LMS/S10859

Defense-Related Uranium Mines Cost and Feasibility Topic Report

Final

June 2014

U.S. DEPARTMENT OF ENERGY | Legacy Management

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Abbreviations

AEC	U.S. Atomic Energy Commission
AML	abandoned mine land
AMLIS	Abandoned Mined Land Inventory System
BLM	U.S. Bureau of Land Management
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	U.S. Department of Energy
EE/CA	engineering evaluation/cost analysis
EPA	U.S. Environmental Protection Agency
ft	feet
GAO	U.S. Government Accountability Office (formerly called General Accounting Office)
HDPE	high-density polyethylene
LM	Office of Legacy Management
LTM&M	Long-Term Monitoring and Maintenance
LTS&M	Long-Term Surveillance and Maintenance
mg/kg	milligrams per kilogram
mrem/yr	millirems per year
NEPA	National Environmental Policy Act
NPS	U.S. National Park Service
OSWER	Office of Solid Waste and Emergency Response
pCi/g	picocuries per gram
PRG	Preliminary Remediation Goal
Ra-226	radium-226
TMDL	total maximum daily load
ULP	Uranium Leasing Program
UMTRCA	Uranium Mill Tailings Radiation Control Act
USFS	U.S. Forest Service

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Executive Summary

The National Defense Authorization Act for Fiscal Year 2013, enacted January 2013, mandates that the U.S. Department of Energy (DOE) prepare a report on abandoned uranium mines. Specifically, Section 3151 of the legislation requests, in part, that "The Secretary of Energy, in consultation with the Secretary of the Interior and the Administrator of the Environmental Protection Agency, shall undertake a review of, and prepare a report on, abandoned uranium mines in the United States *that provided uranium ore for atomic energy defense activities of the United States*." The Act also requires consultation with other relevant federal agencies, affected states and tribes, and the interested public.

DOE defines an abandoned uranium mine (mine) as a named mine or complex developed to extract uranium ore for atomic energy defense-related activities of the United States from 1947 to 1970, as verified by purchase of ore by the U.S. Atomic Energy Commission (AEC) or other means. Since the primary basis of the DOE mine database is the AEC production records, a mine is generally associated with a patented or unpatented mining claim (established under the General Mining Law of 1872) or a lease of federal, state, tribal, or private lands. By this definition, these mines might not be abandoned (some have existing permits), and some mines have been reclaimed or remediated. Mines in any of these categories are included in the set of legacy mines that were considered for evaluation as part of the congressional request for this report. The entire set is labeled as mines, and additional information in the topic reports and final summary report identify the status of these mines.

A mine may be a single feature such as a surface or underground excavation, or it may include an area containing a complex of multiple, interrelated excavations. A mine may include associated mining-related features such as mine adits and portals, surface pits and trenches, highwalls, overburden or spoils piles, mine-waste rock dumps, structures, ventilation shafts, stockpile pads, mine-water retention basins or treatment ponds, close-spaced development drill holes, trash and debris piles, and onsite roads.

For this report, a mine does not include offsite impacts or features such as ore-buying stations, ore transfer stations, or ore used in structures, roads, and general fill. The U.S. Environmental Agency (EPA) noted that they found access roads made from waste materials and significant waste ore at several ore transfer stations on the Navajo Nation. EPA has conducted removal actions at two of these transfer stations. DOE, however, believes the congressional intent was to limit the scope for the Report to Congress to mine sites.

DOE is required to submit a Report to Congress no later than July 2014. That report will describe and analyze:

- The location of mines on federal, state, tribal, and private lands, and the status of efforts to remediate or reclaim these mines.
- The extent to which mines pose a significant radiation hazard or other public health and safety threat, and cause, or have caused, water or other environmental degradation.
- A priority ranking for the reclamation and remediation of abandoned uranium mines.
- The potential cost and feasibility of reclamation and remediation in accordance with federal law.

DOE is addressing these requirements in four topic reports. This topic report covers the fourth item, the potential cost and feasibility of reclamation and remediation of mines.

The general approach used to develop the range of costs for reclamation and remediation included collecting and reviewing historical data from other agencies. Six production-size categories were developed to classify mines within a reasonable size range (e.g., Small is 0 to 100 tons of ore produced, Very Large is over 500,000 tons produced). A cost for each production-size category was developed in lieu of cost for individual mines. Using data from DOE past reclamation projects, DOE developed and validated the average and range of features (e.g., portals, structures) for each production-size category by visiting 84 mines in six different states and measuring the production-size and number of attributes. The difference between "reclamation" and "remediation" was clarified, since they have different objectives and levels of cleanup. Reclamation focuses on mitigating the physical hazards and stabilizing the site, and remediation involves all of the reclamation scope plus remediating contaminated soils and groundwater to risk-based cleanup standards.

A bottom-up cost model was prepared to estimate the cost for performing reclamation and remediation for each production-size category. The cost model relies on making assumptions, such as length of mobilization, and using established labor rates, such as the U.S. Department of Labor's published wage rates (also known as Davis-Bacon wage rates),and equipment rates from a standardized database. The costs were compared to historical costs from other agencies to ensure that the estimates were reasonable. Historical cost data, when used, were escalated to current dollars using a published historical cost index. Because of the unknown features and variable nature of mines, the range of costs per production-size category is only a preliminary estimate and should not be used to estimate the cost for an individual mine.

Other agencies have published numerous reports that pertain to hard-rock mines on the public lands they manage. Most of the reports discuss the nature and hazards of abandoned mines and future costs to mitigate the hazards. The reports analyzed for this topic report were published primarily by the U.S. Government Accountability Office (GAO), EPA, U.S. Bureau of Land Management (BLM), DOE, and U.S. National Park Service (NPS). Except for the GAO reports, the other agencies' reports refer to all abandoned hard-rock mines, which include mines. Generally, BLM and NPS as land management agencies address the physical hazards as the highest priority. EPA, using Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, also known as Superfund) guidance, addresses the environmental and human health risks and remediates a property to some risk-based cleanup level or to a level based on applicable or relevant and appropriate requirements.

A summary of agencies' cost data shows that the average cost to mitigate a physical feature is \$18K, and costs ranged from \$2K to \$55K (all costs are escalated to 2014 dollars). Remediation costs are highly variable and can range from \$215K to \$205M per mine, depending on the number and type of features.

Results

Design assumptions were made to provide a range for each production-size category. Some of the primary factors that varied were mobilizing the subcontractor from different cities, the haul distances for importing topsoil and for the remediation scenario (estimated with the assumption that waste-rock pile material was moved offsite to an engineered disposal cell), the distance to move contaminated material offsite, and the type and complexity of the cover system for a repository. Costs for Very Large mines were not estimated, because they all have some past or current form of reclamation or remediation or have a reclamation bond in place. Although the mine may have a reclamation bond and technically is not abandoned, it is still counted in the DOE mine database, which is consistent with the broad definition of mine identified on the previous page for use in this report.

EPA believes that the high end of the remediation cost ranges may be underestimated. DOE agrees that the higher-range costs for remediation will be underestimated if there are challenging construction conditions, or if repositories cannot be located near groups of mines, or if the material must be transported to a commercial facility. In addition, an individual mine remediation may be significantly higher than the range, as the range depicts a reasonable average for two different scenarios, both of which involve trucking the material 10 miles.

Tons of Ore Produced	Mine Production-Size Category	Range of Reclamation Costs	Range of Remediation Costs
0–100	Small	\$11,000–\$51,000	\$13,000–\$55,000
100–1,000	Small/Medium	\$11,000–\$60,000	\$16,000–\$72,000
1,000–10,000	Medium	\$46,000–\$200,000	\$110,000–\$800,000
10,000–100,000	Medium/Large	\$270,000–\$680,000	\$2,600,000–\$6,600,000
100,000–500,000	Large	\$560,000–\$1,400,000	\$5,000,000–\$15,800,000
>500,000	Very Large	Not Estimated	Not Estimated

The costs for performing long-term monitoring and maintenance were also estimated. Assumptions included inspecting mines annually for 10 years and repositories for 30 years. A certain degree of maintenance was assumed, such as replacing topsoil due to erosion, revegetating areas where plants have not established, and replacing fencing and signs. If revegetation is part of site stabilization, it can be a challenge in some arid parts of the western United States.

Tons of Ore Produced	Annual Cost for a Mine	Annual Cost for a Repository
0–100	\$2,000	\$12,000
100–1,000	\$2,000	\$12,000
1,000–10,000	\$2,000	\$12,000
10,000–100,000	\$3,000	\$12,000
100,000–500,000	\$7,000	\$14,000
>500,000	Not Estimated	Not Estimated

Conclusions

The costs to reclaim or remediate vary significantly, and costs for individual mines cannot be estimated without site-specific data. Although several states, tribes, and BLM have developed guidelines, no national standards exist for either mine reclamation or mine remediation. Consequently, it is difficult to estimate the cost of either reclamation or remediation until a cleanup standard for each mine is established because the cleanup standard can have a significant impact on the project scope and ultimately the project cost.

1.0 Introduction

This topic report describes the development of the potential cost and feasibility for remediation and reclamation of abandoned uranium mines (mines) as they relate to defense-related (former U.S. Atomic Energy Commission [AEC]) activities. In January 2013, Congress passed HR 4310, in which Section 3151 requested in part that "The Secretary of Energy, in consultation with the Secretary of the Interior and the Administrator of the Environmental Protection Agency, shall undertake a review of, and prepare a report on, abandoned uranium mines in the United States that provided uranium ore for atomic energy defense activities of the United States." That report is provided separately, but this summary topic report is one of five topics that are identified in the congressional bill.

The following five topics are identified in HR 4310:

1. The locations of the mines on federal, state, tribal, and private land, accounting for existing inventories undertaken by federal agencies, states, and tribes, and additional information available to the Secretary of Energy.
2. The extent to which the mines (a) pose, or may pose, a significant radiation hazard or other significant threat to public health and safety; and (b) have caused, or may cause, significant water quality degradation or other environmental degradation.
3. A ranking of priority by category for the remediation and reclamation of the mines.
4. The potential cost and feasibility of remediating and reclaiming, in accordance with applicable federal law, each category of mines.
5. The status of any efforts to remediate and reclaim mines.

Topic 4 is addressed in this report. (Topics 1 and 5 are combined into a single report.)

The U.S. Department of Energy (DOE) defines an abandoned uranium mine as a named mine or complex developed to extract uranium ore for atomic energy defense-related activities of the United States from 1947 to 1970, as verified by purchase of ore by AEC or other means. Since the primary basis of the DOE mine database is the AEC production records, a mine is generally associated with a patented or unpatented mining claim (established under the 1872 Mining Law) or a lease of federal, state, tribal, or private lands. By this definition these mines might not be abandoned (some have existing permits), and some mines have been reclaimed or remediated. Mines in any of these categories are included in the set of legacy mines that were considered for evaluation as part of the congressional request for this report. The entire set is labeled as mines, and additional information in the topic reports and final summary report identify the status of these mines.

A mine may be a single feature such as a surface or underground excavation, or it may include an area containing a complex of multiple, interrelated excavations. A mine may include associated mining-related features such as mine adits and portals, surface pits and trenches, highwalls, overburden or spoils piles, mine-waste rock dumps, structures, ventilation shafts, ore stockpiles and stockpile pads, mine-water retention basins or treatment ponds, close-spaced development drill holes, trash and debris piles, and onsite roads.

For this report, a mine does not include offsite impacts or features such as ore-buying stations, ore transfer stations, or ore used in structures, roads, and general fill. The U.S. Environmental Agency (EPA) noted that they found access roads made from waste materials and significant waste ore at several ore transfer stations on the Navajo Nation. EPA has conducted removal actions at two of these transfer stations. DOE recognizes that offsite uses may result in an unacceptable risk to the public or environment, but DOE is adhering to the congressional direction of addressing only mines as defined above.

The general approach used to develop the range of costs for reclamation and remediation included collecting and reviewing historical data from other agencies. Six production-size categories were developed so that all mines could be classified within a reasonable size range (Small, Small/Medium, Medium, Medium/Large, Large, Very Large). Table 2 lists the tons of ore produced for each production-size category.

Figure 1 represents graphically the various production-size categories. For common reference, a typical construction dump truck that is sometimes observed travelling on the streets and highways has a hauling capacity of approximately 20 tons.

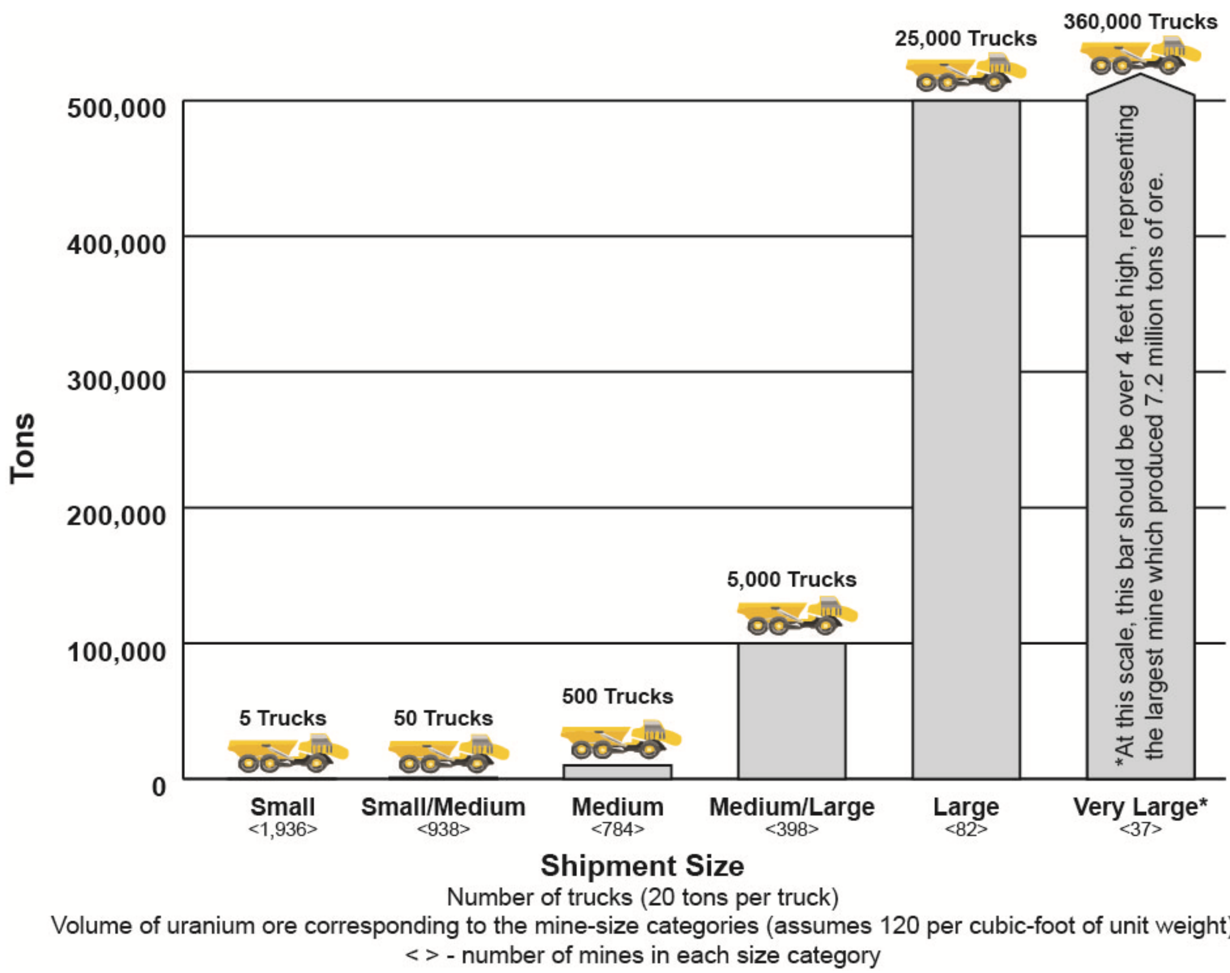

Figure 1. Graphic Illustration of Tons of Ore for Each Production-Size Category

A cost for each production-size category was developed in lieu of costs for individual mines. Using data from DOE past reclamation projects, DOE developed the average and range of numbers of features for each size category based on the historical sites that were evaluated. Mines contain numerous features that may include adits, shafts, highwalls, trenches, waste-rock piles, roads, impoundments, structures, and other items. Figure 2 depicts the typical physical features of a mine. The number of features was further validated by field visits to 84 mines in six states and measurements of the size and number of attributes. The difference between reclamation and remediation was clarified, since each term implies different objectives and levels of cleanup. Reclamation focuses on mitigating the physical hazards and stabilizing the site, while remediation involves all of the reclamation scope plus remediating contaminated soils and groundwater to a risk-based cleanup standard. The primary difference between the costs for reclamation and remediation is that remediation involves removal of the waste-rock pile and surrounding soils that exceed cleanup levels and placing the material in an offsite repository.

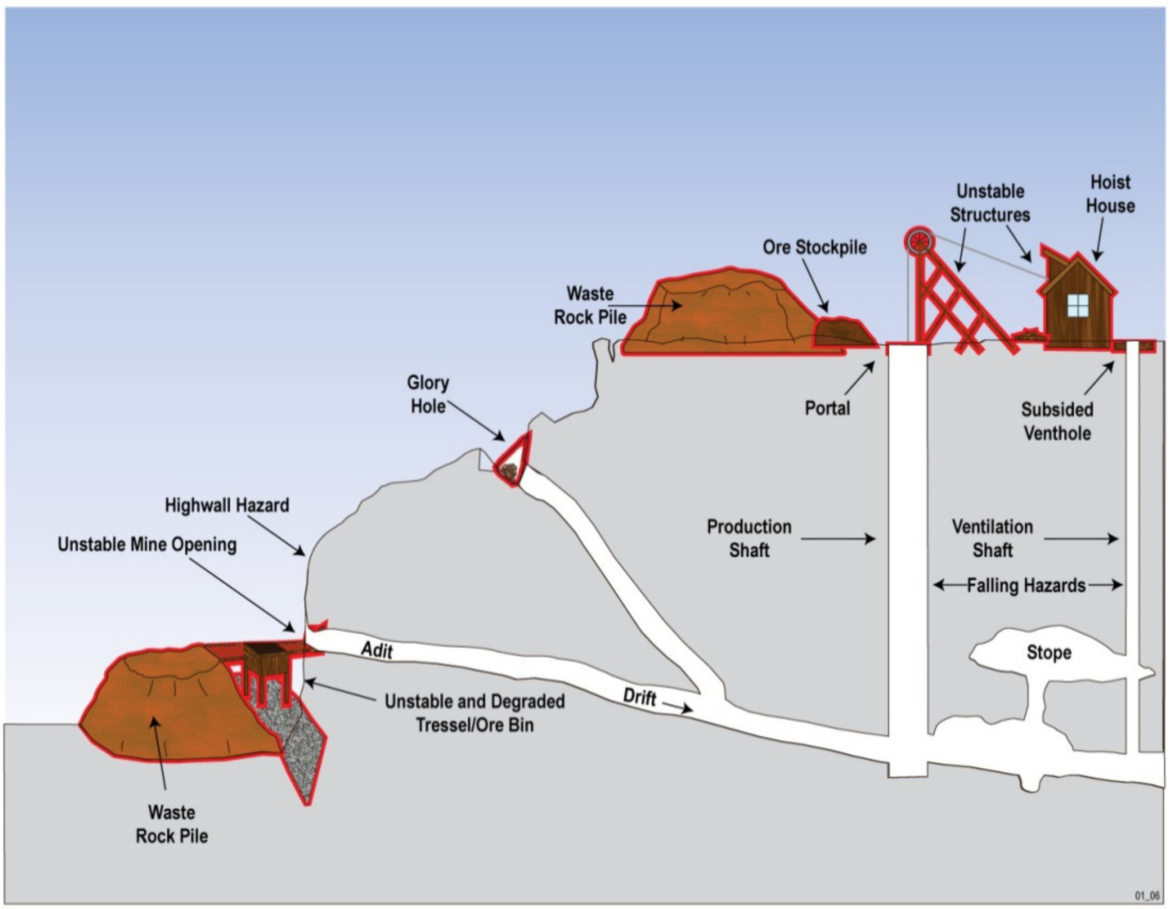

Figure 2. Common Features of Underground Abandoned Uranium Mines

DOE prepared a bottom-up cost model to estimate the cost of performing reclamation and remediation for each production-size category. The cost model relies on several assumptions such as length of mobilization, using established labor rates (e.g., the Department of Labor's published wage rates, also known as Davis-Bacon wage rates), and equipment rates from a standardized database such as RSMeans (Reed Construction Data 2013). The costs were compared to historical costs from other agencies to ensure that they were reasonable. Historical cost data, when used, were escalated to current dollars using the Historical Cost Indexes provided by RSMeans (Reed Construction Data 2013). Because of the unknown features and variable nature of mines, the range of costs per production-size category is only a rough approximation of the potential costs and should not be used to estimate the cost for an individual mine.

2.0 Mine History and Costs

A history of the AEC and mines is presented in Section 2.0 of the *Abandoned Uranium Mines Location and Status Report*, LMS/AUM/10693. That document includes key dates, facts, a summary of the AEC uranium program, and discussion of the history of agencies addressing mines.

Section 2.1 provides historical cost information, Section 2.2 presents data from individual site cleanups, Section 2.3 presents the range of markups used to develop cost estimates, and Section 2.4 presents the issue of using historical data. Figure 3 shows a map of the Uranium Mining Districts with the 4,225 mines identified in the United States.

