Managing Public Concerns about Risk in the Context of Historical Health Impacts – 14614

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ABSTRACT

During the Cold War, operations related to nuclear weapons production were conducted in secret with limited independent oversight and no public scrutiny. Much of the operations took place before the passage of environmental regulations for waste management and environmental protection. While efforts were made to contain wastes generated to some degree, these efforts were frequently inadequate, and significant environmental contamination resulted across the nuclear weapons complex. Although actions were taken to address some of these environmental issues (e.g. the Uranium Mill Tailings Radiation Control Act was passed in 1978), only in the late 1980s and early 1990s was the scope of the problem understood and considerable efforts begun to address the environmental consequences of five decades of nuclear weapons production.

In order to continue to protect human health and the environment from residual contamination, closed sites where remediation has been completed are transferred to the U.S. Department of Energy's (US DOE) Office of Legacy Management (LM), created in 2003 to provide long-term surveillance and monitoring for the sites. Given the long time frames over which many of these sites must be maintained, it is inevitable that potential problems, or risks, will arise. Based on an evaluation of sites already in the LM program, US DOE has categorized these potential risks as falling into one of four categories: human health and environmental risks; regulatory risks; stakeholder risks; and institutional control risks. The keys to minimizing and addressing these potential risks are management of LM sites and open communication between LM and those affected by or with an oversight role, including regulators, community members, and other stakeholders.

INTRODUCTION

The mission of the US DOE Office of Legacy Management (LM) is to fulfill post-closure responsibilities and ensure the future protection of human health and the environment. LM has control and custody of legacy land, structures, and facilities and is responsible for maintaining them at levels consistent with departmental long-term plans. LM's primary goal is to protect human health and the environment at all of its sites. This involves understanding where risks may occur and also where stakeholders may perceive risk in the context of historical health impacts associated with US DOE or predecessor agency activities.

Historical Risk Management Practices

The earliest efforts to develop nuclear weapons technology were carried out under US ACE Manhattan Engineer District (MED) in the early 1940s. With the enactment of the Atomic Energy Act (AEA) of 1946, nuclear weapons development and production became the responsibility of the newly-created Atomic Energy Commission (AEC), predecessor agency to US DOE. AEC developed and managed a network of research, manufacturing, and testing sites, with the goal of stockpiling an arsenal of nuclear weapons [1]. The expansion of the nuclear weapons complex during the late 1940s and early 1950s occurred before the passage of environmental legislation for the protection of human health and the environment. The weapons development effort was so massive that large numbers of private and public entities were involved in different parts of the production process. Records from that time are often incomplete or missing.

Despite the lack of environmental regulations, AEC did follow certain protocols for management of radioactive wastes at its facilities. This often involved burying radioactive materials that exceeded certain guidelines in shallow trenches or landfills; other materials were temporarily contained while awaiting permanent disposal decisions. Containment of these materials was often inadequate, and releases resulted in considerable environmental contamination. Guidelines were also in place for decontamination and decommissioning of radioactively-contaminated facilities (e.g., burial of reactor debris), but AEC was self-regulated with little or no outside oversight. Activities at the sites were conducted largely in secrecy, out of concerns for national security.

The passage of the National Environmental Protection Act (NEPA) and the subsequent creation of the U.S. Environmental Protection Agency (US EPA) in 1970 signaled the start of significant environmental regulation in the United States. In 1975, to address concerns with conflicting roles as both regulator and promoter of nuclear technology, the AEC was split into two organizations—one with regulatory authority over the other. The U.S. Nuclear Regulatory Commission (US NRC) was created to provide formal oversight of nuclear-related activities, primarily through its licensing and inspection processes. US DOE was established two years later. In this same time frame, two early programs were created to address human health and environmental concerns at specific types of sites that were involved in nuclear weapons production—Formerly Utilized Sites Remedial Action Program (FUSRAP) and the Uranium Mill Tailings Radiation Control Act (UMTRCA).

