TABLES

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Table 2-1
Description and Evaluation of General Corrective Measures

Corrective Measure	Technology Description	Technology Evaluation		
		Responsiveness to Corrective Action Objectives	Implementability	Performance
NFA	NFA is a general corrective measure that is carried through the CMS in order to provide a baseline for comparison against remedial action technologies. NFA can be implemented with or without ICs. a) NFA with no ICs b) NFA with ICs	No Yes	Yes Yes	Poor Fair
Comments				
NFA with no ICs is not responsive to corrective action objectives because it does not minimize exposure to site workers, the public, and wildlife; limit migration of contaminants to groundwater; minimize biological intrusion into buried waste; or prevent or limit human intrusion. NFA with ICs is generally responsive to Corrective Action Objectives 1, 2, 3, and 4. ICs include long-term monitoring, long-term surveillance and maintenance, and long-term access controls. The NFA corrective measure is technically and administratively implementable. The long-term performance of the existing operational cover is unknown due to the lack of documentation regarding design, materials used, and construction quality assurance.				

Refer to footnotes at end of table.

Table 2-1 (Continued)
Description and Evaluation of General Corrective Measures

Corrective Measure	Technology Description	Technology Evaluation: Responsiveness to Corrective Action Objectives	Technology Evaluation: Implementability	Technology Evaluation: Performance
ICs	Long-Term Monitoring: This technology would involve the installation of monitoring devices to: 1) detect the presence and extent of moisture and contaminants (e.g., tritium) in the environment; 2) assist in determining the human health and environmental impact of water infiltration and any contaminant releases; and 3) evaluate the performance of site closure measures. Long-term monitoring may include sampling of surface water, soil, soil gas, vegetation, air, and groundwater.	No	Yes	Good
Comments				
Long-term monitoring alone is not responsive to corrective action objectives because it does not minimize exposure to site workers, the public, and wildlife; limit migration of contaminants to groundwater; minimize biological intrusion into buried waste; or prevent or limit human intrusion. However, when used in conjunction with other technologies, it may increase the overall effectiveness of corrective measures. Long-term monitoring has been employed effectively at the MWL since 1969. Continuation and/or modification of the existing controls is technically and administratively implementable. Monitoring systems have a long industrial record of proven performance. Individual components of the monitoring systems will require periodic upgrades and/or replacement. Additionally, staff must be trained and funded to collect and analyze data for the systems in order to be useful in the long-term. Although monitoring alone does not limit water infiltration or the release and migration of contaminants, it is effective in demonstrating the performance of corrective measures. Monitoring may also detect the failure of a corrective measure and the need for corrective action. Long-term monitoring is retained as an implicit part of all corrective measures alternatives.				

Refer to footnotes at end of table.

Table 2-1 (Continued)
Description and Evaluation of General Corrective Measures

Corrective Measure	Technology Description	Technology Evaluation		
		Responsiveness to Corrective Action Objectives	Implementability	Performance
ICs	Long-Term Surveillance and Maintenance: These controls would involve routine inspection and maintenance of the site on a regular basis, including seeding and mulching, minor grading to address subsidence and erosion issues, and maintenance of drainage features. The site maintenance program would be commensurate with long-term needs and requirements.	Yes	Yes	Good
Comments				
Long-term surveillance and maintenance alone are not responsive to Corrective Action Objective 4, but are responsive to Corrective Action Objectives 1, 2 and 3. However, when used in conjunction with other technologies, surveillance and maintenance may increase the overall effectiveness of corrective measures. Surveillance and maintenance have been effectively employed at the MWL since 1959. Continuation and/or modification of the existing controls is technically and administratively implementable. Surveillance and maintenance have a long industrial record of proven performance. Although surveillance and maintenance alone do not limit water infiltration or the release and migration of contaminants, these controls are effective in maintaining the performance of corrective measures. Surveillance may also detect the failure of a corrective measure and the need for corrective action. Long-term surveillance and maintenance are retained as an implicit part of all alternatives.				

Refer to footnotes at end of table.

Table 2-1 (Continued)
Description and Evaluation of General Corrective Measures

Corrective Measure	Technology Description	Technology Evaluation		
		Responsiveness to Corrective Action Objectives	**Implementability**	**Performance**
ICs	Long-Term Access Controls: These controls would involve both physical access and administrative controls to prevent or limit human exposure to contaminants. Physical access controls would involve perimeter signage, fencing, monuments, and security patrols. Administrative controls would include land use restrictions.	Yes	Yes	Good
Comments				
Long-term access controls alone are not responsive to Corrective Action Objectives 1, 2, and 3, but are responsive to Corrective Action Objective 4. However, when used in conjunction with other technologies, these controls may increase the overall effectiveness of corrective measures. Long-term access controls have been employed effectively at the MWL since 1959. Continuation and/or modification of existing controls is technically and administratively implementable. Long-term access controls have a long industrial record of proven performance. Physical access controls are currently in place at TA-3 and at the MWL. These include perimeter signs, fencing, and security patrols. Signage and fencing will require periodic replacement, and staff must be trained and funded to conduct surveillance and maintenance. Physical access and administrative controls provide an extra degree of protection of human health and are simple to implement. Long-term access controls are retained as an implicit part of all alternatives.				

Refer to footnotes at end of table.