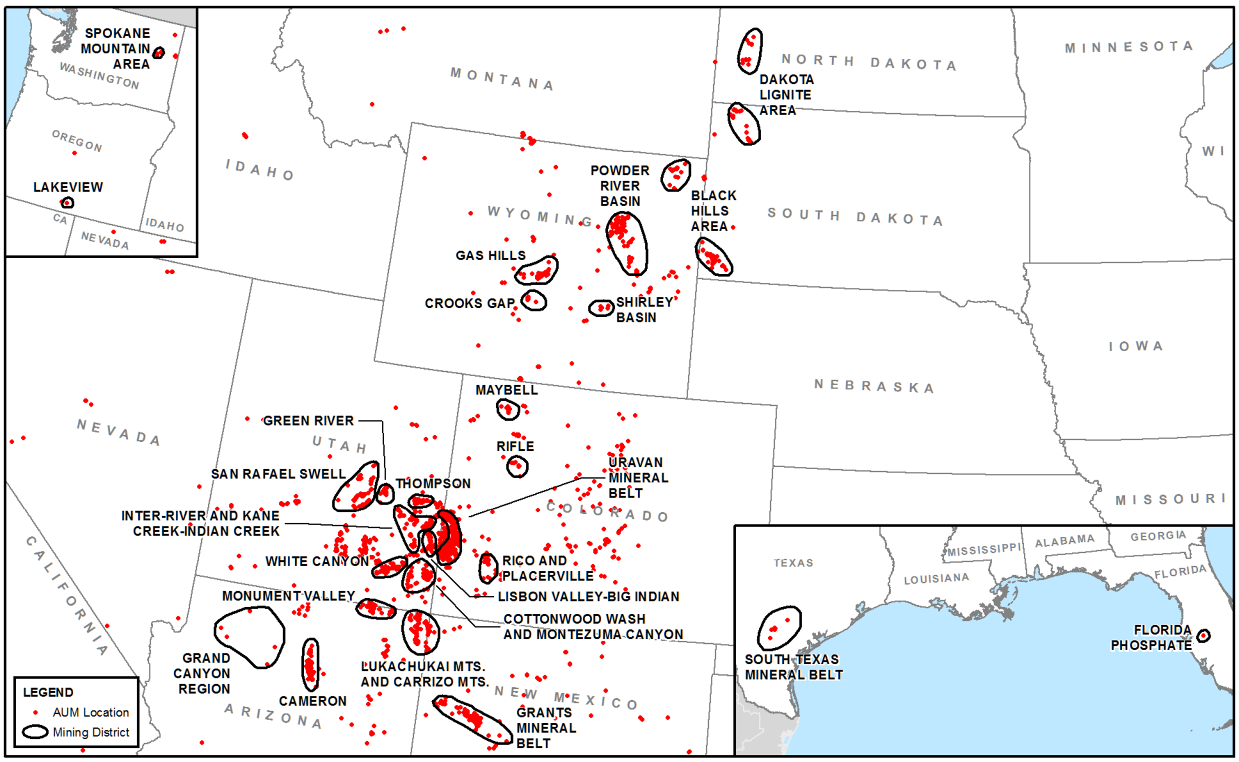

Figure 3. Uranium Mining Districts and Mines in the United States with AEC Mines Shown

2.1 Federal Agencies' Costs for Individual Sites and Features

Other agencies have published numerous reports that deal with hard-rock mines on the public lands the agencies manage. Most of the reports discuss the nature and hazards of abandoned mines and future costs to mitigate the hazards. The reports analyzed for this topic report were published primarily by the U.S. Government Accountability Office (GAO), EPA, U.S. Bureau of Land Management (BLM), DOE, and U.S. National Park Service (NPS). Except for the GAO reports, the other agencies' reports refer to all abandoned hard-rock mines, which include mines. Generally, BLM and NPS, as land management agencies, address the physical hazards as the highest priority. EPA, using Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, also known as Superfund) cleanup standards, addresses the environmental and human health risks. Sections 2.1.1 through 2.1.5 summarize each agency's relevant reports. All costs have been escalated to 2014 dollars unless noted.

2.1.1 GAO

GAO (2008) reported that four federal agencies (BLM, the U.S. Forest Service [USFS], EPA, and the Office of Surface Mining) have spent at least $2.6 billion (in 2008 constant dollars) between 1998 and 2007 to clean up abandoned hard-rock mines. EPA spent the most of the four agencies, about $2.2 billion, to fund the cleanup of abandoned mines, primarily through its Superfund program. GAO did not report information on individual mines or the average cleanup cost per mine. Because abandoned uranium mines are a subset of hard-rock mines, the costs for addressing many of the features should be similar to those of other hard-rock mines. However, abandoned uranium mine costs may be higher due to factors such as having to address health and safety protection costs for workers to handle radioactive wastes.

GAO (2012) listed examples of cleanup activities at mine sites. Total costs and a brief description of the work were provided for 18 mine sites. Cost information is summarized as follows:

- Closure of adits/portals: average cost of $2K, ranging from $1K to $4K.
- Physical hazards: cost estimate for each production-size category—average cost of $14K per site, ranging from $2K to $35K.
- Surface reclamation for small sites: average cost of $12K, ranging from $3K to $18K.
- Surface reclamation for medium sites: average cost of $73K, ranging from $33K to 103K.
- Remediation ranged from $215K for the Pryor Mountain mine, Montana, to $205M for the Midnite mine, Washington. (Two-thirds of the projects cited were estimates, because cleanup had not been started or completed yet.)

GAO reported that BLM and NPS have primarily focused on physical safety hazards to date. (This is supported by other publications.) One BLM official informed the GAO that future costs to address sites with physical safety hazards could be higher because BLM had generally addressed safety hazards that were the least costly due to limited funding available.

2.1.2 EPA

EPA's Technologically Enhanced Naturally Occurring Radioactive Material report (EPA 2006) discusses the reclamation and remediation of mines, in situ leach (also called in situ recovery) sites, and uranium mills but does not include information on individual mines. Table 4.4 in the EPA report presents the average cost of reclamation of 21 uranium mines and mills as $5.06 per ton of ore produced, with costs ranging from $0.40/ton to $55.99/ton of ore produced. The range shows the variability of costs based on size and complexity of the mine (and mill) site.

Other relevant information included:

- Navajo Nation abandoned mine land (AML) program had an average reclamation cost per mine of around $76,000.
- $479,000 to clean up 18 miles of road associated with the Midnite mine and Dawn Mill in Washington.
- Estimated $13M to remediate the Lucky Lass and White King uranium mines (located in the same watershed in Lake County, Oregon) under CERCLA (large open pits).
- Estimated $2.7M to remediate the Juniper mine in California.
- Discussion of stewardship and long-term monitoring with no cost information.
- Estimated $205M to remediate the Midnite mine in Washington, including long-term groundwater treatment.
- EPA reports that actual costs at the Northeast Church Rock and Quivira (New Mexico) mines' interim removal actions and the Cove project (Arizona) were $56/ton, $74/ton, and $146/ton, respectively. (Note: The Northeast Church Rock and Quivira mines are not defense-related mines because they began operating after 1970.)

Figure 4 through Figure 6 show the stages of reclamation of a small uranium mine with adits and waste-rock pile clearly visible before reclamation and blended into the surrounding area following reclamation.

Figure 4. Before Reclamation

Figure 5. During Reclamation

Figure 6. After Reclamation

2.1.3 BLM

BLM (2011) reports that the average cost over the period 2006 to 2010 to inventory abandoned hard-rock mine sites in 14 western states was $2.6K per site (averaged over 10,529 hard-rock mine sites) and $19.5K per site to remediate the physical safety hazards (averaged over 2,979 hard-rock mine sites). BLM's definition of remediation of physical safety hazards includes:

- Closing adits.
- Backfilling highwalls.
- Draining impoundments.
- Removing leftover equipment and debris.
- Revegetating to help offset erosion and improve land stability.

The variability from state to state was significant due to the number of mines involved, type and production size of mine, accessibility to the mine, and approach used by the different state offices. The cost per site to inventory varied from $450 to $454,000, while the average cost to remediate physical safety hazards ranged from $7,300 to $259,700. However, by removing Alaska and Wyoming, which had less than 20 sites each, the range is less variable; the average cost to inventory sites ranged from $450 to $17,200, and the average cost to remediate physical safety hazards ranged from $7,300 to $55,300.

BLM analyzed the state data and found that state offices with average inventory and cleanup costs per mine lower than the national average were due to the following reasons:

- Economies of scale by addressing multiple sites
- Larger corps of AML program employees, volunteers
- Partnerships with universities, nonprofits
- Initially addressing easily accessible sites

BLM cited the following reasons for the state offices with average inventory and cleanup costs per mine higher than the national average:

- Remote sites requiring higher costs for mobilization
- State- or region-specific design requirements
- Number of costly sites

BLM recognized that for future estimating, the average cost from each state office should be used for estimating that state's future needs.

BLM (2006) presents an overall strategic plan by state to address top priorities for abandoned hard-rock mines based on watershed and physical hazard. BLM uses a watershed approach because of the numerous mines concentrated in some areas and their impact on water quality (e.g., acid drainage, mercury). Costs vary depending on size and complexity of the watershed and sites. For example, Utah BLM reported that the average cost to inventory, conduct surveys, perform National Environmental Policy Act (NEPA) studies, and characterize a feature is $2.5K, while the average cost to close a feature is $1.5K. Thus, the cost of characterization and studies may in some cases exceed the cost of reclamation.

2.1.4 NPS

NPS (2013) estimated the costs to remediate the known features on NPS lands (all abandoned mine types) as $19K per feature (range of $15K to $34K) and assumed an average of three features per mine site. NPS definition of a feature is very comprehensive, covering all of the physical attributes typically found at an abandoned mine and includes adits, shafts, highwalls, trenches, waste-rock piles, roads, impoundments, structures, and numerous other items.

2.1.5 DOE

DOE's Uranium Leasing Program (ULP) reported the reclamation cost for 43 mines over the period of 1994 to 2003. A description of the ULP is provided in Appendix D. The average cost for reclamation was $83K per mine site (mineral lease); the average mine production was 26K tons of ore, resulting in an average reclamation cost of $3.19 per ton of ore produced.

2.1.6 States

Several states, including Colorado and Texas, supplied cost data (not escalated).

- From 1984 to 2011, the Colorado program safeguarded 550 uranium-related shafts and adits at an estimated cost of just under $2M for design and construction (approximately $3.6K per feature). Funding for this effort came from Surface Mining Control and Reclamation Act/Office of Surface Mining, BLM's AML program, and state mineral severance tax.
- Texas reported spending approximately $23M on reclamation of 18 open-pit mines. Open-pit mines tended to cost more than the average mine, as it took $1.9M to reclaim the Sickenius/Pawelek site in Texas (a Medium/Large mine).

  Texas also reported that costs of reclamation ranged from $1.50 to $2.00 per cubic yard for recent projects.

2.1.7 Summary of Data

The data from the agencies cover a wide range of scopes and a diverse group of features, ranging from a simple adit closure with no identified environmental or human health risks to a major mine and mill remediation with significant groundwater/surface water impacts. Generally, as shown in Table 1, mine features (waste-rock piles, adits, shafts, load-outs) can be reclaimed for $2K to $55K per feature, with an average cost of $18K.

*Table 1. Agency's Typical Costs for Mitigating Physical Hazards**

Agency	Average Cost per Feature ($K, rounded)	Range of Costs per Feature ($K, rounded)
GAO	14	2 to 35
BLM	20	7 to 55
NPS	19	15 to 34
Summary	**18**	**2 to 55**

*Costs are escalated; State of Colorado's data fall within the Summary Range of Costs per Feature.

Remediation costs are much more variable, and since only limited data were found, the costs are not summarized.

2.2 Data from Individual Site Cleanups

A review of documentation for more than 30 individual mine sites indicated that many sites had only characterization data, although 10 reports included cost data. Appendix A presents a summary of historical cost data found during preparation of this topic report. Most of the data is compiled from DOE's experience reclaiming ULP lease tracts.

2.3 Markups Used to Develop Cost Estimates

Cost estimates are typically prepared by estimating the direct cost to perform the construction work and multiplying the direct cost with other factors to develop the total cost. This method is acceptable for large programs; however, for individual mines, the costs and markups can vary greatly based on factors such as size, subcontracting method, and complexity. The length of time to clean up the mines has not been evaluated for this report. When a time frame is established, the appropriate discounting and amortization of costs can be added.

NPS (2013) includes a detailed approach for the cost elements and associated percentages for markups to be included in cost estimates. The direct cost elements are labor, equipment, materials, and travel for remote locations. The markups are listed as follows:

- Location adjustment: 0 to 20 (average of 10) percent depending on location
- General conditions (e.g., field offices, temporary utilities): 20 percent
- Overhead (e.g., office overhead, workers compensation insurance) and profit: 20 percent
- Contracting method adjustment: 15 percent
- Construction management: 8 percent
- Contingency (design and construction): 10 percent
- Site specific factors such as compliance (e.g., NEPA, special studies): 5 percent or more; historic preservation factors (e.g., working around historic structures): 5 percent, when applicable

In aggregate, these markups (excluding the site-specific factors) amount to a factor of 2.16 times the direct costs to estimate the total cost for a project.

DOE's ULP Programmatic Environmental Impact Statement (DOE 2013) used the following markups in estimating future reclamation costs:

- Architect/engineer (design): 25 percent
- Construction management: 10 percent
- Program management: 6 percent
- Bond: 1 percent
- Subcontractor's overhead and profit: 6 percent

In aggregate, the markups amount to a factor of 1.56 times the direct costs to estimate the total cost of a project.

EPA recently verbally reported that it uses a factor of 1.45 for similar projects to estimate total cost of a project. DOE's experience with the costs of managing large, complex environmental remediation projects falls within the cost range reported by other agencies. The Uranium Mill Tailings Radiation Control Act (UMTRCA) mill sites surface project, completed in 1998, involved surface remediation and relocation of large tailings piles, stringent design criteria developed by the U.S. Nuclear Regulatory Commission, numerous environmental regulations, and significant stakeholder involvement. The final published project costs show that total costs were based on a factor of 1.8 times the direct construction costs.

In summary, the total indirect factors range from 1.45 to 2.16 in the reports reviewed. Based on the average, which is similar to the UMTRCA multiplier, the cost estimates used 1.8 for a total indirect multiplier. The markups and cost per mine do not include one-time costs such as a Programmatic Environmental Impact Statement, which could cost several million dollars.

Because remediation often follows the CERCLA approach and requires more studies and planning, the multiplier was increased to 2.01 to reflect the more complicated design work and additional studies involved with CERCLA remediation.

2.4 Limitations and Value of Historical Data

The value of historical data is that it provides ranges to compare to the DOE cost estimates to ensure they are reasonable and consistent. Historical data have limitations that are important to consider as the values are used for comparison.

Mine land reclamation performed by other agencies historically has focused on closure and mitigation of physical hazards. Most of the historical data are difficult to use directly for estimating future cost because the data lack relevant information, such as:

- Detailed scope, so it is difficult to calculate unit rates. (It is often not clear if historical costs include engineering, NEPA, environmental clearances, construction management, or administrative costs.)
- Type of subcontracting used (e.g., government contractor, Basic Ordering Agreement, small business).
- Size of subcontract (cleanup of a large group of mine sites that would result in attaining economy of scale, or only a few mines).
- Indirect markups, such as overhead and fee.
- Whether older cleanups followed regulations that may have been less stringent (e.g., before storm water regulations were promulgated).
- Identification of factors, such as impact of cultural resources.

  The State of Wyoming believes the reported historical costs are low and do not include factors such as mobilization, design, and environmental clearance costs. In addition, the State noted that BLM often reports only their own costs and not those of other agencies that partner with them or that clean up other portions of a site.

3.0 Defining Mine Lands Reclamation, Remediation, and Relevant Cleanup Standards

3.1 Defining Reclamation, Remediation, and Other Scenarios

Information gathered from the various federal and state agencies indicates that the agencies use similar terminology for the work performed, but the definitions of those terms can vary. The terminology described below was developed for the four mine topic reports.

Reclamation

- Eliminate or mitigate physical hazards by closing portals, adits, and vent holes.
- Address bulk residual radiological materials (remnants of the ore-storage pad or low-grade ore stockpiles) by placing them below grade as part of the portal-closure or recontouring activities.
- Remove trash and debris.
- Recontour or grade waste-rock to a stable condition that minimizes the potential for future erosion and blends in with the original site topography, then cover the site with enough topsoil to enhance revegetation efforts.
- Historical and culturally significant structures/features may be left in place.
- May include knocking down steep highwalls and filling in large excavations, glory holes, and areas of subsidence.

Most state programs that use Surface Mining Control and Reclamation Act funding perform reclamation as described in this definition.

Remediation

- Includes all scope for reclamation stated above.
- Typically follows the CERCLA process and targets radiation risk to humans and the environment (e.g., uranium, radium, gamma), along with other risks.
- Site is typically remediated to a soil or gamma cleanup standard, and material is placed in an onsite or offsite repository.
- EPA designs a disposal cell to protect human health and the environment, including use of liners and reducing gamma exposure rates on the cover to near-background levels.
- Addresses ecological impacts and surface water and groundwater if impacted.
- Full CERCLA-remedial process requires 5-year reviews if the remediation has not achieved unrestricted release.
- Remediation may be required even if reclamation has been previously completed.

- NPS, Navajo Nation (through EPA Region 9), BLM, and USFS may take the lead and follow CERCLA.
- Some of the significant sites following CERCLA protocol include Midnite mine, Washington; Skyline, Arizona; and Jackpile, New Mexico (proposed for National Priorities List).

In-Process

- An agency is conducting ongoing activities that should lead to reclamation or remediation, such as negotiations with potentially responsible parties, a screening report, engineering evaluation/cost analysis (EE/CA), or a remedial investigation/feasibility study.

Partially Reclaimed

- Typically, some physical hazards have been addressed.
- The reclamation/remediation is phased, and not all phases are complete (e.g., Phase 1 complete).

Closed

- Portals, vents, adits, and other openings have been blocked or backfilled to prevent future entry by humans (some have bat gates, which do not fully close the opening but use bars to keep humans out and allow bats and small animals to enter).

Permitted

- Operator has a reclamation bond with a regulatory agency.
- Privately owned, and owner is responsible for reclamation/remediation. Although a claim may have been filed on BLM land, this does not mean the individual is responsible for a mine located within the claim.

Not Reclaimed

- No work has been performed to reclaim, remediate, or mitigate physical and environmental hazards.
- No information is available for these sites, and the status is typically unknown.

Closure is usually the fastest and least expensive action to take and usually results in mitigating serious physical hazards while possibly reducing the radon exposure, if the opening is totally blocked (versus a bat gate). Typically, closure only requires preparation of a generic design and specification to direct the work, and detailed designs are not prepared for each individual mine. The work is often completed in less than a day (backfill with onsite material) or several days for a bat gate. The design, permitting, construction management, and reporting costs are often minimal. Closures work very well to mitigate physical risk when there is no chemical or radiological risk, no impacts to surface water or groundwater, and the area of site disturbance is small. Closures result in some long-term monitoring and maintenance as a result of occurrence such as vandalism and collapse of soils.

Reclamation, like closure, addresses the physical hazards and includes the same work as a closure but with additional work for reclaiming the waste-rock pile and restoring the site. Reclamation does not address chemical or radiological hazards as a primary driver. Reclamation typically has additional design elements to better define the final contours and prevent future erosion, identify the types of grasses and forbs for revegetation, and identify the long-term monitoring and maintenance requirements. These extra elements increase the overall cost for design, construction management, reporting, and long-term monitoring and maintenance.

Remediation includes the identification and remediation of chemical or radiological hazards in addition to reclamation. These hazards could include radium, radon, uranium, thorium, and other heavy metals (e.g., arsenic). In the case of mines, the radiological components are almost exclusively the hazard, since the geology is usually not typical of the rock types that produce acid mine drainage or heavy metal contamination. In the few site-specific reports reviewed in which heavy metals were identified, they were considered part of the cleanup with the radioactive contamination and were not targeted separately. Sites undergoing remediation require detailed investigations, often with an EE/CA or remedial investigation/feasibility study. This includes a formal design process to determine whether the materials can remain onsite with an adequate cover or if an offsite repository is required. For this topic report, the offsite repository was assumed to be located on nearby government land. The project planning, design, permitting, construction management, and reporting are generally more expensive in proportion to the higher project cost. The project will also include the elements of reclamation but with a more robust long-term monitoring and maintenance regime.

Figure 7 and Figure 8 show a load-out and open pit, which are typically found at mine sites.

Figure 7. Load-Out Prior to Reclamation

Figure 8. Open Pit Prior to Reclamation

3.2 Cleanup Standards

There are no national standards for the cleanup of abandoned uranium mines; however, several states (Texas, Colorado, Wyoming), the Navajo Nation, and BLM have indicated they have developed guidelines reflecting current reclamation practices. Approaches used by the different federal agencies vary from generic qualitative guidelines that emphasize removal of physical hazards and surface stabilization to site-specific numerical goals established for each contaminant of concern.

Cleanup standards primarily affect the remediation scenario but can also affect reclamation, although reclamation's primary focus is on mitigating the physical hazards and stabilizing the waste-rock pile. Stabilizing the waste-rock pile typically includes excavating the materials with the highest radioactivity (ore), placing those materials on the waste-rock pile, and regrading and shaping the pile into flatter, more stable slopes. A cleanup standard will affect how much waste-rock and soil will be moved. Topsoil, when available, is spread on top of the waste-rock to promote vegetation growth while reducing gamma exposure and radon flux. The thickness of topsoil and dirt in the waste-rock pile cover affects how much the gamma and radon flux are mitigated. When cleanup standards dictate allowable gamma exposure, radon flux, or design life, the thickness of soil increases and a layer of rock on top of the surface is usually required to mitigate erosion.

CERCLA specifies that remediation goals be established to meet a 1×10^{-4} to 1×10^{-6} incremental lifetime cancer risk and non-cancer risk based on current or reasonably anticipated future land use. Since most public lands do not allow residential use, recreational scenarios (e.g., BLM allows 2 weeks for a camper to stay in one place) are sometimes used, which result in cleanup to less stringent standards (because exposure is assumed to be less frequent than in a residential-use scenario). Past CERCLA mine projects have used cleanup levels of 1.2 to 50 picocuries per gram (pCi/g) for radium-226, depending on the risk scenarios used. (EPA has determined that the more restrictive standard is applicable for cleanup of mines on the Navajo Nation for unrestricted release and the land use scenarios used there.) Radium-226 is commonly targeted because the soil concentration level can be detected by a field instrument (a scintillometer, which measures gamma exposure rates), which correlates to a soil concentration. Also since the radium-226 is commingled with other radioisotopes and heavy metals, it is assumed that if radium-226 is removed, other metals and radioactive contaminants, such as uranium, are also remediated.

