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LETTER REPORT FOR UNEXPLODED ORDNANCE AND ORDNANCE EXPLOSIVES CLEANUP AT GOVERNMENT AND COMMERCIAL FACILITIES

MPH
CHAPTE

VOLUME 3

REFERENCES

SECTION 3.0

Table 3-1. Summary information on DOE sites.

LLNL

Environmental Restoration Site Summary

Site: Lawrence Livermore National Laboratory Site 300

Links to Additional Site Information
Lawrence Livermore National Laboratory Home Page
Lawrence Livermore National Laboratory Environmental Protection Program
1996 Baseline Environmental Management Report Site Narrative
Lawrence Livermore National Laboratory - Site 300 Management Action Process Document

Background

Site 300 of the Lawrence Livermore National Laboratory is located in northern California, approximately 15 miles southeast of the Laboratory's Main Site and 10 miles southwest of the City of Tracy. The site occupies 11 square miles.

Site 300 was purchased from local ranchers in the 1950s. The site's former and current mission is the research and testing of non-nuclear high-explosive components for the Department of Energy nuclear weapons program. Past operations involving the processing, testing, and deactivation of explosive materials have resulted in soil and ground water contamination at the site. Several plumes of contamination were also detected in ground water offsite. In 1990, Site 300 was placed on the Environmental Protection Agency National Priorities List.

All major ground water plumes have been identified at the site. The major area of concern is the General Services Area, a support area with machine shops, motor pool facilities and other support facilities, where solvents discharged into drywells or on the ground have resulted in contamination of the ground water. Remediation of the ground water will involve pump-and-treat and soil-vapor-extraction technologies.

Go to the Office of Environmental Restoration Home Page

About This Document

Last Updated 11/22/1996 (mhp)

1996 BEMR

Lawrence Livermore National Laboratory

HOME BEMR CONTENTS U.S. MAP

Lawrence Livermore National Laboratory is composed of two sites: Main Site and Site 300. The Main Site, also known as the Livermore Site is located approximately 80 kilometers (50 miles) east of San Francisco and 6.4 kilometers (4 miles) from downtown Livermore. It occupies approximately 2.6 square kilometers (one square mile) of relatively flat terrain in the Livermore Valley. Residential subdivisions were recently built adjacent to the site boundary. They are separated from the site by a wide city roadway. Site 300 is approximately 24 kilometers (15 miles) southeast of the Laboratory's Main Site. It occupies approximately 28.6 square kilometers (11 square miles) of rugged foothills that straddle Alameda and San Joaquin Counties.

LOCALITY MAP

Estimated Site Total

(Thousands of Current Year Dollars)						
	FY 1996	**1997**	**1998**	**1999**	**2000**	
Nuclear Material and Facility Stabilization			5,332	2,649	2,729	*Grey shaded area reflects annual cost estimates for the first five years of the site BEMR Base Case (as of October 1995) and includes 3% annual inflation, see Readers' Guide.*
Environmental Restoration	25,549	30,774	32,204	35,205	37,383	
Waste Management	24,455	25,004	25,754	26,527	27,322	
Total	50,004	55,778	63,290	64,381	67,434	
1996 Appropriation	71,674			*These levels reflect the current estimates for compliance with applicable statutes and agreements (as of March 1996), see Readers' Guide.*		
1997 Congressional Request		56,576				

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	
Nuclear Material and Facility Stabilization	1,975	2,460						
Environmental Restoration	30,243	20,877	13,728	11,908	11,024	11,019	5,656	
Waste Management	24,312	24,866	23,088	23,088	23,088	23,088	23,088	
Total	56,529	48,203	36,816	34,996	34,112	34,107	28,744	
	FY 2035	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	
Nuclear Material and Facility Stabilization								
Environmental Restoration	5,656	5,656	5,656	5,656	710			
Waste Management	23,088	23,088	23,088	23,088	23,088	23,088	23,088	
Total	28,744	28,744	28,744	28,744	23,798	23,088	23,088	
	FY 2070	**2075**	**2080**	**2085**	**2090**	**2095**	**2100**	**Life Cycle***
Nuclear Material and Facility Stabilization								22,174
Environmental Restoration								638,945
Waste Management	23,088							1,746,610
Total	23,088							2,407,729

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

FACILITY MISSION

The Department of Energy owns the Lawrence Livermore National Laboratory Main Site and Site 300. The Department and the University of California jointly operate the sites. The Main Site was initially used as a flight training base and an engine overhaul facility. Transition from Naval operations to scientific research began in 1950, when the Atomic Energy Commission authorized construction of a materials-testing accelerator site. The Commission established the University of California Radiation Laboratory, Livermore Site (the predecessor of the Lawrence Livermore National Laboratory) as a facility for nuclear weapons research. Site 300 is a remote high-explosives testing facility. It hosts several areas for high-explosives components, several instrumental firing tables for explosives testing, an advanced test particle accelerator, and various support and service facilities such as a motor-pool and machine shops.

SITE MAP #1

The current mission of the Lawrence Livermore National Laboratory is research, testing, and development that focus on national defense and security, energy, the environment, and biomedicine. The Laboratory's specific defense mission is

researching, testing, and developing technologies related to nuclear weapons. Over the years, the Laboratory's mission has broadened to meet other national needs, such as enhancing economic competitiveness and science education.

Based on the 1993 Environmental Impact Statement/Environmental Impact Report by the University of California and the Department of Energy, the Lawrence Livermore National Laboratory will continue to be a multidisciplinary research and development laboratory focussed on national defense. It will continue to operate both the Main Site and Site 300 for the foreseeable future. This report assumes that the Department of Energy Office of Defense Programs will continue to be responsible for all landlord activities and associated costs.

SITE MAP #2

The Department of Energy purchased Site 300 from local ranchers in the 1950s. The surrounding area is agricultural and has an average population density of fewer than one person per square mile. The site's mission is researching and testing nonnuclear high-explosives components for the Department of Energy's nuclear weapons program. The Department plans to continue using Site 300 to test high explosives components.

FUTURE USE

The Oakland Office and Lawrence Livermore National Laboratory have actively participated in discussions and meetings, coordinated activities, and reached agreement on future land use with the local community, regulators, and other interested stakeholders. This report assumes that the Lawrence Livermore National Laboratory will remain a Controlled Access research and development facility. Future use of the Main Site is classified as Industrial. Site 300 will maintain a mix of Industrial and Open Space/Wildlife Management uses.

FUTURE USE MAP

NUCLEAR MATERIAL AND FACILITY STABILIZATION

This report assumes that the Lawrence Livermore National Laboratory will enter the Environmental Management facility stabilization process in 1998. The report anticipates that the following facilities at the Lawrence Livermore National Laboratory will enter the Nuclear Material and Facility Stabilization program: a chemistry building (#222), a heavy element facility (#251), and a reactor dome (#281). These facilities will be transferred to the Environmental Restoration program in FY 2008. This report assumes that the Environmental Laboratory Building (#412) and the Accelerator Building (#212) will pass directly to the Environmental Restoration decommissioning program. The resulting waste types will include transuranic, low-level mixed, low-level, and hazardous. The costs associated with treating, storing, and disposing of this waste are included in the Waste Management program estimates provided later in this summary. This report assumes that the stabilization and maintenance process at the Lawrence Livermore National Laboratory will be completed by FY 2008. See the Main Site Map for the location of Nuclear Material Facility Stabilization program activities.

Nuclear Material and Facility Stabilization Projects and Waste Volume Table

Facility Number	Begin NM&FS	Transfer to Decommissioning	Assumed Volumes (m3)			
			TRU	LLMW	LLW	Haz.
222/ 251	1998	2008	229	353	293	56
281	1998	2008	40	19	52	6
Total			269	372	345	62

Nuclear Material and Facility Stabilization Activities Cost Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	2005	2010	2015	2020	2025	2030	Life Cycle*
Nuclear Material and Facility Stabilization	1,975	2,460						22,174
* Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.								

ENVIRONMENTAL RESTORATION

Environmental restoration activities at the Main Site and Site 300 are conducted as two distinct projects and are governed by separate Federal Facility Agreements. Parties to these agreements include the Department of Energy, the United States Environmental Protection Agency, and the California Environmental Protection Agency Department of Toxic Substances Control and Regional Water Quality Control Boards. The Department of Toxic Substances Control is the lead state agency for the cleanup at both sites.

Past operations at the Laboratory's Main Site involving handling and storing hazardous materials resulted in the release and subsequent migration of contaminants into soil and ground water. Nineteen different source areas of contamination have been identified in various parts of the site. The Main Site was placed on the National Priorities List by the Environmental Protection Agency in 1987.

Past operations at Site 300 have resulted in the release of hazardous and radioactive materials from landfills, dry wells, and wastewater lagoons to soil and ground water. Some of these contaminants have migrated offsite. Because of these releases, Site 300 was placed on the National Priorities List in 1990. The Federal Facilities Agreement for Site 300 identified six operable units for assessment and remediation.

The costs for shipping and disposition of hazardous waste spent carbon canisters are built into the Environmental Restoration program. All other costs associated with treatment, storage, and disposal are borne by the Waste Management program.

Major Environmental Restoration Activity Milestones

TASK	COMPLETION DATE Fiscal Year
Main Site	
Assessment	
Remedial Action	2001
Site 300	2050
Resource Conservation and Recovery Act Closure of the High Explosive Burn Pits	
Remediation of Building 834	1997
Surveillance and Monitoring of High Explosive Burn Pit Area	2010
Remediation of General Service Area	2025
	2040

MAIN SITE

The major contaminants in soil and ground water at the Main Site are volatile organic compounds and petroleum hydrocarbons. The principal volatile compounds of concern are trichloroethane and tetrachloroethane. Chlorinated hydrocarbons have been detected in ground water at concentrations of up to ten parts per million (California drinking water standard is five parts per billion.) Tritium has also been detected in two areas onsite at concentrations above the drinking water standard. To date, only one source of tritium, a 1991 leak from a tank at Building 292, has been identified and closed. Ongoing investigations are focused on identifying all remaining sources of ground-water contamination.

ENVIRONMENTAL RESTORATION MAP

Between 1961 and 1979, an underground fuel-storage tank released approximately 64,430 liters (17,000 gallons) of

gasoline. The tank was closed-in-place in 1981 and the soil was remediated in 1993 and 1994. This report assumes that a No Further Action approach will be required for the soils at this release site.

Ground-water treatment plans have been proposed to reduce the concentrations of solvents, gasoline, and other contaminants to levels below those specified in Drinking Water Standards. Negotiations with regulatory agencies resulted in an agreement to focus on three issues: the western offsite plume capture, the southern offsite plume capture, and interior areas source control and mass removal.

ASSESSMENT

The primary ground-water contamination at the Main Site is a 3.6 square-kilometer (1.4-square-mile) plume that is threatening private wells and the municipal water supply wells of the nearby city of Livermore. The principal contaminant of concern is trichloroethane. Assessment activities have focussed on determining the extent of ground-water contamination. Chlorinated hydrocarbons have been detected in ground water at concentrations of up to ten parts per million.

Remaining assessment activities involve investigating potential source areas that are identified by the regulatory agencies or the Lawrence Livermore National Laboratory as having radioactive or hazardous materials. Many of the remaining source areas are buildings where hazardous and/or radiative materials were handled but where there is no evidence of releases having occurred.

REMEDIAL ACTION

Currently, the Department of Energy is using enhanced pump-and-treat methods to remediate ground water at five treatment units. It is using onsite and offsite extraction wells to contain further migration of the plume of contaminated ground water. By May, 1995, more than 637 million liters (168 million gallons) of ground water was extracted and treated to remove organic solvents, and more than 37,900 liters (10,000 gallons) of gasoline was recovered. Activated carbon canisters contaminated with volatile organic compounds generated by remedial actions are removed to offsite treatment facilities.

Wells within the plume have been closed and their users provided with a public water supply. The trichloroethane plume is not expected to affect the municipal wells for the next 70 years. The planned pump and treat remediation to reduce the concentrations of contaminants to Maximum Contaminant Levels is expected to require 50 years. Hydraulic control of the western offsite plume was established in 1995 and resulted in a diametric decrease in offsite volatile organic compounds concentrations. The assumed effectiveness of the remedial action approach negates the need for long-term surveillance and monitoring.

Tritium in ground water will be allowed to decay naturally in place. This report assumes that the tritium will take approximately 15 years to decay below Maximum Contaminant Levels. Source controls and mass removal are assumed to be complete.

Contaminated soils have been remediated and a few remaining areas are undergoing source investigations. This report assumes that No Further Action will be required to remediate soils.

DECOMMISSIONING

Decommissioning activities are planned for five buildings currently listed in the Nuclear Material and Facility Stabilization Surplus Facilities Inventory. These facilities include: the Chemistry Building (#222), the Reactor Dome Building (#281), the Environmental Laboratory Building (#412), the Accelerator Building (#212), and the Heavy Element Building (#251). Operations at these facilities include chemistry and material science laboratory analysis, analytical laboratory operations, and multifunction research laboratory analysis. Decommissioning activities will include the cleanup and disposal of radioactive and hazardous materials, including asbestos. The effort will include planning, characterizing, decontaminating, demolishing, and disposing of all building materials so that the resultant vacant sites can be landscaped for soil retention. However, because of data entry errors, this estimate does not include any costs for decommissioning activities.

SITE 300

The environmental restoration at Site 300 focuses on assessing and remediating releases of solvents, tritium, and high-explosive components from landfills, drywells, spills, leaks, and other sources at the site. The site centers its attention on: solvent releases from debris piles and drywells at the General Services Area, from the Building 833 and 834 areas, and from the Pit 6 landfill. It also pays particular attention to solvent and high-explosive component releases from the High-Explosive Process Area, tritium releases from the Building 850 firing table and the Pit 7 landfill complex, and solvent releases at the Canyon behind Building 832. See the Site 300 Site Map for the location of Environmental Restoration program activities.

All major ground-water plumes at Site 300 have been delineated. The major area of concern is the General Services Area, which houses support facilities, such as machine shops, administrative offices, and motor-pool facilities for all of Site 300. From 1950 to 1960, solvents were discharged into drywells or the ground at several locations in this area, resulting in soil and ground-water contamination. Trichloroethene plumes have reached the shallow alluvial aquifer in the Corral Hollow Basin and into the regional aquifer at the General Services Area. At present, the levels of contamination in ground water and soil do not pose immediate health risks to site workers or the public. In the area where high explosives are processed, low concentrations of volatile organic compounds and high explosives are present in soil and perched water-bearing zones.

Offsite, the contaminated ground water threatens two water-supply wells that are monitored regularly. The Department of Energy has made a formal agreement with their users to provide clean water wells or local surface water supplies. Upon securing the alternative water supplies, the Department will deactivate the original wells and convert them into monitoring wells.

ASSESSMENT

Assessment activities have focused on determining the extent of onsite and offsite soil and ground-water contamination. Assessment is 80 percent complete at Site 300. During the next two years, the Department will investigate Building 854, the Building 832 Canyon, the "Sandia" Drop Tower, the Building 815 Area, and the Building 850 Area. Volatile organic carbons are believed to have been released in these areas. Assessment activities will be complete by FY 2001.

The source of contaminants in the eastern General Service Area is an abandoned debris pile that has been removed. The source of contaminants in the central General Services Area is closed drywells where solvents were disposed. The contamination plume at the eastern General Services Area extends offsite and down the Corral Hollow Alluvial channel for approximately 1.6 kilometers (1 mile).

A thermal testing facility in Building 834 has been operating since 1957. Before 1994, this facility used trichloroethene as a heat transfer fluid. In the 1950s, 1960s, and 1970s, trichloroethene was released into the ground through pipe leaks and spills. In the 1980s, the facility piping and solvent storage areas were upgraded to prevent further releases. Historical information about operations and data from site characterization indicate that up to 2084 liters (550 gallons) of trichloroethene was released into the ground. Most of this material is still present in the soil and ground water.

Contaminant concentrations in soil and ground water are very high at Building 834; and it is likely that pockets of free product trichloroethene (dense nonaqueous phase liquid) are present. However, the ground water at Building 834 is perched on a lens of clay close to the top surface. A second clay lens is located below 85 meters (280 feet) of unsaturated sediments. The two clay systems physically separate the Building 834 site from the regional aquifer and the perched ground water has virtually no pathway to leave the site. This poses no risk to the public.

At Pit 6, volatile organic compounds from the closed landfill have contaminated the uppermost aquifer. The ground water from this uppermost aquifer reaches the surface at a location approximately 152 meters (500 feet) west of the landfill within the site boundary where the contaminants slowly evaporate. The concentrations of volatile organic compounds in the ground water have dropped significantly since 1987.

A low-level tritium plume is emanating from the closed landfill complex of Pit 3/Pit 5 and the Building 850 firing table. The plume is entirely onsite. Fate and transport calculations predicted that tritium concentrations offsite will remain below federal and state drinking water standards. Polychlorinated biphenyls, volatile organic compounds, and depleted uranium

also have been detected in the ground water of this operable unit; the extent of contamination is still under investigation.

REMEDIAL ACTION

The treatment of trichloroethene contaminated ground water began at the eastern General Services Area in 1991. At the central General Services Area, ground water from a shallow alluvial aquifer has been remediated for trichloroethene contamination with both pump-and-treat and soil-vapor-extraction systems since 1993. By the end of 1994, a total of 11.6 kilograms (25.6 pounds) of volatile organic compounds had been removed from the two General Service Area ground-water treatment systems.

The Oakland Operations Office proposed that the Department take advantage of the unique situation at the Building 834 area to test removal/cleanup technologies for volatile organic compounds and dense nonaqueous phase liquids. The regulatory agencies granted approval for this approach and the remedial alternative was recorded in the Interim Record of Decision for the Building 834 Operable Unit. Concurrently, the Department of Energy is pursuing an exemption to the Basin Plan for this site from the Regional Water Quality Control Board. This exemption will allow remediation of the Building 834 plume to risk-based standards instead of the much more stringent Maximum Contaminant Level requirement.

Resource Conservation and Recovery Act closure of the High Explosive Burn Pits will begin once the new Explosive Waste Treatment Facility becomes operational, which is scheduled to occur at the end of FY 1997. This cost estimate assumes that the facility will be closed in-place using state performance standards. Closure of the High Explosive Burn Pits will be followed by post-closure monitoring until 2025. It also assumes that the Central Valley Regional Water Quality Control Board will not require solid waste assessment tests to be performed on the existing Site 300 landfills that are presently in the Environmental Restoration program.

Soil remediation will occur at Building 834 and the General Service Area. Remediation will prevent further releases of volatile organic carbons to the ground water. Soil vapor extraction is under way at the central General Service Area and will be undertaken at Building 834. This report assumes 34,000 cubic meters (44,540 cubic yards) at Building 834 and 25,000 cubic meters (32,750 cubic yards) at the General Service Area will be remediated.

Environmental Restoration Activities Cost Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	
Main Site								
Remedial Action	14,083	9,848	6,264	5,194	4,528	4,528	4,473	
Site 300								
Assessment	2,496		135					
Remedial Action	6,633	8,016	4,096	3,666	3,596	3,596		
Facility Decommissioning	171	39	33	6	5	4		
Long-Term Surveil. and Monitoring	601	1,047	1,558	1,683	1,712	1,708		
Direct Program Management/Support	6,259	1,927	1,642	1,359	1,183	1,183	1,183	
Total	30,243	20,877	13,728	11,908	11,024	11,019	5,656	
	FY 2035	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	**Life Cycle***
Main Site								
Remedial Action	4,473	4,473	4,473	4,473				334,053
Site 300								
Assessment								13,158
Remedial Action								148,012
Facility Decommissioning								1,289
Long-Term Surveil. and Monitoring								41,545
Direct Program Management/Support	1,183	1,183	1,183	1,183	710			100,888
Total	5,656	5,656	5,656	5,656	710			638,945

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

Direct Program Management/Support

Program Management tasks support the Environmental Restoration, Waste Management, Technology Development, and Nuclear Material and Facility Stabilization activities at Lawrence Livermore National Laboratory Main Site and Site 300. Program Management tasks supporting the environmental restoration activity at Lawrence Livermore National Laboratory Main Site and Site 300 include personnel management, strategic planning, financial management, interaction with Department of Energy and external regulatory agencies, monitoring of project progress, and administrative support.

Federal grants to the Department of Toxic Substances Control and the two Regional Water Quality Control Boards have been awarded since 1993 to provide financial compensation to the state agencies for their expenditures on the Main Site and on the Site 300 Comprehensive Environmental Response, Compensation, and Liability Act program. These grants are renewed every year. For the past three years, the total annual compensation to the State agencies has been approximately $300,000. Beginning in 1996, the annual expenditures claimed by the State agencies against the grants are expected to show a declining trend as the Remedial Investigation/Feasibility Study work for Site 300 approaches completion.

A Technical Assistance Grant of $100,000 was awarded to the local stakeholder group, Tri-Valley Cares, which has a deep interest in the environmental restoration program at both the Main Site and Site 300. $50,000 of this fund is intended to provide for their efforts prior to the Record of Decision stage and the remaining $50,000 is intended for the Remedial Action phase of the program.

COST SAVINGS

Cost savings for FY 1995 have been realized in several areas. For the Site-wide Monitoring and the General Service Area and Building 834 Operable Units, the regulatory agencies have agreed to accept the use of the "Cost Effective Sampling" statistical algorithm to reduce the sampling frequency of up to 20 percent of the monitoring wells at Site 300. The monthly monitoring results do not have to be transmitted to the regulators for review by formal report submittal as mentioned but are incorporated into the quarterly reports. The Eastern and Central General Service Area quarterly reports are combined. Total cost savings for the three operable units is around $250,000.

For the Pit 6 Operable Unit, under the "Re-engineering Comprehensive Environmental Response, Compensation and Liability Act" initiative, negotiations have been successfully concluded with the regulatory agencies to short circuit the traditional Proposed Plan/Public Meeting/Record of Decision process. The Feasibility Study document will be re-issued as an engineering evaluation/cost analysis document and a new cap cover for Pit 6 will be constructed as a nontime critical removal action. Total savings realized for FY 1995 and 1996 together will be $300,000.

For the High Explosive Process Area Operable Unit, a reduction of the original characterization scope of work has been successfully negotiated with the regulators. Reporting of the characterization work can be issued as an addendum to the site wide report in lieu of a stand-alone report. A total saving of $350,000 has been realized. Using the same approach, a total savings of $230,000 has also been realized for the Building 832 Canyon operable unit.

For FY 1996, additional cost savings will be accomplished in several ways. For the General Services Area Operable Unit, the "Cost Effective Sampling" statistical algorithm will be further refined to reduce both the sampling frequency and the number of analyses for all the monitoring locations. Estimated savings $60,000. For the Pit 6 Operable Unit, the Department will ask the regulatory agencies to accept a more cost effective cap that will save an additional $200,000. For the High Explosive Process Area Operable Unit, by applying the Re-engineering Comprehensive Environmental Response, Compensation and Liability Act initiative to short circuit the traditional Proposed Plan/Public Meeting/Record of Decision process, the Feasibility Study document will no longer be required. Any required removal action will be accomplished as a Comprehensive Environmental Response, Compensation and Liability Act nontime critical removal action. Total savings anticipated will be $255,000. The same approach should also generate a total savings of $300,000 for the Building 850/Pit 3/Pit 5 Operable Unit.

The Department of Energy and the State of California have an Agreement-in-Principle providing for technical and financial support to the State for its activities at Lawrence Livermore National Laboratory Main Site and Site 300. Technical and financial support includes environmental oversight, monitoring, access, emergency preparedness, and other initiatives to ensure compliance with applicable federal, state, and local regulations.

STAKEHOLDER INTERACTIONS

The Oakland Operations Office conducted public participation activities for eight California sites: Energy Technology Engineering Center, General Atomics, General Electric Vallecitos Nuclear Center, Geothermal Test Facility, Laboratory for Energy-Related Health Research, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, and Stanford Linear Accelerator Center. The office made information about the report available and invited comments at a number of existing public involvement forums including the Energy Technology Engineering Center Community Work Group meeting, Lawrence Berkeley National Laboratory regulators meeting, San Fransquito Creek (Stanford Linear Accelerator Site) Coordinated Resource Management Plan Working Group meeting, Laboratory for Energy-Related Health Research community meeting, Lawrence Livermore National Laboratory Community Work Group meetings, and the Lawrence Livermore Site 300 regulators meeting. The Oakland Operations Office newsletter, mailed to 2,000 stakeholders, featured an article about the 1996 report and announced availability of the 1995 report for review.

In response to public comment, the narrative for the 1996 report was modified to provide additional information such as discussion of the removal of contaminated soils near Trailer 5475 at Lawrence Livermore National Laboratory. Comments relating to national issues were forwarded to Department of Energy Headquarters. Commentors submitting written comments received letters outlining action that the Department planned to take in response. If you would like more information about the report or have questions about the results for these sites, please contact:

Public Participation	**Technical Liaison**	**Public Affairs**
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WASTE MANAGEMENT

Waste management activities costs at the site address waste generated by both the Office of Defense Programs and the Office of Environmental Management. In addition to the Main Site and Site 300, satellite operations take place at 2020 Research Drive and the Livermore Airport. Operating under interim status, the Main Site receives hazardous and mixed waste from Site 300 and the two satellite operations. No other offsite locations are currently allowed to send waste to the Main Site. See the Locality Map for the locations of offsite facilities.

In support of programs at the Lawrence Livermore National Laboratory, the Hazardous Waste Management Division stores, treats, packages, and prepares for transport transuranic, transuranic mixed, low-level, low-level mixed, and hazardous waste. Waste is treated onsite or shipped to an offsite waste handling facility; no disposal of this waste occurs onsite at Lawrence Livermore National Laboratory.

The Hazardous Waste Management Division manages four active waste management facilities at the Main Site: Area 514 Facility, the Area 612 Facility, the Building 693 Facility, and the Building 233 Facility. All Main Site waste facilities are presently operating under interim status permits issued by the State of California Department of Toxic Substances Control. The Main Site has submitted a Resource Conservation and Recovery Act Part B permit application for its waste storage and treatment facilities. The Federal Facilities Compliance Act prescribed Site Treatment Plan addressing mixed waste is being evaluated by the State of California Department of Toxic Substances Control. See the Main Site Map for the location of Waste Management program activities.

In addition to Main Site facilities, the Hazardous Waste Management Division manages a permitted hazardous waste storage facility, Building 883, at Site 300. The facility is designed primarily for interim storage of hazardous waste before it is transported to the Main Site for treatment or sent directly offsite for disposal. Site 300 is fully permitted.

WASTE MANAGEMENT MAP

Waste minimization activities are the responsibility of the Hazardous Waste Management Division's Pollution Prevention Group. This group performs program administration, planning, waste characterization, documentation, reporting, evaluation of new technologies, technology transfer assistance, a Laboratory-wide awareness program, and integration of pollution prevention into programmatic activities. The group's activities help to reduce the generation of hazardous, mixed,

radioactive, and nonhazardous (solid) waste. The group will continue to conduct pollution prevention opportunity assessments for various Laboratory processes, including engineering and economic analysis and identification of technologies to be implemented.

Construction projects planned to enhance and streamline waste management operations at the Laboratory include the Decontamination and Waste Treatment Facility, the Mixed Waste Management Facility, and the Explosive Waste Treatment Facility.

The Decontamination and Waste Treatment Facility project will provide new, centralized, and integrated facilities for the Hazardous Waste Management Division and proposed Mixed Waste Management Facility operations. The Decontamination and Waste Treatment Facility portion of the project will fulfill all of the Hazardous Waste Management Division's requirements for storing, handling, treating, and disposing of various Lawrence Livermore National Laboratory-generated waste. The Mixed Waste Management Facility portion of the project is a demonstration project for research and development of a molten salt oxidation process and other treatment processes for mixed waste. The Explosive Waste Treatment Facility, required by a Consent Agreement with the California Department of Toxic Substances Control, will be used to destructively dispose of explosive waste at Site 300.

Each of these planned construction projects has an expected useful life of 30 years. Once the useful life of the facility is over, the Environmental Management program will decommission the buildings. However, this estimate does not include costs for upgrades or ultimate decommissioning of these facilities.

The Hazardous Waste Management Division's planned waste management activities and their projected completion dates are shown in the Milestones table below.

Major Waste Management Activity Milestones

TASK	COMPLETION DATE Fiscal Year
Building 280 Upgrades	1996
Construct the Explosive Waste Treatment Facility	1997
Disposition of Nuclear Material and Facility Stabilization Waste	2002
Disposition of Environmental Restoration Waste	2070
Defense Programs Support	2070

Transuranic Waste

GENERATION AND HANDLING

Transuranic mixed and transuranic waste is generated only at the Livermore Main Site. Virtually all of Lawrence Livermore National Laboratory's transuranic waste is generated by the Office of Defense Programs at the Plutonium Facility (Building 332) and the Heavy Element Facility (Building 251).

Thirty-three 55-gallon drums of transuranic waste were generated and stored in 1994. The annual number of drums usually ranges between 50 and 100, with the addition of one or two TRUPACT-Standard Waste Boxes (volume of 1.89 cubic meters [2.55 cubic yards]).

All of Lawrence Livermore National Laboratory's transuranic waste inventory is considered to be retrievably stored, because it was all generated before an approved transuranic waste quality assurance project plan was implemented. Such a plan should be approved in the latter part of calendar year 1995. The plan will require further waste characterization, such as radiography and headspace gas sampling.

TREATMENT

Currently, no transuranic waste stored by the Hazardous Waste Management Division is known to require treatment to meet the waste acceptance criteria of the Waste Isolation Pilot Plant (Carlsbad, New Mexico). This waste consists of high

efficiency particulate air filters, which may require immobilization of fine particles, and waste that does not meet TRUPACT-II wattage limits or actual gas generation requirements for transport. The latter may merely require repackaging in smaller quantities per drum. Transuranic mixed waste is stored under the assumption that the Waste Isolation Pilot Plant will be granted a No Migration Variance and therefore the waste will not require treatment. Organic liquids are solidified by waste generators under permit exemptions. Some reactive waste may require permitted treatment by the generators.

STORAGE

Current inventory includes glove box trash (approximately 300 drums), organic and aqueous solidified liquids (76 drums), metal scrap (3 standard waste boxes and 30 other boxes, 7 of which also contain high efficiency particulate air filters), salt blocks (3 drums), and high efficiency particulate air filters (3 drums, 1 nonstandard waste box, and parts of 6 other boxes also containing metal scrap).

Transuranic waste is stored at Buildings 625 and 612-1, located in the Area 612 Facility, and in the Building 233 Facility, while waiting for disposal at the Waste Isolation Pilot Plant. The Building 233 Facility, used to store high curie transuranic waste, will be replaced by Building 280 to reduce site personnel exposure resulting from the continued operation of Building 233. Some nonmixed waste, such as Plutonium 238-contaminated waste, is stored by their generators while awaiting radioassay capability.

DISPOSAL

Transuranic waste from Lawrence Livermore National Laboratory will be disposed of at the Waste Isolation Pilot Plant. Existing transuranic waste either meets the waste acceptance criteria of the Waste Isolation Pilot Plant and TRUPACT-II Authorized Methods of Payload Control Criteria or will meet them after repackaging or, in a few cases, treatment. Thirty-one nonstandard boxes will be repackaged in the Decontamination and Waste Treatment Facility, which has not yet been constructed. A small amount of reactive waste will require treatment to remove this hazardous characteristic. This report assumes the life-cycle volume of transuranic waste generated will be 2,057 cubic meters (2695 cubic yards) and the life-cycle volume of transuranic mixed waste generated will be 136 cubic meters (178 cubic yards).

Transuranic waste will be transported in TRUPACT-II Standard Waste Boxes from Lawrence Livermore National Laboratory to the Waste Isolation Pilot Plant. Lawrence Livermore National Laboratory has an approved site-specific TRUPACT-II Authorized Methods of Payload Control Criteria. Approximately half of Lawrence Livermore National Laboratory's transuranic waste does not currently meet TRUPACT-II Authorized Methods of Payload Control Criteria wattage limits for radiolytic hydrogen and methane generation. Studies being conducted by the Department of Energy Gas Generation Program, and similar studies conducted at Lawrence Livermore National Laboratory, are expected to alleviate most of these problems. The Department may have to repackage some waste to meet wattage or actual gas generation limits.

All costs for transportation and disposal of transuranic waste are included in the Waste Isolation Pilot Plant site cost estimates. Characterization and packaging costs are included in the disposal estimate.

Low-Level Mixed Waste

GENERATION AND HANDLING

Research activities at the Laboratory generate mixed waste displaying a wide range of chemical and physical properties. Non-Resource Conservation and Recovery Act or California-only hazardous waste that contains a radiological component is identified and managed as radioactive waste in accordance with applicable Department of Energy Orders and federal nuclear regulatory standards.

TREATMENT

The Hazardous Waste Management Division is responsible for the onsite transfer, treatment, storage, and preparation for offsite shipment of mixed waste generated throughout the Laboratory. The treatment methodology designated for each specific mixed waste stream is established in Lawrence Livermore National Laboratory's Site Treatment Plan as part of the

activities required under the Federal Facilities Compliance Act (1992). Under the Site Treatment Plan, mixed waste will be treated onsite or stored onsite prior to shipment to offsite permitted facilities.

Under the Site Treatment Plan, the mixed waste streams generated at Lawrence Livermore National Laboratory are categorized into 11 treatability groups based on their radiological, matrix, and regulated contaminant parameters. The treatability group matrix descriptions for Lawrence Livermore National Laboratory waste streams, inventory volumes, and projected five-year additional generation rates are provided in the following table.

Mixed waste treatment operations at the Livermore Main Site take place at either the Area 514 Facility or the Area 612 Facility. The treatment processes include chromium reduction, neutralization, metal precipitation, filtration, size reduction, and solidification. Incineration is not conducted at the Livermore Main Site. Treatment such as bulking and pH adjustment may be performed on a small scale in containers in designated container storage units. Mixed waste is treated in containers and/or tanks in Building 612, Building 514, Area 514 Waste Treatment Tank Farm, and Building 513. Lawrence Livermore National Laboratory has requested regulatory agency approval to add centrifugation and evaporation treatment units as well as to increase current treatment operations for mixed waste.

Treatability Group Matrix Descriptions for Lawrence Livermore National Laboratory Waste Streams

Mixed Waste Description	Inventory Volume (m3)	5-Year Projection (m3)
Aqueous liquids and filter cake	174	1460
Homogeneous solids	161	170
Organic liquids with water	31	50
Organic/inorganic debris	60	59
Inorganic debris	15	5
High-efficiency particulate air filters	3	15
Elemental lead	4	5
Reactive metals	1	1
Elemental mercury	1	>1
Other reactives	4	1
Depleted uranium chips with coolant	TBD	TBD

Building 513 in the Area 514 Facility and Building 612 in the Area 612 Facility contain laboratories used to perform small-scale operations under the treatability study exemptions. These two laboratories serve three general functions within the conditions prescribed by the treatability study requirements: (1) perform preliminary analytical testing (prior to state-certified analysis) of waste treated in permitted units to verify reduction of hazardous properties below industrial sewer discharge limits, below hazardous waste characteristic classification thresholds, and/or below land ban disposal treatment standards; (2) develop process improvements, test new or novel process techniques at a test-scale level, provide modeling data, evaluate performance, or provide evidence for new equipment and/or raw material selection; and (3) perform bench-scale treatment to minimize waste, meet Department of Transportation shipping requirements, and/or satisfy land ban disposal treatment standards.

TECHNOLOGY DEVELOPMENT

Lawrence Livermore National Laboratory is developing the Mixed Waste Management Facility to:

- demonstrate and evaluate the integration and operation of mixed waste treatment technologies for low-level, organic, and mixed waste;
- demonstrate alternatives to incineration;
- demonstrate equivalency with applicable federal and state incineration-based standards; and
- meet other Resource Conservation and Recovery Act Land Disposal Restrictions.

The first treatment technology to be demonstrated and evaluated in the Mixed Waste Management Facility will be molten salt oxidation. Specific process support systems, such as ceramic immobilization of process residues, robotic feed preparation, and experimental off-gas, will also be evaluated for process effectiveness.

Mixed waste streams for which Lawrence Livermore National Laboratory does not have existing or currently planned treatment capabilities, will be shipped to the Department of Energy's Hanford facility and the Idaho National Engineering Laboratory.

STORAGE

The onsite mixed waste management facilities at the Livermore Main Site are the Area 514 Facility, the Area 612 Facility, the Building 233 Facility, and the Building 693 Facility. Mixed waste may be received at all four facilities. No mixed waste management facilities are located at Lawrence Livermore National Laboratory's Site 300. Future storage operations will be centralized and integrated in the completed Decontamination and Waste Treatment Facility.

Containerized mixed waste is stored at an onsite waste management facility until it is transported offsite to a permitted and approved treatment, storage, or disposal facility. Mixed waste is packaged in accordance with Environmental Protection Agency storage containment and waste compatibility requirements and Department of Transportation regulations for transportation. Seventeen specific areas are used to store containerized mixed waste. Bulk aqueous mixed waste is stored in two tank units referred to as the Area 514 Storage Tank 514-R501 Unit and the Area 514 Wastewater Treatment Tank Farm.

DISPOSAL

Lawrence Livermore National Laboratory does not dispose of any waste onsite. Waste disposal is accomplished by one or more of the following methods, listed in order of preference: onsite treatment followed by discharge to the sewer, offsite recycling, and/or offsite treatment, storage, and disposal. Treated waste may be discharged to the sewer under the Lawrence Livermore National Laboratory's permits and agreements with the Livermore Water Reclamation Plant. This report assumes that 2,330 cubic meters (3052 cubic yards) of mixed low-level waste will be treated at the Idaho National Engineering Laboratory and subsequently disposed. An additional 372 cubic meters (487 cubic yards) will be disposed of at the Nevada Test Site.

The treatment of "characteristic" mixed waste is typically designed to remove the hazardous characteristic through chemical modification or stabilization/encapsulation to prevent it from leaching out of the waste form. Once the hazardous nature has been removed or stabilized, the waste becomes low-level radioactive waste, which, when certified and approved, is disposed of at the Nevada Test Site.

Envirocare of Utah is presently the only commercial disposal site for mixed waste. Lawrence Livermore National Laboratory will use this site to dispose of contaminated soils and stabilized residue from the treatment of mixed waste containing "listed" hazardous components.

Low-Level Waste

GENERATION AND HANDLING

Significant variations in the physical composition of the low-level waste are prevalent because of the nature of the research work at the Laboratory. The low-level waste generated by the major programs includes miscellaneous construction debris, equipment, laboratory trash, stabilized waste, and contaminated environmental media (e.g., soils, asphalt, concrete, and gravel). This waste is primarily contaminated with uranium, tritium, and plutonium below 100 nanocuries per gram.

TREATMENT

Low-level waste treatment operations at the Livermore Main Site take place at either the Area 514 Facility or the Area 612 Facility, and are primarily for aqueous liquids. The treatment processes include chromium reduction, neutralization, metal precipitation, filtration, and solidification. Treatment, such as bulking and pH adjustment, may be performed on a small scale in containers in designated container storage units. Low-level waste is treated in containers and/or tanks in Building 612, Building 514, Area 514 Waste Treatment Tank Farm, and Building 513.

STORAGE

The onsite low-level waste management facilities at the Livermore site consist of the Area 514 Facility, the Area 612 Facility, the Building 233 Facility, and the Building 693 Facility. Low-level waste may be received at any of these facilities. Future storage operations will be centralized at the completed Decontamination and Waste Treatment Facility.

DISPOSAL

Lawrence Livermore National Laboratory has no waste disposal facility onsite. Low-level waste is shipped to the Nevada Test site for disposal. This report assumes 4,429 cubic meters (5,802 cubic yards) of low-level waste will be generated over the life cycle.

Hazardous Waste

GENERATION AND HANDLING

Hazardous waste types generated include: explosive waste, environmental restoration generated waste, biohazardous waste, organic liquids, inorganic liquids, contaminated soils, organic sludges, inorganic sludges, laboratory chemicals, asbestos, paints, empty containers, polychlorinated biphenyl-contaminated materials, batteries, inorganic gases, and organic gases.

TREATMENT

With the exception of empty containers, which are compacted in Building 612, solid hazardous waste is not treated or compacted onsite for volume reduction. Wastewater that contains hazardous constituents in quantities exceeding sewer discharge limits is also packaged and shipped offsite. Hazardous wastes shipped to an offsite treatment, storage, and disposal facility for treatment and/or disposal include: corrosive liquids, corrosive liquids with metals, contaminated soils, metal-bearing sludges, laboratory chemicals, asbestos, paints, empty drums, and polychlorinated biphenyl-contaminated materials. Waste streams such as solvents, oils, coolant, batteries, certain metal-bearing waste, and some mercury-containing waste are primarily shipped offsite for recycling. The waste is typically packaged in Department of Transportation-approved steel drums and stored in Area 612 prior to offsite shipment to a licensed treatment, storage and disposal facility or recycling facility.

When hazardous waste is treated at the Livermore Main Site, treatment operations take place at either the Area 514 Facility or the Area 612 Facility. Treatment processes include chemical and/or physical alteration of the waste through filtration, solidification/stabilization, neutralization, chemical precipitation, bulking, pH adjustment, silver recovery, chromium reduction, and size reduction, among others. Future additional treatment is proposed in the centralized and integrated Decontamination and Waste Treatment Facility. The Decontamination and Waste Treatment Facility will also house the research, development, and demonstration project called the Mixed Waste Management Facility. Processes and/or equipment may be transitioned out of the Mixed Waste Management Facility and used for treatment if proven successful.

Waste treatment at Site 300 is currently limited to the burning of explosive waste at the High Explosive Burn Pits. Future additional treatment at Site 300 is proposed in the new facility called the Explosive Waste Treatment Facility, where nonnuclear high explosive waste will be destroyed by way of detonation and/or burning.

STORAGE

Hazardous waste is primarily containerized and stored at a hazardous waste management facility until they are transported offsite to a permitted and approved treatment, storage or disposal facility. Hazardous waste is not stored at the hazardous waste management facilities for longer than one year. Waste is packaged in containers that meet the waste compatibility requirements of the Environmental Protection Agency storage regulations.

Each hazardous waste storage area has a continuous base that is impervious to the waste and each area is constructed so that spills and surface water runoff can be contained. Hazardous waste is segregated according to hazardous property information disclosed on the label and waste requisition form. Containers of incompatible waste are segregated by distance or physically separated by dikes, berms, or walls. Storage capability at Lawrence Livermore National Laboratory includes container storage units, a storage tank farm, and portable tank and tank trailer storage facilities. Practical hazardous waste storage capacity is estimated to be 850 cubic meters (1,131 cubic yards).

DISPOSAL

Hazardous waste is primarily sent to appropriate offsite commercial treatment, storage, and disposal facilities. However, Lawrence Livermore National Laboratory also bulks hazardous waste with mixed waste for treatment and discharge to the sanitary sewer. The Lawrence Livermore National Laboratory wastewater discharge permit with the Livermore Water Reclamation Plant defines the limits of hazardous constituents found in aqueous waste, such as toxic metals, volatile halogenated solvents, radioactive components, total dissolved solids, pH and other conventional and nonconventional pollutants. Prior to any discharge, the sewerable wastewater must be tested and, if it is found to be above internal discharge limits, it must be treated at the 514 Facility.

Licensed and certified drivers from the Hazardous Waste Management Division transfer hazardous waste onsite. The waste must meet waste acceptance criteria before it can be transported from a waste accumulation area to a Hazardous Waste Management Division storage facility. If the waste meets this acceptance criteria, it is shipped directly from the waste accumulation area to an approved offsite treatment, storage, or disposal facility. This report assumes that 39,824 cubic meters (52,169 cubic yards) of hazardous waste will be generated over the life cycle.

Direct Program Management/Support

Program management tasks supporting waste management activities at Lawrence Livermore National Laboratory Main Site and Site 300 include facility management; personnel management and training; administrative support; document, guidance, and procedure preparation and revision; data and waste tracking management; liaison with Department of Energy and external regulatory agencies; inspections and audits; budget preparation and control; and waste minimization planning. Waste minimization planning includes evaluating, training, and implementing the following programs: recycling; substituting less hazardous or nonhazardous raw materials; reducing volume and/or toxicity; and modifying source processes.

The California Hazardous Waste Source Reduction and Management Review Act regulates the Waste Minimization program. Pollution prevention planning activities support the waste generators in reducing hazardous, mixed radioactive and nonhazardous waste. This support includes program administration, waste characterization, documentation reporting technology transfer, the Chemical Exchange Warehouse, and recycling.

Waste Management Activities Cost Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)						
FY 1996-2000	2005	2010	2015	2020	2025	2030

Transuranic Mixed Waste								
Storage and Handling	21	93	93	93	93	93	93	
Disposal		26	26	26	26	26	26	
Transuranic Waste								
Storage and Handling	1,383	1,267	1,267	1,267	1,267	1,267	1,267	
Disposal		346	346	346	346	346	346	
Low-Level Mixed Waste								
Treatment	135	135	120	120	120	120	120	
Storage and Handling	1,488	1,488	1,325	1,325	1,325	1,325	1,325	
Disposal	1,082	1,082	964	964	964	964	964	
Low-Level Waste								
Treatment	228	228	202	202	202	202	202	
Storage and Handling	2,505	2,505	2,218	2,218	2,218	2,218	2,218	
Disposal	1,822	1,822	1,613	1,613	1,613	1,613	1,613	
Hazardous Waste								
Storage and Handling	901	901	864	864	864	864	864	
Disposal	4,805	4,805	4,609	4,609	4,609	4,609	4,609	
Direct Program Management/Support	9,941	10,168	9,441	9,441	9,441	9,441	9,441	
Total	24,312	24,866	23,088	23,088	23,088	23,088	23,088	
	FY 2035	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	
Transuranic Mixed Waste								
Storage and Handling	93	93	93	93	93	93	93	
Disposal	26	26	26	26	26	26	26	
Transuranic Waste								
Storage and Handling	1,267	1,267	1,267	1,267	1,267	1,267	1,267	
Disposal	346	346	346	346	346	346	346	
Low-Level Mixed Waste								
Treatment	120	120	120	120	120	120	120	
Storage and Handling	1,325	1,325	1,325	1,325	1,325	1,325	1,325	
Disposal	964	964	964	964	964	964	964	
Low-Level Waste								
Treatment	202	202	202	202	202	202	202	
Storage and Handling	2,218	2,218	2,218	2,218	2,218	2,218	2,218	
Disposal	1,613	1,613	1,613	1,613	1,613	1,613	1,613	
Hazardous Waste								
Storage and Handling	864	864	864	864	864	864	864	
Disposal	4,609	4,609	4,609	4,609	4,609	4,609	4,609	
Direct Program Management/Support	9,441	9,441	9,441	9,441	9,441	9,441	9,441	
Total	23,088	23,088	23,088	23,088	23,088	23,088	23,088	
	FY 2070	**2075**	**2080**	**2085**	**2090**	**2095**	**2100**	**Life Cycle***

Transuranic Mixed Waste		
Storage and Handling	93	6,616
Disposal	26	1,820
Transuranic Waste		
Storage and Handling	1,267	95,605
Disposal	346	24,220
Low-Level Mixed Waste		
Treatment	120	9,150
Storage and Handling	1,325	101,005
Disposal	964	73,480
Low-Level Waste		
Treatment	202	15,410
Storage and Handling	2,218	169,220
Disposal	1,613	123,065
Hazardous Waste		
Storage and Handling	864	65,170
Disposal	4,609	347,635
Direct Program Management/Support	9,441	714,214
Total	23,088	1,746,610

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

DESCRIPTION OF PERSONNEL

Current Composition

Environmental Management personnel comprise a multidisciplinary work force that includes professionals, technicians, laborers, and craft workers. This skill mix is necessary to conduct the environmental management activities of the site. The current federal and contractor personnel needs are presented in the table on the next page.