Table 2-1 (Continued)
Description and Evaluation of General Corrective Measures

Corrective Measure	Technology Description	Technology Evaluation		
		Responsiveness to Corrective Action Objectives	Implementability	Performance
Containment	Vegetative Soil Cover: This technology would involve the construction of a natural soil cover to limit water infiltration and direct surface water away from the landfill. A diverse community of native plants would be established on the cover to extract water and minimize wind and water erosion. A cover constructed of natural soil will function with minimal maintenance by emulating the natural analogue ecosystem.	Yes	Yes	Good
Comments				
This technology is directly responsive to Corrective Action Objectives 1, 2, 3, and generally responsive to Corrective Action Objective 4. This technology is technically and administratively implementable and has been effectively demonstrated at existing, low-level radioactive and mixed waste landfills in Nevada and Idaho. Natural soil to construct the cover is readily available at the site. A major advantage of a soil cover is its simplicity of construction. The performance of vegetative covers and their analogues has been studied extensively and recommended for deployment in the arid and semiarid environments of the western United States. Vegetative soil covers are designed to emulate natural analogues that have performed for thousands of years with minimal infiltration.				

Refer to footnotes at end of table.

Table 2-1 (Continued)
Description and Evaluation of General Corrective Measures

Corrective Measure	Technology Description	Technology Evaluation		
		Responsiveness to Corrective Action Objectives	Implementability	Performance
Containment	Structural Barriers: This technology would involve the construction of a concrete or asphalt barrier over the MWL to minimize water infiltration and limit biological and inadvertent human intrusion into waste disposal cells.	Yes	Yes	Poor
Comments				
This technology is directly responsive to Corrective Action Objectives 1 and 4, but is not responsive to Corrective Action Objectives 2 and 3. This technology is technically and administratively implementable and has been demonstrated at existing, low-level radioactive and mixed waste landfills in New Mexico and South Carolina. Materials used for construction of structural barriers are readily available, and structural barriers are simple to construct. Concrete and asphalt barriers are often used for short-term control of vertical water infiltration and to limit biological and human intrusion. The long-term performance of structural barriers is limited by susceptibility to loading, weathering, and cracking, which impairs the structural integrity of the barrier and facilitates the infiltration of water through the barrier into waste disposal cells. IC's would have to be employed to maintain and eventually replace these types of barriers.				

Refer to footnotes at end of table.

Table 2-1 (Continued)
Description and Evaluation of General Corrective Measures

Corrective Measure	Technology Description	Technology Evaluation		
		Responsive to Corrective Action Objectives	Implementability	Performance
Containment	RCRA Subtitle C Cap: This technology would involve the construction of an engineered cap using natural soil and man-made materials. A cap would consist of layers of soil, compacted clay, and flexible membrane liners. A diverse community of native plants would be established on the cover to extract water and minimize wind and water erosion.	Yes	Yes	Fair
Comments				
This technology is directly responsive to Corrective Action Objectives 1 and 3, and is generally responsive to Corrective Action Objectives 2 and 4. This technology is technically and administratively implementable and has been the baseline technology for hazardous and radioactive waste landfills in the United States since 1989. Materials used to construct RCRA Subtitle C caps are readily available. A minor disadvantage of the RCRA Subtitle C caps is their complexity of construction. Greater care is required to ensure the hydraulic integrity of compacted clay and flexible membrane liners. RCRA Subtitle C caps may not perform well in arid and semiarid environments due to potential deterioration of compacted clay and flexible membrane liners.				

Refer to footnotes at end of table.

Table 2-1 (Continued)
Description and Evaluation of General Corrective Measures

Corrective Measure	Technology Description	Technology Evaluation		
		Responsive to Corrective Action Objectives	Implementability	Performance
Containment	Bio-Intrusion Barrier: This technology would involve the use of gravel and cobbles (rip rap) or woven wire mesh to limit intrusion by deep-rooted plants and burrowing mammals. A bio-intrusion barrier could be used as a stand-alone technology or in conjunction with a cap or cover. A bio-intrusion barrier constructed of resistant material such as gravel and cobbles may also serve as an effective human intrusion barrier.	Yes	Yes	Fair
Comments				
This technology is directly responsive to Corrective Action Objectives 1, 3, and 4, but is not responsive to Corrective Action Objective 2. The bio-intrusion barrier is technically and administratively implementable. Materials used to construct bio-intrusion barriers are readily available from off-site suppliers. A bio-intrusion barrier can be constructed on the existing landfill surface. An advantage of a bio-intrusion barrier is its simplicity of construction. The performance of wire mesh bio-intrusion barriers has not been established. The short-term performance of rip-rap bio-intrusion barriers within covers has been studied recently in Idaho. The results of field and pilot tests indicate that long-term performance is promising.				

Refer to footnotes at end of table.

Table 2-1 (Continued)
Description and Evaluation of General Corrective Measures

Corrective Measure	Technology Description	Technology Evaluation		
		Responsive to Corrective Action Objectives	Implementability	Performance
Containment	Containment Cells: This technology would involve the use of subsurface horizontal and vertical barriers to isolate buried waste from the environment. Grout curtains and slurry walls are common applications of subsurface barriers.	Yes	Yes	Poor
Comments				
This technology is directly responsive to Corrective Action Objectives 1, 3, and 4, and is generally responsive to Corrective Action Objective 2. Installation of subsurface barriers involves extensive intrusive activity that raises exposure concerns for site workers. This technology is technically and administratively implementable. Containment cells could be deployed around individual waste disposal cells or around and under the landfill as a whole. Grouting may involve directional drilling equipment and injection of pressurized fluids. Slurry walls involve vertical trenching and backfilling with bentonite or cement mixtures. Performance of subsurface barriers is limited by the inability of nonintrusive techniques to confirm barrier continuity (e.g., the base of the barrier).				