Other generic approaches are more qualitative. DOE began reclamation of mines on its uranium lease tracts in the mid-1990s. Because no standards existed for these sites, DOE collaborated with BLM to develop reclamation guidelines (BLM 1995). Numerical goals were not established, but the standard practice was to bury higher-radioactivity material under low radioactivity or nonradioactive (natural background) material. Draft BLM guidance for reclamation of mines with radioactive contamination (BLM 2001) adopts a similar approach but uses the 5/15 numerical UMTRCA soil standard. (BLM indicates it uses the 5/15 numerical UMTRCA soil standard primarily for screening sites. BLM also uses Handbook H-1703-1which outlines a CERCLA risk-based approach which results in cost-effective response actions that are more applicable to recreational scenarios.) Colorado BLM has a goal to "minimize radioactivity emanating from the site." This is accomplished by selective burial of higher-radioactivity material covered with lower-radioactivity or nonradioactive (natural background) materials. Similarly, the Navajo AML program recognized three classes of materials. Their approach is to bury the most-radioactive materials (>25 pCi/g radium-226) with those of lesser radioactivity (>background but <25 pCi/g) and finish with a cover approaching natural background (around 2 pCi/g).

Appendix B is from the *Abandoned Uranium Mines Prioritization Report*, which summarizes cleanup standards relevant to CERCLA, the Surface Mining Control and Reclamation Act, BLM, DOE's ULP, state AML programs, and the Navajo Nation AML program. The relevant cleanup standards affect costs, scope, and risk reduction. The bottom-up cost estimates in this report were not based on specific cleanup standards; rather, they were based on assumptions of how much waste-rock and contaminated soils were typically remediated for each mine production-size category.

3.3 Repository Cover

A review of current regulations and regulatory documents identified no established design standards for mine repository covers. Because the uranium and other radioactive elements at mines will be present for thousands of years, EPA and U.S. Nuclear Regulatory Commission standards established under UMTRCA are the most applicable guidance.

Other covers designed for mine repositories (CERCLA projects) have the following characteristics, including total thickness:

- White King, Oregon: 9.5 feet (ft) total thickness—7.5 ft of clay, 2 ft of soil (erosion protection designed to 500-year, 24-hour storm event)
- San Mateo, New Mexico: 3 ft total thickness—geomembrane, 2 ft of soil, and 3 inches of rock
- Skyline, Arizona: 6 ft total thickness—1.5 ft bedding material, 60 mil (0.06 inch) high-density polyethylene (HDPE), 1.5 ft bedding material, 1 ft gravel biointrusion layer, 2 ft soil for vegetation cover

- King Edward, Utah: 3 ft of soil (considered equivalent to geosynthetic clay liner or HDPE)
- Juniper, Utah: 1.5 ft of soil (mitigate gamma)

A review of the 18 disposal cells designed by DOE under Title I of UMTRCA shows covers that range from 3 ft to 10 ft in thickness. The covers ranged in complexity from the simple cover used in Lakeview, Oregon, to the more complex, multicomponent cover used in the Durango, Colorado, cell. Because of the long design life (1,000 years, if possible, 200 years minimum), synthetic materials such as HDPE liners were discouraged, and use of natural materials, such as clay and hard, durable rock, were encouraged.

Based on the UMTRCA design standards, a modified evapotranspiration repository cover was chosen as the standard cover. The modified evapotranspiration cover provides better long-term protection against erosion, burrowing animals, and plants while minimizing infiltration.

The range of costs, however, was derived from the Lakeview (simple cover) and Durango (complex cover) UMTRCA Title I disposal cell designs. The Lakeview cover contains 18 inches of clay, 6 inches of a soil layer, and 12 inches of rock mixed with soil. Figure 9 depicts a cross section of the Durango cover.

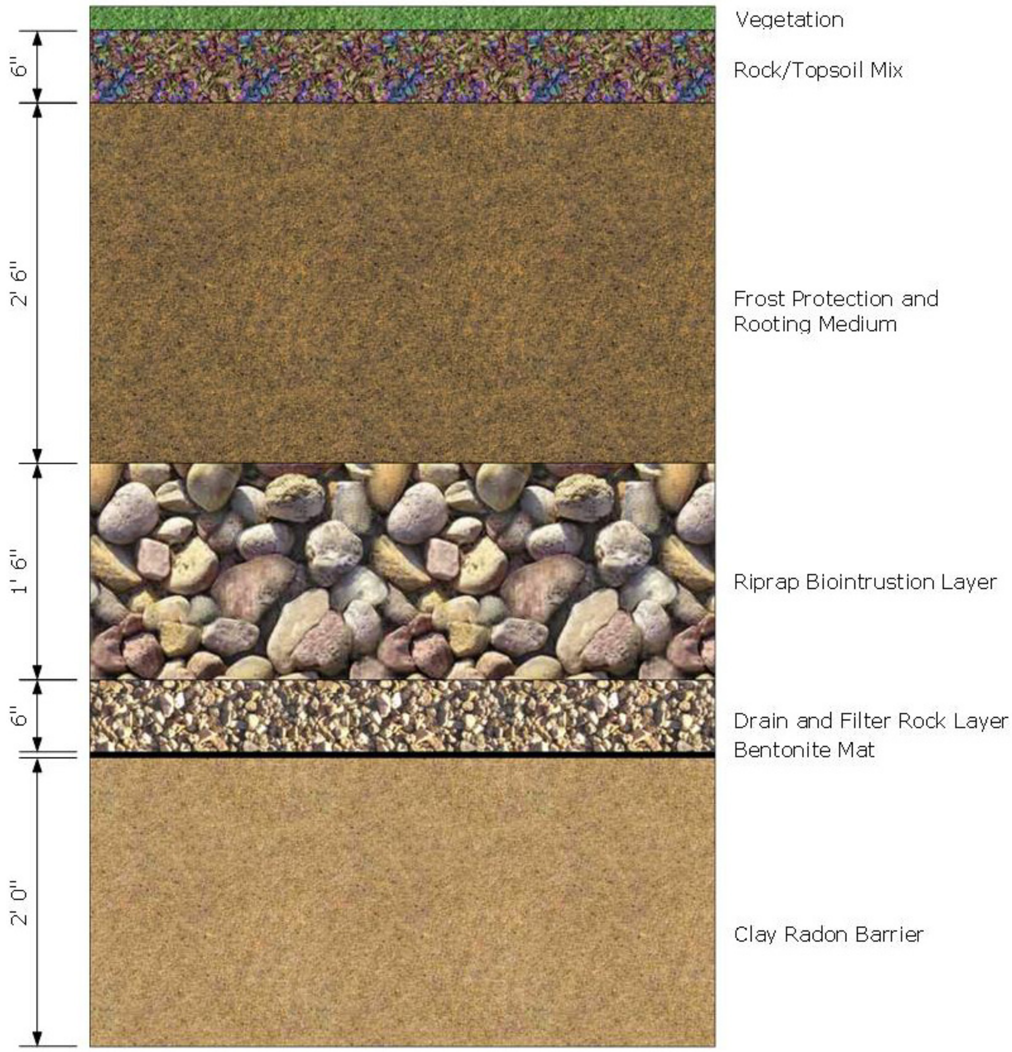

Figure 9. Cross Section Depiction of the Durango, Colorado, Disposal Cell Cover Design

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4.0 Development of Cost Scenarios

4.1 Production-Size Categories

The mines in the DOE mine database were placed into the following generic production-size categories shown in Table 2 to identify generic features and amount of data per size and to assist in costing.

Table 2. Production-Size Categories by Tons of Uranium Ore Produced

Production Size of Mine	Tons of Uranium Ore Produced
Small	0–100
Small/Medium	100–1,000
Medium	1,000–10,000
Medium/Large	10,000–100,000
Large	100,000–500,000
Very Large	>500,000

The number of mines found in each production-size category and other characteristics are identified in the *Abandoned Uranium Mines Location and Status Report*.

4.2 Unique Mine Scenarios

The following are unique circumstances that affect the costs of individual mine cleanups; however, they were not factored into the cost per generic production size.

4.2.1 Very Large Mines

There are 37 Very Large mines with production of uranium ore recorded greater than 500,000 tons. Appendix C shows a list of the mines. A review of these mines shows the following reclamation/remediation status:

- Partially reclaimed: 4
- Reclaimed: 27
- Remediated: 1
- In-process of being reclaimed or remediated: 2
- Permitted with reclamation bond: 3

Seven of the sites have federal involvement; DOE remediated one site, and EPA is involved in six sites using the CERCLA process. The Very Large mines are not abandoned, but they provided ore to the federal government for defense purposes, and consistent with the definition of mine in Section 1.0 on page 1, they are included in this report for reference and other discussions.

As a result of the Very Large mines having some form of reclamation or remediation or having a reclamation bond, the cost for reclamation and remediation will not be estimated. Because of the varying size of the Very Large mines (ore production ranging from 500,416 tons to 7,241,382 tons), it is difficult to estimate an average cost to remediate. The range of historical remediation costs for other Large and Very Large mines is $8M (San Mateo, New Mexico) to $205M (Midnite, Washington). Actual costs were found for only three remediation projects that have been completed.

4.2.2 Open-Pit or Surface Mines

The AEC information combined with state and other sources indicates that approximately 300 mines were identified as a surface mine or a combination of surface and underground mines. This represents approximately 7 percent of the total number of mines. Open-pit mines are unique in that they may have pit lakes and large highwalls left behind, as depicted in Figure 10 that can present dangerous physical hazards to the public and environment. Both features present additional cost to mitigate, and most reclamation programs have not addressed highwalls. The State of Wyoming has found that the best and most successful reclamation consists of backfilling flooded pits with clean fill to an elevation above the predicted water table. Flooded pits over time have generally tended to become more acidic and require some action.

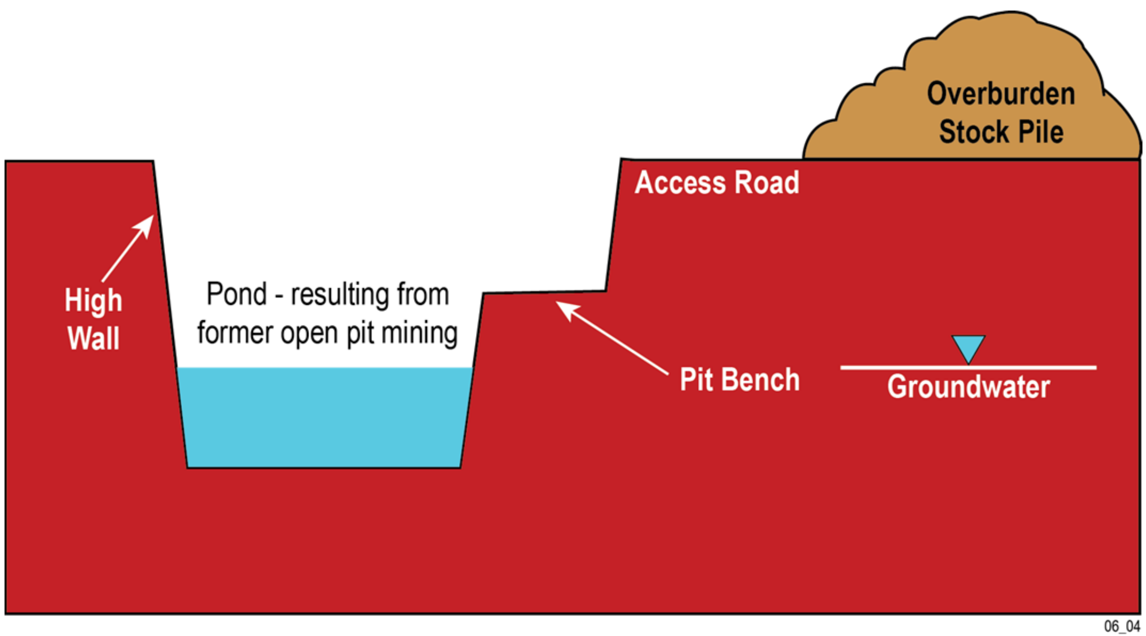

Figure 10. Open Pit Typical Physical Features

Since the number of open-pit and surface mines is a small percentage of the total mines, and the costs vary greatly depending on site-specific conditions, they were not factored into the generic cost per production size. Water treatment was required at two sites, Midnight and Lucky Lass, which involved pit water neutralization. Costs from several mines were collected to estimate a range of costs to reclaim large pit lakes and highwalls (Midnite, Washington; White King and Lucky Lass, Oregon; Sage, Gertrude, JD-7, Bessie #2, Rob Rollo, Colorado; [the JD-7 is a permitted mine, and the cost was based on the reclamation bond]).The costs to reclaim the larger sites ranged from $3M to $13M, with Midnite mine an exception at $205M. The cost to move material to fill the pits ranged from $1 to $3 per cubic yard, which reflected the length of haul and difficulty of terrain. This is consistent with what the State of Texas reports, as noted in Section 2.1.6.

Information on remediation costs was collected from only two open-pit mines, the White King and Lucky Lass mines in Oregon, both remediated under CERCLA protocol. Costs to remediate ranged from $45 to $64 per ton of ore produced.

4.2.3 Groundwater

Groundwater has historically not been part of abandoned uranium mine reclamation. Because of the geology (see detailed discussion in the *Abandoned Uranium Mines Location and Status Report*), most of the mines in the Four Corners region are above groundwater tables. Some mines in the Grants Mineral Belt in New Mexico have deep shafts drilled into aquifers that required dewatering during operations; however, the deep aquifers have historically not required treatment. Typically, reclamation and closure of portals, adits, and vents reduces the possibility of groundwater contamination. Placing contaminated materials in a disposal cell should also reduce the potential for future groundwater contamination.

No factor was used for remediating groundwater in the cost scenarios. However, the cost of remediating the Midnite mine, the costliest of all mines, is primarily due to groundwater and surface water that accumulated in the pit lake. EPA estimates that groundwater treatment will be needed for 140 years at the Midnite mine. Information found on other groundwater cleanups typically involved pit lakes or closing adits to prevent future mine discharge. If groundwater is remediated, it can be very costly, as EPA has seen at other mining sites.

4.2.4 Other Unique Factors

The following other unique factors at mines would affect costs but were not included in the cost estimate:

- *Phosphate mines*: A separate cost was not prepared for the one phosphate mine in Florida, since uranium production was secondary to the phosphate mining.
- *Individual mines in a state*: Pennsylvania, New Jersey, and Alaska each have one mine located in the state. No additional factor is added for the extra cost of addressing an individual mine instead of a group of mines. Costs for factors such as mobilization and contracting will be higher than the average for mines due to the individual cleanup. (The one mine located in Alaska, Ross-Adams, is undergoing a CERCLA action with the USFS.)
- *Land ownership*: No factor was employed to recognize that different agencies may have additional requirements.

4.3 Cost Basis and Assumptions

4.3.1 Typical Mine Features

Based on historical data from the 161 ULP sites, the 182 BLM sites, and the 84 field visits, DOE established the following average set of features for each mine production-size category, as shown in Table 3. Not all of the ULP and BLM sites had a match in the DOE mine database, so the number used in Table 3 does not equal the total number of sites listed. Appendix D provides a summary of DOE's ULP. A summary of the site visits and example of the field trip reports is available in the *Abandoned Uranium Mines Location and Status Topic Report*. The data from the site visits confirmed that the numbers used in Table 3 are conservative, and the number and size of features at sites vary, regardless of the production.

Table 3. Summary of ULP, BLM, and Field Data

	Small Mines	Small/Medium Mines	Medium Mines	Medium/ Large Mines	Large Mines
Number of Mines[a]	13	13	39	36	5
Ore Produced (Tons)	36	489	4,506	31,719	134,480
Waste-Rock Pile Area Range (Acres)	0.005–0.046	0.028–0.076	0.055–0.103	0.155–0.551	1.0–4.4
Waste-Rock Pile Average Area (Acres)	0.028	0.043	0.076	0.243	2.3
Waste-Rock Pile Volume Range (Tons)	35–47	125–165	1,600–8,400	55,600–82,000	107,200–200,000
Waste-Rock Pile Average Volume (Tons)	41	145	4,340	68,650	153,600
Ratio of Ore to Waste	1.0:1.1	1.0:0.3	1.0:1.0	1.0:2.2	1.0:1.1
Thickness (Feet)	1–3	2–5	6–15	12–30	15–50
Shafts (Range)	0–1	0–1	0–2	0–3	1–2
Pits and Trenches (Range)	0–2	0–4	0–5	0–4	1–2
Portals (Range)	1–4	1–4	1–6	1–4	1–2
Vents (Range)	0–1	0–3	0–4	1–6	1–4
Structures (Range)	0–2	0–2	1–4	1–5	1–5

[a] The number of ULP or BLM mines in the DOE mine database used to develop the generic features for each production-size category

4.3.2 Design Assumptions

The scope for reclamation and remediation reflects the definitions presented in Section 3.0. An estimate for each mine production-size category is based on the features determined in Table 3. In addition, the following assumptions were made:

Reclamation

- For the small, small/medium and medium scenarios, the topsoil was assumed to come from onsite and not imported from offsite. For the medium/large and large scenarios, topsoil was imported from a nearby borrow source to create a 12-inch layer over the recontoured waste-rock piles. Although 6 inches is sufficient to establish vegetation, 12 inches is preferred for a longer-lasting cover.
- To provide a range of costs, the number of features was varied, as shown in Table 3, to create the low and high estimates.

Remediation

- The volume of soil to be remediated is calculated by multiplying 1.5 times the volume of the waste-rock pile. This implies that an additional 50 percent of the calculated volume of contamination is spread around the waste-rock pile and site, and the contamination would exceed some cleanup standard. This factor is considered reasonable based on experience at ULP sites. As stated earlier, no specific cleanup standard was used for this estimate.
- Two cover designs (i.e., simple and complex) were used and were based on DOE's experience on UMTRCA sites.
- The simple cover design scenario involves a large repository scenario (volume holding 4.2 million tons of waste); the complex cover design scenario involves a smaller repository (volume holding 20,000 tons of waste). The larger repository results in a lower cost per ton of waste hauled because of the economies of scale to build it.

Feasibility

- Reclamation and remediation of all of the mines appear technically feasible. However, experience from the Navajo AML program indicates that approximately 10 percent of the mines are inaccessible and consequently would be extremely expensive to remediate and could result in significant risks to the workers due to steep terrain and other factors. No determination was made in this report on whether individual mines were feasible to reclaim or remediate.

4.3.3 Cost Estimate

The cost estimate was created as a bottom-up estimate using the data shown in Table 3, RSMeans database (Reed Construction Data 2013), established labor rates, and the previously mentioned assumptions. Appendix E presents the cost estimate. The discussion below divides the estimate into the major topics for ease of discussion. Because of the varying number and size of features, a low and high range is presented for each mine production-size category. The ranges are based on several assumptions as noted in each section below.

4.3.4 Labor Rates

The Davis-Bacon and related acts direct the Department of Labor to determine the prevailing wage rate for contractor and subcontractor employees on federally funded contracts in most regions of the country. Typically, the rates are published in four categories: building, residential, heavy, and highway construction; labor rates vary based on the type of project. The rates used in the cost estimate were based on the heavy construction category. The labor rates were based on the average of the rates established for Arizona, Utah, Colorado, New Mexico, and Wyoming because the majority of the mines are located in that area. The average rate was increased by 20 percent to reflect DOE's experience in the area where contractors typically have paid more than the Davis-Bacon rate to hire qualified labor. The rates include payroll taxes, fringe benefits, and overheads.

4.3.5 Equipment Production Rates

Equipment production rates and costs to operate equipment are from RSMeans database (Reed Construction Data 2013). The database provides information for most heavy equipment, such as the volume of material that a dozer can excavate in an hour (e.g., a large dozer can move 210 cubic yards per hour). No adjustment was made of the production rates for site-specific scenarios, such as remote, steep terrain. The rates used in Appendix E represent the cost of the equipment plus fuel, oil, grease, maintenance. The production rates are considered a conservative estimate.

4.3.6 Mobilization and Demobilization

Mobilization includes the cost to move equipment from the contractor's home base to the site, the cost of insurance and bonds, and temporary facilities, such as trailers, for larger projects. The mobilization distance was calculated by averaging the mobilization distances for a sample of approximately 25 percent of the mines, based on creating clusters of mines (sometimes referred to as the watershed approach) for reclamation and remediation. The distance is from an assumed access point to the cluster of mines from a nearby city large enough to have companies with the expertise and equipment to perform the work. This distance is multiplied by an RSMeans-provided cost for mobilizing each piece of equipment. Although there are smaller cities near the mines (e.g., Cortez and Naturita in southwest Colorado) that may have companies with the expertise, the extra distance provides some contingency for estimating purposes. The personnel time is based on one full day to mobilize. This includes initial site-specific training, loading, travel, unloading, and setup. Demobilization is assumed to be the same cost as mobilization.

Appendix E contains the cost estimates for mobilization for all mine production-size categories. For the cost estimate, mobilization is varied to provide a range of costs. Since the cost for mobilization was based on cleanup of five mines in one area, another range was developed by assuming that only two mines were cleaned up in an area. Thus, the mobilization cost per mine increased, since the costs were prorated across fewer mines.

4.3.7 Access

Access is being defined as the distance required to reach the mine from the closest accessible road. Some mines will be very difficult and will require a significant amount of work to construct an access road to the mine site; others will be off a maintained road and can be easily accessed. To provide an average cost, the estimate assumes that Small and Small/Medium mines are accessible with existing roads with only a small effort to make them usable. Medium mines assume 1 hour of grading, installing storm water controls, and constructing erosion prevention features. The Large mines assume that the mine is 9 miles from the access point and requires 1 mile of access construction. Appendix E contains the access cost estimates for all mine production-size categories.

4.3.8 Reclamation Features

BLM's *Abandoned Mine Land Inventory Manual* (BLM 2012) was used to develop the cost and scope for reclamation of several features.

The bottom-up estimate used the BLM manual's cost for removing structures and sealing portals and also for description of the work to seal a shaft and ventilation hole. Table 3 shows the number of features used in the estimate, and Appendix E contains the cost estimates for reclamation features for all mine production-size categories.

4.3.9 Reclamation Cost Estimate

The cost estimates are sorted by mine production size using the quantities from Table 3 and the BLM *Abandoned Mine Land Inventory Manual* (BLM 2012). The scope for reclamation involves estimating the cost for

- Mobilization/demobilization.
- Access.
- Clearing and grubbing (removing vegetation in the work area).
- Stabilizing the waste-rock piles (consolidating material, regrading and shaping, covering with topsoil).
- Portal closure.
- Pits/trenches.
- Shaft closure.
- Bored vents.
- Structures/debris (bury if possible, remove remaining to a landfill).
- Revegetation.