Full-Time Equivalent Composition Table*

LABOR CATEGORY	FEDERAL FTEs			CONTRACTOR FTEs						TOTAL FTEs*		
				DIRECT			INDIRECT					
	1996	1997	1998	1996	1997	1998	1996	1997	1998	1996	1997	1998
General Managers, Exec., Pl. Supp.	0	0	0	20	18	17	3.5	3	2.5	[illegible]	[illegible]	[illegible]
Gen. Admin. Ser., and Clerical	0	0	0	32	30	28	8.5	8	7.5	[illegible]	[illegible]	[illegible]
Admin. and Other Professionals	0	0	0	38	36	31	11	10.5	10	[illegible]	[illegible]	[illegible]
Engineers	0	0	0	38	31	27	8	7.5	7	[illegible]	[illegible]	[illegible]
Scientists	0	0	0	41	38	33	8	8	7	[illegible]	[illegible]	[illegible]
Technicians	0	0	0	79.5	88.5	81.5	32	31	17.5	[illegible]	[illegible]	[illegible]
Crafts	0	0	0	5	5	4	1.5	1.5	1	[illegible]	[illegible]	[illegible]
Laborers and Other Gen. Workers	0	0	0	1	1	1	0.5	0.5	0.5	[illegible]	[illegible]	[illegible]
Operators	0	0	0	11	8	8	0	0	0	[illegible]	[illegible]	[illegible]
TOTAL	0	0	0	264.5	256.5	238.5	68	62	53	[illegible]	[illegible]	[illegible]

*The projections for Full-Time Equivalent employees are based on FY 1996 planning baselines (see Reader's Guide).

Site Management Structure

The Oakland Operations Office is the field organization responsible for implementing Management Plans at the Laboratory. The University of California is the management and operating contractor responsible for environmental restoration and

waste management activities. The current contract will expire in FY 1998 and the Oakland Operations office is currently evaluating its options. Defense Programs performs site management activities.

CONTRACTING OPPORTUNITIES

If you would like more information about performing work for the Department of Energy's Environmental Management program at this site, please contact:

Major Procurements	**Small Business Procurements**
Anthony Pino Director Program Acquisition and Assistance Division United States Department of Energy Oakland Operations Office 1301 Clay Street, MR 700-N Oakland, CA 94612 p: (510) 637-1850 f: (510) 637--2004 e-mail: anthony.pino@oak.doe.gov	Dorothy Martinez Program Acquisition and Assistance Division United States Department of Energy Oakland Operations Office 1301 Clay Street, MR 700-N Oakland, CA 94612 p: (510) 637-1850 f: (510) 637-2004 e-mail: d.martinez@oak.doe.gov

Future Full-Time Equivalent Needs

This report expects that with declining waste generation and completion of environmental restoration activities, the number of environmental management Full-Time Equivalents will also decline accordingly.

FUNDING ESTIMATE

The following tables present estimated funding information for the Lawrence Livermore National Laboratory.

Defense Funding Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	2005	2010	2015	2020	2025	2030	
Nuclear Material and Facility Stabilization	1,871	2,331						
Environmental Restoration	30,243	20,877	13,728	11,908	11,024	11,019	5,656	
Waste Management	22,204	22,737	20,802	20,802	20,802	20,802	20,802	
Total	54,318	45,944	34,530	32,710	31,826	31,821	26,458	
	FY 2035	2040	2045	2050	2055	2060	2065	
Nuclear Material and Facility Stabilization								
Environmental Restoration	5,656	5,656	5,656	5,656	710			
Waste Management	20,802	20,802	20,802	20,802	20,802	20,802	20,802	
Total	26,458	26,458	26,458	26,458	21,512	20,802	20,802	
	FY 2070	2075	2080	2085	2090	2095	2100	Life Cycle*
Nuclear Material and Facility Stabilization								21,010
Environmental Restoration								638,945
Waste Management	20,802							1,576,840
Total	20,802							2,236,795
* *Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*								

Nondefense Funding Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	2005	2010	2015	2020	2025	2030	
Nuclear Material and Facility Stabilization	104	129						
Waste Management	2,107	2,130	2,286	2,286	2,286	2,286	2,286	
Total	2,211	2,259	2,286	2,286	2,286	2,286	2,286	
	FY 2035	2040	2045	2050	2055	2060	2065	
Nuclear Material and Facility Stabilization								
Waste Management	2,286	2,286	2,286	2,286	2,286	2,286	2,286	
Total	2,286	2,286	2,286	2,286	2,286	2,286	2,286	
	FY 2070	2075	2080	2085	2090	2095	2100	Life Cycle*
Nuclear Material and Facility Stabilization								1,164
Waste Management	2,286							169,770
Total	2,286							170,934
* *Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*								

COMPARISON WITH PREVIOUS ESTIMATE

The FY 1996 life-cycle cost estimate of $2.4 billion represents a 15 percent increase over the FY 1995 life-cycle estimate of $2.2 billion, after taking the 1995 expenditure of $71 million into account.

Comparison Table

Activity	FY 1995 Life Cycle	FY 1995 Only [1]	FY 1996 Life Cycle	Change in Dollars	Change in Percent
	Thousands of Dollars				
Nuclear Mat. & Fac. Stab.	36,929	-	22,174	-14,755	-40
Environmental Restoration	401,623	20,935	638,945	258,257	68
Waste Management	1,295,718	44,710	1,746,610	495,602	40
Landlord	-	-	-	-	-
Program Management [2]	438,757	5,065	-	-	-
Site Total	2,173,027	70,710	2,407,729	305,412	15

1 The FY 1995 life-cycle and annual costs are provided to determine the corrected FY 1995 cost.
2 Program Management was reported in an independent cost table last year, but is reported as a line item in the relevant program (Nuclear Material and Facility Stabilization, Environmental Restoration, and Waste Management) activity cost estimate tables for the FY 1996 Baseline Report.

The overall life-cycle costs for the Lawrence Livermore National Laboratory Environmental Restoration program are 68 percent higher in the 1996 Baseline Report ($639 million) than in the 1995 Baseline Report ($402 million), after taking into account the 1995 expenditure of $21 million. There are a number of changes in estimated cost and duration of Environmental Restoration activities. Decommissioning costs are $34 million (82 percent) lower in the 1996 report because an error in data entry caused the inadvertent omission of some costs for decommissioning activities. Remediation costs increased from $317 million in 1995 to $482 million in 1996 and surveillance and maintenance cost estimates increased from $15 million in 1995 to $44 million in 1996. These changes were the result of applying improved estimating techniques. The estimated duration of remedial action activities is five years shorter in the 1996 report because of the application of improved technology. The estimated duration of surveillance and maintenance activities is also five years shorter and is due to increased knowledge of the overall project. Program management costs allocated to the Environmental Restoration program decreased from $188 million in 1995 to $101 million in 1996 as the result of reduced overhead and improved cost estimating techniques.

The 1996 life-cycle estimate for the Lawrence Livermore National Laboratory Waste Management program is $1.7 billion, which is a 40 percent increase over the 1995 estimate of $1.3 billion, after taking the 1995 expenditure into account. As a result of the national assumption that all Waste Management support of non-Environmental Management Department of Energy programs will continue until FY 2070, Waste Management support to the Office of Defense Programs at Lawrence Livermore National Laboratory has been extended 40 years. Hazardous waste management costs decreased from $783 million in the 1995 Baseline Report to $413 million in the 1996 Report. This change is attributed to using more thorough "bottom up" data and assuming continued success with waste minimization/pollution prevention activities. Low-level waste costs increased from $65 million in the 1995 report to $308 million in the 1996 report. Mixed low-level waste costs increased from $165 million to $184 million in the 1996 Baseline Report. Support costs increased from $304 million in 1995 to $714 million in 1996. These changes are due to improved cost estimating techniques, an increase in program duration and added work scope. Finally, estimated transuranic waste management costs decreased from $205 million in 1995 to $128 million in 1996. This is attributed to an assumption in 1996 that treatment needs for transuranic waste to meet the current Waste Isolation Pilot Plant Waste Acceptance Criteria were minimal. In contrast, the 1995 report included costs associated with treatment to Land Disposal Restriction requirements.

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Posted 08/14/1996 (fr)

1.4 Project Team Members

The LLNL Site 300 project team includes personnel from DOE, LLNL, EPA, the public, and two State regulatory agencies. The public includes members of Tri-Valley CAREs, as well as interested parties on the LLNL Site 300 mailing list. The Project Team is presented in Exhibit 1.4-1.

Exhibit 1.4-1
Project Team Members

Core Project Team Members				
Name	**Title**	**Organization**	**Role/ Responsibility**	**Phone**
Kathy Angleberger	Program Manager	DOE HQ	Program Guidance	(301) 903-8170
Mike Brown	Deputy Division Director	DOE OAK	Program Direction	(510) 423-7061
Donna Sutherland	Project Manager	DOE OAK	Project Manager	(510) 422-0752
John Montella	Assistant Project Manager	DOE OAK	Assist Project Manager	(510) 422-0785
John Ziagos	Program Leader	LLNL	Project Manager	(510) 422-5479
Monya Lane	Deputy Program Leader	LLNL	Project Manager	(510) 422-1886
Lida Tan	Remedial Project Manager	U.S. EPA Region IX	LLNL Site 300	(415) 744-2212
Susan Timm	Remedial Project Manager	RWQCB Region 5	LLNL Site 300	(916) 255-3057
Robert Feather	Remedial Project Manager	DTSC	LLNL	(510) 540-3748

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Technical Project Team Members				
Subject Area	**Name**	**Title**	**Organization**	**Phone**
Biology, Chemistry, Risk Assessment, Envir. Sampling	Tina Carlsen	Environmental Chemistry & Biology Group Leader	LLNL	(510) 422-7103
Hydrogeology	Rick Landgraf	Hydrogeology Group Leader	LLNL	(510) 423-9164
Operable Unit 1	Leslie Rueth	OU Leader	Weiss Assoc.	(510) 422-0060
Operable Unit 2	Paul Daley	OU Leader	LLNL	(510) 423-1759
Operable Unit 3	Tom Berry	OU Leader	Weiss Assoc.	(510) 422-0565
Operable Unit 4	Vic Madrid	OU Leader	Weiss Assoc.	(510) 422-9930
Operable Unit 5	Michael Taffet	OU Leader	LLNL	(510) 422-6114
Operable Unit 6	Jack Gardner	OU Leader	Weiss Assoc.	(510) 422-7928
Legal	Andrea Blohm	Attorney	Dept. of Energy	(510) 637-1669

Other Key Participants				
Name	**Title**	**Organization**	**Role/ Responsibility**	**Phone**
Marylia Kelly	President	Tri-Valley CAREs	Citizen Advocate TAG participant	(510) 443-7148

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Date: 27 Jan 1997 09:45:03 -0800
From: "John Ziagos" <John.Ziagos@quickmail.llnl.gov>
Subject: Re: Request for Bombs and Bu
To: KEdelmayer@SCIENTECH.Com
Cc: "Tina Carlsen" <Tina.Carlsen@quickmail.llnl.gov>,
"Alan Copeland" <Alan.Copeland@quickmail.llnl.gov>,
"Bill McConachie" <Bill.McConachie@quickmail.llnl.gov>,
"Nan Prentice" <Nan.Prentice@quickmail.llnl.gov>

RE>Request for Bombs and Bullets... 1/27/97

Kory,

In answer to your questions:

Q1) Does LLNL have needs for Unexploded Ordnance Cleanups as part of the ER Program?

A1) No. Ordinance testing has never been part of the LLNL/S300 operations program.

Q2) Does LLNL have High Explosive contamination in the soils such as TNT or RDX?

A2) Yes. Trace concentrations of high explosives have been detected at our remote explosives testing site called Site 300.

Q3) Is so, how can I find out what is planned for cleanup of these items and other information. Is there any printed material or technical contacts that you could give me?

A3) Because the concentrations are so low we have decided not to remove or cleanup the high explosives. We do not have any printed material or technical contacts to pass along.

Hope this answers your questions. If you have any other questions please feel free to email or call (510-422-5479).
John

Date: 1/27/97 7:23 AM
To: John Ziagos
From: KEdelmayer@SCIENTECH.Com
John, I sent you an email message on January 24, 1997 to receive some

Weldon Springs

Environmental Restoration Site Summary

Site: Weldon Spring Site

Links to Additional Site Information
Weldon Spring Site Remedial Action Project Home Page
1996 Baseline Environmental Management Report Site Narrative
Weldon Spring Site Remedial Action Project Management Action Process Document

Background

The Weldon Spring Site is located in eastern Missouri, about 30 miles west of St. Louis. The site occupies 229 acres.

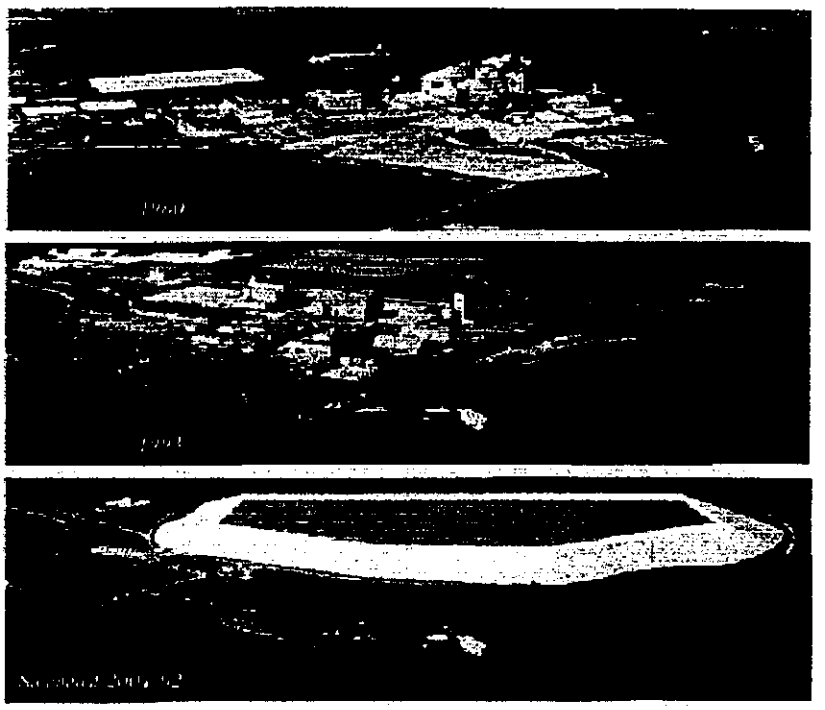
Weldon Spring was part of a site used by the U.S. Army as an ordnance works in the 1940s. In the 1950s and 1960s, the Atomic Energy Commission used the site for processing uranium ore in the Weldon Spring chemical plant. The plant was subsequently deactivated, and no activities have been carried out at the site until remediation was undertaken. Contamination has been was found in three areas of the site: an old quarry; four waste lagoons (raffinate pits); and the chemical plant. Some contamination has also been found in adjacent vicinity properties. The Weldon Spring Site was placed on the Environmental Protection Agency National Priorities List in 1989.

Remediation activities on the site will involve removal, treatment and disposal of contaminated materials from the quarry and raffinate pits, and decontamination and demolition of 44 contaminated buildings. Remediation of vicinity properties will involve removal and disposal of contaminated soils, and monitoring of potentially contaminated surface and ground water. A section of the site will be used as a permanent disposal area for wastes generated from cleanup of the site. The costs for cleanup of the chemical plant will be shared between the Department of the Army and the Department of Energy.

1-27-97
* Contacted Martha 314 441 8086 ext. 2702
to receive information

* 2-6-97 sent email to Request ROD
inss@envinfo.com

* 2-11-97 Contacted Martha 314 441 8086 ext. 2702
left message to determine status of
requested information



Remediation of the Weldon Spring Site

Go to the Office of Environmental Restoration Home Page

About This Document

Last Updated 11/25/1996 (mhp)

1996 BEMR

Weldon Spring Site

HOME BEMR CONTENTS U.S. MAP

The Weldon Spring Site consists of 91.6 hectares (229 acres), approximately 32 kilometers (20 miles) west of St. Louis, Missouri. The Weldon Spring Chemical Plant and the Weldon Spring Quarry occupy the site.

LOCALITY MAP

Estimated Site Total

(Thousands of Current Year Dollars)						
	FY 1996	1997	1998	1999	2000	
Environmental Restoration	67,500	79,803	79,177	95,316	76,082	*Grey shaded area reflects annual cost estimates for the first five years of the site BEMR Base Case (as of October 1995) and includes 3% annual inflation, see Readers' Guide.*
1996 Appropriation	58,500			*These levels reflect the current estimates for compliance with applicable statutes and agreements (as of March 1996), see Readers' Guide.*		
1997 Congressional Request		67,500				

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	2005	2010	2015	2020	2025	2030	Life Cycle*
Environmental Restoration	74,887	14,700						447,937

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

FACILITY MISSION

The Weldon Spring Site was part of a site used by the U.S. Army as an ordnance works in the 1940s. In the 1950s and 1960s, the Atomic Energy Commission used the site to process uranium ore in the Weldon Spring Chemical Plant. The plant was subsequently deactivated and no activities were carried out at the Weldon Spring Site until remediation began in 1985. In February 1985, a Memorandum of Understanding between Department of Energy and the Department of Army resulted in the transfer of ownership from the Department of Army to the Department of Energy. Since then, the Department of Energy's Oak Ridge Operations Office has administered the Weldon Spring Site as Major Project #182, Weldon Spring Site Remedial Action Project. In 1986, the Environmental Protection Agency and the Department of Energy signed a Federal Facilities Agreement, which was amended in 1992.

SITE MAPS

The Environmental Protection Agency placed the Weldon Spring quarry on the National Priorities List in 1987. The entire site was placed on the National Priorities List in 1989. The current mission for the Weldon Spring Site is to eliminate potential hazards to the public and the environment. The Department of Energy is conducting a comprehensive remedial action program to complete this mission.

Remedial action at the Weldon Spring Site is scheduled for completion in FY 2003. A section of the site, the Weldon Spring Disposal Facility, will be used as a permanent disposal area for waste removed during cleanup of the site, and it will be

monitored after closure of the disposal facility.

	WELDON SPRING DISPOSAL FACILITY
Location:	Northeastern portion of the Chemical Plant Site Northeastern portion is currently occupied by the Material Storage Area and Asbestos Storage Area; Central and Southern portions are occupied by Chemical Plant building foundations and underground piping.
Size:	28 hectares (72 acres) (16.8 hectares [42 acres] of actual waste materials)
Waste Volume	912,000 cubic meters (1,194,720 cubic yards)
Types/Origin of Waste	☐ Quarry bulk waste (chemically contaminated soil and rubble) ☐ Contaminated soil from Chemical Plant Area and Vicinity Properties ☐ Sludge from the raffinate pits ☐ Contaminated sediment from Vicinity Properties ☐ Contaminated structural material from the Chemical Plant buildings and Quarry ☐ Contaminated vegetation from the Quarry and Vicinity Properties ☐ Residues from the site and Quarry water treatment plants ☐ Contaminated soil from adjacent Army Superfund site
Basic Design:	☐ Lined facility with a leachate collection system ☐ Total cell thickness of 12 to 14 meters (13 to 15 yards) ☐ Primary and Secondary Liners will be composite, consisting of flexible membrane liners and clay liners
Schedule:	Begin cell construction March 1997

The Department of Army currently contributes 24 percent of the overall costs for the cleanup. The cost tables in this report reflect only the Department of Energy portion of the cleanup. The Estimated Site Total table presents Environmental Management program costs. There are no current or planned Nuclear Material and Facility Stabilization projects at the Weldon Spring Site. All waste management activities are conducted within the scope of environmental restoration. There is no current or anticipated additional need for stabilization or decommissioning activities at this site.

FUTURE USE

In 1991, the Environmental Protection Agency and the Department of Energy signed a Record of Decision for the removal of bulk waste in the Weldon Spring quarry. In 1993, the Environmental Protection Agency and Department of Energy signed another Record of Decision for the final disposal of all site waste. An onsite engineered disposal cell will be constructed to house all waste from remediation efforts at the quarry and chemical plant areas. This area will continue to be monitored while access controls are maintained. This report assumes that the excess real property will be used for recreational purposes because the Weldon Spring Site is currently surrounded by wildlife areas.

FUTURE USE MAPS

ENVIRONMENTAL RESTORATION

To support the remedial action at the Weldon Spring Site, the Department conducts radiological, chemical, and geotechnical investigations as well as extensive characterizations to determine the types and extent of contamination. The Environmental Protection Agency Region VII is the primary regulatory authority governing Comprehensive Environmental Response, Compensation and Liability Act remediation activities at the site, and conducts onsite monitoring as necessary. The lead agency for the State of Missouri regarding the Weldon Spring Site is the Missouri Department of Natural Resources. A grant is in place to provide funding to the Missouri Department of Natural Resources to allow onsite monitoring of activities by State employees at the site.

Contamination is present in three major areas at the Weldon Spring Site: four waste lagoons (raffinate pits), a chemical plant, and a quarry, located approximately 6.4 kilometers (4 miles) from the chemical plant. The total volume of contaminated media at the Weldon Spring Site has been estimated at 671,120 cubic meters (879,176 cubic yards), which includes approximately 167,200 cubic meters (219,032 cubic yards) of sludge, 91,080 cubic meters (119,315.8 cubic yards) of sediment, 257,640 cubic meters (337,508 cubic yards) of contaminated soil, 128,896 cubic meters (168,854 cubic yards) of structural material, 3,010 cubic meters (3,943 cubic yards) of process chemicals and 23,294 cubic meters (30,515 cubic yards) of contaminated vegetation. Some contamination is also present in adjacent ("vicinity") properties.

This report assumes that the Department will accomplish restoration by excavating contaminated soils and debris at the quarry and chemical plant sites, dismantling the chemical plant buildings, and excavating their foundations. The Department will treat and discharge the water in the raffinate pits, remove remaining raffinate pit sludge, and excavate contaminated vicinity property areas. It will also incinerate a small quantity of Resource Conservation and Recovery Act waste at the Oak Ridge K-25 Site and send the ash to Envirocare of Utah. Coordination with the Waste Management program at Oak Ridge is proceeding toward the goal of incinerating the waste in early 1996. It is assumed that Weldon Spring will accept an additional small quantity of contaminated soil from the adjacent Department of Army site. All site waste will then be entombed in an engineered disposal facility. All costs associated with treatment, storage, and disposal are included within the scope of remedial action.

This estimate assumes that no waste will be received from distant sites and that ongoing ground-water operable unit and quarry residuals operable unit studies will result in No Further Action Record(s) of Decision.

Landlord or support functions are required for the environmental restoration activities conducted at the Weldon Spring Site and they are included as an integral (i.e., not separate) cost of remedial actions. There are no directly appropriated costs associated with landlord activities at the Weldon Spring Site. Support functions include analytical laboratory services; janitor and guard services; groundskeeping; maintenance and repair for administrative facilities and vehicles; design, construction, and operation of support buildings and facilities; construction and maintenance of access roads and parking areas; installation and operation of site utilities; and equipment and supplies for safe field operations.

Major Environmental Restoration Activity Milestones

TASK	COMPLETION DATE Fiscal Year
Bulk Quarry Waste OU - Remedial Action	1996
Quarry Residuals OU - Assessment	1998
Site Ground Water OU - Assessment	1999
Vicinity Properties - Remedial Action	2000
Chemical Plant OU - Remedial Action	2001
Onsite Disposal Cell Construction	2002
Onsite Disposal Cell Operations	2003

ASSESSMENT

The Weldon Spring Site is divided into four operable units: quarry bulk waste, the chemical plant, quarry residuals, and site ground water. The 1991 Record of Decision provides for the removal of quarry bulk waste, which consists of contaminated building and equipment debris; concrete rubble and rock; soil sludge and sediment; and vegetation. The 1993 Chemical Plant Record of Decision provided for the onsite disposal of site waste in an engineered disposal facility. As of September 1995, approximately 88,160 cubic meters (115,489.6 cubic yards) of this waste have been removed from the quarry.

A Remedial Investigation/Feasibility Study is currently being prepared for the last two operable units, quarry residuals and site ground water. A Record of Decision is expected for the site ground-water operable unit in FY 1998 and for the quarry residuals operable unit in FY 1999.

Principal source areas and contaminated media at the site are chemical plant buildings, surface water and sludge from the raffinate pits, contaminated soil at the south and north dumps, coal storage area, and around certain chemical plant buildings, groundwater in the upper aquifer, and containerized chemicals in storage. Offsite locations have been impacted by contaminant transport from these source areas and are known as "vicinity properties". The major pathways that have resulted in transport to these offsite locations are surface water runoff, surface water loss to ground water, ground-water discharge to surface water (gaining streams), and leaching from surface or subsurface material to ground water. Results of the site risk assessment indicate that interim actions have improved site conditions. Potential health risks to workers from onsite exposure do not exceed the upper end of the U.S. Environmental Protection Agency target risk range. Radiological and chemical carcinogenic risks estimated for a recreational user at the offsite vicinity properties are also within or below the Agency's target risk range. This report assumes that all assessments for the Weldon Spring Site will be completed by FY 2001.

In FY 1993, the Department of Energy and the U.S. Environmental Protection Agency signed a Record of Decision providing for final disposal of all site waste. According to this Record of Decision, an onsite engineered disposal facility will

be designed and constructed in which all site waste will be entombed. This report assumes that construction of this facility will be completed by FY 2002.

REMEDIAL ACTION

The site used four waste lagoons (raffinate pits) to store contaminated residue from uranium ore processing. They contain approximately 310,027 cubic meters (406,135.37 cubic yards) of raffinate sludge and contaminated soil. They also contain approximately 216 million liters (57 million gallons) of contaminated water. The contaminated water will be treated at the Site Water Treatment Plant and released. The raffinate sludge and contaminated soil will be excavated, treated in the onsite Chemical Stabilization/Solidification Facility, and disposed of in the onsite disposal facility. Raffinate pits remediation activities will be completed by FY 2001.

The chemical plant is a complex of 44 buildings and other structures where uranium ore was processed. It contains approximately 264,476 cubic meters (346,463.56 cubic yards) of contaminated soil and building material. The Department has dismantled 43 of the buildings and structures. The remaining structure is a Resource Conservation and Recovery Act material storage building that will be dismantled in FY 1999. The chemical plant building foundations and contaminated soil will be excavated by FY 1998. All waste and contaminated material will be disposed of in the onsite disposal facility.

The quarry is a 3.6-hectare (9-acre) site that was used in the 1950s and 1960s for the disposal of waste generated during uranium ore processing. It contains approximately 92,565 cubic meters (121,000 cubic yards) of radiologically and chemically contaminated soil and rubble. It also contains approximately 11 million liters (3 million gallons) of radiologically and chemically contaminated water. The contaminated water has been treated and discharged to the Missouri River. The excavation of all contaminated soil and rubble, and its transportation to the chemical plant for temporary storage was complete in FY 1995. The quarry waste will be permanently disposed of in the onsite disposal facility. Depending upon the results of environmental assessment and monitoring efforts, residual contamination in the quarry may be treated; however, current estimates assume that no further action will be required. Restoration of the quarry will be complete by FY 2002.

Approximately 19,304 cubic meters (25,288.24 cubic yards) of low-level radiologically contaminated soil is present at various vicinity properties beyond the boundaries of the Weldon Spring Site. These properties include lakes and wildlife areas contaminated from the runoff of uranium during plant operations. The contaminated soil will be excavated and hauled to the onsite disposal facility for permanent disposal. Surface and ground water will continue to be monitored at current levels during remedial action; however, costs for long-term surveillance and monitoring are not included in this estimate. The vicinity properties will be remediated by FY 2000.

The Weldon Spring Site began an aggressive interim response action program in 1987 to stabilize the site and to ensure adequate protection of public health and safety. Several tasks were completed under this program, including the removal of overhead piping, asbestos, electrical poles and lines, construction of two water treatment plants, removal of contaminated buildings, consolidation and containment of chemicals, and construction of temporary storage areas for contaminated material.

All waste generated at the Weldon Spring Site is low-level waste in the form of radiologically and chemically contaminated soil, building debris, contaminated water, and raffinate sludge left behind after the operation of the ordnance works and the uranium ore processing plant. The Department will construct a Chemical Stabilization/Solidification plant to treat raffinate pit sludge. A waste processing facility will also be constructed to reduce the volume of waste from the dismantling of buildings before permanent placement in the onsite disposal facility. In addition, two water treatment plants have been constructed and have treated over 379 million liters (100 million gallons) of contaminated water to date. The Weldon Spring Site is exploring the use of a wet oxidation process to treat liquid mixed waste. A more economical solution involving incineration at the Oak Ridge K-25 Site will be available in 1996.

Waste will be stored temporarily in several locations at the Weldon Spring Site until permanent placement in the onsite disposal facility. Bulk waste removed from the quarry is stored at the Temporary Storage Area. Building debris and contaminated foundations and soil are stored at the Material Staging Area. Chemicals and tri-butyl phosphate waste are placed in containers and stored in a Resource Conservation and Recovery Act storage area until final disposal is arranged. Approximately 1,200 cubic meters (1,572 cubic yards) of asbestos is temporarily stored onsite in sealand containers. Disposal for all site waste will be in the onsite disposal facility, which will be a lined facility with a leachate collection system. Building waste, soil, and equipment will also be placed into the disposal facility. The waste will then be entombed with a stabilized cement material produced from raffinate pit sludge. The disposal facility is designed to hold 912,000 cubic meters (1,194,720 cubic yards) of waste. This report assumes that approximately 38,230 cubic meters (50,000 cubic yards) of waste from an adjacent Superfund site, being remediated by the Department of Army, will also be placed in the permanent Weldon Spring Site Remedial Action Project disposal facility.

After the closure of the onsite disposal facility, the Department will perform post-closure activities such as inspections, maintenance, and monitoring. These activities are not currently reflected in the total project cost estimate for the Weldon Spring Site. Institutional controls pertinent to the future use of the site property, such as monitoring, and restrictions on the use of land or ground water, will not be identified until a Comprehensive Environmental Response, Compensation, and

Liability Act Record of Decision is signed for the ground-water operable unit. This report estimates that this will occur in FY 1999.

Environmental Restoration Activities Cost Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	2005	2010	2015	2020	2025	2030	Life Cycle*
Weldon Spring Site								
Assessment	1,427	21						7,240
Remedial Action	70,738	14,106						424,219
Direct Program Management/Support	2,722	573						16,478
Total	74,887	14,700						447,937

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

Direct Program Management/Support

Program management includes funding for site project integration tasks, including project management, administration, and implementation. Additional program management functions include all site environmental, safety, and health activities, regulatory compliance, engineering design, procurement, construction management, cost and schedule management, and quality assurance.

The Weldon Spring Site provides funding for several county, state, and federal agencies to participate in the remedial action effort. On the county level, a grant is in place to provide funding to the St. Charles County Citizens' Commission to provide for citizen oversight of the remedial action work. Funding is also provided to St. Charles County for a consultant to perform independM0PEAÖ¿¿dÁBÖ¿¿cÁ;PM2FP

wyattsl@oro.doe.gov

Program support funding for the Weldon Spring Site provides for the following activities: environmental, safety, and health monitoring and protection; regulatory protection; construction safety; strategic planning; procurement; contract management; cost and schedule control; engineering design; training; construction management; financial management; stakeholder support/public participation; quality assurance; and administrative support.

Cost savings have been realized at the Weldon Spring Site because of the active management of the number of personnel onsite to perform the work. Onsite staffing was reduced from a proposed 350 to 300, reducing costs by 14 percent in the program management area. Future program management activities will be the same as current activities. They will end when the project is complete. This report anticipates completion in FY 2003.

DESCRIPTION OF PERSONNEL

Current Composition

The personnel at the Weldon Spring Site possess a wide range of expertise, as can be seen in the following table. Because the site is required to perform many of the functions of a field office, it has acquired personnel experienced in engineering design, construction management, facility operation and maintenance, procurement and contract management, financial accounting and reporting, cost and schedule control, training, communication services, environmental monitoring, laboratory analysis, graphics, community relations, and all other applicable administrative functions. Personnel supporting ongoing

activities at the Weldon Spring Site include federal and contractor personnel. The federal Full-Time Equivalents are included in the Oak Ridge Operations Office (Tennessee) section of this report.

Full-Time Equivalent Composition Table*

* The Projections for Full-Time Equivalent employees are based on FY 1996 planning baselines (see Reader's Guide).

Site Management Structure

The Department of Energy is responsible for the oversight of all work at the Weldon Spring Site. MK-Ferguson and Jacobs Engineering have been hired as the project management contractors responsible for all design, procurement, and construction activities associated with remedial action work. In addition, the contractor is responsible for all site environmental, safety, and health monitoring activities. The Department has hired Professional Analysis, Inc. as the support services contractor. The company provides assistance to the Department in the areas of project planning, technical review, and regulatory review. Argonne National Laboratory has been selected as the Comprehensive Environmental Response, Compensation, and Liability Act and National Environmental Policy Act process management contractor. This contractor performs the technical studies necessary to support the required level of environmental assessment.

The project management contractor contract is a full-term, fully priced cost plus fixed fee contract. Studies are currently under way to investigate the potential for savings through the application of force-account work. In the design of the remedial action work, the project management contractor has made frequent use of the value engineering process. To date, this process has resulted in identifying over $20 million in potential savings.

CONTRACTING OPPORTUNITIES

If you would like more information about performing work for the Department of Energy's Environmental Management program at this site, please contact:

Major Procurements	**Small Business Procurements**
Peter Dayton Director Procurements and Contracts Division., AD-42 United States Department of Energy Oak Ridge Operations Office P.O. Box 2001 Oak Ridge, TN 37831-8755 p: (423) 576-0795 f: (423) 576-9189	Chiquita Young Procurements and Contracts Division., AD-42 United States Department of Energy Oak Ridge Operations OfficeP.O. Box 2001 Oak Ridge, TN 37831-8755 p: (423) 576-5657 f: (423) 576-9189

In carrying out the remedial work, the project management contractor subcontracts as many of the remedial action activities as possible. This approach is intended to ensure the use of available industry capability as opposed to build-up of project management contractor manpower and government-furnished equipment. It also ensures maximum use of fixed price, competitively bid contracts and effective use of minority and disadvantaged contractors. All subcontracts contain a value engineering cost proposal clause that provides a cost saving incentive to the subcontractor. In FY 1995, the value engineering cost proposal process identified $938,000 in savings.

Future Full-Time Equivalent Needs

The Weldon Spring Site expects its personnel needs to remain stable through FY 1998 and then to begin to taper off as the project nears completion in FY 2003.

FUNDING ESTIMATE

The following table presents estimated funding information for the Weldon Spring Site Remedial Action Project.

Nondefense Funding Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	2005	2010	2015	2020	2025	2030	Life Cycle*
Environmental Restoration	74,887	14,700						447,937

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

COMPARISON WITH PREVIOUS ESTIMATE

The FY 1996 life-cycle cost estimate for the Weldon Spring Site is approximately $448 million. This represents an increase of approximately 10 percent over the FY 1995 estimate. See the Comparison table on the following page for additional life-cycle cost information.

Comparison Table

Activity	FY 1995 Life Cycle	FY 1995 Only [1]	FY 1996 Life Cycle	Change in Dollars	Change in Percent
	Thousands of Dollars				
Nuclear Mat. & Fac. Stab.	529,236	150	457,038	-	-14
Environmental Restoration	303,312	33,300	447,937	177,925	66
Waste Management	2,360,044	41,400	3,968,465	1,649,821	71
Landlord	-	0	346,714	293,094	547
Program Management [2]	158,438	21,700	-	-	-
Site Total	461,750	55,000	447,937	41,187	10

1 The FY 1995 life-cycle and annual costs are provided to determine the corrected FY 1995 cost.
2 Program Management was reported in an independent cost table last year, but is reported as a line item in the relevant program (Nuclear Material and Facility Stabilization, Environmental Restoration, and Waste Management) activity cost estimate tables for the FY 1996 Baseline Report.

The estimate in the FY 1995 Baseline Environmental Management Report reflected compliance level funding. Since the FY 1995 report's release, the Weldon Spring Site has completed a cost rebaseline, which reflects the impact of funding reductions over the past two years and the schedule changes that resulted from information gained during completion of the disposal facility. The increase in Environmental Restoration program costs is due to the rebaselined schedule, and to adjustments in general and administrative rates. Program management costs are estimated to be approximately $4 million lower in the FY 1996 estimate than in last year's estimate.

About This Document

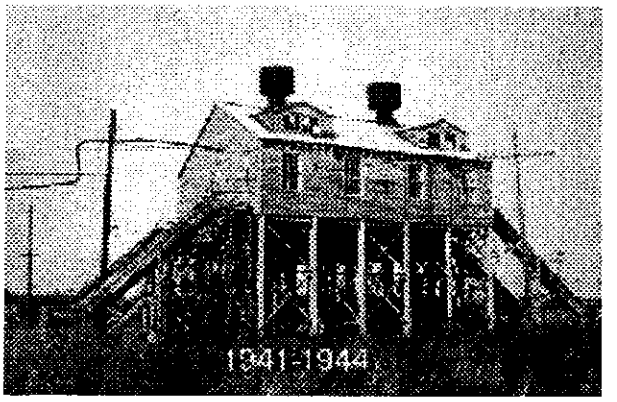
Posted 08/14/1996 (fr)

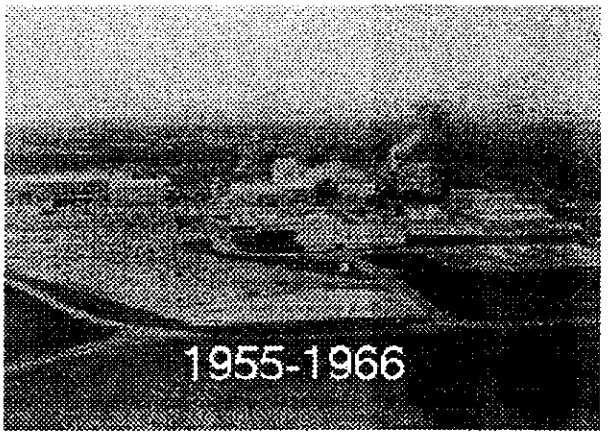
Community Relation Department wssrap@inlink.com
314 441-8086

www.em.doe.gov/wssrap/index.html

WSSRAP History

The Weldon Spring Site has a complex history of production processes. Between 1941 and 1944, the Department of the Army operated the Weldon Spring Ordnance Works at the site. Twenty explosives production lines were operated. Four of them were located in the area now occupied by the chemical plant. Sixteen others were distributed across the area now occupied by the U.S. Army Weldon Spring Training Area. The ordnance works produced dinitrotoluene (DNT) and trinitrotoluene (TNT) during World War II.





In 1955, 205 acres of the former ordnance works property were transferred to the U.S. Atomic Energy Commission (AEC) for construction of the Weldon Spring Uranium Feed Materials Plant, now called the Weldon Spring Chemical Plant. From 1957 until 1966, the feed materials plant processed uranium ore and a small amount of thorium. Wastes generated during these operations were stored in four settling basins called the raffinate pits.

In 1958, the AEC acquired title to the Weldon Spring Quarry. Earlier, during the period when the ordnance works was operating, the Department of Army had used the quarry for disposal of TNT-contaminated rubble.

After the 1958 acquisition, the AEC used the Quarry and raffinate pits to dispose of uranium and radium contaminated building rubble and soils from the demolition of a uranium ore processing facility in St. Louis. A small amount of thorium residue was also disposed of in the Quarry and raffinate pits.

After closure by the AEC in 1967, the chemical plant was reacquired by the Army. The Army partially decontaminated several buildings, dismantled some of the equipment,and began converting the facilities

to produce Agent Orange. In 1969, prior to becoming operational, the Agent Orange project was canceled. In 1984, the Army repaired several of the buildings at the chemical plant, decontaminated some of the floors, walls and ceilings and isolated some contaminated equipment.

In May 1985, the DOE, as successor to the AEC, designated the control and decontamination of the Weldon Spring Site as a Major Project (this project has since been designated as a Major System Acquisition). In October 1985, custody of the chemical plant was transferred to the DOE.

On October 15, 1985, the Environmental Protection Agency (EPA) proposed to include the Weldon Spring Quarry on the National Priorities List (NPL). Placement on this list was due to the threat of the groundwater contamination of a well field one quarter mile away that serviced 60,000 users in the rapidly growing St. Charles County. This listing was effective on July 30, 1987. On June 24, 1988, the EPA proposed to expand this designation to include the raffinate pits and chemical plant area. On March 30, 1989, these areas were also included in the listing and resulted in a single designation as the Weldon Spring Site.

In February 1986, MK-Ferguson Company with Jacobs Engineeering Group as an integrated subcontractor was selected as the Project Management Contractor(PMC).

In July 1986, a DOE project office was established on site. On October 1, 1986, the PMC assumed control of work at the site.

In 1988 cleanup investigations were conducted at the chemical plant and raffinate pits area, and since that time a number of cleanup actions have been under taken to stabilize the site and to reduce off-site migration of contaminants.

Building dismantlement activities began in 1988, and the last of the site's 44 structures was successfully dismantled in the Fall of 1994. Risk reductions have been realized with the dismantlement of building super structures, debris consolidation, asbestos removal, and chemical consolidation, with placement of building rubble and materialsin interim storage.

Removal of bulk waste removal from the quarry began on May 27, 1993. In November, 1995, after removing over 120,000 cubic yards of contaminated waste, the quarry bulk waste removal activity was declared substantially complete. With the completion of this milestone, the main threat at the quarry, potential contamination of the St. Charles County well field, has been significantly reduced.

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About This Document

Posted 05/13/96 (mas)

Site Name: WELDON SPRING QUARRY/PLNT/PITS
City : ST. CHARLES State: MO EPA Region: 7
ROD Date : 09/28/1990 EPA ID: MO3210090004
NTIS Report Number: EPA/ROD/R07-90/043
Contaminant(s): ORGANICS
PCBS
PAHS
RADIOACTIVE MATERIALS
METALS
ARSENIC
LEAD
Env. Media Affected: SOIL
SLUDGE
DEBRIS

ROD Abstract-
THE 226-ACRE WELDON SPRING QUARRY/PLANT/PITS (USDOE) SITE IS A FORMER ORDNANCE WORKS AND CHEMICAL PLANT NEAR THE CITY OF WELDON SPRING IN ST. CHARLES COUNTY, MISSOURI. THE SITE IS DIVIDED INTO TWO NONCONTIGUOUS AREAS: A 217-ACRE CHEMICAL PLANT AREA, COMPRISED OF VARIOUS BUILDINGS, PONDS AND FOUR RAFFINATE PITS, AND A 9-ACRE QUARRY, WHICH FORMS A VALLEY WALL AT THE EDGE OF THE MISSOURI RIVER FLOODPLAIN. SINCE THE EARLY 1940S, THE SITE HAS BEEN USED BY VARIOUS GOVERNMENT AGENCIES FOR CHEMICAL AND ORDNANCE PROCESSING WITH CHEMICAL AND RADIOACTIVE WASTE DISPOSAL IN THE QUARRY. FROM 1941 TO 1946, THE SITE WAS AN ARMY ORDNANCE WORKS USED FOR THE PRODUCTION OF TRINITROTOLUENE (TNT) AND DINITROTOLUENE (DNT) EXPLOSIVES, AND THE QUARRY WAS USED TO DISPOSE OF THE CHEMICAL WASTES. FROM 1955 TO 1966 THE ATOMIC ENERGY COMMISSION (AEC), THE PREDECESSOR TO THE DEPARTMENT OF ENERGY, CONSTRUCTED AND OPERATED THE CHEMICAL PLANT FOR PROCESSING URANIUM AND THORIUM. TYPES OF WASTES DISPOSED OF ONSITE INCLUDED URANIUM AND THORIUM ORE RESIDUES (DRUMMED AND UNCONTAINED), RADIOACTIVELY CONTAMINATED BUILDING DEBRIS, PROCESSING EQUIPMENT, AND RESIDUES OF TNT AND DNT FROM CLEANUP OF THE FORMER ORDNANCE WORKS. EXCEPT FOR PARTIALLY DECONTAMINATING BUILDINGS AND DISMANTLING SOME EQUIPMENT, THE SITE HAS NOT BEEN USED SINCE 1967. IN 1990, EPA RELEASED A REMEDIAL INVESTIGATION/FEASIBILITY STUDY AND PROPOSED PLAN, WHICH DOCUMENTED FIVE REMEDIAL ACTIONS FOR THE QUARRY. THE FIRST REMEDIAL ACTION INVOLVES TREATING CONTAMINATED SURFACE WATER, FOLLOWED BY DISCHARGE OF TREATED WATER TO THE MISSOURI RIVER. THE SECOND REMEDIAL ACTION, WHICH IS DOCUMENTED IN THIS RECORD OF DECISION (ROD), ADDRESSES INTERIM DEPOSITION OF BULK WASTES IN THE QUARRY TO MINIMIZE FUTURE GROUND WATER AND AIR CONTAMINATION AND TO FACILITATE ADDITIONAL CHARACTERIZATION OF WASTE AND RESIDUALS IN AND AROUND THE QUARRY. FINAL DECISIONS FOR DISPOSAL OF WASTES WILL BE MADE IN A SUBSEQUENT ROD FOR THE CHEMICAL PLANT. FUTURE REMEDIAL ACTIONS WILL ADDRESS MATERIALS REMAINING IN THE QUARRY WALLS AND FLOOR, GROUND WATER CONTAMINATION, AND CONTAMINATED PROPERTIES OUTSIDE THE QUARRY. THE PRIMARY CONTAMINANTS OF CONCERN AFFECTING THE QUARRY SOIL, SLUDGE, AND DEBRIS ARE ORGANICS INCLUDING PCBS AND PAHS; RADIOACTIVE MATERIALS; AND METALS INCLUDING ARSENIC AND LEAD.