Refer to footnotes at end of table.

Table 2-1 (Continued)
Description and Evaluation of General Corrective Measures

Corrective Measure	Technology Description	Technology Evaluation: Responsive to Corrective Action Objectives	Technology Evaluation: Implementability	Technology Evaluation: Performance
Stabilization/*In situ* Treatment	*In Situ* Vitrification: This technology would involve using an electric current at extremely high temperatures to convert soil and waste to a crystalline mass, which is a chemically stable, leach-resistant, vitreous material. The process destroys and/or removes organic material while retaining heavy metals and radionuclides.	Yes	Yes	Poor
Comments				
This technology is directly responsive to Corrective Action Objectives 2, 3, and 4, but is not responsive to Corrective Action Objective 1. *In situ* vitrification increases the risk of exposure to radioactive and hazardous vapors for site workers. This technology is implementable at the MWL but the heterogeneity and size of waste may affect its effectiveness. Vitrification temperatures up to 2,000°C would generate and release radioactive and hazardous vapors to the environment. An off-gas hood and treatment system would be needed to collect and treat these vapors. A volume reduction in the soil matrix of 20 to 50% may occur (e.g., a 20-ft deep melt would create a depression of 4 to 10 ft). Performance is limited by the inability of nonintrusive techniques to confirm complete vitrification. *In situ* vitrification would severely limit future remedial alternatives for the MWL (e.g., wastes may remain at the MWL forever).				

Refer to footnotes at end of table.

Table 2-1 (Continued)
Description and Evaluation of General Corrective Measures

Corrective Measure	Technology Description	Technology Evaluation		
		Responsive to Corrective Action Objectives	**Implementability**	**Performance**
Stabilization/*In-situ* Treatment	*In Situ* Grouting or Chemical Fixation: This technology would involve either physical stabilization (grouting) or chemical stabilization (fixation) of wastes within waste disposal cells.	Yes	Yes	Poor
Comments				
This technology is directly responsive to Corrective Action Objectives 2, 3, and 4, but is not responsive to Corrective Action Objective 1. *In situ* grouting and chemical fixation involves extensive intrusive activity that raises exposure concerns for site workers. This technology is technically and administratively implementable. Stabilization with physical and chemical agents would require direct access to waste disposal cells. This technology requires injection of pressurized fluids directly into waste. Performance of grout or chemical reagents is limited by the directional control of the drilling technology delivering the grout or chemical reagents, the proper viscosity of the fluids, effective mixing, and the inability of nonintrusive techniques to confirm fluid delivery at depth and complete encapsulation and stabilization. *In situ* grouting or chemical fixation would severely limit future remedial alternatives for the MWL (e.g., wastes may remain at the MWL forever).				

Refer to footnotes at end of table.

Table 2-1 (Continued)
Description and Evaluation of General Corrective Measures

Corrective Measure	Technology Description	Technology Evaluation: Responsive to Corrective Action Objectives	Technology Evaluation: Implementability	Technology Evaluation: Performance
Excavation/ Storage/ Treatment/ Disposal	Complete Excavation with Aboveground, Retrievable Storage: This technology would involve complete excavation of the MWL and permanent storage of wastes in an on-site, aboveground, retrievable storage facility. This technology would require on-site capabilities for removal, shielding, handling, characterization, repackaging, transport, and storage of radioactive and mixed waste.	Yes	Yes	Good
Comments				
This technology is directly responsive to Corrective Action Objectives 2, 3, and 4, but is not responsive to Corrective Action Objective 1. Excavation involves extensive intrusive activity and direct exposure of site workers to radioactive materials. This technology is technically and administratively implementable. Appropriate time, distance, and shielding to protect site workers would require the use of remote handling and/or robotic equipment. Fugitive emissions generated from excavation activities may pose significant health risks to site workers and the public. Excavation and aboveground retrievable storage would require the construction of secure, high-bay warehouses to stockpile, process, store, and monitor waste. Regulations would limit the duration and storage of hazardous and mixed waste, and pretreatment of waste may be required before permanent storage. It is likely that some waste would need to be shipped off site for treatment and disposal.				

Refer to footnotes at end of table.

