring as an institutional control involves establishing procedures and criteria to physically maintain an engineered remedy and evaluate its continuing effectiveness. At many sites, different types of controls are proposed for use in different portions of the site. Table 4.3.3 summarizes the proposed ICs for each of the sites; where different controls are proposed for different portions of a site, the portions are listed separately. The controls proposed for each site are discussed in more detail below.

Nearly all the sites will require some form of institutional controls to restrict land use or access; however the range of institutional controls proposed for use at the six sites is not particularly

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[79] 401 KAR 34:070 7 & 10(1) (1999).
[80] 401 KAR 34:070 8(1) (1999).
[81] 401 KAR 34:070 8(2) (1999).
[82] 401 KAR 34:070 10(2) (1999).

broad. Most sites propose maintenance and monitoring of land disposal facilities, as well as restricting access to those facilities. A greater difference between the sites is in the proposed implementation of these controls, discussed in detail in Section 4.3.4. It is difficult to evaluate the effectiveness of the selected ICs because at the majority of these sites implementation has not yet begun.

TWCA — The TWCA site has two distinct parcels that each require a different set of institutional controls. Because the facility will remain operational, most of the institutional controls address contamination that has or may move off-site. Hazards persisting only on the grounds of the facility will be addressed during NRC's decommissioning process. Around the site of the facility itself, the remedy required containment of contamination in groundwater at the west perimeter of the site. Alternatively, TWCA could use natural attenuation if it could demonstrate that this would be effective and if TWCA could obtain a deed restriction on the use of groundwater from all properties on the western perimeter. On the eastern perimeter of the site, after the ROD was developed, a plume of VOCs (primarily vinyl chloride) was discovered beneath residences. Due to potential indoor air quality problems and associated difficulties, TWCA purchased the residences and properties.

The TWCA site also includes the Soil Amendment area, a 60-acre area owned by the city where lime sludges were used as fertilizer. Levels of radon and radon progeny in the soil are quite high. Institutional controls proposed for this area would address concerns about radon concentrations in any buildings that might be constructed on the site. EPA and the City of Millersburg continue to negotiate the implementation of the controls, but intend to require the operation of an active radon resistant construction technology. Deed restictions, zoning provisions, or other local ordinances could be used to require builders to adopt this technology.

CWM — As a RCRA-permitted hazardous waste disposal facility, CWM is required to develop and follow a post-closure plan containing a number of specific institutional control requirements.

FEMP — The remedies selected for the FEMP site require the implementation of institutional controls both to restrict access to the on-site disposal facility (OSDF) and to prevent future residential or agricultural use of the remainder of the site. Constructing a disposal facility rather than compacting waste in place was identified as providing greater flexibility in future land use for the remaining site. Constraints on the amount of soil that could be disposed at the on-site disposal facility influenced the selection of remediation levels for soils in and around the site. The combination of a centralized disposal facility and the restricted usage for the remaining on-site soils required the development of two different sets of institutional controls to restrict access and maintain the effectiveness of the on-site disposal facility and permanently restrict usage of the surrounding site.

The primary institutional control for the site will be continued federal ownership, combined with access controls for the more restricted disposal facility area. Currently, DOE plans to restore the natural resources of the facility and create a park with low-impact recreational opportunities such as hiking and biking. In 1997 DOE developed a draft Natural Resource Restoration Plan that includes an impact assessment and a restoration plan, and in 1999 DOE developed a draft master plan for post-remedial public use of the site.

MFDS — The remedy selected for the MFDS site requires the on-site disposal of approximately 3 million gallons of solidified trench leachate of mixed chemical and radioactive waste, as well as the management of 4.8 million cubic feet of low-level radioactive waste disposed at the site. The disposal of low-level waste necessitates institutional controls to ensure that the cap over the wastes is not disturbed by public trespass or occupancy, and that the remedy continues to function as planned over the long term. Furthermore, the selected remedy relies on natural subsidence of the wastes placed in trenches, an interim maintenance period which is likely to take up to 100 years. A cap will be installed during an initial closure period, but the final cap and final closure period will not occur until the wastes have subsided naturally during the interim maintenance period. The extended time frame required for natural subsidence will require a different set of institutional controls to ensure that the site continues to be monitored for subsidence, that appropriate maintenance is performed on the initial cap as needed, and that the final cap is installed when subsidence is complete. The site will require perpetual land use restrictions. Among the land use restrictions is the establishment of a state-owned buffer zone around the perimeter of the site to prevent activities that might increase erosion and reduce the effectiveness of the disposal cell, as well as to ensure continued access by state personnel to areas near the site for monitoring.

NFSS — NFSS continues to remain in federal ownership and the current remedy is considered an interim phase. The institutional control program at the site includes access restriction, maintenance, and monitoring.

SFC — Like Fernald, SFC plans for the disposal of waste in an on-site disposal cell. The proposed decommissioning plan calls for the areas of the site outside of the disposal cell and its buffer zone to be released from license without any restrictions on land use; no institutional control program is required for this portion of the site. The disposal cell and the buffer around it would require institutional controls to ensure that an intruder cannot access the site and disturb the integrity of the cell as well as to ensure that the disposal cell continues to function as intended. The institutional control program has not yet been developed.

ANTICIPATED DURATION

Duration of the proposed institutional controls is in some cases dictated by law; in others the selected remedy dictates the duration. Both chemical and radiation sites in the study recognized the potential need for perpetual institutional control programs. At TWCA, EPA believes that radon resistant new construction will need to be maintained in perpetuity. Although only 30 years of post-closure care are required under RCRA, at CWM the state has exercised its discretion in this area to require CWM to establish a financial mechanism to provide funding for institutional control (primarily maintenance and monitoring activity) in perpetuity. At FEMP, the several RODs specifically call for institutional controls for the site in perpetuity. The majority of the site will remain in federal ownership into the foreseeable future, and the on-site disposal facility will be federally owned indefinitely. Both SFC and MFDS are governed by NRC land disposal regulations (or state equivalents) requiring that a disposal cell be engineered not to rely on institutional controls for more than 100 years. At MFDS, however, the Commonwealth of Kentucky plans to employ land use restrictions on the site in perpetuity.

Table 4.3.3: Type of Institutional Controls Proposed

Site	Area under ICs	Type of ICs
TWCA	Site compound	Groundwater use restriction Purchase of contaminated residences
TWCA	Soil Amendment area	Building construction/operation requirements
CWM	Full site	Maintenance Monitoring Access restriction Notification
FEMP	OSDF	Federal ownership Maintenance Monitoring Land use restriction Access restriction Notification
FEMP	Remainder of site	Federal ownership Land use restriction
MFDS	Full site	Maintenance Monitoring Access restriction Deed restriction Land acquisition
NFSS	Full site	Maintenance Monitoring Access restriction
SFC	Disposal cell	Maintenance Monitoring Access restriction Possible deed restriction
SFC	Rest of site	No ICs required

LAYERING CONTROLS

Institutional controls may be more effective when a variety of controls are "layered" to create redundancy.[83] Some sites demonstrate that a variety of controls may be used. At FEMP, according to DOE officials the primary institutional control is continued federal ownership. DOE has proposed additional controls including the use of deed restrictions and notifications in the event of property transfer, access controls and signage at the on-site disposal facility, continued monitoring of the disposal facility and leachate, and providing notification of the location of the disposal facility to local agencies responsible for zoning and land use. At MFDS, controls of several types are proposed, including deed restrictions, physical access restrictions, warning signs, and continued monitoring.

Additional notification measures include filing a survey plat and notice with county judge/executive, which will serve as an additional public announcement of the content of the site. The state-acquired buffer zone around the site will serve as an additional institutional control by preventing the landowners adjacent to the site from conducting activities which could expose them to contamination or cause the remedy to function less effectively, exposing a larger population to contamination. At other sites, it is not clear at this time whether a variety of controls will be proposed or implemented.

LOCAL GOVERNMENT AND PUBLIC INVOLVEMENT IN IC SELECTION

Community and local government involvement in the institutional control selection process is essential because it is the community that will remain most directly affected by the site and decisions made about it. Community endorsement of institutional controls will also greatly enhance their effectiveness by providing a broad body of individuals who have an awareness of activities at the site on an on-going basis.

At TWCA, the local government has been extensively involved in negotiations over institutional controls for the Soil Amendment area. The City of Millersburg has a very small government consisting of a part-time mayor and a secretary. The county government provides services such as sewer and water. However, the municipal government owns the site and must be responsible for ensuring the protectiveness of the remedy. Teledyne Wah Chang has assisted the city in its work with EPA on the institutional controls by hiring environmental counsel for the city.

At FEMP, the Fernald Citizen's Advisory Board (FCAB) has been central to the development of remediation and future use plans. The citizens most involved in the site remediation are generally supportive of natural resource restoration goals. Some citizens would prefer that access to the site remain restricted; other citizens, mainly those in the town of Crosby, which has an abundance of parkland, would prefer to see the site developed for industrial uses. Other citizens support natural resource restoration but strongly advocate the use of the site for

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[83] *See* ELI. *Institutional Controls in Use*, September 1995; and ELI. *Protecting Public Health at Superfund Sites: Can Institutional Controls Meet the Challenge?* May 2000. *See also* U.S. EPA. *Site Manager's Guide to Identifying, Evaluating, and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups.* September 2000. EPA 540-F-00-005.

Native American reburial and the creation of a museum about the site's history and place in the Cold War. FCAB has convened public meetings on future use to obtain input from a broader spectrum of the community. DOE also works closely on remediation plans generally with Ohio Environmental Protection Agency. Several township trustees are also members of FCAB, but DOE does not specifically seek input from the county or township governments on future use issues.

At MFDS, the citizen group Maxey Flats Concerned Citizens (MFCC) is the primary contact regarding the site and institutional control issues. MFCC serves as the primary contact for the state and EPA with information about the site, and serves as the voice of area residents in communication with these agencies. In its comments on remediation plans, MFCC requested permanent deed restrictions on use of the site, as well as permanent markers stating that the site served as nuclear waste repository. The state does not frequently contact the county judge/executive or the county health department. At one time, the health department was more involved in site investigation and sampling, but since the department did not have the capacity to conduct all necessary analysis, the state has taken over this function and the health department has agreed to limit its involvement with MFDS.

At SFC, the licensee has consulted with a variety of local entities regarding the disposal facility to identify a possible steward for the site once decommissioning is complete. The Cherokee Nation (CN) in particular has discussed with SFC the possibility of taking a stewardship role for the disposal cell. The Nation has outlined the conditions which must be met for the tribe to assume a stewardship role. These are: 1) that NRC or another participating federal agency offer support/partnership; 2) that the CN receive a federal guarantee of no-liability from the project; 3) that the CN acquire or partner with those having full technical expertise to do the necessary work; 4) that the financial benefits to the CN are favorable; and 5) that members of the CN and entities in proximity to any such project request or concur in the stewardship role of the CN. SFC management has also consulted with other federal and local agencies such as the I-40 Industrial Park and Port Authority and the Tenkiller Utility Authority.

NFSS and CWM have not significantly involved the local government or the public in institutional control selection processes at this time. Identification of institutional controls is in its early phases at both sites, particularly at NFSS.

4.3.4. *Institutional Control Implementation and Enforcement*

CURRENT STATUS

At most of the sites remediation has progressed to the point that institutional controls have been implemented. At some sites, more detailed plans for implementation of institutional controls are being developed. At others, the institutional control programs have not been fully specified.

TWCA — At TWCA, some institutional controls have been implemented. TWCA has obtained restrictive covenants on groundwater use from properties along the western perimeter of the site. Natural attenuation may not be working; TWCA has installed a pumping system in at least one area on the perimeter. On the eastern perimeter of the site, TWCA purchased the residences and properties affected by a plume of VOCs. Implementation is much slower for the institutional controls relating to the Soil Amendment area, and as of March 2000 the details were still in negotiation was on-going and no details were available.

CWM — CWM continues to own and operate the disposal cells, so institutional controls have not been implemented. The post-closure plans required for each hazardous waste management unit include specifications for frequency of monitoring and maintenance activities that will ensure the landfill cells continue to be protective of public health.

FEMP — Remediation is on-going at the site, but DOE has turned its attention to institutional controls, particularly those relating to the future use of the site. Recently, DOE submitted a draft master plan for post-remedial public use of the site to the Citizen's Advisory Board. This plan serves as a detailed addendum to the Natural Resource Restoration plan, focusing primarily on options and restrictions on public access and activities on the restored area of the site. The plan is being distributed to the CAB for comments and to initiate further stakeholder involvement and broader public discussion. The CAB has held one public meeting on future use and DOE expects it to hold additional meetings. The Natural Resource trustees and regulatory agencies (OEPA and EPA) have approved DOE's plan.

A study has been done on market interest in the 23-acre parcel that has been set aside for possible commercial development. So far there is little interest in commercial development in the area, but the site will be held as-is for the possibility of commercial development by a leaseholder; there will be no natural resource restoration on this parcel.

MFDS — Site remediation, including the development of institutional controls, are requirements set out in the Statement of Work and Consent Decree for the site. At this time, the settling private parties have developed a performance standards verification plan that EPA must approve. The purpose of the plan is to develop mechanisms, including field sampling and analysis, that will ensure that the remedy is functioning properly. An additional two years of work may be required before the remedy is complete. The Commonwealth must develop institutional controls for the interim maintenance period and the post-closure period, and has not yet begun to do so. The post-closure period may occur up to 100 years after the interim remedy is completed.

NFSS — At NFSS, an ICs program has been in place since DOE completed the initial remediation. The site remains in federal ownership and is monitored and maintained. Site investigation is on-going and dependent on the results of any future remedial actions; a new institutional control program may be required in the future.

SFC — Sequoyah Fuels Corporation submitted its draft decommissioning plan to NRC in late 1999. The draft commissioning plan includes information on how the corporation proposes to meet NRC's institutional control requirements. As of March 2000, no steward had been identified for the disposal cell.

AGENCY AUTHORITIES AND INTER-AGENCY COORDINATION

At most sites, a variety of agencies oversee the remedial process and possess differing levels of authority over activities at the site during different phases of work at the site. At FEMP, for instance, while most institutional controls will be administered by DOE, OEPA conducts additional environmental monitoring at the site. OEPA also evaluates DOE's Integrated Environmental Monitoring Program. DOE has worked with OEPA, U.S. Forest Service, U.S. Department of Interior, and the Ohio Department of Health (to a lesser degree) on development of future use plans.