FUSRAP was created in 1974 to address contamination at sites formerly used for MED and early AEC operations that were not addressed by other programs. Cleanup of eligible FUSRAP sites was the responsibility of AEC and its successor agencies, including US DOE, until 1997. These agencies were self-regulated and established cleanup criteria and remediation processes for FUSRAP that reflected internationally-accepted standards for radiological protection. More than 600 properties were evaluated for inclusion in FUSRAP; of these, 46 were designated for inclusion in FUSRAP at that time. The present total of sites in the program is 54.

Congress passed UMTRCA in 1978 to address hazards that resulted from processing of uranium ores. The act addressed the cleanup of abandoned mill facilities (Title I) and sites that were operating under a current NRC license (Title II). US DOE was responsible for cleanup of the Title I facilities and was designated as the long-term steward for both Title I and Title II disposal sites. UMTRCA is carried out under NRC authority.

Growing concerns about safety and environmental problems contributed to closure of various parts of the weapons-producing complex in the 1980s. While initially intended to be temporary, most of these shutdowns became permanent when the Soviet Union dissolved in 1991. It was during this time that significant efforts were initiated to understand the nature and extent of environmental contamination at the US nuclear weapons complex. This change in mission required a dramatic shift in the way US DOE conducted business.

US DOE was gradually required to acknowledge that cleanup of the nuclear weapons complex was subject to regulation by such outside entities as EPA and the individual states, as well as to more scrutiny from the general public [2]. The AEC had historically avoided public notification of releases from the weapons plants and their possible health effects. This practice created substantial public distrust of the AEC's successor, US DOE, its methods, motivation, and mission. This distrust has been very difficult to address and to overcome. However, significant progress towards openness was made beginning in the 1990's when DOE began to provide the public with information on past practices, including intentional environmental releases of radiation. In August 1990, US Secretary of Energy James D. Watkins announced that during the 1940s and 1950s thousands of children had received significant radiation doses as a result of operations at the Hanford, Washington plant. President Clinton appointed the Advisory Committee on Human Radiation Experiments in 1994 to investigate and report on human radiation experiments and cases where the government had intentionally released radiation into the environment for research purposes. These admissions contrasted with previous US DOE assurances that no releases posing a threat to human health had ever occurred, and increased public skepticism about the accuracy of US DOE claims regarding health risks from contamination throughout the weapons complex [2]. This skepticism lingers today.

In 1989, the Department systematically began to inventory and address complex-wide environmental management issues. Many sites that had been decommissioned were reexamined in light of current regulatory requirements. Sites that required further remediation were addressed through formal federal or state cleanup programs (e.g., CERCLA, RCRA, or state-specific regulations). The US DOE Office of Environmental Management was responsible for conducting environmental remediation activities; at sites without a continuing mission, the goal was to close the sites and ready them for long-term surveillance and maintenance. LM, established in 2003, manages US DOE's post-closure responsibilities and ensures the continued protection of human health and the environment.

Sites Currently In the LM Program

The LM site inventory reflects the diverse nature of activities that took place in support of nuclear weapons development. Besides FUSRAP and UMTRCA sites, LM sites include large manufacturing sites (e.g., the Rocky Flats, Colorado Site), sites where underground nuclear tests were conducted (e.g., the Shoal, Nevada Site), and sites where reactor debris is buried or entombed (e.g., the Piqua, Ohio Decommissioned Reactor Site). LM currently manages 90 sites that were contaminated from Cold War activities. Table I provides characteristics and common elements of the LM sites associated with different cleanup programs.

TABLE I. DOE Legacy Management Program Descriptions.