THE SELECTED INTERIM REMEDIAL ACTION FOR THIS SITE INCLUDES EXCAVATING AN ESTIMATED 95,000 CUBIC YARDS OF CHEMICALLY AND RADIOACTIVELY CONTAMINATED BULK WASTES FROM THE QUARRY AND TEMPORARILY STORING THE WASTES ONSITE IN THE CHEMICAL PLANT AREA; AND IMPLEMENTING SITE ACCESS RESTRICTIONS. THE ESTIMATED TOTAL COST FOR THIS REMEDIAL ACTION IS $11,000,000. THERE ARE NO O&M COSTS ASSOCIATED WITH THIS REMEDIAL ACTION.

PERFORMANCE STANDARDS OR GOALS; NOT PROVIDED. INSTITUTIONAL CONTROLS; NOT APPLICABLE.

ROD Remedy-

THIS OPERABLE UNIT REMEDIAL ACTION IS THE SECOND OF FIVE RESPONSE ACTIONS PLANNED AS PART OF THE OVERALL REMEDIAL ACTION FOR THE WELDON SPRING QUARRY. THE FIRST RESPONSE ACTION TO BE INITIATED AT THE QUARRY IS A REMOVAL ACTION INVOLVING TREATMENT OF CONTAMINATED SURFACE WATER AND DISCHARGE OF THE TREATED WATER TO THE MISSOURI RIVER. THE QUARRY WATER REMOVAL ACTION IS EXPECTED TO BE INITIATED IN 1991. THE FUNCTION OF THIS OPERABLE UNIT IS TO REMOVE BULK WASTES FROM THE QUARRY. THIS WILL ELIMINATE THE WASTES AS A POTENTIAL CONTINUING SOURCE OF GROUNDWATER CONTAMINATION AND MINIMIZE RISKS ASSOCIATED WITH EXPOSURE TO CONTAMINANTS RELEASED INTO THE AIR. IT WILL ALSO FACILITATE ADDITIONAL CHARACTERIZATION OF THE WASTES AND RESIDUAL CONTAMINATION IN AND AROUND THE QUARRY. BULK WASTES ARE DEFINED AS MATERIALS THAT CAN BE REMOVED FROM THE QUARRY USING STANDARD EQUIPMENT AND PROCEDURES. THIS REMEDIAL ACTION IS NOT THE FINAL REMEDIAL ACTION FOR THE QUARRY, AND IT DOES NOT ADDRESS FINAL DISPOSITION OF THE BULK WASTES. DISPOSAL DECISIONS FOR THESE WASTES WILL BE MADE AS PART OF THE REMEDIAL ACTION DECISION FOR THE CHEMICAL PLANT AREA OF THE WELDON SPRING SITE. A DECISION ON THE FINAL REMEDIAL ACTION FOR THE QUARRY WILL BE MADE IN A SUBSEQUENT DECISION MAKING PROCESS AFTER THE BULK WASTES HAVE BEEN REMOVED.

THE MAJOR COMPONENTS OF THE SELECTED REMEDY INCLUDE;

* REMOVAL OF THE BULK WASTES FROM THE QUARRY USING STANDARD EQUIPMENT AND PROCEDURES.
* TRANSPORTING THE BULK WASTES ALONG A DEDICATED HAUL ROAD TO THE CHEMICAL PLANT AREA OF THE WELDON SPRING SITE.
* PLACING THE BULK WASTES IN CONTROLLED STORAGE IN AN ENGINEERED TEMPORARY STORAGE FACILITY.

FOLLOWING REMOVAL OF THE WASTES, DETAILED STUDIES WILL BE MADE OF THE EMPTY QUARRY AND LOCAL GROUNDWATER SYSTEM. THESE STUDIES WILL FACILITATE DECISIONS WITH REGARD TO THE THREE REMAINING COMPONENTS OF THE QUARRY REMEDIAL ACTION, I.E., (1) RESIDUAL MATERIALS REMAINING IN THE QUARRY WALLS AND FISSURES, (2) GROUNDWATER, AND (3) VICINITY PROPERTIES. THE VICINITY PROPERTIES ARE CONTAMINATED PROPERTIES THAT ARE OUTSIDE THE QUARRY AND FOR WHICH THE US DEPARTMENT OF ENERGY IS RESPONSIBLE (E.G., THE FEMME OSAGE SLOUGH). COMPREHENSIVE RESPONSE ACTIONS FOR RESIDUAL MATERIALS, GROUNDWATER, AND VICINITY PROPERTIES CAN BE DEVELOPED ONLY AFTER THE BULK WASTES HAVE BEEN REMOVED FROM THE QUARRY SO THAT THE NATURE AND EXTENT OF RESIDUAL CONTAMINATION AND MIGRATION PATHWAYS CAN BE FULLY ASSESSED.

Tonopah Test Range

Environmental Restoration Site Summary

Site: Tonopah Test Range Area

Links to Additional Site Information
Nevada Environmental Restoration
1996 Baseline Environmental Management Report Site Narrative
Management Action Process Document for the Nevada Test Site and Tonopah Test Range

Background

The Tonopah Test Range Area is located in southern Nevada on the Nellis Air Force Range, about 150 miles northwest of Las Vegas.

The Test Range Area is a research facility with the mission to test the mechanical operation and delivery systems for nuclear ordnance and other defense-related projects. The site was used to test ordnance delivery systems employing mock-ups of nuclear weapons, and tests with conventional explosives. The site is still actively used by Sandia National Laboratories and the U.S. Air Force. Past operations at the site have resulted in the contamination of soils, and possibly the ground water with radioactive and hazardous materials.

Forty two areas are currently under study at the Tonopah Test Range Area. Remediation activities in these areas are expected to involve soil removal, in situ cleanup methods, and possible treatment of ground water. Conventional unexploded ordnance will be detonated in place.

Go to the Office of Environmental Restoration Home Page

About This Document

Last Updated 11/25/1996 (mhp)

* Contacted Kevin Cabble 702 295 5000
will send requested info. 1-28-97
* 2-11-97 left message Kevin Cabble to determine status of requested information.

Environmental Restoration Site Summary

Site: Nevada Test Site

Links to Additional Site Information
Nevada Environmental Restoration
1996 Baseline Environmental Management Report Site Narrative
Management Action Process Document for the Nevada Test Site and Tonopah Test Range

Background

The Nevada Test Site is located in southern Nevada, about 65 miles northwest of Las Vegas. The site occupies 1,350 square miles.

Since its establishment in 1950, the primary mission of the Nevada Test Site has been to conduct field testing of both nuclear and conventional explosives in connection with the research and development of nuclear weapons. In addition to weapons testing, the site also hosted numerous secondary missions, including: open-air nuclear reactor, nuclear engine, and nuclear furnace tests; hazardous materials spill response testing; and experiments involving radioactive and non-radioactive materials. Above-ground testing of nuclear weapons was the predominant site activity until operations were ceased in 1963. Subsurface nuclear weapons testing continued until October 1992. Currently, the site is one of the primary low-level waste disposal sites for the Department of Energy complex.

Approximately 2,000 potential areas have been identified at the site requiring some level of investigation and possible remediation. These sites have been divided into three categories for the purpose of environmental restoration: Underground Test Areas, representing approximately 1,030 areas related to the underground testing of nuclear weapons; Soil Sites, representing more than 100 areas affected by aboveground testing; and Industrial Sites, representing the remaining areas used in support of testing operations. Remediation activities are currently underway at many of these sites.

The Sedan Crater at the Nevada Test Site

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About This Document

Last Updated 11/25/1996 (mhp)

1996 BEMR

Nevada Test Site & Tonopah Test Range

HOME BEMR CONTENTS U.S. MAP

The Nevada Test Site is located approximately 104 kilometers (65 miles) northwest of Las Vegas, Nevada in a sparsely populated region about the size of the State of Rhode Island. The Tonopah Test Range is approximately 240 kilometers (150 miles) northwest of Las Vegas. The site encompasses 3,510 kilometers (1,350 square miles) of desert and mountainous terrain, and is surrounded on three sides by the Nellis Air Force Range, which provides a substantial buffer between the site and public lands.

LOCALITY MAP

Estimated Site Total

(Thousands of Current Year Dollars)

	FY 1996	1997	1998	1999	2000
Nuclear Material and Facility Stabilization					
Environmental Restoration	48,649	62,591	57,028	58,690	60,370
Waste Management	32,887	26,735	23,261	20,734	21,146
Total	81,536	89,326	80,289	79,425	81,516
1996 Appropriation	65,944				
1997 Congressional Request		76,292			

Grey shaded area reflects annual cost estimates for the first five years of the site BEMR Base Case (as of October 1995) and includes 3% annual inflation, see Readers' Guide.

These levels reflect the current estimates for compliance with applicable statutes and agreements (as of March 1996), see Readers' Guide.

(Five-Year Averages, Thousands of Constant 1996 Dollars)

	FY 1996-2000	2005	2010	2015	2020	2025	2030
Nuclear Material and Facility Stabilization		37,660	47,100	43,448	11,825		
Environmental Restoration	54,104	52,727	59,341	60,194	61,183	62,332	62,527
Waste Management	23,706	15,977	14,397	13,397	13,197	5,902	5,902
Total	77,810	106,364	120,838	117,039	86,205	68,234	68,429

	FY 2035	2040	2045	2050	2055	2060	2065
Nuclear Material and Facility Stabilization							
Environmental Restoration	22,292	3,854	4,138	4,467			
Waste Management	5,902	5,902	5,902	5,902	5,902	5,902	5,902
Total	28,194	9,756	10,040	10,369	5,902	5,902	5,902

	FY 2070	2075	2080	2085	2090	2095	2100	Life Cycle*

	FY 2070	2075	2080	2085	2090	2095	2100	Life Cycle*
Nuclear Material and Facility Stabilization								700,166
Environmental Restoration								2,235,796
Waste Management	7,902							708,472
Total	7,902							3,644,434

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

FACILITY MISSION

For over 40 years, the primary mission of the Department of Energy, Nevada Operations Office was to conduct field testing of nuclear explosives in connection with the research and development of nuclear weapons. This testing was conducted primarily at the Nevada Test Site, which was established in 1950, when President Truman authorized a continental weapons testing area at the Las Vegas Bombing and Gunnery Range.

In addition to weapons testing, the Nevada Test Site has also hosted secondary missions: neutron and gamma-ray interaction studies; open air reactor, nuclear engine, and nuclear furnace tests; hazardous materials spill response testing; and a variety of other experiments involving radioactive and nonradioactive materials conducted by the Department of Defense.

The Department of Energy, Albuquerque Operations Office and the Department of Defense have historically used the Tonopah Test Range, northwest of the Nevada Test Site, for research and development of ordnance delivery systems, electronic combat training missions, and other activities. For cost and project management efficiency, the Department of Energy has consolidated the management of all Department of Energy environmental restoration activities for the site under the purview of the Department of Energy, Nevada Operations Office. This Baseline Environmental Management Report treats the two sites as one.

SITE MAP #1

Environmental restoration activities at the site, which began in 1989, focus on characterizing and remediating sites and facilities contaminated as the result of the historic nuclear testing activities. Contaminants include surface and subsurface radionuclides; organic compounds; chromium and other metals; petroleum; and residues from plastics, epoxy, and drilling muds used during test hole drilling and instrumentation. Most of the materials were released as an unavoidable consequence of testing activities. Most of the waste generated was from post-test sampling and construction and/or maintenance operations associated with testing. Disposal of this waste occurred in landfills, underground injection, sumps, and leachfields, as well as offsite disposal. Some residual materials remain in inactive storage tanks. In addition, approximately 1,200 hectares (3,000 acres) of surface and shallow subsurface soils are contaminated as the result of safety shots and plutonium-dispersion tests conducted on the Nevada Test Site and portions of the Tonopah Test Range and Nellis Air Force Range. When atmospheric and shallow cratering tests are included, this number increases to 10,900 hectares (27,000 acres). Areas highlighted in the above map are discussed in the Environmental Restoration program section.

SITE MAP #2

The Department of Energy, Nevada Operations Office operates a variety of waste facilities at the Nevada Test Site. Low-level radioactive waste originating both from the Nevada Test Site and from other U.S. Department of Energy installations is disposed of onsite. The site also stores the current inventory of transuranic mixed waste from Lawrence Livermore National Laboratory, pending shipment to the Waste Isolation Pilot Plant in Carlsbad, New Mexico. Limited mixed waste disposal for offsite generators will be available on the Nevada Test Site pending completion of the Site-Wide Environmental Impact Statement in FY 1996 and approval from the State of Nevada of the Site Treatment Plan. An expanded mixed waste disposal facility will be constructed when the State of Nevada issues the Resource Conservation and Recovery Act permit application. The site remains an active facility for other Department of Energy programs (the Office of Environmental Management constitutes only 10 percent of the current Department of Energy budget for the Nevada Site Operations Office). This estimate assumes the site will remain an active facility for other Department of Energy activities, and landlord responsibility for the site will remain with the Department of Energy.

REGULATORY ISSUE
FEDERAL FACILITY AGREEMENT AND CONSENT ORDER

The previous Baseline Environmental Management Report reflected the Comprehensive Environmental Response, Compensation, and Liability Act as the central legal driver for cleanup activities. Completion of negotiations with the State of Nevada has resulted in a Federal Facility Agreement and Consent Order that governs Department of Energy environmental management activities in Nevada under the state's Resource Conservation and Recovery Act authority and its hazardous waste and water pollution control laws.

Conservation and Recovery Act authority and its hazardous waste and water pollution control laws.

On November 22, 1995, in a letter to the Nevada Operations Office that contained review comments on the FY 1996 Department of Energy/Nevada submittal to the Baseline Environmental Management Report, the state identified key issues regarding information contained within the submittal. These issues are addressed in highlighted portions of this report in "Regulatory Issues" sidebar discussions to assist the reader in understanding the state's position regarding Environmental Management activities within the state.

Because the Nevada Test Site, Tonopah Test Range, and Nellis Air Force Range are under institutional control, risk to workers and the public is considered minimal. However, the site conducts risk assessments and interim removal actions where necessary to ensure the safety of workers and the public.

REGULATORY ISSUE
DISPOSAL OF WASTE GENERATED OFFSITE

"Nevada Test Site land withdrawal orders restrict the use of the site to atomic testing activities. State officials in Nevada have long contended that the U.S. Department of Energy must seek both congressional and State approval to use the site for new activities, such as the disposal of radioactive waste from offsite generators." (Letter from the State of Nevada to Carl Gertz, Acting Assistant Manager for Environmental Restoration and Waste Management Division, November 22, 1995).

FUTURE USE

This Baseline Environmental Management Report assumes the Nevada Test Site will remain under Department of Energy institutional control and maintain its current mix of Industrial, Open Space, and Controlled Access uses. A Site-Wide Environmental Impact Statement is in progress and a formal land-use plan will be developed based on the results of that effort. The Department will also conduct risk assessments, as appropriate, to determine future land uses. Several public briefings have been held to obtain public input, which has provided valuable feedback to the Environmental Impact Statement and the land-use planning process. As the Department completes these activities and makes final decisions, annual updates of the Baseline Environmental Management Report will reflect the accumulated data.

In conjunction with the Nevada Test Site-Wide Environmental Impact Statement, the Nevada Operations Office is developing a Resource Management Plan for the Nevada Test Site to take advantage of the extensive data collection and public participation activities associated with the National Environmental Policy Act. The Department is developing the Resource Management Plan to improve land-use and resource management planning at the Nevada Test Site. This plan will use the data in the Technical Site Information document as a starting point, and will ultimately gather other ongoing management and planning activities under the comprehensive plan. It will identify the criteria for evaluating the compatibility of activities with human health and safety, ongoing missions, existing infrastructures, cultural and natural resources, public values, and other resource issues and constraints.

REGULATORY ISSUE
FUTURE USE

"State officials contend that any final strategy to address surface soil contamination at the Nevada Test Site must be developed in the context of future land uses that embrace the concept of how clean is clean for what use. Department officials in Nevada are establishing an approach to embrace this concept by developing a site-wide Resource Management Plan as part of the Nevada Test Site-Wide Environmental Impact Statement" (Letter from the State of Nevada to Carl Gertz, Acting Assistant Manager for Environmental Restoration and Waste Management Division, November 22, 1995).

NUCLEAR MATERIAL AND FACILITY STABILIZATION

The facility stabilization and maintenance activities commenced at the Nevada Test Site in 1995. However, these activities are currently performed by the Environmental Restoration program. All of the 289 Nevada Test Site facilities identified on the Surplus Facilities Inventory Assessment listing are potential candidates for stabilization and maintenance activities pending future decisions on the missions of the Nevada Test Site. Some of these facilities are buildings and equipment previously used in support of nuclear tests such as explosive magazines, fallout shelters, railroad boxcars, etc. The resulting waste will be managed by the Waste Management program for disposition and is accounted for in their cost estimate. Completion of stabilization and maintenance activities is anticipated by 2012.

Nuclear Material and Facility Stabilization Activities Cost Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)

(Five-Year Averages, Thousands of Constant 1996 Dollars)

	FY 1996-2000	2005	2010	2015	2020	2025	2030	Life Cycle*
Nuclear Material and Facility Stabilization		37,660	47,100	43,448	11,825			700,166

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

ENVIRONMENTAL RESTORATION

Within the Nevada Test Site and the Tonopah Test Range approximately 2,400 potential corrective action sites require some level of investigation and possible remediation. Approximately 930 of these sites are related to the underground testing of nuclear weapons; more than 100 resulted from above-ground testing. The remaining sites include waste disposal facilities, leach fields, landfills, storage tanks, injection wells, inactive and abandoned buildings, and associated equipment contaminated by prior operations, spill areas, and hundreds of other small sites where unregulated disposal or storage of waste materials occurred during more than 40 years of operations. The Department has divided the assessment and remediation of these sites into three categories: Industrial Sites, which include all sites used in support of testing operations; Soils Sites, which include all surface and shallow subsurface soil contamination resulting primarily from historic safety shots; and Underground Test Areas, which are sites that were impacted by previous underground testing activities. Activities within the Industrial Sites focus on physical investigation and remediation of the individual sites. Activities within Soils Sites focus on defining appropriate cleanup levels (standards do not exist at this time) and remediating surface soils where risk potentially exists to workers and the public. Activities within Underground Test Areas focus on determining the potential boundaries of contamination and the requirements to monitor the identified boundaries. See the Site Maps for the location of Environmental Restoration program activities at the Nevada Test Site and Tonopah Test Range.

Major Environmental Restoration Activity Milestones

TASK	COMPLETION DATE Fiscal Year
Industrial Sites	
Assessment	
Remedial Action	2015
Decommissioning	2035
Soil Sites	2025
Assessment	
Remedial Action	2025
Underground Test Areas	2030
Assessment	
Remedial Action	1996
Site-Wide	2002
Long-Term Monitoring	2050

The Department of Energy Albuquerque Operations Office initiated environmental restoration activities at the Tonopah Test Range in the late 1980s. In 1987, the Department conducted a preliminary assessment that was evaluated by Environmental Protection Agency-Region IX in 1988. The Environmental Protection Agency declared the facility to be in a No Further Action Planned status with respect to the Comprehensive Environmental Response, Compensation and Liability Act activities. Corrective actions would, however, continue to be completed according to the requirements of the Resource Conservation and Recovery Act. In 1993, for logistical reasons, the Albuquerque Operations Office agreed to turn over environmental restoration responsibilities for this site to the Nevada Operations Office. Since 1993, the Nevada Operations Office has conducted a comprehensive inventory of potential release sites and has identified approximately 40 sites that will require site characterization activities. Tonopah Test Range is now managed under the Industrial Sites grouping of the Nevada site.

The following figure describes the process used by the Nevada Office to clean up a site. The process, which applies to all areas at the Nevada Test Site, groups all of the sites into Corrective Action Sites and then groups these into Corrective Action Units to facilitate administration. After a Corrective Action Unit has been organized, the process to be used to remediate it is identified. After the office takes several steps mandated by environmental regulations, a closure report is submitted to the State of Nevada certifying the site has been closed properly and actions are complete.

The corrective action strategy portion of the Federal Facility Agreement and Consent Order establishes the methodology by which all other site investigations and corrective actions will take place. In general, the strategy calls for sites to be grouped using various combinations of similarity of site Aowner", functional category, location, and length of time required for corrective action. The groupings enable economies of scale from commonality of work, including approach and logistics during assessment and remediation. Consideration is given to minimizing long-term monitoring when choosing a remediation approach. Sites will use the Streamlined Approach for Environmental Restoration, often referred to as SAFER, when it is applicable and acceptable to the State of Nevada. Sites will consider the probable remediation method when performing and coordinating assessments. To facilitate the estimating process, this report has made two assumptions. The

performing and coordinating assessments. To facilitate the estimating process, this report has made two assumptions. The first is that activated metals are considered a source and are estimated in the categories of rubble/debris and low-level radioactive waste. The second assumption is radon is not considered to be a significant source because it is controlled by ventilation in impacted tunnels and exists at near-background levels for surface-based activities.

Technical Approach to Remediation Activities

To determine the expected costs and waste volumes for the potential release sites not yet characterized, parametric modeling and bounding conditions were used to fill in data gaps. For example, the waste volumes assumed to be generated at some facilities were calculated by multiplying the square footage of the facility by contamination factors developed using characterization information to date. Estimates generated for this document do not include active sites and sites not yet transitioned to the Environmental Management program. Such sites include, but are not limited to nuclear shots in the Pacific (including Bikini Atoll), the Liquefied Gaseous Fuels Test Facility, and contaminated sites remaining under Department of Defense funding.

Waste disposal for onsite environmental restoration activities takes place primarily at the Area 3 and Area 5 Radioactive Waste Management Sites on the Nevada Test Site. All costs for treatment, storage, transportation, and disposal of waste generated by environmental restoration activities at the Nevada Test Site are included within the estimated costs for assessment, remedial action, and decommissioning activities. Bulk low-level waste is disposed of as containerized bulk waste at the Area 3 site. All other low-level waste is disposed of at Area 5. Mixed waste is also disposed of in Area 5, while mixed waste subject to land disposal restrictions is placed on the Transuranic Waste Pad in Area 5 to await treatment. Hazardous waste is shipped offsite to approved commercial disposal facilities. Disposal costs for the Area 3 and Area 5 disposal facilities are $446 per cubic meter ($341 per cubic yard) for FY 1996, $623 per cubic meter ($475 per cubic yard) for FY 1997 through FY 2021, and then $2,402 per cubic meter ($1,833 per cubic yard) through the outyears.

Industrial Sites

The Nevada Test Site Source Groupings include the assessment and remediation of "like-waste units", e.g., tunnel muck piles, tunnel ponds, sumps and injection wells, inactive tanks, leach fields, contaminated waste sites, atmospheric test debris, and miscellaneous other sites. The subject waste units are the result (or byproduct) of past testing and support activities at the Nevada Test Site.

The Tonopah Test Range Source Groupings include the assessment and remediation of contaminated sites on the Tonopah Test Range, such as landfills, storage tanks, bomblet pits, and construction debris areas. Contamination at the subject sites is the result of testing ordnance delivery systems employing mock-ups of nuclear weapons and tests with conventional explosives. Contaminants include chemicals, lead, explosives, unexploded ordnance items, and radioactive and mixed waste.

The Environmental Restoration Sites Inventory involves conducting an inventory of all known release sites (approximately 2,400) and validates information through photographic monitoring and field verification, including surveys using global positioning system techniques. New sites are identified through reviewing archived literature and photographs, visiting sites, and maintaining an established data base to compile all the information on each site. Existing and newly identified sites are assigned to the Industrial Sites, Soil Sites, or Underground Test Areas if remedial action is required. The inventory fulfills the Nevada Test Site Resource Conservation and Recovery Act Part B applicable requirements to list solid waste management units. Over 266 closure reports have been delivered to the state for sites identified in the inventory.

Specific Resource Conservation and Recovery Act Closures provide for closure of eight industrial sites named in the Resource Conservation and Recovery Act Part B Permit Application. These waste units were generally used more recently than Source Groupings Waste Units. Three of the units have been closed: U-3fi Injection Well, Area 23 Landfill trenches, Area 27 Explosive Ordnance Disposal Facility. The remaining five facilities include the Area 6 Decontamination Facility, Area 6 Steam Cleaning Effluent Ponds, Area 23 Building 650 Leach Field, Area 2 Bit Cutter Shop Injection Well, and U-2bu Subsidence Crater. Activities in support of these Resource Conservation and Recovery Act closures include developing and implementing characterization plans, analyzing data, analyzing risk, preparing characterization reports, developing closure strategies, and preparing and implementing Resource Conservation and Recovery Act Closure Plans.

The Resource Conservation and Recovery Act Permit governs all work at the Industrial Sites for the next two to three years, except decommissioning, which is currently governed by Department of Energy Orders. All work is governed by requirements of the Federal Facility Agreement and Consent Order, which establishes the methodology by which all site investigation and corrective actions will take place.

ASSESSMENT

Because of the extensive number of sites, most of the Industrial Sites have not been fully characterized to date. However, initial assessment activities indicate contamination problems include surface and subsurface soils that have been impacted by releases from leach fields, sumps, disposal wells, leaking tanks, and other sources of waste. Contaminants may include petroleum hydrocarbons, hazardous waste, low-level radioactive materials, and mixed waste. In general, this report assumes most of the soil contamination related to the units in question is confined to the vadose zone at the Nevada Test Site.

most of the soil contamination related to the units in question is confined to the vadose zone at the Nevada Test Site. However, it is possible that Industrial sites at the Tonopah Test Range have impacted ground water.

Completed activities include work plans for abandoned septic tanks and leach fields, including sampling; completed characterization of the U-3fi Injection Well, the Area 27 Explosive Ordinance Disposal Facility, the Area 6 Bit cutter shop Injection Well, the Tonopah Test Range 5 Points Landfill, the Jr. Hot Cell, and the EPA Farm. The Department completed field verification on 864 sites, surveyed 670 sites, and identified 134 new sites. Outyears beyond FY 2001 are still being prioritized in site baselining activities. This estimate assumes assessment activities will continue through 2015.

REMEDIAL ACTION

Because characterization at Industrial Sites is not complete, definitive remedial action approaches are not available. However, conventional unexploded ordnance will be detonated in place. Any explosive residue will be detonated on range, rendering nonhazardous debris, recyclable debris, or nonhazardous solid waste.

INTERIM REMOVAL AND COMPLETED REMEDIAL ACTIONS TO DATE

Area 23 Hazardous Waste Trenches
Area 27 Explosive Ordnance Disposal Facility
U-3fi Injection Well
Tonopah Test Range Bomblet Pit
Tonopah Test Range 5 Points Landfill Ordnance Removal
Tonopah Test Range Roller Coaster Sewage Lagoons Ordnance Removal
Tonopah Test Range Area 9 Landfill Ordnance Removal
Tonopah Test Range Area 9 Construction Debris Area Ordnance Removal
Tonopah Test Range Antelope Lake Road Site Ordnance Removal
Closure or removal of 55 Underground Storage Tanks
Completion of 71 Environmental Restoration Inventory Sites
Submission of 266 Closure Reports to the State

Outyear activities beyond FY 2001 are still being prioritized in site baselining activities. This estimate assumes remedial action activities will continue through FY 2035. As discussed in the introduction to the Environmental Restoration section, low-level waste and low-level mixed waste will be disposed onsite and hazardous waste will be shipped offsite. Pollution control activities include well established waste minimization programs. During waste generating operations, the waste is segregated to the extent possible to avoid contaminating clean material and to avoid mixing different contaminants. The Department estimates the waste volumes generated at the Industrial Sites during assessment and remedial action will consist of the following:

Industrial Sites Waste Type and Volume

WASTE TYPE	MEDIA	VOLUME (cubic meters)
Low-Level Mixed	Liquid Soil	230 50
Low-Level	Debris Liquid Soil	600 10 2,000
Hazardous	Ground water Liquid Soil	270 420 75,980
Sanitary	Debris	350

DECOMMISSIONING

Industrial sites include facilities no longer needed and contaminated by Department of Energy mission-related activities. Decommissioning activities include the decontamination and decommissioning of these surplus facilities. Decommissioning activities are governed by the terms of the Federal Facility Agreement and Consent Order with the state. Surveillance and monitoring of the identified facilities is ongoing, and initial decommissioning activities were conducted at the sites in 1974 and 1983.

This report assumes the eight surplus facilities already transferred from Defense Programs to Environmental Management will undergo decommissioning. All of the facilities except two were used for nuclear rocket, nuclear engine, nuclear furnace, and associated tests; one was used for radiological research on intake of radionuclides through the food chain, and the other evaluated the response of missile parts to radiation flux. The facilities include E-MAD, R-MAD, Pluto, Super Kukla, Test

evaluated the response of missile parts to radiation flux. The facilities include E-MAD, R-MAD, Pluto, Super Kukla, Test Cell A, Test Cell C, EPA Farm, and Jr. Hot Cell. This estimate assumes no additional facilities will transition to Environmental Restoration, and that all eight facilities will be demolished.

Characterization of the identified decontamination and decommissioning facilities includes periodic surveillance and maintenance before decommissioning takes place. Characterization activities include documenting building deterioration, planning characterization, collecting and analyzing samples, managing and evaluating data, assessing risks and doses, and preparing assessment reports. The Facility Assessment Report documents and discusses the nature and extent of contamination present in each facility, release criteria calculations and the risk/dose assessment, and findings. Design for each of the facilities specifies the construction and demolition activities necessary to remediate facilities.

Contamination in the facilities is generally limited to portions of buildings specifically used for "hot" work on radioactively impacted machinery, equipment, or experiments. Most of the contamination appears to be radioactivity, although other constituents of concern will be investigated. Some facilities also have asbestos- containing materials in their construction, and at least one facility is known to have poly-chlorinated biphenyl contaminated hydraulic oil. A site-specific work plan is prepared for each characterization effort, and applicable permits are obtained. National Environmental Policy Act determination is made and endangered species clearances obtained. Surveys to comply with the Historic Preservation Act of 1966 are also completed.

Characterization field activities completed to date include Jr. Hot Cell and the EPA Farm. Remediation of Jr. Hot Cell is complete. It included demolition of the facility and waste disposal at the Area 5 Radioactive Waste Management Site. Remediation of the EPA Farm is scheduled for FY 1997 and this report assumes the facility will be demolished. Final determination of the appropriate decommissioning approach for the rest of the facilities awaits completion of scheduled assessment activities; most of the facilities will not begin assessment prior to FY 2000.

This estimate assumes that debris generated by decommissioning will consist of approximately 6,200 cubic meters (8,122 cubic yards) of sanitary waste, and 240 cubic meters (314 cubic yards) of low-level waste.

Soils Sites

The Soils Sites comprise several activities related to the investigation of and necessary corrective remedial actions for contaminated surface and shallow subsurface soils on the Nevada Test Site, Tonopah Test Range, and Nellis Air Force Range. Contamination is the result of historic U.S. Department of Energy, Nevada Operations Office above-ground and near surface nuclear detonations, safety shot tests, rocket engine development, and hydro nuclear testing. Contaminants of concern include americium, plutonium, depleted uranium, and other types of transuranic waste; radionuclides; and fission products. In addition, metals, particularly lead, are of concern at some sites. Long-term soils remediation strategies have not been finalized with the State and other stakeholders.

The Department conducted safety shots at several locations on the Nellis Air Force Range and Tonopah Test Range (Double Tracks; Clean Slates 1, 2, and 3; and Area 13); at Plutonium Valley in Area 11 of the Nevada Test Site; and the GMX site in Area 5 of the Nevada Test Site. The safety tests did not result in significant nuclear yield, but did disperse contaminants in excess of 40 picocuries per gram, in surficial soils over more than 1,200 hectares (3,000 acres). When 82 atmospheric and near surface tests are included, the acreage contaminated in excess of 40 Pico curies per gram increases to approximately 10,800 hectares (27,000 acres). Most of the increased area is on the Nevada Test Site.

Soils Sites include nine cratering events from underground tests. The events used nuclear devices to excavate large volumes of earth. Contamination from these tests includes subsurface impacts, less than 300 meters (984 feet) deep and impacts to surface soils as the result of material expelled during testing. The nine events include Sedan, Schooner, Ess, Buggy, Cabriolet, Palanquin, Johnnie Boy, Danny Boy, and Uncle.

Hydronuclear tests involve classified data. Therefore, this report cannot address the details of these tests. Most of the tests impacted shallow surface soils to depths of less than 30 meters (98 feet). No surface soil impacts have been identified at this time.

REGULATORY ISSUE
CLEANUP LEVELS

"The current cleanup strategy calls for reducing contaminated soils by excavation and disposal in existing subsidence craters. This strategy proposes to increase radionuclide concentration action levels from 40 picocuries per gram to a Anegotiated" 200 picocuries per gram. The State has only concurred that this higher level is acceptable as interim action level. The U.S. Department of Energy, Nevada Operations Office is proposing to establish >Land Withdraw Zone(s)' to provide containment of these contaminants at these levels, which would be preemptive of the future decisions in the Resource Management Planning process." (Letter from the State of Nevada to Carl Gertz, Acting Assistant Manager for Environmental Restoration and Waste Management Division, November 22, 1995).

Nuclear Rocket Engine tests encompass a number of sites in Area 25 where surface soils were contaminated with a wide range of radionuclides released during the tests. Buildings associated with these activities are included under the Industrial Sites activities.

This report assumes the immediate effort will include interim actions to clean up the Double Tracks and Clean Slates 1, 2, and 3 sites. These remedial actions will be in accord with the Federal Facility Agreement and Consent Order. Currently, no cleanup standards exist for these sites; this report assumes a final cleanup level will be negotiated near the 200 Pico curries per gram level. For the long term, this report assumes all areas on the Nevada Test Site will remain under institutional control and will provide for an economically feasible containment of contaminants. It further assumes the cleanup of soils sites, when warranted, will consist of excavation and transportation to bulk disposal in an appropriate subsidence crater located onsite. This is a critical assumption, since bulk disposal should reduce costs by at least an order of magnitude. The cleanup will comply with State of Nevada and National Emissions Standards for Hazardous Air Pollutants regulations, with particular attention paid to minimizing fugitive dust emissions during excavation of contaminated soil.

ASSESSMENT

Most sites within the Soils Sites have sufficient background data available regarding the sources of contamination, but some of the data is classified and few of the sites have been characterized because of funding constraints. All assessment activities concentrate on determining the type and extent of contamination. Most radiological assessment activities will involve in situ measurements using a wide array of approaches. Some discrete sampling is required to determine the extent of such contamination by wet chemical analysis. Once cleanup levels are established, based on future land use and related risks, cleanup scenarios will be evaluated and documentation will be prepared for negotiating cleanup procedures, if required.

In the past, assessment activities have concentrated on determining the extent of plutonium-contaminated soils and preliminary testing of soil removal technologies. Sites at which plutonium contaminated soil might be excavated have conducted soil stabilization revegetation experiments and an existing Nevada Test Site facility was retrofitted into a Treatability Test Facility at which five bench-scale soil volume reduction tests were conducted.

Current assessment activities include completing the characterization effort in support of an Interim Corrective Action Plan for the Double Tracks site on the Nellis Air Force Range. Assessment efforts over the next few years will concentrate on Clean Slates 1, 2, and 3 sites on the Tonopah Test Range. Outyear activities beyond FY 2001 are still being prioritized in site baselining activities. This estimate assumes that assessment activities will continue through FY 2025.

REMEDIAL ACTION

Surface soil remedies will include in situ identification and removal of hot spot materials located in small selected areas. Larger areas will require the use of mechanical excavation to remove the contaminated materials. Mechanical excavation may use size separators or other physical processes to reduce waste volumes. Subsurface remedies will range from soil excavation to containment strategies. Remedial actions will be based on applicable regulatory standards or proposed cleanup levels, if no standards apply. Proposed levels will be based on pertinent factors, including but not limited to assessment of risk, current and projected land use, resource management, and technical and cost feasibility. Where sufficient information is available, the Department will use the Streamlined Approach for the Environmental Restoration process. Interim removal actions will be performed when risk exists to workers and the public.

The first site scheduled for remediation is the Double Tracks site. It is scheduled for an interim removal action in FY 1996. Outyear activities beyond FY 2001 are still being prioritized in site baselining activities. This estimate assumes remediation will be completed by FY 2030.

The large areas and volumes of contaminated soils potentially result in high disposal costs; therefore, bulk disposal in subsidence craters has been assumed for cost estimates for this report. This report also assumes approximately 1.1 million cubic meters (1.4 million cubic yards) of low-level waste will be generated by remediation of the Soils Sites and disposed of in subsidence craters. The Department is continually evaluating new technologies to find a more cost-effective way to clean up the sites. The search for technologies has thus far focused on volume reduction and cost-effectiveness.

Underground Test Areas

The Nevada Test Site has been the location for approximately 930 underground nuclear tests conducted between 1951 and 1992. These locations test areas have been bounded into six geographic areas that have distinct contaminant source, geologic, and hydrologic characteristics. The six areas include Frenchman Flat, Western Pahute Mesa, Yucca Flat, Central Pahute Mesa, Ranier Mesa/Shoshone Mountain, and Climax Mine.

Frenchman Flat consists of ten sites located in the northern portion of Area 5 and the southern part of Area 11. These test events were conducted in both vertical emplacement holes and mine shafts located in deep alluvium. The deeper geology is not well known.

not well known.

Western Pahute Mesa consists of 18 sites along the western edge of Area 20. These events were all conducted in vertical emplacement holes. This area is separated from Central Pahute Mesa by the Boxcar Fault and is distinguished by the relative abundance of tritium. Transport of contaminants on and from Western Pahute Mesa involves ground-water flow in both welded and vitric tuffs, both in the rock matrix and in the fracture system.

Yucca Flat consists of 717 sites located in Areas 1, 2, 3, 4, 6, 7, 8, 9, and 10. Events at these sites were conducted in vertical emplacement holes. Contaminant transport in Yucca Flat may involve alluvium, both welded and vitric tuffs, and carbonate rock.

Central Pahute Mesa consists of 64 sites in Areas 19 and 20 on Pahute Mesa. Events at these sites were all conducted in vertical emplacement holes. While distinguished from Western Pahute Mesa only by the presence of the Boxcar Fault, this Corrective Action Unit also contains a relative abundance of tritium. In addition, transport of contaminants and/or from Central Pahute Mesa involve ground-water flow in volcanic rocks and flow in both the rock matrix and the fracture system.

Rainier Mesa/Shoshone Mountain consists of 60 sites where events were all conducted in tunnels. Contaminants from this Corrective Action Unit flow in volcanic rock and fractured media. Climax Mine consists of three sites where events were all conducted in tunnels. Contaminants from the climax Mine Corrective Action Unit flow through fractured granite rock.

The Department is investigating the effects of the underground testing on the ground water and surrounding media in these areas. Investigations are using data collection and analysis to determine whether contaminants have moved appreciable distances from the nuclear explosion locations. Because all of the sites are under institutional control, the Department considers risk to public health and the environment from the testing activities to be minor at this time. The ambient or background radiological conditions around the site are normal. However, assessment activities will include risk assessment to quantify risk to human health and the environment.

Field activities include the use of new and existing wells for monitoring and testing to help develop transport models. The Department will install some new wells near shot cavities to collect data about the near-field environment. The Department expects to encounter tritium during drilling; therefore, a liquid waste treatment system will be used. Attenuation characteristics provide for little migration of radionuclides other than tritium. Other radionuclides will be included in the source evaluation if tritium migration indicates the need.

There are many uncertainties regarding remedial action of the Underground Test Area. This report assumes that for the foreseeable future the Department will concentrate on the modeling and ground-water monitoring activities to limit the extent of contamination. These actions will be in accord with the Federal Facility Agreement and Consent Order. For the long term, because no known cost-effective technologies exist to extract contamination, or neutralize and stabilize the shot cavities, this report assumes that the sites will be characterized and the ground-water resource withdrawn from future-use considerations. Estimates within this report reflect the necessary modeling and ground-water monitoring to limit the contamination to satisfy the State of Nevada Division of Environmental Protection. The estimates do not include remedial actions or Natural Resource Damage Assessments that might be necessary if contamination exceeds the boundaries agreed upon for closure.

REGULATORY ISSUE
UNDERGROUND TEST SITES

"It is an undisputed fact that the underground nuclear testing program contaminated the ground water beneath the Nevada Test Site because approximately one-third of the underground nuclear tests were conducted at or within the ground water. The water beneath the Nevada Test Site is under State of Nevada jurisdiction and accordingly is regulated by the state. State officials believe that, at the present time, it is unreasonable to assume that limited monitoring of the Underground Test Areas will be sufficient to document that there is containment and control over the contaminant plumes. It is also presumptive to conclude, without knowledge or control over the future regional stresses and withdrawals from these groundwater resources, that there will be definitive monitoring results to support a 30-year target date for Underground Test Area closure activities"

"While modeling will be utilized to define the extent of ground-water contamination, it must be able to verify the validity of the models through the acquisition of actual hydrological information. After the model's predictability has been verified, it may then be used to understand the existing complex hydrological regime and to determine the extent of radionuclide contamination and rate of movement of nuclides of concern in the ground water. Such a determination can only be achieved through the installation of a number of deep characterization wells, which may subsequently be able to function as monitoring wells or part of any remedial actions." (Letter from the State of Nevada to Carl Gertz, Acting Assistant Manager for Environmental Restoration and Waste Management Division, November 22, 1995.)

The estimate assumes these areas will be closed in place, assuming there is no threat to the environment or natural barrier failure, and monitoring will continue for 30 years.

ASSESSMENT

This report assumes that Underground Test Area assessment activities will be complete in FY 1996. Most of the extensive data for the Underground Test Areas is classified; therefore, the assessment activities to date have focused primarily on data collection and analysis to determine the potential for contamination of deep aquifers. Installation, testing, and monitoring of wells has been an essential element of the assessment tasks to determine if migration of contaminants has occurred. These activities have addressed the portion of the saturated zone where ground water could be effected, the vadose zone between sources, and the water table.

Assessment activities to date have also included developing a data base to analyze existing and newly acquired data; data management and analysis, including flow and transport modeling; and preliminary risk assessment activities. Thirteen characterization wells have been installed, and 11 existing wells have been modified for characterization.

Present efforts include the completion of regional ground-water flow and solute transport modeling. Future work involves the quantification of risk to human health and the environment based on the ground-water flow and solute transport models, and the completion of the Phase I Report to document the assessment activities.

REMEDIAL ACTION

No cost-effective technologies exist for restoring these sites. Remediation activities that will begin in FY 1996 are limited to developing specific ground-water flow and solute transport modeling for the six areas previously identified. Based on this effort, the Department will establish a regulatory compliance zone. Field activities in each area will provide data collection in the near field environment, including installation of monitoring wells in locations specified by modeling results. The effort will include near-field ground-water flow and solute transport modeling; risk assessment; stakeholder/regulatory concerns; and a monitoring network design.

The Department is currently conducting monitoring activities to assess the extent of contamination and to support modeling efforts to establish protective boundaries around the six areas. A five-year monitoring program will determine if data is consistent with predictions. If monitoring results are satisfactory to the State, the Department will prepare a closure report for approval by the Nevada Division of Environmental Protection. The Department will conduct post-closure monitoring for 30 years. Monitoring will be consistent with the compliance requirements.

Waste generated during remediation activities will take the form of the low-level liquid effluent drilling mud and drill cuttings. The largest volume of waste to be generated is liquid effluent (approximately 7,600 cubic meters [9,956 cubic yards]). Pollution control activities involving liquid effluents rely on evaporation to reduce waste volume. After evaporation, the low-level waste residual will include 1,150 cubic meters (1,507 cubic yards) of contaminated soils and 1,190 cubic meters (1,559 cubic yards) of contaminated sludge. This report assumes low-level waste will be disposed of at the Area 5 Radioactive Waste Management Site.

Long-Term Surveillance and Monitoring

Post-closure monitoring activities consist of collecting periodic measurements and/or samples from monitoring wells, and effluent streams, as stipulated in each unit's Post-Closure Care Permit. Condition inspection and maintenance of any remedial systems, such as caps or active systems is included in estimates of scheduled activities. Sample analysis and preparation of a report for each monitoring period is also included. The need for, and specifics of post-closure monitoring is determined on a case-by-case basis. Monitoring typically lasts for 30 years for complex Resource Conservation and Recovery Act sites, but the State has approved shorter periods of time.

Estimates in this report differentiate between monitoring to establish the contamination boundaries and monitoring to obtain closure and post-closure monitoring. The cost for the former are included within the costs for assessment and remedial action. The latter are provided for under the costs for long-term surveillance and maintenance. This report assumes the post-closure monitoring (long-term surveillance and maintenance) will continue through FY 2050.

Current post-closure surveillance and monitoring at the Industrial Sites includes quarterly monitoring of the Area 23 Hazardous Waste Trenches and U-3fi Injection Well. At this time, maintenance of these systems consists of an inspection of the condition of the Area 23 closure cap for erosion or other disturbances and monitoring and general integrity of the U-3fi Injection Well unit. Post-closure monitoring of the Soils Sites and Underground Test Area will begin when the site receives the Notice of Completion approval of the final corrective actions.

Environmental Restoration Activities Cost Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)						
FY 1996-2000	2005	2010	2015	2020	2025	2030

	FY 1996-2000	2005	2010	2015	2020	2025	2030	
Nevada Contaminated Soils								
Assessment	506	1,859	1,859	1,859	1,859	1,859		
Remedial Action	5,339	9,104	12,815	12,771	12,771	12,661	3,788	
Nevada Industrial Sites and Facilities								
Assessment	1,501	4,827	2,367	2,386	37	174		
Remedial Action	6,292	11,988	25,630	25,700	27,900	27,900	38,556	
Facility Decommissioning	756	1,023	1,003	914	1,063	926	110	
Nevada Underground Test Areas								
Assessment	560							
Remedial Action	26,739	10,001						
Long-Term Surveil. and Monitoring	164	611	1,576	1,620	1,620	1,730	1,660	
Direct Program Management/Suppo	12,247	13,315	14,091	14,944	15,933	17,082	18,413	
Total	54,104	52,727	59,341	60,194	61,183	62,332	62,527	
	FY 2035	2040	2045	2050	2055	2060	2065	Life Cycle*
Nevada Contaminated Soils								
Assessment								49,005
Remedial Action								346,245
Nevada Industrial Sites and Facilities								
Assessment								56,458
Remedial Action	14,406							891,860
Facility Decommissioning	110	110	110	110				31,174
Nevada Underground Test Areas								
Assessment								2,800
Remedial Action								183,699
Long-Term Surveil. and Monitoring	1,660	1,660	1,660	1,660				78,105
Direct Program Management/Suppo	6,116	2,084	2,368	2,697				596,450
Total	22,292	3,854	4,138	4,467				2,235,796

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

Direct Program Management/Support

Activities conducted within this work scope provide management support of the Department of Energy, Nevada Operations Office Environmental Management activities that will characterize and remediate environmental conditions on the Nevada Test Site, Tonopah Test Range, and Nellis Air Force Range; as well as offsite locations in five states. The scope of this work also involves managing the treatment, storage, and disposal facilities and operations under the purview of the Department of Energy, Nevada Operations Office.