At MFDS, two state agencies currently oversee work at the site, and the Commonwealth plans to involve both agencies in work at the site in the future. The primary agency is the Cabinet for Health Services Radiation Control Office which is responsible for ensuring that the disposal operation remains protective of human health. The other agency involved is the Natural Resource and Environmental Protection Cabinet, which has responsibility for the non-radiological components of the remedy, as well as for the Commonwealth's Superfund program. The Cabinet of Health has the capability of performing detailed laboratory analysis; the Natural Resources Cabinet has a small lab at the site for basic analysis, as part of their responsibility as the licensee. The institutional controls will be overseen by the Cabinet of Health, although as the lead agencies under Superfund, the five-year review will be conducted by both state agencies. The Common-wealth acknowledges that having more agencies involved in the maintenance of the site is desirable, but has not developed a specific division of the responsibilities at this time.

At other sites, the process of developing and implementing institutional controls has not advanced far enough to demonstrate the coordination between various agencies. At SFC, the decommissioning process is overseen by NRC; EPA has also been involved with the remediation of non-radiation contamination under RCRA. NRC will provide the final approval of the decommissioning plan. None of these agencies will implement institutional controls; the corporation hopes to identify a government entity willing to take responsibility for doing so. At TWCA, EPA and the City of Millersburg have grappled with issues of authority regarding the proposed radon resistant new construction requirement and have not yet determined the appropriate role for each entity. At CWM, an institutional controls program has not yet been implemented because the facility is operating. At NFSS, DOE and subsequently the U.S. Army Corps of Engineers have monitored and maintained the storage facility.

FUNDING

Funding for institutional control programs is an important issue that has not been resolved at most of the sites. Because many institutional controls programs are expected to endure in perpetuity, identifying a source of funding early in the process ensures that state or local governments will not be forced to cover these expenses, and helps to assure the implementation of an effective long-term institutional control program.

At three sites, CWM, MFDS, and SFC, attempts have been made at ensuring that funding will be available into the future for institutional controls. At CWM, the state of New York has imposed a "perpetual care" requirement on the facility. This addition to the facility's permit extends the post-closure period from the minimum of 30 years to "perpetuity unless the Department determines that such care is no longer necessary" and requires CWM to establish a fund/endowment that will provide resources for maintenance of the site if CWM becomes insolvent. If the facility has ceased operations and CWM is insolvent, the state will assume ownership of the facility and maintain the landfills, using the perpetual maintenance fund. If CWM sells or transfers the facility and the permit transfers as well, the corporation that receives the permit will be subject to the same requirements. If the permit does not transfer, NYS DEC will have to renegotiate the agreement to establish a perpetual maintenance fund.

At MFDS, the Commonwealth required the creation of a perpetual care fund for the site. The owner was required to pay the Commonwealth for each cubic foot of waste disposed. There is more than $1 million in this fund at this time. In addition, the Commonwealth is required to put $0.5 million each year into a fund for emergency use until $7 million is accumulated. DOE and DOD, as responsible parties, have agreed to contribute $10 million a year in the event of a catastrophe. Many of the funds that have been arranged for will be useful only in emergency situations and may not be used for routine maintenance. Once the initial remedy phase is complete, if the remedy functions as designed for three five-year review periods, the settling private parties are freed of financial responsibility regarding the site. At that time the Commonwealth will assume full responsibility for maintenance of the site through the end of the post-closure period. It is probable that the Commonwealth will be required to provide funding each year for purposes of maintaining institutional controls at the site. The state develops a biennial budget so it has not addressed funding needs in the future. Similarly, NRC has required the Sequoyah Fuels Corporation to establish a fund to provide for expenses related to decommissioning, including institutional controls and long-term stewardship.

At other sites, funding remains more uncertain, subject in some cases to governmental budgetary processes. At FEMP, funding for maintenance and management has not been established. DOE has acknowledged its obligation to undertake these tasks, but the discussion of how to fund implementation of institutional controls at federal facilities will take place at the national level. At TWCA, and NFSS, funding for institutional controls has not yet been addressed.

MONITORING OF ENGINEERING BARRIERS

Sites that have addressed monitoring concerns have generally done so through the development of detailed monitoring and analysis specifications that will provide performance standards for determining whether the remedy is functioning. The Post-Closure Care and Inspection plan developed for the on-site disposal facility at FEMP is an example of such a plan. The plan elaborates a monitoring program that will ensure that the engineered remedy is functioning correctly. The plan calls for monitoring the leachate and the surrounding environment of the facility, as well as the facility itself to ensure that an intruder has not entered the restricted area or ruptured the cap. Routine inspections will be conducted during the first five years of the post-closure period, and again during the seventh and ninth years, to be extended as necessary. Ohio law requires monitoring to continue for 30 years, although DOE has stated that it intends to monitor the facility in perpetuity. At MFDS a similar plan has been developed for the disposal cell. At other sites, detailed procedures for monitoring remedy effectiveness have not yet been developed.

Maintenance and Distribution of ICs Records

Providing a formal record of institutional controls and property use restrictions is an essential element of an institutional controls program. Some laws and regulations such as RCRA and CERCLA require certain information (in some cases) to be filed with local officials or noted on a deed. At sites with remedies governed by these laws or their state equivalents, information concerning the contamination at a site has been filed with local zoning officials or other local government entities. For instance, at FEMP, Ohio law requires that information on the location and type of contamination placed in the disposal facility be provided to the local recorders office as well as the local health department. DOE intends to create a map of the FEMP facility and provide a survey plat to the county records office. These mechanisms will serve to record existing restrictions as well as to preserve a record of the location of contamination. At MFDS, the ROD and Statement of Work contain provisions for the creation of formal records of the institutional controls and contamination at the site. The county judge/executive was supposed to receive information about waste at the site within 15 days of the signing of the consent decree. When the final closure period is complete, the Commonwealth will file a survey plat with the county records office and record restrictions on the deed to the property. At other sites recording mechanisms may be developed in the future.

Incorporation of Community Education and Outreach Efforts

Community education is an important but often overlooked component of the institutional control process. Keeping communities informed of the potential hazards in an area and the restrictions on activity in the area is one way to ensure that controls will be observed and public health will remain protected. One of the unique challenges agencies dealing with long-term contamination face is instituting community education processes that will endure. At FEMP the community has proposed informal mechanisms that may serve to reinforce DOE's institutional controls and preserve local memory about site activities. One such suggestion is the creation of a museum on the site that would present information about the activities at the site. If such a museum existed, area residents would be informed about the contents of the disposal facility and reminded of the reasons for the restricted land use of the entire site.

An additional project that is currently underway is the Fernald Living History Project. The project began in 1997 as a grassroots effort involving residents, staff and faculty of two local universities, and Fernald site officials. The goal of the project is to preserve the environmental and social history of the communities around the FEMP. The project will document community and worker experiences at the site, establish a video archive of interviews and photographs, and develop educational materials and mobile exhibits. The project is in its initial stages, and as of December 1998 had created a promotional video and begun soliciting interest in participation. This project too will serve the community by perpetuating the legacy of the site. These informal mechanisms may prove to be as important as the more formal controls in protecting the public at the site by ensuring broad and continuing public awareness of the necessary restrictions on use of the land.

The Fernald community education efforts has shown great innovation and initiative. Other sites have undertaken less ambitious projects. At MFDS, a high school teacher sent students to the site open house for extra credit, exposing a younger generation to information about the site.

Continuing education efforts at the sites are based in community initiative rather than institutionalized by agencies with oversight authority.

4.4 Public Involvement

Public involvement is defined in this study as activities that educate the public about risk management practices, identify public concerns regarding perceived health risks, and incorporate public preferences in remedies as appropriate. The types of activities examined in this study include formal public hearings, informal public meetings, technical assistance provisions, access to and dissemination of information, and use of media. The term “public” or “stakeholders” includes citizens, local environmental groups, and in some cases, local governments in the direct vicinity of the sites involved.

Communities that host a contaminated facility bear risks that they assume, perhaps unwillingly. It is important that the risk management processes include mechanisms to educate communities about risk and provide opportunities for communities to comment on the level of risk they are willing to assume. As Joseph Sax wrote,

> “As self-government is at the core of democratic government, and genuine choice is a key to self-government, assuring that risks taken are the product of such genuine choice is fundamental to the legitimacy of environmental decisions . . . . We cannot demand unanimity, but we can insist that decisions be made under conditions of sufficient knowledge and consideration so as to reflect a true choice fully appreciative of the consequences.”[84]

Furthermore, public involvement in risk management strengthens decisions by ensuring that decisions are based on realistic scenarios. This is particularly important in cases where persistent contaminants will be left on-site under a program of institutional controls. It is essential that risk managers have full information on how communities use sites so that institutional controls can be designed to protect communities effectively.

In the risk harmonization context, the statutes governing both chemical and radiation risk management call for the use of similar public involvement tools, such as notice and comment and the use of public meetings or hearings. Similarly, both radiation and chemical risk managers must explain risk management concepts to communities in order for communities to make informed decisions about risk. Chemical and radiation risk managers can use and reform similar public involvement techniques to develop similar and effective approaches to incorporating public concern in risk management.

In analyzing public involvement activities, this study compares each site across six elements that represent the level and type of public interaction with regulators and risk managers at each site. The factors addressed are the history of public involvement, the legal “drivers” governing public involvement, the types of community actors present at the sites, the tools used by regulators in

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[84] Sax, Joseph. “The Search for Environmental Rights,” 6 Journal of Land Use and Environmental Law 93 (1990).

interacting with public, the way in which information is distributed, and the level of stakeholder involvement. A table at the beginning of each section presents a summary of the information that is discussed in detail in the section.

4.4.1 *History of Public Involvement at Sites*

Examining the nature of public involvement demonstrates a commonality in historical patterns with regard to the development of public involvement activities. This section traces the progress at sites from secrecy and public exclusion to inclusion and widespread public involvement. This process was often triggered by an accident or crisis at a facility that contributed to local outrage, the formation of local groups and increased public scrutiny of facility operations, a political response to the situation in the community, and ultimately the implementation of formal public involvement processes at the sites. While each of the sites did not go through all of these steps, the general trend was a movement from exclusion to a greater inclusion through a process of increased interaction between the facility and community. This dynamic, however, may be reflected differently in communities that have had a strong interest in the continued operation of a facility. Table 4.4.1 summarizes the history of public involvement activities at the six sites.

Several sites historically operated with a high level of secrecy, providing no opportunity for public involvement during their operations. This is most notable at the FEMP site, where residents were not aware of the purpose of the facility for many years. Some residents, because of the name "Feed Materials Production Center" and the red and white logo, believed that the facility made Purina dog food.[85] Residents near MFDS said that they were not informed of the purpose of the facility when it was first licensed by the Commonwealth of Kentucky in 1966.[86] At both of these sites, public sentiment was quite powerful at the onset of remedial activity at the site. At other sites, such as SFC and CWM, the purpose of operations was not concealed from their host communities, but historically the public was not often involved in or informed about activities at the facility.

Given the limited opportunity for public involvement at most of the sites, often a crisis in the form of actual, suspected, or potential off-site emissions lead to public outrage. For instance:

FEMP — The release of nearly 300 pounds of enriched uranium oxide to the atmosphere from the dust collector system of one of the plants, and subsequent disclosure that in 1981 three off-property wells south of the facility were found to be contaminated with uranium, caused local residents to advocate for increased information and involvement with the site.[87]

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[85] *America's Defense Monitor: The Nuclear Threat at Home.* Broadcast June 12, 1994.
[86] U.S. EPA. *Record of Decision, Maxey Flats Nuclear Disposal.* September 30, 1991.
[87] U.S. DOE. *Community Relations Plan.* January 1995.

Table 4.4.1: History of Public Involvement

Site	History of Public Involvement
TWCA	• Major employer in community • State and national environmental groups concerned about site • Little local concern for environmental issues
CWM	• Organization of local groups opposing facility operations • Facility provides funding to town and local schools
FEMP	• Secrecy about purpose of site • Off-site contamination • Public distrust of regulators • Organization of local groups • Outside political involvement
MFDS	• Initial secrecy about purpose of site • Off-site contamination • Public distrust of regulators • Organization of local groups • Outside political involvement
NFSS	• Local groups participate and comment on site remediation • More limited public involvement during initial remedial action • Outside political involvement
SFC	• Major employer in community • Off-site contamination • Casualties and human health impacts • Public distrust of regulators and facility

MFDS — The suspected migration of radionuclides from the disposal site in the 1970s sparked initial citizen activity aimed at terminating operations at the site.[88]

SFC — Two accidents during operations in 1986 and 1992 that caused casualties both on and off the site were major catalysts in public interest in the facility.

CWM — The threat of air emissions from a proposed hazardous waste incinerator at the CWM landfill galvanized community concern and initiated a lengthy legal battle.[89]

TWCA — Local residents were most concerned by process odors from the facility, while environmental groups were concerned that sludge ponds in the Willamette River floodplain would contaminate the river.[90]

NFSS -- DOE's 1982 remedial actions at the site stimulated community interest. Previously, the community had been focused on other area sites and turned their attention to NFSS when unexpected activity began at the site.

At some sites, local groups were organized in response to releases (or potential releases). This is most evident at MFDS, where two local groups with very specific aims organized in response to local conditions and disbanded upon achieving their goals: The Maxey Flats Radiation Protection Association (MFRPA) organized local and state-level support to shut down the facility and disbanded in 1977 after the state revoked the operator's license. Two years later, in response to reports of tritium releases from the site, the Concerned Citizens of Maxey Flats (CCMF) formed to fight for the extension of the public water supply to the rural residents nearest the facility. This group disbanded when the water supply was extended in 1985.[91] Other groups forming in response to releases at sites include FRESH, Fernald Residents for Environmental Safety and Health, and the local group Residents Organized for Lewiston-Porter's Environment (ROLE), formed to combat the proposed incinerator at CWM.

At all of the sites, local outrage was followed by increased scrutiny of activities at the sites. At Sequoyah Fuels, NACE intervened in the license process to request public disclosure of financial reorganization of the parent company. Members of the groups at Maxey Flats collected water samples for analysis. At Fernald, FRESH requested increased access to environmental monitoring data. Some of the facilities began to respond to public concerns by increasing their involvement with the public.

At sites where the communities' concerns about the facilities were not resolved by the facilities' efforts, citizens brought their concerns to state and national level politicians, who often took up citizen's causes and battled with regulatory agencies. At Maxey Flats, citizen activists visited their state legislators and brought the conditions at the site to their attention. The activists credit

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[88] U.S. EPA. *Record of Decision, Maxey Flats Nuclear Disposal.* September 30, 1991.
[89] *See* Olsen, R. Nils. "The Concentration of Commercial Hazardous Waste Facilities in the Western New York Community." 39 Buff.L.Rev. 473 (1991).
[90] U.S. EPA. *Community Relations Plan for Teledyne Wah Chang Albany Site.* November 1987.
[91] U.S. EPA. Record of Decision for Maxey Flats site, 1991.

this tactic as significant in their fight to close the site, and continue to appeal to legislators when they believe that they are being excluded from decisions about the remediation of the site. Fernald has been the subject of Congressional hearings, class action lawsuits, and national media coverage.[92] NFSS has received the attention of the area's New York State Congressmen, who was instrumental in arranging for the National Academy of Sciences to conduct an independent assessment of the storage site.