Program Sites	**Fundamental Characteristics/Common Elements**
UMTRCA Title I Disposal Sites	These sites include a disposal cell cover and engineered disposal cells (most uranium tailings piles were relocated from the processing site area to geologically stable, isolated locations). All are US DOE-owned, except sites located on tribal land (e.g. Navajo Nation). The primary institutional control (IC) for these sites is US DOE ownership. Sites require annual inspections by law. Contaminants of concern (COCs) are generally limited to radiological and trace metal constituents such as uranium, molybdenum, and selenium. US NRC and State oversight and involvement.
UMTRCA Title I Processing Sites	Included here as a separate category for sites where uranium tailings were relocated for disposal (although under the UMTRCA Title I program). US DOE does not own these sites, so ICs play a much greater role in protection of human health and the environment. The groundwater plumes often extend for some distance beyond the boundaries of the former processing sites. US NRC and State regulatory involvement. Groundwater at the sites has a prolonged time frame (up to100 years) to come into regulatory compliance using passive remediation (natural flushing). Processing sites are not licensed by US NRC; however, US NRC does have regulatory authority over site-related contaminated groundwater.
UMTRCA Title II Disposal Sites	Former independent licensees remediated these sites—tailings ponds and impoundments are mostly capped in place. Like the Title I sites, these US NRC-licensed sites require annual inspections by law. Most sites had alternate concentration limits applied to groundwater following corrective action that failed to meet maximum concentration limits or background concentrations. Often a significant plume of groundwater contamination remains; disposal cell and most (if not all) land located over the groundwater plume transferred to US DOE ownership. US NRC must approve US DOE Long-Term Surveillance Plans with long-term care requirements.
CERCLA/RCRA Sites	Sites often consist of a large number of individual and physically separate units with different post-closure care requirements. Often, the suite of COCs monitored is broader and more complex than that of UMTRCA sites. Five-year reviews are required. US EPA and State involvement.
FUSRAP	Relatively small sites where soils and buildings are remediated for radiological constituents; groundwater contamination is not an issue at this time, although limited monitoring will be conducted at some. Supplemental limits may have been applied in lieu of generic standards at some sites. US DOE (or predecessor agencies) was self-regulated for

Program Sites	Fundamental Characteristics/Common Elements
	these cleanups; cleanups may be decades old, and documentation may be limited. Many of these sites are in populated areas and receive high visibility. For these sites, especially if residual contamination remains, the need to monitor land use may be greater than for other sites.
Nevada Offsites Program	These are sites where underground nuclear tests and experiments were performed outside of National Nuclear Security Site (formerly called the Nevada Test Site).
D&D Sites/Other	At the time of transfer, the main regulatory driver for these sites was US DOE Order 5400.1, *General Environmental Protection Program*, first issued in 1988. Sites include decommissioned reactors, decontaminated buildings, and landfills.

These sites pose a diverse set of risk-related issues and stakeholder concerns. Following is a discussion of the types of risks associated with these sites, as well as a presentation of four case studies to illustrate how US DOE addresses site-specific issues.

Types of Potential Future Risks

LM manages US DOE's post-closure responsibilities and ensures the continued protection of human health and the environment. At most LM sites, some residual hazards remained at the time cleanup was completed because of resources and technical impracticality. However, US DOE still has an obligation to protect human health and the environment after cleanup is completed. LM fulfills US DOE's post-closure obligation by providing long-term management of post-cleanup sites that do not have continuing missions.

Based on experience to date with the LM program, three main risk categories were identified: (1) human health and environmental risk; (2) regulatory risk; and (3) stakeholder risk. Most technical activities conducted in support of the LM program relate to concerns in one of these categories. An additional category, referred to as "institutional controls risks," is related to overall protectiveness at a site but was evaluated separately to differentiate risk due to issues with administrative controls from those due to issues with physical or engineered controls. Each of these risk categories is discussed below.

Human Health/Environmental Risks

These risks represent those identified through a typical risk assessment process (i.e., "real risks" such as those characterized by the Hazard Ranking System scoring process). This covers the likelihood that releases will occur (or are possibly occurring in the case of environmental receptors) due to the physical instability of a site, and that human receptors, ecological receptors, or both will be exposed to site-related contamination. These risks are those that are generally addressed before a site is transferred to the LM program.

Stakeholder Risk

Stakeholder risk means the likelihood that the status of a given site can be affected or questioned in some way based on input from stakeholders (individuals or organizations). This scrutiny could lead to a need for conducting additional studies or characterization at a site in order to respond to stakeholder concerns. In some cases, these concerns could result in reevaluating an already implemented remedy or selecting a different remedy.