Table 2-1 (Continued)
Description and Evaluation of General Corrective Measures

Corrective Measure	Technology Description	Technology Evaluation		
		Responsive to Corrective Action Objectives	Implementability	Performance
Excavation/ Storage/ Treatment/ Disposal	Complete Excavation with Off-Site Disposal: This technology would involve complete excavation of the MWL and shipment of wastes to a licensed, off-site facility. This technology would require on-site capabilities for removal, shielding and handling, and temporary on-site facilities for characterization, pretreatment, and repackaging prior to shipment and disposal of the waste.	Yes	Yes	Good
Comments				
This technology is directly responsive to Corrective Action Objectives 2, 3, and 4, but is not responsive to Corrective Action Objective 1. Excavation involves extensive intrusive activity and direct exposure of site workers to radioactive materials. This technology is technically and administratively implementable. Appropriate time, distance, and shielding to protect site workers would require the use of remote handling and/or robotic equipment. Fugitive emissions generated from excavation activities may pose significant health risks to site workers and the public. Excavation and off-site disposal would require the construction of secure, high-bay warehouses to stockpile, process, package, store, and ship waste. Regulations would limit the duration of storage of hazardous and mixed waste, and pretreatment of waste, including demilitarization of classified waste, may be required before shipment. Transportation of waste to an off-site facility may pose DOT and public health concerns. The acceptance of waste by an off-site disposal facility may be limited by pretreatment requirements and/or facility-specific waste acceptance criteria.				

Refer to footnotes at end of table.

Table 2-1 (Continued)
Description and Evaluation of General Corrective Measures

Corrective Measure	Technology Description	Technology Evaluation		
		Responsive to Corrective Action Objectives	Implementability	Performance
Excavation/ Storage/ Treatment/ Disposal	Partial Excavation with Aboveground Retrievable Storage: This technology would involve excavation of the classified area of the MWL and permanent storage of wastes in an on-site, aboveground, retrievable storage facility. The classified area was selected because it contains various radioactive sources, tritium, uranium, and activation and fission products. This technology would require on-site capabilities for removal, shielding, handling, characterization, repackaging, transport, and storage of radioactive and mixed waste.	Yes	Yes	Good
Comments				
This technology is directly responsive to Corrective Action Objectives 2, 3, and 4, but is not responsive to Corrective Action Objective 1. Excavation involves extensive intrusive activity and direct exposure of site workers to radioactive materials. This technology is technically and administratively implementable. Appropriate time, distance, and shielding to protect site workers would require the use of remote handling and/or robotic equipment. Fugitive emissions generated from excavation activities may pose significant health risks to site workers and the public. Excavation and aboveground retrievable storage would require the construction of secure, high-bay warehouses to stockpile, process, store, and monitor waste. Regulations would limit the duration of storage of hazardous and mixed waste, and pretreatment of waste would be required before permanent storage. It is likely that some waste would need to be shipped off site for treatment and disposal. The unclassified area of the landfill would require additional technology for remediation such as containment or stabilization.				

Refer to footnotes at end of table.

Table 2-1 (Continued)
Description and Evaluation of General Corrective Measures

Corrective Measure	Technology Description	Technology Evaluation		
		Responsive to Corrective Action Objectives	Implementability	Performance
Excavation/ Storage/ Treatment/ Disposal	Partial Excavation with Off-Site Disposal: This technology would involve excavation of the classified area of the MWL and shipment of wastes to a licensed, off-site facility for disposal. The classified area was selected because it contains radioactive sources, tritium, activation products, and wastes that pose national security concerns. This technology would require on-site capabilities for removal, shielding, handling, and temporary on-site facilities for characterization, pretreatment, and repackaging prior to shipment and disposal of the waste.	Yes	Yes	Good
Comments				
This technology is directly responsive to Corrective Action Objectives 2, 3, and 4, but is not responsive to Corrective Action Objective 1. Excavation involves extensive intrusive activity and direct exposure of site workers to radioactive materials. This technology is technically and administratively implementable. Appropriate time, distance, and shielding to protect site workers would require the use of remote handling and/or robotic equipment. Fugitive emissions generated from excavation activities may pose significant health risks to site workers and the public. Excavation and off-site disposal would require the construction of secure, high-bay warehouses to stockpile, process, package, store, and ship waste. Regulations would limit the duration of storage of hazardous and mixed waste, and pretreatment, including demilitarization of classified waste, may be required before shipment. Transportation of waste to an off-site facility must be in compliance with DOT regulations. As with other radioactive waste shipments, such transportation may raise public concerns. The acceptance of waste by an off-site disposal facility may be limited by pretreatment requirements and/or facility-specific waste acceptance criteria. The unclassified area of the landfill would require additional technology for remediation such as containment or stabilization.				

Refer to footnotes at end of table.

Table 2-1 (Concluded)
Description and Evaluation of General Corrective Measures

Corrective Measure	Technology Description	Technology Evaluation		
		Responsive to Corrective Action Objectives	Implementability	Performance
Excavation/ Storage/ Treatment/ Disposal	Future Excavation: This technology would involve complete excavation of the MWL at some time in the future when remote handling and/or robotics equipment would not be necessary. Aboveground retrievable storage and/or shipment of waste to a licensed, off-site facility for disposal would be employed. This technology would require on-site capabilities for removal and handling of waste and temporary on-site facilities for characterization, pretreatment, and repackaging of waste prior to permanent storage on site or shipment to a licensed, off-site facility for disposal.	Yes	Yes	Good
Comments				
This technology is directly responsive to Corrective Action Objectives 1, 2, 3, and 4. This technology is technically and administratively implementable. Excavation would be conducted when total radionuclide activity has decayed to safer levels than those that currently exist. Fugitive emissions generated from excavation activities may pose health risks to site workers and the public. Excavation would require the construction of secure, high-bay warehouses to stockpile, process, store, and monitor waste prior to disposition. Regulations may limit the duration of storage of hazardous and mixed waste, and pretreatment of waste, including demilitarization of classified waste, may be required. It is likely that some waste would need to be shipped off site for treatment and disposal. Transportation of waste to an off-site facility must be in compliance with DOT regulations. As with other radioactive waste shipments, such transportation may raise public concerns. The acceptance of waste by an off-site disposal facility may be limited by pretreatment requirements and/or facility-specific waste acceptance criteria.				