Most sites responded to community concerns by changing their practices and initiating some process of community involvement. The types of programs that facilities developed and the degree to which the community believes these programs were successful is the focus of the remainder of this section. While some of the sites have made great efforts to increase community participation in decisions, these programs were primarily developed after protracted efforts on the part of communities to gain a greater voice in decisions.

There is a pronounced difference in community dynamics in cases where facilities are still operating or where facilities have provided a number of jobs to local community members. CWM and Teledyne continue to operate, and at both sites local concerns are related mainly to operational issues. At CWM, although there is serious environmental contamination at the facility, the biggest concerns for the community have been the proposed incinerator and truck traffic to the facility. At Teledyne, the largest employer in the area, residents are primarily concerned that the facility not be burdened with costly remedial tasks that force it to close. SFC was the major employer in the community before it shut down operations. This has deeply divided the community between those who oppose the facility because of its environmental problems, and those who would have preferred that the facility continue to operate. This problem has been so pervasive that activists working in the community have at times been denied the use of public schools as meeting places.

4.4.2 *Legal Drivers for Public Involvement*

Each of the six sites operates under a different array of state and federal regulatory requirements, many of which require public participation. The federal laws that govern these sites include CERCLA provisions for public involvement, RCRA corrective action public participation requirements, NEPA, FACA, NRC's license termination under restricted release requirements, NRC regulation of LLRW, and DOE's policy on public involvement. The requirements of many of these laws include one or more of the following: public notice, public meeting or hearing, provisions for public comment, provisions for the formation of public advisory groups, and distribution of information to the public. Table 4.4.2 presents the requirements and optional provisions of the major statutes, implementing regulations and/or agency guidance. The statutory and regulatory requirements, including agency guidance where available are summarized in more detail in Appendix 3.

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[92] U.S. DOE. *Community Relations Plan*. January 1995.

Table 4.4.2 Legal Drivers for Public Involvement

Law	Sites Remediated Under Law	Public Notice	Public Hearing	Provisions for Public Comment	Advisory Group	Distribution of Information	Technical Assistance
CERCLA	FEMP MFDS TWCA	Lead agency must notify before and after adopting remedial plan	Lead agency must provide opportunity to discuss proposed plan	Lead agency provide opportunity for comment on proposed plan	Optional to form Community Advisory Group	Public notice in newspaper must include summary of proposed plan	Local groups can apply for technical assistance grant
RCRA	CWM SFC	Required from permittee and/or lead agency before permit issuance or modification	Lead agency must hold if requested or at agency discretion; also required of permittee in certain cases	Permitting agency provides opportunity for comment on permit or modification	N/A	Summary of permit or modification included with public notice	N/A
NEPA	NFSS possibly SFC	Lead agency must provide for hearings, meetings, and availability of documents	Lead agency must hold in cases of controversy or significant interest	Lead agency provides opportunity to comment on scope and draft EIS	N/A	Documents must be made publically available	N/A
NRC License Termination: Restricted Release	SFC	NRC must publish notice in Federal Register and local publication	Licensee provide an opportunity for discussion of issues	Licensee must seek public comment on remedy and institutional controls	Formation of SSAB recommended by NRC draft guidance	Summary of decommissionin g plan included with public notice	N/A
DOE Policy	FEMP	Recommended	Recommended	Recommended	Not required but SSAB can be convened at DOE facility	Not specifically addressed	N/A

4.4.3 *Stakeholders and Stakeholder Groups*

A variety of stakeholders participated in public involvement activities at the six sites. Some of the most active participants were members of local citizen groups. Some groups existed in the area prior to citizen involvement, others formed in response to concerns about the site, while others were convened by a regulatory agency and formally charged with addressing the remediation of the site. Some groups continued to exist beyond the period of formal public involvement, while others dissolved once they achieved their aims. State and national environmental groups have been involved in activities at some sites, and citizens that are not members of more organized groups often participate in public activities. Local governments also were stakeholders in public involvement activities, and participate either by serving on formal groups or by providing comments on remediation plans. Table 4.4.3 presents the variety of groups and their concerns, discussed in detail in this section.

LOCAL GROUPS

Local groups were often organized at the sites in response to releases or other perceived threats to the community. Members of local groups frequently were the most active participants in agency public involvement activities. Often the groups themselves helped to facilitate contact between the public and management at the sites. The sites with local groups are FEMP, CWM (and NFSS), MFDS, and SFC.

FEMP — Neighbors of the facility formed FRESH almost immediately after they learned of the releases in 1984. When DOE initially began to interact with the community, the meetings tended to be like scripted public affairs sessions, providing little opportunity for citizen input. FRESH was among the groups that changed the dynamic between DOE and the community, demanding and getting a seat at the table and a voice in the decisions. FRESH does not receive any funding to provide for technical assistance but finds that DOE and remediation contractors are willing to supply information. The group members have provided comments to DOE on remediation plans. FRESH continues to meet bi-monthly and remains involved in the work at the site.

CWM — Another citizen group that actively changed community-facility dynamics is the ROLE. This group formed in 1986 in response to concerns about a proposed incinerator and traffic to the CWM facility. After battling for several years over the proposed incinerator, hiring legal representation, and engaging in court battles, ROLE was part of an agreement with CWM that prevented construction of the incinerator. The group continues to be active in environmental issues in the area, including the NFSS.

MFDS — A number of local groups organized in response to the changing conditions at the MFDS site. The most enduring of the groups is the MFCC. The members of the group include some of the residents who have historically opposed the facility, as well as other community members with histories of local activism. The group was formed in 1990 in response to EPA's newly announced Technical Assistance Grants (TAG) program. The group met the eligibility requirements for the TAG program and received the second TAG in the country. MFCC has managed its funds wisely and continued to extend its original grant for 10 years. The group has used its grant to obtain the advice of a technical expert in reviewing agency documents and providing comments to EPA.

Table 4.4.3: Stakeholder Groups and Concerns

Site	Local Group / Concerns	Advisory Group / Mission	State or Nat'l group / Concerns	Other Stakeholders / Concerns
TWCA			Forelaws on Board & Greenpeace / Sludge lagoons	
CWM	ROLE / Initial concerns were truck traffic to facility and proposed incinerator	CAC / Mission was to develop agreement to traffic and incinerator conflict		
FEMP	FRESH / Oversight of DOE generally, protection of aquifer and area residents	FCAB / Provide recommendations on future use, remediation levels, waste disposition, and remediation priorities		
MFDS	MFRPA / Closure of facility CCMF / Extension of water supply to rural residents MFCC / Oversight of remediation			
NFSS	ROLE / Long-term storage of wastes			
SFC	NACE / Funding for decommissioning, oversight of process			CN / Stewardship of disposal site; contamination of Arkansas River. EARTH / Decommissioning process

SFC — Native Americans for a Clean Environment (NACE) began as a grassroots organization in the early 1980s, but is not in existence today. The group played a prominent role in the decommissioning process, serving as an intervenor in SFC's application for license amendment in 1995. NACE requested a hearing on the company's proposed reorganization and the process occupied nearly a year. NACE was concerned that the company's reorganization was an attempt to divert financial resources from remediation and long-term maintenance of the site. Citizens who have been involved in the decommissioning process have been frustrated by their exclusion from meetings discussing financial assurance, although NRC has included citizens in all meeting that have not involved proprietary information. The involved public is concerned that NRC will not insist on adequate financial assurance for decommissioning and that the site will not be remediated properly due to lack of finances. NACE's request for hearing was an attempt to formally express the community's concerns regarding financial assurance. Another locally-based group operating at SFC is Environment As Relates to Health (EARTH), which functions as a citizen advisory group for the Nuclear Risk Management for Native Communities project, discussed in the section on Other Stakeholders.

TWCA — No local groups emerged during the public involvement process.

ADVISORY GROUPS

In addition to local groups organized by citizens, at two sites groups were convened as official advisory groups to the remediation process. At federal facilities, the generic name for this type of committee is the Site Specific Advisory Board (SSAB), convened under the federal law known as FACA. At Superfund sites, the generic name for this type of group is a Community Advisory Group (CAG), which are not organized under FACA. FEMP is the only site with an SSAB. CWM has a similar committee authorized under New York State law.

DOE convened the Fernald Citizen's Advisory Board (FCAB (originally Fernald Citizen's Task Force)) in 1993 before the department had officially adopted the concept of the SSAB, and FCAB was one of the first SSABs at the nuclear weapons complex. A DOE-appointed convener selected the members of the committee, who lived or worked in the area of the site and had a range of skills and interests related to the site.[93]

Charged to provide recommendations on future use, remediation levels, waste disposition, and remediation priorities, the members of FCAB were required to develop a high level of familiarity with a number of technical issues in a limited time. FCAB hired a technical consultant to assist in this task. At monthly meetings, FCAB discussed site issues and began developing recommendations, making use of a variety of innovative tools and information provided by DOE. In 1995, FCAB published *Recommendations on Remediation Levels, Waste Disposition, Priorities, and Future Use*, probably the most substantive citizen effort among the six sites. This report was released as DOE was developing the record of decision for the environmental media at the site (OU5). The group recommended soil and groundwater remediation levels, agreed that the use of an on-site disposal facility for low-level waste would be a cost-effective and acceptable remedy, and recommended that no residential or agricultural uses be permitted at the remediated site. DOE adopted most of FCAB's recommendations in the OU5 ROD.[94] FCAB's report represents the most substantive citizen effort of the six sites. The report addresses comprehensively the group's consensus opinion on acceptable cleanup levels, waste disposal options, and future use of the site.

[93] Fernald Citizens Task Force. *Recommendations on Remediation Levels, Waste Disposition, Priorities, and Future Use.* July 1995.
[94] *Ibid.*

CWM landfill is the only site with a group similar to FCAB. The CAC was established in 1993 during the permitting of the last landfill cell to open at the facility. The committee members include representatives from the towns of Lewiston and Porter, the Niagara County Health Department, and the citizen group Residents Organized for Lewiston-Porter's Environment.

As required by New York State Environmental Conservation law[95], the CAC worked with CWM to develop a solution to pressing community concerns, which were the proposed construction of a hazardous waste incinerator and truck traffic to the facility. Chem Waste had begun the scoping process to construct two 100,000 ton per year incinerators at the site of the landfill in 1990, and had faced community opposition to the proposal throughout the process. Citizens were concerned because nearly 80 trucks traveling at high speeds *en route* to the facility passed the local school each day.[96] Prior to the public hearing on the facility's proposed landfill expansion, the CAC and CWM developed and signed an agreement addressing both issues of community concern. CWM agreed that it would not attempt to construct a hazardous waste incinerator at any location in Niagara County for 10 years, and to restrict the times of day and speed for truck traffic to the facility. The agreement also required the organizations with representation on the CAC (ROLE and the towns of Lewiston and Porter) to agree that they would not become parties in opposition to the proposed landfill. Members of ROLE believe that this decision was a very effective compromise, since the group would likely have had little success in opposing the expansion of the landfill. Although the CAC continues to meet with CWM, the meetings primarily serve to inform members about events at the facility.

Both sites with formal advisory committees changed their activities based on citizen input. However, at both sites community members outside of the formal group asserted that the group was not representative of the community. At FEMP, for instance, some commenters expressed the opinion that many members of FCAB did not live in the communities most impacted by the facility

OTHER STAKEHOLDERS

Local or tribal governments, state and national environmental groups, and outside groups that work at the local level are some of the other stakeholders that participated in decisions about these sites.

SFC — The Cherokee Nation is very involved in the decommissioning process. The tribal government is in regular contact with both NRC and the facility's management. The Cherokee Nation is a contributing agency to the EIS that NRC is developing, and has been in discussion with the facility management about site stewardship issues. The government is concerned about proposals for decommissioning the site to restricted release levels and has developed a set of conditions that they would like to have met before serving as site stewards. Outside organizations have become valued contributors to the public involvement process. A project funded by the National Institute for Environment Health Sciences, Nuclear Risk Management for Native Communities (NRMNC), works with the local community. Its goal is to qualify and quantify the effects of the facility on the

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[95] N.Y.S. ECL §27-1113 *(see Appendix 3 for discussion of these provisions).*
[96] *See infra* note 17 in Olsen, R. Nils. "The Concentration of Commercial Hazardous Waste Facilities in the Western New York Community." 39 Buff.L.Rev. 473 (1991).

community. In response to community needs for basic information about the site, the project now concentrates on providing technical assistance and summaries of NRC materials. The site licensee has been grateful to the group for organizing large open meetings that the licensee has been unable to convene.

NFSS — In the phase I remedial activity at the NFSS, the local governments were among the primary participants in DOE activities. The town of Lewiston hired an attorney to represent them and assist them in preparing comments for the Environmental Impact Statement the department developed under NEPA. Several national environmental groups, including Greenpeace and Sierra Club, provided comments during the 1983 EIS scoping process.

TWCA — State and national level groups were significantly involved in early phases of remediation. Public involvement has been largely focused on contaminated sludge stored in unlined ponds in the floodplain of the Willamette River. Forelaws on Board, a state environmental group based in Portland, sponsored three ballot initiatives between 1984 and 1990 proposing tighter standards for licensing disposal facilities. Greenpeace, an international environmental organization, also protested the site in 1985. Although the first ballot initiative organized by Forelaws on Board passed, two subsequent initiatives met a heavy public relations campaign organized by TWCA, and neither passed.[97]

4.4.4 *Community Contact Tools*

The regulators and managers at the six sites made use of a variety of public involvement tools (*i.e.*, individual contact, small group meetings, formal public hearings, and facility open houses) to convey information to the communities and gain public input on proposed site activities. The most common tools used to gain public input were traditional notice and comment mechanisms, but other innovative and less formal methods were also used. Table 4.4.4 and the discussion below characterize the use of tools at each of the sites.

INDIVIDUAL CONTACT

The most common occurrences of individual contact between site personnel and community members occurred during the development of community relations plans or community assessments under CERCLA. EPA or the lead agency must conduct interviews with local officials, community residents, public interest groups and others to learn about community concerns and information needs, and to assess the ways the community would like to be involved in the response action. On the basis of the interviews, the lead agency develops a Community Relations Plan (CRP), which details the public involvement activities the agency plans to undertake. EPA requires that these activities provide appropriate opportunities for involvement in site-related decisions, including site analysis and characterization, alternatives analysis, and selection of remedy.