The assessment of stakeholder risk is based on past history of stakeholder involvement at specific LM sites or types of LM sites. Some sites have active stakeholder groups that regularly participate in public meetings or other site-related events. Sites not owned by US DOE often receive more intense scrutiny than US DOE-owned facilities (e.g., sites on the Navajo Nation); those in populated regions may also receive more attention. In some cases, past history of a particular geographic area may increase stakeholder awareness of US DOE activities because of historical activities and risks (e.g., properties located near the former Love Canal or those on Native American lands).

Regulatory Risk

Regulatory risk reflects the likelihood that a site may not attain compliance goals (as in the case of sites where groundwater cleanup is ongoing) or that compliance may not be maintained into the future (if the remedy is no longer operating properly). While it is assumed that all sites in LM are controlled and managed to be protective, this does not mean that cleanups have been fully completed or releases completely stopped.

At a number of LM sites, multiple or overlapping regulatory authorities are involved that may have different end goals. Regulatory agencies could include state environmental agencies, tribal nations, US NRC, and US or Navajo Nation EPA.

Groundwater cleanup (passive and active) continues at a large number of LM sites, and final cleanup goals often have not been achieved. As noted in Table I, UMTRCA Title I sites are allowed an extended time frame for remediation, and many are not predicted to achieve compliance for several decades. On the other hand, at UMTRCA Title II sites, groundwater compliance was required before transfer to US DOE. Subsequent monitoring data collected for some of those sites have shown that the groundwater systems may not be stable, and the ability to maintain compliance levels into the future may be questionable.

Additionally, the LM sites include a large number of disposal cells that are designed to last for centuries; some seepage from the tailings within the cells is expected over these long periods. Most of these structures are still in the performance verification stage. Some questions remain regarding how adequate performance is demonstrated and when performance monitoring can be terminated. Uncertainties about remedy performance and future compliance all contribute to regulatory risk.

Institutional Controls Risks

LM manages a number of sites that contain materials or media (e.g., groundwater) with contamination that currently exceeds a regulatory standard. To maintain protectiveness at LM sites, it is critical that exposure to these contaminants be avoided. At many of these sites, engineered controls are in place to contain this contamination (e.g., at disposal cells). However, these controls can only remain effective for the long time frames required by also implementing institutional controls (ICs). In other cases, ICs provide the sole assurance that exposures will not occur (e.g., to prevent the use of contaminated groundwater in aquifers as a domestic water source). Therefore, while ICs are frequently used only as part of a “defense of depth” strategy for sites, in some cases, protection of public health depends more significantly on ICs being enforced and maintained.

It has been increasingly recognized that ICs are key components of many final remedial actions. A fairly recent study conducted by the Government Accountability Office (formerly called the General Accounting Office) (GAO) has found that while ICs were commonly *selected* as part of a CERCLA remedial action or RCRA corrective action, there were numerous instances in which subsequent implementation and verification controls were lacking [3]. The GAO recommended better means of tracking and enforcing these controls. This is being done in a number of states where the use of ICs has been formalized through regulation, and registries have been created and made available for public use.

IC risks reflect the potential that ICs could be violated in the future. This is dependent on both property ownership and land use in the site area. If US DOE or another government entity is the property owner, it is assumed the controls are more durable. If a property is located in a more populated area that is undergoing development, it is assumed that potential violation of ICs is more likely. Physical controls were assumed to be part of the physical site remedy (and considered for human health and environmental risks). In those cases where an IC has not been implemented, it is conservatively assumed that the activities leading to exposure which would be prevented by an operational IC do, in fact, occur.

Case Studies—Risk To Human Health and the Environment

1) The New Rifle site in Colorado is a former UMTRCA Title Me uranium processing site. Uranium mill tailings from the abandoned site were relocated for offsite disposal. However, based on past disposal practices at the Rifle site, a groundwater plume remained that extended downgradient of the former mill site in the site’s uppermost alluvial aquifer. The alluvial aquifer was used locally for drinking water, though ambient water quality in the area is poor. Domestic water wells were in use on properties downgradient of the processing site. Though they contained concentrations of uranium elevated above the drinking water standard, it was not clear if contamination was naturally occurring or site-related.