Appendix E contains the cost estimates for reclamation for all mine production-size categories. The number of portals, shafts, vents, and structures was varied to produce a range of costs.

4.3.10 Remediation

Remediation includes all of the scope for reclamation, except that the waste-rock piles are moved offsite and placed in a new repository rather than stabilized onsite. The primary assumption is that a new repository would be constructed for a group of mines and require a 10-mile haul of waste material. The 10-mile haul was based on the average distance of hauls from over 1,100 mines to individual repository locations located near a cluster of mines. No specific location has been designated for any repository. This is simply an average distance on a map and does not consider land availability or political or technical factors that would be required to site a repository. DOE recognizes that some mines may require longer hauls, which will significantly impact costs. The waste quantity was assumed to be the sum of the waste-rock for the mines in the group, plus additional contaminated soil assumed equal to one-half of the waste-rock volume. RSMeans was used to provide the costs for the materials for the repository estimate. Production for landfill excavation, loading waste, and transporting the haul truck is limited by the excavator. Production for the repository bottom liner task, placement of the waste, and building the repository cap are limited by the production capability of the dozer.

Appendix E contains the cost estimates for remediation for all mine production-size categories. The estimate reflects two scenarios: a simple (Lakeview UMTRCA) cover as described in

Section 3.3 and a more complex (Durango UMTRCA) multicomponent cover as depicted in Figure 9. A cost per ton was calculated from the total estimated costs for each repository scenario. The unit cost was then multiplied by the volume of waste-rock for that mine production-size category (e.g., Small Mine Reclamation—Low Cost Scenario is 35 tons; see page E-1) and the amount of waste rock placed.

4.3.11 Long-Term Monitoring and Maintenance

There are no specific regulations concerning the long-term monitoring of reclaimed abandoned uranium mine sites. Reclaimed uranium mill sites that are assigned to DOE, as specified by UMTRCA, are inspected at least annually and monitored for vandalism, erosion damage, vegetation, groundwater contamination, and other parameters. For this report, for cost purposes only, it is assumed that inspections similar to those that DOE performs at UMTRCA disposal cell sites, as applicable, will be implemented at reclaimed or remediated mine sites. The cost estimates assume that the monitoring program will be operated by a single federal program under one agency.

4.3.11.1 Institutional Controls

The condition of the sites after reclamation or remediation will determine the level of institutional controls, such as warning signs or fences, that might be provided to reduce the potential risk to visitors. Underground mines that have been sufficiently reclaimed (on public lands) would present a very low risk to the public, since the objective of the reclamation is to recontour and revegetate such that the area blends in with the natural surroundings. In this case, adding fences or signs would increase the cost and could potentially draw interest to an otherwise inconspicuous site. Repositories, however, are typically obvious aboveground impoundments, and signs and fences could be used as the primary deterrent to discourage access to areas. The cost estimates assume a three-strand barbed wire fence with signage on 100 ft spacing around the repositories. No cost was assigned for land use controls, such as environmental covenants, land-use restrictions, or permanent land withdrawals, that might need to be established for repositories.

4.3.11.2 Inspection

For cost purposes, inspections are assumed to occur once per year for 10 years for mine sites and for 30 years for repositories. Inspections will include monitoring for the success of revegetation, spraying for noxious weeds, and looking for indications of erosion, settlement, and violation of institutional controls. The cost assumes that inspections will be grouped and coordinated to minimize the duplication of travel expenses. Refer to Appendix E for cost buildup and pricing.

4.3.11.3 Groundwater and Surface Water Monitoring

Cost development included adding sites with impacted surface water or groundwater where the monitoring wells and surface water will be sampled and analyzed once per year for 10 years. The analysis was assumed to include uranium, radium, and two other heavy metals. For cost estimating purposes, the site will have five monitoring wells drilled to a 30 ft depth and two surface water sampling points for a total of seven analyses run annually. Refer to Appendix E for cost buildup and pricing.

4.3.11.4 Maintenance

For reclaimed and remediated sites, it is assumed for estimating annual costs that

- 5 percent of the topsoil will need to be replaced each year for 10 years due to erosion or settling.
- 5 percent of the surface area will need to be revegetated for 10 years.
- 5 percent of the length of the fencing will be replaced each year.
- One monitoring well will be replaced every 10 years.

Refer to Appendix E for cost buildup and pricing. Long-term monitoring and maintenance costs for individual mines will vary greatly, as some mines will require little or no maintenance, and others may have substantial erosion that results in costly repairs.

4.3.11.5 Historical Costs

Appendix F presents a summary of long-term monitoring and maintenance costs found in Record of Decision and EE/CA documents for several sites remediated under CERCLA. The costs range from $1,550 to $77,160 annually per site.

4.4 Summary of Reclamation and Remediation Costs

Table 4 and Table 5 present the range of costs for performing reclamation and remediation. Estimated values are rounded to the nearest ten thousand or hundred thousand (for Large mines). Table 6 presents the annual cost for long-term monitoring and maintenance for each production-size mine group. The detailed cost estimate for each production-size category is in Appendix E.

Table 4. Summary of Range of Costs for Reclamation and Remediation

Tons	Mine Production Size	Reclamation	Remediation
0–100	Small	$11,000–$51,000	$13,000–$55,000
100–1,000	Small/Medium	$11,000–$60,000	$16,000–$72,000
1,000–10,000	Medium	$46,000–$200,000	$110,000–$800,000
10,000–100,000	Medium/Large	$270,000–$680,000	$2,600,000–$6,600,000
100,000–500,000	Large	$560,000–$1,400,000	$5,000,000–$15,800,000
>500,000	Very Large	Not Estimated	Not Estimated

Note: The range of remediation costs includes the cost of reclamation. The two columns should not be added together to get a total cost for reclamation/remediation.

Table 5. Summary of Range of Historical Costs for Reclamation and Remediation

Tons	Mine Production Size	Reclamation Historical Cost**	Remediation Historical Cost**	No. of Sites*
0–100	Small	$6,000–$14,000	Not Available	3/0
100–1,000	Small/Medium	$3,000–$21,000	Not Available	7/0
1,000–10,000	Medium	$4,000–$162,000	$2,962,000–$7,813,000	16/2
10,000–100,000	Medium/Large	$3,000–$630,000	$636,000	17/1
100,000–500,000	Large	$35,000–$477,000	$7,635,000	5/1
>500,000	Very Large	Not Available	$6,298,000–$204,666,000	0/3

*No. of sites: number of mines used for reclamation and remediation historical cost range.
**Costs are escalated to January 2014.

Table 6. Long-Term Monitoring and Maintenance (LTM&M) Costs Summary

Tons	Mine Production Size	LTM&M for Mine Annual Cost	LTM&M for Repositories Annual Cost
		1–10 Years	1–10 Years
0–100	Small	$2,000	$12,000
100–1,000	Small/Medium	$2,000	$12,000
1,000–10,000	Medium	$2,000	$12,000
10,000–100,000	Medium/Large	$3,000	$12,000
100,000–500,000	Large	$7,000	$14,000
>500,000	Very Large	Not Estimated	Not Estimated

5.0 References

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Appendix A

Summary of Historical Costs

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Sorted By State

Note	CLAIM NAME	Status	Source	Year of Cost	Total Cost	Escalated Cost	STATE NAME	ACRES	TONS ORE	PRODUCTION CLASS	LAND OWN AGENCY	Cost Per Feature	Total Number of Features
1	Workman Creek Uranium Mines	Remediation	Estimate	2011	$600,000	$620,000	AZ		44,950	10,000-100,000	FS	$150,000	4
2	Juniper	Remediation	Estimate	2005	$2,215,865	$2,889,000	CA		6,632	1,000-10,000	FS	#N/A	#N/A
3	ML-AT(05-1)-36 (a, *)	Reclaimed	Actual	2001	$388,731	$614,000	CO		88,438	10,000-100,000	DOE	$5,000	76
3	AT(05-1)-ML-4 (a, *)	Reclaimed	Actual	2000	$284,220	$464,000	CO		113,893	100,000-500,000	DOE	$5,000	53
3	AT(05-1)-ML-6 (a, *)	Reclaimed	Actual	2001	$165,001	$261,000	CO		25,638	10,000-100,000	DOE	$4,000	45
3	AT(05-1)-ML-17 (a)	Reclaimed	Actual	2000	$157,453	$257,000	CO		13,415	10,000-100,000	DOE	$52,000	3
3	ML-AT(05-1)-526 (b, *)	Reclaimed	Actual	2001	$146,530	$231,000	CO		165,397	100,000-500,000	DOE	$7,000	20
3	AT(05-1)-ML-30 (a)	Reclaimed	Actual	2000	$123,300	$201,000	CO		15,308	10,000-100,000	DOE	$7,700	16
3	AT(05-1)-ML-44 (a)	Reclaimed	Actual	2001	$100,074	$158,000	CO		7,690	1,000-10,000	DOE	$8,000	13
3	AT(05-1)-ML-46 (a, *)	Reclaimed	Actual	2001	$97,612	$154,000	CO		42,330	10,000-100,000	DOE	$98,000	1
3	AT(05-1)-ML-29 (a, *)	Reclaimed	Actual	2001	$94,875	$150,000	CO		58,162	10,000-100,000	DOE	#N/A	0
3	AT(05-1)-ML-1 (a, *)	Reclaimed	Actual	2001	$79,867	$126,000	CO		48,724	10,000-100,000	DOE	$5,000	15
1	Hawk Mine	Reclaimed	Actual	2011	$97,589	$101,000	CO	4	10,585	10,000-100,000	BLM	#N/A	0
1	New Verde	Reclaimed	Actual	2011	$78,524	$81,000	CO	6	31,900	10,000-100,000	BLM	$6,000	14
3	AT(05-1)-ML-15 (a)	Reclaimed	Actual	2000	$38,627	$63,000	CO		3,248	1,000-10,000	DOE	$4,000	9
3	AT(05-1)-ML-8 (b)	Reclaimed	Actual	1994	$31,200	$59,000	CO		13,536	10,000-100,000	DOE	$3,000	10
3	AT(05-1)-ML-20 (a)	Reclaimed	Actual	2001	$33,499	$53,000	CO		14,797	10,000-100,000	DOE	$2,000	14
3	AT(05-1)-ML-39 (a, *)	Reclaimed	Actual	1999	$28,888	$49,000	CO		135,003	100,000-500,000	DOE	$29,000	1
3	AT(05-1)-ML-14 (a)	Reclaimed	Actual	2000	$28,865	$47,000	CO		33,746	10,000-100,000	DOE	$4,120	7
3	AT(05-1)-ML-5 (b)	Reclaimed	Actual	1994	$22,703	$43,000	CO		9,490	1,000-10,000	DOE	$1,890	12
3	AT(05-1)-ML-10 (a)	Reclaimed	Actual	2000	$25,368	$41,000	CO		125,221	100,000-500,000	DOE	$8,460	3
3	AT(05-1)-ML-21 (a)	Reclaimed	Actual	2001	$23,413	$37,000	CO		1,798	1,000-10,000	DOE	$1,000	24
3	AT(05-1)-ML-47 (a, *)	Reclaimed	Actual	1999	$20,070	$34,000	CO		132,884	100,000-500,000	DOE	$10,040	2
3	AT(05-1)-ML-12 (*)	Reclaimed	Actual	2000	$19,435	$32,000	CO		4,246	1,000-10,000	DOE	$4,000	5
3	AT(05-1)-ML-32 (a)	Closure	Actual	2003	$20,160	$30,000	CO		1,741	1,000-10,000	DOE	$7,000	3
3	AT(05-1)-ML-2 (*)	Reclaimed	Actual	2001	$18,157	$29,000	CO		11,132	10,000-100,000	DOE	$380	48
3	AT(05-1)-ML-9 (b)	Reclaimed	Actual	1994	$14,641	$28,000	CO		3,555	1,000-10,000	DOE	$1,630	9
3	AT(05-1)-ML-18 (a)	Reclaimed	Actual	2001	$16,250	$26,000	CO		9,926	1,000-10,000	DOE	$5,000	3
3	AT(05-1)-ML-7 (a)	Reclaimed	Actual	1994	$12,703	$24,000	CO		7,220	1,000-10,000	DOE	$1,000	20
3	AT(05-1)-ML-37 (a)	Reclaimed	Actual	2000	$13,370	$22,000	CO		39,405	10,000-100,000	DOE	$4,460	3
3	AT(05-1)-ML-28 (a, *)	Reclaimed	Actual	2000	$12,057	$20,000	CO		1,456	1,000-10,000	DOE	$4,000	3
3	AT(05-1)-ML-27 (a)	Reclaimed	Actual	1994	$10,639	$20,000	CO		970	100-1,000	DOE	$4,000	3
1	Northern Light Mines	Reclaimed	Actual	2011	$17,121	$18,000	CO	2	870	100-1,000	BLM	#N/A	0
3	AT(05-1)-ML-41 (a)	Reclaimed	Actual	1999	$8,652	$15,000	CO		1,828	1,000-10,000	DOE	$8,650	1
3	AT(05-1)-ML-25	Reclaimed	Actual	1999	$8,162	$14,000	CO		4,482	1,000-10,000	DOE	$1,000	8
3	AT(05-1)-ML-34 (a)	Reclaimed	Actual	2001	$8,725	$14,000	CO		15	0-100	DOE	$1,454	6
1	Mesa No. 5	Reclaimed	Actual	2011	$12,963	$13,000	CO	4	14,790	10,000-100,000	BLM	#N/A	0
3	AT(05-1)-ML-19	Reclaimed	Actual	1999	$7,844	$13,000	CO		97	0-100	DOE	$2,000	4
3	AT(05-1)-ML-23 (a)	Closure	Actual	2000	$7,373	$12,000	CO		22,842	10,000-100,000	DOE	$1,840	4
3	AT(05-1)-ML-3	Reclaimed	Actual	1994	$4,778	$9,000	CO		1,862	1,000-10,000	DOE	$370	13
3	AT(05-1)-ML-31	Reclaimed	Actual	2003	$6,267	$9,000	CO		679	100-1,000	DOE	$1,570	4
3	AT(05-1)-ML-43 (a)	Reclaimed	Actual	1999	$3,968	$7,000	CO		2,255	1,000-10,000	DOE	#N/A	0
3	AT(05-1)-ML-22 (b)	Reclaimed	Actual	1999	$3,604	$6,000	CO		2,048	1,000-10,000	DOE	$510	7
3	AT(05-1)-ML-42 (a)	Closure	Actual	2000	$3,623	$6,000	CO		14	0-100	DOE	$1,810	2

Note	CLAIM NAME	Status	Source	Year of Cost	Total Cost	Escalated Cost	STATE NAME	ACRES	TONS ORE	PRODUCTION CLASS	LAND OWN AGENCY	Cost Per Feature	Total Number of Features
3	AT(05-1)-ML-45 (a)	Reclaimed	Actual	1994	$2,510	$5,000	CO		346	100-1,000	DOE	$1,260	2
3	AT(05-1)-ML-24 (a)	Reclaimed	Actual	2000	$2,460	$4,000	CO		6,383	1,000-10,000	DOE	$1,230	2
3	AT(05-1)-ML-48	Reclaimed	Actual	1994	$2,156	$4,000	CO		203	100-1,000	DOE	$2,160	1
3	AT(05-1)-ML-11 (a)	Closure	Actual	2000	$1,828	$3,000	CO		17,270	10,000-100,000	DOE	$1,000	3
1	Nine Mile Hill Mines	Reclaimed	Actual	2011	$2,524	$3,000	CO	1	102	100-1,000	BLM	#N/A	0
2	North East Church Rock - Alternative 4	Remediation	EE/CA	2009	$41,565,048	$45,626,000	NM	125	1,260,000	Over 500,000	Najavo Nation	#N/A	#N/A
1	San Mateo Uranium Mine	Remediated	Actual	2011	$7,200,000	$7,438,000	NM	35	261,000	100,000-500,000	FS	$3,600,000	2
1	White King Lucky Lass	Remediated	Actual	2011	$5,939,087	$6,135,000	OR	140	1,260,000	Over 500,000	FS	$742,000	8
4	Skyline	Remediated	Actual	2012	$7,500,000	$7,614,000	UT		5,037	1,000-10,000	Najavo Nation	#N/A	#N/A
1	Terry Mine	Reclaimed	Actual	2011	$10,443	$11,000	UT		196	100-1,000	NPS	#N/A	0
1	Midnite Mine	Remediation	Estimate	2011	$193,000,000	$199,380,000	WA		33,000,000	Over 500,000	BLM	#N/A	#N/A

Note
1 - GAO Report
2 - Engineering Evaluation/ Cost Analysis
3 - ULP Legacy Reclamation Cost Data - DOE
4 - EPA

Sort By Cost

Note	CLAIM NAME	Status	Source	Year of Cost	Total Cost	Escalated Cost	STATE NAME	ACRES	TONS ORE	PRODUCTION CLASS	LAND OWN AGENCY	Cost Per Feature	Total Number of Features
1	Midnite Mine	Remediation	Estimate	2011	$193,000,000	$199,380,000	WA		33,000,000	Over 500,000	BLM	#N/A	#N/A
2	North East Church Rock - Alternative 4	Remediation	EE/CA	2009	$41,565,048	$45,626,000	NM	125	1,260,000	Over 500,000	Najavo Nation	#N/A	#N/A
4	Skyline	Remediated	Actual	2012	$7,500,000	$7,614,000	UT		5,037	1,000-10,000	Najavo Nation	#N/A	#N/A
1	San Mateo Uranium Mine	Remediated	Actual	2011	$7,200,000	$7,438,000	NM	35	261,000	100,000-500,000	FS	#N/A	0
1	White King Lucky Lass	Remediated	Actual	2011	$5,939,087	$6,135,000	OR	140	1,260,000	Over 500,000	FS	#N/A	0
2	Juniper	Remediation	Estimate	2005	$2,215,865	$2,889,000	CA		6,632	1,000-10,000	FS	#N/A	#N/A
1	Workman Creek Uranium Mines	Remediation	Estimate	2011	$600,000	$620,000	AZ		44,950	10,000-100,000	FS	#N/A	0
3	ML-AT(05-1)-36 (a, *)	Reclaimed	Actual	2001	$388,731	$614,000	CO		88,438	10,000-100,000	DOE	#N/A	#N/A
3	AT(05-1)-ML-4 (a, *)	Reclaimed	Actual	2000	$284,220	$464,000	CO		113,893	100,000-500,000	DOE	#N/A	#N/A
3	AT(05-1)-ML-6 (a, *)	Reclaimed	Actual	2001	$165,001	$261,000	CO		25,638	10,000-100,000	DOE	#N/A	#N/A
3	AT(05-1)-ML-17 (a)	Reclaimed	Actual	2000	$157,453	$257,000	CO		13,415	10,000-100,000	DOE	#N/A	#N/A
3	ML-AT(05-1)-526 (b, *)	Reclaimed	Actual	2001	$146,530	$231,000	CO		165,397	100,000-500,000	DOE	#N/A	#N/A
3	AT(05-1)-ML-30 (a)	Reclaimed	Actual	2000	$123,300	$201,000	CO		15,308	10,000-100,000	DOE	$1,600	76
3	AT(05-1)-ML-44 (a)	Reclaimed	Actual	2001	$100,074	$158,000	CO		7,690	1,000-10,000	DOE	$2,000	53
3	AT(05-1)-ML-46 (a, *)	Reclaimed	Actual	2001	$97,612	$154,000	CO		42,330	10,000-100,000	DOE	$2,000	45
3	AT(05-1)-ML-29 (a, *)	Reclaimed	Actual	2001	$94,875	$150,000	CO		58,162	10,000-100,000	DOE	$32,000	3
3	AT(05-1)-ML-1 (a, *)	Reclaimed	Actual	2001	$79,867	$126,000	CO		48,724	10,000-100,000	DOE	$4,000	20
1	Hawk Mine	Reclaimed	Actual	2011	$97,589	$101,000	CO	4	10,585	10,000-100,000	BLM	#N/A	0
1	New Verde	Reclaimed	Actual	2011	$78,524	$81,000	CO	6	31,900	10,000-100,000	BLM	N/A	0
3	AT(05-1)-ML-15 (a)	Reclaimed	Actual	2000	$38,627	$63,000	CO		3,248	1,000-10,000	DOE	$39,000	1
3	AT(05-1)-ML-8 (b)	Reclaimed	Actual	1994	$31,200	$59,000	CO		13,536	10,000-100,000	DOE	N/A	0
3	AT(05-1)-ML-20 (a)	Reclaimed	Actual	2001	$33,499	$53,000	CO		14,797	10,000-100,000	DOE	$2,000	15
3	AT(05-1)-ML-39 (a, *)	Reclaimed	Actual	1999	$28,888	$49,000	CO		135,003	100,000-500,000	DOE	#N/A	#N/A
3	AT(05-1)-ML-14 (a)	Reclaimed	Actual	2000	$28,865	$47,000	CO		33,746	10,000-100,000	DOE	#N/A	#N/A
3	AT(05-1)-ML-5 (b)	Reclaimed	Actual	1994	$22,703	$43,000	CO		9,490	1,000-10,000	DOE	$2,520	9
3	AT(05-1)-ML-10 (a)	Reclaimed	Actual	2000	$25,368	$41,000	CO		125,221	100,000-500,000	DOE	$2,540	10
3	AT(05-1)-ML-21 (a)	Reclaimed	Actual	2001	$23,413	$37,000	CO		1,798	1,000-10,000	DOE	$2,000	14
3	AT(05-1)-ML-47 (a, *)	Reclaimed	Actual	1999	$20,070	$34,000	CO		132,884	100,000-500,000	DOE	$20,070	1
3	AT(05-1)-ML-12 (*)	Reclaimed	Actual	2000	$19,435	$32,000	CO		4,246	1,000-10,000	DOE	$3,000	7
3	AT(05-1)-ML-32 (a)	Closure	Actual	2003	$20,160	$30,000	CO		1,741	1,000-10,000	DOE	$2,000	12
3	AT(05-1)-ML-2 (*)	Reclaimed	Actual	2001	$18,157	$29,000	CO		11,132	10,000-100,000	DOE	$6,050	3
3	AT(05-1)-ML-9 (b)	Reclaimed	Actual	1994	$14,641	$28,000	CO		3,555	1,000-10,000	DOE	$610	24
3	AT(05-1)-ML-18 (a)	Reclaimed	Actual	2001	$16,250	$26,000	CO		9,926	1,000-10,000	DOE	$8,000	2
3	AT(05-1)-ML-7 (a)	Reclaimed	Actual	1994	$12,703	$24,000	CO		7,220	1,000-10,000	DOE	$3,000	5
3	AT(05-1)-ML-37 (a)	Reclaimed	Actual	2000	$13,370	$22,000	CO		39,405	10,000-100,000	DOE	$4,460	3
3	AT(05-1)-ML-28 (a, *)	Reclaimed	Actual	2000	$12,057	$20,000	CO		1,456	1,000-10,000	DOE	$0	48
3	AT(05-1)-ML-27 (a)	Reclaimed	Actual	1994	$10,639	$20,000	CO		970	100-1,000	DOE	$1,000	9
1	Northern Light Mines	Reclaimed	Actual	2011	$17,121	$18,000	CO	2	870	100-1,000	BLM	#N/A	0
3	AT(05-1)-ML-41 (a)	Reclaimed	Actual	1999	$8,652	$15,000	CO		1,828	1,000-10,000	DOE	$430	20
3	AT(05-1)-ML-25	Reclaimed	Actual	1999	$8,162	$14,000	CO		4,482	1,000-10,000	DOE	$3,000	3
3	AT(05-1)-ML-34 (a)	Reclaimed	Actual	2001	$8,725	$14,000	CO		15	0-100	DOE	$2,908	3
1	Mesa No. 5	Reclaimed	Actual	2011	$12,963	$13,000	CO	4	14,790	10,000-100,000	BLM	#N/A	0
3	AT(05-1)-ML-19	Reclaimed	Actual	1999	$7,844	$13,000	CO		97	0-100	DOE	#N/A	#N/A
3	AT(05-1)-ML-23 (a)	Closure	Actual	2000	$7,373	$12,000	CO		22,842	10,000-100,000	DOE	$7,370	1