[97] U.S. EPA. *Community Relations Plan for the Teledyne Wah Chang Albany Site.* November 1987.

Table 4.4.4: Community Contact Tools

Site	Individual Interviews	Small Group / Informal Meeting	Public Hearings	Facility Open House
TWCA	Interviews were conducted during development of community relations plan.		Held as required by CERCLA, though no hearing held for soil ROD due to lack of interest	TWCA has given tours to local residents.
CWM		The CAG meets with CWM staff routinely; during permit actions CWM will organize small meetings.	Held by NYSDEC for each permit revision.	CWM will give tours to interested parties.
FEMP	Conducted for community assessment in 1994; Envoy program provides informal one-on-one contact.	DOE and OEPA organized availability sessions, DOE attends meetings of local groups.	DOE held hearings in connection with each ROD.	Offered periodically; residents most involved with site have access cards.
MFDS	Conducted for community relations plan in 1987 and 1992.	EPA and MFCC held informal meetings at several times during RI/FS.	EPA held a public hearing for the ROD.	EPA conducted tours in 1987 and 1991; responsible parties have offered several recent tours.
NFSS		DOE held meetings after the EIS was drafted; Army Corps now provides information sessions.	DOE held public hearings as required by NEPA when developing EIS.	
SFC		SFC met with community organizations beginning in 1993; grant-funded research project held four meetings open to general public; NRC held meetings in 1995 for EIS process.	NRC held public hearing for EIS process in 1995; SFC held public hearing on institutional controls in 1998.	SFC held facility open house in 1995.

All of the sites remediated under CERCLA (TWCA, FEMP, MFDS and recently, NFSS) made contact with local residents as they developed the community relations plans.

At non-CERCLA sites, individual interviews were less commonly used. CWM will telephone or meet with the individuals most involved with the site to discuss proposed changes before the changes are announced to the broader community. Neither the NRC nor the site licensee conducted individual interviews during decommissioning at the SFC site.

In addition to conducting interviews, at FEMP DOE developed an innovative, nationally recognized program to facilitate two-way communication between decision makers and stakeholders. Initiated in 1994, the Envoy program provides an opportunity for Fernald employees to serve as liaisons between DOE and community organizations of which they are members. The program aims to increase one-on-one communication between site personnel and local residents. Currently, 36 Envoys serve as liaisons to 42 community groups. Envoys attend meetings of community groups such as township governments, business interests, environmental groups, and school associations. They present information on cleanup activities and let members know that they are available to answer their questions about the site. The Envoys also communicate the public's concerns to DOE.[98] The program provides increased contact between DOE and the community through employees already working for the facility and community organizations that already exist, providing a cost-effective means for improved communication.

SMALL GROUP MEETINGS

Most of the sites held some form of small group or informal meetings. Many of these meetings were held to provide information to the community and answer questions about community concerns, reserving the opportunity to provide comments for more formal, transcribed meetings. At FEMP, both DOE and Ohio Environmental Protection Agency (OEPA) held numerous small meetings during the development of the records of decision for each operating unit. DOE began holding regular public meetings on RI/FS development and community roundtables on topics of interest in 1989. DOE began using breakout sessions at public meetings in 1993, allowing the public to discuss a topic of interest in a small group setting.[99] OEPA offered technical availability sessions excluding DOE staff from its meetings in order to provide an opportunity for OEPA's technical staff, who had been involved in reviewing DOE's proposed remediation plans, to meet one-on-one with the community to learn of their concerns and provide technical explanations of the alternatives.

At other sites, small group meetings also began early in the remedial process and continued to be held throughout the process as a mechanism to communicate information about progress at the site. At MFDS, EPA conducted its first citizens' information meetings during the remedial investigation period, and continues to convene small group meetings as requested by MFCC. CWM will hold meetings to inform the community of proposed permit modifications, and NYSDEC will

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98 Fernald Envoy Program fact sheet, October 1997. Available at http://www.fernald.gov/aboutfernald/FactSheets/4799envoy.pdf

99 U.S. DOE. *Community Relations Plan.* January 1995.

also hold an information session at the start of the public comment period on any proposed permit modifications. At NFSS, the Army Corps has begun to offer two information sessions a year. At TWCA, due to limited community interest in the remedial process, few, if any, small meetings were held.

At the SFC site, small group meetings were convened by the licensee early in the decommissioning process. In 1993, after preparing a draft decommissioning plan, SFC began holding meetings with local groups such as the Lions, Kiwanis, and Rotary. The company also met with state, local, and federal agencies such as the local water utility, the Corps of Engineers, the Cherokee Nation, and the Mayor of Gore. The company held over 35 meetings between 1993 and mid-1998.[100] These meetings were generally open only to members of specific groups and the purpose of the meetings was to present information about plans for the site. NRMNC was asked to convene meetings for the general public, reportedly because the company had difficulty organizing meetings for members of the community that were concerned about decommissioning plans.

FORMAL PUBLIC HEARINGS

The formal public hearing, along with public comment provisions, is one of the most common legal requirements for public involvement, and every site held at least one formal meeting to record public comment. At CERCLA sites, meetings were held prior to the issuance of a ROD, while at sites governed by NEPA, public comment on the EIS was required. RCRA facilities have provisions for public comment in the permit process. The public hearings at most sites were generally well attended, and at some sites many community members also submitted written comments.

At sites remediated under CERCLA a public hearing was held when preferred remedial alternatives were identified.

FEMP — A public hearing was held for the development of each of five RODs. DOE reports that on average 60 people attended the hearings.

MFDS — EPA held a public hearing on the preferred remedial alternative, and due to public interest in the issue extended the public comment period from 30 to 60 days.

TWCA — A public hearing in the vicinity of the site was held for the first two records of decision. Approximately 30 people attended each of these meetings, though EPA believes that the company may have sent many attendees. EPA received no comments during the development of the third ROD, and only one request to hold a public hearing.

Federal sites remediated under programs governed by NEPA generally hold at least one public hearing at the start of the EIS process to obtain input on the scope of the EIS. An additional public hearing may be held after the draft EIS is completed.

[100] Decommissioning Plan for Sequoyah Fuels Facility; Appendix H. 1999.

NFSS — Public meetings were held during the EIS scoping in Lewiston as well as Oak Ridge, TN, and Hanford, WA, to obtain comment from stakeholders that might be affected under different alternatives. After the draft EIS was completed public hearings were held in the same locations to obtain comment on the alternatives. DOE responded to these comments in the final EIS.

SFC — NRC has held a scoping meeting in the area In 2000, NRC began to develop a draft EIS. Some citizen activists believe that many company employees were sent to the meeting to "crowd out" dissenting viewpoints.

Public hearings were also held to meet other legal requirements. Under NRC's restricted release regulations, SFC was required to hold at least three public meetings to obtain input on four issues. Because the regulations were promulgated four years after SFC began the decommissioning process, and SFC had already conducted informal public outreach activities, the company decided to hold two additional public meetings in which public comment on the decommissioning plan would be received and recorded. SFC prepared a 21-page paper describing the decommissioning plan and associated financial issues, and distributed it to over 75 individuals and groups nearly a month before the first scheduled meeting in October 1998.[101] SFC planned to hold both meetings in the administration building on the grounds of the facility. Only 13 people attended the first meeting at the facility, and attendees stated that other interested members of the community had not attended the meeting because of a fear of contamination at the facility. In response to the low attendance at the first meeting SFC canceled the second meeting and scheduled a third meeting at an off-site location two weeks later. Approximately 50 people attended the off-site meeting. The licensee has responded to the comments it received during these meetings in the draft decommissioning plan.

At CWM, public hearings are required in connection with permit modifications under both federal RCRA and New York State Environmental Conservation Law. A significant public hearing took place during the permitting process for the facility's second landfill. There have been no formal public hearings in connection with the corrective action at the facility.

FACILITY OPEN HOUSE

All of the sites held one or more open houses during the remedial process. The community responded favorably to the events at most sites. In fact, at TWCA, in the early stages of remedial action at the site (prior to NPL listing) the company organized a tour of the facility for state regulators. Activists concerned about the sludge ponds protested the tours, insisting that they be allowed to join. Although they were not allowed to participate in this tour, the company later organized tours open to the public.[102]

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[101] Decommissioning Plan for Sequoyah Fuels Facilit. Revision 2. Appendix H. March 1999.
[102] U.S. EPA. *Community Relations Plan for Teledyne Wah Chang Albany Site.* November 1987.

At other sites, arranging for public tours was not as controversial. At SFC, 50 people attended an open house in 1995.[103] CWM also regularly brings groups and individuals to the landfill. At MFDS, EPA conducted tours of the site in 1987 and 1991, early in the remediation process.[104] In August 1998, the settling parties organized a public tour of the site for area residents. Although in the past the FEMP site was highly restricted, at this time public access to the facility is widespread. DOE regularly offers tours of the site to community members, school groups, and visitors. Neighbors of the facility who have worked very frequently with DOE on the decision-making and cleanup processes have been issued identity cards allowing them to access the site whenever they need to access information or talk with people on-site.

4.4.5 *Communicating With Stakeholders*

Providing information to stakeholders is an important element in effective public involvement. Information that might be communicated includes announcements of agency or facility activities and meetings, the availability of new information on the site, and how the public can access this information. The information in this section and Table 4.4.5 present the availability of information at each of the sites, considering the use and utility of information repositories, the development and dissemination of fact sheets, and the mechanisms for publicizing meetings and hearings.

INFORMATION REPOSITORY

Statutes and regulations commonly require agencies or site operators to establish an information repository in the vicinity of the site. Every site in this study has a nearby information repository that was established early in the remedial process. Often the information repository is at a public building like a library or city hall. The Public Environmental Information Center (PEIC) at FEMP contains more diverse resources than most information repositories. In addition to administrative record required by CERCLA and background on the site, the center houses computers with access to real time radon monitoring data and the Internet, as well as many state and federal legal and information resources. PEIC staff will also copy documents at no cost to the requestor.[105] At the other sites, repositories are located at local libraries that are not able to provide free copies of documents. However, the repositories are in public buildings that community members may visit regularly.

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[103] Decommissioning Plan for Sequoyah Fuels Facility, Appendix H. 1999.
[104] U.S. EPA *Draft Revised Community Relations Plan for Maxey Flats Disposal Site*. February 4, 1993.
[105] Public Environmental Information and Technical Information Centers, Fact sheet. October 1997.

Table 4.4.5: Communication Tools

Site	Information Repository	Fact Sheets	Distribution of Information
TWCA	Established near facility.	Developed for each ROD.	
CWM	Information available at NYSDEC regional offices and at the town hall.	NYSDEC develops fact sheets for significant permit modifications.	NYSDEC and facility use mailing list and ads in papers.
FEMP	Information repository established at site and library in 1985; consolidated near site in 1992; provides materials free of charge.	DOE and OEPA developed numerous fact sheets.	Postcards and fact sheets sent to 1000 person mailing list to announce meetings and other significant events; site specific website; general and special interest newsletters sent to mailing list.
MFDS	Two information repositories established in 1988 at public libraries; EPA provided shelving to libraries.	EPA developed fact sheets for each ROD.	Fact sheets and announcements sent to 600 person mailing list; MFCC distributed fact sheets in grocery stores.
NFSS	Information on site is available at nearby USACE offices.	USACE has developed fact sheets.	USACE sends postcards announcing meetings to 800 names on mailing list.
SFC	NRC repository established at local library but community believes it does not have the most recent documents and finds cost of duplicating prohibitive; SFC has on-site repository.	None developed; SFC produced a 21-page summary of decommissioning plan.	Advertise meetings in newspapers; communicate through letters to individuals on mailing list.

At the SFC site, some citizen activists reported problems with the local information repository. The NRC public document room (PDR) is located in the library in Salisaw. In 1982, a community activist stated that the PDR was actually a folder in the librarian's drawer an inch thick. The librarian asked many questions before allowing the individual to access the folder. The company later provided the local library with copies of documents, but the library required people to sign in before using the material, which deterred some people from seeking information there. The cost of copying the information is eight cents per page, and community activists have found this to be somewhat prohibitive. The most recent documents are not always available in hard copy in the PDR, and NRC will provide them on microfiche. Most members of the public will not be able to read documents this way, and the microfiches do not always contain all of the figures included in the hard copy. Some of the problems evidenced at the PDR are believed to be related to local tensions between supporters and opponents of the facility and to the limited resources of the community, and other problems seem to be disconnects between the regulators establishing the PDR and those maintaining it.

In addition to the NRC PDR, SFC established an information trailer outside the site. When a tornado destroyed the trailer, the materials were moved into the site and are available during business hours or at other hours by request. The Cherokee Nation reports that it is able to obtain information by requesting it from either the facility or NRC.

FACT SHEETS

Rather than reviewing lengthy technical documents at the information repository, the public generally relies on fact sheets or other summaries of technical information to learn about the plans for sites in their communities. Fact sheets are required under CERCLA and RCRA, and the sites regulated under these laws used fact sheets to summarize proposed plans. Most of the fact sheets are written in non-technical language and contain contact information for the agency that issued it. All sites except SFC issued fact sheets at more than one point in the remedial process.

The lack of fact sheets at the SFC site was striking to the outside researchers of the Nuclear Risk Management for Native Communities project. In 1998, SFC drafted a 21-page summary of the decommissioning plan in order to provide community members with information in advance of formal meetings in which the public was asked to provide comment on proposed institutional controls. Prior to this, neither the licensee nor NRC had issued any summary of the decommissioning plan. The researchers found that many community members had little understanding of either the technical issues at the site or the regulatory requirements governing the remedial process. The project team believed that the community would benefit from a simplified yet comprehensive explanation of the decommissioning plan and process. The group developed a community workbook that translated information on the site to a seventh grade level.

DISTRIBUTING INFORMATION

The six sites utilized similar mechanisms to distribute information and announcements to the community. The most common means were by mail and through newspaper advertisements. At Fernald, postcards announcing meetings and other events are mailed to 1000 people on the facility mailing list and meetings were advertised in three local newspapers. At the MFDS, EPA mailed more than 600 fact sheets describing the proposed plan in May 1991, also announcing the formal public hearing to take place in June.[106] Information about public meetings and hearings was published in local newspapers as well. NRC, SFC, and NRMNC advertised general public meetings in community papers such as the Sequoyah County Times, and SFC sent letters directly to interested individuals on their mailing list. NRMNC also posted flyers advertising its meetings. USACE currently has 800 names on its mailing list for the NFSS, and mails postcards to advertise information sessions.

In addition to mail and newspaper advertising, some groups such as NRMNC posted flyers at the SFC. At MFDS, MFCC conducted its own outreach, placing fact sheets in grocery stores, telling citizens about the site and letting them know the location of information repositories. At FEMP, an extensive site-specific website publicizes upcoming events and provides information about the site.