CMS Corrective Measures Study
°C Degrees Celsius
DOT U.S. Department of Transportation
ft Foot (feet)
IC Institutional Controls
MWL Mixed Waste Landfill
NFA No Further Action
RCRA Resource Conservation and Recovery Act
TA Technical Area

Table 2-2
Results of Technology Screening for the MWL

Technology	Screening Criteria: Responsiveness to Corrective Action Objectives[a] (Yes/No)	Implementability[b] (Yes/No)	Performance (Good, Fair, Poor)	Screening Evaluation (Accepted/ Rejected)
NFA with no ICs	No	Yes	Poor	Rejected
NFA with ICs	Yes	Yes	Fair	Accepted
Long-Term Monitoring	No	Yes	Good	NA[c]
Long-Term Surveillance and Maintenance	Yes	Yes	Good	NA[c]
Long-Term Access Controls	Yes	Yes	Good	NA[c]
Vegetative Soil Cover	Yes	Yes	Good	Accepted
Structural Barriers	Yes	Yes	Poor	Rejected
RCRA Subtitle C Cap	Yes	Yes	Fair	Accepted
Bio-Intrusion Barrier	Yes	Yes	Fair	Accepted
Containment Cells	Yes	Yes	Poor	Rejected
In Situ Vitrification	Yes	Yes	Poor	Rejected
In Situ Grouting or Chemical Fixation	Yes	Yes	Poor	Rejected
Complete Excavation with Aboveground Retrievable Storage	Yes	Yes	Good	Accepted
Complete Excavation with Off-Site Disposal	Yes	Yes	Good	Accepted
Partial Excavation with Aboveground Retrievable Storage	Yes	Yes	Good	Accepted
Partial Excavation with Off-Site Disposal	Yes	Yes	Good	Accepted
Future Excavation	Yes	Yes	Good	Accepted

[a]"Yes" implies that the technology is responsive to at least one of the corrective action objectives.
[b]"Yes" implies that the technology is technically or administratively implementable.
[c]ICs are implicit in all proposed corrective measures alternatives.

IC Institutional Controls
MWL Mixed Waste Landfill
NA Not applicable
NFA No Further Action
RCRA Resource Conservation and Recovery Act

Table 3-1
Development of Corrective Measures Alternatives for the MWL

General Corrective Measure	Alternative	Description	Technology											
			NFA	Long-Term Monitoring	Long-Term Surveillance & Maintenance	Long-Term Access Controls	Vegetative Soil Cover	RCRA Subtitle C Cap	Bio-Intrusion Barrier	Complete Excavation with Aboveground Retrievable Storage	Complete Excavation with Off-Site Disposal	Partial Excavation with Aboveground Retrievable Storage	Partial Excavation with Off-Site Disposal	Future Excavation
	I.a	NFA with ICs	X	X	X	X								
Containment	III.a	Bio-Intrusion Barrier		X	X	X			X					
	III.b	Vegetative Soil Cover		X	X	X	X							
	III.c	Vegetative Soil Cover with Bio-Intrusion Barrier		X	X	X	X		X					
	III.d	RCRA Subtitle C Cap		X	X	X		X						
	III.e	RCRA Subtitle C Cap with Bio-Intrusion Barrier		X	X	X		X	X					
Excavation	V.a	Complete Excavation with Aboveground Retrievable Storage		X	X	X				X				
	V.b	Complete Excavation with Off-Site Disposal		X	X	X					X			
	V.c	Partial Excavation with Aboveground Retrievable Storage		X	X	X						X		
	V.d	Partial Excavation with Off-Site Disposal		X	X	X							X	
	V.e	Future Excavation		X	X	X								X

IC Institutional Controls
MWL Mixed Waste Landfill
NFA No Further Action
RCRA Resource Conservation and Recovery Act

Table 3-2
Estimated Direct Costs for MWL Corrective Measures Alternatives

General Corrective Measure	Alternative	Description	Direct Cost
	I.a	NFA with ICs	$1,082,143
Containment	III.a	Bio-Intrusion Barrier	$2,201,668
	III.b	Vegetative Soil Cover	$1,953,501
	III.c	Vegetative Soil Cover with Bio-Intrusion Barrier	$2,527,007
	III.d	RCRA Subtitle C Cap	$2,850,872
	III.e	RCRA Subtitle C Cap with Bio-Intrusion Barrier	$3,636,474
Excavation	V.a	Complete Excavation with Aboveground Retrievable Storage—Option A	$545,620,660
		Complete Excavation with Aboveground Retrievable Storage—Option B	$416,018,751
	V.b	Complete Excavation with Off-Site Disposal—Option A	$702,088,516
		Complete Excavation with Off-Site Disposal—Option B	$579,110,303
	V.c	Partial Excavation with Aboveground Retrievable Storage—Option A	$139,718,215
		Partial Excavation with Aboveground Retrievable Storage—Option B	$103,569,857
	V.d	Partial Excavation with Off-Site Disposal—Option A	$157,360,724
		Partial Excavation with Off-Site Disposal—Option B	$116,638,183
	V.e	Future Excavation	$72,512,261[a]

[a]Costs for aboveground retrievable storage of waste and/or shipment of waste to an off-site, licensed facility for disposal are not included.