Note	CLAIM NAME	Status	Source	Year of Cost	Total Cost	Escalated Cost	STATE NAME	ACRES	TONS ORE	PRODUCTION CLASS	LAND OWN AGENCY	Cost Per Feature	Total Number of Features
1	Terry Mine	Reclaimed	Actual	2011	$10,443	$11,000	UT		196	100-1,000	NPS	#N/A	0
3	AT(05-1)-ML-3	Reclaimed	Actual	1994	$4,778	$9,000	CO		1,862	1,000-10,000	DOE	$600	8
3	AT(05-1)-ML-31	Reclaimed	Actual	2003	$6,267	$9,000	CO		679	100-1,000	DOE	$1,040	6
3	AT(05-1)-ML-43 (a)	Reclaimed	Actual	1999	$3,968	$7,000	CO		2,255	1,000-10,000	DOE	#N/A	#N/A
3	AT(05-1)-ML-22 (b)	Reclaimed	Actual	1999	$3,604	$6,000	CO		2,048	1,000-10,000	DOE	$900	4
3	AT(05-1)-ML-42 (a)	Closure	Actual	2000	$3,623	$6,000	CO		14	0-100	DOE	$910	4
3	AT(05-1)-ML-45 (a)	Reclaimed	Actual	1994	$2,510	$5,000	CO		346	100-1,000	DOE	#N/A	#N/A
3	AT(05-1)-ML-24 (a)	Reclaimed	Actual	2000	$2,460	$4,000	CO		6,383	1,000-10,000	DOE	$190	13
3	AT(05-1)-ML-48	Reclaimed	Actual	1994	$2,156	$4,000	CO		203	100-1,000	DOE	$540	4
3	AT(05-1)-ML-11 (a)	Closure	Actual	2000	$1,828	$3,000	CO		17,270	10,000-100,000	DOE	#N/A	0
1	Nine Mile Hill Mines	Reclaimed	Actual	2011	$2,524	$3,000	CO	1	102	100-1,000	BLM	$1,000	3

Note
1 - GAO Report
2 - Engineering Evaluation/ Cost Analysis
3 - ULP Legacy Reclamation Cost Data - DOE
4 - EPA

Appendix B

Cleanup Standards/Guidance

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The following is an excerpt from the Prioritization Topic Paper, Section 2.3, with minor modifications. (All references to sections and reference sources refer to the Prioritization Topic Paper, and not to this document.)

A literature survey was completed to identify site-specific and generic remediation standards for uranium mines sites. Approaches range from generic qualitative guidelines that emphasize removal of physical hazards and surface stabilization (e.g., BLM 1992) to site-specific numerical goals established for each contaminant of concern (e.g., Midnite mine; EPA 2006a). The attached table summarizes the site-specific standards and generic guidance.

CERCLA specifies that remediation goals be established to meet a 1×10^{-4} to 1×10^{-6} incremental lifetime cancer risk. This is reflected in CERCLA guidance for radioactively contaminated soils. CERCLA guidance notes that the 5/15 UMTRCA soil standard (see Section 2.1.2) for radium-226 is generally consistent with the higher end of the CERCLA risk-range if contaminants and their distribution are similar to those found at UMTRCA sites (EPA 1997b). EPA recommends a dose of 15 millirems per year (mrem/yr) effective dose equivalent as an appropriate remediation goal (i.e., equal to approximately a 3×10^{-4} increased lifetime cancer risk).

Other generic approaches are more qualitative. DOE began reclamation of mines on its uranium lease tracts in the mid-1990s. Because no standards existed for these sites, DOE collaborated with BLM to develop reclamation guidelines (BLM 1995). Numerical goals were not established, but the standard practice was to bury higher-radioactivity material under low-radioactivity or nonradioactive (natural background) material. Draft BLM guidance for reclamation of mines with radioactive contamination (BLM 2001) adopts a similar approach but uses the 5/15 numerical UMTRCA soil standard. Colorado BLM has a goal to "minimize radioactivity emanating from the site." This is accomplished by selective burial of higher-radioactivity material with lower-radioactivity or nonradioactive (natural background) materials. Similarly, the Navajo AML program recognized three classes of materials. Their approach is to bury the most-radioactive materials (>25 pCi/g radium-226) with those of lesser radioactivity (>background but <25 pCi/g) and finish with a cover approaching natural background (around 2 pCi/g).

Most of the site-specific mine cleanups included in the following table were conducted under CERCLA. In a number of cases it was noted that background levels of radium-226 exceeded the acceptable risk range. The National Academy of Sciences (NAS 1999) notes that in a study of uncontaminated (i.e., background) surface soils in the United States, measured values of radium-226 ranged from 0.23 to 4.2 pCi/g. Concentrations of radium-226 in soil corresponding to the 1×10^{-4} to 1×10^{-6} risk range for a residential setting are 1.24 to 0.0124 pCi/g (http://epa-prgs.ornl.gov/radionuclides/). Therefore, even low background values equate to risks greater than the low end of EPA's acceptable risk range. In order to accommodate this, remediation goals were often established as background or as background plus a concentration equal to an acceptable incremental excess risk (e.g. Workman Creek, Juniper mine, Quivira mine). For mines on or near tribal lands, a residential scenario was most often assumed appropriate, and cleanup goals were established that were essentially at background. In situations where a recreational scenario was deemed more appropriate, substantially higher levels were determined to be acceptable. Background levels varied widely among different mine sites reviewed for this report.

Though the examples in the following table are dominated by CERCLA-type cleanups, this is not to suggest that the most mine cleanups are designed to meet CERCLA cleanup levels. A substantial number of mines have been reclaimed using the SMCRA [Surface Mining Control and Reclamation Act] approach with more emphasis placed on stabilizing a site and addressing physical hazards than in achieving specific numerical goals. These types of sites tend to be less formally documented and do not show up in a literature review. Large numbers of mines have been reclaimed according to Navajo AML, DOE/BLM, and BLM guidance. Based on EPA Region 9 studies of some of the Navajo sites, further remediation will likely be required before these sites can meet criteria for unrestricted residential use (see additional discussion in Section 3.3.4).

The survey of different cleanup levels and approaches reinforces conclusions drawn by NAS that a variety of guidelines or methods have been used in the absence of standards specific to uranium mines. Final goals vary widely, depending on assumed future land uses. Where residential use is assumed, cleanup goals are driven to lower levels.

Site-Specific Levels	Document	Cleanup/Action Level	Basis/Exposure Scenario	Notes
Northeast Church Rock Mine	Engineering evaluation/cost analysis (EE/CA) (EPA Region 9, 2009a)	2.24 pCi/g radium-226 (Ra-226)	Mean background + residential Preliminary Remediation Goal (PRG) (1.24 pCi/g Ra-226)	CERCLA cleanup
Midnite Mine	Record of Decision (EPA 2006a)	43 milligrams per kilogram (mg/kg) uranium (total) 7.5 pCi/kg lead-210 4.7 pCi/g Ra-226	Background; risk-based levels are less than background for residential and recreational use scenarios	Nonresidential risks dominated by meat/plant ingestion (near subsistence); CERCLA cleanup
White King	Record of Decision (EPA 2001)	442 mg/kg As 6.8 pCi/g Ra-226	Background; risk-based levels are less than background	Worker/recreational risks slightly higher than 10^{-4}; residential around 10^{-1}; arsenic is main risk-driver for nonresidential exposures; gamma/radon main residential risk drivers
Lucky Lass	Record of Decision (EPA 2001)	38 mg/kg As 3.6 pCi/g Ra-226	Background; risk-based levels are less than background	Worker/recreational risks slightly higher than 10^{-4}; residential around 10^{-1}; arsenic is main risk-driver for nonresidential exposures; gamma/radon main residential risk drivers
San Mateo Uranium Mine	EE/CA (USFS 2009b)	Tables with values not included in the report	1×10^{-4} risk level; gamma exposure, 14-day camper scenario	14-day gamma exposure value from EPA technologically enhanced naturally occurring radioactive material (TENORM) report is 307 pCi/g Ra-226 for 1×10^{-4} (not clear if this is the number they used)
Quivira Mine	Action Memorandum, EPA Region 9 (EPA 2010b)	2.24 pCi/g Ra-226	Mean background + residential PRG (1.24 pCi/g Ra-226; 1×10^{-4})	
Tronox Mine Sections 32 and 33	Removal Assessment Report (EPA 2012b)	2.11 pCi/g Ra-226	Highest background (0.900 pCi/g) + residential PRG (1.21 pCi/g)	Incremental increase in dose of 15 mrem/yr above background
Juniper Uranium Mine	EE/CA (USFS 2005)	Concentration not specified; background + 12 µR/h	PRG is to reduce gamma to below 15 mrem/yr assuming 52-day exposure; human health benchmark of 0.2 pCi/g Ra-226 included in table	52-day gamma exposure value from EPA TENORM report is 83 pCi/g Ra-226 for 1×10^{-4} (not clear if this is the number they used)
Skyline Uranium Mine	Removal Assessment Report (EPA 2010c)	10.36 pCi/g Ra-226	RESRAD offsite; estimated dose for offsite residents of 5 mrem/yr	Inaccessibility of site was recognized
Cove Transfer Station	Removal Action Report (EPA 2013b)	2.1 pCi/g Ra-226	Background (0.79 pCi/g) + residential PRG (1.21 pCi/g Ra-226 for 1×10^{-4} risk)	Not a mine, but included because of similar wastes
Workman Creek Uranium Mine Sites	EE/CA (USFS 2008)	7.57 pCi/g Ra-226 for campgrounds; 67.4 pCi/g for mine areas	5 pCi/g + background; 30-day/yr recreational scenario; 1×10^{-4} incremental risk above background	Used 30-day 10^{-4} value from EPA TENORM table divided by 30 years
Riley Pass Uranium Mines	EE/CA (USFS 2006b)	3 categories identified: Category 1: $\leq$30 pCi/g Ra-226 Category 2: >30–50 pCi/g Ra-226 Category 3: >50 pCi/g Ra-226	EE/CA states cleanup based on 10^{-5} for recreational scenario (hunter) with ingestion of meat from the site	Different management approach for each category: Category 1: No removal of material—vegetate and stabilize Category 2: Bring average measurements down to 30 pCi/g or less by covering, removing, etc. Category 3: Excavate and place in repository; in case of coal seams exceeding criteria, seams will be covered or otherwise mitigated but not removed
King Edward Mine	EE/CA (USFS 2006a)	Does not appear that formal numerical cleanup levels were established	Used EPA PRGs for comparison—3.69 pCi/g Ra-226; assessed qualitative risks to recreational users	Recommended remediation approach is to consolidate and cap waste-rock piles to minimize exposures and erosion/leaching; the mine is located near the head of Cottonwood Wash, which has been the subject of efforts to include surface water quality
Butterfly and Burrell Mines	EE/CA (USFS 2011)	No numerical criteria established for soils, waste rock; compared metals to BLM risk management criteria for recreational scenarios	Notes that recreational use is most likely to occur	Preferred alternative involves removing physical risks; final state of site will discourage camping; wastes will be covered and contoured to prevent erosion
Cottonwood Wash, Utah	Cottonwood Wash TMDL (UDEQ 2002)	Stabilize mine waste dumps that are affecting surface water quality; close mine openings to protect the public; gross alpha TMDLs developed for different locations in the watershed	Public lands—multiple use (nonresidential)	Main driver is CWA; TMDL completed

Generic Guidance	Document	Cleanup/Action Level	Basis/Exposure Scenario	Notes
Navajo AML general approach	May 30, 2013 presentation	3 classes of materials: Class A: near natural background (around 2 pCi/g) Class B: above background but below 25 pCi/g (50 μR/h) Class C: above 25 pCi/g (>50 μR/h)		General management approach is to bury Class C followed by Class B; finish with a cover of Class A
BLM	Handbook H-3042-1: Solid Minerals Reclamation Handbook (BLM 1992)	Not specified. Emphasis on site stabilization; control mine drainage	Public lands—multiple use (nonresidential)	A draft revised *Solid Mineral Reclamation Handbook* (2/9/2001) incorporated the UMTRCA standard of 5/15 pCi/g for radioactive mine wastes. It also notes that wastes should be covered with not less than 6 inches of soil with an upper Ra-226 limit of 5 pCi/g above background. It is further noted that 18 to 24 inches over such cover is preferable.
Colorado BLM Abandoned Uranium Mine Reclamation Guidelines	Supplement to BLM Handbook H-3042-1 (BLM 1995)	Goal is to minimize radioactivity emanating from the site; mine openings with radon working level > 10 are to be sealed; bury higher radioactive material under lower or nonradioactive material	Public lands—multiple use (nonresidential)	
Use of Soil Cleanup Criteria in 40 CFR 192 as Remediation Goals for CERCLA sites	OSWER Direction No. 9200.4-25 (EPA 1998)	Discusses applicability of 5/15 pCi/g (over background) Ra-226 at CERCLA sites	Residential	Only relevant if contaminants and their distribution are similar to that at UMTRCA sites
Cleanup Levels for CERCLA Sites with Radioactive Contamination	OSWER No. 9200.4-18 (EPA 1997b)	10^{-4} to 10^{-6} risk range; 15 mrem/yr effective dose equivalent if a dose assessment is conducted (approximately equivalent to 3×10^{-4} increased lifetime risk)	CERCLA risk range; numerical goals for individual contaminants will depend on land use assumptions	
Risk Management Criteria for Metals at BLM Mining Sites	BLM Technical Note 390 (BLM 2004)	Provides human health risk-based criteria for metals in soils, sediments and surface water for different exposure scenarios; provides standards for surface water; provides wildlife and livestock risk management criteria for metals in soils	Based on a 10^{-5} excess cancer risk for each scenario (includes resident, camper, worker, among others)	Equations provided for calculating risk-based concentrations, but exposure assumptions not included (e.g., frequency, duration)

Abbreviations:
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
EE/CA = engineering evaluation/cost analysis
μR/h = microroentgens per hour
mg/kg = milligrams per kilogram
OSWER = Office of Solid Waste and Emergency Response
pCi/g = picocuries per gram
PRG = Preliminary Remediation Goal
Ra-226 = radium-226
TENORM = technologically enhanced naturally occurring radioactive material
TMDL = total maximum daily load

Appendix C

Very Large Mines and Their Status

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LM ID	State Name	County Name	Tons Ore	Mine Status	Landowner/Agency
602	New Mexico	Valencia	7,241,382	Reclaimed	Indian Trust
4159	New Mexico	McKinley	3,851,523	Reclaimed	State
4160	New Mexico	Cibola	2,894,860	Reclaimed	BIA
586	New Mexico	McKinley	2,100,751	Reclaimed	Private
594	New Mexico	McKinley	1,995,325	Reclaimed	Private
3646	Wyoming	Fremont	1,597,153	Reclaimed	Unknown
587	New Mexico	McKinley	1,496,321	Partially Reclaimed	Private
588	New Mexico	McKinley	1,442,869	Reclaimed	Private
1667	Utah	San Juan	1,244,122	Reclaimed	BLM
531	New Mexico	McKinley	1,239,058	Partially Reclaimed	Indian Allotment
589	New Mexico	McKinley	1,134,103	Reclaimed	Private
4006	Washington	Stevens	1,057,156	In Process	BIA
571	New Mexico	McKinley	1,042,415	Reclaimed	Private
597	New Mexico	McKinley	997,049	Reclaimed	Private
575	New Mexico	McKinley	891,920	Reclaimed	Private
583	New Mexico	McKinley	859,880	Reclaimed	Private
580	New Mexico	McKinley	789,310	Reclaimed	Private
1797	Arizona	Navajo	763,013	Reclaimed	BIA
549	New Mexico	McKinley	723,031	Reclaimed	Private
1652	Utah	San Juan	692,223	In Process	BLM
3625	Wyoming	Fremont	690,235	Reclaimed	BLM
3707	Wyoming	Carbon	680,741	Reclaimed	Unknown
3620	Wyoming	Fremont	675,390	Partially Reclaimed	BLM
1668	Utah	San Juan	630,202	Reclaimed	BLM
3860	Colorado	Moffat	596,700	Reclaimed	BLM
3311	Wyoming	Crook	588,392	Partially Reclaimed	Non-Federal
3183	Utah	San Juan	578,081	Permitted	BLM
3630	Wyoming	Fremont	571,239	Reclaimed	BLM
604	New Mexico	Valencia	557,966	Reclaimed	BIA
3644	Wyoming	Fremont	541,670	Reclaimed	BLM
1672	Utah	San Juan	537,519	Permitted	BLM
137	Colorado	Montrose	514,344	Permitted	BLM
574	New Mexico	McKinley	510,880	Reclaimed	State/Private
584	New Mexico	McKinley	507,498	Reclaimed	BLM/Private
3653	Wyoming	Natrona	506,253	Reclaimed	BLM
3857	Colorado	Moffat	500,439	Reclaimed	BLM
552	New Mexico	Cibola	500,416	Remediated	FS

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Appendix D

DOE's Uranium Leasing Program and Assistance to BLM Programs

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DOE ULP and BLM Program

ULP

The U.S. Department of Energy (DOE) is responsible for administering the DOE Uranium Leasing Program (ULP) and its 31 uranium lease tracts located in the Uravan Mineral Belt of southwestern Colorado. The ULP began in 1948 when Congress authorized the U.S. Atomic Energy Commission (AEC) to withdraw lands from the public domain for the sole purpose of exploring for, developing, and mining uranium ore bodies. Through a series of public land orders, AEC took control of approximately 500,000 acres of land in Colorado, New Mexico, Utah, and Wyoming. The U.S. Geological Survey assisted AEC in implementing a massive exploration program to identify lands that contained the most favorable geologic formations for uranium. Subsequently, AEC retained only lands (approximately 25,000 acres) that met the most favorable criteria. DOE still administers those lands today.

In addition to administering the ULP for the last 6 decades, DOE has also undertaken the significant task of reclaiming a large number of abandoned uranium (legacy) mine sites and associated features located throughout the Uravan Mineral Belt. These legacy mine sites were typically operated during the 1940s through the 1960s, at a time when there were no regulations requiring operators to reclaim their mine sites once mining activities were suspended.

In 1994, DOE initiated a 3-year reconnaissance program to locate and delineate (through extensive on-the-ground mapping) the legacy mine sites and associated features contained within the historically defined boundaries of its uranium lease tracts. That program ultimately identified 161 distinct mine sites that required some form of site reclamation.

During that same timeframe, DOE recognized the lack of regulations pertaining to the reclamation of legacy mine sites. Through contact with the U.S. Department of Interior Bureau of Land Management (BLM), DOE established a dialogue with the various field offices located in southwestern Colorado (Grand Junction, Montrose, and Durango) concerning the reclamation of legacy mine sites. Ultimately, DOE collaborated with BLM to develop reclamation criteria specifically tailored to abandoned uranium mine sites. In November 1995, The BLM Colorado State Office formally issued the *U.S. Department of the Interior Colorado Bureau of Land Management Closure/Reclamation Guidelines, Abandoned Uranium Mine Sites* as a supplement to its *Solid Minerals Reclamation Handbook*, H-3042-1.

From 1996 to 2001, DOE utilized the BLM guidance document and reclaimed the 161 identified mine sites.

BLM Program

In 2000, BLM requested technical and administrative assistance from DOE and its Technical Assistance Contractor in support of BLM's abandoned mine lands reclamation program. An Interagency Agreement was established between the two agencies to support this effort. Under the various task orders associated with the agreement, BLM requested (and funded) DOE personnel to provide assistance in (1) conducting additional inventory work on BLM mine sites and DOE-administered sites that were proposed for return to public domain and (2) reclaiming known abandoned uranium mine sites on the public domain under BLM's administrative jurisdiction.

Mine-site inventory activities consisted of field investigations, updating inventoried mine sites in the Abandoned Mine Land Inventory System (AMLIS) database, literature reviews, GPS data collection, mapping, and documentation. The AMLIS database for DOE-controlled mines sites within the three BLM areas was updated. As part of the update, the DOE mining claim information and the existing BLM inventory files were examined to identify data gaps, with additional field investigation for BLM sites as required. During the 8-year period (2000 through 2008), DOE personnel performed reclamation activities at 182 separate BLM mine sites.