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[106] U.S. EPA. *Record of Decision, Maxey Flats Nuclear Disposal.* September 30, 1991.

Fernald also publishes a general interest newsletter that is distributed to the 1,000 people on the mailing list, and additional newsletters for special interest groups. Of the six sites, the FEMP site has devoted the most resources to developing outreach materials for the public. At other sites, outside groups have stepped in to ensure that news about the site extends beyond the names on the official mailing list or those who see the information in the paper.

4.4.6 *Media Relations*

Media relations do not figure prominently at most of the sites. Several of the sites received significant coverage in local and national media. Most sites will issue press releases when studies are completed, plans are developed, or new actions initiated or completed. No sites made efforts beyond issuing a press release to ensure that there would be coverage in local papers. Several of the sites, including FEMP, SFC, CWM, and NFSS, have been unhappy with some of the coverage in local papers.

At MFDS, MFCC actively seeks out the press to get publicity for its views. The organization also learns about site developments from its media contacts. At TWCA, the company has used the media most effectively during the voter referendums relating to the sludge ponds. Although the first initiative was passed by the state's voters, the company was successful in encouraging voters to reject the next two initiatives. Regulators might use the media more effectively to engage the public in discussion about the sites.

4.4.7 *Stakeholder Involvement in Decisions*

The most important metric for the success of a public involvement program may be the extent to which stakeholders feel they have been involved in the decisionmaking process. The purpose of conducting public involvement activities is to gain input from the public in decisions and if possible, incorporate public opinion into environmental risk management. Public involvement activities that are planned and conducted with this goal in mind, and decisionmakers who acknowledge and respond to public concerns, are likely to achieve a higher level of stakeholder involvement.

Generally, public involvement approaches can be divided into two categories: consultative processes and collaborative processes. In a consultative process, the government exchanges ideas and information with a group of non-governmental stakeholders. While this process involves input from stakeholders, it does not include efforts to articulate a group or consensus opinion. Collaborative processes, on the other hand, involve active deliberation among group members and encourage groups to develop a consensus opinion. The result of collaborative processes is normally a formal recommendation on which an agency may act. Both consultative and collaborative processes are ways to educate stakeholders and obtain opinions and information about sites and communities, but the deliberative nature of collaborative processes helps create a deeper understanding of problems and how they might be resolved.[107] At the sites studied, public involvement activities at most were

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[107] Beierle, Thomas and Rebecca J. Long. "Chilling Collaboration: The Federal Advisory Committee Act and Stakeholder Involvement in Environmental Decisionmaking." 29 ELR 10399.

consultative processes. At the FEMP and CWM sites, collaborative processes were employed, and at these sites stakeholders reported that they felt that decisionmakers had responded to their opinions about sites.

At the FEMP site, FCAB served as the collaborative body that developed a nearly consensus decision on difficult issues about the site. All but one member of the group supported a recommendation to DOE to store all but the highest level of waste on-site. Among the reasons the group gave for its decision were economic, political, and public safety concerns. The group reached a consensus on its recommendations for future use of the site and remediation levels, again citing economic and public safety concerns to support its proposals. FCAB's recommendations reflect an in-depth understanding of the issues at the FEMP site. Members of FCAB believe that DOE took the group's recommendations seriously, and feel that DOE has continued to involve the group in the remediation of the site. In addition to the role of FCAB, DOE has devoted significant resources to public involvement activities at this site. DOE established a Public Involvement Program in November 1993. The purpose of this program was to create an open and accessible decisionmaking process that would lead to informed decisions. The program emphasized establishing a dialogue between FEMP's decisionmakers and community members early in the decisionmaking process, as well as increasing the role of management in public involvement. A DOE contractor found that project managers, particularly the DOE contractors, were the most resistant to increasing public involvement. The focus of project managers had historically been on completing the cleanup effort; as a result of DOE's public involvement program, managers have increased their participation in public involvement activities. Some of the citizens who were most frustrated with DOE at the start of the remediation process now say that they are pleased with DOE's current work at the facility.

The CAC at CWM was convened specifically to develop a mutually agreeable solution to a contentious issue. Like FCAB's recommendations, the CAC's agreement with CWM reflects an understanding of political, financial, and public health issues at the site. CWM continues to meet with the CAC to discuss the on-going corrective action and operations at the facility.

At most sites, public hearings are significant events in the public involvement process because they provide an opportunity for stakeholders to give comments directly to agency and facility personnel. Likewise, they offer a chance for agency and facility staff to demonstrate to the community that they will be responsive to community concerns. However, under a collaborative process, the public hearing may reflect the success or result of the collaboration, as can be seen in the public hearings held at FEMP and CWM. The agreements and conclusions of the groups at these sites altered the dynamics at public hearings because regulators and key activists had already reached compromises. While individuals spoke against the conclusions of the groups, the comments presented at the hearings might have been different had the groundwork for compromises not been laid in advance.

At sites where processes were less collaborative, citizens did not always develop and articulate the complex opinions of the formal advisory groups. MFCC at MFDS is an exception. The group's technical advisor assisted the members in developing recommendations for EPA that included specific construction techniques for the waste on-site and the establishment of large buffers around the site. The members of MFCC believe that EPA has respected the community's opinion. However, the group also believes that EPA could be more proactive in providing information about on-going activities at the site. For instance, in March 1999 the group learned of a problem in the remedial action from a contact in the media rather than being directly informed by EPA. Further, when the EPA project manager for the site changed, the new manager did not make an effort to contact the head of MFCC, who represents most of the community to EPA. Public involvement activities at MFDS were successful in establishing a consultative process where citizens provided EPA comments that the agency could incorporate in its remedial action. However, the process has not developed a collaborative environment or a sense in the community that EPA is looking out for local interests in its work at the site.

At other sites, citizens feel that their input has not been taken seriously by regulatory agencies. One example may be found in the public involvement process at NFSS. DOE's NEPA process involved obtaining public input from citizens in three communities (Lewiston, NY; Oak Ridge, TN; and Hanford, WA) during both the scoping process and review of the draft EIS. The scoping meetings in Lewiston were held on February 17 and 19, 1983. However, in April 1982, DOE developed interim actions for dismantling structures at the site and consolidating and capping wastes in an internal process without public input.[108] Although these activities would not be completed until 1986, in 1984 DOE established as the baseline no-action alternative for the EIS the condition of the site anticipated in 1986 with the completion of the interim remedial action.[109] Although DOE's remedial action was quite costly, the costs associated with this activity were not included in the costs for the no action alternative. All other alternatives, however, included the cost that would be incurred by dismantling the structures created by the interim action as well as the additional costs for developing new storage facilities.[110] DOE determined that the no action alternative would be the best option at NFSS partially on the basis of the unusual assumptions included in the cost calculations for the no action alternative.

As a result of comments during the scoping process, DOE considered an additional remedial alternative: storage of the bulk of the waste on-site but transfer of the more radiologically contaminated residues to an off-site location. Comments on the draft EIS from the town of Lewiston and Niagara County reveal that although residents would have preferred removal of all wastes from the site, removal of only the most radioactive substances would have been an acceptable alternative. Like the communities at FEMP and MFDS, the communities in this area acknowledged that cost and political concerns would drive the remediation process and require compromises. In spite of the community's willingness to compromise, DOE did not treat the public as a partner in the public involvement process. One letter of comment from residents near the facility expressed frustration with the public involvement process. It stated, "[w]e can't help but feel that the government has already made their decision and is just giving us this opportunity to speak because they have to follow certain steps to protect themself (sic) legally. That's great for the government, but what recourse do people like us have? We are at the mercy of the decision-makers, who of course, do not live next door to constant threat."[111]

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[108] U.S. DOE. FEIS, Sections 1 and 2.
[109] U.S. DOE. FEIS, Section 1.
[110] U.S. DOE. FEIS, Appendix F.
[111] U.S. DOE. FEIS, p. K-16.

Similarly, at SFC, some community members express great frustration at being excluded from decisions about the site. Although the decommissioning plan for the site has not been approved, residents are concerned about apparent activity at the site, stating that this activity indicates that the company does not intend to take community opinions into account in its decommissioning plan. Regardless of the actual nature of activity at the site, it is clear that some community members who are concerned about the site do not feel adequately involved in the decisionmaking process. The licensee has made some efforts to obtain community input as required by NRC, and has received around 100 comments as a result of these efforts. Under NRC's restricted release regulations, licensees must only obtain public input on issues related to institutional controls. In the draft decommissioning plan, the licensee stated that approximately half the comments were related to institutional control issues. Although the licensee responded to all comments, it was not required to incorporate concerns other than those related to institutional controls in the decommissioning plan. Community activists also claim that at public meetings company officials do not appear to take citizen comments seriously. The activists continue to distrust the licensee and the regulatory agencies.

At Teledyne, public involvement in decisions was fairly limited. This was due primarily to lack of interest in the local community in the environmental problems at the site. A state regulator commented that the public meetings at the Teledyne were the only he had ever attended where the community was hostile toward EPA for requiring the facility to spend money cleaning up and potentially threatening the company's viability. EPA made the required efforts to obtain community input, and it may be that no efforts on the part of EPA could have encouraged further interest in remedial process.

The effectiveness of stakeholder involvement at each of the sites depends on agencies as well as communities. At sites where stakeholders felt their opinions were taken seriously, agencies invested a great deal of time and effort to provide opportunities for public involvement. Likewise the communities at these sites put in time and effort of their own. When public involvement was treated perfunctorily, stakeholders remained suspicious that their concerns were not being taken seriously.

4.4.8 *Summary of Findings Related to Public Involvement*

Table 4.4.8 summarizes findings derived from analysis of public involvement at the six sites. The focus of the findings is on the most successful public involvement approaches identified in the case studies, as well on instances where communities expressed dissatisfaction with the level of public involvement.

Table 4.8.1: Summary of Conclusions on Public Involvement

Conclusions	Examples
Effective public involvement approaches	
Tasking a group of interested citizens to develop recommendations on risk management demonstrates a commitment to obtaining community input.	FEMP and CWM had advisory boards that developed approaches to risk management that incorporated community concerns.
Providing sufficient information about risks and costs allows stakeholders to develop pragmatic approaches to risk management.	At FEMP and MFDS stakeholders agreed to the storage of radioactive waste on-site in accordance with specified criteria.
Providing easy access to technical information, including summaries, increases citizen's ability to comment on remediation plans.	Most sites provided fact sheets and local information repositories. At sites where technical assistance was provided, such as FEMP and MFDS, citizen comment on technical issues was more evident.
Community-agency relationships	
Involving all levels of project management in interacting with the public creates a more successful public involvement approach and builds trust.	At FEMP, DOE's involvement with the community changed the community's perception and satisfaction with DOE dramatically.
Citizen's initiatives were often a cause of changes to the facility's approach to public involvement.	At most sites public involvement activities allowed for only minimal citizen input at the outset; at FEMP and CWM citizen groups sought and obtained more involvement in the process.
Stakeholders bring a variety of biases to risk management.	At TWCA citizens were more concerned about regulatory burden on the industry than remediation; at FEMP and other sites, initial biases were changed through education.
Laws and regulations	
Existing laws provide a floor, not a ceiling.	At sites where public involvement was most successful, agencies exceeded their legal requirements.
Timing	
Public involvement should occur before key decisions are made.	An opportunity for public comment should be provided prior to any activities that will influence risk management; at NFSS, DOE activities begun without public input prior to the NEPA process influenced the outcome of the process.
Public involvement should continue beyond the initial decision-making period, particularly in cases involving institutional controls.	At FEMP and MFDS, community members and site management have demonstrated a commitment to public involvement during the remediation process.

5.0 CONCLUSIONS

5.1 Chapter Overview

Risk harmonization embodies the idea that a common policy framework is desirable for making decisions about how to manage radiation and chemical risks. Harmonization is desirable because it has the potential to lower overall costs, reduce confusion among the public, and help craft transparent decisionmaking. Conceptually, harmonization does not mean that all decisions involving chemical and radiological hazards must be treated identically.

As these case studies show, most site specific actions are pragmatic, and seek to protect public health, welfare and the environment. They provide examples of how chemical and radiation risks are managed and offer the opportunity to examine similarities and differences in approach and decision making. Ultimately, site specific choices indicate where and how risk management harmonization is occurring. Based on these case studies, there appear to be any number of methods that can achieve public health protectiveness. We cannot say that the "environmental" or "radiation" method is better or worse, in the abstract. Any of the rigorous schemes proposed in federal and state regulations, when applied properly, will protect public health.

In this chapter, we have identified four general themes that, according to our analysis, shape risk management decisions. For each of these themes, we evaluate site-by-site similarities and differences and present a cross-site analysis. Because of methodological differences, it is not possible to carry out a comparative site analysis with respect to risks. Nevertheless, our cross-site examination leads us to offer questions and challenges for future risk harmonization investigations. It also highlights the central role of the process employed in managing risk.

In general, we found that there is much common ground in the management of chemical and radiation risks. Radiation risk managers typically apply a "top down" approach, using internationally established standards based on aggregate risk. Protectiveness is then increased by the application of ALARA. Chemical risk management is typically described as "bottom up" acceptable risk levels within a protective risk range are established individually for chemical contaminants. In cleanups under Superfund, nine criteria are applied to the risk management decisionmaking process. Functionally, they are similar to the ALARA approach favored in radiation risk management. Despite these differences in approach, protection of public health is the fundamental goal at all of these sites.

We feel that several promising opportunities for further harmonization can be pursued. We believe that these areas can be harmonized in the short term. We have also pointed out several long-term efforts that can be undertaken to move further toward harmonization.

5.2 Overarching Themes

ASSUMPTIONS ABOUT FUTURE USE OF THE SITE, INCLUDING LAND USE SCENARIOS AND OFF-SITE RISKS, DRIVE RISK MANAGEMENT DECISION-MAKING.

Not surprisingly, risk management decisions about how a site will be used after the cleanup is completed were pivotal in determining management options. We found this to be true at both chemical and radiation risk management sites (and sites with both chemical and radiological waste) with some important differences.

For example, all sites except a portion of the SFC site assumed restricted and non-residential future use. Subsequently, the exposure scenarios employed for risk evaluation and setting cleanup goals were based on a series of assumptions founded on the notion that the site would be restricted in the future. Worker, resident intruder and trespassers were thus assumed to be receptors for the on-site exposure risk calculations. Exposure scenarios for potentially susceptible receptors such as children and "senior" citizens were not considered (with the exception of the FEMP site).