IC Institutional Controls
MWL Mixed Waste Landfill
NFA No Further Action
RCRA Resource Conservation and Recovery Act

Table 3-3
Cost Breakdown for Individual Excavation Alternatives

Alternative	Description	Cost of Excavation, Characterization, and Transportation	Cost of Aboveground Retrievable Storage Facility and/or Waste Processing Facility	Total Direct Cost
V.a	Complete Excavation with Aboveground Retrievable Storage—Option A	$420,059,569	$125,561,091	$545,620,660
	Complete Excavation with Aboveground Retrievable Storage—Option B	$367,196,113	$48,822,638	$416,018,751
V.b	Complete Excavation with Off-Site Disposal—Option A	$653,265,878	$48,822,638	$702,088,516
	Complete Excavation with Off-Site Disposal—Option B	$530,287,665	$48,822,638	$579,110,303
V.c	Partial Excavation with Aboveground Retrievable Storage—Option A	$97,997,927	$41,720,288	$139,718,215
	Partial Excavation with Aboveground Retrievable Storage—Option B	$79,510,583	$24,059,274	$103,569,857
V.d	Partial Excavation with Off-Site Disposal—Option A	$138,479,388	$18,881,336	$157,360,724
	Partial Excavation with Off-Site Disposal—Option B	$97,756,847	$18,881,336	$116,638,183
V.e	Future Excavation[a]	$48,452,987	$24,059,274	$72,512,261

[a]Costs for aboveground retrievable storage of waste and/or shipment of waste to an off-site, licensed facility for disposal are not included.

Table 3-4
Summary of Development of Corrective Measures Alternatives for the MWL (Chapter 3.0)

General Corrective Measure	Alternative	Description	Effectiveness at Meeting Corrective Action Objectives				Implementability			Evaluation Summary
			Minimize Exposure to Workers, the Public, and Wildlife	Limit Migration of Contaminants to Groundwater	Minimize Biological Intrusion into Waste	Prevent or Limit Human Intrusion	Constructability Concerns	Worker Health and Safety Risk	Maintenance Requirements	
	I.a	NFA with ICs	Yes	Yes	Yes	Yes	Insignificant	Low	Minimal	Suitable
Containment	III.a	Bio-Intrusion Barrier	Yes	No	Yes	Yes	Minimal	Low	Minimal	Unsuitable
	III.b	Vegetative Soil Cover	Yes	Yes	Yes	Yes	Minimal	Low	Minimal	Suitable
	III.c	Vegetative Soil Cover with Bio-Intrusion Barrier	Yes	Yes	Yes	Yes	Minimal	Low	Minimal	Suitable
	III.d	RCRA Subtitle C Cap	Yes	No	Yes	Yes	Moderate	Low	Moderate	Unsuitable
	III.e	RCRA Subtitle C Cap with Bio-Intrusion Barrier	Yes	No	Yes	Yes	Moderate	Low	Moderate	Unsuitable
Excavation	V.a	Complete Excavation with Aboveground Retrievable Storage	No	Yes	Yes	Yes	Significant	High	Moderate	Unsuitable
	V.b	Complete Excavation with Off-Site Disposal	No	Yes	Yes	Yes	Significant	High	Moderate	Unsuitable
	V.c	Partial Excavation with Aboveground Retrievable Storage	No	Yes	Yes	Yes	Significant	High	Moderate	Unsuitable
	V.d	Partial Excavation with Off-Site Disposal	No	Yes	Yes	Yes	Significant	High	Moderate	Unsuitable
	V.e	Future Excavation	Yes	Yes	Yes	Yes	Significant	Medium	Moderate	Suitable

IC Institutional Controls
MWL Mixed Waste Landfill
NFA No Further Action
RCRA Resource Conservation and Recovery Act