The Environmental Restoration Project Support activity provides for administrative and technical project management support; project planning, including Activity Data Sheet development; project control, including Project Tracking System and Performance Measurement System reporting; programmatic Quality Assurance and Self Assessment support; programmatic health and safety support; training; development of programmatic National Environmental Policy Act documentation; waste management coordination; compliance reporting; and public participation support. An Activity Data Sheet entitled *Project Support* captures these activities.

Sheet entitled *Project Support* captures these activities.

COST SAVINGS

Cost savings for FY 1995 are being achieved through a series of productivity initiatives. These initiatives include contracting initiatives; replacing contractor Full-Time Equivalents with Federal Full-Time Equivalents; reducing infrastructure costs; engaging in a single contractor for remediation; streamlining documents; integrated field activities; and reducing analytical cost and culture resource costs. The FY 1995 cost savings target of $4.3 million was not fully achieved because of a delay in a contract award. Initiatives are being determined to achieve the FY 1996 target savings of $7.4 million.

Management of the Federal Facility Agreement with the State of Nevada and oversight of Agreements-in-Principle and grants is covered under an Activity Data Sheet entitled *Agreements*.

This section does not include Program Direction within Environmental Restoration. These activities provide overall management of the entire Department of Energy, Nevada Operations Office Environmental Restoration program. The direct costs of subproject activities capture subproject management costs because those costs are directly attributable and are required to accomplish field activities.

Agreements-in-Principle fund the States of Alaska, Mississippi, and Nevada to provide oversight of the Department of Energy Environmental Restoration activities. The Agreements-in-Principle describe the understandings and commitments between the parties regarding the Department of Energy' s provision of technical and financial support for state activities in environmental oversight, monitoring, site access, and emergency response initiatives. Amendments to existing Agreements-in-Principle managed by other Department of Energy offices will address activities in Colorado and New Mexico. Grants provide educational and research opportunities for students and faculty at the University of Nevada at Reno and the University of Nevada at Las Vegas, in support of technical programs being conducted at the Nevada Test Site.

PRODUCTIVITY

Because most sites are in the assessment characterization phase, it is difficult to quantify estimates of productivity savings for the future. There are areas of activities in which productivity savings can be realized based upon previous experiences and assumptions of the future activities of the project. In revising the estimate for savings, activities were examined for possible efficiencies and reduction in work activities while achieving the desired goals. These areas were identified and rough orders of magnitude estimates were developed.

Areas in which savings could be realized include the learning curve. Multiple closures in Corrective Action Units will yield remedies for future closures. Increased use of management information systems will reduce support and indirect costs. Cost/Risk/Benefit Analyses can be used to evaluate alternative cleanup requirements. The Streamlined Approach for Environmental Restoration method and the Supplier Quality Information Group will eliminate the expense of an independent audit. In addition, negotiation with regulators concerning the required level of cleanup and amount of monitoring needed will help define end goals and provide opportunities to meet these goals at less cost.

STAKEHOLDER INTERACTIONS

The Nevada Operations Office conducted public participation activities for the Nevada Test Site and Tonapah. Activities consisted of announcement of preliminary 1996 Nevada Operations Office data in Environmental Restoration-Waste Management Update, a publication distributed to over 1,200 interested stakeholders, and a briefing to the Community Advisory Board for Nevada Test Site Programs at the board's November 1995 meeting. Draft copies of the Nevada Operations Office data and narrative submissions were made available to the Board budget committee and others attending the meeting. The State of Nevada provided comments, most of them of a philosophical nature, which were incorporated as sidebar information in the 1996 report. If you would like more information about the report or have questions about the results for these sites, please contact:

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WASTE MANAGEMENT

Waste management operations include storing the current inventory of transuranic mixed waste received previously from

Waste management operations include storing the current inventory of transuranic mixed waste received previously from Lawrence Livermore National Laboratory; developing construction projects to treat, store, and dispose of waste generated by the Nevada Operations Office project; enforcing the Radioactive Waste Acceptance Program waste generator review and audit process; and identifying and storing Nevada Test Site-generated hazardous waste prior to offsite disposal at appropriate commercial facilities. Waste Management manages five types of waste at the Nevada Test Site: transuranic mixed waste, low-level mixed waste, low-level waste, and hazardous waste. Sanitary waste is managed by the site landlord, the Office of Defense Programs.

WASTE MANAGEMENT MAP

The Nevada Test Site is a major low-level waste disposal facility for other Department of Energy and a few Department of Defense installations. Two principal active waste management sites are located on the Nevada Test Site: the Area 5 Radioactive Waste Management Site and the Area 3 Radioactive Waste Management Site. The Area 5 Radioactive Waste Management Site is located approximately 19 kilometers (12 miles) north of Mercury, Nevada. It consists of 296 hectares (732 acres). Less than 15 percent of the capacity is currently used. The site is currently used for disposal of onsite- and offsite-generated low-level waste and onsite-generated low-level mixed waste, as well as for storage of transuranic waste. At the current rate of land use, the facility can be expected to provide a total disposal capacity of 10,884 cubic meters (14,258 cubic yards) per year for more than 100 years. Some additional land may be required to improve access for transport vehicles, but this is not expected to impact operations for several years.

The Area 3 Radioactive Waste Management Site occupies an area of approximately 50 hectares (125 acres) and is situated about 38 kilometers (23 miles) north of Mercury. Adjacent subsidence craters created from underground nuclear weapons tests, which were conducted at depths well above the ground-water table, are used as waste disposal cells. The subsidence craters have been modified for shallow landfill disposal to accommodate waste disposal activities. The remaining disposal capacity at the Area 3 Radioactive Waste Management Site is 1.8 million cubic meters (2.3 million cubic yards) and should provide sufficient disposal capacity for more than 100 years.

Major Waste Management Activity Milestones

TASK	COMPLETION DATE Fiscal Year
Road 5-01 Construction	1997
U3AX/BL Closure	1998
Preparations to Ship TRU to Waste Isolation Pilot Plant	2000
Low-Level Waste Operations	2070

Transuranic Mixed Waste

Approximately 610 cubic meters (799 cubic yards) of transuranic mixed waste received from Lawrence Livermore Nationalrtment of E

and Recovery Act to receive and dispose of low-level mixed waste from the Rocky Flats Plant. This waste is disposed in Pit 3 at the Area 5 Radioactive Waste Management Site. Because of the promulgation of Environmental Protection Agency Land Disposal Restrictions, disposal of low-level mixed waste from the Rocky Flats Plant ceased in May 1990. A revised Resource Conservation and Recovery Act Part B permit application, which included sampling and analysis for Land Disposal Restriction compliance, was submitted to the State of Nevada for review in July 1992. During FY 1994, the Department of Energy, Nevada Operations Office continued to revise the application in response to technical review comments by the Nevada Division of Environmental Protection.

In accordance with the Federal Facility Compliance Act, the Department of Energy, Nevada Operations Office and the Nevada Division of Environmental Protection negotiated the Site Treatment Plan and its associated Compliance Order for low-level mixed waste identified in the Mixed Waste Inventory Report. On March 27, 1996, an agreement was achieved concerning enforceable treatment schedules for these waste streams.

The Mutual Consent Agreement allows any low-level mixed waste generated by the Department of Energy, Nevada Operations Office in the State of Nevada to be stored on the unused portion of the existing Area 5 transuranic mixed waste storage pad. The low-level mixed waste does not have to meet land disposal restrictions prior to being accepted for storage on the Area 5 transuranic mixed waste storage pad. For newly identified mixed waste not specified in the Site Treatment Plan, the Department of Energy is required to develop treatment and disposal alternatives within nine months of placing such waste on the transuranic mixed waste storage pad. In anticipation of potential mixed waste volumes generated from future operational, characterization, and remediation activities conducted within the State of Nevada, the Department submitted a Part B permit application in January 1995 for the construction of a Mixed Waste Storage Facility.

GENERATION AND HANDLING

Currently, there are nine previously generated low-level mixed waste streams located on the Nevada Test Site. They have a combined volume of approximately 290 cubic meters (340 cubic yards), and they are labeled as backlog waste. This life-cycle report assumes that activities at the Nevada Test Site will generate an additional 4,696 cubic meters (6,156 cubic yards) of low-level mixed waste.

TREATMENT

As required by the Federal Facility Compliance Act, the Site Treatment Plan discusses low-level mixed waste at the Nevada Test Site and identifies alternatives for treatment. The Proposed Site Treatment Plan, originally scheduled for completion in February 1995, was delayed until March 1995 as agreed upon by the National Governors' Association and the Department of Energy. Final approval of the Site Treatment Plan by the State of Nevada was originally expected to be received by October 6, 1995, via a Unilateral Order. The State of Nevada extended final approval of the Site Treatment Plan approximately six months beyond the October 6, 1995 deadline. Once completed, schedules and activities identified in the Site Treatment Plan became enforceable milestones. This report expects periodic negotiations with the state on low-level mixed waste issues as long as mixed waste is listed in the Site Treatment Plan or in the annual updates.

STORAGE

The low-level mixed waste previously generated at the Nevada Test Site is currently being stored on the transuranic pad in accordance with a 1994 Mutual Consent Agreement between the Department of Energy and the Nevada Division of Environmental Protection developed in January 1994 and revised in June 1995. Nine Nevada Test Site backlogged low-level mixed waste streams are currently stored on the transuranic pad having a combined volume of approximately 290 cubic meters (340 cubic yards). In accordance with this agreement, the Department amended its Resource Conservation & Recovery Act Part B Permit application in January 1995, to include construction of a low-level mixed waste storage facility at the Area 5 Radioactive Waste Management Site.

The Cotter Concentrates, originally shipped to the Nevada Test Site in 1987 from the Mound Plant as strategic materials for storage, were formally declared a waste in January 1995. Analytical and characterization data have shown the Cotter Concentrates to be a low-level mixed waste stream. Further characterization efforts resulted in dividing the waste into two populations. Cotter Concentrate - Population A is stored northeast of the Area 5 Radioactive Waste Management Site in the Strategic Materials Storage Yard. This waste stream, which has a volume of approximately 260 cubic meters (341 cubic yards), is stored in accordance with a management plan approved by the State of Nevada in July 1995. Cotter Concentrate - Population B is stored on the transuranic pad and consists of approximately 1.4 cubic meters (1.8 cubic yards).

DISPOSAL

The Nevada Test Site is one of the remaining 15 sites out of the original 49 sites the Department is evaluating for disposal of low-level mixed waste. The ultimate identification of low-level mixed waste disposal activities at the Nevada Test Site will follow state and federal regulations for siting and permitting. It will also include public involvement in the decisionmaking process and during preparation of the site-wide Environmental Impact Statement.

The State of Nevada has given the Department approval to dispose low-level mixed waste in Pit 3 of the Area 5 Radioactive Waste Management Site if the waste meets land disposal restrictions. The low-level mixed waste must also meet the characteristics and packaging requirements for disposal under the Nevada Department of Energy Waste Acceptance Criteria (NVO-325, Rev. 1). This estimate assumes approximately 33,263 cubic meters (43,575 cubic yards) of low-level mixed waste will ultimately be disposed at Pit 3. Approximately 4,696 cubic meters (6,152 cubic yards) of this total will be generated at the Nevada Test Site. The remainder will originate from the Rocky Flats Site, which will generate 28,199 cubic meters (36,940 cubic yards), and Lawrence Livermore National Laboratory, which will generate 372 cubic meters (487 cubic yards).

Low-Level Waste

GENERATION AND HANDLING

GENERATION AND HANDLING

Historically, approximately 50 percent of the 481,000 cubic meters (630,110 cubic yards) of low-level waste disposed of at the Nevada Test Site was generated onsite. However, approximately 99 percent of waste received and disposed of in the last five years was from offsite generators. Offsite generated waste was accepted at the Nevada Test Site beginning in FY 1978. In FY 1995, 24,353 cubic meters (31,902 cubic yards) of low-level waste was disposed of at the Nevada Test Site. Of that volume, 62 cubic meters (81 cubic yards) was generated at the Nevada Test Site. The Nevada Test Site is expected to receive an average of 24,000 cubic meters (31,440 cubic yards) of low-level waste per year for the next three years. In FY 1995, the Department limited the total disposal volume at the Nevada Test Site to 26,043 cubic meters (34,116 cubic yards). This self-imposed limit is based on an interpretation of an Order in a lawsuit brought against the Department of Energy by the State of Nevada.

Low-level waste treatment is not currently provided or assumed to be needed during the life cycle of this estimate. Storage costs are avoided because low-level waste is disposed of as soon as it is received.

REGULATORY ISSUE
LOW-LEVEL WASTE DISPOSAL

"The Order issued on January 12, 1995 by the U.S. District Court placed no limits on the Department's ability to dispose of low-level waste at the NTS. While the court dismissed claims by the State regarding shipment of low-level waste from the DOE's Fernald site (based on a previous decision under CERCLA) it upheld claims by the State concerning other low-level waste disposal activities at the NTS. [Litigation under this lawsuit continues.]" (Letter from the State of Nevada to Carl Gertz, Acting Assistant Manager for Environmental Restoration and Waste Management Division, November 22, 1995).

DISPOSAL

The low-level waste disposal costs are contingent upon the amount of waste shipped to the Nevada Test Site. The Department of Energy/Nevada Operations Office Waste Management Division does not receive any Headquarters funding for disposal costs of low-level waste at the Nevada Test Site. Instead, the Nevada Operations Office relies on generator fees collected from the waste generators. The Nevada Operations Office plans to maintain this generator fee structure in the future.

The Nevada Test Site accepts and disposes of low-level waste at the Area 3 and Area 5 Radioactive Waste Management Site from approved Department of Energy, Department of Defense, and other designated facilities across the United States. This estimate assumes that there will be a total of 19 approved generators, and 16 are currently approved. Life-cycle estimate information for 13 of the generators is provided in the following table.

Nevada Offsite Waste Generators

SITE	VOLUME (cubic meters)	START FY	COMPLETE FY
Energy Technology Engineering Center	2,540	1996	2001
Fernald Environmental Management Project	57,330	1996	2005
Inhalation Toxicology Research Institute	2,877	1996	2070
Kansas City Plant	30	1996	2070
Lawrence Livermore National Laboratory	4,429	1996	2070
Mound Plant	1,390	1996	2012
Oak Ridge K-25 Plant	26,434	1998	2002
Oak Ridge National Laboratory	78,930	1996	2070
Oak Ridge Y-12 Plant	244,506	1999	2070
Pantex Plant	8,355	1996	2070
Reactive Metals, Inc.	29,162	1996	2002
Rocky Flats Environmental Technology Site	32,522	1996	2045
Sandia National Laboratory - New Mexico	45,134	1996	2070
TOTAL	544,715		

TOTAL	544,715

At the current rate of land use, the facility can be expected to provide disposal capacity of approximately 3 million cubic meters (4 million cubic yards) in the next 100 years. The Nevada Operations Office conducts site monitoring and characterization activities in support of the low-level waste disposal operations at the Area 3 and 5 Radioactive Waste Management Sites.

The Performance Assessment for the Area 5 Radioactive Waste Management Site was sent to the Department of Energy Performance Assessment Peer Review Panel for approval. The Performance Assessment for the Area 3 Radioactive Waste Management Site is scheduled for completion in March 1998. Performance Assessments are required for low-level waste disposal sites under Department of Energy Order 5820.2A.

The Waste Examination Facility is scheduled to be constructed in FY 1996 and will provide a 140 square meter (1,500 square foot) facility to examine low-level waste containers at the Area 5 Radioactive Waste Management Site. A new primary access road, approximately 5 kilometers (3.1 miles) long, has been designed and is scheduled for construction in FY 1997. The new road will meet all transportation and safety standards. Design of an extensive 500-year flood protection berm is currently proposed for FY 1998, with construction continuing into FY 1999.

Hazardous Waste

Hazardous waste is accumulated at numerous satellite locations on the Nevada Test Site and then transferred to the Area 5 Hazardous Waste Storage Unit. Hazardous waste containers are checked for radioactive contamination by hand-held instrument surveys and swipe sampling. Process knowledge and radiological analyses are used to ensure none of the hazardous waste being released for transport offsite contains radioactive constituents above established limits. Although every operational entity at the Nevada Test Site is a potential satellite generator of hazardous waste, the Department of Defense is the primary generator. Sources include analytical laboratories, paint shops, vehicle maintenance shops, and mining and construction operations.

Waste characterized as hazardous under the Land Disposal Restrictions must be shipped offsite to a Resource Conservation and Recovery Act-permitted facility within one year. The report expects a total of approximately 18,924 cubic meters (24,790 cubic yards) will be shipped to commercial facilities during the life cycle.

All waste shipments are made in accordance with applicable Department of Energy, Department of Transportation, Environmental Protection Agency, state, and local hazardous waste regulations. Generators of the waste pay the shipping costs.

Waste Management Activities Cost Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)

	FY 1996-2000	2005	2010	2015	2020	2025	2030
Transuranic Mixed Waste							
Storage and Handling	200	200					
Low-Level Mixed Waste							
Treatment	2,742	1,402	1,402	1,402	1,402	1,402	1,402
Disposal	200	150					
Low-Level Waste							
Disposal	14,888	7,800	7,200	6,200	6,000	3,000	3,000
Hazardous Waste							
Treatment	350	980	350	350	350	350	350
Storage and Handling	150	150	150	150	150	150	150
Direct Program Management/Suppor	5,176	5,295	5,295	5,295	5,295	1,000	1,000
Total	23,706	15,977	14,397	13,397	13,197	5,902	5,902
	FY 2035	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**
Transuranic Mixed Waste							
Storage and Handling							
Low-Level Mixed Waste							

Waste							
Treatment	1,402	1,402	1,402	1,402	1,402	1,402	1,402
Disposal							
Low-Level Waste							
Disposal	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Hazardous Waste							
Treatment	350	350	350	350	350	350	350
Storage and Handling	150	150	150	150	150	150	150
Direct Program Management/Suppor	1,000	1,000	1,000	1,000	1,000	1,000	1,000

Full-Time Equivalents Composition Table*

* The Projections for Full-Time Equivalent employees are based on FY 1996 planning baselines (see Reader's Guide).

Site Management Structure

Site Management Structure

The management structure of Nevada is divided into four major suborganizations (Assistant Manager for Operations; Assistant Manager for Environment, Safety & Health; Assistant Manager for Environmental Management; and Assistant Manager for Administration) and several matrix suborganizations (for example, Office of Chief Counsel, Office of Chief Financial Officer, Office of External Affairs, etc.). In turn, Nevada is supported by numerous contractors who operate under contracts of a diverse nature (for example, management and operating, architectural/engineering services, etc.), and type (for example, cost plus award fee, cost plus fixed fee, etc.). Currently, the majority of the contractor support to Nevada is provided by Bechtel Nevada, which took over operations in January 1996.

CONTRACTING OPPORTUNITIES

If you would like more information about performing work for the Department of Energy's Environmental Management program at this site, please contact:

Major Procurements	**Small Business Procurements**
Joanne M. Bradbury Director Contracts Division United States Department of Energy Nevada Operations Office P.O. Box 98518 Las Vegas, NV 89193-8518 p: (702) 295-1040 f: (702) 295-5305	Darby Dietrich Contracts Division United States Department of Energy Nevada Operations Office P.O. Box 98518 Las Vegas, NV 89193-8518 p: (702) 295-1560 f: (702) 295-5305

Future Full-Time Equivalent Needs

The consolidation of the previous management and operating contractors (that is, three into one) into the Bechtel Nevada contract is expected to result in a significant reduction in Full-Time Equivalents in the near term, and a gradual reduction of Full-Time Equivalents in the long term, tailored to match the accomplishment of the Nevada projects and programmatic activities.

FUNDING ESTIMATE

The following tables present estimated funding information for the Nevada Test Site.

Defense Funding Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	
Nuclear Material and Facility Stabilization		36,067	45,108	41,610	11,325			
Environmental Restoration	54,104	52,727	59,341	60,194	61,183	62,332	62,527	
Waste Management	23,706	15,977	14,397	13,397	13,197	5,902	5,902	
Total	77,810	104,771	118,846	115,201	85,705	68,234	68,429	
	FY 2035	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	
Nuclear Material and Facility Stabilization								
Environmental Restoration	22,292	3,854	4,138	4,467				
Waste Management	5,902	5,902	5,902	5,902	5,902	5,902	5,902	
Total	28,194	9,756	10,040	10,369	5,902	5,902	5,902	
	FY 2070	**2075**	**2080**	**2085**	**2090**	**2095**	**2100**	**Life Cycle***
Nuclear Material and Facility Stabilization								670,549
Environmental Restoration								2,235,796
Waste Management	7,902							708,472
Total	7,902							3,614,817

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

Nondefense Funding Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**Life Cycle***
Nuclear Material and Facility Stabilization		1,593	1,992	1,838	500			29,617

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

COMPARISON WITH PREVIOUS ESTIMATE

The 1996 life-cycle cost estimate for the Environmental Management program at the Nevada Test Site and Tonopah Test Range is $3.6 billion, about 8 percent more than the 1995 estimate of $3.5 billion. Overall, the 1996 estimate is comparable to the 1995 estimate. The pre-FY 1996 costs have been adjusted to reflect actual costs through 1995 and an annual escalation factor of 3 percent has been applied to the 1996 estimate. The 1996 estimate includes about $10 million in costs associated with Environmental Restoration program activities at the Tonopah Test Range; these costs were reported under the Nevada Offsites section of the 1995 report. Cost estimates associated with Environmental Restoration program activities increased almost 50 percent in the FY 1996 estimate. Cost estimates for the Nuclear Materials and Facility Stabilization program increased by about 80 percent, but this increase was offset by a 37 percent reduction in projected Waste Management program costs. The following sections compare the 1995 and 1996 cost estimates for the Nuclear Material and Facility Stabilization program, the Environmental Restoration program, and the Waste Management program at the Nevada Test Site.

Comparison Table

Activity	FY 1995 Life Cycle	FY 1995 Only [1]	FY 1996 Life Cycle	Change in Dollars	Change in Percent
	Thousands of Dollars				
Nuclear Mat. & Fac. Stab.	386,413	-	700,166	313,753	81
Environmental Restoration	1,557,449	31,784	2,235,796	710,131	47
Waste Management	1,142,309	21,098	708,472	-412,739	-37
Landlord	-	-	-	-	-
Program Management [2]	364,216	14,605	-	-	-
Site Total	3,450,388	67,487	3,644,434	261,533	8

1 The FY 1995 life-cycle and annual costs are provided to determine the corrected FY 1995 cost.
2 Program Management was reported in an independent cost table last year, but is reported as a line item in the relevant program (Nuclear Material and Facility Stabilization, Environmental Restoration, and Waste Management) activity cost estimate tables for the FY 1996 Baseline Report.

Nuclear Material and Facility Stabilization

The 1996 life-cycle cost estimate for the Nuclear Material and Facility Stabilization program is $700 million, an increase of about $314 million from the 1995 estimate. Although parametric modeling was again used in developing the 1996 estimate, the estimate assumes an increase in the scope of program activities.

Environmental Restoration

The 1996 life-cycle cost estimate for the Environmental Restoration program is $2.2 billion, which is an increase of approximately 47 percent over the FY 1995 report. The increase in costs associated with major Environmental Program activities, that is, Contaminated Soils, Industrial Sites, Underground Test Areas, and Surveillance and Monitoring, are primarily associated with redefinitions of program scope, schedule revisions, and more refined cost estimating techniques. However, in contrast to the FY 1995 report, the Tonopah Test Range was included in the Nevada Test Site for the FY 1996 report. Applicable program management costs have also been added.

Waste Management

The 1996 life-cycle cost estimate for the Waste Management program is $708 million, about $413 million less than the 1995 estimate. A comparison of this year's Baseline Environmental Management Report estimates with those of the FY 1995 Baseline Environmental Management Report indicates considerable differences in waste management activities resulting in these estimated reductions in life-cycle costs. For comparison, an analysis was conducted using the same criteria as last year. Under treatment activities, the construction of a Transuranic Waste Examination Facility will be built in FY 1996. The construction of the liquid waste treatment system has been postponed while project needs are being reviewed and reevaluated. Under storage activities, the construction of an expanded hazardous waste storage pad was put on hold indefinitely because the Nevada Division of Environmental Protection issued a revision to the Hazardous Waste Permit on May 1, 1995. The revision extended the storage of hazardous waste on the existing pad from 90 days to one year. The construction of a mixed waste storage pad scheduled for FY 1996 was put on hold because of the lack of identified need. The disposal activities at the Nevada Test Site also show a decline in shipments of low-level waste to the Nevada Test Site in the outyears.

About This Document

Posted 08/14/1996 (fr)

Table 1-1
Nevada Tonopah Test Range Project Team

Core Project Team Members					
Name	**Title**	**Organization**	**Responsibility/Subject Area**	**Phone**	**E-mai**
Stephen Mellington	ER Div. Director	DOE-NV	DOE-NV ER Project	(702) 295-0844	
Janet Appenzeller-Wing	Project Manager Field Operations Manager	DOE-NV	Offsites	(702) 295-0461	
Kevin Cabble	Assistant Manager	DOE-NV	TTR Industrial Sites	(702) 295-5000	
Steven Lawrence	Project Manager	DOE-NV	Technical Integration	(702) 295-1078	
Frank Maxwell	Assistant Manager	DOE-NV	Offsites	(702) 295-1050	
Bobbie McClure	Environment Protection Specialist	DOE-NV	Strategic/Project Planning, Control and Reporting, HQ Interface	(702) 295-1862	
Runore Wycoff	Regulatory Specialist	DOE-NV	Regulatory Compliance, Community Relations	(702) 295-0250	
Kevin Rohrer		DOE-NV	ER Contact for Citizen Advisory Board & Public Affairs	(702) 295-0197	
David Shafer	Program Manager	DOE-HQ EM-45	Policy, Budget, Oversight	(301) 903-3979	david.shafer@em.doe.gov
Ethan Merrill	Program Manager	DOE-HQ EM-45	Policy, Budget, Oversight	(301) 903-8185	ethan.merrill@em.doe.gov
Paul Lievendorfer	Chief	State of Nevada Dept of Env Prot	Chief of Bureau of Federal Facilities		
Dale Schutte	Chairman	Citizens Advisory Board	Chairman of the Citizens Advisory Board		
Robert Bangerter	Project Manager	DOE/NV	Underground Test Areas	(702) 295-7340	
Monica Sanchez	Project Manager	DOE/NV	Soils	(702) 295-0160	

Thomas Greene	Assistant Project Manager	DOE/NV	Offsites	(702) 295-0513	

Core Project Team Members

Name	Title	Organization	Responsibility/Subject Area	Phone	E-mai
Kevin Leary	Assistant Project Manager	DOE/NV	Soils	(702) 295-0184	
David Hippensteel	Assistant Project Manager	DOE/NV	Underground Test Area	(702) 295-1467	
Jonathan Pickus	Data Management Specialist	DOE/NV	Database Integration/CAU Prioritization	(702) 295-0515	
Patricia Hall	Environment Protection Specialist	DOE/NV	AIPs, Grants, FFA Admin.	(702) 295-0193	
Sheila Arceo	Environment Engineer	DOE/NV	Change Controls/PMS	(702) 295-0146	
K.C. Thompson	Physical Scientist	DOE/NV	Cost Estimating/PTS	(702) 295-0187	
Richard Pearl	Hydrologist	DOE/NV	Hydrogeologic Support	(702) 295-0853	
Jim Kennard	Assistant General Manager	Bechtel Nevada	EM-Programs		
Robert Dodge	Project Manager	Bechtel Nevada	Offsites, Industrial Sites	(702) 295-1632	
Ken Ortega	Project Manager	Bechtel Nevada	Underground Test Area	(702) 794-5526	
Mary Lou Brown	Project Manager	IT Corporation	EM-Projects	(702) 794-1701	
Dick McKinley	Project Manager	IT Corporation	Soils	(702) 794-1703	
Mark Hampton	Project Manager	IT Corporation	Underground Test Area	(702) 794-1502	
Ken Beach	Project Manager	IT Corporation	Industrial Sites	(702) 794-1516	
Rick Deshler	Project Manager	IT Corporation	Off sites	(702) 794-1724	
Doug Trudeau		Contractor	USGS - Technical Advisor	(702) 897-4004	
Robert Clark		Contractor	PAI - Program Support	(702) 794-0290	

Roger Jacobson		Contractor	DRI - Technical Advisor	(702) 295-0474	
Ward Hawkins		Contractor	LANL - Technical Advisor	(505) 665-7996	
Gayle Polaski		Contractor	LLNL - Technical Advisor		

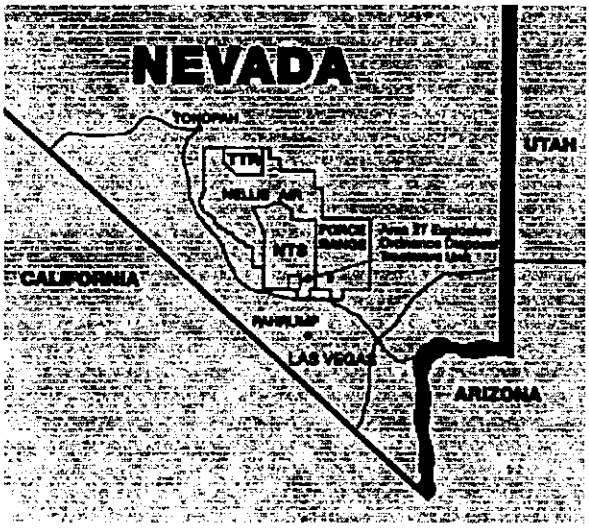
Other/Technical Team Members

Name	Title	Organization	Responsibility/Subject Area	Phone	E-mai
Leah Dever	Assistant Manager Environmental Management	DOE/NV	DOE/NV EM Project	(702) 295-0952	
Peter Sanders		DOE/NV	DOE - Environmental Protection	(702) 295-1037	
Joanne Burrows		DOE/NV	DOE - Health Physics	(702) 295-0995	
Cynthia May		DOE/NV	DOE - Budget Resource Management	(702) 295-0968	

 http://www.nv.doe.gov/infotran/erwm/erwm7.htm

Restoration of the Area 27 Explosive Ordnance Disposal Treatment Unit

The U.S. Department of Energy (DOE) plans to remediate a former explosive ordnance disposal area in the southern area of the Nevada Test Site. The effort, being carried out in 1994 by the Nevada Operations Off ice's Environmental Restoration Project, involves a new, streamlined approach toward site remediation.



At the Area 27 Explosive Ordnance Disposal (EOD) Treatment Unit, workers burned or detonated non-radioactive explosives as well as nonexplosive combustibles such as packing materials. DOE is no longer using this site and wants to clean up any contamination from the former operations. This treatment unit was never used for treating or disposing of radioactive waste.

In preparation for site restoration, environmental specialists developed a closure plan in accordance with the Resource Conservation and Recovery Act. This environmental law authorizes cradle-to-grave control of hazardous wastes by the U.S. Environmental Protection Agency and/or the states. The State of Nevada Division of Environmental Protection is the regulating agency that approves the plan and seeks public comments.

A major effort identified for the environmental cleanup is to identify, remove, and dispose of contaminated soil. Any equipment used for removing contaminated soil will be decontaminated as necessary before leaving the Nevada Test Site.

SAFER Approach for Cleanup

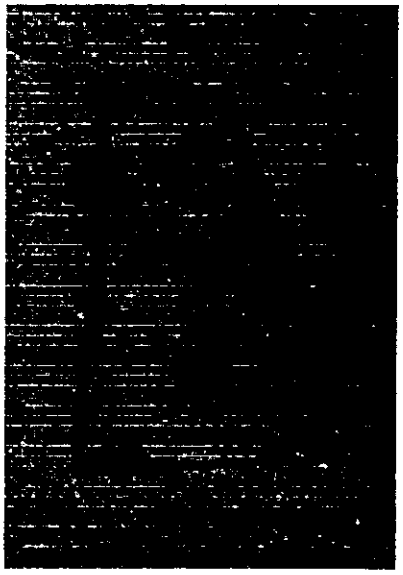
The site is being restored under the Streamlined Approach for Environmental Restoration, or SAFER. Briefly, the SAFER concept recognizes that remedial decisions may be made under conditions of

Briefly, the SAFER concept recognizes that remedial decisions may be made under conditions of uncertainty, based on available information and the experience of the decision maker.

Under this process, a key component is creating and validating assumptions about a particular site. One key assumption made in this case is that clean closure may be a practical remediation alternative. Under clean closure, there is a small likelihood of residual wastes or hazardous contituents remaining after the site is closed.

Researching the site's operating history and checking site conditions show that contamination at the site is probably minimal, extending neither deep nor wide. In addition, cleanup choices are limited. The only reasonable alternative is to remove any soil contaminated above acceptable regulatory levels. Therefore, DOE decided, and the State of Nevada concurred, that it was practical and cost effective to use the SAFER concept.

History of EOD Site



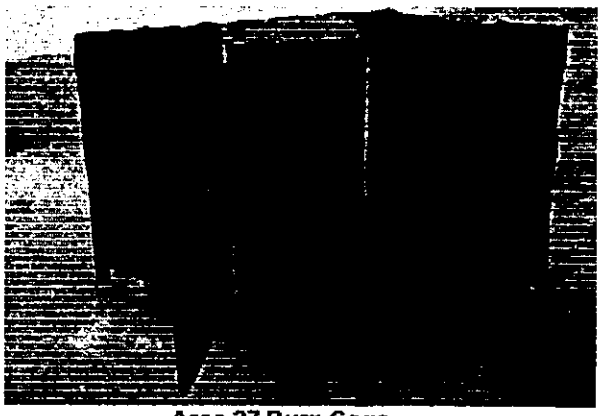
Area 27 Burn Remains Pit and surrounding area.

DOE operated the Explosive Ordnance Disposal Treatment Unit from about 1960 until November 1992. In the past five years, this site has only been used once for treatment purposes. The site consists of a burn pit, explosion pits, boreholes, and a personnel protection/control bunker.

During a single burn/detonation event, a maximum quantity of 23 kilograms (50 pounds) of explosives was generally used. Typically, the amount was much less. For each burn event, about 19 liters (five gallons) of kerosene were used to ignite the nonradioactive explosive waste. These explosives and their byproducts, from Area 27 assembly operations, were burned and/or detonated the same day they arrived.

Burning and detonating activities were controlled and conducted according to military guidelines for quantity and evacuation distance. Experts state there is "extremely low" potential for encountering unexploded ordnance while working at the site. When explosives were burned or detonated, they were placed inside the burn pit, explosion pit or open borehole.

Site Restoration and Site Monitoring



Area 27 Burn Cage in the Burn Pit.

To restore the site, experts are collecting soil samples and analyzing them to determine if constituents of concern are present, and in what concentrations. If samples contain metals and organic compounds above acceptable regulatory standards, the soil will be removed from those locations. To do this, workers will place the affected soils in containers approved for such use. Most wastes removed from the location are expected to be stored at the Nevada Test Site in appropriate areas. However, if necessary, any wastes taken off the Nevada Test Site for disposal will be packed in U.S. Department of Transportation-approved containers. The destination of the shipment depends on the type of waste. For example, Hazardous waste would be temporarily stored on-site and eventually shipped to a commercial facility.

DOE expects to remove soil contaminated with lead, cadmium, chromium, kerosene, and residual explosive waste. The metals come from containers or other components that were with the waste when it was treated. Kerosene was used during burning. Some of these soil excavations are expected to be about one-third meter (one foot) deep. This depth is based on the assumption that 19 liters (five gallons) of kerosene poured onto sandy soil over an area of one square meter (about one square yard) does not penetrate more than one-third meter (one foot) deep. Some small objects at the site could be decontaminated and/or placed with the soil and disposed of as hazardous waste.

Following soil removal, additional samples will be taken to validate that the site can be closed. The decision whether to approve site closure is made by the State of Nevada Division of Environmental Protection. Generally, if sampling results indicate any contaminated levels are less than the regulatory standard, the area will be declared "clean-closed." If not, more soil will be systematically removed until analysis shows the site is clean.

Conclusion

The streamlined approach for remediation at this treatment unit is expected to take several months to complete. The faster and less expensive SAFER approach requires simultaneous characterization and remediation. The major efforts for the EOD Treatment Unit are soil sampling and removal. The success of this effort will determine whether the SAFER approach is used in future restoration projects at the Nevada Test Site.

Contact

For more information or to comment on the Environmental Restoration Project, contact:

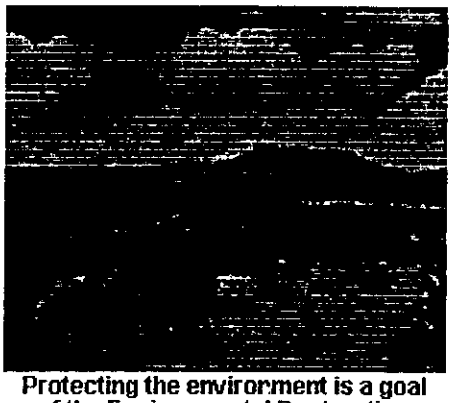
U.S. Department of Energy
Nevada Operations Office
Office of External Affairs
P. 0. Box 98518
Las Vegas, NV 89193-8518

http://www.nv.doe.gov/infotran/erwm/erwm7.htm

(702) 295-1379

 http://www.nv.doe.gov/infotran/erwm/erwm9.htm

Environmental Restoration at the Nevada Test Site



Protecting the environment is a goal of the Environmental Restoration Project. Shown above is a view of Rainier Mesa in the northern part of the Nevada Test Site.

The Environmental Restoration Project at the Nevada Test Site is part of the U.S. Department of Energy's (DOE) 30-year program to address contamination from nuclear weapons research. The DOE Nevada Operations Office began this project in the late 1980s to address contamination resulting primarily from nuclear weapons testing and related support operations.

The goals of the Environmental Restoration Project are to safeguard the public's health and safety, including workers, and to protect the environment. This involves the assessment and cleanup of contaminated sites and facilities to meet standards required by federal and state environmental laws. The DOE's Nevada Operations Office is following all applicable environmental laws, regulations, guidelines, and orders.

The Nevada Test Site has been the location for many nuclear tests, both above and below ground, since 1951. These tests, related support operations, and nuclear rocket experiments have resulted in some contamination of the 3,510 square kilometer (1,350 square mile) site. Contaminants include radioactive materials, metals such as beryllium and lead, used motor oil and diesel, and residues from plastic and epoxy. Scientists have not yet determined the total volume of materials released and wastes generated.

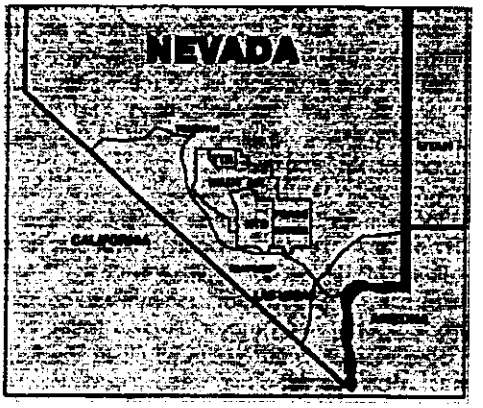
Since the Nevada Test Site is remote, and public access is controlled, there is little potential for public exposure to these contaminants. DOE also takes special precautions to protect the workers. While scientists consider there is little potential for health risks from off-site migration of contaminants, they will thoroughly study that possibility as part of the cleanup program. The potential pathways for exposure are by air through the disturbance of contaminated soils, and by water through the movement of groundwater.

Some 825 sites of former underground nuclear tests will be investigated as part of the Environmental Restoration Project, along with areas where more than 100 aboveground tests were conducted. In addition, environmental scientists have identified about 2,000 other sites for potential environmental remediation. These sites are part of an evolving, comprehensive inventory of sites ranging from lead bricks and empty drums to storage tanks, sewage lagoons, and landfills. Eventually, all known environmental restoration sites, including nuclear testing sites, will be part of the inventory.

The Nevada Operations Office has responsibility for remediation activities at the Nevada Test Site, parts of the Tonopah Test Range, and the Nellis Air Force Range. In addition, there are eight off-site locations in five states, including Nevada, where DOE conducted underground nuclear tests and experiments. The off-site locations in Nevada are the Central Nevada Test Site, almost 97 kilometers (60 miles) east of Tonopah, and the Project Shoal Site, about 48 kilometers (30 miles) southeast of Fallon.

The Nevada Operations Office is working closely with state and federal representatives to comply with applicable regulations. A Federal Facility Agreement between DOE and the State of Nevada will set priorities, schedules and deadlines for the cleanup program.

The Environmental Restoration Process



The Nevada Test Site is located 105 kilometers (65 miles) northwest of Las Vegas, NV.

In general, the environmental restoration process involves identifying the nature of contamination, determining its risk to the public and to the environment, and acting to protect or restore the natural resources adversely affected by releases of hazardous substances.

At the Nevada Test Site, the scope of environmental restoration covers:

- Development and implementation of closure plans for numerous sites where hazardous and/or mixed wastes were disposed (mixed wastes are defined as a combination of hazardous and radioactive wastes);
- Studies the nature and extent of any contamination and to evaluate proposed remedies;
- Cleanup of large surface areas contaminated with small amounts of radioactive materials;
- Remediation of some industrial sites as required;
- Evaluation and restoration of off-site locations;
- Decontamination and decommissioning of eight facilities at the Nevada Test Site.

Environmental restoration essentially involves two processes: remediation, and decontamination and decommissioning.

Remedial actions are those activities necessary to identify contamination that must be removed or isolated so it does not pose a threat to human health or the environment. A remedial action involves four tasks:

 http://www.nv.doe.gov/infotran/erwm/erwm9.htm

tasks:

- Survey and identification of sites, preliminary assessment, and inspection to determine the extent and nature of contamination;
- Site characterization, analysis of cleanup alternatives and remedy selection;
- Cleanup, which includes waste handling, decontamination, treatment, removal or storage, and site closure;
- Compliance monitoring to ensure the site is no longer contaminated.

Decontamination and decommissioning involves the stafe dismantling and removal of inactive nuclear facilities, including hot cells, processing plants, storage tanks, and other structures. Several tasks are involved;

- Surveillance and maintenance to prevent human exposure to potential hazards;
- Assessment of type, extent and nature of contamination;
- Environmental review to assure compliance with environmental, health and safety laws;
- Engineering design for facility dismantlement;
- Dismantlement and/or cleanup of facilities;
- Removal of wastes for storage or tretment;
- Closure of facility.

Specific Major Activities at the Nevada Test Site

A liner is installed over a landfill as part of remediation activities at the Nevada Test Site.

Groundwater Studies.

The effects of underground nuclear weapons testing on the groundwater and surrounding soils are being investigated, through data collection and subsequent analysis, to find out whether contaminants have moved appreciable distances from the nuclear explosion locations. Examples of field activities include the use of new and existing wells for monitoring as well as the collection of groundwater samples. Many monitoring wells will be more than 600 meters (2,000 feet) deep. The project grew out of DOE's hydrology studies program which began in the 1970s.

Industrial Sites.

Many sites were used to dispose of incidental industrial wastes generated during nuclear testing operations. Several areas were used for the disposal of unexploded ordnance, wastewater, leachfield wastes and soils, drilling muds and drill cuttings. Among those sites currently scheduled for closure are injection wells, leachfields and underground storage tanks. In late 1993, workers completed remediation of an old landfill containing hazardous wastes near Mercury on the Nevada Test Site.

Plutonium Soils Project.

This project is part of the broader phase of environmental restoration that addresses all contaminated soils at the Test Site. Safety tests on nuclear weapons conducted during the 1950s and 1960s left at least 1,200 hectares (3,000 acres) of surface soil contaminated with microscopic particles of plutonium. The DOE Nevada Operations Office is testing and evaluating equipment and procedures for separating contaminated soil from clean soil. Many soil removal, treatment, and revegetation technologies have been evaluated over the past few years for potential application to the project. A related effort is the use of an advanced, aircraft-based sensing system to identify the general locations and levels of plutonium-contaminated soils.

Decontamination and Decommissioning.

These activities focus on the installations left from the nuclear rocket engine development program conducted during the 1960s in the southwest area of the Nevada Test Site. Also included is the research farm operated by the U.S. Environmental Protection Agency for many years. Each facility will be assessed and characterized, determining the need for decontamination, decommissioning, or future reuse of the facility.

Environmental Impact Statement to be Prepared

The Nevada Operations Office will prepare an Environmental Impact Statement (EIS) to determine the potential impacts associated with alternatives for environmental remediation and waste management at DOE sites in Nevada. The statement will discuss treatment, storage, and disposal options, and evaluate the potential environmental impacts of the proposed activities. The National Environmental Policy Act sets guidelines for the preparation of the impact statement, which is required when a proposed federal action may significantly impact the environment. The EIS process is expected to take two to four years.

Background Information on the Nevada Test Site

DOE's Nevada Operations Office manages the Nevada Test Site and also is responsible for eight other inactive test locations in Nevada, Alaska, Colorado, New Mexico, and Mississippi. The Nevada Test Site is an outdoor scientific laboratory approximately the size of the state of Rhode Island. The Site is located in a sparsely populated region of south-central Nevada. The principal missions include: management and operation of national test and demonstration facilities; national nuclear response and radiation measurement capability; weapons testing readiness; nuclear non-proliferation and treaty verification; environmental restoration and waste management; and technical and administrative support for the Yucca Mountain Project.

In April 1992, DOE dedicated the Nevada Test Site as a member of the Department's Environmental Research Park Network. This designation broadens the role of the Nevada Test Site as an outdoor laboratory where scientists and students can conduct research on environmental issues.

About 8,000 employees are associated with the Nevada Operations Office, including federal workers, DOE contractors, and national laboratory personnel. The site is located about 105 kilometers (65 miles) northwest of Las Vegas in Nye County, Nevada.