ICs were an important feature of future use scenarios. Almost all of these sites will require the implementation of ICs to restrict future land uses and maintain acceptable levels of exposure and risk. The proposed ICs include government ownership (and stewardship), long-term maintenance and monitoring deed restrictions and other limitations on land use. Frequently, different ICs are proposed for different portions of the same site. At this point, we cannot evaluate the effectiveness of the proposed ICs because at the majority of these sites implementation has not yet begun. Although MFDS, TWCA, and FEMP are further along in implementing ICs than the other sites, no ICs have been functioning long enough to warrant extensive evaluation.

For long-term management of all sites, continuous use of ICs potentially will be required for both chemical and radiological site contamination. At the FEMP site, several of the RODs stated that ICs would be needed in perpetuity. The CWM site has established a financial mechanism to provide funding for ICs in perpetuity, even though the traditional time frame for RCRA post-closure care is 30 years. NRC regulations, which apply at SFC and MFDS, state that on-site disposal cells cannot rely on ICs beyond 100 years. At MFDS, land use restrictions will be placed in perpetuity on the site.

Funding for ICs is also an important issue, and at most sites it has not been resolved. Unless state or local governments are going to bear the costs of the ICs, identifying an early and reliable source of funding is critical. At CWM, MFDS and SFC, attempts have been made to ensure that future funding will be available. At the other sites, funding is less certain. For example, at FEMP operation and maintenance funding has not been set aside or guaranteed. At TWCA and NFS no ICs funding source has been found.

In addition, at most of these sites limited attention was paid to the evaluation of off-site exposure and risks. Across all six sites, groundwater (as drinking water) was the only commonly evaluated pathway that considered off-site exposures. This pathway was frequently eliminated because it was assumed that the groundwater was not potable, or was not currently used as, drinking water. At two of the sites (MFDS and FEMP) a more thorough examination of off-site exposure and its potential risks was carried out.

PUBLIC PARTICIPATION, INPUT AND ACCEPTANCE ARE CRITICAL FOR SUCCESSFUL RISK MANAGEMENT.

Because communities are most directly affected by site risks and decisions about how to address them, their input and participation in the crafting of the remedy is essential. Additionally, if ICs are to be used, the affected communities must be fully informed about the nature of the residual risks, the way in which the selected ICs will protect them and who will be responsible for the long-term implementation of the ICs.

When communities were provided with clear and sufficient information about site risks and costs, they were able to choose between and support pragmatic approaches to risk management. Our case studies showed that communities were able to accept some risk if explicit public involvement and input were sought and incorporated into risk management decisionmaking. At sites where risk managers provided information about the risks and cost-effectiveness of remedial options, citizens were able to make recommendations based on these facts. At FEMP, FCAB and FRESH supported the creation of an on-site disposal facility for low-level waste because citizens recognized that removing all waste was not cost effective or politically expedient. At MFDS, the community also agreed to the continued storage of waste on-site, requesting that a buffer be provided around the site to ensure that activities around the site would not inadvertently impact the remedy.

Our case studies also indicated that communities treated radiological and chemical wastes in similar fashions, based on the information about the hazards. Although it is often assumed that radiation triggers a more emotional response, there was little difference in citizen reaction. Community concerns seemed to be keyed more to the loss of, or threats to, specific resources. At the Fernald site, protection of the Great Miami Aquifer was an important concern. At Maxey Flats, citizens were interested in health affects (to their families and to livestock) associated with using and consuming water that contained high levels of chemicals and radionuclides. At SFC, contamination of the Arkansas River was a prominent issue in the discussion of decommissioning and at TWCA contamination of the Williamette River concerned activist citizen groups. In western New York (where NFSF and CWA are located) citizens expressed concern when plans were introduced to place a hazardous waste incinerator at the CWM site.

A VARIETY OF APPROACHES ARE USED ACROSS SITES TO ASSESS AND MANAGE RISKS.

Because site-by-site approaches and post-remediation risk goals were different, it is not feasible to compare risks across the six sites discussed in this report. We can, however, discuss them in detail and illustrate the variety of approaches that were taken. These differences were noted in the proceedings of the Risk Harmonization Workshop. The case studies emphasized the points that workshop participants raised. In particular, there are three methodological issues selection of CoCs, assumptions about exposure duration and site time frame, and establishing target goal (dose/risk) — that warrant further discussion.

For both chemical and radiological baseline risk assessment for waste cleanup, major sources of uncertainty include exposure pathways, receptors, fate and transport modeling, and the issues associated with non-random or directed sampling. At all sites except MFDS, risks were calculated deterministically, *i.e.*, a point estimate (or a single value) was used.

SELECTION OF CoCs. One of the most significant differences relates to the selection of CoCs and use of health based screening criteria. Methods of screening large numbers of constituents to select CoCs were undertaken at all sites as starting points for site risk assessment. In general, the screening process used two criteria to evaluate contaminants: the relationship of the level of the contaminant to the site-specific natural background level and the comparison of the level of the contaminant to a health- or risk-based screening level. Not all sites explicitly considered natural background levels in screening for CoCs. Health risk screening criteria varied significantly among sites and contaminant type.

For determining CoCs for organic compounds, natural background levels were assumed to be below the limit of detection. Therefore, any amount of an organic compound was considered to be above background. For inorganic compounds at the SFC and TWCA sites, natural background levels were established, and concentrations of these compounds below those levels were excluded from further consideration. At the CWM site, natural background levels of chemicals were not considered in its site-wide corrective measure study.

For radionuclides attention to natural background was more commonly a factor. For example, at TWCA gamma radiation below natural background did not enter into cleanup decisions. At the MFDS site, radionuclides with concentrations at or below natural background were not selected as CoCs. At the SFC site, there was no documentation of how background was factored into decisionmaking about radiological CoCs. Historical information and data from a site investigation were used to determine CoCs.

At FEMP, compounds with concentration below natural background levels were not excluded. The baseline risk assessment calculated all site-related risks without separating the contribution from natural background, even if background levels contributed to an incremental lifetime cancer risk of greater than 10^{-4} or HI>0.01.

Health risk based screening criteria differed not only between radiological and chemical contamination, but also varied between sites. Risk-based screening levels (cancer risk $>10^{-6}$ and HI>0.01) were used at the TWCA site to select chemical CoCs but for radiation constituents the UMTRCA standard of 5 pCi/g (radium in soil) and .2 pCi/L and .68 pCi/L (groundwater) were used. At CWM, risks for individual chemicals were first estimated and summed for each exposure medium. Substances with highest risk levels contributing to 99% of the total risk for each exposure medium were selected as CoCs. At the FEMP site a similar protocol was used for both chemical and radiological contaminants. Both chemical and radiological contaminants were initially screened based on an ILCR of 10^{-7} and/or an HI>0.01 (for chemicals) and ICLR of 10^{-4} to 10^{-10} (for radiation).

Contaminants with risks exceeding the screening levels were summed and compounds contributing to 99% of the total risks were selected as CoCs.

At MFDS, chemical contaminants in groundwater were compared to the MCLs or RfDs. Chemicals with levels exceeding these benchmarks were selected as CoCs. Radiation CoCs were selected based on two criteria: how the IS compared among the potential radiation constituents and how other physical characteristics affect the ranking established by the IS value. The IS value is the largest of the representative concentration-toxicity product. At SFC, chemical constituents were also screened based on benchmarks such as the MCLs and the EPA Region VI human health screening levels for tap water. Chemicals exceeding these health benchmarks were considered to be CoCs. For radiation hazards, CoCs were selected based on potential contribution to the dose and historical findings from site investigations.

Although all of the CoC selection approaches implemented at the six sites are reasonable, variable methods for selection could lead to differences in CoCs and resulting remediation strategies. An assessment of the impact of these differences was beyond the scope of this research. Accordingly, the impact of these variations in selection cannot be determined, but only hypothesized.

ASSUMPTIONS ABOUT EXPOSURE DURATON AND SITE TIME FRAME. Across sites, a consistent assumption is applied to worker exposure scenarios (25 years RME). For other exposures, however, there is considerable variability. At TWCA and SFC, the duration of exposure for RME adults is 30 years. At FEMP and MFDS, it is 70 years. Although it is unlikely that these differences greatly impact risk estimates and cleanup decisions, a consistent approach should be developed.

The long term follow-up and outlook of sites also differed. The presence of long-lived radionuclides required assessment beyond the 70-year time frame typically applied to CERCLA sites. At the MFDS site, evaluation of exposure time frames were extended to 100 and 500 years. For sites containing both long-lived radionuclides and persistent chemicals or non-degrading compounds such as elemental metals, a longer time frame would seem warranted. Yet at sites which did not have radionuclide contamination, chemicals were not evaluated beyond 70 years.

At FEMP, MFDS and SFC, a 1,000-year time frame was included in the cleanup and remediation evaluation. At NFSS a final resolution has not been made due to the long half life of radium-226 and thorium-230. In contrast, at CWM (where only chemical problems were associated with contamination) the site cleanup remedies spanned only 30 years.

ESTABLISHING TARGET CLEANUP GOALS (DOSE/RISK). In general, radiation risk management goals were established for site-wide cleanup, and not on a medium-by-medium basis. At SFC, the radiological criteria of TEDE 25 mrem/year (unrestricted release) and 100 mrem/year (restricted release) were met when a site-wide total dose approach was employed. At the FEMP and MFDS sites, site-wide cleanup risk goals were established. At the MFDS sites, cumulative risk goals were set for radiation; at FEMP cumulative risk goals were set for both chemical and radiological contamination.

In contrast, at the CWM site only media-specific cancer risks were determined for chemical contaminants. Both radiation and chemical contamination was present at TWCA and a sample-specific approach was undertaken to ascertain spatial distributions of risks in the contaminated media. The target risk goals for TWCA and CWM were based on the worker exposure scenarios because it was assumed that the sites would be used for industrial purposes in the future.

Cleanup goals for contaminated media differed. For groundwater, existing MCLs were used as cleanup goals at both TWCA and FEMP. In the event that an MCL was not available for a contaminant, a cleanup goal was established based on risk (1 x 10^{-5} at the FEMP site and 1 x 10^{-6} at the TWCA site). For uranium (total), a goal of 20 ppb was set at the FEMP site. These sites were also distinguished by the scope of the cleanup. At TWCA, the cleanup proposal was limited to the site's boundaries; at FEMP, the ground water cleanup addressed both on-site and off-site resources (*i.e.*, the Great Miami Aquifer). At the CWM site, a groundwater cleanup goal for volatile organics (on-site) of 100 mg/L was chosen.

For the MFDS, NFSS and SFC sites, groundwater is not presently used as drinking water and off-site migration of contamination was not considered. Therefore, groundwater pathways of exposure were characterized as incomplete pathways, and groundwater cleanup goals were not established. Nevertheless, based on the modeling of the baseline risk assessment at the MFDS site, the MCLs for tritium, strontium-90 and beta activity were exceeded during the 70-year time frame, and the MCLs for tritium, strontium-90 and radium-226 would be exceeded over the 500-year time frame. Efforts to prevent contamination from migrating to off-site groundwater were incorporated into all six sites' remedial action plans.

Four sites (TWCA, SFC, FEMP, and CWM) selected different approaches to manage risks from chemical and radiation contamination in soil. For individual on-site constituents in soil, post-remediation risk goals in the range of 10^{-4} to 10^{-6} were selected at the TWCA and CWM sites, and for the individual off-site contaminants at the FEMP site. For on-site contaminants at the FEMP site, a similar risk range was established based on the sum of all contaminants and individual on-site contaminants were constrained at 10^{-6} risk level.

In addition to these goals, at the TWCA sites a cleanup level of < 3 pCi/L was established for radium-226 to limit radon levels to less than 4 pCi/L. At the FEMP site, final remediation levels for uranium-total were established using ALARA at 50 ppm for on-site leachable soils, 82 ppm for on-site less leachable soils and 50 ppm for off-site soils. In contrast, only dose criteria were used at the SFC site to establish final soil remediation goals for individual radionuclide contaminants. Using the guideline of 25 mrem/year TEDE for unrestricted releases and 100 mrem/year for restricted releases, the final remediation goals for radium-226 were lower than the goals set at TWCA. The table 5.2.1 below summarizes the different soil cleanup goals.

The different approaches in establishing remediation goals ranging from the cumulative risk perspectives (FEMP and MFDS), site-wide total radiological dose criteria (SFC), exposure medium specific risks (FEMP and CWM), to the spatial distribution of sample specific risks (TWCA), make it extremely difficult to compare risks across sites. These differences may be justifiable because of varying level of contamination from site to site and applicable local regulations. Nevertheless, harmonization dialogues can be greatly impeded by such vast differences in approaches.

Table 5.2.1: Soil remediation cleanup goals for Radium-226 and Uranium-total

Sites	Radium-226 (unrestricted release)	Radium-226 (restricted release)	Uranium (unrestricted release)	Uranium (restricted release)
SFC	1 pCi/g	1.8 pCi/g	35 pCi/g	110 pCi/g
TWCA	3 pCi/g	N/A	N/A	N/A
FEMP	N/A	N/A	50 ppm	50-82 ppm.

RISK MANAGEMENT APPROACHES ARE PRAGMATIC.

Remedies at all sites were based on balanced considerations of feasibility and effectiveness of remedies, health and environmental protection, and costs. At FEMP, MFDS and TWCA, CERCLA's nine criteria (40 CFR §300) were employed to reach cleanup goals and decisions. At SFC, an ALARA approach was used. At CWM, consideration of the risks and benefits associated with on-going operations, risks to current workers, cost, feasibility and effectiveness were integral criteria in selecting corrective actions.

CERCLA's nine balancing criteria and ALARA's approach offer pragmatic ways to determine cleanup actions. The CERCLA process also allows for a cumulative evaluation of chemical and radiation risks. CERCLA offers greater opportunity for stakeholder input than an ALARA approach, because ALARA analysis is generally carried out as a technical exercise without extensive stakeholder input. Nevertheless, practical considerations associated with radiation site cleanups have resulted in a more open ALARA process in certain cases.

It also appeared that pragmatic remedies are being implemented that are commensurate with the scope of the site contamination. A balance among public health and environmental protection objectives, technical feasibility and effectiveness and societal and economic considerations takes place regardless of the nature of the waste. CERCLA provides a uniform framework for balancing these considerations and for data collection, analysis, deliberation, and selection of cleanup remedies. The nine balancing criteria contained in the NCP are a useful and effective organizing tool. The CERCLA process also allows for the joint and cumulative evaluation of chemical and radiation risks. Similarly, the optimization principle that underlies ALARA is also successful in achieving public health protective cleanups.