Table 4-1
Summary Evaluation of MWL Candidate Corrective Measures Alternatives

Evaluation Criteria	MWL I.a NFA with ICs	MWL III.b Vegetative Soil Cover	MWL III.c Vegetative Soil Cover with Bio-Intrusion Barrier	MWL V.e Future Excavation
Long-Term Reliability and Effectiveness				
Magnitude of Remaining Risk(s) after Implementation of the Alternative	Nonrad: HI = 0.00; excess cancer risk = 1E-9; risk below NMED guidelines. Rad: TEDE = 3.3E-1 mrem/yr; excess cancer risk = 2.2E-6; below EPA guidelines. Ecorisk less than NMED guidelines. Risk would decrease with time due to radioactive decay. Risk would increase if erosion or intrusion occurs should ICs be relinquished.	Nonrad: HI = 0.00; excess cancer risk ≈ 0.00; risk below NMED guidelines. Rad: TEDE = 2.4E-5 mrem/yr; excess cancer risk = 3.4E-10; below EPA guidelines. Ecorisk less than NMED guidelines. Risk would decrease with time due to radioactive decay. Risk would increase if erosion or intrusion occurs should ICs be relinquished.	Nonrad: HI = 0.00; excess cancer risk ≈ 0.00; risk below NMED guidelines. Rad: TEDE = 2.4E-5 mrem/yr; excess cancer risk = 3.4E-10; below EPA guidelines. Ecorisk less than NMED guidelines. Risk would decrease with time due to radioactive decay. Risk would increase if erosion or intrusion occurs should ICs be relinquished.	Nonrad: HI = 0.00; excess cancer risk ≈ 0.00; risk below NMED guidelines. Rad: TEDE = 0.00 mrem/yr; excess cancer risk = 0; below EPA guidelines. Ecorisk approximately 0. Risk approaches 0 assuming COCs are removed to background screening levels.
Extent of Long-Term Monitoring	Minimum of 70 years. The operational cover will be monitored and maintained to prevent ponding and intrusion of deep-rooted plants and promote surface runoff and growth of native vegetation. ICs will include environmental monitoring, site surveillance and maintenance, access controls, and groundwater and tritium monitoring.	Minimum of 70 years. The vegetative soil cover will be monitored and maintained to prevent ponding and intrusion of deep-rooted plants and promote surface runoff and growth of native vegetation. ICs will include environmental monitoring, site surveillance and maintenance, access controls, and groundwater and tritium monitoring.	Minimum of 70 years. The vegetative cover with bio-intrusion barrier will be monitored and maintained to prevent ponding and intrusion of deep-rooted plants and promote surface runoff and growth of native vegetation. ICs will include environmental monitoring, site surveillance and maintenance, access controls, and groundwater and tritium monitoring.	No monitoring required after excavation.
Uncertainties Associated with Leaving Waste in Place	Low	Low	Low	NA – No waste left in place.

Refer to footnotes at end of table.

Table 4-1 (Continued)
Summary Evaluation of MWL Candidate Corrective Measures Alternatives

Evaluation Criteria	MWL I.a NFA with ICs	MWL III.b Vegetative Soil Cover	MWL III.c Vegetative Soil Cover with Bio-Intrusion Barrier	MWL V.e Future Excavation
Potential for Failure of Alternative	Very Low	Very Low	Very Low	NA – No waste left in place.
Reduction in Toxicity, Mobility, and Volume				
Reduction in Toxicity	No reduction other than natural radioactive decay. Reduction of radiological toxicity can be achieved only by the passage of time.	No reduction other than natural radioactive decay. Reduction of radiological toxicity can be achieved only by the passage of time.	No reduction other than natural radioactive decay. Reduction of radiological toxicity can be achieved only by the passage of time.	NA
Reduction in Mobility	Minimal bio-intrusion, human access, and inadvertent human intrusion protection.	Minimized by limiting water infiltration, bio-intrusion, human access, and inadvertent human intrusion.	Minimized by limiting water infiltration, bio-intrusion, human access, and inadvertent human intrusion.	Eliminated by removal of waste from landfill disposal cells.
Reduction in Volume	None	None	None	Potential increase in volume
Short-Term Effectiveness				
Short-Term Reduction in Existing Risk(s)	Nonrad: Incremental HI = 0.07. Incremental excess cancer risk = 3.31E-6. Risk below NMED guidelines. Rad: TEDE unchanged. Ecorisk unchanged.	Nonrad: Incremental HI = 0.07. Incremental excess cancer risk = 3.31E-6. Risk below NMED guidelines. Rad: TEDE reduced by 3.3E-1 mrem/yr; excess cancer risk reduced by 2.2E-6. Ecorisk reduced.	Nonrad: Incremental HI = 0.07. Incremental excess cancer risk = 3.31E-6. Risk below NMED guidelines Rad: TEDE reduced by 3.3E-1 mrem/yr; excess cancer risk reduced by 2.2E-6. Ecorisk reduced.	Nonrad: None (assumes maximum concentrations reported during characterization). Risk below NMED guidelines. Rad: TEDE increased by 3.23E+3 mrem/yr; excess cancer risk increased by 3.7E-2. Ecorisk unchanged.
Time Needed to Achieve Reduction in Risk(s)	1 month	4 months	4 months	2 years (excavation only)

Refer to footnotes at end of table.

Table 4-1 (Concluded)
Summary Evaluation of MWL Candidate Corrective Measures Alternatives

Evaluation Criteria	MWL I.a NFA with ICs	MWL III.b Vegetative Soil Cover	MWL III.c Vegetative Soil Cover with Bio-Intrusion Barrier	MWL V.e Future Excavation
Short-Term Risk(S) Posed to Site Workers, the Community, and the Environment During Implementation of the Alternative	Transportation: Injuries: 1.8E-2 Fatalities: 4.9E-4 Implementation: Injuries: 9.5E-2 Fatalities: 2.4E-3	Transportation: Injuries: 4.9E-2 Fatalities: 1.3E-3 Implementation: Injuries: 2.6E-1 Fatalities: 3.2E-3	Transportation: Injuries: 2.5E-1 Fatalities: 6.6E-3 Implementation: Injuries: 3.2E-1 Fatalities: 3.5E-3	Transportation: Injuries: 8.8E-1 Fatalities: 2.3E-1 Implementation: Injuries: 2.2E+0 Fatalities: 1.1E-2
Implementability				
Availability of Materials, Equipment, and Contractors	Readily available	Readily available	Readily available	Readily available
Technical and Administrative Difficulties	None. Addition of soil presents minimal concerns.	None. Addition of compacted fill presents minimal concerns.	None. Addition of compacted fill and the barrier present moderate concerns.	Significant. Excavation and characterization activities present significant concerns.
Permits and Approvals	Air quality	Air quality	Air quality	Digging, rad worker, waste storage, waste treatment, air quality
Cost				
Capital and Operation and Maintenance Costs (Net Present Value)	$1,772,882	$4,335,274	$7,096,859	$106,209,085[a]

[a]The estimated cost for future excavation does not include costs for waste disposal or operations and maintenance because of the uncertainties associated with future waste disposal and the difficulties in estimating these costs.