To address human health concerns about use of alluvial groundwater for drinking water, US DOE helped fund the construction of a new water supply system for the City of Rifle, which included extending the water line to downgradient populations. ICs were put in place that required property owners to either connect to the city water supply or to treat water from their private wells prior to use as drinking water. US DOE provided the initial funding for treatment units to affected private well users. Eventually all of these properties were annexed into the city limits and were required to tap into the city water supply. Currently, the only complete exposure pathway to site-related contamination is through contact with water in two gravel ponds located downgradient of the site. Concentrations of molybdenum in one of the ponds exceed state livestock standards. With the consent of the property owner, ICs have been established to prevent the use of the gravel ponds for livestock watering. Thus, by using a combination of approaches, human health and environmental risks have been managed. Regular monitoring is included in the groundwater compliance action plan for the site to ensure that conditions remain protective and that ICs continue to be effective.

2) Operable Unit (OU) III of the Monticello, Utah Disposal and Processing Sites is a CERCLA site located in southeast Utah. The site is a former uranium mill site where processing of uranium ores resulted in a contaminated alluvial groundwater system along Montezuma Creek. ICs were put in place to prevent use of contaminated groundwater as a source of drinking water. However, local residents were concerned that groundwater and associated surface water contamination could adversely affect crops, livestock, and wildlife in the area.

To address these concerns, US EPA, with the cooperation of US DOE, conducted several studies that involved sampling a variety of media. Analyses were done on samples of plants that rooted into contaminated groundwater, plants irrigated with contaminated groundwater, and on cattle and deer grazed and watershed in OU III. Contaminant levels from the most commonly consumed parts of the animals (i.e., edible soft tissues) were tested for concentrations of both metals and radionuclides; the results from the study showed that levels in deer and cattle tissue from the City of Monticello were similar to those in reference animals [4]. The results from the study suggest that no adverse health effects to cattle would result from the continual ingestion of alfalfa containing the concentrations of metals found in the soils. Additionally, modeling results using maximum grass and cattle concentrations and basic human health exposure assumptions indicate that it is unlikely that a typical person consuming meat from cattle grazing on these lands would be exposed to uranium levels exceeding established health guidelines [5]

A group of concerned citizens from the city of Monticello requested that the Environmental Epidemiology Program (EEP) within the Bureau of Epidemiology in the Utah Department of Health conduct a Public Health Assessment (PHA) to identify possible public health hazards posed by past exposure from the former vanadium and uranium mill and resulting mill tailings. EEP has a cooperative agreement with the Agency for Toxic Substance and Disease Registry (ATSDR) to conduct site-specific health assessments following ATSDR assessment protocols [6] A PHA was subsequently completed and issued for initial public comment release in January 2013 [7]. The PHA concluded that all significant pathways for contaminant exposure had been addressed by remediation activities, but recommended continued monitoring of the site. Because residual contamination remains at the site, regular five-year reviews are required by CERCLA. The most recent five-year review concluded that site conditions are protective and that the remedy is operating as anticipated [8]. A public meeting was held as part of the PHA process, and notifications were provided to the public as part of the CERCLA five-year review.

Case Study—Stakeholder Risk

The Niagara Falls Vicinity Properties, New York Site is a FUSRAP site located in the state of New York. The Niagara Falls site occupies approximately 607 hectares of the original 3,036-hectare Lake Ontario Ordnance Works (LOOW), a former trinitrotoluene manufacturing facility built during the 1940s. In 1944, the LOOW was reassigned to MED for use as a storage location for radioactive residues and other radioactive material that resulted from developing the atomic bomb. By 1948, 2,428 hectares of the site had been sold by the federal government, leaving the remaining 607 hectares in the control of the newly formed AEC, the agency that succeeded MED. AEC used the property for storage, disposal, and transshipment of radioactive materials. Subsequently, most of the remaining property was transferred to non-federal owners in discrete parcels, leaving the 77-hectare Niagara Falls site. These parcels were later addressed as the Niagara Falls site vicinity properties (VPs). As a result of review of the Niagara Falls site and surrounding areas conducted in the 1970s and 1980s, the Niagara Falls site proper and associated VPs were designated for remediation under FUSRAP.