Appendix E

Cost Estimate for Each Production-Size Category

Small Mine Reclamation—Low-Cost Scenario

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Mobilization					100 mile mobilization from city to access
Foreman	$16.36	8	hours	$130.88	Acting as foreman & operating excavator
Operator	$13.66	8	hours	$109.28	
Laborer/Operator	$11.23	8	hours	$89.84	
CAT 307 Excavator	$615.00	1	each	$615.00	RSMeans 015436500020, 015436502500
CAT 247 Skidsteer	$615.00	1	each	$615.00	RSMeans 015436500020, 015436502500
5,000 Gal Water Truck	$78.60	8	hours	$628.80	
4x4 Truck	$26.05	8	hours	$208.40	
Subtotal				$2,397.20	
Cost Reduction				-$1,917.76	Prorated discount (over 5 mines)
Mobilization Subtotal				**$479.44**	
Access				**$0.00**	Assuming no cost for building access to small mines, sufficient access already in place
Clearing and Grubbing	$3,275.00	0.005	acres	**$16.38**	RSMeans 311110100020
Waste-Rock Dumps		35	tons		
Foreman	$16.36	1.0	hours	$16.36	Acting as foreman, operating excavator
Operator	$13.66	1.0	hours	$13.66	
Laborer/Operator	$11.23	1.0	hours	$11.23	
CAT 307 Excavator	$49.76	1.0	hours	$49.76	Rounded to one hour for reasonableness
CAT 247B Skidsteer	$29.99	1.0	hours	$29.99	
5,000 Gal Water Truck	$78.60	0.5	hours	$39.30	
4x4 Truck	$26.05	0	hours	$0.00	
Waste-Rock Dumps Subtotal				**$160.30**	
Portals	$4,000.00	1	each	**$4,000.00**	Data from ULP & BLM actual mine reclamation
Pits/Trenches		0	each		Cost covered by waste-rock dump above
Shafts		0	each		

Small Mine Reclamation—Low-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Bored Vents		0	each		Assuming diameter of vent is 18" wide, 10' deep, closure using low density mine closure foam
Operator	$13.66	0	hours		
Laborer/Operator	$11.23	0	hours		
Foam	$7.80	0	CF	$0.00	
Foam Applicator	$400.00	0	each	$0.00	Cost prorated over 5 mines
Bored Vents Subtotal				**$0.00**	
Structures/Debris	$1,000.00	0	each	**$0.00**	Abandoned Mine Land Inventory Manual, Section C: Cost Guidelines, modified for mine size
Demobilization	$479.44	1	each	**$479.44**	Same as mobilization
Revegetation	$1,009.00	1	acres	**$1,009.00**	RSMeans 329219130020
Subtotal				**$6,144.56**	
Design, Permits, Procurement	10%			$614.46	
Project Management	15%			$921.68	
Bonding	1%			$61.45	
G&A & Fee	23%			$1,780.69	
Contingency	20%			$1,536.14	
Small Mine Reclamation - Low Cost Scenario Total				**$11,058.98**	

Small Mine Reclamation—High-Cost Scenario

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Mobilization					100 mile mobilization from city to access
Foreman	$31.85	8	hours	$254.80	Acting as foreman & operating excavator
Operator	$27.24	8	hours	$217.92	
Laborer/Operator	$17.89	8	hours	$143.12	
CAT 307 Excavator	$615.00	1	each	$615.00	RSMeans 015436500020, 015436502500
CAT 247 Skidsteer	$615.00	1	each	$615.00	RSMeans 015436500020, 015436502500
5,000 Gal Water Truck	$78.60	8	hours	$628.80	
4x4 Truck	$26.05	8	hours	$208.40	
Subtotal				$2,683.04	
Cost Reduction				-$1,341.52	Prorated discount (over 2 mines)
Mobilization Subtotal				**$1,341.52**	
Access				**$0.00**	Assuming no cost for building access to small mines, sufficient access already in place
Clearing and Grubbing	$3,275.00	0.046	acres	**$150.65**	RSMeans 311110100020
Waste-Rock Dumps		47	tons		
Foreman	$31.85	1.0	hours	$31.85	Acting as foreman, operating excavator
Operator	$27.24	1.0	hours	$27.24	
Laborer/Operator	$17.89	1.0	hours	$17.89	
CAT 307 Excavator	$49.76	1.0	hours	$49.76	Rounded to one hour for reasonableness
CAT 247B Skidsteer	$29.99	1.0	hours	$29.99	
5,000 Gal Water Truck	$78.60	0.5	hours	$39.30	
4x4 Truck	$26.05	0	hours	$0.00	
Waste-Rock Dumps Subtotal				**$196.03**	
Portals	$4,000.00	4	each	**$16,000.00**	Data from averaged ULP & BLM actual mine reclamation
Pits/Trenches		2	each		Cost covered by waste-rock dump above

Small Mine Reclamation—High-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Shafts		1	each		3'x3'
Laborer/Operator	$17.89	40	hours	$715.60	2 FTEs, 5 days
Lumber/Fasteners	$2,000.00	1	lump	$2,000.00	
Foam	$7.80	135	CF	$1,053.00	
Foam Applicator	$1,000.00	1	each	$1,000.00	Split with bored vent cost
Concrete (delivered)	$150.00	3	CY	$450.00	Assuming concrete is delivered locally
Shafts Subtotal				**$5,218.60**	
Bored Vents		1	each		Assuming diameter of vent is 12" wide, 10' deep, closure using low density mine closure foam
Operator	$27.24	8	hours		
Laborer/Operator	$17.89	8	hours		
Foam	$7.80	31	CF	$241.80	
Foam Applicator	$1,000.00	1	each	$1,000.00	Cost prorated over 2 mines
Bored Vents Subtotal				**$1,241.80**	
Structures/Debris	$1,000.00	2	each	**$2,000.00**	Abandoned Mine Land Inventory Manual, Section C: Cost Guidelines, modified for mine size
Demobilization	$1,341.52	1	each	**$1,341.52**	Same as mobilization
Revegetation	$1,009.00	1	acres	**$1,009.00**	RSMeans 329219130020
Subtotal				**$28,499.12**	
Design, Permits, Procurement	10%			$2,849.91	
Project Management	15%			$4,274.87	
Bonding	1%			$284.99	
G&A & Fee	23%			$8,259.04	
Contingency	20%			$7,124.78	
Small Mine Reclamation - High Cost Scenario Total				**$51,292.72**	

Small/Medium Mine Reclamation—Low-Cost Scenario

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Mobilization					100 mile mobilization from city to access
Foreman	$16.36	8	hours	$130.88	Acting as foreman & operating excavator
Operator	$13.66	8	hours	$109.28	
Laborer/Operator	$11.23	8	hours	$89.84	
CAT 307 Excavator	$615.00	1	each	$615.00	RSMeans 015436500020, 015436502500
CAT 247 Skidsteer	$615.00	1	each	$615.00	RSMeans 015436500020, 015436502500
5,000 Gal Water Truck	$78.60	8	hours	$628.80	
4x4 Truck	$26.05	8	hours	$208.40	
Subtotal				$2,397.20	
Cost Reduction				-$1,917.76	Prorated discount (over 5 mines)
Mobilization Subtotal				**$479.44**	
Access				**$0.00**	Assuming no cost for building access to small mines, sufficient access already in place
Clearing and Grubbing	$3,275.00	0.028	acres	**$91.70**	RSMeans 311110100020
Waste-Rock Dumps		125	tons		
Foreman	$16.36	1.1	hours	$18.00	Acting as foreman, operating excavator
Operator	$13.66	1.1	hours	$15.03	
Laborer/Operator	$11.23	1.1	hours	$12.35	
CAT 307 Excavator	$49.76	1.1	hours	$54.74	
CAT 247B Skidsteer	$29.99	1.1	hours	$32.99	
5,000 Gal Water Truck	$78.60	0.55	hours	$43.23	
4x4 Truck	$26.05	0	hours	$0.00	
Waste-Rock Dumps Subtotal				**$176.34**	
Portals	$4,000.00	1	each	**$4,000.00**	Data from ULP & BLM actual mine reclamation
Pits/Trenches		0	each		Cost covered by waste-rock dump above
Shafts		0	each		

Small/Medium Mine Reclamation—Low-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Bored Vents		0	each		Assuming diameter of vent is 18" wide, 10' deep, closure using low density mine closure foam
Operator	$13.66	0	hours		
Laborer/Operator	$11.23	0	hours		
Foam	$7.80	0	CF	$0.00	
Foam Applicator	$400.00	0	each	$0.00	Cost prorated over 5 mines
Bored Vents Subtotal				**$0.00**	
Structures/Debris	$3,000.00	0	each	**$0.00**	Abandoned Mine Land Inventory Manual, Section C: Cost Guidelines, modified for mine size
Demobilization	$479.44	1	each	**$479.44**	Same as mobilization
Revegetation	$1,009.00	1	acres	**$1,009.00**	RSMeans 329219130020
Subtotal				**$6,235.92**	
Design, Permits, Procurement	10%			$623.59	
Project Management	15%			$935.39	
Bonding	1%			$62.36	
G&A & Fee	23%			$1,807.17	
Contingency	20%			$1,558.98	
Small/Medium Mine Reclamation - Low Cost Scenario Total				**$11,223.41**	

Small/Medium Mine Reclamation—High-Cost Scenario

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Mobilization					100 mile mobilization from city to access
Foreman	$31.85	8	hours	$254.80	Acting as foreman & operating excavator
Operator	$27.24	8	hours	$217.92	
Laborer/Operator	$17.89	8	hours	$143.12	
CAT 307 Excavator	$615.00	1	each	$615.00	RSMeans 015436500020, 015436502500
CAT 247 Skidsteer	$615.00	1	each	$615.00	RSMeans 015436500020, 015436502500
5,000 Gal Water Truck	$78.60	8	hours	$628.80	
4x4 Truck	$26.05	8	hours	$208.40	
Subtotal				$2,683.04	
Cost Reduction				-$1,341.52	Prorated discount (over 2 mines)
Mobilization Subtotal				**$1,341.52**	
Access				**$0.00**	Assuming no cost for building access to small mines, sufficient access already in place
Clearing and Grubbing	$3,275.00	0.076	acres	**$248.90**	RSMeans 311110100020
Waste-Rock Dumps		165	tons		
Foreman	$31.85	1.4	hours	$44.59	Acting as foreman, operating excavator
Operator	$27.24	1.4	hours	$38.14	
Laborer/Operator	$17.89	1.4	hours	$25.05	
CAT 307 Excavator	$49.76	1.4	hours	$69.66	
CAT 247B Skidsteer	$29.99	1.4	hours	$41.99	
5,000 Gal Water Truck	$78.60	0.7	hours	$55.02	
4x4 Truck	$26.05	0	hours	$0.00	
Waste-Rock Dumps Subtotal				**$274.45**	
Portals	$4,000.00	4	each	**$16,000.00**	Data from ULP & BLM actual mine reclamation
Pits/Trenches		4	each		Cost covered by waste-rock dump above

Small/Medium Mine Reclamation—High-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Shafts		1	each		3'x3'
Laborer/Operator	$17.89	40	hours	$715.60	2 FTEs, 5 days
Lumber/Fasteners	$2,000.00	1	lump	$2,000.00	
Foam	$7.80	135	CF	$1,053.00	
Foam Applicator	$1,000.00	1	each	$1,000.00	Split with bored vent cost
Concrete (delivered)	$150.00	3	CY	$450.00	Assuming concrete is delivered locally
Shafts Subtotal				**$5,218.60**	
Bored Vents		3	each		Assuming diameter of vent is 12" wide, 10' deep, closure using low density mine closure foam
Operator	$27.24	24	hours		
Laborer/Operator	$17.89	24	hours		
Foam	$7.80	93	CF	$725.40	
Foam Applicator	$1,000.00	1	each	$1,000.00	Cost prorated over 2 mines
Bored Vents Subtotal				**$1,725.40**	
Structures/Debris	$3,000.00	2	each	**$6,000.00**	Abandoned Mine Land Inventory Manual, Section C: Cost Guidelines, modified for mine size
Demobilization	$1,341.52	1	each	**$1,341.52**	Same as mobilization
Revegetation	$1,009.00	1	acres	**$1,009.00**	RSMeans 329219130020
Subtotal				**$33,159.39**	
Design, Permits, Procurement	10%			$3,315.94	
Project Management	15%			$4,973.91	
Bonding	1%			$331.59	
G&A & Fee	23%			$9,609.59	
Contingency	20%			$8,289.85	
Small/Medium Mine Reclamation - High Cost Scenario Total				**$59,680.27**	

Final

Medium Mine Reclamation—Low-Cost Scenario

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Mobilization					100 mile mobilization from city to access
Foreman	$16.36	8	hours	$130.88	Acting as foreman & operating loader
Operator	$13.66	16	hours	$218.56	2 FTEs
Laborer/Operator	$11.23	16	hours	$179.68	2 FTEs
CAT 320 Excavator	$615.00	1	each	$615.00	RS Means 015436500020 RS Means 015436502500
CAT 966 Front Loader	$822.00	1	each	$822.00	RS Means 015436500100 RS Means 015436502500
CAT D6 Dozer	$615.00	1	each	$615.00	RS Means 015436500020 RS Means 015436502500
5,000 Gal Water Truck	$78.60	8	hours	$628.80	
4x4 Truck	$26.05	8	hours	$208.40	
Mobilization Subtotal				**$3,418.32**	
Access					Assuming 9 miles from the access point and requiring one mile of access construction
Foreman	$16.36	1	hours	$16.36	Acting as foreman & operating loader
Operator	$13.66	2	hours	$27.32	2 FTEs
Laborer/Operator	$11.23	2	hours	$22.46	2 FTEs
CAT 320 Excavator	$90.86	1	hours	$90.86	
CAT 966 Front Loader	$111.59	1	hours	$111.59	
CAT D6 Dozer	$99.55	1	hours	$99.55	Estimating 1 hour to complete access clearing
4x4 Truck	$26.05	1	hours	$26.05	
5,000 Gal Water Truck	$78.60	1	hours	$78.60	
Access Subtotal				**$472.79**	
Clearing and Grubbing	$3,275.00	0.055	acres	**$180.13**	RSMeans 311110100020
Waste-Rock Dumps		1600	tons		
Foreman	$16.36	7	hours	$114.52	Acting as foreman & operating loader
Operator	$13.66	14	hours	$191.24	2 FTEs
Laborer/Operator	$11.23	14	hours	$157.22	2 FTEs
CAT 320 Excavator	$90.86	7	hours	$636.02	
CAT 966 Front Loader	$111.59	7	hours	$781.13	
CAT D6 Dozer	$99.55	7	hours	$696.85	Assuming 100 yard push, limiting factor

Medium Mine Reclamation—Low-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
5,000 Gal Water Truck	$78.60	7	hours	$550.20	
4x4 Truck	$26.05	0	hours	$0.00	
Waste-Rock Dumps Subtotal				**$3,127.18**	
Portals	$4,000.00	1	each	**$4,000.00**	Data from ULP & BLM actual mine reclamation
Pits/Trenches		0			Cost covered by waste-rock dump above
Shafts		0	each		10'x10'x10 false work, 15'x10'x10 Low Density Mine Closure Foam, 5'x10'x10 concrete
Laborer/Operator	$11.23	0	hours	$0.00	2 FTEs, 5 days
Lumber/Fasteners	$2,000.00	0	lump	$0.00	
Foam	$7.80	0	CF	$0.00	
Foam Applicator	$1,000.00	0	each	$0.00	Split with bored vent cost
Concrete (delivered)	$150.00	0	CY	$0.00	Assuming concrete is delivered locally
Shafts Subtotal				**$0.00**	
Bored Vents		0	each		Assuming diameter of vent is 3' wide, 10' deep, closure using low density mine closure foam
Operator	$13.66	0	hours	$0.00	
Laborer/Operator	$11.23	0	hours	$0.00	
Foam	$7.80	0	CF	$0.00	
Foam Applicator	$1,000.00	0	each	$0.00	Split with shaft cost
Bored Vents Subtotal				**$0.00**	
Structures/Debris	$10,000.00	1	each	**$10,000.00**	Abandoned Mine Land Inventory Manual, Section C: Cost Guidelines
Demobilization	$3,418.32	1	each	**$3,418.32**	Same as mobilization
Revegetation	$1,009.00	1	acres	**$1,009.00**	RSMeans 329219130020
Subtotal				**$25,625.74**	
Design, Permits, Procurement	10%			$2,562.57	
Project Management	15%			$3,843.86	
Bonding	1%			$256.26	
G&A & Fee	23%			$7,426.34	
Contingency	$6,406.44	$6,406.44	$6,406.44	$6,406.44	
Medium Mine Reclamation - Low Cost Scenario Total				**$46,121.21**	

Medium Mine Reclamation—High-Cost Scenario

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Mobilization					100 mile mobilization from city to access
Foreman	$31.85	8	hours	$254.80	Acting as foreman & operating loader
Operator	$27.24	16	hours	$435.84	2 FTEs
Laborer/Operator	$17.89	16	hours	$286.24	2 FTEs
CAT 320 Excavator	$615.00	1	each	$615.00	RS Means 015436500020 RS Means 015436502500
CAT 966 Front Loader	$822.00	1	each	$822.00	RS Means 015436500100 RS Means 015436502500
CAT D6 Dozer	$615.00	1	each	$615.00	RS Means 015436500020 RS Means 015436502500
5,000 Gal Water Truck	$78.60	8	hours	$628.80	
4x4 Truck	$26.05	8	hours	$208.40	
Mobilization Subtotal				**$3,866.08**	
Access					Assuming 9 miles from the access point and requiring one mile of access construction
Foreman	$31.85	1	hours	$31.85	Acting as foreman & operating loader
Operator	$27.24	2	hours	$54.48	2 FTEs
Laborer/Operator	$17.89	2	hours	$35.78	2 FTEs
CAT 320 Excavator	$90.86	1	hours	$90.86	
CAT 966 Front Loader	$111.59	1	hours	$111.59	
CAT D6 Dozer	$99.55	1	hours	$99.55	Estimating 1 hour to complete access clearing
4x4 Truck	$26.05	1	hours	$26.05	
5,000 Gal Water Truck	$78.60	1	hours	$78.60	
Access Subtotal				**$528.76**	
Clearing and Grubbing	$3,275.00	0.103	acres	**$337.33**	RSMeans 311110100020
Waste-Rock Dumps		8400	tons		
Foreman	$31.85	37	hours	$1,178.45	Acting as foreman & operating loader
Operator	$27.24	74	hours	$2,015.76	2 FTEs
Laborer/Operator	$17.89	74	hours	$1,323.86	2 FTEs
CAT 320 Excavator	$90.86	37	hours	$3,361.82	
CAT 966 Front Loader	$111.59	37	hours	$4,128.83	
CAT D6 Dozer	$99.55	37	hours	$3,683.35	Assuming 100 yard push, limiting factor

Medium Mine Reclamation—High-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
5,000 Gal Water Truck	$78.60	37	hours	$2,908.20	
4x4 Truck	$26.05	0	hours	$0.00	
Waste-Rock Dumps Subtotal				**$18,600.27**	
Portals	$4,000.00	6	each	**$24,000.00**	Data from averaged ULP & BLM actual mine reclamation
Pits/Trenches		5			Cost covered by waste-rock dump above
Shafts		2	each		3'x3'x10 false work, 15'x3'x3' Low Density Mine Closure Foam, 5'x3'x3' concrete
Laborer/Operator	$17.89	80	hours	$1,431.20	2 FTEs, 5 days
Lumber/Fasteners	$2,000.00	2	lump	$4,000.00	
Foam	$7.80	270	CF	$2,106.00	
Foam Applicator	$1,000.00	2	each	$2,000.00	Split with bored vent cost
Concrete (delivered)	$150.00	6	CY	$900.00	Assuming concrete is delivered locally
Shafts Subtotal				**$10,437.20**	
Bored Vents		4	each		Assuming diameter of vent is 2' wide, 10' deep, closure using low density mine closure foam
Operator	$27.24	64	hours	$1,743.36	
Laborer/Operator	$17.89	64	hours	$1,144.96	
Foam	$7.80	504	CF	$3,931.20	
Foam Applicator	$1,000.00	1	each	$1,000.00	Split with shaft cost
Bored Vents Subtotal				**$7,819.52**	
Structures/Debris	$10,000.00	4	each	**$40,000.00**	Abandoned Mine Land Inventory Manual, Section C: Cost Guidelines
Demobilization	$3,866.08	1	each	**$3,866.08**	Same as mobilization
Revegetation	$1,009.00	1	acres	**$1,009.00**	RSMeans 329219130020
Subtotal				**$110,464.24**	
Design, Permits, Procurement	10%			$11,046.42	
Project Management	15%			$16,569.64	
Bonding	1%			$1,104.64	
G&A & Fee	23%			$32,012.54	
Contingency	20%			$27,616.06	
Medium Mine Reclamation - High Cost Scenario Total				**$198,813.54**	

Medium/Large Mine Reclamation—Low-Cost Scenario

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Mobilization					100 mile mobilization from city to access
Foreman	$16.36	8	hours	$130.88	
Operator	$13.66	24	hours	$327.84	3 FTEs
Laborer/Operator	$11.23	16	hours	$179.68	2 FTEs
CAT 320 Excavator	$615.00	1	each	$615.00	RS Means 015436500020 RS Means 015436502500
CAT 966 Front Loader	$822.00	1	each	$822.00	RS Means 015436500100 RS Means 015436502500
CAT D9 Dozer	$822.00	1	each	$822.00	RS Means 015436500020 RS Means 015436502500
CAT 725 Road Dump Truck	$822.00	2	each	$1,644.00	RS Means 015436500100 RS Means 015436502500
5,000 Gal Water Truck	$78.60	8	hours	$628.80	
Con Ex Box	$615.00	1	each	$615.00	RS Means 015436500020 RS Means 015436502500
4x4 Truck	$26.05	8	hours	$208.40	
Mobilization Subtotal				**$5,993.60**	
Access					Assuming 9 miles from the access point and requiring one mile of access construction
Foreman	$16.36	1	hours	$16.36	
Operator	$13.66	3	hours	$40.98	3 FTEs
Laborer/Operator	$11.23	2	hours	$22.46	2 FTEs
CAT 320 Excavator	$90.86	1	hours	$90.86	
CAT 966 Front Loader	$111.59	1	hours	$111.59	
CAT D9 Dozer	$268.94	1	hours	$268.94	Estimating 1 hour to complete access clearing
CAT 725 Road Dump Truck	$106.62	2	hours	$213.24	
5,000 Gal Water Truck	$78.60	1	hours	$78.60	
Con Ex Box	$1.79	1	hours	$1.79	
4x4 Truck	$26.05	1	hours	$26.05	
Access Subtotal				**$870.87**	
Clearing and Grubbing	$3,275.00	0.155	acres	**$507.63**	RSMeans 311110100020