COC	Contaminant of concern.
Ecorisk	Ecological risk
EPA	U.S. Environmental Protection Agency
HI	Hazard Index
IC	Institutional Controls
mrem/yr	Millirem(s) per year
MWL	Mixed Waste Landfill
NA	Not applicable
NFA	No Further Action
NMED	New Mexico Environment Department
Rad	Radiological
TEDE	Total Effective Dose Equivalent

Table 4-2
Summary of the MWL CMS Alternatives Risk Results

Alternatives	Human Health (IND)		Ecological		Transportation and Remediation Injuries and Fatalities			
					Transportation		Implementation	
	Nonrad	Rad	Nonrad	Rad	Injuries	Fatalities	Injuries	Fatalities
MWL Risk Baseline—NFA with No ICs	HI = 0.07 CR = 3E-6	TEDE = 3.3E-1 mrem/yr CR = 2.2E-6	No HQ exceedence after uncertainty addressed	Mouse = 1.6E-3 Owl = 1.6E-3	No Transportation Risk		No Remediation Risk	
MWL–Ia. NFA with ICs	HI = 0.00 CR = 1E-9	TEDE = 3.3E-1 mrem/yr CR = 2.2E-6	No HQ exceedence after uncertainty addressed	Mouse = 1.6E-3 Owl = 1.6E-3	0.018	0.00049	0.095	0.0024
MWL–IIIb. Vegetative Soil Cover	HI = 0.00 CR ~ 0.00	TEDE = 2.4E-5 mrem/yr CR = 3.4E-10	HQ ~ 0.00	HI ~ 0.00	0.049	0.0013	0.26	0.0032
MWL–IIIc. Vegetative Soil Cover with Bio-Intrusion Barrier	HI = 0.00 CR ~ 0.00	TEDE = 2.4E-5 mrem/yr CR = 3.4E-10	HQ ~ 0.00	HI ~ 0.00	0.25	0.0066	0.32	0.0035
MWL–V.e Future Excavation	HI = 0.07 CR = 3E-6	TEDE = 3.23E3 mrem/yr CR = 3.7E-2	HQ ~ 0.00	HI ~ 0.00	0.88	0.023	2.22	0.011

CMS Corrective Measures Study
CR Cancer Risk
HI Hazard Index
HQ Hazard Quotient
IC Institutional Controls
IND Industrial
mrem/yr Millirem(s) per year
MWL Mixed Waste Landfill
NFA No Further Action
Rad Radiological
TEDE Total Effective Dose Equivalent

Table 4-3
Detailed Cost Breakdowns for Candidate Corrective Measures Alternatives, Including Capital Costs, Operation and Maintenance Costs, Administrative Costs, and Escalation

General Corrective Measure	Alternative	Description	Cost Component	Cost Breakdown		
				Direct Cost[a]	Markups[b]	Total Cost
NFA	I.a	NFA with ICs	Capital Cost[c]	$1,082,143	$690,739	$1,772,882
			Operations & Maintenance[d]	$0	$0	$0
			Total Cost[e] (Net Present Value)	NA	NA	$1,772,882
Containment	III.b	Vegetative Soil Cover	Capital Cost[c]	$1,953,501	$1,525,040	$3,478,541
			Operations & Maintenance[d]	$309,301	$547,432	$856,733
			Total Cost[e] (Net Present Value)	NA	NA	$4,335,274
	III.c	Vegetative Soil Cover with Bio-Intrusion Barrier	Capital Cost[c]	$2,527,007	$1,959,816	$4,486,823
			Operations & Maintenance[d]	$849,300	$1,760,736	$2,610,036
			Total Cost[e] (Net Present Value)	NA	NA	$7,096,859
Excavation	V.e	Future Excavation	Capital Cost[c]	$72,512,261	$33,696,824	$106,209,085
			Operations & Maintenance[d]	$0	$0	$0
			Total Cost[e] (Net Present Value)	NA	NA	$106,209,085

[a]Direct costs include material, labor, and equipment used to implement the alternative.
[b]Markups are all costs other than direct costs that do not contribute to the alternative, and include SNL/NM's administrative costs (loads) and contingency allowances.
[c]Capital costs include construction and installation costs, equipment costs, and indirect costs such as engineering costs, legal fees, permitting fees, and startup and shakedown costs.
[d]Operation and maintenance costs are estimated for 30 years only, and include operating labor and materials costs, maintenance labor and materials costs, replacement costs, utilities, monitoring and reporting costs, administrative costs, and indirect costs.
[e]Total costs are based upon net present value, and do not include escalation.

IC Institutional Controls
NA Not applicable
NFA No Further Action
SNL/NM Sandia National Laboratories/New Mexico