US DOE completed remediation of 23 of the 26 designated VPs before 1997, when Congress transferred FUSRAP cleanup responsibilities to the US Army Corps of Engineers (US ACE). The US ACE Buffalo, New York District is responsible for remediating the remaining three VPs under FUSRAP.

In 2009, US ACE informed US DOE of an inquiry from a stakeholder about whether a feature of the remediated VPs, the Central Drainage Ditch, posed a risk to children playing in the area. Additional inquiries were received about the protectiveness of all the remediated VPs. US DOE met with stakeholders at a US ACE-sponsored public meeting and committed to evaluating the final radiological conditions of the remediated properties. This led to an ongoing interaction with stakeholders as US DOE addressed their concerns and made reports of radiological conditions at the completed Niagara Falls site VPs available to the public.

US DOE found that the assessment surveys were designed to identify gamma-emitting radionuclides that exceeded cleanup limits, and to allow delineation of uncontaminated areas. Excavation of radiological contamination was conducted using gamma surveys to ensure that contamination was removed. US DOE conducted independent verification of remediated areas. Surveys were designed with knowledge of historical activities and were capable of detecting radionuclides of concern. Gamma scan density was adequate to detect gamma anomalies that could exceed cleanup criteria. Soil samples adequately represented radiological conditions with a high degree of confidence. Radiological contamination was assessed and remediated areas met the conditions for unrestricted use and unlimited exposure. US DOE summarized all of this information into a vicinity property report [9]. The report was distributed to interested stakeholders and also made available on the LM website.

No comments from stakeholders challenged these conclusions, and the report provides a summary of remediation and protectiveness for use in the future. US DOE responses to stakeholder inquiries resulted in a common understanding of site conditions and site risk. US DOE expects additional interaction with stakeholders at the former LOOW as US ACE completes remediation of the active VPs and the Niagara Falls site proper. These relationships will hopefully build trust between US DOE and the stakeholders that US DOE will perform its duties in an open and transparent manner that includes stakeholders as stewards for remediated FUSRAP sites.

Case Study—Regulatory Risk

The El Verde, Puerto Rico Site is a former research facility where AEC-funded research was conducted. Between 1964 and 1976, AEC supported a terrestrial ecology research program with the University of Puerto Rico (UPR). In one of the studies conducted at the site in 1968, a tree was injected with 17 MBq (0.46 mCi) of Cs-137 [10]. When US DOE's research at the station was concluded in the early 1980s, US DOE completed decontamination and decommissioning of the research station according to requirements of US DOE orders. Decommissioning included removal and disposal of radioactively contaminated soils. However, because of difficulties with removal and transport, the radioactive tree remained in place. The facilities were then transferred to the US Department of Agriculture, Forest Service. The UPR continues to operate the research station under an NRC license. Radioactive materials at the site, including those injected into the tree, were included in the license inventory along with other radioactive materials located at the station. As a licensing requirement, access to the radioactive tree was to be controlled in order to limit public exposures to radioactivity. Fencing and signage were included as license conditions for access control. Because experiments with the tree were carried out under US DOE authority, US DOE had responsibility for LTS&M, which included inspections of the site every 3 years.

Studies of the tree and surrounding area conducted during the 1990s suggested that radioactivity associated with the tree did not pose a significant hazard [11]. Contamination was limited in extent and had decayed significantly since the initial injection of radioactivity. However, no attempt was made to change the US NRC license to reflect these conditions. In 2000, an US NRC inspection took place at the El Verde site. It was noted that the fence surrounding the tree had been damaged, rendering it accessible to the public. This violated a condition of the US NRC license and a notice of violation (NOV) was issued. In response, US DOE paid to have the fence repaired.