Contact:

If you would like more information or to comment on the Environmental Restoration Project, contact:
U.S. Department of Energy
Nevada Operations Office
Office of External Affairs
P.0. Box 98518
Las Vegas, NV 89193-8518
(702) 295-3521

Unexploded Ordnance Items Removed from Tonopah Test Range

A one-armed mobile robot joined team members on a dangerous cleanup mission at Tonopah Test Range in central Nevada. Two contractors and a Federal laboratory teamed to clean up several thousand potentially "live" unexploded ordnance items from six disposal sites. The items were removed and detonated; nearly 100 detonations and several hundred pounds of explosives were used to demilitarize and vent bomb casings and other parts. Most of the metal was recycled; some soils were shipped off-site for treatment.

IT Corporation was the lead contractor for the remediation effort. The company provided a team of former military unexploded ordnance specialists, drum-crushing equipment, and an equipment operator, in addition to handling management, oversight, and documentation responsibilities. Reynolds Electrical and Engineering Co., Inc. provided radiation safety personnel, while Sandia National Laboratories contributed a radio-controlled, one-armed mobile robot. The Department of Energy's Nevada Environmental Restoration Division oversaw and funded the endeavor.

The prototype robot, which was mounted on an all-terrain vehicle, was used to collect submunitions, or bomblets, released from serial drops of cluster bombs. An operator worked the robot's radio-controlled manipulator arm via interactive video from a trailer more than 3,000 feet away.

During the five-month project, about 22,000 bomblets and 150 larger practice bombs and artillery shells were detonated and disposed of safely. Nearly 400 spent rocket motors were cut up as scrap and more than 120 tons of scrap steel and five tons of scrap aluminum were recycled. All six sites are free of ordnance and debris; three of the sites are ready for site characterization work, the other three require surface soil sampling to verify that contaminants have been removed.

For more information contact, David Shafer at 301-903-3979.

About This Document

Posted 03/07/1996 (alb)

 http://www.nv.doe.gov/infotran/erwm/erwm10.htm

Tonopah Test Range

In 1956, the Atomic Energy Commission, now known as the U.S. Department of Energy (DOE), began testing weapons, research rockets, and artillery on the Tonopah Test Range. The test range is located 250 kilometers (160 miles) northwest of Las Vegas and 64 kilometers (40 miles) southeast of Tonopah, Nevada. Recent DOE activities, conducted by Sandia National Laboratories, include testing equipment for use in nuclear weapons.

In addition to DOE activities, the U.S. Department of Defense uses the range for test activities. Recent Defense activities conducted at the Tonopah Test Range by the U.S. Air Force include development of the Stealth aircraft.

As a result of these DOE-conducted tests, contaminants have been introduced to parts of the Tonopah Test Range. These contaminants include photographic chemicals, lead, explosives, and other hazardous materials. Additionally, some sites contain radioactive and mixed waste.

Preliminary Investigations

The introduction of contaminants has created environmental concerns. In response to these concerns, the Environmental Restoration Project of the DOE Nevada Operations Office is conducting studies and surveys of inactive areas at the Tonopah Test Range. These studies, called preliminary investigations, are used to determine the type and extent of contamination. They also examine the potential risk to the public and environment. Based on these studies, scientists will determine cleanup options.

The preliminary investigations currently being conducted at the Tonopah Test Range include:

Geophysical Surveys.

These surveys measure the characteristics of the earth's upper surface. This enables scientists to locate underground storage tanks and sumps, trace pipes and cables, define leachfields and septic tanks, and map landfill boundaries.

Inventory of Contaminated Sites.

An inventory of the contaminated sites is conducted to assist in developing a work plan. As part of the inventory, scientists collect historical information, interpret aerial and ground photographs, and review engineering drawings. This information provides a record for each site. Site inspections are conducted to recheck the accuracy of the information.

Aerial Surveys.

Scientists conduct aerial surveys from helicopters with radiation detection equipment. These surveys map the general location and concentration of radioactive soil and debris from testing activities. Ground survey crews then mark the locations, and the contaminated areas are identified as environmental

 http://www.nv.doe.gov/infotran/erwm/erwm10.htm

restoration sites.

Aerial Mapping.

Other aerial surveys use sophisticated sensors to detect subtle changes in the geologic makeup of surface soils. These changes may indicate hazardous or radioactive waste burial sites. The objective of these surveys is to identify former hazardous or radioactive waste burial sites, and then add them to the list of environmental restoration sites.

These background studies and surveys are the basis for a work plan being developed by DOE. This work plan will guide cleanup activities through the year 2000.

Contaminated Soil Studies

In addition to the studies and surveys mentioned above, a study of plutonium contaminated soils is being conducted at the Tonopah Test Range. Soil was contaminated during a series of safety tests in 1963. Scientists designed these tests to see if conventional explosives could accidentally set off nuclear weapons. These tests proved that nuclear detonations would not occur. However, plutonium and uranium from these tests contaminated surface soil.

These contaminated surface soils are being examined so that potential cleanup options can be developed. Scientists are working to see if it is possible to separate plutonium-contaminated soil from clean soil. This would reduce the volume of contaminated soil requiring cleanup or disposal.

Contact:

If you would like more information or to comment on the Environmental Restoration Project, contact:
U.S. Department of Energy
Nevada Operations Office
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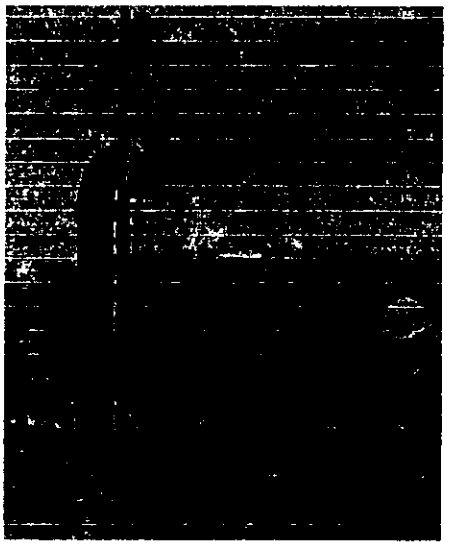
(702) 295-3521

 http://www.nv.doe.gov/infotran/erwm/erwm5.htm

Inventory of Environmental Restoration Sites

The U.S. Department of Energy (DOE), Nevada Operations Office has started an enormous task to identify, verify, and document sites that are potential candidates for environmental restoration. These sites range from craters created during nuclear testing to lead bricks and empty drums.



An environmental scientist uses a global positioning system for the inventory of environmental restoration sites.

This comprehensive inventory is being carried out by the Environmental Restoration Project for the Nevada Operations Office with oversight from the State of Nevada Division of Environmental Protection.

By early 1994, environmental specialists had identified almost 2,000 potential sites through historical research, data review, and field efforts. Of those, almost 1,000 have been evaluated. Cleanup procedures are being developed for sites as appropriate. Other sites have already been restored, and regulatory approval will be obtained as needed for final closure.

Environmental scientists are looking at areas where DOE conducted nuclear tests and experiments. Areas in Nevada include the Nevada Test Site, parts of the Tonopah Test Range, parts of the Nellis Air Force Range, the Central Nevada Test Site east of Tonopah, and the Project Shoal Site southeast of Fallon. Six offsite locations in four states (Alaska, Colorado, New Mexico, and Mississippi) also are included in the inventory.

Future restoration efforts in part will be determined by the inventory's results.

 http://www.nv.doe.gov/infotran/erwm/erwm5.htm

More than 3,000 sites are expected to be identified through this effort.

To complete an inventory, many steps are required. These include:

- Reviewing and compiling site-specific historical data to get specific information about each potentially contaminated site;
- Performing on-site verification;
- Using a global positioning system to mark the exact location of each site (this system uses satellites which send information to computers giving the location);
- Collecting field samples and sending them for laboratory analysis;
- Taking photos of each site;
- Keeping a log of photos taken with information on exact location, type of contamination, and other information related to the site;
- Interpreting aerial photos for site-specific and historical data;
- Entering inventory information into a database;

Environmental specialists use the latest state-of-the-art equipment for the inventory. For example, an intricate system that combines geographical, historical, photographic, and field-collected information is being used to collect and store all kinds of information about the sites. This system is called the Environmental Restoration Management Application, or ERMA. This system will maintain accessible records for years to come.

A digital camera will be used to obtain color images which can be transferred directly from the camera into a computer. After the image is received by the camera, text may be added onto the image. The image, along with the text, is then printed. This camera system allows visual and written information about the sites to be stored in the computer for easy retrieval and access.

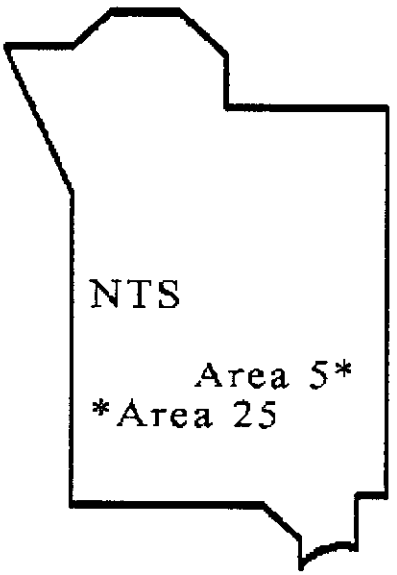
The database being developed will serve more than one function. In addition to collecting information to help determine restoration priorities, it also will be used as a central repository for all site-specific information. Information about each site, with its own identification number, will include its name, location, history, description, previous and/or current use, regulatory status, estimates of waste quantities and types, information references, photographs, maps, and directions to the location.

The Nevada Division of Environmental Protection will give final approval on whether or not a site is clean, and therefore "closed-out." Stakeholders will be invited to review materials regarding this effort as appropriate.

Contact:

If you would like more information or to comment on the Environmental Restoration Project, contact:
U.S. Department of Energy
Nevada Operations Office
Office of External Affairs
P.0. Box 98518
Las Vegas, NV 89193-8518
(702) 295-3521

Demilitarization



A Joint Demilitarization Technology (JDT) Program has been established between the Departments of Defense and Energy. The program is being implemented by the Joint Ordnance Commanders Group and the Department of Energy Nevada Operations Office. The JDT Program will demonstrate and validate environmentally acceptable technologies for resource recovery and recycling (R3), alternative destruction, or treatment technologies as appropriate to specific excess stockpile and obsolete munitions. The accomplishment of the JDT will be the result of Government, industry, and academia teaming and the leverage of existing or complimentary new programs.

Lawrence Livermore National Laboratory, Los Alamos National Laboratory, and Sandia National Laboratories with Bechtel Nevada and Radian International are participating in a series of experiments in the X-tunnel complex, at the Nevada Test Site (NTS) in Area 25. In Area 5, Los Alamos National Laboratory, with Lawrence Livermore National Laboratory, Sandia National Laboratories, and Bechtel Nevada will conduct the Navy Thermal Treatment Unit demonstration. A mobile contained missile burn unit will be designed, constructed, and tested in Y-tunnel Area 25 by Bechtel Nevada and Lockheed Martin.

Contained Rocket Motor Burns--X-Tunnel Area 25

Detonation of Conventional Munitions--X-Tunnel Area 25

Navy Thermal Treatment Unit--HAZMAT Spill Center Area 5

Mobile Contained Tactical Missile Burn--Y-Tunnel Area 25

Detonation of Conventional Munitions--X-Tunnel Area 25

Lawrence Livermore National Laboratory will serve as the chief investigator for the Detonation of Conventional Munitions experiments in X-tunnel, Area 25. Sandia and Los Alamos National Laboratories, along with Bechtel Nevada and Radian International, will provide support. These experiments involve detonating 155-millimeter artillery shells while monitoring the effluents in a contained environment. The test series will consist of 4 detonations ranging from 100 to 1,000 pounds (net explosive weight) of artillery shells.

A variety of diagnostic methods will be used for sampling and analysis. Following successful ventilation, the tunnel complex will be reentered, solid waste removed, and the test chamber readied for the next experiment.

The purpose of these experiments is to provide the Department of Defense with information on the emission products from open detonation and to look at ways to optimize the open detonation process to minimize emissions.

The first test, "Banshee," was successfully conducted on December 18, 1996 at 11:05 a.m. This test involved the detonation of six 155-millimeter artillery shells (approximately 100 pounds net explosive weight). Initial results indicate that all diagnostic equipment functioned as intended.

Tentative Schedule

January 23, 1997: "Polaris" 500 lb. Test

February 11, 1997: "Beast" 500 lb. Test

March 11, 1997: "Colossus" 1000 lb. Test

Return-Path: Ethan.Merrill@em.doe.gov
From: Ethan.Merrill@em.doe.gov
Date: 27 Jan 97 11:54:00 -0500
To: KEdelmayer@SCIENTECH.COM
Subject: Re: Bombs and Bullets
Ua-Content-Id: Re: Bombs and Bu
P1-Recipient: KEdelmayer@SCIENTECH.COM
P1-Message-Id: US*ATTMAIL*USDOE;c\em\970127115810e
Original-Encoded-Information-Types: IA5-Text
X400-Trace: US*ATTMAIL*USDOE; arrival 970127115400-0500 deferred 970127115400-0500 action Relayed
P1-Content-Type: P2

---------- Forwarded with Changes

From: David Shafer at EM-45_CLF
Date: 1/24/97 4:56PM
To: kse@scientech.com_at_INTERNET at X400PO
To: Ethan Merrill
To: William Spurgeon
To: Kevin Cabble at EM
cc: Janet Wing at EM
Subject: Re: Bombs and Bullets

--

Kory --

Attached is a response David Shafer prepared. I am sending to your new address. Let me know if you need further assistance. Thanks
Ethan Merrill, EM-45, 301-903-8185

_____ Forward Header
_____
Subject: Re: Bombs and Bullets
Author: David Shafer at EM-45_CLF
Date: 1/24/97 4:56 PM

NPL SITE

? WHAT Remediation under

Kory--Nevada's main unexploded ordnance problems are on the Tonopah Test Range in Nevada. In 1995, NV remediated over 20,000 "objects" from several sites, including the "bomblet pit". In 1996, Nevada remediated soils with trace quantities of TNT and RDX from the Five Points Landfill.

Although the 1995/96 work took care of sites where there were discrete concentrations of unexploded ordnance, there are still are large number of objects at Tonopah that are scattered over wide area from dispersal studies of "anti-personel devices". NV is still looking at options for economically locating and collecting these devices.

The person I would suggest you talk to at the Nevada Operations Office is Kevin Cabble who can be reached at (702) 295-5000. He has copies of completion reports of those sites that have been remediated.

Thanks

David Shafer
(301) 903-3979

_____ Reply Separator

_____

Subject: Bombs and Bullets
Author: kse@scientech.com_at_INTERNET at X400PO
Date: 01/24/97 04:28 PM

X-Sender: kse@eaglerock.if.scientech.com
Return-Receipt-To: kse@scientech.com
X-Mailer: Windows Eudora Pro Version 2.1.2
Mime-Version: 1.0
Content-Type: text/plain; charset="us-ascii"

David, I am working on a Benchmarking effort here at the INEL for LMITCO and

DOE. This effort includes identifying other DOE sites with Unexploded Ordnance or Ordnance Explosive Waste needs. I obtained some material that named yourself as a contact to recieve more information about UXO from the Nevada Test Site and Tonopah Test Range. Can you tell me:

1) Does the Nevada Test Site and Tonopah Test Range have needs for Unexploded Ordnance Cleanups as part of the ER Program?

2) Does the Nevada Test Site and Tonopah Test Range have High Explosive

contamination in the soils such as TNT or RDX?

3) If so, how can I find out what is planned for cleanup of these items

Received 2/28/97

DOE/NV-386
UC-700

Nevada
Environmental
Restoration
Project

Voluntary Corrective Action Work Plan for Ordnance Removal from Five Disposal Sites at the Tonopah Test Range

January 1995

Environmental Restoration
Division

U.S. Department of Energy
Nevada Operations Office

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This report is publicly available from the Department of Commerce, National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. (703) 487-4650

DOE/NV--386
UC-700

VOLUNTARY CORRECTIVE ACTION WORK PLAN FOR ORDNANCE REMOVAL FROM FIVE DISPOSAL SITES AT THE TONOPAH TEST RANGE

Prepared for

DOE Nevada Operations Office
Las Vegas, Nevada

Prepared by

IT CORPORATION
4330 South Valley View Boulevard, Suite 114
Las Vegas, Nevada 89103

Work Performed Under Contract No.
DE-AC08-92NV10972

January 1995

VOLUNTARY CORRECTIVE ACTION WORK PLAN FOR ORDNANCE REMOVAL FROM FIVE DISPOSAL SITES AT THE TONOPAH TEST RANGE

Submitted by: Kevin Cabble Date: 1/31/95

Kevin J. Cabble
Tonopah Test Range Subproject Manager

Approved by: Stephen A. Mellington Date: 1/31/95

Stephen A. Mellington, Project Manager
Nevada Environmental Restoration Project

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Plate 1 - Environmental Restoration Fiscal Year 1994 Voluntary Corrective Action Ordnance Clean-up Sites, Site Location Map, Tonopah Test Range

Plate 2 - Environmental Restoration Fiscal Year 1994 Voluntary Corrective Action Ordnance Clean-up Sites, Area 9, Site Location Map, Tonopah Test Range

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List of Acronyms and Abbreviations

AEC	U.S. Atomic Energy Commission
ASI	Advanced Security, Inc.
BLM	U.S. Bureau of Land Management
CAR	Corrective Action Request
CBU	cluster bomb unit
CFR	Code of Federal Regulations
DCO	Document Control Officer
DMP	Data Management Plan
DOE	U.S. Department of Energy
DOE/AL-KAO	DOE Albuquerque Operations Office - Kirtland Area Office
DOE/NV	U.S. Department of Energy Nevada Operations Office
DOP	Detailed Operating Procedure
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
ERMA	Environmental Resource Management Applications
ft	foot
g	gram
gal	gallon
in.	inch
IT	IT Corporation
kg	kilogram
km	kilometer
km^2	square kilometer
lb	pound
LSC	linear-shaped charge
m	meter
mi	mile
mi^2	square mile
mm	millimeter
M&TE	Measurement and Test Equipment
MSDS	material safety data sheet
NCR	Nonconformance Report
NDEP	Nevada Department of Environmental Protection

List of Acronyms and Abbreviations *(Continued)*

NEPA	National Environmental Policy Act
NV ERP	Nevada Environmental Restoration Project
OSHA	Occupational Safety and Health Administration
QA	Quality Assurance
QAC	Quality Assurance Coordinator
QAPjP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
REECo	Reynolds Electrical & Engineering Co., Inc.
RETRVIR	Remote Telerobotic Vehicle for Intelligent Retrieval
RFI	RCRA Facility Investigation
SNL	Sandia National Laboratories
SOP	Standard operating procedure
SSHASP	Site-Specific Health and Safety Plan
SWO	Stop Work Order
TTR	Tonopah Test Range
USAF	U.S. Air Force
UXO	unexploded ordnance
VCA	Voluntary Corrective Action

1.0 Introduction

The five sites addressed by this Voluntary Corrective Action (VCA) Work Plan are within the Tonopah Test Range (TTR), located in south-central Nevada (Figure 1-1). A Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Work Plan for the TTR is currently in preparation by the U.S. Department of Energy, Nevada Operations Office (DOE/NV). The RFI Work Plan addresses 43 waste sites at the TTR that were identified by the Environmental Restoration Sites Inventory process. The five sites addressed by this VCA Work Plan are the Bomblet Pit, Five Points Landfill, Roller Coaster Sanitary Sewage Lagoons, Area 9 Landfill, and the Area 9 Construction Debris Area. Actions proposed for these sites are the removal and disposal of ordnance and other debris.

1.1 Scope and Objective of Voluntary Corrective Action

The focus of this VCA is the removal of unexploded ordnance (UXO) and debris from the five sites to allow closure at a later date. These sites are a high priority due to the safety hazard posed to personnel by the UXO. All five sites are to be free of UXO after the VCA activities. Closure of the sites requires verification sampling to confirm that no RCRA-regulated substances remain. Closure verification is not part of the scope of this VCA Work Plan. Closure plans for each site will be submitted to the Nevada Department of Environmental Protection (NDEP) for approval before closure activities begin.

1.2 Tonopah Test Range

The TTR covers an area of approximately 1,350 square kilometers (km^2) (520 square miles [mi^2]) in Nye County, Nevada, on the northern portion of the Nellis Air Force Range (Figure 1-1). It is approximately 225 kilometers (km) (140 miles [mi]) northwest of Las Vegas by air and approximately 64 km (40 mi) southeast of Tonopah by road (DOE, 1992a). The TTR is bordered on the south, east, and west by the Nellis Air Force Range and on the north by sparsely populated public land administrated by the U.S. Bureau of Land Management (BLM) and the U.S. Forest Service (DOE, 1992a).

In November 1956, a Memorandum of Understanding between the U.S. Air Force (USAF) and the U.S. Atomic Energy Commission (AEC) (predecessor agency to the DOE) provided 369,280 acres (the TTR) to the AEC (BLM, 1979). Construction at the TTR began in 1956, and Sandia National Laboratories (SNL) has operated the facility for the DOE since 1957 (DOE/USAF, 1988).

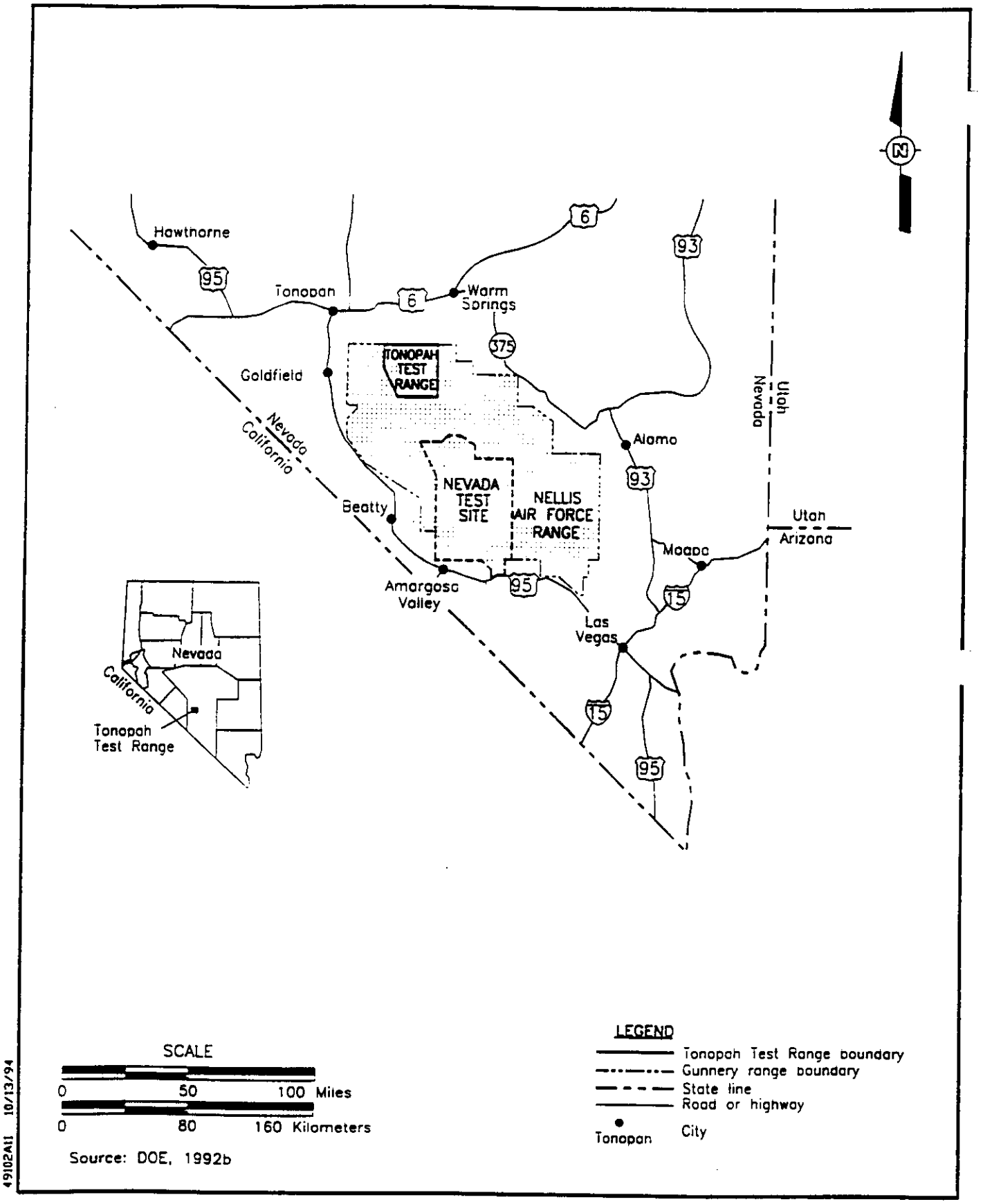

Figure 1-1
Location Map
Tonopah Test Range

In 1957, the TTR was established to field test conventional and nuclear weapons, research rockets, and artillery and was made a permanent facility in 1958 (Ecology and Environment, Inc., 1989). Activities vary from tests of hardware components or systems needing limited support to rocket launches or air drops of test vehicles requiring full range support for the USAF, U.S. Army, and U.S. Navy operational and test groups and some defense contractors (ERDA, 1975).

The TTR is divided into areas (Figure 1-2) with Areas 3 and 9 and a Test Area being under SNL control. Areas 3 and 9 are the main centers of SNL activities. Area 3 is the Control Point Area, which contains support facilities for maintenance and operations. Area 9 is the center for rocket and gun firings, ordnance storage, and related test support operations, with impact areas to the southeast. The Test Area is a series of dry lakes that begins at Main Lake near Area 9, continues south for about 21 km (13 mi), and ends with Antelope Lake (ERDA, 1975). Area 10 and other remote parts of the range are under USAF (Nellis) control.

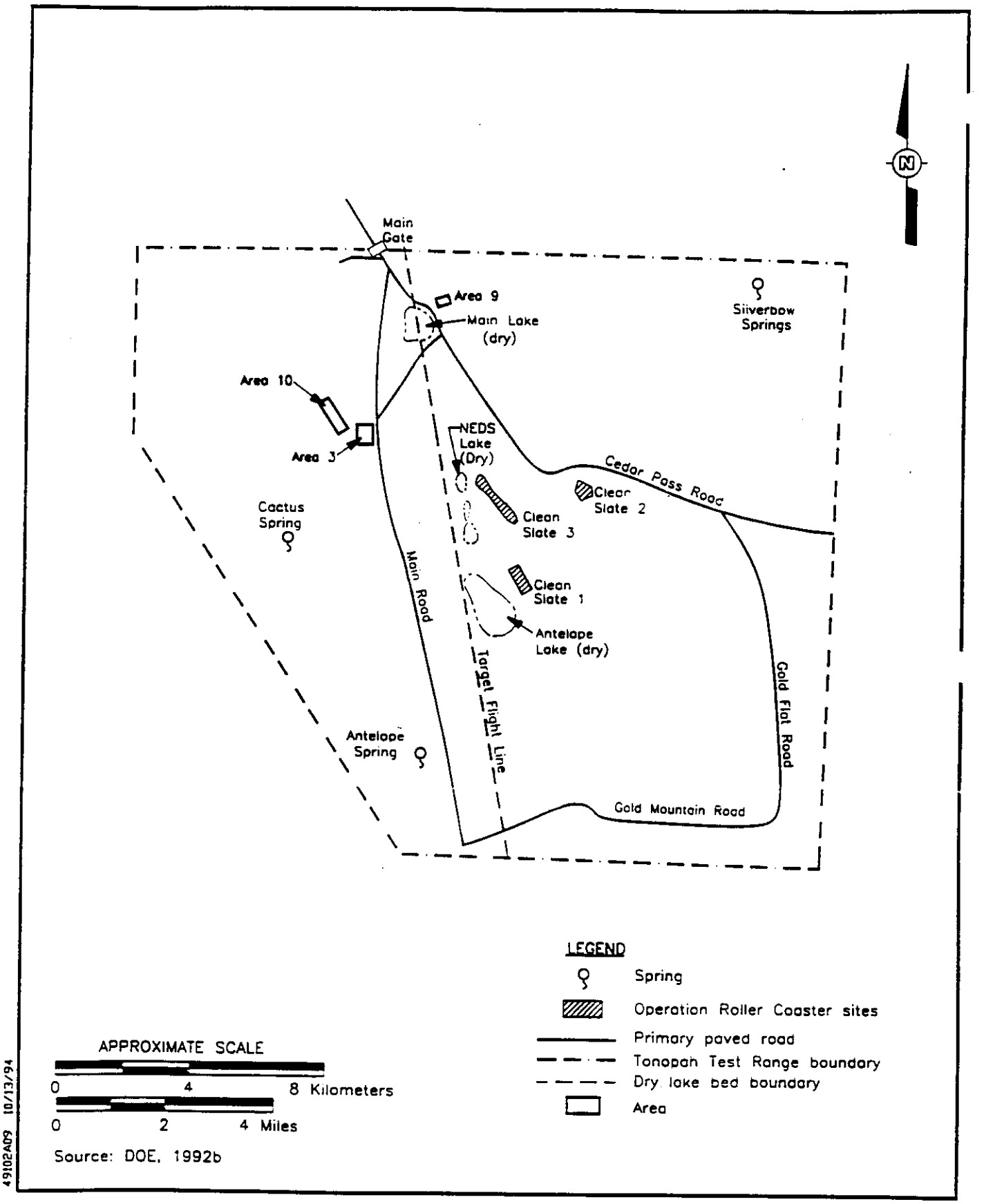

Figure 1-2
Tonopah Test Range Layout

2.0 Project Background and Descriptions

This VCA Work Plan addresses the removal of UXO and other debris from five sites on the TTR (Plate 1). The sites are the Bomblet Pit, the Roller Coaster Sewage Lagoons, the Five Points Landfill, the Area 9 Landfill, and the Area 9 Construction Debris Pit.

These sites have been used as collection locations for debris that has been accumulated from various testing areas during periodic range clean-up efforts by SNL. The five sites contain conventional UXO, spent solid-fuel rocket boosters, target drums, and construction debris.

2.1 Bomblet Pit

The Bomblet Pit is located approximately one mile northwest of Bunker 2 Road, as shown in Plate 1. The pit, which is surrounded by a fence, contains many bomblets (or cluster bomb units [CBUs]), bomblet-dispenser clamshell sections, spent rocket motors, and other assorted debris (see Figure 2-1). The number of bomblets in the pit ranges from an estimated 400 to 1,000 CBUs. An observed dispenser section was labelled as "inert BLU-63 w/mod M219E1 fuze." This identification denotes a bomblet that was not filled with an explosive main charge, but did have a live fuze containing less than 1 gram (g) of explosives. All visible dispensers in the pit are clearly marked as inert submunitions with M219E1 fuzes (Czajkowski, 1994). Assuming each fuze to be intact with 1 g of explosives, the pit could collectively contain a maximum of 1 kilogram (kg) of explosives. Other UXO observed in the Bomblet Pit includes two MK84 2,000-pound (lb) bombs that appear to be unfuzed. Because of the quantity of UXO, the Bomblet Pit has the highest priority for action during this project.

The Bomblet Pit was used for disposal of debris from antipersonnel and antivehicular CBU tests. These tests were conducted between the north end of Antelope Lake and Mid-Target (Plate 1) during the 1970s. Each test involved the aerial drop of one or more dispensers containing hundreds of bomblets. These bomblets had fuzes that were armed during free fall (West, 1993). Mid-Target, located approximately 1 km east of the Bomblet Pit, is a known training range used for inert munitions.

The open Bomblet Pit is approximately 11 meters (m) (35 feet [ft]) long, 3 m to 5 m (10 ft to 15 ft) wide, and 1 m (3 ft to 4 ft) deep. A small mound of earth is located on the north

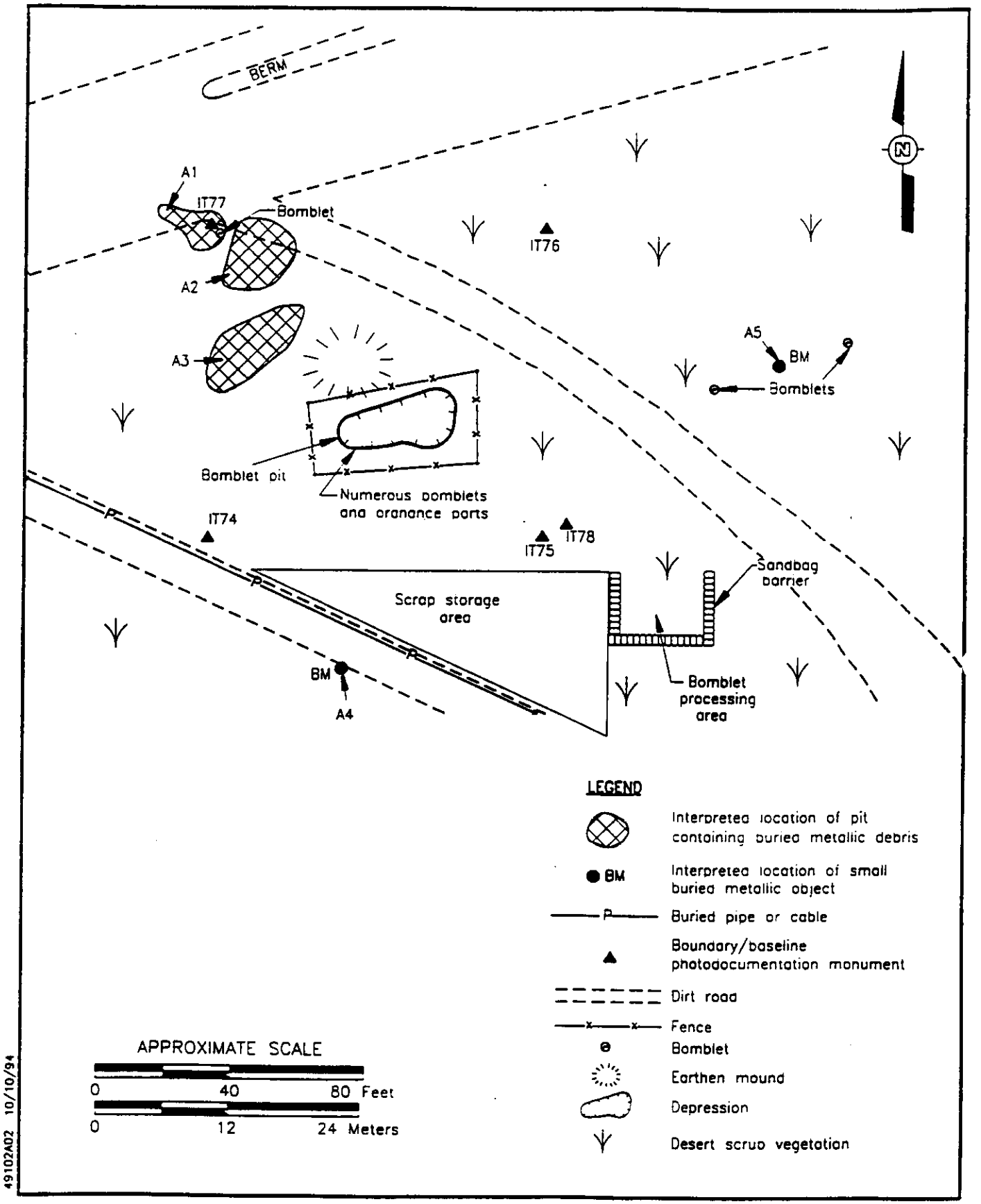

Figure 2-1
Site Map
Bomblet Pit, Tonopah Test Range

side of the fence (Figure 2-1). A geophysical investigation conducted at this site found five anomalies (labeled as A1 through A5 on Figure 2-1) that were identified as buried metallic debris (DOE, 1994b). In addition to these anomalies, three bomblets have been identified on the surface outside the fenced area. Buried pipes and/or cables currently in use were also identified at the site during the geophysical investigation (DOE, 1994b) and will be avoided during subsurface activities on the site.

2.2 Roller Coaster Sanitary Sewage Lagoons

The Roller Coaster sanitary-sewage lagoons and ancillary disposal pit are located approximately 8 km (5 mi) south of Area 3 along South Main Road (Plate 1). The sewage lagoons received liquid sanitary wastes from the main camp for DOE/NV personnel who worked on Operation Roller Coaster in 1963. The lagoons are presently dry and have been filled with debris consisting of spent rocket motors; empty propellent containers; aircraft targets, made by welding six 55-gallon (gal) drums together to form a pyramid; construction debris; cable spools; pallets; and some UXO (DOE, 1994b). The ancillary disposal pit contains similar types of debris. The ancillary disposal pit is approximately 32 m long by 14 m wide by 3 m deep (100 ft long by 40 ft wide by 10 ft deep) and is located approximately 24 m (80 ft) north of the sewage lagoons (Figure 2-2).

2.3 Five Points Landfill

The Five Points Landfill is located approximately 2 km (1 mi) north of the Five Points intersection along Perimeter Road (Plate 1). The site consists of a fenced depression approximately 130 m long by 35 m wide by 3 m deep (440 ft long by 110 ft wide by 10 ft deep) with a mostly flat bottom. Practice bombs, spent rocket motors, soil piles, concrete fragments, lumber, steel fence posts, large steel-plate structures, and wires are found mostly along the slopes of the depression (DOE, 1994b).

There is also a large graded area that extends approximately 200 m (660 ft) east of the eastern fence, which was investigated using surface geophysical methods (Figure 2-3). Surface geophysical surveys, including surface conductivity and magnetometer surveys, were completed in 1993 (DOE, 1994b). The geophysical surveys indicate that no buried disposal cells exist at this area east of the fence.

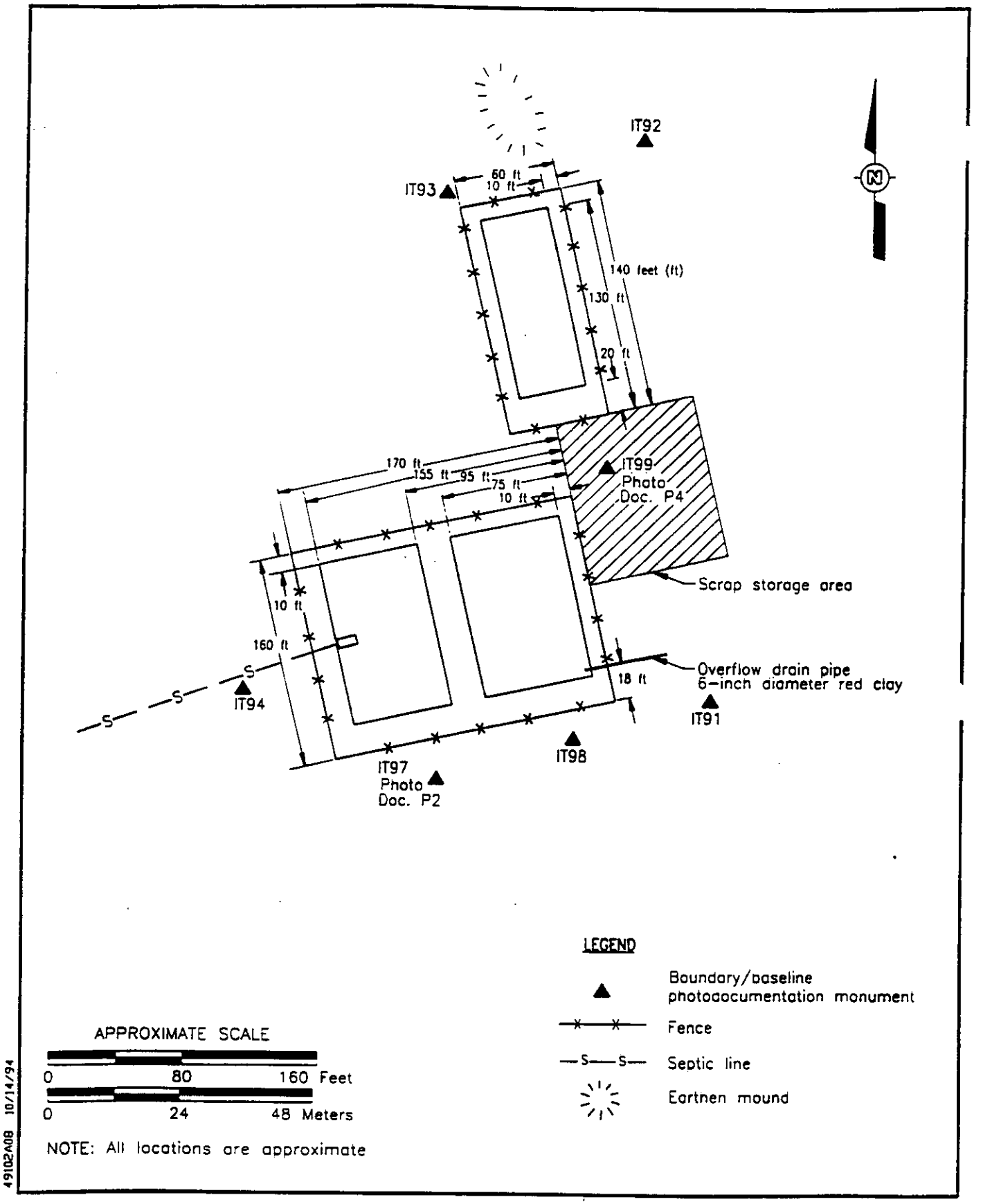

Figure 2-2
Site Map
Roller Coaster Sanitary Sewer System and Lagoons
Tonopah Test Range

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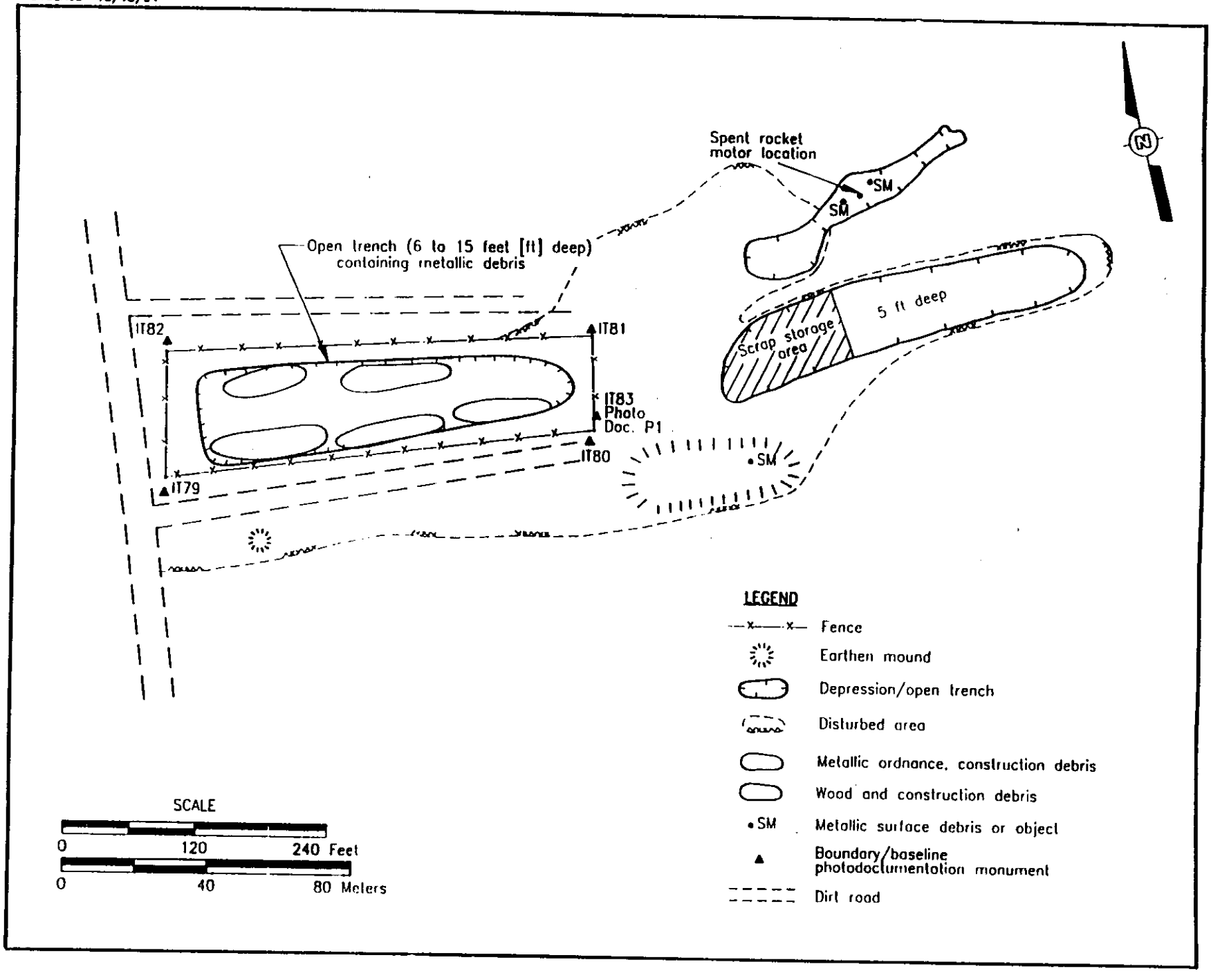

Figure 2-3
Site Map
Five Points Landfill
Tonopah Test Range

2.4 The Area 9 Landfill

The Area 9 Landfill covers approximately 9.3 km^2 (2 acres) and is located along the Area 9 Bypass Road northwest of Area 9 (Plates 1 and 2). This site consists of an open pit approximately 14 m long by 6 m wide (40 ft long by 20 ft wide), which is the subject of the VCA activities, and four covered landfill cells, the largest of which is approximately 81 m long by 12 m wide (260 ft long by 40 ft wide) (Figure 2-4). No material will be removed from the covered cells. The open trench has been observed to contain spent rocket booster parts, 155-millimeter (mm) ammunition canisters (empty), two 155-mm artillery rounds that appear to be unfuzed, 55-gal drums, practice bombs, insulated cables, reinforced concrete, and other construction debris. The covered cells received residues from the burning of high explosives, gun propellants, electrical igniters, and solid-fuel rocket motors (ERDA, 1975). They also received construction debris, trash from Area 9, debris from range cleanup, and possible ordnance. The cells were also reportedly used as burn pits (Karas, 1993). The location of the covered trenches was verified by surface geophysical surveys (DOE, 1994b).

2.5 Area 9 Construction Debris Disposal Area

The Area 9 Construction Debris Disposal Area is located east of Main Lake along Lake Road (Plates 1 and 2). This site covers approximately 4 km^2 (1 acre) and contains ordnance, broken reinforced concrete with conduits running through it, wood scraps, and plastic pipe. The ordnance will be the only material removed from the site. Ordnance at this site consists of one MK84 2,000-lb bomb with its inert filler exposed and several inert 20-lb practice bombs lying at the eastern edge of the construction debris pile. There is no evidence that anything was buried at this site, and no prior investigations have been conducted.