Medium/Large Mine Reclamation—Low-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Waste-Rock Dumps	$16.36	164	hours	$2,675.34	
Foreman	$13.66	523	hours	$7,148.20	3 FTEs
Operator	$11.23	327	hours	$3,672.87	2 FTEs
Laborer/Operator	$90.86	164	hours	$14,858.28	
CAT 320 Excavator	$111.59	164	hours	$18,248.25	
CAT 966 Front Loader	$268.94	164	hours	$43,979.60	Assuming 200 yard push, limiting factor
CAT D9 Dozer	$106.62	33	hours	$3,487.10	2 trucks for import of top soil
CAT 725 Road Dump Truck	$78.60	82	hours	$6,426.71	
5,000 Gal Water Truck	$1.79	164	hours	$292.72	
Con Ex Box	$26.05	0	hours	$0.00	
4x4 Truck				**$100,789.07**	
Waste-Rock Dumps Subtotal	$3,000.00	1	each	**$3,000.00**	Data from ULP & BLM actual mine reclamation
Portals		0			Cost covered by waste-rock dump above
Pits/Trenches		0	each		(HxWxL) 10'x3'x3' false work, 15'x3'x3' Low Density Mine Closure Foam, 5'x3'x3' concrete
Shafts	$11.23	0	hours	$0.00	2 FTEs, 5 days per shaft
Laborer/Operator	$2,000.00	0	lump	$0.00	per shaft
Lumber/Fasteners	$7.80	0	CF	$0.00	1500 CF per shaft
Foam	$1,000.00	0	each	$0.00	Split with bored vent cost
Foam Applicator	$150.00	0	CY	$0.00	Assuming concrete is delivered locally
Concrete (delivered)				**$0.00**	
Shafts Subtotal	$16.36	164	hours	$2,675.34	
Bored Vents		1	each		Assuming diameter of vent is 3' wide, 10' deep, closure using low density mine closure foam
Operator	$13.66	16	hours	$218.56	2 days per vent
Laborer/Operator	$11.23	16	hours	$179.68	2 days per vent
Foam	$7.80	283	CF	$2,207.40	283 CF per vent
Foam Applicator	$1,000.00	1	each	$1,000.00	
Bored Vents Subtotal				**$3,605.64**	

Medium/Large Mine Reclamation—Low-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Structures/Debris	$30,000.00	1	each	**$30,000.00**	Abandoned Mine Land Inventory Manual, Section C: Cost Guidelines
Demobilization	$5,993.60	1	each	**$5,993.60**	Same as mobilization
Revegetation	$1,009.00	1	acres	**$1,009.00**	RSMeans 329219130020
Subtotal				**$151,769.41**	
Design, Permits, Procurement	10%			$15,176.94	
Project Management	15%			$22,765.41	
Bonding	1%			$1,517.69	
G&A & Fee	23%			$43,982.78	
Contingency	20%			$37,942.35	
Medium/Large Mine Reclamation - Low Cost Scenario Total				**$273,154.58**	

Medium/Large Mine Reclamation—High-Cost Scenario

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Mobilization					100 mile mobilization from city to access
Foreman	$31.85	8	hours	$254.80	
Operator	$27.24	24	hours	$653.76	3 FTEs
Laborer/Operator	$17.89	16	hours	$286.24	2 FTEs
CAT 320 Excavator	$615.00	1	each	$615.00	RS Means 015436500020 RS Means 015436502500
CAT 966 Front Loader	$822.00	1	each	$822.00	RS Means 015436500100 RS Means 015436502500
CAT D9 Dozer	$822.00	1	each	$822.00	RS Means 015436500020 RS Means 015436502500
CAT 725 Road Dump Truck	$822.00	2	each	$1,644.00	RS Means 015436500100 RS Means 015436502500
5,000 Gal Water Truck	$78.60	8	hours	$628.80	
Con Ex Box	$615.00	1	each	$615.00	RS Means 015436500020 RS Means 015436502500
4x4 Truck	$26.05	8	hours	$208.40	
Mobilization Subtotal				**$6,550.00**	
Access					Assuming 9 miles from the access point and requiring one mile of access construction
Foreman	$31.85	1	hours	$31.85	
Operator	$27.24	3	hours	$81.72	3 FTEs
Laborer/Operator	$17.89	2	hours	$35.78	2 FTEs
CAT 320 Excavator	$90.86	1	hours	$90.86	
CAT 966 Front Loader	$111.59	1	hours	$111.59	
CAT D9 Dozer	$268.94	1	hours	$268.94	Estimating 1 hour to complete access clearing
CAT 725 Road Dump Truck	$106.62	2	hours	$213.24	
5,000 Gal Water Truck	$78.60	1	hours	$78.60	
Con Ex Box	$1.79	1	hours	$1.79	
4x4 Truck	$26.05	1	hours	$26.05	
Access Subtotal				**$940.42**	
Clearing and Grubbing	$3,275.00	0.551	acres	**$1,804.53**	RSMeans 311110100020

Medium/Large Mine Reclamation—High-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Waste-Rock Dumps		82,000	tons		
Foreman	$31.85	241	hours	$7,681.47	
Operator	$27.24	772	hours	$21,022.87	3 FTEs
Laborer/Operator	$17.89	482	hours	$8,629.29	2 FTEs
CAT 320 Excavator	$90.86	241	hours	$21,913.29	
CAT 966 Front Loader	$111.59	241	hours	$26,912.88	
CAT D9 Dozer	$268.94	241	hours	$64,862.00	Assuming 200 yard push, limiting factor
CAT 725 Road Dump Truck	$106.62	48	hours	$5,142.85	2 trucks for import of top soil
5,000 Gal Water Truck	$78.60	121	hours	$9,478.24	
Con Ex Box	$1.79	241	hours	$431.71	
4x4 Truck	$26.05	0	hours	$0.00	
Waste-Rock Dumps Subtotal				**$166,074.60**	
Portals	$3,000.00	4	each	**$12,000.00**	Data from averaged ULP & BLM actual mine reclamation
Pits/Trenches		4			Cost covered by waste-rock dump above
Shafts		3	each		(HxWxL) 10'x3'x3' false work, 15'x3'x3' Low Density Mine Closure Foam, 5'x3'x3' concrete
Laborer/Operator	$17.89	120	hours	$2,146.80	2 FTEs, 5 days per shaft
Lumber/Fasteners	$2,000.00	3	lump	$6,000.00	per shaft
Foam	$7.80	405	CF	$3,159.00	1500 CF per shaft
Foam Applicator	$1,000.00	3	each	$3,000.00	Split with bored vent cost
Concrete (delivered)	$150.00	6	CY	$900.00	Assuming concrete is delivered locally
Shafts Subtotal				**$15,205.80**	
Bored Vents		6	each		Assuming diameter of vent is 3' wide, 10' deep, closure using low density mine closure foam
Operator	$27.24	96	hours	$2,615.04	2 days per vent
Laborer/Operator	$17.89	96	hours	$1,717.44	2 days per vent
Foam	$7.80	1698	CF	$13,244.40	283 CF per vent
Foam Applicator	$1,000.00	1	each	$1,000.00	Split with shaft cost, 1 per site
Bored Vents Subtotal				**$18,576.88**	

Medium/Large Mine Reclamation—High-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Structures/Debris	$30,000.00	5	each	**$150,000.00**	Abandoned Mine Land Inventory Manual, Section C: Cost Guidelines
Demobilization	$6,550.00	1	each	**$6,550.00**	Same as mobilization
Revegetation	$1,009.00	1	acres	**$1,009.00**	RSMeans 329219130020
Subtotal				**$378,711.23**	
Design, Permits, Procurement	10%			$37,871.12	
Project Management	15%			$56,806.68	
Bonding	1%			$3,787.11	
G&A & Fee	23%			$109,750.51	
Contingency	20%			$94,677.81	
Medium/Large Mine Reclamation - High Cost Scenario Total				**$681,604.47**	

Large Mine Reclamation—Low-Cost Scenario

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Mobilization					100 mile mobilization from city to access
Foreman	$16.36	16	hours	$261.76	2 FTEs
Operator	$13.66	48	hours	$655.68	6 FTEs
Laborer/Operator	$11.23	32	hours	$359.36	4 FTEs
CAT 320 Excavator	$615.00	2	each	$1,230.00	RS Means 015436500020 RS Means 015436502500
CAT 966 Front Loader	$822.00	2	each	$1,644.00	RS Means 015436500100 RS Means 015436502500
CAT D9 Dozer	$822.00	2	each	$1,644.00	RS Means 015436500020 RS Means 015436502500
CAT 725 Road Dump Truck	$822.00	4	each	$3,288.00	RS Means 015436500100 RS Means 015436502500
5,000 Gal Water Truck	$78.60	16	hours	$1,257.60	2 pieces
Con Ex Box	$615.00	4	each	$2,460.00	RS Means 015436500020 RS Means 015436502500
4x4 Truck	$26.05	32	hours	$833.60	4 trucks
Mobilization Subtotal				**$13,634.00**	
Access					Assuming 9 miles from the access point and requiring one mile of access construction
Foreman	$16.36	1	hours	$16.36	
Operator	$13.66	3	hours	$40.98	3 FTEs
Laborer/Operator	$11.23	2	hours	$22.46	2 FTEs
CAT 320 Excavator	$90.86	1	hours	$90.86	
CAT 966 Front Loader	$111.59	1	hours	$111.59	
CAT D9 Dozer	$268.94	1	hours	$268.94	Estimating 1 hour to complete access clearing
CAT 725 Read Dump Truck	$106.62	2	hours	$213.24	
5,000 Gal Water Truck	$78.60	1	hours	$78.60	
Con Ex Box	$1.79	1	hours	$1.79	
4x4 Truck	$26.05	1	hours	$26.05	
Access Subtotal				**$870.87**	
Clearing and Grubbing	$3,275.00	1.0	acres	**$3,275.00**	RSMeans 311110100020

Large Mine Reclamation—Low-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Waste-Rock Dumps		107,200	tons		
Foreman	$16.36	315	hours	$5,158.21	2 FTEs
Operator	$13.66	1072	hours	$14,643.52	6 FTEs
Laborer/Operator	$11.23	631	hours	$7,081.51	4 FTEs
CAT 320 Excavator	$90.86	315	hours	$28,647.62	
CAT 966 Front Loader	$111.59	315	hours	$35,183.67	
CAT D9 Dozer	$268.94	315	hours	$84,795.20	Assuming 200 yard push, limiting factor
CAT 725 Road Dump Truck	$106.62	126	hours	$13,446.66	4 trucks for import of top soil
5,000 Gal Water Truck	$78.60	158	hours	$12,391.06	
Con Ex Box	$1.79	1261	hours	$2,257.51	
4x4 Truck	$26.05	0	hours	$0.00	
Waste-Rock Dumps Subtotal				**$203,604.96**	
Portals	$3,000.00	1	each	**$3,000.00**	Data from averaged ULP & BLM actual mine reclamation
Pits/Trenches		1			Cost covered by waste-rock dump above
Shafts		1	each		10'x8'x8' false work, 15'x8'x8' Low Density Mine Closure Foam, 5'x8'x8' concrete
Laborer/Operator	$11.23	40	hours	$449.20	2 FTEs, 5 days per shaft
Lumber/Fasteners	$2,000.00	1	lump	$2,000.00	Per shaft
Foam	$7.80	960	CF	$7,488.00	1500 CF per shaft
Foam Applicator	$1,000.00	1	each	$1,000.00	Split with bored vent cost
Concrete (delivered)	$150.00	12	CY	$1,800.00	Assuming concrete is delivered locally
Shafts Subtotal				**$12,737.20**	
Bored Vents		1	each		Assuming diameter of vent is 3' wide, 10' deep, closure using low density mine closure foam
Operator	$13.66	16	hours	$218.56	2 days per vent
Laborer/Operator	$11.23	16	hours	$179.68	2 days per vent
Foam	$7.80	283	CF	$2,207.40	283 CF per vent
Foam Applicator	$1,000.00	1	each	$1,000.00	Split with shaft cost, 1 per site
Bored Vents Subtotal				**$3,605.64**	

Large Mine Reclamation—Low-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Structures/Debris	$50,000.00	1	each	**$50,000.00**	Abandoned Mine Land Inventory Manual, Section C: Cost Guidelines
Demobilization	$13,634.00	1	each	**$13,634.00**	Same as mobilization
Revegetation	$1,009.00	4.6	acres	**$4,641.40**	RSMeans 329219130020
Subtotal				**$309,003.07**	
Design, Permits, Procurement	10%			$30,900.31	
Project Management	15%			$46,350.46	
Bonding	1%			$3,090.03	
G&A & Fee	23%			$89,549.09	
Contingency	20%			$77,250.77	
Large Mine Reclamation - Low Cost Scenario Total				**$556,143.73**	

Large Mine Reclamation—High-Cost Scenario

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Mobilization					100 mile mobilization from city to access
Foreman	$31.85	16	hours	$509.60	2 FTEs
Operator	$27.24	48	hours	$1,307.52	6 FTEs
Laborer/Operator	$17.89	32	hours	$572.48	4 FTEs
CAT 320 Excavator	$615.00	2	each	$1,230.00	RS Means 015436500020 RS Means 015436502500
CAT 966 Front Loader	$822.00	2	each	$1,644.00	RS Means 015436500100 RS Means 015436502500
CAT D9 Dozer	$822.00	2	each	$1,644.00	RS Means 015436500020 RS Means 015436502500
CAT 725 Road Dump Truck	$822.00	4	each	$3,288.00	RS Means 015436500100 RS Means 015436502500
5,000 Gal Water Truck	$78.60	16	hours	$1,257.60	2 pieces
Con Ex Box	$615.00	4	each	$2,460.00	RS Means 015436500020 RS Means 015436502500
4x4 Truck	$26.05	32	hours	$833.60	4 trucks
Mobilization Subtotal				**$14,746.80**	
Access					Assuming 9 miles from the access point and requiring one mile of access construction
Foreman	$31.85	1	hours	$31.85	
Operator	$27.24	3	hours	$81.72	3 FTEs
Laborer/Operator	$17.89	2	hours	$35.78	2 FTEs
CAT 320 Excavator	$90.86	1	hours	$90.86	
CAT 966 Front Loader	$111.59	1	hours	$111.59	
CAT D9 Dozer	$268.94	1	hours	$268.94	Estimating 1 hour to complete access clearing
CAT 725 Read Dump Truck	$106.62	2	hours	$213.24	
5,000 Gal Water Truck	$78.60	1	hours	$78.60	
Con Ex Box	$1.79	1	hours	$1.79	
4x4 Truck	$26.05	1	hours	$26.05	
Access Subtotal				**$940.42**	
Clearing and Grubbing	$3,275.00	4.4	acres	**$14,410.00**	RSMeans 311110100020

Large Mine Reclamation—High-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Waste-Rock Dumps		200,000	tons		
Foreman	$31.85	588	hours	$18,735.29	2 FTEs
Operator	$27.24	2000	hours	$54,480.00	6 FTEs
Laborer/Operator	$17.89	1176	hours	$21,047.06	4 FTEs
CAT 320 Excavator	$90.86	588	hours	$53,447.06	
CAT 966 Front Loader	$111.59	588	hours	$65,641.18	
CAT D9 Dozer	$268.94	588	hours	$158,200.00	Assuming 200 yard push, limiting factor
CAT 725 Road Dump Truck	$106.62	235	hours	$25,087.06	4 trucks for import of top soil
5,000 Gal Water Truck	$78.60	294	hours	$23,117.65	
Con Ex Box	$1.79	2353	hours	$4,211.76	
4x4 Truck	$26.05	0	hours	$0.00	
Waste-Rock Dumps Subtotal				**$423,967.06**	
Portals	$3,000.00	2	each	**$6,000.00**	Data from averaged ULP & BLM actual mine reclamation
Pits/Trenches		2			Cost covered by waste-rock dump above
Shafts		2	each		10'x8'x8' false work, 15'x8'x8' Low Density Mine Closure Foam, 5'x8'x8' concrete
Laborer/Operator	$17.89	80	hours	$1,431.20	2 FTEs, 5 days per shaft
Lumber/Fasteners	$2,000.00	2	lump	$4,000.00	Per shaft
Foam	$7.80	1920	CF	$14,976.00	1500 CF per shaft
Foam Applicator	$1,000.00	1	each	$1,000.00	Split with bored vent cost
Concrete (delivered)	$150.00	24	CY	$3,600.00	Assuming concrete is delivered locally
Shafts Subtotal				**$25,007.20**	
Bored Vents		4	each		Assuming diameter of vent is 3' wide, 10' deep, closure using low density mine closure foam
Operator	$27.24	64	hours	$1,743.36	2 days per vent
Laborer/Operator	$17.89	64	hours	$1,144.96	2 days per vent
Foam	$7.80	1132	CF	$8,829.60	283 CF per vent
Foam Applicator	$1,000.00	1	each	$1,000.00	Split with shaft cost, 1 per site
Bored Vents Subtotal				**$12,717.92**	

Large Mine Reclamation—High-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Structures/Debris	$50,000.00	5	each	**$250,000.00**	Abandoned Mine Land Inventory Manual, Section C: Cost Guidelines
Demobilization	$14,746.80	1	each	**$14,746.80**	Same as mobilization
Revegetation	$1,009.00	4.6	acres	**$4,641.40**	RSMeans 329219130020
Subtotal				**$767,177.60**	
Design, Permits, Procurement	10%			$76,717.76	
Project Management	15%			$115,076.64	
Bonding	1%			$7,671.78	
G&A & Fee	23%			$222,328.07	
Contingency	20%			$191,794.40	
Large Mine Reclamation - High Cost Scenario Total				**$1,380,766.24**	

Remediation Unit Cost—Low-Cost Scenario

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Mobilization					100 mile mobilization from city to access
Foreman	$16.36	8	hours	$130.88	1 FTEs
Operator	$13.66	48	hours	$655.68	6 FTEs
Laborer/Operator	$11.23	32	hours	$359.36	4 FTEs
CAT 320 Excavator	$615.00	2	each	$1,230.00	RS Means 015436500020 RS Means 015436502500
CAT 966 Front Loader	$822.00	2	each	$1,644.00	RS Means 015436500100 RS Means 015436502500
CAT D9 Dozer	$822.00	2	each	$1,644.00	RS Means 015436500020 RS Means 015436502500
CAT 725 Read Dump Truck	$822.00	7	each	$5,754.00	RS Means 015436500100 RS Means 015436502500
CAT 140 Motor Grader	$615.00	1	each	$615.00	RS Means 015436500020 RS Means 015436502500
5,000 Gal Water Truck	$78.60	16	hours	$1,257.60	2 pieces
Con Ex Box	$615.00	4	each	$2,460.00	RS Means 015436500020 RS Means 015436502500
4x4 Truck	$26.05	32	hours	$833.60	4 trucks
Mobilization Subtotal				**$16,584.12**	
Access					Assuming 9 miles from the access point and requiring one mile of access construction
Foreman	$16.36	1	hours	$16.36	1 FTEs
Operator	$13.66	6	hours	$81.96	6 FTEs
Laborer/Operator	$11.23	4	hours	$44.92	4 FTEs
CAT 320 Excavator	$90.86	1	hours	$90.86	
CAT 966 Front Loader	$111.59	1	hours	$111.59	
CAT D9 Dozer	$268.94	1	hours	$268.94	Estimating 1 hour to complete access clearing
CAT 725 Read Dump Truck	$106.62	4	hours	$426.48	
CAT 140 Motor Grader	$93.63	2	hours	$187.26	Estimating 2 hours for road grading
5,000 Gal Water Truck	$78.60	2	hours	$157.20	Estimating 2 hours for dust control
Con Ex Box	$1.79	1	hours	$1.79	
4x4 Truck	$26.05	1	hours	$26.05	
Access Subtotal				**$1,413.41**	

Remediation Unit Cost—Low-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Clearing and Grubbing	$3,275.00	43.10	acres	**$141,159.86**	Data derived from AEC locations and mine sizes, plus additional 20% for lay down and construction access
Repository Excavation		4,172,298	tons		Data derived from AEC locations and mine sizes
Foreman	$16.36	13416	hours	$219,481.66	1 FTEs
Operator	$13.66	93061	hours	$1,271,215.26	6 FTEs
Laborer/Operator	$11.23	26831	hours	$301,317.73	4 FTEs
CAT 320 Excavator	$90.86	13416	hours	$1,218,954.97	
CAT 966 Front Loader	$111.59	13416	hours	$1,497,063.45	
CAT D9 Dozer	$268.94	13416	hours	$3,608,031.59	Assuming 200 yard push, limiting factor
CAT 725 Read Dump Truck	$106.62	52814	hours	$5,631,017.88	4 trucks, 1 mile haul
5,000 Gal Water Truck	$78.60	6708	hours	$527,238.94	
Con Ex Box	$1.79	53663	hours	$96,056.76	
4x4 Truck	$26.05	0	hours	$0.00	
Repository Excavation Subtotal				**$14,370,378.24**	
Repository Bottom Liner Installation		1,564,612	SF		Data derived from AEC locations and mine sizes
Sand	$30.00	93,877	tons	$2,816,300.92	1 ' lift, delivered from local source
Gravel	$30.00	93,877	tons	$2,816,300.92	1 ' lift, delivered from local source
Liner (40 mil HDPE)	$1.37	1,564,612	sf	$2,143,517.92	RSMeans 334713531200 (Includes Install)
Impervious Clay Layer	$0.00	187,753	tons	$0.00	2 ' lift, local borrow source within 5 miles
Foreman	$23.97	1104	hours	$26,473.23	1 FTEs
Operator	$19.12	10198	hours	$194,992.83	6 FTEs
Laborer/Operator	$14.88	2209	hours	$32,867.89	4 FTEs
CAT 320 Excavator	$90.86	3995	hours	$362,963.26	Loading trucks for haul
CAT 966 Front Loader	$111.59	1104	hours	$123,243.54	
CAT D9 Dozer	$268.94	1104	hours	$297,025.87	Assuming 200 yard push
CAT 725 Read Dump Truck	$106.62	3995	hours	$425,920.57	4 trucks
5,000 Gal Water Truck	$78.60	1997	hours	$156,993.80	