Subsequent to receiving the NOV, US DOE reevaluated the characterization data compiled for the site. Working with the licensee (UPR), US DOE developed a technical argument that the tree did not present a hazard and met the "hot spot" criterion for unrestricted use. Data from radiologic surveys and risk modeling were used to demonstrate that the tree and surrounding land met NRC's 10 CFR Part 20 unrestricted use criteria. A proposal was submitted to NRC to remove the tree from the source materials license. NRC analyzed the action through preparation of an environmental assessment, which underwent stakeholder review [12]. NRC approved the removal of the tree from the materials license along with the unnecessary regulatory burden of inspections and maintaining fencing and signage, thereby reducing LM's regulatory risk at the site.

Case Study—Institutional Control Risks

In order to evaluate its IC risks, LM inventoried ICs at a subset of sites in its program. These sites included all FUSRAP and UMTRCA sites as well as some from other programs. The objective of the inventory was to both identify gaps where ICs are needed but are not yet in place, and to identify weaknesses where ICs have the greatest likelihood of breaking down in the future.

LM has been successful in maintaining ICs that prevent exposure to contamination, including physical controls such as disposal cell covers and access controls. LM also manages a vast number of administrative controls, such as restrictive easements, environmental covenants, and deed notices.

To preserve knowledge of ICs at its sites, LM uses informational ICs and other mechanisms to ensure that current and future landowners are aware of ICs and observe the restrictions on the land or resource. These mechanisms maintain awareness and reassure the stakeholders that the sites are protective.

Some type of control was needed at all LM sites evaluated, except FUSRAP sites considered to be “records only.” The focus of LM’s evaluation of ICs has been primarily on sites that have legally enforceable ICs; these include environmental covenants, quitclaim deeds, zoning ordinances, restrictive easements, and tribal ordinances. These types of ICs have provisions for enforcement and are the most effective in preventing exposures to site-related contamination. LM also inventories physical controls such as monument and fences, and specifically the engineered controls such as cell covers, as part of its obligation to maintain federal assets. There has been less focus on informational controls that provide information about past activities and potential contamination as these controls, while helping to preserve knowledge, generally lack permanence and have no enforcement mechanism.

For both the sites in LM’s inventory and the sites in the process of transition to LM, there are processes to evaluate the sites for needed ICs to ensure protectiveness throughout LTS&M. The most significant issue is to ensure that the required restrictions are visible to the parties affected by them, are enforceable if an absolute restriction to a land use or resource is warranted, and will remain in effect until the control is no longer needed. LM recognized a significant gap in its inability to monitor all ICs for these three essential elements.

To address the risk of violations to ICs that are not effectively monitored and maintained, LM is developing a comprehensive ICs program which includes an ICs Guidance Document, an ICs Data Standard, and a tracking system to maintain information on all the ICs at LM sites. The data standard identifies all of the elements to determine what the restriction is, why it is needed, what it covers, how it will be monitored, and any actions that are taken as a result of it being in place (such as violations and requests for actions that have the potential to violate a control). LM’s tracking system will mandate each IC be monitored on an established frequency to ensure its efficacy. The tracking system will also mandate an entire site review for each site with ICs to ensure the assumptions made when the ICs were implemented are still valid, and to track appropriate updates needed to address changed site conditions.

CONCLUSIONS

US DOE and its predecessor agencies operated with autonomy during the era following World War II; production and stockpiling of nuclear weapons was the primary mission. These activities were conducted in secrecy and with limited oversight. With the end of the Cold War and the shift toward cleanup of the weapons complex, priorities changed from production to protection of human health and the environment. In addition, US DOE had to respond to greater scrutiny from regulators, the public, community members, and elected representatives. As sites are transferred to the LM program, risks to human health and the environment should largely be eliminated or controlled. However, due to inherent uncertainties of remedy performance and the long time frames involved (thousands of years in many cases), potential problems—and risks—may arise. Other than "traditional" risks to human health and the environment, LM has recognized that risks can also involve the lack or failure of ICs, an inability to comply with regulatory requirements, and concerns raised by stakeholders. The keys to minimizing and addressing these potential risks are diligent management of LM sites and open communication between LM, regulators, and other stakeholders.

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