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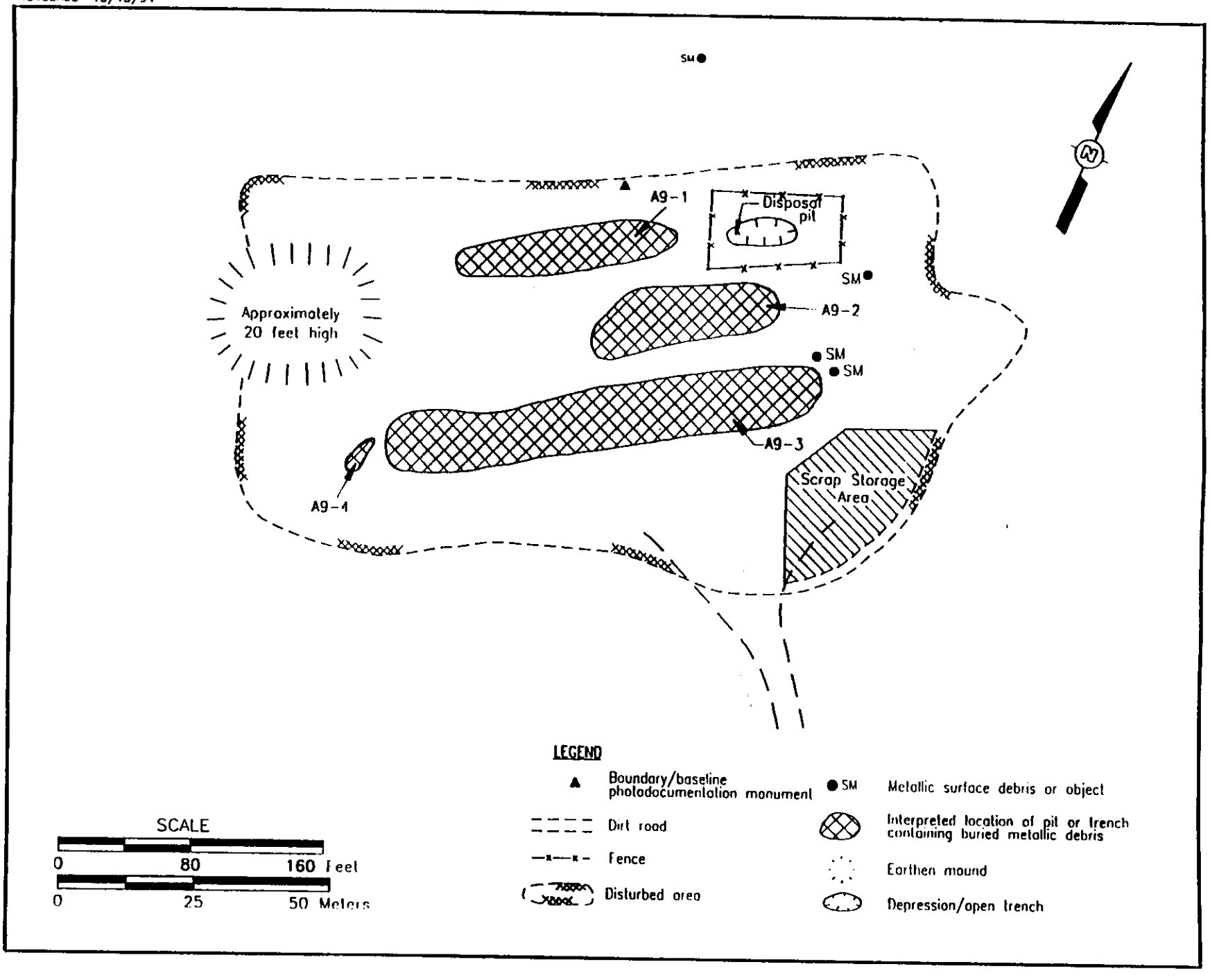

Figure 2-4
Site Map
Area 9 Landfill
Tonopah Test Range

3.0 Voluntary Corrective Action Activities

The planned activities for the VCA will be conducted in accordance with the findings of a Safety Assessment (under separate cover) conducted for the planned activities. Specific guidance for conducting the planned activities are contained in the IT Corporation (IT) Detailed Operating Procedures (DOPs) ITLV-TTR-004, Unexploded Ordnance Removal, Handling, Processing, and Disposal at the Tonopah Test Range Ordnance Disposal Sites and ITLV-TTR-005, Explosives Handling, Transportation, and Storage at the Tonopah Test Range and in the TTR Standard Operating Procedure (SOP) SP472561, RETRVIR Mobile Manipulation System (Appendix A of this document). Site-Specific Health and Safety Plans ([SSHASP] Appendices B and C) have also been prepared for the project (see Section 9.0). The SSHASPs provide the details for safe operations and are consistent with the requirements of relevant DOE Orders and Occupational Safety and Health Administration (OSHA) requirements. The SSHASPs are included in this VCA Work Plan and, as such, have been included in the formal review and approval process for this plan.

The VCA consists of the removal and disposal of the UXO contents of five disposal sites. One of the sites, known as the Bomblet Pit, presents unique hazards because the contents of the pit include very large UXO (e.g., two 2,000-lb bombs) and a large number of very small UXO (bomblets). Because of this, activities at the Bomblet Pit are being conducted differently than at the other four sites in that the removal of bomblets and possibly other small UXO at this site will employ specialized remote handling equipment. These activities are described in Section 3.2.3.

The following sections first describe the procedures to be followed at all five sites. Specific instructions to be used by site UXO specialists can be found in ITLV-TTR-004 and ITLV-TTR-005. Personnel qualifications and specific responsibilities for various activities are presented in Section 4.0 of this plan.

3.1 Unexploded Ordnance Identification

Much of the debris that is the subject of the removal action is UXO. IT UXO specialists will remove and dispose the UXO safely and efficiently. This operation will be facilitated by the fact that most of the items observed during the site survey were determined to be inert and do not present an explosive hazard. However, in the interest of project safety, this observation cannot be considered to be an indication that all UXO present at the five sites is inert. Therefore, all UXO will be considered live and extremely hazardous until proven otherwise.

The UXO will be examined for explosive hazards before removal from the debris pile. The UXO will then be classified into the following three categories:

Free from Explosives and Vented - UXO that does not contain any explosive hazards and has an opening in the case exposing the inert filler. These items present no explosive hazard and are ready for processing as scrap.

Inert but Requiring Processing - An inert UXO may still require processing prior to being considered as nonhazardous scrap. All sealed cases and components must be vented prior to processing as scrap. These items include the intact bomblets in the Bomblet Pit. Even though the UXO may be identified as inert, it must still be treated by explosive venting.

Explosively Hazardous UXO - Explosively Hazardous UXO other than bomblets will be processed in place without prior movement. Bomblets will be remotely moved to a nearby bomblet processing area for processing by detonation.

A decision-tree diagram for UXO segregation operations is included as Figure 3-1.

3.2 Unexploded Ordnance and Debris Removal and Processing

The UXO specialists from IT will work in two-person teams to identify, remove, and process UXO from the disposal sites. No UXO will be moved manually unless it can be positively identified and determined to be safe (e.g., does not contain a fuze, is inert, and will not affect surrounding UXO). UXO, other than bomblets, will be processed in place prior to movement. Bomblets will be moved remotely using the methods discussed in Section 3.2.3.

Each of the five sites is a separate project site and will be addressed independently. Site exclusion and support zones will be established and marked with wooden stakes and flagging tape or barricades, as appropriate. Any local hazards (e.g., suspected buried objects and ditches) will also be clearly marked with flagging tape for easy identification.

3.2.1 General Setup of Sites and Surrounding Areas

3.2.1.1 Explosive Fragmentation Hazard Area

The purpose of the explosive fragmentation hazard area is to establish an area, based on the explosive fragmentation hazard radius of a particular UXO, into which no personnel are allowed during remote movement of UXO or explosive operations. An explosive hazard of 1,000 lbs (i.e., the equivalent amount of explosives contained in a 2,000-lb bomb) is the

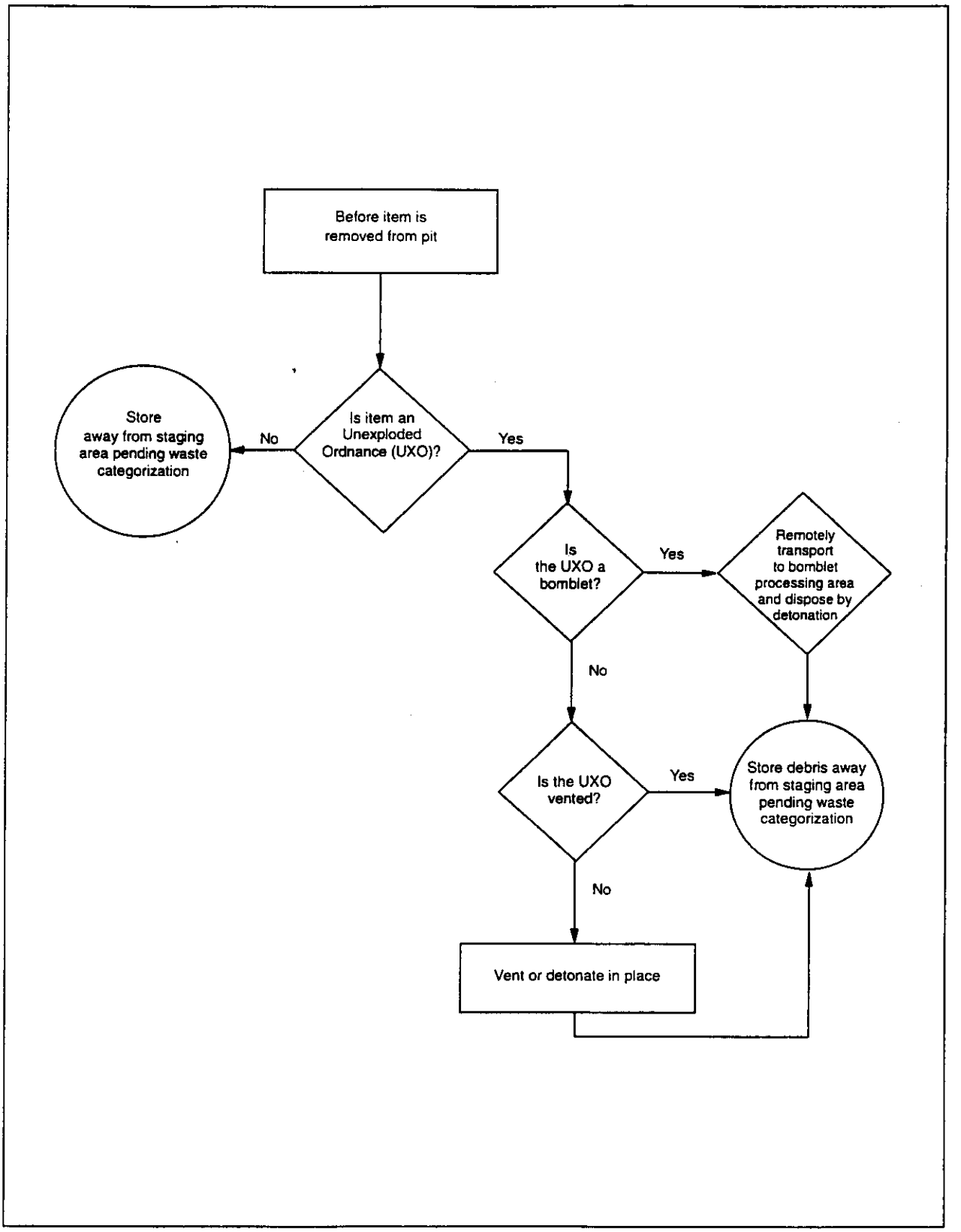

Figure 3-1
Decision Tree for Unexploded Ordnance Segregation Operations

minimum explosive hazard that will be assumed to be subject to accidental detonation unless it can be demonstrated that a smaller explosive hazard is known to exist. It may be possible to determine that a smaller explosive hazard exists as UXO removal nears completion at a particular site and the remaining contents of the disposal pit are visible. In that case, decreasing the fragmentation hazard radius may safely increase project efficiency. The following formula will be used to determine the fragmentation hazard area:

$$(300)(\sqrt[3]{N}) = D_f$$

where
N = Net Explosive Weight (pounds)
D_f = Fragmentation Distance (feet).

Based on this equation, if the explosive contents of a site are not known, a fragmentation hazard radius of 3,000 ft will be observed. If a lesser explosive hazard is known, the fragmentation hazard area may be reduced to the distance determined by the formula. However, a minimum fragmentation hazard radius of 900 ft shall always be observed. The fragmentation radius chart in Attachment A to ITLV-TTR-004 is based on the formula above and can be used for determining a reduced fragmentation hazard radius.

3.2.1.2 Exclusion Zone

Although the fragmentation hazard radius may be reduced in response to a decreasing explosive hazard, the exclusion zone for all five sites will be a radius of 3,000 ft. The exclusion zone is established on all roadways or pathways entering the area to control entry to the site by all nonessential, nonproject personnel, including general TTR personnel and visitors. However, unlike the fragmentation hazard area, the exclusion zone may be entered by essential and necessary project personnel during VCA activities.

The 3,000-ft exclusion zone will be established by Advanced Security, Inc. (ASI), security personnel during explosives handling operations, and all entry into the exclusion zone will be controlled. Roads within 3,000 ft of a site where activity is being conducted will be closed by ASI guards, who will be in radio communication with the IT Senior UXO Supervisor. The Senior UXO Supervisor will allow personnel to traverse a road inside the exclusion area only after ensuring that no explosively hazardous operations are being conducted.

3.2.2 Unexploded Ordnance Processing

The UXO will be processed as discussed in the following sections based on their identification. All UXO processing will be in accordance with the *DOE Explosives Safety Manual* (DOE, 1994a), as well as applicable federal and state statutes, including the requirements of 40 Code of Federal Regulations (CFR) §264.601c, Miscellaneous Units - Environmental Performance Standards, and 40 CFR §265.382, Open burning; waste explosives. Additional information on UXO processing may be found in Sections 5.2 and 5.4 of ITLV-TTR-004.

3.2.2.1 Unexploded Ordnance Free from Explosives and Vented

The UXO that does not contain any explosive hazards and has an opening in the case exposing the inert filler presents no explosive hazard and is ready for processing as scrap. Items ready for off-site disposal as scrap will be certified free of explosives by the UXO Supervisor according to the requirements of the *DOE Explosives Safety Manual* (i.e., XXXXX [5X] Rule, DOE, 1994a) and turned over to Reynolds Electrical & Engineering Co., Inc. (REECo) for off-site disposal.

3.2.2.2 Unexploded Ordnance Inert but Requiring Processing

Inert UXO with sealed cases and components may still require processing prior to being considered nonhazardous scrap. All sealed cases and components must be explosively vented prior to processing as scrap even though the UXO may be identified as inert. Inert UXO that will require venting include the 2,000-lb bombs and intact bomblets in the Bomblet Pit. Once processed, items ready for off-site disposal as scrap will be certified free of explosives by the UXO Supervisor according to the requirements of the *DOE Explosives Safety Manual* (i.e., XXXXX [5X] Rule, DOE, 1994a) and turned over to REECo for off-site disposal.

Processing of inert UXO will be done using the following general procedures:

- All UXO will be positively identified and classified into explosively hazardous and nonhazardous categories by the UXO specialist from IT.

- UXO identified as nonhazardous will be further inspected by the UXO specialist to determine if venting is required. All UXO with sealed cases require venting to ensure that explosions are not caused by the sudden release of expanding gases if the UXO are heated during recycling. Nonvented items requiring further processing will be identified and segregated from items that are already vented and have exposed fillers.

- Nonvented UXO, other than bomblets, will be processed in place. Bomblets will be processed in a designated bomblet processing area. The bomblet processing area will be

located in a previously-disturbed area that has been surveyed for the presence of UXO. The area will be clearly marked with flagging tape and signs. Processing of UXO will be accomplished by explosively cutting the case of the UXO to expose the filler.

- Small UXO, such as the bomblets, will be remotely placed in a cardboard pipe and cut in half by detonating a length of linear-shaped charge positioned above the UXO. Larger UXO, such as inert bomb bodies, will be vented by puncturing the case in at least three locations with a shaped charge penetrator.

- Following the successful demolition procedure, the UXO will be inspected to ensure that the inert filler is visible and that no hazardous components or fuzes remain. After successful venting and inspection, the item will be placed in the area designated for nonhazardous and vented scrap ready for off-site disposal.

3.2.2.3 Explosively Hazardous Unexploded Ordnance

Any UXO that is considered potentially-hazardous or explosively loaded shall be disposed by detonation. All UXO, except bomblets, will be detonated in place in order to avoid the potential hazards associated with moving the UXO. Bomblets will be moved remotely using the SNL Remote Telerobotic Vehicle for Intelligent Retrieval (RETRVIR) system. The bomblets will be moved to the designated bomblet disposal area for processing by detonation. When moving UXO remotely, all required precautions, such as evacuation of all personnel to the determined safe distance, will be taken in preparation for a possible unplanned detonation. Procedures ITLV-TTR-004 and ITLV-TTR-005 shall be followed when conducting disposal detonations.

Electric initiation of detonations will be used to allow the maximum degree of control and timing of the disposal detonation. Explosives will be stored in the magazines at Area 9 with the initiators and main charges stored in separate magazines. Site personnel will coordinate with the TTR Explosives Officer, or his designee, to ensure that all regulations specific to the facility are followed. Once detonated, remaining scrap ready for off-site disposal will be certified free of explosives by the UXO Supervisor according to the requirements of the *DOE Explosives Safety Manual* (DOE, 1994a) and turned over to REECo for off-site disposal.

3.2.3 Bomblet Pit

Ordnance removal will occur from the open pit, the three surface bomblet locations, and possibly the five subsurface anomalies. As mentioned in Section 2.1, the debris within the Bomblet Pit primarily consists of antipersonnel and antivehicular bomblets, bomblet dispenser clamshell sections, two MK84 2,000-lb bombs, and other assorted debris. Due to the quantity

of UXO in the Bomblet Pit, removal operations involving unprocessed UXO at the Bomblet Pit will be performed remotely.

3.2.3.1 Removal of Large Ordnance and Debris

Prior to bomblet removal activities, large ordnance will be processed in place. Subsequently, both the processed bombs and other large debris will be removed and segregated into recyclable and nonrecyclable materials piles. A 3,000-ft fragmentation hazard radius will be observed during the large UXO processing activities.

The two MK84 2,000-lb bombs are believed to be inert, but will be treated as explosively hazardous and vented in place using either linear- or conical-shaped charges as described in ITLV-TTR-004. Due to the size of the bombs, venting will be done in three locations on the bombs to ensure adequate exposure of the inert filler and to vent both booster wells.

A fragmentation hazard area and exclusion zone will be established per ITLV-TTR-004 prior to venting operations. Once vented, the bombs and other large debris will be removed from the open pit using remote methods (e.g., robotics or cables). The fragmentation hazard area for debris removal activities will be downscaled once the larger debris has been removed since the bomblets will be the only remaining UXO. The fragmentation radius for a bomblet is approximately 450 ft; however, a minimum safe distance of 900 ft will be observed as discussed in Section 3.2.1.1.

Once the UXO is vented, removal activities will be conducted with a backhoe and/or by manual labor. All processed UXO debris will be examined by a UXO specialist to ensure complete detonation of all explosive material prior to removal. All debris removed from the pit will be segregated into recyclable and nonrecyclable material piles. All piles will be placed in areas of previously disturbed soil.

3.2.3.2 Bomblet Removal

Due to their small size, variability of hazard, and large numbers, all bomblets in and around the Bomblet Pit, regardless of hazard status, will be removed using the RETRVIR. During bomblet removal operations, a 900-ft fragmentation hazard area will be observed. The bomblets will be removed from the pit one at a time and placed into a bomblet handling bin attached to the RETRVIR system using the RETRVIR's remote manipulator arm. The RETRVIR system will then transport the bomblets out of the pit and place them into prepared cardboard bomblet-handling tubes. The tubes will be 4 inches (in.) in diameter and 5 ft in

length with a 1/4-in. thick wall. The bomblet-handling tubes will be staged in groups of four (or more) tubes in a prepared processing location south of the Bomblet Pit. The processing area will have sandbags and berms to contain small fragments resulting from venting detonations (see Figures 2-1, 3-2, and ITLV-TTR-004, Section 5.1.5).

The RETRVIR system is operated via a radio communications link with a remote vehicle-mounted command post. The command post contains a sophisticated computer system that integrates with on-board computer systems on the RETRVIR vehicle to provide real-time viewing of remote operations and computerized efficient movement of the RETRVIR system and its various subsystems (e.g., the manipulator arm). The command post will be stationed outside the fragmentation hazard area, and all associated personnel will remain outside the fragmentation hazard area during UXO handling operations conducted with the RETRVIR system. The command-post vehicle will remain unmanned during all explosive UXO processing activities.

There are two identified antivehicular bomblets that are too large to fit into the 4-in. diameter bomblet-handling tubes. These two antivehicular bomblets, and any others identified during bomblet removal operations, will be detonated in place.

Once a set of bomblet-handling tubes has been filled (approximately 60 to 80 bomblets), the linear-shaped charges attached to the inside of the tubes will be detonated. After venting is complete, each processed bomblet will be inspected to ensure that the venting was complete. Any fuzes remaining intact will be removed with a pair of tongs and placed in a closed metal container for subsequent disposal by flashing (see ITLV-TTR-004, Section 5.4.5).

Once the UXO is processed, the site will be inspected by UXO specialists, any remaining hazards removed, and scrap removal activities conducted with a backhoe and/or by manual labor. All processed UXO debris will be examined by a UXO specialist to ensure complete detonation of all explosive material prior to removal. All debris removed from the pit will be segregated into recyclable and nonrecyclable material piles in areas of previously disturbed soil. Once the inspection and scrap removal is complete, the next bomblet processing pad will be installed and RETRVIR will recommence bomblet removal. This sequence of operations will be repeated until all of the bomblets have been processed.

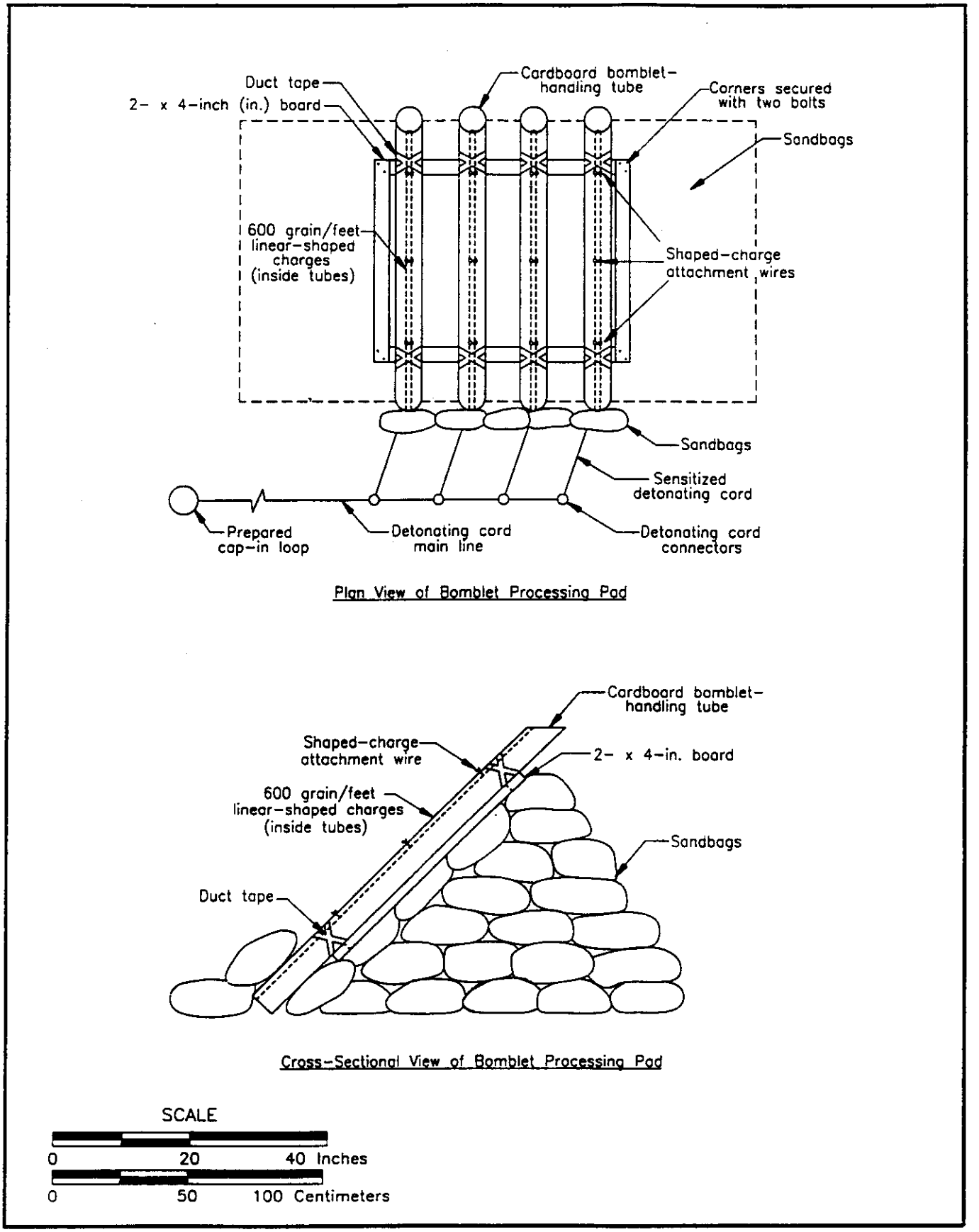

Figure 3-2
Bomblet Processing Pad Design

3.2.3.3 Excavation and Removal of Buried Objects

Excavation will be required to remove the three known large anomalies northwest of the Bomblet Pit and the two smaller anomalies south and east of the pit (Figure 2-1), discovered during a surface geophysical survey in 1993 (IT, 1994). These anomalies are expected to contain additional buried bomblets. The nature of the anomalies will be determined by excavation followed by visual identification.

3.2.3.3.1 Anomaly Detection and Location

The exact location of the anomalies will be determined by using a Foerster Ferex MK26 Ordnance Locator to locate their outer boundaries. The outer boundaries will be marked using pin flags and flagging tape.

The Foerster Ferex Ordnance Locator is a geophysical instrument used for subsurface ordnance location by U.S. Military Explosive Ordnance Disposal (EOD) forces. The Foerster Ferex Ordnance Locator is a hand-held unit that uses two fluxgate magnetometers, aligned and mounted a fixed distance apart to detect changes in the earth's ambient magnetic field caused by ferrous metal or disturbances caused by soil conditions. Both an audio and metered signal are provided to the operator.

A Schonstedt Instrument Company GA-52C magnetometer will also be available on site for use by the UXO specialists during excavation operations. The Schonstedt GA-52C magnetometer is also a dual fluxgate magnetometer and operates on the same principle as the Foerster Ferex Ordnance Locator. The Schonstedt GA-52C will be used as an inexpensive and highly portable magnetometer to quickly screen surface and near-surface areas for ferrous content while performing excavations at the bomblet pit.

3.2.3.3.2 Subsurface Anomaly Investigation and Excavation

Excavation of the anomalies themselves will be accomplished using manual and/or mechanical techniques. Mechanical excavation will be initiated by the RETRVIR system at the location of the anomaly. If successful, the RETRVIR system will fully excavate the anomaly. If the RETRVIR system is unable to excavate the anomaly, a backhoe will be used to excavate a trench two feet outside the boundary of an anomaly and continue until the excavated area has reached a depth below the top of the anomaly, as determined by frequent inspection with the magnetometer.

Attempts to remove the remaining two feet of earth separating the anomaly from the mechanically-excavated area will be made using the RETRVIR system first. If RETRVIR is unsuccessful, then the remaining earth will be removed using manual excavation techniques. Based on geophysical studies, the anomalies are suspected to be relatively shallow. The excavation will be sloped in accordance with OSHA (Title 29 CFR Part 1926, Subpart P, Excavations) prior to being entered by the excavation team. All personnel expected to enter an excavation or trench will be properly trained in excavation and trenching safety per OSHA requirements. The excavation team, consisting of two UXO specialists, will enter the excavation and carefully remove the earth separating them from the anomaly while frequently checking the area with the magnetometer to determine their proximity to the anomaly.

Using progressively smaller and more delicate tools to remove the soil as they get nearer to the anomaly, the excavation team will expose the contents of the anomaly in the wall of the excavation for inspection and identification without moving or disturbing its contents. Once identified, the contents of the anomaly will either be processed in place or remotely removed (as discussed in Section 3.2.2) to a processing area and processed.

3.2.4 Five Points Landfill

Removal activities at Five Points Landfill will consists of surface debris removal and segregation and the venting of at least one observed UXO. Refer to Section 2.3 for a complete description of items located in Five Points Landfill.

The UXO will be vented in place using either linear- or conical-shaped charges (see ITLV-TTR-004). Due to the size of the UXO, it will be vented in at least three locations to ensure adequate exposure of the inert filling. Once vented, the UXO will be inspected to verify that adequate venting has occurred and that it can safely be removed from the pit.

Once the UXO is vented, removal activities will be conducted with a backhoe and/or by manual labor. All processed UXO debris will be examined by a UXO specialist to ensure complete detonation of all explosive material prior to removal. All debris removed from the pit will be segregated into recyclable and nonrecyclable material piles. All piles will be placed in areas of previously disturbed soil.

3.2.5 Roller Coaster Sanitary Sewage Lagoons

Removal activities at the Roller Coaster Sanitary Sewage Lagoons site will occur at the two sewage lagoons and one ancillary pit. As mentioned in Section 2.2, the debris within the

lagoons and pit is mainly aircraft targets made of 55-gallon drums welded together and construction debris. Unsafe UXO that is encountered during removal activities will be vented in place using either linear- or conical-shaped charges, as mentioned above.

Once the UXO is vented, removal activities will be conducted with a backhoe and/or by manual labor. All processed UXO debris will be examined by a UXO specialist to ensure complete detonation of all explosive material prior to removal. All debris removed from the pit will be segregated into recyclable and nonrecyclable materials piles. All piles will be placed in areas of previously disturbed soil.

3.2.6 Area 9 Landfill

Removal activities will occur at the open pit in the Area 9 Landfill. As mentioned in Section 2.4, the pit contains mostly rocket booster parts, 55-gal drums, and construction debris. There are two 155-mm artillery rounds that appear to be unfuzed. The two 155-mm artillery rounds will be vented in place in the pit and then removed from the pit by hand. The artillery rounds will be vented using either linear- or conical-shaped charges. After venting, the artillery rounds will be inspected to verify that complete venting occurred. The vented rounds will then be placed in the predesignated scrap storage area (see Figure 2-4)

Once the UXO is vented, removal activities will be conducted with a backhoe and/or by manual labor. All processed UXO debris will be examined by a UXO specialist to ensure complete detonation of all explosive material prior to removal. All debris removed from the pit will be segregated into recyclable and nonrecyclable materials piles. All piles will be placed in areas of previously disturbed soil.

3.2.7 Area 9 Construction Debris Disposal Area

The Area 9 Construction Debris Disposal Area largely contains construction debris, as described in Section 2.5. There is one MK84 2,000-lb bomb with its inert filler exposed and several inert 20-lb practice bombs lying at the eastern edge of the construction debris pile.

The MK84 2,000-lb bomb may require additional venting if the opening in the bomb does not provide adequate exposure of the inert filler. A similar decision could be made for the 20-lb practice bombs. Venting will be performed in place using either linear- or conical-shaped charges. Once vented, the bombs will be moved to a scrap metal pile.

Once the UXO is vented, removal activities will be conducted with a backhoe and/or by manual labor. All processed UXO debris will be examined by a UXO specialist to ensure complete detonation of all explosive material prior to removal. All debris removed from the pit will be segregated into recyclable and nonrecyclable materials piles. All piles will be placed in areas of previously disturbed soil.

3.3 Other Activities

3.3.1 Ordnance Scrap Removal

Once processed and/or determined to be safe, all ordnance will be rendered into scrap by REECo through the use of a cutting torch or other means if processing has not accomplished this objective. Prior to being torch cut, the scrap will be certified free of explosives by the UXO supervisor according to the requirements of the *DOE Explosives Safety Manual* (i.e., XXXXX [5X] Rule, DOE, 1994a) or will be further processed (e.g., flashing) to meet these requirements (see ITLV-TTR-004, Section 5.4.5). Flashing will only be conducted under an appropriate open-burning permit, which has been received from the NDEP (NDEP, 1994).

3.3.2 Non-Ordnance Debris Inspection and Removal

After the removal of the vented bombs from each site, the other nonhazardous debris at the sites will be manually removed and segregated into recyclable and nonrecyclable materials piles. These materials will also be inspected by the UXO specialist prior to removal to ensure that they are not UXO or will not effect any UXO not previously visible.

Much of the debris at each of the sites consists of nonordnance construction debris, such as wooden pallets, target drums, steel ducting, concrete, and paper. While ordnance processing is not required to handle this type of solid waste, the proximity of ordnance at each of the sites requires that waste removal be performed under the direction of the UXO specialists. Nonordnance debris will be staged separately from ordnance and segregated into recyclable and nonrecyclable materials piles. Once UXO scrap has been inspected by the UXO specialist to ensure that no explosive materials remain, REECo will process the UXO scrap into unrecognizable metal scrap using a cutting torch. Ordnance and nonordnance debris ready for off-site disposal as scrap will be turned over to REECo for off-site disposal. REECo will be responsible for loading the recyclable materials, as well as hauling any non-recyclable debris from the sites to the Area 10 landfill for disposal.

3.3.3 Hazardous or Radioactive Waste Management

Through visual observation of site contents and recorded and reported history of site uses, it is not expected that hazardous or radioactive wastes will be produced during the VCA. However, if these wastes are produced or discovered, the materials will be containerized, as appropriate, and stored on site for later disposition in accordance with RCRA Corrective Action requirements.

3.4 Photographic and Video Records

Photographic logs of site activities will be maintained throughout the project. Specifically, photos will be taken prior to the beginning of activities, at the beginning and end of significant site activities, and throughout the project in sufficient quantity to document the complete removal of UXO from the sites as planned and to document the success of the different methods to be utilized for the project. Video recording of the activities, particularly those involving the RETRVIR system, may also be conducted throughout the site activities. All photographic and video information collected will be managed according to the Data Management Plan, Section 5.0 of this VCA Plan.

3.5 Activities Reporting

Upon the completion of each day's operations and prior to the beginning of the next day's activities, a summary of the daily activities will be supplied in person or by facsimile to the DOE Subproject Manager. The daily summary will include a brief description of the day's activities and activities scheduled for the next day.

Upon completion of all the removal activities and later closure activities, DOE/NV will provide to NDEP a closure report, which will include documentation that all UXO was removed in accordance with this plan. The report will include the following:

- Inventory of all removed UXO
- Final disposition of the UXO
- Description of removal activities
- Number, time, and exact location of all detonations
- Radiological screening results from UXO removal activities
- Resolution of any permitting compliance issues encountered
- Any required certifications or manifests.

3.6 Operational Safety Requirements

The following conditions or requirements must be met in order for UXO operations to be conducted:

- All persons expected to work in close proximity to the UXO and processing explosive will be trained in accordance with all applicable requirements (see ITLV-TTR-004 and ITLV-TTR-005).

- All remote activities (e.g., remote UXO handling or detonation of processing explosives) shall be conducted outside the fragmentation hazard radius as determined from the net explosive weight (see the VCA Work Plan, Section 3.2.1.1, or ITLV-TTR-004, Section 5.1.1, for information on calculating the fragmentation hazard radius).

- The exclusion zone will be established at a radius of 3,000 feet from the work area and will be enforced for all nonproject personnel.

- The UXO team will maintain radio contact with the DOE Subproject Manager and the IT Subproject Manager.

- The lightning threat warning system supplied by SNL must be operable and indicate that atmospheric conditions are not conducive to lightning strike as discussed in ITLV-TTR-005.

- In order for a UXO to be moved, it must be both positively identified and known to be safe to be moved. Any UXO that does not meet those two criteria must be moved remotely without exposing any personnel to the theoretical fragmentation range in the event of a high-order detonation.

- Explosive storage and transportation will be conducted in accordance with the requirements of ITLV-TTR-005. Explosives will be stored in existing storage structures at TTR.

- Demolition procedures will be conducted in accordance with ITLV-TTR-004 and ITLV-TTR-005. These procedures include approved guidance on equipment and procedures for initiating explosives.

4.0 Quality Assurance Project Plan

DOE Order 5700.6C, Quality Assurance, requires that all activities are performed in accordance with approved plans and procedures. Contractor-specific procedures will comply with the applicable requirements of DOE Orders, SOPs, and project planning documents. All deviations from approved procedures will be documented and approved prior to implementation.

This Quality Assurance Project Plan (QAPjP) describes the measures that will be taken to ensure that the activities conducted during the VCA at the TTR UXO sites (see Sections 1.0, 2.0, and 3.0 of this VCA Work Plan) are in compliance with applicable requirements and achieve project objectives. This plan pertains to all activities related to the VCA. The organization of this plan reflects the format of DOE Order 5700.6C, Quality Assurance. This format allows for the inclusion of DOE requirements that are in addition to U.S. Environmental Protection Agency (EPA) and state of Nevada guidance. This QAPjP covers three major areas: Management, Performance, and Assessment. Management entails the planning and preparation, including permitting, required for the successful completion of the subproject mission. Additionally, this section incorporates quality improvement processes to detect and prevent quality problems. Performance sets the requirements and procedures to be implemented to ensure that activities are conducted in accordance with approved work instructions, including discussion of permitting and environmental compliance requirements and procedures. Assessment provides a feedback loop to subproject management whereby subproject management can use the information obtained to assess and, if necessary, modify a system or process to ensure the quality of the product.

4.1 Organizations and Responsibilities

Subproject management shall be provided throughout the course of the VCA to direct and document subproject activities and to secure the data and evaluations generated. A comprehensive roles and responsibilities list is detailed in the TTR Subproject Management Plan. A synopsis of roles and responsibilities follows.

4.1.1 Environmental Restoration Project Manager

The DOE Nevada Environmental Restoration Project (NV ERP) Manager has technical oversight and management responsibilities for all subprojects within the NV ERP. The NV ERP Manager is the senior management official responsible for ensuring that this QAPjP

is established and implemented and that opportunities for improvement are identified and incorporated into the activities of the TTR subproject.

4.1.2 DOE Nevada Operations Office Subproject Manager

The DOE/NV Subproject Manager reports directly to and is the prime point of contact with the NV ERP Manager. The DOE/NV Subproject Manager has day-to-day management responsibilities for technical, financial, and scheduling issues. The DOE/NV Subproject Manager will monitor contractor performance and manage subproject activities. At a minimum, the DOE/NV Subproject Manager shall

- Review, approve, and direct the implementation of subproject plans
- Participate in the organization and planning of activities in order to consistently meet project quality objectives
- Disseminate pertinent information from DOE/NV to subproject participants
- Review and approve variances to subproject documents
- Notify the NV ERP Manager, the DOE/NV Quality Assurance Coordinator (QAC), and other involved personnel of significant conditions adverse to quality or any identified trends
- Monitor the quality-achieving activities of participating organizations and provide direction and guidance for improvement
- Perform audits and surveillances to verify compliance with applicable requirements.

4.1.3 DOE Nevada Operations Office Quality Assurance Coordinator

The DOE/NV QAC reports to the NV ERP Manager and has a direct line of communication with the DOE/NV Subproject Manager. The DOE/NV QAC is responsible for assisting subproject management in the development, verification, and implementation of this QAPjP and will provide the overall direction of the QA function. At a minimum, the DOE/NV QAC shall

- Identify and respond to quality assurance and quality control (QA/QC) needs, resolve problems, and provide guidance or assistance
- Review and evaluate quality-related changes to documents that contain QA criteria
- Verify that appropriate corrective actions are taken for nonconformances

- Notify the NV ERP Manager, the DOE/NV Subproject Manager, and other involved personnel of significant conditions adverse to quality or any adverse trends.

4.1.4 Tonopah Test Range Subproject Participants

All participants in the TTR subproject are responsible for developing procedures and for ensuring that all work is performed in accordance with applicable federal, state, local, and DOE/NV regulations; this QAPjP; and approved subproject plans and procedures. To fulfill responsibilities specific to QA, the subproject participants shall, at a minimum:

- Report to the DOE/NV Subproject Manager on schedule, cost, technical execution, and quality achievement of task-order activities
- Ensure that proper resources and budget are provided for QA personnel and that QA activities are integrated into subproject activities
- Evaluate task-order activities to ensure that planning-document requirements are implemented
- Develop and implement procedures and instructions that govern TTR subproject activities
- Ensure that work is technically sound, of acceptable quality, and consistent with subproject objectives
- Evaluate the qualifications of personnel and identify and provide additional training, as needed
- Ensure that personnel are trained and qualified to consistently achieve initial proficiency, maintain proficiency, and adapt to changes in technology, methods, or job responsibilities
- Provide orientation and any necessary activity-specific training to field personnel on the requirements of this QAPjP and other subproject plans prior to the start of work
- Perform audits and surveillances to verify compliance with applicable requirements
- Identify deficient areas and implement effective corrective actions for quality problems
- Notify the DOE/NV Subproject Manager and other involved personnel of significant conditions adverse to quality or any adverse trends
- Verify that appropriate corrective actions are taken for nonconformances
- Track and trend nonconformances for conditions adverse to quality

- Ensure that all measurement and test equipment (M&TE) is calibrated and that calibration is documented prior to use

- Establish and maintain a records management system.

4.2 Reports to Management

Fundamental to the success of this VCA is the active participation of management in the TTR subproject. Management will be aware of subproject activities, as applicable, and will participate in the development, review, and operation of the subproject. Management will be informed of quality-related activities through the receipt, review, and/or approval of the following:

- Subproject-specific QA plans and procedures
- Audit schedules
- Postaudit reports and audit closures
- Corrective action and schedules
- Corrective action requests
- Nonconformance reports
- Surveillance reports
- Management assessments.

4.3 Readiness Reviews

Readiness reviews will verify that all planning documents and systems are in place for the successful and efficient accomplishment of the mission. The readiness review will be conducted in accordance with DOE Order 5700.6C, Quality Assurance, Attachment 1, Section A.1.J. IT will perform the readiness review and coordinate the activities with DOE/NV and the TTR Range Safety Officer.

Readiness reviews will be performed prior to the start of any major scheduled activity and prior to restarting work following Stop Work Orders (SWOs) to verify and document that subproject planning and prerequisites have been satisfactorily completed. These reviews will include subproject management, health and safety, and QA personnel. At a minimum, readiness reviews will verify that

- The scope of work is compatible with subproject objectives

- The planned work is appropriate to meet objectives

- Work instructions have been reviewed for adequacy and appropriateness, formally approved, and issued to personnel who will be performing the work

- Proper resources (e.g., personnel, equipment, and materials) have been identified and are available
- Assigned personnel have read the applicable work instructions and have been trained and qualified
- Internal and external interfaces have been defined
- Proper work authorizations and permits have been obtained
- The calibration of all M&TE is current.

4.4 Stop Work Order

An SWO will be initiated when a condition adverse to quality is identified that, if allowed to continue, would result in personal injury, damage to DOE equipment or property, or have an adverse impact on mission accomplishment, budget, or schedule. If imminent danger exists, an SWO may be verbally imposed. An SWO may be limited to a specific activity, item, or design, or it may be broad in scope and encompass all activities relating to the deficiency or violation.

4.4.1 Stop Work Order Identification

All individuals are empowered with the authority to stop work when continuing work may result in the following

- Failure to adequately control the processing, delivery, installation, modification, or operation of a nonconforming item
- Serious failure or breakdown of the QA program
- Significant hazard to those items or activities that are important to health and safety, the environment, or the mission of the project.

Resumption of work will begin only upon completion of the necessary actions specified on the SWO and with the approval of the DOE/NV Subproject Manager. If the SWO involves a health and safety issue, the approval of the health and safety representative is also required.

4.4.2 Stop Work Order Process

In accordance with DOE/NV Order 5700.6C, all subproject participants will develop and implement procedures governing SWOs. These procedures will clearly delineate the reporting

responsibilities and lines of communication. At a minimum, the procedures will include the following:

- Immediate verbal notification to the supervisor or manager of the responsible organization of the intent to issue an SWO
- Verbal notification of DOE and contractor subproject management when an SWO has been verbally imposed
- A written SWO issued to the responsible organization.

4.5 Personnel Training and Qualifications

Personnel assigned to the TTR subproject will be trained and qualified to perform the tasks to which they are assigned. All contractors and support agencies will establish minimum education, experience, and training requirements for activities to be performed. Objective evidence of qualifications may include academic credentials, personal resumes, registrations and/or certifications, licenses, and training records.

Contractor subproject management will be responsible for providing personnel with the instructions necessary to perform quality-related activities. Training may take the form of orientation and/or indoctrination, formal classroom training, or on-the-job training. This training will include contractual and regulatory requirements, scopes of work, QA/QC compliance requirements, and applicable work instructions. On-the-job training will be conducted and documented by personnel qualified to perform the task. Any work performed by a trainee will be under the supervision of a qualified individual. All TTR subproject participants will be responsible for maintaining personnel qualification and training records as quality documents.

All site personnel involved in this project shall have completed the OSHA training course for Hazardous Waste Site Workers in accordance with Title 29 CFR §1910.120 and current refresher training. Any personnel with supervisory responsibility on the site will have obtained OSHA Site Supervisor training. All personnel expected to enter an excavation or trench will be properly trained per OSHA requirements in excavation safety (see Title 29 CFR Part 1926, Subpart P, Excavation). In addition, a minimum of two site workers will be trained and certified for Red Cross First Aid and Cardiopulmonary Resuscitation and will be present on site at all times that work is proceeding.

All site UXO specialists shall be graduates of the U.S. Naval School of Explosive Ordnance Disposal at Indian Head, Maryland, or Elgin Air Force Base, Florida.

4.6 Quality Improvement

Processes will be established that prevent, as well as detect and correct, problems that adversely affect quality during all phases of technical and management activities. Personnel at all levels are encouraged to identify process improvement opportunities and problems and offer solutions to those problems. The following sections identify processes that, at a minimum, will be implemented.