Remediation Unit Cost—Low-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Con Ex Box	$1.79	15979	hours	$28,602.43	
4x4 Truck	$26.05	0	hours	$0.00	
Repository Bottom Liner Installation Subtotal				**$9,425,203.18**	
Load and Transport of Waste		4,172,298	tons		
Foreman	$16.36	13416	hours	$219,481.66	1 FTEs
Operator	$13.66	173889	hours	$2,375,320.31	6 FTEs
Laborer/Operator	$11.23	26831	hours	$301,317.73	4 FTEs
CAT 320 Excavator	$90.86	13416	hours	$1,218,954.97	Loading trucks for haul
CAT 725 Read Dump Truck	$106.62	160473	hours	$17,109,631.26	7 trucks, Assuming 10 mile haul from mine to Repository
5,000 Gal Water Truck	$78.60	13416	hours	$1,054,477.89	
Con Ex Box	$1.79	53663	hours	$96,056.76	
4x4 Truck	$26.05	0	hours	$0.00	
Load and Transport of Waste Subtotal				**$22,375,240.58**	
Placement of Waste		4,172,298	tons		Data derived from AEC locations and mine sizes
Foreman	$16.36	12271	hours	$200,761.16	1 FTEs
Operator	$13.66	24543	hours	$335,256.42	6 FTEs
Laborer/Operator	$11.23	24543	hours	$275,617.10	4 FTEs
CAT 966 Front Loader	$111.59	12271	hours	$1,369,372.75	
CAT D9 Dozer	$268.94	12271	hours	$3,300,287.72	Assuming 200 yard push, limiting factor
5,000 Gal Water Truck	$78.60	12271	hours	$964,537.13	
Con Ex Box	$1.79	49086	hours	$87,863.69	
4x4 Truck	$26.05	0	hours	$0.00	
Placement of Waste Subtotal				**$6,533,695.97**	
UMTRA Title 1 Repository Cap Installation		1,564,612	SF		Data derived from AEC locations and mine sizes.
Erosion Protection (Rock-Soil Matrix)	$30.00	93,877	tons	$2,816,300.92	1 ' lift, delivered from local source
Radon Barrier (Clay)	$0.00	140,815	tons	$0.00	1.5 ' lift, local borrow source within 5 miles
Bedding Layer (Local Soil)	$0.00	46,938.35	tons	$0.00	.5 ' lift, local borrow source within 5 miles
Foreman	$16.36	828	hours	$13,551.38	1 FTEs

Remediation Unit Cost—Low-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Operator	$13.66	9646	hours	$131,766.46	6 FTEs
Laborer/Operator	$11.23	1657	hours	$18,604.15	4 FTEs
CAT 320 Excavator	$90.86	3995	hours	$362,963.26	Loading trucks for haul
CAT 966 Front Loader	$111.59	828	hours	$92,432.65	
CAT D9 Dozer	$268.94	828	hours	$222,769.40	Assuming 200 yard push
CAT 725 Read Dump Truck	$106.62	3995	hours	$425,920.57	4 trucks
5,000 Gal Water Truck	$78.60	1997	hours	$156,993.80	
Con Ex Box	$1.79	15979	hours	$28,602.43	
4x4 Truck	$26.05	0	hours	$0.00	
UMTRA Title 1 Repository Cap Installation Subtotal				**$4,269,905.02**	
Demobilization	$16,584.12	1	each	**$16,584.12**	Same as mobilization
Revegetation	$1,009.00	43.1	acres	**$43,490.17**	RSMeans 329219130020
Subtotal				**$57,193,654.67**	
Studies, Design, Permits, Procurement	25%			$14,298,413.67	
Project Management	15%			$8,579,048.20	
Bonding	1%			$571,936.55	
G&A & Fee	23%			$18,547,902.21	
Contingency	20%			$16,014,223.31	
Remediation Unit Cost - Low Cost Scenario Total				**$115,205,178.60**	
Cost Per Ton				**$27.61**	

Remediation Unit Cost—High-Cost Scenario

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Mobilization					100 mile mobilization from city to access
Foreman	$31.85	8	hours	$254.80	1 FTEs
Operator	$27.24	48	hours	$1,307.52	6 FTEs
Laborer/Operator	$17.89	32	hours	$572.48	4 FTEs
CAT 320 Excavator	$615.00	2	each	$1,230.00	RS Means 015436500020 RS Means 015436502500
CAT 966 Front Loader	$822.00	2	each	$1,644.00	RS Means 015436500100 RS Means 015436502500
CAT D9 Dozer	$822.00	2	each	$1,644.00	RS Means 015436500020 RS Means 015436502500
CAT 725 Read Dump Truck	$822.00	7	each	$5,754.00	RS Means 015436500100 RS Means 015436502500
CAT 140 Motor Grader	$615.00	1	each	$615.00	RS Means 015436500020 RS Means 015436502500
5,000 Gal Water Truck	$78.60	16	hours	$1,257.60	2 pieces
Con Ex Box	$615.00	4	each	$2,460.00	RS Means 015436500020 RS Means 015436502500
4x4 Truck	$26.05	32	hours	$833.60	4 trucks
Mobilization Subtotal				**$17,573.00**	
Access					Assuming 9 miles from the access point and requiring one mile of access construction
Foreman	$31.85	1	hours	$31.85	1 FTEs
Operator	$27.24	6	hours	$163.44	6 FTEs
Laborer/Operator	$17.89	4	hours	$71.56	4 FTEs
CAT 320 Excavator	$90.86	1	hours	$90.86	
CAT 966 Front Loader	$111.59	1	hours	$111.59	
CAT D9 Dozer	$268.94	1	hours	$268.94	Estimating 1 hour to complete access clearing
CAT 725 Read Dump Truck	$106.62	4	hours	$426.48	
CAT 140 Motor Grader	$93.63	2	hours	$187.26	Estimating 2 hours for road grading
5,000 Gal Water Truck	$78.60	2	hours	$157.20	Estimating 2 hours for dust control
Con Ex Box	$1.79	1	hours	$1.79	
4x4 Truck	$26.05	1	hours	$26.05	
Access Subtotal				**$1,537.02**	

Remediation Unit Cost—High-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Clearing and Grubbing	$3,275.00	0.21	acres	**$687.03**	Data derived from AEC locations and mine sizes, additional 20% for lay down and construction access
Repository Excavation		20,308	tons		Data derived from AEC locations and mine sizes
Foreman	$31.85	65	hours	$2,079.77	1 FTEs
Operator	$27.24	453	hours	$12,338.64	6 FTEs
Laborer/Operator	$17.89	131	hours	$2,336.40	4 FTEs
CAT 320 Excavator	$90.86	65	hours	$5,933.07	
CAT 966 Front Loader	$111.59	65	hours	$7,286.72	
CAT D9 Dozer	$268.94	65	hours	$17,561.52	Assuming 200 yard push, limiting factor
CAT 725 Read Dump Truck	$106.62	257	hours	$27,408.09	4 trucks, 1 mile haul
5,000 Gal Water Truck	$78.60	33	hours	$2,566.25	
Con Ex Box	$1.79	261	hours	$467.54	
4x4 Truck	$26.05	0	hours	$0.00	
Repository Excavation Subtotal				**$77,978.00**	
Repository Bottom Liner Installation		7,615	SF		Data derived from AEC locations and mine sizes
Sand	$30.00	913.80	tons	$27,414.00	2 ' lift, delivered from local source
Gravel	$30.00	913.80	tons	$27,414.00	2 ' lift, delivered from local source
Liner (40 mil HDPE)	$1.37	7,615	sf	$10,432.55	RSMeans 334713531200 (Includes Install)
Impervious Clay Layer	$0.00	1,827.60	tons	$0.00	4 ' lift, local borrow source within 20 miles
Foreman	$23.97	11	hours	$257.69	1 FTEs
Operator	$19.12	303	hours	$5,787.06	6 FTEs
Laborer/Operator	$14.88	22	hours	$319.94	4 FTEs
CAT 320 Excavator	$90.86	141	hours	$12,773.52	Loading trucks for haul
CAT 966 Front Loader	$111.59	11	hours	$1,199.66	
CAT D9 Dozer	$268.94	11	hours	$2,891.26	Assuming 200 yard push
CAT 725 Read Dump Truck	$106.62	141	hours	$14,989.13	4 trucks
5,000 Gal Water Truck	$78.60	70	hours	$5,524.98	

Remediation Unit Cost—High-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Con Ex Box	$1.79	562	hours	$1,006.59	
4x4 Truck	$26.05	0	hours	$0.00	
Repository Bottom Liner Installation Subtotal				**$110,010.38**	
Load and Transport of Waste	$31.85	65	hours	$2,079.77	1 FTEs
Foreman	$27.24	846	hours	$23,055.28	6 FTEs
Operator	$17.89	131	hours	$2,336.40	4 FTEs
Laborer/Operator	$90.86	65	hours	$5,933.07	Loading trucks for haul
CAT 320 Excavator	$106.62	781	hours	$83,278.42	7 trucks, Assuming 10 mile haul from mine to Repository
CAT 725 Read Dump Truck	$78.60	65	hours	$5,132.50	
5,000 Gal Water Truck	$1.79	261	hours	$467.54	
Con Ex Box	$26.05	0	hours	$0.00	
4x4 Truck				**$122,282.98**	
Load and Transport of Waste Subtotal	$31.85	65	hours	$2,079.77	1 FTEs
Placement of Waste		20,308	tons		Data derived from AEC locations and mine sizes
Foreman	$31.85	60	hours	$1,902.38	1 FTEs
Operator	$27.24	119	hours	$3,254.06	6 FTEs
Laborer/Operator	$17.89	119	hours	$2,137.12	4 FTEs
CAT 966 Front Loader	$111.59	60	hours	$6,665.21	
CAT D9 Dozer	$268.94	60	hours	$16,063.63	Assuming 200 yard push, limiting factor
5,000 Gal Water Truck	$78.60	60	hours	$4,694.73	
Con Ex Box	$1.79	239	hours	$427.66	
4x4 Truck	$26.05	0	hours	$0.00	
Placement of Waste Subtotal				**$35,144.79**	
UMTRA Title 1 Repository Cap Installation		7,615	SF		Data derived from AEC locations and mine sizes
Erosion Protect (Topsoil)	$40.00	457	tons	$18,276.00	1' lift, delivered from local source
Bio-intrusion Layer (Riprap)	$30.00	228	tons	$6,853.50	.5' lift, delivered from local source
Capillary Break (Sand)	$30.00	457	tons	$13,707.00	1' lift, delivered from local source
Freeze/Thaw Barrier (Clay)	$0.00	1,142	tons	$0.00	2.5' lift, local borrow source within 5 miles

Remediation Unit Cost—High-Cost Scenario (continued)

Item	Unit Price	Qty.	U/M	Total	Notes/Assumptions
Radon Barrier (Geotextile Bentonite Layer)	$0.65	7,615	sf	$4,949.75	Includes Install
Radon Barrier (Clay)	$0.00	913.80	tons	$0.00	2' lift, local borrow source within 5 miles
Bedding Layer (Local Soil)	$0.00	228	tons	$0.00	.5' lift, local borrow source within 5 miles
Foreman	$31.85	10	hours	$318.50	1 FTEs
Operator	$27.24	371	hours	$10,118.61	6 FTEs
Laborer/Operator	$17.89	20	hours	$357.80	4 FTEs
CAT 320 Excavator	$90.86	176	hours	$15,966.90	Loading trucks for haul
CAT 966 Front Loader	$111.59	10	hours	$1,115.90	
CAT D9 Dozer	$268.94	10	hours	$2,689.40	Assuming 200 yard push
CAT 725 Read Dump Truck	$106.62	176	hours	$18,736.41	4 trucks
5,000 Gal Water Truck	$78.60	88	hours	$6,906.22	
Con Ex Box	$1.79	703	hours	$1,258.23	
4x4 Truck	$26.05	0	hours	$0.00	
UMTRA Title 1 Repository Cap Installation Subtotal				**$101,254.22**	
Demobilization	$17,573.00	1	each	**$17,573.00**	Same as mobilization
Revegetation	$1,009.00	0.21	acres	**$211.67**	RSMeans 329219130020
Subtotal				**$484,252.09**	
Studies, Design, Permits, Procurement	25%			$121,063.02	
Project Management	15%			$72,637.81	
Bonding	1%			$4,842.52	
G&A & Fee	23%			$157,042.95	
Contingency	20%			$135,590.59	
Remediation Unit Cost - High Cost Scenario Total				**$975,428.98**	
Cost Per Ton				**$48.03**	

Long-Term Surveillance and Maintenance (LTS&M)

Warning Sign and 3 Strand Barbed Wire Fence		1	acre		
Item	**Unit Price**	**Qty.**	**U/M**	**Total**	**Notes/Assumptions**
Warning Sign and 3 Strand Barbed Wire Fence		211	ft		Assumption
3 Strand Barbed Wire Fence	$22.25	211	LF	$4,694.75	RS Means 323113200200
Warning Sign	$60.00	2	each	$120.00	1 per 100 ft
Warning Sign and 3 Strand Barbed Wire Fence Subtotal				**$4,814.75**	
Subtotal				**$4,814.75**	
Studies, Design, Permits, Procurement	10%			$481.48	
Project Management	15%			$722.21	
Bonding	1%			$48.15	
G&A & Fee	23%			$1,395.31	
Contingency	20%			$1,203.69	
Warning Sign And 3 Strand Barbed Wire Fence Total				**$8,665.59**	
Price per acre				**$8,665.59**	
10 Years of Inspecting of Mines	1	acre			
Item	**Unit Price**	**Qty.**	**U/M**	**Total**	**Notes/Assumptions**
Mobilization					100 mile mobilization from city to access
Laborer/Operator	$17.89	320	hours	$5,724.80	2 FTEs, 20 mobilizations
Mobilization Subtotal				**$5,724.80**	
Inspection					100 mile mobilization from city to access
Laborer/Operator	$17.89	800	hours	$14,312.00	2 FTEs, 8 hours per inspection
Inspection Subtotal				**$14,312.00**	
10 Years of Inspecting of Mines Subtotal				**$5,724.80**	
Subtotal				**$20,036.80**	
Studies, Design, Permits, Procurement	0%			$0.00	
Project Management	15%			$3,005.52	
Bonding	1%			$200.37	
G&A & Fee	23%			$5,345.82	
Contingency	20%			$4,608.46	
10 Years of Inspecting Of Mines Total				**$33,196.97**	
Price Per Acre				**$33,196.97**	

Long-Term Surveillance and Maintenance (LTS&M) (continued)

30 Years of Inspecting of Repositories	30	years			
Item	**Unit Price**	**Qty.**	**U/M**	**Total**	**Notes/Assumptions**
Mobilization					100 mile mobilization from city to access
Laborer/Operator	$17.89	960	hours	$17,174.40	2 FTEs, 20 mobilizations
Mobilization Subtotal				**$17,174.40**	
Inspection					100 mile mobilization from city to access
Laborer/Operator	$17.89	960	hours	$17,174.40	2 FTEs, 8 hours per inspection
Inspection Subtotal				**$17,174.40**	
30 Years of Inspecting of Repositories Subtotal				**$17,174.40**	
Subtotal				**$34,348.80**	
Studies, Design, Permits, Procurement	0%			$0.00	
Project Management	15%			$5,152.32	
Bonding	1%			$343.49	
G&A & Fee	23%			$9,164.26	
Contingency	20%			$7,900.22	
30 Years of Inspecting Of Repositories Total				**$56,909.09**	
Price per year				**$1,896.97**	
Groundwater and Surface Water Monitoring at Repositories for 10 years					
Item	**Unit Price**	**Qty.**	**U/M**	**Total**	**Notes/Assumptions**
Initial Monitoring Wells					Assuming already on site
Installation of wells	$4,240.60	5	each	$21,203.00	RSMeans 014523507700
Initial Monitoring Wells Subtotal				**$21,203.00**	
Replacement Monitoring Wells					Assuming already on site
Installation of wells	$4,240.60	2	each	$8,481.20	1 every 5 years
Replacement Monitoring Wells Subtotal				**$8,481.20**	
Sampling Mobilization					100 mile mobilization from city to access
Laborer/Operator	$17.89	160	hours	$2,862.40	2 FTEs, 10 mobilizations
Sampling Mobilization Subtotal				**$2,862.40**	

Long-Term Surveillance and Maintenance (LTS&M) (continued)

Sampling					100 mile mobilization from city to access
Laborer/Operator	$17.89	160	hours	$2,862.40	2 FTEs, 8 hours per sample
Analysis - Radium	$124.00	70	each	$8,680.00	5 wells, 2 surface, once per year, 10 years
Analysis - Uranium	$124.00	70	each	$8,680.00	5 wells, 2 surface, once per year, 10 years
Sampling Subtotal				**$20,222.40**	
Subtotal				**$21,203.00**	
Studies, Design, Permits, Procurement	0%			$0.00	
Project Management	15%			$3,180.45	
Bonding	1%			$212.03	
G&A & Fee	23%			$5,656.96	
Contingency	20%			$4,876.69	
Initial TOTAL				**$35,129.13**	
Subtotal				**$31,566.00**	
Studies, Design, Permits, Procurement	0%			$0.00	
Project Management	15%			$4,734.90	
Bonding	1%			$315.66	
G&A & Fee	23%			$8,421.81	
Contingency	20%			$7,260.18	
YEARLY TOTAL				**$52,298.55**	
Price Per Year				**$5,229.85**	
Yearly Maintenance	1	acre			
Item	**Unit Price**	**Qty.**	**U/M**	**Total**	**Notes/Assumptions**
Mobilization					
Laborer/Operator	$9.36	16	hours	$149.76	
CAT 247 Skidsteer	$615.00	1	each	$615.00	RSMeans 015436500020, 015436502500
Mobilization Subtotal				**$615.00**	
Topsoil Replacement					100 mile mobilization from city to access
Topsoil delivered	$30.00	120	tons	$3,593.70	5% per acre, assuming 4" deep of impacted soil
Laborer/Operator	$9.36	30	hours	$280.31	
CAT 247 Skidsteer	$29.99	15	hours	$449.06	
Topsoil Replacement Subtotal				**$4,323.07**	

Long-Term Surveillance and Maintenance (LTS&M) (continued)

Topsoil replacement					100 mile mobilization from city to access
Revegetation	$1,009.00	0.05	acres	$50.45	RSMeans 329219130020
Topsoil replacement Subtotal				**$50.45**	
Warning Sign and 3 Strand Barbed Wire Fence Replacement		211	ft		assuming square plot
3 Strand Barbed Wire Fence	$22.25	211	LF	$4,694.75	RS Means 323113200200, assuming square plot
Warning Sign	$60.00	2	each	$120.00	1 per 100 ft
Warning Sign and 3 Strand Barbed Wire Fence Replacement Subtotal				**$4,814.75**	
Demobilization	$615.00	1	each	$615.00	
Yearly Maintenance Fixed Price Subtotal				**$1,230.00**	
Studies, Design, Permits, Procurement	0%			$0.00	
Project Management	15%			$184.50	
Bonding	1%			$12.30	
G&A & Fee	23%			$328.16	
Contingency	0%			$0.00	
Yearly Maintenance Fixed Price				**$1,754.96**	
Yearly Maintenance Cost per acre Subtotal				**$9,188.27**	
Studies, Design, Permits, Procurement	0%			$0.00	
Project Management	15%			$1,378.24	
Bonding	1%			$91.88	
G&A & Fee	23%			$2,451.43	
Contingency	20%			$2,113.30	
Yearly Maintenance Cost Per Acre				**$15,223.13**	
Summary	Initial	Per Acre	Per Year		
LTSM for Mines 10 Years	$0.00	$57,085.68	$1,754.96		
LTSM for Repository 10 Years	$35,129.13	$23,888.71	$8,881.79		
LTSM for Repository additional 20 Years	$0.00	$23,888.71	$3,651.93		

Appendix F

Mine Long-Term Monitoring and Maintenance Costs

Mine Long-Term Monitoring Costs
CERCLA Sites

White King/Lucky Lass, Oregon (Record of Decision 2001)

Scope

- Inspect twice a year of physical features such as fences, signs, storm water systems
- Assume 5 percent of vegetation and 5 percent of topsoil volume will be replaced each year
- Inspect the cover system for settlement and significant erosion
- Maintain erosion controls for 1 year, such as wattles, revegetation jute mats, and hay bales; replace as needed
- Monitor surface water and groundwater; sample nearby creek once a year; monitor shallow groundwater wells upgradient and downgradient from cell
- Implemented institutional controls, including deed restrictions; build and maintain fence around the site

Costs

- $47,630 annually; present worth of 30 years is $256,691
- Breakdown of cost in Record of Decision

Butterfly/Burrell, Colorado (EE/CA 2011)

Scope

- Annual site inspections for 3 years to assess condition of soil cover and success of revegetation
- Limited site work the first year

Costs

- $2,500 per year

San Mateo, New Mexico (EE/CA 2009)

Scope

- Periodic inspection, operation and maintenance
- Annually in perpetuity

Costs

- Annual cost of $1,400 (annual site visit $950; maintenance $450)

King Edward, Utah (EE/CA 2005a)

Scope

- Received input from DOE and USFS to get an estimate

Costs

- Estimated $10,000–15,000 annually

Northeast Church Rock, New Mexico (EE/CA 2009a)

Scope

- Looked at onsite repository alternative, alternative 4 (the new disposal cell on the Church Rock mill site; O&M will be part of DOE's Long-Term Surveillance and Maintenance [LTS&M])
- Regular inspection of cell cover and storm water controls; maintenance and repairs

Costs

- $150,000 annually (no detail); looked at present worth of 30 years, 7 percent discount rate

Juniper, California (EE/CA 2005b)

Scope

- Long-term monitoring and inspections

Costs

- Years 5–30 of O&M costs $347,856 or $13.9K annually. (They did not break out years 1–5)