5.3 Questions and Challenges: Moving Toward Fuller Risk Harmonization

As discussed above, future challenges and questions fall into two general categories. First, we identify those challenges that can be addressed in the short term. These challenges include evaluating future use scenarios, determining the need for and feasibility of a harmonized approach to identifying and analyzing CoCs, developing a cross-discipline public participation model, developing cross-discipline and harmonizing risk and dose cleanup goals. Second, we point out certain areas where a longer-term approach will be needed. These areas include the nature of protection that should be afforded to groundwater and the possibility of harmonizing the pragmatic approaches set out in CERCLA's nine criteria and the ALARA principle. We set out these questions in detail below. Although these questions are separated for purposes of this report, we know that in practice they can, and will, overlap. Nevertheless, we believe that it could be appropriate to consider them separately as long as it is recognized that they are interconnected.

5.3.1 *Short-Term Questions and Challenges*

FUTURE USE SCENARIOS. Our research indicates that future use decisions require input from the affected communities and close attention to the nature of the site contamination. Nevertheless, a fuller, and more systematic, discussion of future use scenarios would be useful. For example, it might to helpful to develop a continuum of possible site uses that represent a continuum of possible cleanup options. These future uses could range from "return to natural state (pre-use)" to restricted access in perpetuity. This continuum could serve as a starting point for a dialogue with the community and give risk managers a tool to explain the variety of options that are available. In addition, a generic list of "intruders" should be developed for the same purposes. Perhaps most significantly, ICs should be addressed in a similar fashion. These tools could be employed in a harmonized way to evaluate site contamination from chemical, radiological, or mixed waste sites.

COCs. Our research indicates that various but reasonable approaches were used at the six sites to select CoCs. Nevertheless, it remains unclear if the different approaches could impact the site risk estimates and ultimately the remediation strategies. A reanalysis of the site-specific data employing different approaches of selecting CoCs would help clarify this point. It would also help answer the question of whether a harmonized approach to identifying, evaluating and selecting CoCs is needed and how such harmonization could affect the public health protectiveness of the remedy.

PUBLIC PARTICIPATION AND INVOLVEMENT. This report indicates that effective public participation is extremely important. The laws and regulations requiring public participation create a minimal standard for engaging communities, but our analysis indicates that additional avenues of public involvement are essential. Early and frequent public participation is essential for forging effective remedies. Accordingly, it would be useful to explore whether, and how, a model can be developed that could harmonize early and meaningful public involvement in cleanup decisionmaking. The laws and regulations regarding the public role in site cleanup vary substantially; what additional steps should be taken to encourage more meaningful public engagement?

INSTITUTIONAL CONTROLS. ICs are being used more and more to manage risks that will remain at sites. As it becomes apparent that technology, and/or the lack of full funding are barriers to complete cleanups, ICs have emerged as methods to reduce exposure to contaminants that could harm human health. To date, evaluations of ICs have not demonstrated that ICs are effective; at best their effectiveness could be considered unproved. It is important to continue to evaluate IC effectiveness in detail, especially as our societal reliance on them increases. Can institutional controls be developed that will be effective in protecting public health at sites contaminated with radionuclides, chemicals, or both? Given the fact that institutional controls are relatively new and that more and more sites are likely to select future use scenarios that require some sort of restricted access, this area of inquiry is critical.

RISK AND DOSE. Chemical risk management generally relies upon selecting a risk range and determining how site contamination can be reduced so that human health risks fall within or below that range. Also, chemical risk management uses a radionuclide by radionuclide approach, and then cumulates the risk. In contrast, traditional radiation risk management cumulates dose, which is the multiplied by a generic risk coefficient. Sites that fall under CERCLA utilize the chemical risk management approach. Traditional radiation risk managers are most comfortable establishing a dose that is public health protective and managing the site based on the selected dose. Conversion factors exist that can translate radiation dose to risk, and vice versa. It would be useful to explore in more detail whether these approaches have methodological differences that separate them. Can an agreed-upon risk range, or dose, be established that would allow for a harmonized way to control radiation risks? We suspect that the debates between risks and dose are of those of "jargons" and philosophy.

5.3.2 *Longer-Term Questions and Challenges*

GROUNDWATER PROTECTION. The treatment of groundwater can be a contentious issue. At CERCLA sites, MCLs are used as ARARs for groundwater. Radiation risk managers do not agree with EPA's decision to treat groundwater separately from other pathways for risks. An additional concern of radiation risk managers is that while EPA's MCLs for radionuclides are reasonably consistent with MCLs for chemicals on a risk scale, doses used as ARARs in other media are not. For example, unlike MCLs the 4 pCi/L radon criteria for indoor air is based largely on technological feasibility of remediation.

How should both on-site and off-site groundwater resources be treated? Should uses today (*e.g.*, current use of an aquifer as a source of drinking water) be dispositive of how the resource is characterized in the future? Should risks associated with groundwater contamination be singled out for remediation, or treated in a cumulative fashion with risks from other media?

ALARA AND CERCLA. Are the nine criteria used by Superfund risk managers to make decisions about cleanup similar or equivalent to ALARA? The case studies demonstrate that both decisionmaking pathways lead to pragmatic remedies that protect public health and the environment. How specifically do they differ and can they be harmonized? Are the differences between them procedural or substantive? Our case studies indicate that CERCLA may provide opportunities for public involvement that are not traditionally part of ALARA. It would be useful to see whether these two approaches are functionally equivalent.

5.4 Limitations of This Study

This study evaluated cleanup decisionmaking — risk management — at six sites containing different types of hazardous substances, including chemical and radiological contamination. It focused on the processes and methods used to reach conclusions about how to determine, and remediate, the risks associated with this contamination. Our site selection was not random, and relied on the criteria set out earlier in this study. Our study design called for an in-depth analysis of six sites, rather than a survey of a larger number. While this provides a detailed analysis of the selected sites, it may limit the generalizability of our results. In addition, we were unable to analyze fully the effectiveness of the selected institutional controls because most had not yet been implemented. Furthermore, because the methodologies of determining risk were different for each site, we could not carry out a site-by-site comparison to evaluate which site ranked as the highest (or lowest) risk site.

5.5 Public Health Goals for the Management of Chemical and Radiation Risks

This examination of case studies illustrates the wide variety of site evaluation and management approaches. Despite these differences in approach, the protection of public health is the fundamental goal of cleanup activities at all of these sites. While regulatory mandates, historical assessment methodologies and site management practices can diverge, a core set of public health objectives have emerged from the case studies. The following list of these core public health objectives provides a common ground for chemical and radiation risk management.

SURVEILLANCE:

- Identification of on-site hazards, exposure pathways and worker risks;
- Evaluation of actual and potential off-site migration;
- On-going monitoring of worker and community exposures;
- Tracking of key health indicators to identify any adverse effects on workers or the community; and
- Response plan to address changes in site status and prevent adverse public health consequences.

PARTNERSHIPS IN HARMONIZATION:

- Coordination of all federal, state, and local agencies involved in the assessment and management of risks;
- Establishment of clear lines of authority and responsibility at each site, and communication of roles to all stakeholders; and
- Active and meaningful community involvement in identifying public health concerns and selection of risk management options.

SITE MANAGEMENT AND REMEDIATION:

- Selection of site remedies that address key pathways and consider future risks;
- Preservation of site integrity through operation and maintenance and appropriate ICs; and
- Periodic evaluation of remediation strategies to assure effective public health protection and identify emerging technologies for improving site management.

The lessons learned from these case studies are clear. The core public health objectives apply to both chemical and radiation hazards. This common ground can provide a foundation for moving forward in the harmonization of risk management, and ultimately to a more cohesive approach to decisionmaking and protection of public health.

APPENDICES

APPENDIX 1

LIST OF ACRONYMS

AEA	Atomic Energy Act
AEC	Atomic Energy Commission
ALARA	As Low As Reasonably Achievable
ALJ	Administrative Law Judge
ARAR	Applicable or Relevant and Appropriate Requirement
BEIR	Biological Effects of Ionizing Radiation
CAB	Citizens Advisory Board
CAC	Community Advisory Committee
CAMU	Corrective Management Unit
CCMF	Concerned Citizens of Maxey Flats
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CMS	Corrective Measures Study
CN	Cherokee Nation
COC	Constituent of Concern
CRP	Community Relations Plan
CT	Concentration-Toxicity
CWM	Chemical Waste Management
D&D	Decommissioning & Decontamination
DCE	Dichloroethylene
DCGL	Derived Concentration Guideline Levels
DEQ	Department of Environmental Quality
DOD	Department of Defense
DOE	Department of Energy
DP	Decommissioning Plan
DUF_4	Depleted uranium tetraflouride
DUF_6	Depleted uranium hexaflouride
EIS	Environmental Impact Statement
ELI	Environmental Law Institute
EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
FACA	The Federal Advisory Committee Act
FCAB	Fernald Citizen''s Advisory Board
FEMP	Fernald Environmental Management Project
FQPA	Food Quality Protection Act
FRESH	Fernald Residents for Environmental Safety and Health
FS	Feasibility Study
FUSRAP	Formerly Utilized Sites Remedial Action Program
GW	Groundwater
HCB	Hexachlorobenzene
HHE	Health Hazard Evaluation
HI	Hazard Index
HQ	Hazard Quotient
HRS	Hazard Ranking System

IC	Institutional Controls
ICB	Institutional Control Boundary
ICM	Interim Corrective Measure
ICRP	International Committee on Radiological Protection
IS	Impact Sum
ISCORS	Interagency Steering Committee on Radiation Standards
K-65	Residues resulting form the processing of ore containing 35-60% U_3O_8
KAR	Kentucky Administrative Regulations
K_{OW}	Octanol/water partition coefficient
LLRW	Low-Level Radioactive Waste
LOOW	Lake Ontario Ordnance Works
MCL	Maximum Contaminant Level
MED	Manhattan Engineer District
MFCC	Maxey Flats Concerned Citizens
MFDS	Maxey Flats Disposal Site
MFRPA	Maxey Flats Radiation Protection Association
MIBK	Methyl isobutyl ketone
mrem	Millirem - unit of measurement for the effect of radiation on the human body
NACE	Native Americans for a Clean Environment
NCRP	National Council on Radiation Protection and Measurements
NECO	Nuclear Engineering Company
NEPA	National Environmental Policy Act
NESHAP	National Emission Standard for Hazardous Air Pollutants
NFSS	Niagara Falls Storage Site
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
NRC	National Research Council
NRMNC	Nuclear Risk Management for Native Communities
NYCRR	New York Codes, Rules and Regulations
NYS DEC	New York State Department of Environmental Conservation
NYSPDES	New York State Pollutant Discharge Elimination System
O&M	Operation and Maintenance
OEPA	Ohio Environmental Protection Agency
OSDF	On-site disposal facility
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
pCi	Pico curies
PEIC	Public Environmental Information Center
POP	Proof of Principle
PRP	Potentially Responsible Party
Pu	Plutonium
RAGs	Risk Assessment Guidelines for Superfund
RCRA	Resource Conservation and Recovery Act
RD/RA	Remedial Design/Remedial Action
RESRAD	Residual Radioactive Materials Guideline Implementation
RfD	Reference Dose

RFI	RCRA Facility Investigation
RI	Remedial Investigation
RI/FS	Remedial Investigation and Feasibility Study
RME	Reasonably Maximum Exposure
ROD	Record of Decision
ROLE	Residents Organized for Lewiston-Porter's Environment
SAB-RAC	Science Advisory Board - Radiation Advisory Committee
SDWA	Safe Drinking Water Act
SFC	Sequoyah Fuels Corporation
SSAB	Site Specific Advisory Board
SW	Surface water
SWMU	Solid Waste Management Unit
TAG	Technical Assistance Grants
TCA	Trichloroethane
TEDE	Total Effective Dose Equivalent
TSD	Treatment, Storage and Disposal
TVOC	Total Volatile Organic Compounds
TWCA	Teledyne Wah Chang Albany
UMTRCA	Uranium Mill Tailings Radiation Control Act
USACE	United States Army Corps of Engineers
VOC	Volatile Organic Compound
WCS	Waste Containment Structure
WLM	Working Level Months

APPENDIX 2

LIST OF INDIVIDUALS INTERVIEWED

Interviewee	Organization	Site
Mike Abeer	EPA Region VI	SFC
Kevin Anderson	OR Dept of Health	TWCA
John Applegate	U Indiana Law School/ FCAB	FEMP
Michelle Barzak	Army Corps of Engineers	NFSS
Lisa Crawford	FRESH/ FCAB	FEMP
JoKay Dowell	ERTH	SFC
Cindy Gibson	US EPA RIV	MFDS
Pat Gwin	Cherokee Nation	SFC
Laura Hafer	OH EPA	FEMP
Tim Handy	Clark University/ NRNMC	SFC
Tim Henderson	ROLE	CWM/NFSS
Ed Henshaw	Resident, Gore, OK	SFC
Arlene Kreusch	Army Corps of Engineers	NFSS
Jim McElfish	ELI	NFSS
Graham Mitchell	OH EPA	FEMP
Kathryn Nickel	DOE	FEMP
Dave Pedersen	CDC/NIOSH	FEMP
Michelle Pirzadoh	US EPA Region X	TWCA
Nancy Powell	MFCC	MFDS
Kevin Rochlin	US EPA Region X	TWCA
Doug Sarno	Phoenix Enivronmental/ FCAB	FEMP
Jim Shepard	NRC	SFC
Blair Spitzberg	NRC Region IV	SFC
Gary Stegner	DOE	FEMP
Jim Strickland	NYS DEC	CWM
John Volpe	KY Health and Human Resources Cabinet	MFDS
Sue Walpoole	DOE	FEMP
Bill Wertz	NYS DEC	CWM
Becky Zayatz	CWM	CWM

APPENDIX 3

SUMMARY OF FEDERAL AND STATE PUBLIC INVOLVEMENT REQUIREMENTS

Federal laws

CERCLA-- Several sites were remediated under CERCLA: Fernald (under the federal facilities provisions), Maxey Flats, and Teledyne Wah Chang. In carrying out its responsibilities under CERCLA, "EPA is committed to promoting participation in the decision-making process by whose lives are affected by Superfund sites located in their neighborhoods."[1] Under CERCLA's statutes and implementing regulations there are numerous provisions for public comment. In addition to the legally mandated provisions, EPA provides guidance for optional public involvement activities in its Risk Assessment Guidance for Superfund. Notice and comment activities are the backbone of EPA's public involvement requirements, but provisions for optional technical assistance to community groups are part of EPA's implementing regulations. CERCLA Section 117 encourages community involvement in the Superfund process by providing the public with the opportunity to comment on the remedies selected to clean up facilities and by requiring consideration of public comments in the remedy selection process. Before the lead agency can adopt a plan for remedial action, it must publish a notice and brief analysis of the proposed plan and make the plan available to the public. In addition, the agency must provide reasonable opportunity for a public meeting at, or near, the facility regarding the proposed plan and proposed findings on cleanup standards.[2] Notice of the final remedial action plan must be made available to the public, including a response to significant comments and an explanation of significant changes to the proposed plan.[3]

EPA's regulatory requirements under CERCLA are set out in detail in the National Contingency Plan.[4] Removal actions require less public involvement than remedial actions because they are generally short-term responses to an immediate threat to public health, and do not often result in a permanent solution. Both removal and remedial actions require the lead agency to establish administrative records and make the records available to the public. Longer removal actions and remedial actions also require the lead agency to establish an information repository near the site. The lead agency must provide an opportunity for public comment during both actions, and for longer removal actions and remedial actions must develop a CRP. Remedial actions also require the lead agency to inform the public of EPA's Technical Assistance Grants (TAGs) and to prepare a fact sheet about the remedy selected.