4.6.1 Nonconformance

A nonconformance is a deficiency in characteristic, documentation, or procedure that renders the quality of an item or activity unacceptable or indeterminate (ASME, 1989).

4.6.1.1 Nonconformance Reporting

Field participants will implement approved procedures that are in compliance with DOE/NV requirements for the identification, documentation, and resolution of nonconforming conditions. Field nonconformances for this subproject will be reported in accordance with DOE/NV Orders, using the approved DOE/NV Nonconformance Report (NCR) Form (Figure 4-1). Copies of all NCRs and any related documents and/or correspondence will be transmitted to an organization's internal QA department or representative.

4.6.1.2 Nonconformance Trends

Reviews and trend analyses of NCRs will be performed to identify any possible adverse trends. At a minimum, adverse trends are considered to be

- Repetitive nonconformances for which previous corrective measures have proven ineffective
- Nonconformances that appear to be related and represent a programmatic or system breakdown or loss of confidence in the integrity or effectiveness of the item or activity.
- Indication that a root cause may have generic implication to a broad group of possible deficiencies.

The reviews of NCRs will be documented in a trend report. Adverse trends will be brought to the attention of the appropriate contractor senior manager and the DOE/NV Subproject Manager. Adverse trends will be documented and reported in a corrective action request.

U. S. DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE

NONCONFORMANCE REPORT

INITIATOR

INITIATOR ORGANIZATION: (1)	NCR DATE: (2)	NCR NO.: (3)
RESPONSIBLE ORGANIZATION: (4)	LOCATION: (5)	

SPECIFICATION/DRAWING/PROCEDURE REQUIREMENT(s): (6)

DEFICIENCY: (7)

(8) INITIATOR: DATE:

PROPOSED DISPOSITION

DISPOSITION: (9)

TECHNICAL JUSTIFICATION: (10)

APPROXIMATE COST TO IMPLEMENT DISPOSITION: (11)	AUTHORIZED DISPOSITIONER: (12)

DISPOSITION CONCURRENCE/APPROVAL

USER: (13)	NTSO: (14)
(NAME/TITLE) (DATE)	(NAME/TITLE) (DATE)

DISPOSITION COMPLETION/NCR CLOSEOUT

DISPOSITIONING ACTIONS COMPLETED: (DATE)	NCR CLOSED: (16)
(15) VERIFIED BY (NAME/TITLE) (DATE)	(DATE)

DISTRIBUTION

Figure 4-1
Nonconformance Report Form

4.6.2 Corrective Action Request

A Corrective Action Request (CAR) will be used to identify and report significant conditions adverse to quality and to document the resolutions of such conditions. All TTR subproject participants are responsible for the development and implementation of approved procedures to govern the CAR process. These procedures will comply with the applicable requirements of DOE/NV Orders. A CAR will be initiated when a significant condition adverse to quality has been identified, i.e., demonstrated by one of the following conditions:

- The existence of conditions that, if left uncorrected, may possibly compromise the quality program or degrade the quality of an item
- An identified adverse trend
- A failure to respond or resolve deficiencies identified during audits and surveillances or documented on an NCR in a timely manner
- A significant programmatic breakdown of management controls or the QA Program
- The conduct of quality-affecting activities outside the scope of approved QA program plans or procedures.

The aforementioned conditions will be documented on a CAR, in accordance with internal procedures, and issued to the appropriate subproject management. When an external organization is involved, the CAR will be transmitted via a cover letter to the DOE/NV Subproject Manager. A CAR status log will be maintained by the Subproject participant conducting the VCA activities for the purpose of tracking open CARs.

4.7 Documents and Records

Systems and controls will be implemented for identifying, preparing, reviewing, approving, revising, collecting, indexing, filing, storing, maintaining, retrieving, distributing, and disposing pertinent quality documentation and records. These systems and controls will be applicable to all forms of documents and records.

4.7.1 Variances/Change Control

Variances (changes or modifications) to approved plans may be necessary in order to adjust an activity to actual field conditions or to revise programmatic methods of implementing subproject requirements. A system will be employed to ensure that variances are properly identified, documented, approved, and controlled. Variances will be approved by the DOE/NV Subproject Manager, the affected Contractor Subproject Manager, and Contractor

QA representative prior to implementation. Changes that impact cost will be in accordance with the DOE SOP-ERD-01-003, Change Control.

4.7.2 Document Review and Control

Documents will be reviewed, approved, and revised in accordance with prescribed processes and DOE SOP-ERD-01-002, Document Review and Coordination. The TTR subproject documents, as well as changes to documents, will be reviewed for quality requirements, technical adequacy, completeness, and accuracy prior to their approval and issuance.

A system or process for identifying and controlling documents will be implemented to ensure that the latest revision of a document is in use. Contractor subproject management will be responsible for ensuring that personnel who perform work are in possession of the most current version of the documents applicable to the activities being conducted.

4.8 Field Documentation

Field documentation will be of sufficient detail to facilitate the reconstruction of field activities. Field personnel will document activities on a daily activity report or log. Entries in the log will be made in indelible ink and will include the following:

- The subproject name
- The date and start time of each field activity
- Names and affiliations of field personnel
- The equipment used
- Calibration information
- A general description of the day's field activities, showing the sequence of events
- Problems encountered
- Changes or modifications to the approved activities plan
- Nonconformances and any corrective actions taken
- Weather conditions
- Field measurements or tests performed
- The number and type of UXO processed
- References to associated forms for details of each activity conducted
- The signature of the individual completing the report.

Subproject management or a designee will review the field-generated records for correctness. This review will be documented by an initial and date. Reviewed records will be maintained in the project files.

The maintenance of records will include provisions for retention, protection, preservation, traceability, accountability, and retrievability. Records will be maintained in accordance with DOE Order 1324.2A, Records Disposition.

4.9 Calibration

Measurement and test equipment that require calibration shall be uniquely identified by the manufacturer's serial number or a suitable assigned number. Whenever possible, the M&TE identification number will be permanently marked on the equipment. The calibration status will be identified on labels or stickers affixed to the instrument. These labels will include the current calibration date and the next calibration due date. When it is impractical to label M&TE due to size or configuration, calibration records traceable to the M&TE must include this information and be kept in close proximity to the equipment. M&TE to be used for this VCA include the following:

- Foerster Ferex Ordnance Locator (aka, MK 26 Ordnance Locator) - factory service-center calibrated prior to operations
- Schonstedt Instrument Company GA-52C magnetometer - factory calibrated
- Lightning Detection Equipment - existing system operated by SNL at TTR

If required, M&TE will be calibrated prior to use for the TTR subproject activities and at prescribed intervals thereafter. During M&TE usage, operational checks of the equipment will be performed to verify the equipment's continued accuracy and operational function. Calibrations of M&TE will be performed by trained and qualified personnel, approved external agencies, or the equipment manufacturer. Calibration will be performed in accordance with DOE/NV subproject-approved procedures or the manufacturer's recommendations. All periodic and operational calibrations will be documented and maintained in the subproject files. These record files will include, as applicable, M&TE calibration certificates and reference standard certifications. Calibration controls are not required for rulers, tapes, levels, and similar devices if normal commercial M&TE provides adequate accuracy.

4.9.1 Calibration Frequency

Measurement and test equipment will be calibrated at prescribed intervals. The frequency of periodic calibrations will be based on the manufacturer's recommendations, national standards of practice, equipment type and characteristics, and past experience. Operational calibrations

and/or source-response checks will be performed on the appropriate M&TE prior to the start of work and reestablished at prescribed intervals that have been predetermined and are instrument specific. During use, calibration and/or response checks will be performed and documented on the appropriate field form to verify that the M&TE function correctly.

4.9.2 Calibration Failure

Each individual user of M&TE is responsible for checking the calibration status of equipment to be used and confirming the acceptable calibration status prior to use. Equipment for which the periodic calibration period has expired, equipment that fails calibration, or equipment that becomes inoperable will be tagged "out-of-service" and, when possible, segregated to prevent inadvertent use. The M&TE will be repaired and/or recalibrated by the appropriate vendor, manufacturer, or qualified personnel prior to being returned to service. Results of activities performed using equipment that is found to be out of calibration will be evaluated for adverse affects. If the activity results are adversely affected, the evaluation will be documented as a nonconformance and the appropriate personnel will be notified.

4.9.3 Preventive Maintenance

Periodic preventive maintenance will be required for all field and laboratory equipment. Preventive maintenance schedules and practices will be developed for all M&TE on the project and documented throughout the life of the subproject. Information pertaining to the histories of equipment maintenance will be kept in individual logs or files for each instrument. Instrument manuals will be kept on file as references for equipment needs and repair. The frequency of preventive maintenance will be based on manufacturers' recommendations and the users' professional knowledge and experience.

4.10 Procurement

Items and services of a technical nature provided to the TTR subproject will be of a quality that meets the requirements of the subproject. Controls will be established to ensure that procured equipment and services meet or exceed specifications and that systems are in place to track items and confirm the delivery of procured items and services. Subproject participants will have a program in place, invoking the appropriate quality-related requirements of the contractor's QA program plans and procedures and this QAPjP, for the procurement of items and services. All procurement documents will be submitted to QA for review to ensure that the applicable quality-affecting requirements have been included. Quality assurance will initial and date the procurement documents to verify that the review has taken place.

Procurement documents will define the scope of work for the item or service being procured, specifications, and any documentation required. Technical requirements will either be directly included in the procurement documents or included by reference to specific drawings, specifications, procedures, regulations, or codes that describe the items or services to be furnished. Documentation required to provide evidence that items and services conform to quality standards will be identified in the procurement documents. The procurement documents will require that all purchased and rented M&TE be calibrated to national standards prior to acceptance and a calibration sticker affixed to the instrument. Calibration certification and instrument manufacturers' manuals will be available in subproject files for all M&TE.

If applicable, procurement documents will provide for free access to the subcontractors' facilities, including their subtier facilities, work areas, and records for surveillance, inspection, and audit to verify acceptability. Objective evidence of conformance to procurement requirements will be thoroughly evaluated. The authority to stop work, based on significant quality problems, will be clearly stated.

4.11 Inspection and Acceptance Testing

Inspections and acceptance testing will be accomplished in accordance with approved inspection documents and test procedures that reflect acceptance and performance criteria. Individuals performing inspections and acceptance testing will be independent of those who performed the work. The M&TE used in the performance of inspections or acceptance tests will be calibrated and properly maintained.

4.12 Management Assessment

Planned and periodic assessments will be conducted and will involve management at all levels. Management assessments will include the direct participation of senior management. The primary emphasis of management assessments is to evaluate the implementation of the integrated QA program and identify problems that hinder the achievement of objectives. Contractor management will conduct an assessment of the VCA at the conclusion of this activity and document this assessment in a Lessons Learned Report. The management assessment will focus on such issues as the following:

- Adequacy of implementation of the integrated QA program, with particular emphasis on quality improvement

- Existence of any management biases or organizational barriers that impede the improvement process
- Adequacy of the appraised organization's structure, staffing, and physical facilities
- Existence of effective training programs.

The results of the assessment will be documented in a final report and issued to the appropriate managers. Senior management has the primary responsibility to ensure the timely follow-up of corrective actions, including an evaluation of the effectiveness of management's actions. Results of the management assessment will be entered into a tracking system for the purposes of identifying trends and lessons learned.

4.13 Independent Assessments

Audits and/or surveillances may be performed to verify compliance with the QA and health and safety programs and to determine the effectiveness of their implementation. The focus of these assessments will be on improving items and processes. Subproject participants will have QA programs and procedures in place that satisfy the requirements of DOE/NV Order 700.6C for the conduct of independent assessments.

5.0 Data Management Plan

5.1 Introduction

This Data Management Plan (DMP) describes the system that will be implemented to provide a centralized, consistent, accurate, and flexible data repository for the TTR Subproject. The purpose of this DMP is to establish the procedures to be used to provide effective management of data generated during the planned activities in accordance with the TTR QAPjP. The TTR Subproject will employ the NV ERP Environmental Resource Management Applications (ERMA) system.

5.1.1 Data Management Role

Environmental data have become key products of environmental studies. Historical data must be integrated with data generated by new investigations to allow complete analysis and decisions to be performed. Data management systems are an essential component for all subprojects.

5.1.2 Data Volume

On large sites like the TTR, the large volume of data generated during field activities, investigations, and data analysis becomes a management issue. The quantity and types of data collected will grow rapidly with the number of project-related activities performed. Types of data to be collected are as follows:

- Ecological data (e.g., wetlands/flood plains, cultural resources, or threatened/endangered species)
- Historical data, such as aerial photographs, maps, and reports
- Field logs, including geophysical survey logs, calibration logs, photographs and photographic logs, and other field notes
- Health and safety records
- QA audit data
- Site characterization results (e.g., geology or hydrogeology)
- Risk or safety assessment results.

5.1.3 Compliance with Regulatory Controls

Tonopah Test Range data generated in accordance with the RFI Work Plan are historically significant and necessary for the RCRA process and subsequent investigations to ensure compliance with federal and state hazardous waste and environmental protection laws and regulations. Maintenance of one central data repository helps ensure that TTR environmental data are accurately and completely maintained for the life of the subproject and that appropriate data are accessible for multiple, concurrent evaluation efforts.

5.2 Data Management Life Cycle

The data management system was constructed to manage data during each phase of the life cycle. Guidelines for data transfer and handling procedures will be strictly followed.

5.2.1 Data Repository

Data are loaded into the data-base repository using ERMA software. This data base is the heart of the environmental data management system. Data entry in ERMA is accomplished either electronically or through manual data entry. Hard copies of the data, data that are not amenable to electronic format (e.g., photographs; historical documents, information, or data; or field logs), and original field data will be stored in the generator's project-specific files and will be available to DOE on request.

5.2.2 Data Analysis

Data are retrieved or accessed to support a wide range of activities, including modeling, statistics, mapping and visual displays, and summary data tables. Some of the data analyses include an evaluation of existing data and an assessment of their usability for current applications.

5.2.3 Data Archival and Storage

Periodic back-up tapes will be made of the data base and stored in a remote location. In addition, the electronic data base will be permanently archived in a neutral ASCII file format. All project data that cannot be converted into computerized format (e.g., photographs; historical documents, information, or data; or field logs) will be inventoried and assigned filing codes. These data will be stored and archived in the project-specific file room at the generating contractor's office.

5.2.4 Document Control and Inventory

A Document Control Officer (DCO) will be appointed by the contractor to monitor the files. The DCO will inventory, file, and track the locations of all project documents, with the exception of health and safety records for the field team. Health and safety records will be maintained by the contractor Health and Safety Officer.

5.3 Environmental Resource Management Applications System Overview

The ERMA system will be used for data-base management and environmental modeling. The core of the system is the ORACLE™ Relational Data Base Management System. Users do not have to be familiar with a special computer language or data-base management software to enter data, execute queries, or produce reports and graphics. Most data-processing activities (other than entering data) are presented as selections from menu options. Data entry into ERMA is accomplished either electronically or through a series of standard forms. For example, data can be entered manually into a computer in the field, then transferred into the main computer via modem or a floppy disk. Standard tabular reports are available for presenting analytical, water-level, and field data. ERMA also includes software for the purposes of generating lithologic logs, XY plots, cross sections, contour maps, and other graphics. With minimum effort, ERMA can be expanded to accommodate the addition of new data entry forms, standard reports, and menus, and a data-base management system specifically tailored to satisfy all job-specific data processing requirements can be developed.

ERMA offers a number of tools and features for data processing. Forms are available for entering geotechnical, sampling, analytical, and geographic data. Output options allow the user to produce tabular reports, XY plots, contour maps, and lithologic logs; retrieve information on chemical constituents; and display sampling and analytical information on the screen. Among the features and capabilities ERMA offers are the following:

- A reference chemical data base containing Chemical Abstract Service numbers, physical and chemical properties, and regulatory and advisory limits for over 2,500 substances
- Unlimited data tables for entering field and analytical data
- The capability to import electronically transmitted analytical data directly into the data base from floppy disks or other electronic media
- A library of standard reports for presenting water-level measurements, field data, and analytical results
- The capability to generate ad hoc reports.

5.4 Procedures for Data Transmittal, Storage, and Retrieval

This section addresses the procedures for transmitting data between the contractor and DOE/NV. All data transmittal, storage, and retrieval will be done in accordance with the DOE/NV procedures and appropriate contracts.

5.4.1 Data Transmittal

During the execution of the TTR investigations, data will be transmitted using computer media and printed reports, maps, and correspondence.

All official data transmittals, including computer files sent via modem, will be documented by a letter of transmittal naming the sender, the recipient, and the type of data being transmitted.

5.4.2 Data Storage

Data will be stored using computer media and printed matter. Computer disks, tapes, or cassettes will be backed up to guard against loss from media failure. In addition, measures will be taken, as needed, to prevent the introduction of viruses. Indexes to the content and location of computer media and files associated with the project will be maintained during entering or manipulating the computer data.

Printed matter, such as reports, maps, and other documents, will be stored in file cabinets or map racks at the contractor's office. Photographs will be stored in a manner that prevents their deterioration.

All final reports will be provided in hard-copy and diskette format to the DOE/NV.

5.4.3 Data Retrieval

To aid in the data retrieval, indexes to the content and location of computer media and files associated with the subproject will be maintained by the contractor at all times, including while entering or manipulating computer data. In addition, the DCO will maintain an index of the location and contents of printed files.

6.0 Project Management Plan

Subproject management will be provided throughout the course of the VCA to direct and document subproject activities and to secure any data or evaluations generated. This plan defines organizational structure, responsibilities of the various participants, and project tracking and reporting procedures.

6.1 Project Organization

This section describes the responsibilities of key individuals within the project organization.

6.1.1 DOE Nevada Operations Office

6.1.1.1 DOE Nevada Operations Office Environmental Restoration Project Manager

The NV ERP Manager has technical oversight and management responsibilities for all subprojects within the overall NV ERP. Responsibilities include the following:

- Coordinate all division staff and other internal groups, such as QA, Health and Safety, Health Physics, Waste Management, and other DOE/NV groups
- Determine the scopes of work for TTR VCA participants
- Review and approve all subproject deliverables to the NDEP
- Secure subproject funding from DOE Headquarters through the submission of an environmental baseline, Activity Data Sheets, and other DOE programmatic functions.

6.1.1.2 DOE Nevada Operations Office Director of Environmental Protection Division

The DOE/NV Director of Environmental Protection Division or designee serves as the point of contact for interactions with the NDEP, EPA Region 9, and local concerns about DOE matters related to environmental restoration issues at the TTR. Responsibilities include the following:

- Coordination of all documents, approvals, reports, and other correspondence related to the TTR VCA transmitted to the NDEP
- Direct responsibility for National Environmental Policy Act (NEPA) compliance with regard to TTR VCA activities.

6.1.1.3 DOE Nevada Operations Office Environmental Restoration Project Subproject Manager

The NV ERP Subproject Manager is the primary point of contact with the DOE/NV during this subproject. The Subproject Manager is responsible for the following:

- Primary direction of the TTR VCA participants
- Compliance with all QA, health and safety, and regulatory requirements
- Oversight of procurement and supervision of contractor services
- Review and approval of any subproject-specific plans, specifications, cost estimates, and reports
- Tracking subproject costs incurred by contractors
- Performing surveillances
- Contact with media and all other visitors
- Determination of the appropriateness of reporting nonconformances and changes to the DOE/NV, appropriate documentation of any reporting, and submittal of change orders for DOE/NV approval.

6.1.2 DOE Albuquerque Operations Office - Kirtland Area Office Subproject Manager

The DOE Albuquerque Operations Office, Kirtland Area Office (DOE/AL - KAO), Subproject Manager is responsible for oversight and consultation of TTR VCA activities. The TTR is currently an operational responsibility of KAO, although the Interim Agreement between DOE/NV and DOE/AL has transferred primary responsibility for environmental restoration activities to DOE/NV. Responsibilities include the following:

- Review, comment, and concurrence of Work Plan and other TTR VCA documents, in accordance with the Interim Agreement between DOE/NV and DOE/AL
- Direction of the KAO oversight contractor (SNL) to interface with the DOE/NV Subproject Manager and the IT Subproject Manager in the review and comment of TTR VCA documents
- Direction of the TTR Site Manager to assist in the scheduling and coordination of VCA field efforts at the TTR with range operations personnel.

6.1.3 IT Corporation

IT will be responsible for explosive operations and safety. This responsibility includes the handling, processing, and free-from-explosives certification of inert UXO and the disposal of explosive items. This work will be done by qualified UXO specialists, all of which are former military EOD technicians and graduates of the U.S. Naval School of EOD in Indian Head, Maryland.

6.1.3.1 IT Corporation Subproject Manager

The IT Subproject Manager is responsible for the overall coordination of efforts at the site and other duties as assigned by the DOE/NV Subproject Manager. Responsibilities include the following:

- Provide resources for the implementation of the VCA Work Plan
- Coordinate project budgets and schedules to meet requirements of the VCA Work Plan
- Conduct activities in compliance with all appropriate state, federal, and local regulations and DOE Orders
- Review and comply with all project-specific plans and procedures
- Coordinate with SNL, REECo, and other VCA participants
- Provide necessary status reports to the DOE/NV Subproject Manager regarding cost, schedules, and technical issues
- Directly supervise the task managers and subcontractors
- Directly supervise the IT UXO supervisor.

6.1.3.2 IT Corporation Unexploded Ordnance Supervisor

The UXO Supervisor assigned to the project will be responsible for determining the hazard presented by each UXO. Qualified UXO specialists may also be delegated the authority to identify UXO and determine the hazard presented by UXO during routine site operations. But, any item that is not easily and positively identifiable must be brought to the attention of the UXO Supervisor for the determination of the procedures to be used for handling that specific UXO prior to any action being taken. The UXO Supervisor will also act as the site Safety Officer during site operations and will maintain radio contact with the DOE Subproject Manager and IT Subproject Manager. The UXO Supervisor will be supported by a Health and Safety Technician who will perform industrial hygiene monitoring and other support

functions. The UXO Supervisor will also interface with the TTR Range Safety Officer on both UXO identification issues and site safety issues.

The UXO personnel will be qualified and experienced in the utilization of the MK26 Foerster Ferex ordnance locators and Schonstedt Instrument Company heli-flux magnetometers.

6.1.4 Reynolds Electrical & Engineering Co., Inc.

REECo will be responsible for all radiological safety issues, including radiological screening of items removed from the sites to ensure they are fit for off-site disposal under the requirements of the *DOE Radiological Control Manual* (DOE, 1994c). REECo will also prepare for disposal and dispose all scrap items after they are inspected and certified as free from explosives by IT. Once UXO scrap has been inspected by the UXO specialist, REECo will process the UXO scrap into unrecognizable metal scrap using a cutting torch. REECo will be responsible for loading the recyclable materials, as well as hauling any nonrecyclable debris from the sites to the Area 10 landfill for disposal.

6.2 Voluntary Corrective Action Activities Schedule

These sites, along with ancillary staging areas, have been surveyed for threatened and endangered species and cultural resources with respect to NEPA. A project readiness review will be conducted in accordance with DOE Order 5700.6C, Quality Assurance.

Voluntary Corrective Action begins when activities described in Section 3.0 of this plan begin. These VCA activities are expected to be completed within 39 days. The expected closure schedule by completion dates is as follows:

- Day 1: Mobilize to TTR
- Day 2: Conduct Readiness Review; begin site preparation at the Bomblet Pit
- Day 10: Complete processing of large UXO, removal of processed UXO, and site preparation at Bomblet Pit
- Day 18: Complete ordnance and debris removal at the Five Points Landfill
- Day 25: Complete ordnance and debris removal at Roller Coaster Sanitary Sewage Lagoon
- Day 28: Begin bomblet activities with RETRVIR system
- Day 39: Complete detonations and ordnance removal at the Bomblet Pit

- Day 46: Complete ordnance and debris removal from Area 9 Landfill and the Area 9 Construction Debris Disposal Area

Upon completion of the VCA, closure activities will begin on the Bomblet Pit and Five Points Landfill per the RCRA Streamlined Approach for Environmental Restoration Closure Plan for these sites, and the remaining three sites will continue to be investigated under the RFI Work Plan for the TTR.

7.0 Community Relations Plan

A Community Relations Plan will be developed for environmental restoration activities at Nevada sites operated by DOE/NV. Under this plan, specific public-involvement activities will be outlined for key milestone activities specified for the NV ERP, including the TTR.

Until the Community Relations Plan is developed, public-participation activities for the NV ERP are referenced in *Public Participation Plan for the ERWM Program, Nevada Operations Office* (DOE, 1993). Any public-participation activities specifically relating to DOE/NV environmental restoration activities at the TTR will be publicly announced through press releases and/or newspaper advertisements.

A fact sheet covering environmental restoration activities at the TTR has been prepared. The fact sheet and other public information materials can be obtained by writing to the following address:

U.S. Department of Energy
Nevada Operations Office
Office of External Affairs
P.O. Box 98518
Las Vegas, Nevada 89193-8518

8.0 Waste Management Plan

All waste generated through the performance of the planned activities from each of the sites will be managed in accordance with existing federal and state of Nevada regulations, DOE waste minimization and pollution prevention objectives, waste management programs, and radiological control programs. The waste will be categorized as sanitary solid waste or hazardous waste. No radioactive waste, low level or otherwise, is expected to be generated through the performance of the planned activities. If radiological constituents are discovered during the implementation of the VCA Work Plan, activities will cease, and further characterization will be required.

Process knowledge of the sites addressed by this plan suggest no reason to suspect radiological contamination. The absence of radiological constituents will be demonstrated through the use of radiological screening instrumentation, such as a beta-gamma detector ("pancake probe") and an alpha detector. In addition, swipes will be collected on larger items removed from the sites before disposal off site. These swipes will be analyzed using a gas-proportional detector for radiological constituents per the *DOE Radiological Control Manual* (DOE, 1994c). Off-site release limits listed in the Radiological Manual will apply. If radioactively contaminated materials are identified, they will not be released for off-site disposal or recycling as uncontaminated scrap, but will instead remain on site until the proper disposal of the materials can be arranged as required by DOE Order 5820.2A, Radioactive Waste Management.

Hazardous waste is defined in Title 40 CFR Part 261. Waste will be categorized through documented process knowledge and/or sampling and analysis. Soil shown to be uncontaminated is not a waste and may be returned to the location from which it was excavated. Hazardous waste will also be managed in accordance with DOE Order 5400.1, General Environmental Protection Program. Hazardous wastes will be disposed off the TTR at a permitted, commercial Treatment Storage and Disposal Facility and will be packed in containers that meet all U.S. Department of Transportation criteria for shipment and any additional criteria specified by the receiving disposal site.

Nonhazardous recyclable solid metal scrap is exempted from consideration as either solid or hazardous waste under a requirement found in Title 40 CFR §261.2(e)(1)(i). Under this consideration, using information found in Material Safety Data Sheets (MSDS) for the propellants and with process knowledge available from various sources, a number of scrap

metal sources are considered to be nonhazardous. These include inert or expended test ordnance, target drums, miscellaneous metal pipe, and sheet metal.

Spent (or expended) solid-fuel rocket boosters from various sources and types of military ordnance are also included in the recyclable designation. These rocket boosters are solid fuel and have been documented to contain varying amounts of lead in the combustion products developed during deployment. However, evidence is available through MSDSs that the expended rocket boosters would contain negligible levels of residual materials. Therefore, the residues (scrap metal casings) would be considered as nonhazardous (non-RCRA) and would be handled as normal scrap metals. The use of these sources of information negate the need to do more elaborate testing to confirm nonhazardous waste designations.

The nonhazardous recyclable metal solids (scrap metal) will be turned over to a commercial recycler after final radiological screening has been completed to DOE/NV radiological control criteria.

Nonrecyclable solid wastes will be disposed at the TTR Area 10 Landfill operated by the USAF.

9.0 Site-Specific Health and Safety Plans

The health and safety protocols for the field activities related to the implementation of this Work Plan are delineated in the SSHASPs presented in Appendices B and C. The SSHASP sets forth the specific requirements and procedures that will be followed while performing operations under the NV ERP. The SSHASP includes the following information:

- Engineering and administrative controls
- Monitoring for site-specific chemical and radiological contaminants
- Personal protective equipment selection and use
- Site control
- Emergency communications
- Emergency reporting protocol
- Decontamination
- Site characterization
- Training.

All field activities will be preformed in accordance with the SSHASP. All field personnel involved in these activities will be cognizant of the details of the SSHASP. All visitors to the work sites will be required to abide by this plan.

The objective of the SSHASP is the protection of workers during NV ERP activities. This will be accomplished through compliance with DOE Orders, Occupational Safety and Health Administration Regulations, and the DOE/NV *NV/YMP Radiological Control Manual* (DOE, 1992b), as well as the SSHASP. Many of the operations conducted under the NV ERP are regulated under DOE Order 5480.11, Radiation Protection for Occupational Workers; the Radiological Control Manual; and the following Title 29 CFR Parts:

1910.120	Hazardous Waste Operations and Emergency Response
1910.134	Respiratory Protection
1926 Subpart P	Excavations
1910.1200	Hazard Communication and Right-to-Know Standards
1910.95	Hearing Protection
1926 Subpart T	Demolition
1910.1000	Air Contaminants

SSHASPs are intended to be supplementary documents to the NV ERP Health and Safety Plan. Unique logistics, hazards, and site conditions, individual sites and/or tasks, and relevant regulations require the production of an SSHASP.

The SSHASP is considered a living document and, as new information becomes available, changes should be made as appropriate, with concurrence and approval of the Contractor Project Manager, Contractor Health and Safety Manager, the NV ERP Subproject Manager, and the NV ERP Health and Safety Manager.

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Appendix A

SP472561, Issue A
RETRVIR Mobile Manipulation System
(no modifications)

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DISK 1600 SOP RETRVIR

ACTIVITY-SPECIFIC ES&H STANDARD OPERATING PROCEDURE

RETRVIR MOBILE MANIPULATION SYSTEM

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1.0 PURPOSE, SCOPE, AND OWNERSHIP

1.1 Purpose

The purpose of this document is to define and inform personnel of the Safe operations and procedures associated with the use of the Honda Pilot telerobotic vehicle, the manipulator sub-system attached to it, and associated equipment that make up the RETRVIR Mobile Manipulation System. The RETRVIR is an experimental system developed by Sandia National Laboratories that integrates a hydraulic manipulator with a remotely driven vehicle to allow dexterous manipulation at remote locations. Specific guidelines are provided for the operation of the RETRVIR and its sub-systems. These guidelines are not intended to replace the judgment and common sense of the users of this equipment.

1.2 Discussion

The RETRVIR System has been developed jointly by Organizations 1661 and 9616 of Sandia National Laboratories to examine computer assisted teleoperation of vehicles and mobile manipulators. The RETRVIR will apply these technologies to several aspects of buried waste remediation including remote sizing (e.g., cutting of large objects), recovery and removal of hazardous objects and materials. All waste and other hazardous materials will be simulated in all experiments. Since RETRVIR operations are not well-defined due to the anticipated unstructured nature of the buried waste environment, commercial equipment on the RETRVIR has been modified to support the experimental nature of the work. In particular, the Honda Pilot ATV has been modified to operate remotely and the manipulator has been modified for computer control. The ability to automatically respond to sensor information has been incorporated into both the vehicle and manipulator. All personnel who work with the RETRVIR are responsible for its safe operation and general cleanliness.

Safety is the key element of all vehicle operations. There are four main areas of safety procedures implemented with this System:

- Access to the vehicle's work area is limited during machine operations to individuals with special training and a job related need to enter the vehicle work area.
- Equipment in this system has been designed for safe operation with particular emphasis on mechanical response in the event of loss of electrical, hydraulic or engine power and in the event of loss of communication with the vehicle.
- All System Operators are trained in the recommended safe operating procedures and the recommended procedures for emergency situations.
- A work environment promoting safety awareness has been established through safety meetings, warning posters and training classes.

1.3 Scope

This Standard Operating Procedure covers operation of all equipment associated with the RETRVIR Mobile Manipulation System. The major pieces of equipment in this System that may present significant hazards include the teleoperated Honda Pilot and a hydraulic manipulator sub-system. The system is operated under either remote Operator control

(teleoperation), combined operator/computer control (telerobotic operation), or computer control (autonomous operation).

The RETRVIR is a mobile system and may be transported to various sites at and away from Sandia National Laboratories. This SOP shall apply where ever the RETRVIR is operated. If a site specific SOP exists, it shall supplement this SOP in the operation of the RETRVIR. In the interest of safety, if there are conflicts between the requirements of this SOP and the site specific SOP, the conflicts shall be resolved through negotiations between the Principal User, or designee, and a representative of the site. These negotiations will be documented in writing, signed by the negotiators and retained for the period of one year.

1.4 Document Ownership

Organization 1661 and the Principal User are responsible to maintain and uphold all responsibilities of this SOP. A copy of this SOP will be kept in a conspicuous location in the maintenance area and base station areas at all times. This SOP will be required reading for all personnel who use the RETRVIR for any reason. As equipment changes or is updated, or more specific procedures are required, an addendum may be added to this SOP, or may be addressed through a site-specific Operating Procedure controlled within the relevant Center or external organization.

2.0 RESPONSIBILITIES

The Department Manager is responsible for seeing that personnel who wish to use the RETRVIR System are qualified, checked out and certified by the Principal User or manufacturer, and have read applicable governing procedures and signed the accompanying appropriate Authorized User Lists.

The Principal User is responsible for overseeing activities, scheduling and verifying maintenance of equipment, and enforcing safety procedures of the RETRVIR System as outlined in this document. The Principal User is responsible for ensuring that experimenters have been briefed on the use and safety considerations of appropriate equipment prior to their being granted use of that piece of equipment, and has the responsibility of maintaining an adequate supply of material and appropriate handbooks and references for the RETRVIR's efficient operation. Finally, the Principal User has the authority to acquire new equipment and change equipment layout or location as it becomes necessary and to authorize others to perform these tasks.

Authorized Users of this RETRVIR System are responsible for reading, signing, and adhering to the guidelines and safety procedures specified in this document. These users are to use only the major equipment that they have been trained on and signed off to use, as documented in the Authorized Users Lists (Appendices C & D) posted with this document.

3.0 JOB QUALIFICATIONS

All users of this System (both Operators and service personnel) shall be trained in the recommended safe operating procedures and the appropriate user responses in case of an emergency. Training will be accomplished in phases including instruction on general aspects of robot safety as well as specific techniques for safely operating this System.

All employees operating the manipulator shall have received formal robot operations and safety instructions for this manipulator either from the robot manufacturer or from the Principle User or his official designee. All required safe operations training of the manipulator shall be in accordance with SOP #10113 9002 (and it's subsequent versions), and all employees shall have read and signed the appropriate Standard Operating Procedure.

The Principal User is responsible for providing all Authorized Users with information about changes in the RETRVIR System including updates, system enhancements, and manufacturer's modifications. The Principal User is also responsible for providing appropriate training and certification for all new personnel and Authorized Users.

This SOP shall be used by all personnel whose research requires them to be working with the RETRVIR System. The only personnel authorized to operate this vehicle, are those who have received the training described below and know and understand the robot safety and operational hardware, systems, and procedures.

Authorized Users must:

- Read ANSI/RIA R15.06 American National Standard for Industrial Robots and Robot Systems - Safety Requirements (read before initial operation)

- Take the class on ANSI/RIA R15.06 (1600 videotape, viewed before initial operation), or equivalent training.

- Read, understand, and sign the following ES&H Standard Operating Procedures:
    1. RETRVIR Mobile Manipulation System, #SP472561
    2. Schilling Titan Manipulator, #10113 9002 (and subsequent versions)
    3. Remote Controlled Vehicle Fleet (Range Safety), #49600 8608
    4. RETRVIR Mobile Operations Center #SP472621 (yet to be drafted)

- Read and understand the Risk Assessment for the Schilling Titan Manipulator.

- User must have hands-on training in the safe and proper operation of the RETRVIR System from the Principal User and be certified for operation by the Principal User.

- All users must have completed the SNL mandatory ES&H training:
  LTO100 - Lockout/Tagout awareness, reviewed every three years.
  RAD102 - Radiation Awareness, reviewed every two years.
  EMP100 - ES&H rights, reviewed annually.
  FRP100 - Fire Extinguisher Awareness, reviewed annually.

- Be familiar with the robot safety and operational hardware, systems and procedures. Show a demonstrated proficiency with the equipment to be used.

- Have completed specialized classes in the safe operation of individual pieces of equipment, as appropriate, and shall have received both Pressure Safety (PRS102 in the SNL ES&H Training system) and Basic Electrical Safety (ELC105 in the SNL ES&H Training system).

Authorized Service Personnel representing manufacturers of equipment which comprise elements of the RETRVIR System, are exempted from the above requirements under the following conditions:

- Shall be briefed on the basic safety issues for the entire RETRVIR System and the specific modifications that have been made to the related sub-systems.
- An Authorized User must be present at any time that equipment is powered.

Authorized Users may allow the remote operation of the RETRVIR System by visitors as a means of demonstrating the capabilities of the System. However, an Authorized User must be present at all times during these demonstrations and must have access to an independent Emergency Stop system as an additional measure of safety assurance for casual observers and bystanders. These Visitors shall be instructed on the limits of the safe operation of the RETRVIR System before assuming the operator controls.

4.0 DEFINITIONS

• AUTHORIZED USER	Specially trained personnel that operate equipment, systems, and sub-systems of the RETRVIR System. All Authorized Users must acknowledge their responsibilities described in Section 2 and must have completed specialized training described in Section 3. (Synonymous with User)
• BARRIER	Physical barrier (e.g., rope, chain or fence).
• BASE STATION	The control point for the remote operation of the vehicle which provides continuous Operator interface to the RETRVIR System.
• EMERGENCY STOP BUTTON (E-STOP)	A red palm button which, when pressed, shuts off the engine and depressurizes the hydraulic system on the RETRVIR. The Emergency Stop Button shall be reset only by purposeful action of an Authorized User.
• MANIPULATOR ARM WORK ENVELOPE	The volume of space enclosing the maximum reach of the manipulator arm, relative to the vehicle, including the end effector. See Appendix B.
• MOBILE MANIPULATION	The use of a vehicle mounted manipulator to accomplish dexterous tasks in a variety of environments. Both the vehicle and manipulator are typically telerobotic.
• OBSERVER	An Authorized User who ensures the safe operation of the RETRVIR System by maintaining constant and direct observation of the vehicle and remaining in continuous communication with the Operator located at the base station. This person shall require the Operator to stop the vehicle and shut off the hydraulic system anytime the work envelope is approached with unauthorized entry.

• OPERATOR	An Authorized User who is located at the RETRVIR System base station and performs computerized, remote control of the RETRVIR. This Operator is in constant communication with the System Observer.
• PRINCIPAL USER	A person designated by the Department Manager who has certain authorities and responsibilities pertaining to the RETRVIR System as defined in Sections 2.0 and 3.0 of this SOP. The Principal User has documented, device specific training for the operation of a particular sub-system(s). This person is authorized to train and certify Authorized Users.
• RESTRICTED MANIPULATOR ARM WORK ENVELOPE	That portion of the Arm Work Envelope to which the manipulator arm is restricted by limiting devices. These established limits will not be exceeded in the event of any reasonable, foreseeable failure of the manipulator or its controls.
• RESTRICTED VEHICLE WORK ENVELOPE	That portion of the vehicle work envelope to which the vehicle is restricted by current speed, braking capabilities, gear selection, control means, and other controllable engineering factors. This area will not be exceeded in the event of any reasonable, foreseeable failure of the vehicle or its controls. Access to this area is limited to qualified personnel with a specific need.
• RETRVIR	REmote TeleRobotic Vehicle for Intelligent Retrieval
• RETRVIR SYSTEM	A combination of the vehicle sub-system and the manipulator sub-system. Sometimes referred to simply as System, or RETRVIR Mobile Manipulation System
• SAFEGUARDED AREA	The area around the vehicle and manipulator arm in which awareness devices and administrative means are used to prevent entry by unauthorized or casual personnel. The safeguarded area may include the Vehicle Work Envelope and the Restricted Vehicle Work Envelope, as well as the Arm Work Envelope and Restricted Arm Work Envelope, depending on the mode of operation.
• TELEROBOTIC	A combination of manual remote operation (teleoperation) and local computer control (robotic) of a mechanical device. Local sensors and computers modify operator commands to provide safe, effective semi-autonomous operation in remote environments. The Operator is typically located remote to the vehicle or device being commanded.
• USER	Authorized User.

- VEHICLE WORK ENVELOPE — The volume of space swept by the vehicle along all possible paths relative to its current position for a distance of 63 ft. (Stopping distance for the maximum speed of 20 mph, 1 second reaction time, 0.4g deceleration.). See Appendix A.

5.0 HAZARDS IDENTIFICATION

The RETRVIR System is used as a research tool and, as such, has no standard operating modes. However, the following safety systems, precautions, and procedures shall be observed at all times. The two major sub-systems -- the vehicle sub-system and the manipulator sub-system -- comprise the most significant hazards.

5.1 Vehicle Sub-System

This vehicle provides a mobile platform for the manipulator and will be used in a number of buried waste remediation experiments. It is also used as a testbed to develop supervisory control, such as KRITIC, for teleoperated vehicles. The vehicle can be teleoperated either using a pendant or via an RF link.

Mobile robots and teleoperated robots are specifically excluded from the ANSI Standard. The safety concerns addressed by the standard are still pertinent to the vehicle and an attempt to conform to the standard where ever possible has been made. (Refer to the Center 1600 Risk Assessment for the RETRVIR Teleoperated Vehicle for more information.)

The Vehicle Work Envelope is shown in Appendix A. Authorized Users should be familiar with this work envelope as it cannot be permanently marked due to the mobile nature of the vehicle. Note that the vehicle can only move forward or backward, not directly to the side. The distance and direction encompassed by the Restricted Vehicle Work Envelope varies depending on the vehicle's state (i.e., running of engine, selected gear, mode of control and current speed).

Stopping Distance Versus Speed

Vehicle Speed in mph	Reaction Distance (1 sec.) in feet	Braking Distance (0.4g) in feet	Stopping Distance in feet
10	14.7	8.3	23
20	29.3	33.4	63
50	73.3	209.0	282

The vehicle cannot change direction of motion abruptly. It takes some time for the actuator to change between forward and reverse gears. A white light visible from the rear of the vehicle is activated when reverse gear is selected.

The RETRVIR vehicle has a gross weight of approximately 1000 LB, fully loaded, and is powered by a 35 hp engine. A worker near this vehicle could be injured if the vehicle were

to strike or capture the worker between the vehicle and any fixed obstacle in the area. Due to the weight of the vehicle, high speed collisions and even relatively low speed pinching could have severe consequences. Other collision/pinch hazards include the individual control actuators, the steered wheels and the drive belts associated with the vehicle's engine. These hazards are mitigated by the following means:

- Restricting workspace access to fully informed and trained personnel under controlled conditions,
- Establishing the primary area of operation for the vehicle as the Robot Vehicle Range (RVR) on Kirtland AFB. This is a remote site providing large areas for teleoperated vehicle testing. The RVR is primary, however, it is not the only site where experimentation will be conducted,
- The presence of awareness devices at all operation sites, which include warning signs on all roads and a warning light on the control station,
- Warning signs and warning lights mounted on the vehicle,
- The vehicle's Operator and Observer may never stand or allow others to stand in the path of the vehicle during teleoperation,
- When the trained Operator can not maintain direct view of the vehicle, a trained Observer is used to prevent unauthorized personnel from encroaching on the path of the RETRVIR. The Observer maintains direct view of the vehicle and continuous voice contact with the Operator. It is the Observer's responsibility to monitor the vehicle operation and the area of operation for any potential intrusions.
- Both the Operator and Observer are trained in the range safety practices. At least one must be a qualified range safety officer per the RVR Range Safety SOP (#15900 8804).

The engine ignition is fail-safe. The ignition relay requires continual polling by the computer to maintain ignition on. In the event of a computer failure or electrical power loss, the relay automatically kills the engine. This does not explicitly deactivate the hydraulic system but without engine power the hydraulic system will depressurize in less than half a minute.

A cover prevents intrusion to belts and internal equipment during normal operation. When the cover is removed during maintenance and debugging, it is the Operator's responsibility to clear the actuators before causing motion.

Several robot engineering features are designed to control collision and pinch risks:

- Emergency stop (E-STOP) buttons (3) are located on the vehicle. These stop both the engine and the actuators. An emergency Kill button is located on the base station which kills the engine and applies brakes.
- Hardware and software features are in use to detect the possibility of failure to complete an intended motion of the actuators.
- Automatic shutdown of the vehicle will occur if communication to or from the vehicle is lost.

Sources of voltage and/or current are present in the RETRVIR System (i.e., 110VAC, 5VDC, 12 VDC, 24/28VDC, high voltage ignition spark, etc.). The primary means of risk management is by precluding access to these sources, except by qualified maintenance personnel.

Both the vehicle and electric generator for the RETRVIR System are powered by gasoline fueled, internal combustion engines which meet applicable consumer standards. Both are contained within the roll cage of the vehicle. Over flow of the carburetor is routed away from ignition sources. Gasoline is carried onboard the vehicle and is used to fuel both the vehicle and electric generator. Handling and storage is conducted in accordance with the Sandia ES&H Manual. The vehicle and generator engines produce combustion by-products that can cause an asphyxiation hazard in enclosed areas. Operation of the vehicle's engine inside garage areas is limited to entering and exiting the area.

Unauthorized use of the vehicle is precluded by the removal of the key by the Operator when the vehicle is not in use.

5.2 Manipulator Sub-System

The manipulator attached to RETRVIR is used for manual and automatic operations associated with experimentation in mobile manipulation and buried waste remediation. These experiments involve the manipulation of sensor packages and various other payloads within the Manipulator Arm Work Envelope. The manipulator is mounted on the RETRVIR teleoperated vehicle and can only operate while the vehicle is stationary.

A minimum distance of 10 feet beyond the work space of the manipulator will be established and marked with awareness barriers during stationary vehicle demonstrations for visitors. The tour guide is responsible for keeping visitors outside the marked area.

A hard hat must be worn at all times while working within the work envelope of the manipulator whenever the vehicle engine is running and the hydraulic system is activated.

There must be at least two persons present when working in the manipulator's work envelope with the vehicle engine running and hydraulics activated. A second person must be outside the work envelope and must be familiar with Section 7.4 (Emergency Procedures) of this SOP.

Mechanical motions of the manipulator joints can cause injury to personnel by impact, or by pinching (pinning) personnel between the manipulator arm and any fixed obstacle in the area, including the ground, stationary obstacles, or the vehicle itself. These situations can be caused by:

- joints which are free to move due to loss of braking action,
- unanticipated motions due to joint singularities or control computer malfunction, or
- computer or manual controlled motions.