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[1] U.S. EPA. *Risk Assessment Guidance for Superfund. Volume I. Human Health Evaluation Manual (Part A).* EPA PB99-963303.

[2] 42 U.S.C.§9617.

[3] 42 U.S.C.§9617(b) and (c).

[4] 40 C.F.R. §300.415(n) and §300.430(c) (1998).

In addition to the statutory and regulatory requirements, EPA has recently issued as part of its Risk Assessment Guidance for Superfund a guidance document on community involvement in Superfund risk assessments.[5] The guidance recommends initiating public involvement during the earliest phases of risk assessments conducted at Superfund sites. EPA recommends obtaining public input during all phases of the risk assessment process to ensure that concerns are addressed and that public knowledge about the site is included. The guidance identifies key questions to ask at all phases of the risk assessment and provides suggestions for involvement techniques.

RCRA -- Although CWM is the only RCRA licensed facility in this study, portions of the remedial actions at Sequoyah are governed by RCRA as well. Public participation requirements for EPA and authorized states for the issuance of permits for hazardous waste treatment, storage, and disposal facilities are set forth in RCRA §7004[6]. The statute requires that "public participation in the development, revision, implementation, and enforcement of any regulation, guideline, information or program under [RCRA] be provided for, encouraged, and assisted by the Administrator and the States."[7] Similarly to CERCLA, public involvement is governed by notice and comment activities, although RCRA does not contain provisions for technical assistance as CERCLA does. Prior to the issuance of a permit for a facility, the Administrator must publicize the intention to issue a permit. If the Agency receives written notice within 45 days of opposition to the permit and a request for hearing, the Administrator must hold an informal public hearing and provide for written and oral comments. The Administrator may also decide to hold a hearing without such a request. Notice of the hearing's date, time, and subject matter must be given through major local newspapers, local radio stations, and provided to appropriate local government and state agencies.[8]

EPA's regulations implementing this law require public involvement during permit issuance, permit modification, and corrective action. These requirements include activities to be conducted by the permittee and the permitting agency. The permittee may be required to publicize and hold a public meeting prior to submitting the permit application, under the 1995 expanded public participation requirements. The permitting agency must notify the public when it receives a permit application, initiate a 45-day public comment period, hold a public hearing if requested, and notify the public of the agency's decision and provide responses to comments received. Many of the modifications at CWM, including the addition of a new landfill or the corrective action measures, are consider significant (Class 2 and 3) permit modifications. For such modifications, the permittee must notify the public of the request for modification, which initiates a 60 day public comment period. A public meeting must be held in the vicinity of the facility, and responses to comment provided.[9]

Public involvement in the corrective action process is governed by the procedures outlined for permit modifications. The implementation of a corrective action program is considered a class 3 modification. However, for corrective actions initiated under RCRA §3008 orders, there are no public

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[5] U.S. EPA. *Risk Assessment Guidance for Superfund. Volume I. Human Health Evaluation Manual (Part A).* EPA PB99-963303.

[6] 42 U.S.C. §6974.

[7] 42 U.S.C. §6974(b)(1) (1999).

[8] 42 U.S.C. §6974 (1999).

[9] *See* 40 CFR 124.8-10, 31-33; and 40 CFR 270.42 (1999).

involvement requirements. EPA encourages permitting agencies to provide public involvement opportunities as possible under the constraints of enforcement actions.[10]

National Environmental Policy Act -- The National Environmental Policy Act (NEPA) requires that agencies develop an environmental impact statement (EIS) for all "major federal actions significantly affecting the quality of the human environment."[11] Among the requirements for the development of the environmental impact statement are public disclosure and public involvement requirements. In general, agencies preparing environmental impact statements are required to "make diligent efforts to involve the public in preparing and implementing their NEPA procedures."[12] Certain NEPA processes explicitly require public involvement. For instance, public participation is required in the scoping process. The scoping process determines which issues the EIS will address, and is intended to be "an early and open process."[13] The lead agency drafting an EIS shall invite the participation of "Federal, State, and local agencies, and any affected Indian tribe, the proponent of the action, and other interested persons (including those who might not be in accord with the action on environmental grounds) . . ."[14] in the scoping process to determine the significant issues that must be addressed in the EIS. Public comment provisions are also included in NEPA's implementing regulations. After preparing the draft EIS and before preparing a final EIS, the lead agency must invite comments from, among others, state and local environmental agencies, Indian tribes, and the public.[15] The agency preparing the EIS must respond to comments both individually and collectively. The agency may respond to comments by modifying alternatives, developing alternatives not previously considered, improving or modifying its analysis, making factual corrections, or explaining why the comments do not warrant further response. All substantive comments must be attached to the final EIS.[16]

More generally, agencies must provide information about proposed project to the public in several ways, including public notice of hearings, meetings, and the availability of environmental documents. Public notice for actions of local concern should be provided through general circulation newspapers, other local media sources, potentially interested community organizations, and direct mailing, among other sources.[17] The agency must hold or sponsor public hearings or meetings if there is substantial controversy over the project or substantial interest in holding the meeting, if a hearing is requested by another agency with jurisdiction over the action, or if a hearing or meeting is required by another applicable statute. If a draft EIS is to be considered at a public hearing, the agency must make the document available to the public 15 days before the hearing.[18] Agencies must also solicit information from the public, make available the EIS, supporting documents, and comments received, and explain to interested parties how they can obtain this information.[19]

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[10] U.S. EPA. RCRA Public Participation Manual, 1996 Edition.
[11] 42 U.S.C. §4332(2)(C) (1999).
[12] 40 CFR 1506.6(a) (1999).
[13] 40 CFR 1501.7 (1999).
[14] 40 CFR 1501.7(a)(1) (1999).
[15] 40 CFR 1503.1(a)(2) and (4) (1999).
[16] 40 CFR 1503.4 (1999).
[17] 40 CFR 1506.6(b) (1999).
[18] 40 CFR 1506.6(c) (1999).
[19] 40 CFR 1506(d), (e), and (f) (1999).

Standards for Protection Against Radiation: Criteria for license termination under restricted release conditions -- In 1997, NRC adopted a new license termination rule that requires licensees to seek public advice when a licensed site is to be released under restricted use provisions.[20] The Sequoyah Fuels Facility may be released under such conditions when decommissioning is complete. Under this law, the licensee is required to seek public advice on four issues related to the use of institutional controls. The licensee must seek public comment on whether the proposed institutional controls will 1) provide reasonable assurance that the total effective dose equivalent from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 25 mrem per year; 2) be enforceable; 3) not impose undue burdens on the local community or other affected parties and 4) be supported by sufficient financial assurance to enable a third party, including a governmental custodian of a site, to assume and carry out responsibilities for any necessary control and maintenance of the site[21]

The licensee is required by these regulations to seek public input from a "broad cross section of community interests." The licensee must provide an opportunity for a discussion on the issues and a publicly available summary of the results of the discussions. The summary must include a description of individual viewpoints and document the extent of agreement or disagreement of participants on the issues discussed.[22]

NRC has additional public involvement requirements when terminating a license under restricted release conditions. Upon receipt of a decommissioning plan the Commission must publish a notice in the Federal Register and in a forum that is readily accessible to the community near the site, and solicit comments from the affected parties. NRC must also solicit comments from state and local governments or Indian nations in the vicinity of the site.[23]

NRC issued DG 4006 in 1998 to provide guidelines for licensees on the license termination process.[24] The document includes a section entitled "Seeking Public Advice on Institutional Controls," that provides NRC's recommendations to licensees on obtaining public comment on the four required issues. The guidance includes suggestions for identifying affected parties and methods for seeking advice. NRC recommends the use of a site specific advisory board (SSAB) for obtaining public comment and provides suggestions for convening an SSAB. Alternatively, NRC states that other methods of seeking advice may be used if an SSAB is not an appropriate mechanism in a community. If the licensee does not convene an SSAB, NRC guidance recommends holding at least three public meetings for discussion of the issues. It is recommended that the licensee provide information to affected parties that describes the decommissioning process and about the request for license termination under restricted release conditions. The licensee should provide information to affected parties at least 30 days prior to the meeting.

DOE Policy 1210.1-- DOE Policy 1210.1 sets out the Department's policy on public involvement in its program operations, planning activities, and decision-making in all DOE activities, including

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[20] 10 CFR 20.1403 (1999).

[21] 10 CFR 20.1403(d)(1) (1999).

[22] 10 CFR 20.1403(d)(2) (1999).

[23] 10 CFR 20.1405 (1999).

[24] U.S. NRC. Demonstrating Compliance with the Radiological Criteria for License Termination. DG 4006. August 1998. Note: Draft Regulatory Guides are issued for public comment in the early stages of the development of a regulatory position. They have not received complete staff review and do not present an official NRC staff position.

remediation of sites such as Fernald. DOE states that it "recognizes the many benefits to be derived from public participation, for both stakeholders and DOE. Public participation provides a means for the Department to gather the most diverse collection of opinions, perspectives, and values from the broadest spectrum of the public, enabling the Department to better, more informed decisions."[25] The policy requires that each site develop and implement a site-specific public participation program that promotes openness and two-way communication. DOE's goals are to 1) actively seek and consider public input; 2) inform and empower the public to participate in the decision-making process; and 3) consistently incorporate public participation in Department operations at headquarters and in the field. The policy calls for DOE to implement mechanisms for open, ongoing, two-way communication through use of informal conversation, scheduled meetings and workshops, legally required hearings, and federal-state-local-tribal agreements.[26]

Field managers are accountable for assuring that public participation activities meet the Department's goals and the stakeholder's needs.[27] The Department's guidance on implementing the public involvement policy specifically requires managers to identify and plan for an appropriate level of public participation activities in their programs, ensure that program staff practice and understand public participation values, and provide the necessary resources to conduct a program of public involvement, including staff training. The guidance also requires that Department officials provide honest and accurate information in their public statements, and consistently listen and respond to suggestions made by the public. Management is responsible for ensuring that Department personnel, federal, state, and local officials, tribes, and other stakeholders are integrated into program development, planning and decision-making processes. Stakeholders and field managers will determine the pre-decisional access points for public involvement.[28]

Federal Advisory Committee Act-- The Federal Advisory Committee Act (FACA) governs the creation and activities of certain groups established or utilized Ain the interest of obtaining advice or recommendations for the President or one or more agencies or officers of the Federal Government . . . ."[29] The Fernald Citizen's Advisory Board was convened under FACA as one of the groups in DOE Environmental Management Site Specific Advisory Board. Committees established under FACA must adhere to a number of specific statutory requirements, namely that the committee: establishes a written charter explaining the mission of the committee; gives timely notice of meetings in the Federal Register; has fair and balanced membership; opens committee meetings to the public (where possible); has the sponsoring agency prepare minutes of the meetings; provides public access to the information used or produced by the committee; grants the federal government the authority to convene and adjourn meetings; and terminates within two years unless the charter is renewed.[30]

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[25] U.S. DOE Policy 1210.1, July 29, 1994.

[26] *Ibid.*

[27] *Ibid.*

[28] O'Leary, Hazel. Memorandum for All DOE Employees. Guidance on Implementation of the Department's Public Participation Policy. July 29, 1994.

[29] 5 U.S.C. app. 2 §3(2).

[30] 5 U.S.C.A. app. 2 §§5, 9, 10, 11, and 14. (1999).

State laws

State laws regulate many of the remedial activities at the sites and serve as ARARs for remedial activities. Many of the state laws that require public involvement are similar to federal statutes such as RCRA or NEPA. However, New York State Environmental Conservation Law contains provisions for public involvement for host communities of hazardous waste facilities beyond the requirements set forth in the federal RCRA. Under these provisions, a county within which a hazardous waste treatment, storage, and disposal facility will be located, must form an advisory committee "for the purpose of entering into a dialogue with the applicant to develop mutually acceptable solutions to problems which may be created by the siting of the facility in the community."[31] The committee must have between 9 and 15 members who are appointed by the county and the affected town or city.[32] During the expansion of the CWM landfill the county developed a community advisory committee (CAC. It is discussed in detail in the section on stakeholders and stakeholder groups.

In addition to county development of an advisory committee, under the Uniform Procedure regulations of N.Y.S. Environmental Conservation Law, all applications for permits for "major projects" (not only projects involving hazardous waste) must undertake public notice and comment activities similar to those required under federal RCRA.[33] However, NYS law provides for several phases of public hearings that differ from provisions in federal RCRA. If the public demonstrates significant interest in the permit application, the Department of Environmental Conservation must convene a legislative hearing. An administrative law judge (ALJ) presides over the legislative hearing and receives unsworn statements relating to the permit applications.[34] If unresolved concerns exist following the legislative hearing, including public concerns as well concerns of the applicant and regulators, the ALJ will convene an issues conference where concerned parties will attempt to resolve issues without resorting to sworn testimony.[35] If concerns remain unresolved at the termination of the issues conference, the ALJ may convene an adjudicatory hearing if the concerns in question are substantive or significant. Substantive issues are those that cast doubt on the applicant's ability to meet statutory and regulatory requirements; significant issues are those that have the potential to result in denial of the permit or significant modifications to the permit.[36] In order for parties other than the applicant and the state to participate in an adjudicatory hearing, the party must petition for full party status by identifying their interest in the proceeding and grounds for opposition or support. Parties can present evidence at the hearing, cross-examine witnesses, and appeal adverse rulings by the ALJ.[37]

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[31] N.Y.S. ECL §27-1113(1).

[32] N.Y.S. ECL §27-1113(2).

[33] N.Y.S. ECL §621.1 and 40 CFR 124.8-10, 31-33; and 40 CFR 270.42 (1999).

[34] N.Y.S. ECL §§621.7(c)(1) and 624.4(a).

[35] N.Y.S. ECL §624.4(b).

[36] N.Y.S. ECL §624.4(c).

[37] N.Y.S. ECL §624.5.

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