The manipulator sub-system uses 3000 psi hydraulic pressure. High pressure hazards can occur during maintenance operations or in the event of a hydraulic line break. All operations must be conducted in accordance with the Sandia Pressure Safety regulations.

The manipulator can throw payloads and tooling during a malfunction. If the manipulator stops in mid-motion (mid-air) during a failure of the System, the arm or an object could inadvertently be released. To mitigate these hazards:

- The workspace is sized and the restricted area is defined to protect personnel from possible projectiles.
- The manipulator has mechanical brakes that function during E-Stops to lock the first three joints.

These above mentioned potential hazards are controlled by the implementation of physical and administrative safeguards which include:

- Training/ Required Reading.
- Warning signs.
- Three (3) emergency stop (E-STOP) buttons are located on the vehicle, and an emergency kill button is located on the driving station. These kill the vehicle's engine and depressurize the hydraulic system. These actions stop the System.
- The RETRVIR System will never be operated unattended.
- Self checks for erratic behavior are built into the manipulator.
- Only Authorized Users will have keys to the manipulator.
- Software features to detect loss of RF communication are in use.
- Software features are in use for the detection of failure to complete intended motion.
- The Operator must follow the ES&H SOP for the manipulator and experiment and be aware of the machine operating characteristics.
- If the Operator must enter the workspace, there must be at least 1 person capable of stopping the manipulator within audible distance and outside the workspace.
- Consideration shall be given to avoid trapping by picking the safest location within the workspace for each experiment.
- Only Authorized Users will have keys to the RETRVIR System.

5.3 Base Station

The base station controller cabinet is operated by a 110 volt, 30 amp circuit which can result in electrical shock during controller maintenance operations.

5.4 Mobile Command Center

The Mobile Command Center is a mobile trailer containing the base station control room and a vehicle transport maintenance area. The following hazards are resident in the confines of the mobile trailer:

- A 110 volt, 30 amp service electrical hazard which is operated by a 10 kW gasoline generator.
- A 12V battery powered backup electrical system is provided for the back-up lighting and towing system requirements.
- Fuel for the generator and vehicle is stored in minimal quantities (2 - 5 gal. tanks) within flammable cabinets contained in the trailer.
- During transportation, the RETRVIR is tied down by straps having a 6000 lb. maximum capacity.

Additional transportation safety requirements are addressed in the ES&H Activity Specific SOP entitled RETRVIR Mobile Operations Center, (IER# 921622SA, SP472621).

5.5 General Precautions

All materials not in use shall be stored in the proper location to avoid a tripping hazard.

A yellow warning light shall be illuminated and clearly visible from all points of approach to the vehicle whenever the vehicle engine is running.

Warning and instructional signs shall be visible to personnel approaching the vehicle.

6.0 EQUIPMENT AND MATERIALS

6.1 Equipment/Maintenance

The RETRVIR System is composed of the following elements:

- Honda Pilot ATV
- Honda 1000 Generator
- VME Bus computer system
- Hydraulic Manipulator Arm
- Hydraulic Power Unit
- Base Station Controller

The following checks will be made on a semi-annual basis or when the need arises.

- Check indicator lights.
- Check condition of cabling and electrical connections.
- Check link bolt connections
- Check the brake pads and tires

The following checks will be made on a monthly basis or when the need arises.

- Check the vehicle fluid levels
- Check the condition of fluids (including the generator)
- Check the control linkages
- Check all safety devices

6.2 Materials

Gasoline is used to fuel both the vehicle and the electric generator. Gasoline is a flammable liquid. Handling and storage shall be conducted in accordance with the Sandia ES&H Manual Motor oil, premix oil, and antifreeze are also used by the vehicle and generator. Detailed information on each of these materials is contained in the manufacturer supplied Material Safety Data Sheets (MSDSs). Copies of these MSDSs are filed in the Mobile Manipulation Lab and the Mobile Operations Trailer and in the 1600 ES&H office (building MO249/2).

The hydraulic fluid used for the manipulator, Tellus Oil 32, is described in the manufacturer supplied Material Safety Data Sheet (MSDS) as non-toxic, non-flammable and non-irritating to the skin and eyes. Copies of this MSDS are filed in the Mobile Manipulation laboratory, at the ES&H station in Building 847, and in the 1600 ES&H office (building MO249/2).

Any fluid spills must be cleaned up immediately and disposed of properly before they enter the environment. See Section 8.0 of this SOP for further instructions on waste disposal.

6.3 Device Safeguards

Adjust and secure all device safeguards to take full advantage of their protecting capabilities. Never remove safeguards without implementing alternate safeguard procedures.

Turn off engine, electrical, and hydraulic power and remove the key before safeguards are removed for repair or adjustments.

Report any defective or missing safeguards to the Principal User.

Prior to first use, all kill systems must be reviewed by a knowledgeable person not directly working on the project. This review is to be repeated after completion of any modification to the safety system. The date and initials of the reviewer shall be maintained in the Mobile Manipulation Laboratory Log Book.

7.0 STANDARD OPERATING PROCEDURE

7.1 Prerequisites

Only Authorized Users shall have a access keys which is required for operation of the RETRVIR System (see section below).

7.2 Precautions

This RETRVIR System is used as a research device and as such has no standard operating modes. However, the following precautionary safety systems and procedures will be observed at all times:

- Protective equipment must be in place as required in Section 5.0.
- Familiarity with reference materials located in the Mobile Manipulation Laboratory for the RETRVIR System and applicable sub-systems, and with any relevant Operating Procedures for these systems maintained by Center 1600.
- When use of safeguard barriers is possible/feasible, fences, warning signs, and rope-off chains, shall be placed such that inadvertent access to the vehicle or manipulator work envelopes by unauthorized personnel is avoided. These barriers shall be placed such that objects that might be "thrown" by the manipulator will not leave the safeguarded area.
- A yellow warning light on the vehicle shall be illuminated and clearly visible from all points of approach into the work area whenever the vehicle sub-system is operational.
- Warning and instructional signs shall be visible to all personnel in the operational vicinity of the safeguarded area.
- Load rating for the manipulator at the end of the arm is 600 pounds. The weight of the RETRVIR System is 1000 pounds. To come to a complete stop when traveling at the maximum operating speed of 20 mph, RETRVIR requires 63 feet of unobstructed travel.
- The safety systems installed by Department 1661 shall be maintained and used during normal operations.
- Since this is a research device, this System shall never be operated unattended.
- If the RETRVIR is operated out of sight of the Operator, an Observer shall maintain direct view of the RETRVIR and be in continuous voice communication with the Operator during all operations. Each of these participants will stand ready to issue an emergency stop condition.
- Operations shall cease and the engine and hydraulics be disabled if intrusion by unauthorized personnel appears imminent.
- The RETRVIR engine shall never be left running while the vehicle is unattended.

- The RETRVIR's generator and engine may not be operated indoors except to access parking or maintenance areas unless adequate ventilation or exhaust venting is provided.

- The Operator and/or Observer shall have ready access to an EMERGENCY STOP button when the engine is running.

- RETRVIR System safety interlocks shall not be overridden or defeated unless required for a specific test procedure or maintenance.

- The RETRVIR shall only be operated by Authorized Users (see Appendices C & D), or under the direct supervision of an Authorized User. **Note that Users must also have read and signed the SOP for the Schilling Titan Manipulator #10112 9002 (or its subsequent versions) before using the Manipulator sub-system..

- The following safety system checks shall be performed prior to each day's operations:
  1. Verify pendant engine kill switch operation.
  2. Verify pendant enable (deadman) switch operation.
  3. Verify pendant hydraulic kill switch operation (if the hydraulic system will be used).

- If remote operation is planned:
  1. Verify remote engine kill switch operation.
  2. Verify remote hydraulic kill switch operation if hydraulic system will be used.

- The following safety system checks shall be conducted monthly and recorded in the RETRVIR log book. If the RETRVIR is inoperative for more than a month this shall be noted in the log book instead. These checks shall be conducted and recorded before resuming regular operations:
  - Verify communication-loss kill mechanisms.
  - Verify software kill mechanisms.
  - Verify Emergency Stop buttons function.
  - Examine the hydraulic reservoir breather for obstructions.

7.3 Operations

7.3.1 Vehicle Sub-System

The RETRVIR System shall not be operated remotely at speeds above 20 mph unless a special use SOP, defining high speed mobile operations with sensor assistance, has been prepared.

The local (pendant) mode of operation has an enable switch (deadman switch) safety feature. A button on the pendant handle must be depressed in order to control servo functions from the pendant. If this button is not depressed (e.g. if the pendant is dropped), then the actuators are servoed to centered steering, brake is applied and throttle is turned off. If the pendant is not connected, and the base station is not enabled, the brake is applied. If the pendant is not connected, then the servos track Base Station commands.

Vehicle start-up is conducted per the Operating Procedures controlled by Center 1600 and is subject to change dependent on experimental status. The vehicle status shall be verified by the Operator prior to starting the vehicle.

Prior to driving the RETRVIR, the Operator shall alert personnel in the area that the vehicle will be active and verify that personnel are clear of the vehicle's path.

Normal Vehicle shut down is accomplished as follows:

1. Position the vehicle on level ground or have the parking brake set.
2. Shut off the onboard generator.

Emergency Vehicle shut down is accomplished by any one of the following means:

1. Hit the Emergency Stop button on either side of the roll cage, or at the rear of the vehicle. These will shut down engine ignition, depressurize the hydraulic system and disable power to the actuators, or,
2. Press the Emergency Stop button located at the base station. This will issue a kill command via the RF link, will shut down the engine ignition and depressurize the hydraulic system, but will not remove actuator power. It will place the actuators into a predetermined "safe" position, instead, (see pendant deadman).
3. If radio communication to the vehicle is lost, a "watchdog" timer automatically issues a kill command after a 2 second interval, the vehicle is placed in neutral, manipulator motion is stopped, and all actuators are placed in a "safe" position.
4. If there is a computer failure onboard the vehicle, the ignition relay will automatically kill the engine; this will disable the hydraulic pump to the manipulator arm, however, note that there will be a time lag of 30 seconds before arm is completely depressurized.

7.3.2 Manipulator Sub-System

Use and operation of the Schilling Manipulator Arm is covered by SOP IER #10113 9002; each manipulator Operator shall read and sign-off on this SOP. Several exceptions to this SOP are created when the manipulator is mounted on RETRVIR. These exceptions are noted just below. After reading the following section, each Authorized User must sign Appendix D of this SOP noting these exceptions.

- Due to the mobile nature of the RETRVIR System, the Mobile Manipulation laboratory does not have physical barriers or electrical safety interlock systems available.

- Use of barriers and interlocks are replaced by administrative controls such as: training and required reading, the presence of the Observer, warning signs, and an extended safeguarded area.

- Power for mobile manipulation is provided by the Hydraulic Power Unit (HPU) driven by the vehicle's engine, therefore all references to the electrical precautions and safety procedures are invalid.

- Normal shutdown for the manipulator sub-system:
  1. Position arm in safe configuration.
  2. Initiate the "hydraulic off" command from base station or the pendant controller. This will return engine to idle and depressurize the hydraulic system.

- Emergency shutdown for the manipulator sub-system accomplished by following the same procedures as for emergency vehicle shut down. These procedures are addressed in Section 7.3.1 above.

- Since this is a research device, this System shall never be operated unattended.

- The manipulator arm shall be at the full extent of its travel and the Authorized User must stand outside of the work envelope when manual tool changes are performed.

- Hydraulic arm power shall never be left on when the Vehicle Work Area is unattended. The Honda pilot engine shall be off and its key removed when the System is unattended.

- Authorized Users shall have ready access to an emergency stop button when hydraulic power is on.

- Determine status of 3000 psi hydraulic fluid system before initiating maintenance or repairs to the system.

- Prior to turning the manipulator sub-system power on, Authorized Users shall verify the presence of any personnel in the manipulator arm work envelope.

- Prior to moving the manipulator arm, Authorized Users shall verify the current location of the arm and understand the consequences of the intended movement.

- Manipulator safety interlocks shall not be overridden or defeated unless required for a specific test procedure or maintenance. Overriding robot safety systems is a serious operation! This may only be done with the consent of the RETRVIR System Principal User or designee. In addition, a sign indicating that robot safety systems have been overridden must be placed on the manipulator controller. The Principal User, or designee, must verify proper resetting of the safety system before the manipulator may be placed back into service and the sign indicating safety system override is removed from the controller.

- Prior to activating the Hydraulic Power Unit (HPU), the Operator shall alert personnel that the manipulator will be active.

- A logbook shall be maintained in order to record unusual occurrences, operations, maintenance procedures, systems, etc. See Section 6.1 for maintenance checklists and Section 7.2 for safety system checklist.

- Manipulator shall only be operated by a Manipulator Sub-System Authorized User, or under the direct supervision of an Authorized User. All RETRVIR System Users must read and sign the Schilling Titan Manipulator SOP, (#10113 9002 and it's subsequent versions), and then read and sign Appendix D of this SOP acknowledging the differences created when the manipulator is attached to this RETRVIR.

7.4 Emergency Procedures

7.4.1 Specific Emergency Responses

Hit the Emergency Stop button on either side of the roll cage, or at the rear of the vehicle. These will shut down engine ignition, depressurize the hydraulic system and disable power to the actuators. Or,

Press the Emergency Stop button located at the base station. This will issue a kill command via the RF link, will shut down the engine ignition and depressurize the hydraulic system, but will not remove actuator power. It will place the vehicle actuators into a predetermined "safe" position, instead.

If radio communication to the vehicle is lost, a "watchdog" timer automatically issues a kill command after a 2 second interval, the vehicle is placed in neutral, the manipulator motion is stopped, and all actuators are placed in a "safe" position.

DO NOT POWER DOWN THE ON BOARD GENERATOR UNLESS ARM MOTION OR ACTUATOR MOTION CONTINUES. Turning off the console may interfere with extricating trapped personnel or objects, and may prevent understanding the events leading to the emergency.

Release any persons trapped or caught by the arm unless it appears that the attempt may cause further danger or injury. Apply any necessary attention to injured persons. After aiding injured persons, attempt to determine the cause of the emergency. Do not enable arm power until any hardware failures have been repaired and software errors have been corrected, except as necessary to investigate the emergency. If possible, do not power down the control console until the problem cause is satisfactorily established.

Obtain/apply First-Aid or medical assistance as necessary. If emergency medical assistance is required, call **144**.

If assistance is needed to free trapped personnel, call the Fire Department at **117**.

Notify the 1661 Department Manager of all injuries and enter them into the RETRVIR log book.

7.4.2 General Emergency Responses

For minor cuts or abrasions use the First-Aid kits located in the Department Administrative offices and machine shops.

After aiding any injured persons, attempt to determine the cause of the emergency.

All unexplained or hazardous manipulator motions must be noted in the logbook, with relevant circumstances.

All serious incidents should be reported to Safety Engineering as soon as possible so that a prompt investigation can be made and any corrective actions can be taken.

Notify the RETRVIR System Principal User.

7.5 Postrequisites

Shut down the Generator and remove the key from the vehicle before leaving the area unattended.

8.0 WASTE DISPOSAL

The only hazardous waste associated with the RETRVIR System is the generation of oily rags. These oily rags will be deposited in the red covered waste receptacle labeled "OILY RAGS ONLY". Operations that utilize additional hazardous materials or wastes will be performed under specific test plans that are separate from this SOP.

Waste disposal will be in accordance with guidance in the ES&H Manual, (MN471001), Chapter 10, Section A. In general, waste is minimized by ordering only those quantities of chemicals, gas, etc., that are needed to perform an operation. Chemical identity and control will be maintained throughout its use cycle. Containers will be appropriately labeled by using a Hazardous Waste label (SA 2088 CWL, dated 10-88). Waste products should be disposed of by completing the Chemical Waste Disposal Request form (SA 2008-CWD, dated 9-90) and forwarding this form to Organization 7221. Organization 7221 will arrange for pick-up and disposal.

9.0 ES&H REPORTING AND DOCUMENTATION

The following records shall be completed using dark, indelible ink and submitted as follows:

- The approved activity specific ES&H SOP shall be submitted to the Engineering Release Center (ERC) for release and distribution
- Annual reviews of this SOP will be performed and Authorized Users will read and sign-off on any changes or revisions. Copies of the review will be filed with this SOP
- Authorized Users Signature Sheet, updated annually, filed with SOP
- ES&H Training Personnel records (maintained in 1600 ES&H office)
- Maintenance Logs (Procedures, Unusual Occurrences, System Updates)
- Preliminary Hazard Assessment (PHA) shall be maintained according to SNL guidelines
- Preliminary Hazard Classification (PHC) shall be completed and maintained according to SNL Management Implementation and Integration Project (IP) guidelines

- RETRVIR System Log Book (for maintenance and accident records, and off normal occurrences
- Risk Assessment for the Schilling Titan Manipulator used for Mobile Manipulation
- Risk Assessment for the RETRVIR Telerobotic Vehicle
- RETRVIR Pressure Data Package

10.0 REFERENCES

10.1 Documents that this ES&H SOP supersedes

This SOP replaces SOP #50018 9006 (Safe Operating Procedure for the Telemanaged Robotic Vehicle(TRV), Organization 5260, dated 6/14/90.)

10.2 SNL Requirements

Adherence to policies and procedures as outlined by the Environmental, Safety and Health program, Quality Assurance, and Conduct of Operations (as outlined in the Management Implementation and Integration Program)

Environmental Safety and Health Manual, MN471001, Sandia National Laboratories, February, 1991

Preliminary Hazard Assessment (PHA) and updates

Employee Handbook, SAND88-3406, Chemical Hazard Communication, Jan. 1989

Preliminary Hazard Classification (PHC) and updates

10.3 Other

Manufacturer's Owner and Operator Manuals

American National Standard for Industrial Robots and Robot Systems - Safety Requirements, ANSI/RIA R15.06-1992, Robotic Industries Association.

Center 1600 Robot Safety Class, videotape

Hydraulic Robot Manipulator Laboratory Standard Operating Procedure, SOP #10113 9002

Environmental Safety and Health Pressure Safety Manual, MN471000, Sandia National Laboratories, February, 1991

SNL corporate guidelines for Lockout/Tagout

Risk Assessment for the Schilling Titan Manipulator Robot used for Mobile Manipulation

Risk Assessment for the RETRVIR Teleoperated Vehicle

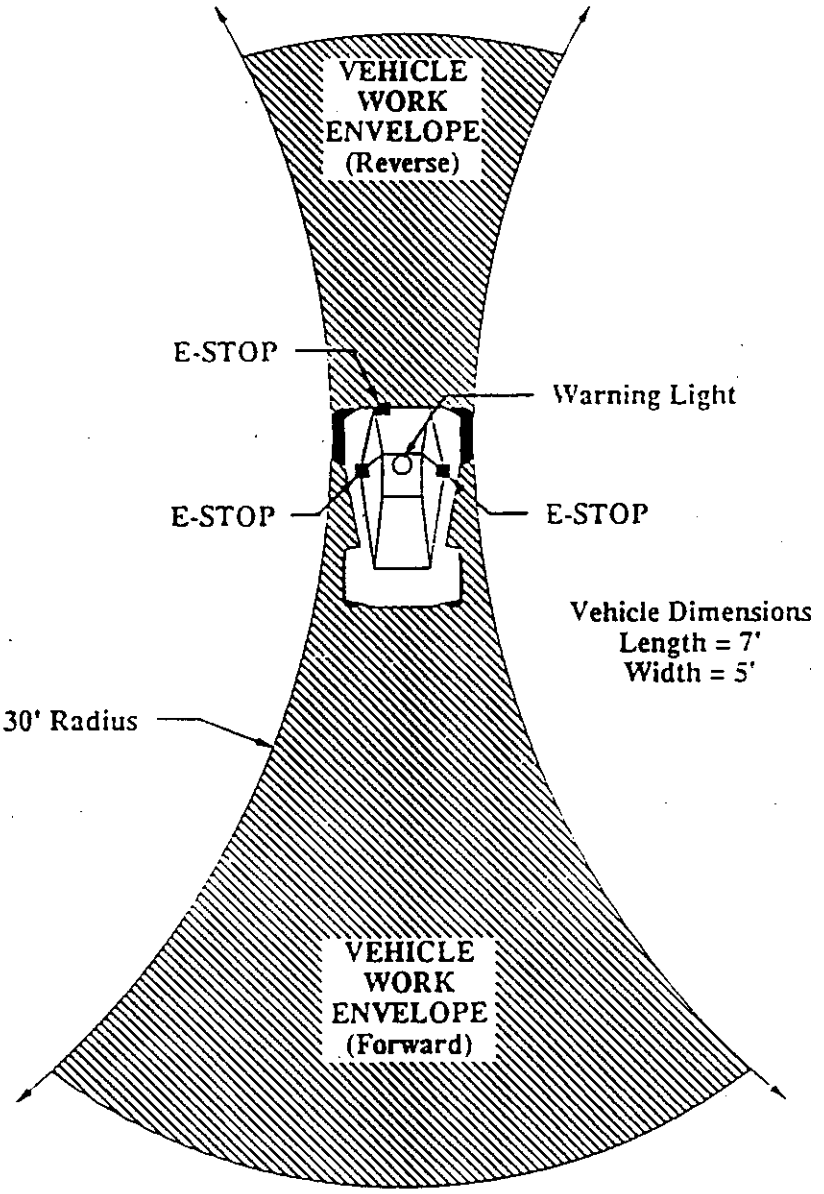
Management Integration and Implementation Project for Center 1600

RETRVIR Pressure Data Package

RETRVIR System Log Book (for maintenance and accident records, and off-normal occurrences)

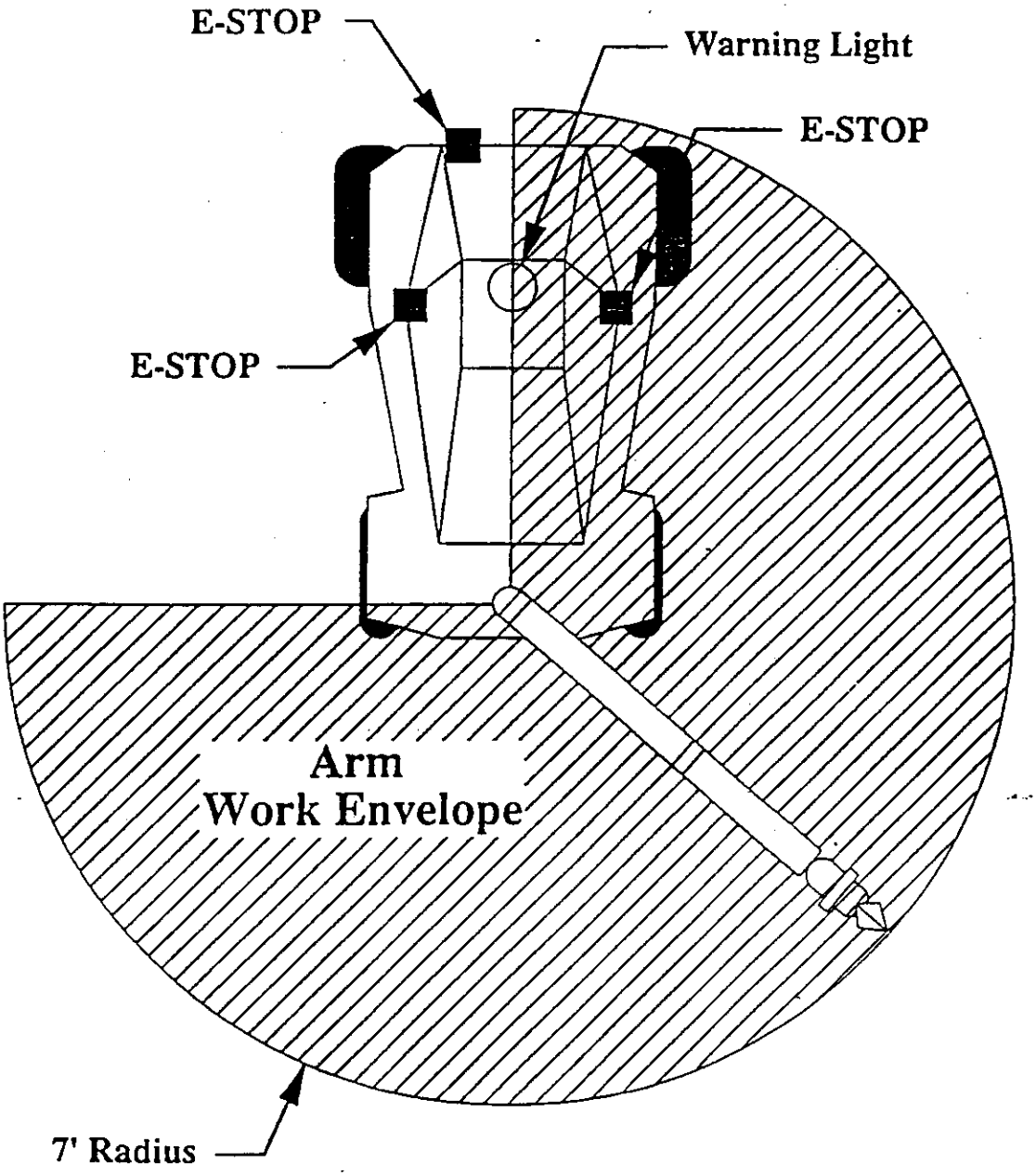
11.0 APPENDICES

Appendix A RETRVIR Vehicle Work Envelope



RETRIVR Vehicle Work Envelope

Appendix B RETRVIR Manipulator Arm Work Envelope



RETRIVR Arm Work Envelope

Appendix C RETRVIR System Authorized Users List

Activity-Specific ES&H SOP for the RETRVIR Mobile Manipulation System.

Issue A Document ID Number - SP472561

By my signature below, I affirm that I have read and understood this ES&H SOP and all references called out in procedural steps, and I agree to operate within the stated constraints. I also verify that I have completed the requirements as defined under Job Qualifications, Section 3.0.

Name (printed)	Signature	Org./Company	Date
Peter Boissiere		1661	
Chris Wilson		1661/Spectra	
Charles O. Little			

APPENDIX D RETRVIR Manipulator Sub-System Authorized Users List

Activity-Specific ES&H SOP for the RETRVIR Mobile Manipulation System
Issue A Document ID Number - SP472561

Activity-Specific ES&H SOP for the Schilling Titan Manipulation
Issue A Document ID Number - 10113 9002

By my signature below, I affirm that I have read and understood both the Schilling Titan Manipulator, SOP #10113 9002, and the RETRVIR Mobile Manipulation System SOP SP#472561. I understand the exceptions and procedural steps noted in Section 7.3.2 for operating a Schilling Manipulator when mounted to a vehicle sub-system and I agree to operate within the stated constraints. I also verify that I have completed the requirements as defined under Job Qualifications, Section 3.0.

Name (printed)	Signature	Org./Company	Date
Peter Boissiere		1661	
Chris Wilson		1661/Spectra	
Charles O. Little			

Appendix B

Site-Specific Health and Safety Plan for the Bomblet Pit at the Tonopah Test Range

Site-Specific Health and Safety Plan

Project Name: Tonopah Test Range

Project Number: ~~301975~~ 760491 RAD 1-31-95 .02010000

Site: Bomblet Pit

Lead Organization: IT Corporation, Las Vegas

Proposed Dates of Project: Beginning Date:_____ **Ending Date:** _____

Lead Organization
Project Manager: Richard A. Dubiskas **Signature:** Richard A. Dubiskas **Date:** 1-31-95

Author: Cheryl Swaton **Signature:** Cheryl P. Swaton **Date:** 1/31/95

Concurrences:

Name: _____ **Signature:** _____ **Date:**_____ **Organization:**_____

Name: _____ **Signature:** _____ **Date:**_____ **Organization:**_____

Name: _____ **Signature:**__ **Date:**_____ **Organization:**_____

Name: _____ **Signature:**_____ **Date:**_____ **Organization:**_____

I have read and approved this Health and Safety Plan (HASP) with respect to present hazards, regulations, requirements, and site procedures.

Name: Brian G. Klenk, CIH CSP **Signature:** [signature] **Date:** 1/31/95
Lead Organization
Health & Safety
Representative

DECLARATION OF UNDERSTANDING

Site Health and Safety Plan Acknowledgement

I have read and understand this Health and Safety Plan (HASP), and agree to abide by the procedures and limitations specified here and in the NV ERP Health and Safety Plan. Personnel unable to read this document must have their supervisor explain the contents of this document prior to working on the site. Individuals who have questions on information found in this plan should discuss their questions with their supervisor for clarification.

Name	Signature	Employer	Employee Number	Date
1)				
2)				
3)				
4)				
5)				
6)				
7)				
8)				
9)				
10)				

NOTES:

1. All personnel signing above must appear in part G, *Personnel Categorization*.
2. All sub-contractors must abide by the specifications and limitations contained in this HASP.
3. All personnel working on-site must sign this form.
4. This HASP is to be used in conjunction with the NV ERP Health and Safety Plan and Tailgate Safety Briefing form.

DECLARATION OF UNDERSTANDING

Site Health and Safety Plan Acknowledgement

I have read and understand this Health and Safety Plan (HASP), and agree to abide by the procedures and limitations specified here and in the NV ERP Health and Safety Plan. Personnel unable to read this document must have their supervisor explain the contents of this document prior to working on the site. Individuals who have questions on information found in this plan should discuss their questions with their supervisor for clarification.

Name	Signature	Employer	Employee Number	Date
11)				
12)				
13)				
14)				
15)				
16)				
17)				
18)				
19)				
20)				

NOTES:

1. All personnel signing above must appear in part G, *Personnel Categorization*.
2. All sub-contractors must abide by the specifications and limitations contained in this HASP.
3. All personnel working on-site must sign this form.
4. This HASP is to be used in conjunction with the NV ERP Health and Safety Plan and Tailgate Safety Briefing form.

Section A General Project Information

Investigative Objective/Activity Description:
Prior to removal activities an exclusion zone of 3,000-ft will be established and controlled by ASI. Ordnance removal will occur from the open pit, three surface bomblet locations and the five subsurface anomalies. The surface bomblets, subsurface anomalies, and any other local hazards will be clearly marked with flagging tape for easy identification.

Removal activities will occur in the following order:

- a 3,000-ft radius exclusion zone will be established;
- large ordnance within the Bomblet Pit will be vented in place using shaped charges placed in three different locations;
- once vented, the bombs and the debris overlying the bomblets, will be removed from the open pit using a minimum of 1,000-ft length tow-lines;
- the bomblets will then be removed from the open pit and placed into processing tubes using the SNL Remote Telerobotic Vehicle for Intelligent Retrieval (RETRVIR System). The processing tubes have been prepared with shaped charges for processing the bomblets;
- bomblets removed from the open pit will be processed through detonation of the prepared processing tubes;
- after processing the bomblets, the five subsurface anomalies will be excavated using mechanical methods or mechanical and hand excavation methods as described in Section 3.2.3.3.2 of the VCA Work Plan;
- once identified, the contents of the anomaly will either be processed in place or remotely removed to a processing area and processed;
- the debris will be cleaned up from the processing areas. This debris and the debris removed from the Bomblet Pit, will be segregated into recyclable and nonrecyclable materials piles;
- the recyclable materials will then be loaded onto the recycler's transport vehicle and transported offsite;
- the nonrecyclable materials will be transported to the TTR Area 10 landfill for disposal.

NOTE: The excavations will be sloped in accordance with Occupational Safety and Health Administration (OSHA) requirements prior to being entered by the hand excavation team.

Project Background Review:	☒ Complete	☐ Not Available	☐ Preliminary	☐ Further Study Required
29 CFR §1910.120 Regulated Site:	☒ Yes	☐ No	☐ Unknown	

Section A (continued)

Project HASP Summary

Level(s) of Protection: ☐ A ☐ B ☐ C ☒ D ☐ Mixed ☒ Modified

Overall Hazard Estimate: ☐ High ☒ Moderate ☐ Low ☐ Unknown

Additional Documentation Attached: ☐ TLV Table ☐ Full HASP ☐ Sampling Methods ☐ Radiological Work Permit

☒ Other: TTR Explosive Materials Sheet (Attachment 1)

Section B Site/Material Characteristics

Material/Waste Type(s): ☐ Liquid ☒ Solid IN ☐ Drums ☐ Tanks ☒ Soil ☐ Surface Water ☐ Gas ☐ Sludge ☐ Groundwater ☒ Other Buried Objects

Characteristics: ☐ Ignitable ☐ Corrosive ☐ Toxic ☐ Reactive ☐ Radioactive ☒ Explosive

Facility: Type: Ordnance Debris Disposal Pit and Five Subsurface Anomalies

☐ Open? ☒ Closed? When? Abandoned in the 1970's or 1980's

Size: *Bomblet Pit:* 35-ft long x 10- to 15-ft wide x 3- to 4-ft deep;
Anomalies A1, A2, and A3: 20 ft x 10 ft, 20 ft x 20 ft, and 35 ft x 15 ft;
Anomalies A4 and A5: Possibly 1 ft x 1 ft (bomblet size)

Terrain: Level valley, sparsely vegetated; there is a small mound of dirt along the north edge of the Bomblet Pit.

Indoors? ☐ Yes ☒ No

Confined Spaces (Describe):
None anticipated.

NOTE: ***Inspection/Test form completion required if confined space involved.***
☐ Additional Information Attached

Investigation Derived Waste (IDW) handling:
Discarded PPE and decontamination liquid will be drummed separately and left on location until closure verification sampling of the Bomblet Pit and the five anomaly excavations has been completed. Upon receiving sampling results, the decontamination rinsate and discarded PPE will either be characterized for waste disposal classification or disposed as trash.

All debris removed from the Bomblet Pit, surrounding area, and the anomalies will be segregated into recyclable and nonrecycleable materials piles and disposed accordingly. Prior to transportation and disposal, the debris will be screened to ensure that the debris is not radiologically contaminated per TTR release limits.

Site History:
The Bomblet Pit was used for disposal of debris from antipersonnel and antivehicular Cluster Bomb Units (CBUs). These tests were conducted between the north end of Antelope Lake and Mid-Target during the 1970s. Each test involved the aerial drop of one or more dispensers containing hundreds of bomblets. These bomblets had fuzes that were armed during free fall. Mid-Target, located

approximately 1 km east of the Bomblet Pit, is a known training range used for inert munitions.

Range clean-up operations within recent years consisted of picking up ordnance and debris scattered about TTR and disposing of these items in open pits located at various places along the flight line. The debris within the Bomblet Pit primarily consists of antipersonnel and antivehicular bomblets, bomblet dispenser clamshell sections, four MK84 2,000-lb bombs, and other assorted debris.

A geophysical investigation performed in 1993 identified five subsurface anomalies. In addition to the anomalies, three bomblets were identified on the surface outside the Bomblet Pit.

Section C Hazard Analysis

Evaluation of the principal hazards for each site and operation identified in the operational planning document(s).

Chemical Substances:
High explosives residual products may have adverse health effects.

Physical Agents:
Possible detonation of UXO and the fragmentation hazard radius associated with each type of UXO: the fragmentation hazard radius associated with the different types of UXO is given in Section 3.0 of the VCA Work Plan and is to be followed during all removal and processing operations.

Explosive hazards of the high explosives to be used for UXO processing and disposal operations: Section 5.0 of the IT DOP ITLV-TTR-005 will be followed for the storage, handling, and transportation of high explosives.

Communication equipment: such equipment have the potential to inadvertently detonate UXO; therefore, all communication equipment will be checked by the UXO site supervisor and/or the TTR UXO specialist prior to operation on site.

Heavy equipment used for large debris removal and for anomaly excavations: heavy equipment will be inspected daily and preferably prior to the start of each shift. Frayed cables, leaking hydraulic hoses, missing lock pins, and other deficiencies which may cause unsafe conditions will be corrected prior to operation.

Excavations: excavations will be enclosed on all sides by means of wooden or metal barricades with battery powered warning lights spaced no greater than 20-feet apart. A distance of 2 feet from the edge will be maintained by all personnel. Yellow or yellow and black nylon tape at least 3/4-inch wide will be stretched between barricades.

It is imperative that all site personnel carefully follow the IT UXO Supervisors instructions.

Caution should be used when handling the vented 2,000-lb bomb and other large debris to avoid back injury and the possibility of being crushed.

Caution should be used when driving (1) at night to avoid colliding with wild horses or other animals which roam freely over the range and (2) in freezing conditions as ice or black ice may have formed on the roadways.

Radiological:
Radioactive contamination is not anticipated. If field screening indicates radiological contamination, operations will cease and be reevaluated.

Biological:
Snakes, poisonous spiders, and scorpions may be encountered when removing debris from the pit. Avoid crevices, shrubs and other areas where these animals may be found. Use caution when moving debris. Additionally, hantavirus may be of concern (See Attachment 2).

Environmental: ("Physical" elements contributing to the potential for accidents)
The desert environment presents slip, trip, and fall hazards. Flash flooding is a hazard even from seemingly remote rain events. Also, rain, humid conditions, and cold can cause site workers to be irritable, and error prone.

Snow will make identification of UXO, especially small UXO such as the bomblets, difficult if not impossible. If there is a heavy snowfall, or if it becomes impossible to identify UXO, UXO removal operations will stop. Operations may start back up only when identification of UXO is possible in the opinion of the IT UXO Supervisor.

Noise from heavy equipment operations will hinder hearing considerably. Remain in line of site of equipment at all times. Pinch and crush hazards are of concern during excavation activities. **A spotter and hearing protection are required during backhoe operations.**

Cold Stress
Site workers should be protected from exposure to cold so that the deep core temperature does not fall below 36°C (96.8°F). Lower body temperatures will very likely result in reduced mental alertness, reduction in rational decision making, or loss of consciousness with the threat of fatal consequences. To prevent such occurrence, the following measures will be implemented:

- Site workers shall wear warm clothing, such as mittens, heavy socks, etc., when working below 45°F. Protective clothing, such as Tyvek or other disposable coveralls, may be used to shield employees from the wind.

- When the air temperature is below 35°F, additional clothing for warmth will be worn by employees. This may include:

  - Insulated suits, such as whole body thermal underwear
  - Wool socks over polypropylene socks to keep moisture off the feet
  - Insulated gloves
  - Insulated head cover such as a knit cap
  - Insulated parka, with hood and wind and water resistant outer layer
  - Insulated pants, with wind and water resistant outer layer, and
  - Insulated safety boots.

- At air temperatures below 35°F, the following work practices must be implemented:

  - If a site worker's underclothing becomes wet in any way, the worker must change into dry clothing immediately. If the clothing becomes wet from perspiration (and the employee is not uncomfortable), the employee may finish the task at hand prior to changing into dry clothing.

- Site workers will be provided with a warm (65°F or above) break area. A heated truck cab may suffice, if necessary.

- Hot liquids such as soups or warm, sweet drinks should be consumed during breaks. The intake of coffee and tea should be limited, due to their circulatory and diuretic effects. Meals should be taken at 4 to 6 hour intervals to assist in temperature regulation.

- The buddy system shall be practiced at all times on site. Any site worker observed with severe shivering shall leave the work area immediately.

- Site workers should dress in layers, with thinner lighter clothing worn next to the body.

- Site workers should avoid overdressing when going into warm areas or when performing strenuous activities. In addition, work should be planned and executed so as to minimize sweating.

Symptoms of Hypothermia

Mild Hypothermia (Core Temperature 35°C)
Pallor
Shivering
Lack of coordination or weakness
Dulled mental state

Moderate Hypothermia (Core temperature 34-30°C)
Pallor
Reduced/no shivering
Slow, weak pulse
Weak breathing (<10 breaths per minute)
Unconsciousness between 32-30°C core temperature

Severe Hypothermia (Core temperature <30°C)
Unconsciousness.
Skin very cold to touch
Extreme pallor
Generalized rigidity of limbs, neck
Slow or no pulse
Blue patches of skin
Puffy appearance of skin
Minimal breathing

Treatment varies for hypothermic patients. Application of warm blankets and *immediate medical treatment* is critical to the survival of the victim. Any signs of hypothermia should be treated as a medical emergency.

Section D Site Control

Personal Protection Required:

☐ Anti-C ☐ A ☐ B ☐ C ☒ D ☐ Mixed ☒ Modified

Note: *Minimum Level D equipment includes a hardhat, safety-toe boots, safety glasses, and substantial work clothing. All hardhats, glasses, and boots, must be ANSI approved.*

Mixed (Areas/Levels):
None anticipated.

Modified (Action Levels/Modifications):
Modified Level D PPE will be worn by site personnel. When working during the winter months, wearing layers of clothing is suggested.

Sturdy leather work gloves will be added to the Level D PPE for all personnel handling scrap debris. The gloves will be left in the work area at all times and disposed in a drum identified for used PPE at the end of the each work shift.

Additional Personal Protective Equipment Information:
Personnel handling and working with explosives or UXO, will wear the PPE described in Section 5.0 of the IT DOP ITLV-TTR-005.

Face shield and PVC raingear are to be worn when using decontamination sprayers (high and low pressure).

Surveillance Equipment:

☐ PID (9.8eV ☐ 10.2eV ☐ 11.7eV ☐) ☐ FID ☐ Detector Tubes ☐ Types: _____

☐ Oxygen ☐ Explosimeter ☒ TLD ☒ Radiation ☒ Types: Alpha/Beta/Gamma

☐ Diffusion ☐ Toxic Gas (Gas:) ☐ Particulate Sampling ☐ Heat Stress (Area ☐ Personal ☐)

☐ Other: _____

NOTES: A Geiger-Mueller (Pancake) probe and Count Rate Meter with an Alpha Scintillator will be used.

Site Surveillance/Monitoring

Instrument	Surveillance Frequency	Monitoring Location	Calibration
Geiger-Mueller (Pancake) Probe and Survey Meter	☐ Every ____minutes ☐ Hourly ☒ Daily at Shift End ☐ Daily at Shift Start ☒ Other: To be performed on personnel or equipment leaving the exclusion zone.	☐ Breathing Zone ☒ Other: Equipment tires and other parts that were in contact with the debris being removed and the outer layer of clothing.	☐ Manufacturer Specs Per SOP #: ☒ Start of Shift ☐ End of Shift Check ☒ Source Check
Count Rate Meter with Alpha Scintillator	☐ Every ____minutes ☐ Hourly ☒ Daily at Shift End ☐ Daily at Shift Start ☒ Other: To be performed on personnel or equipment leaving the exclusion zone.	☐ Breathing Zone ☒ Other: Equipment tires and other parts that were in contact with the debris being removed and the outer layer of clothing.	☐ Manufacturer Specs Per SOP #: ☒ Start of Shift ☐ End of Shift Check ☒ Source Check
	☐ Every ____minutes ☐ Hourly ☐ Daily at Shift End ☐ Daily at Shift Start ☐ Other:	☐ Breathing Zone ☐ Other:	☐ Manufacturer Specs Per SOP #: ☐ Start of Shift ☐ End of Shift Check ☐ Source Check
	☐ Every ____minutes ☐ Hourly ☐ Daily at Shift End ☐ Daily at Shift Start ☐ Other:	☐ Breathing Zone ☐ Other:	☐ Manufacturer Specs Per SOP #: ☐ Start of Shift ☐ End of Shift Check ☐ Source Check
	☐ Every ____minutes ☐ Hourly ☐ Daily at Shift End ☐ Daily at Shift Start ☐ Other:	☐ Breathing Zone ☐ Other:	☐ Manufacturer Specs Per SOP #: ☐ Start of Shift ☐ End of Shift Check ☐ Source Check

Section E Site Operations/Documentation

Initial Hotline Location: Outside of the 3,000-ft exclusion zone.

Initial Command Post Location: Outside of the 3,000-ft exclusion zone.

NOTES:

Decontamination:

RETRVIR System	1	Spray tires with bug sprayer containing a soap and water solution. Wipe arm and body of unit with a damp towel to remove visible dust. Do not use soapy water to moisten towel.	4	If the rad survey is positive, repeat steps 1-3 until the survey is negative.
	2	Rinse tires with tap water. Wipe arm and body with a clean damp towel.	5	
	3	Perform radiological survey for Beta/Gamma.	6	
Light Equipment	1	Wash hand tools with soap and water.	4	If the rad survey is positive, repeat steps 1-3 until the survey is negative.
	2	Rinse with tap water.	5	
	3	Perform radiological survey for Beta/Gamma.	6	
Heavy Equipment	1	N/A	4	
	2		5	
	3		6	

Section E Site Operations/Decontamination (continued)

Personnel Decon:				
	1	Wash hands, forearms, and face with soap and water.	4	
	2	Perform radiological survey for Beta/Gamma.	5	
	3	If the rad survey is positive, repeat steps 1-2 until the survey is negative.	6	

Special Facilities Required:
A break trailer where site workers may retreat to in inclement weather or when they need a warm place to rest.

Site Entry Procedure:
A 3,000-ft radius exclusion zone will be established around the site and controlled by ASI Security during operations involving explosives. Only personnel essential to the removal operations will be allowed inside the exclusion zone.

In addition to the exclusion zone, a fragmentation hazard radius will be established for all explosive and potentially explosive operations. Personnel will **not** be allowed in this area during explosive operations.

Team Size: 10-15 **Pre-field Briefing Date:** TBA

Work Schedule: The work schedule consists of five 10-hour-days per week for approximately four to six weeks. The work will be conducted Mondays through Fridays.

Work will be conducted during daylight hours only.

No more that 15 hours per day (includes portal to portal) will be worked.

Other Information:
For heavy equipment operations, 2-each 20-lb classified ABC fire extinguishers are to be present on site and readily accessible during field activities.

Section E (Continued)

Action Levels

Parameter	Value	Action
Geiger-Mueller (Pancake) Probe and Survey Meter	☒ Greater than 2 x background ☐ Less than _____ ☐ Equal to _____	☐ Upgrade to: _____ ☐ Downgrade to: _____ ☐ Evacuate: _____ ☒ Stop and notify: DOE Subproject Manager and Site Supervisor. ☒ Other action: Do not leave area until rad survey is negative, or RCT says to leave.
Count Rate Meter with Alpha Scintillator Probe	☒ Greater than 20 dpm/cm^2 ☐ Less than _____ ☐ Equal to _____	☐ Upgrade to: _____ ☐ Downgrade to: _____ ☐ Evacuate: _____ ☒ Stop and notify: DOE Subproject Manager and Site Supervisor. ☒ Other action: Do not leave area until rad survey is negative, or RCT says to leave.
	☐ Greater than _____ ☐ Less than _____ ☐ Equal to _____	☐ Upgrade to: _____ ☐ Downgrade to: _____ ☐ Evacuate: _____ ☐ Stop and notify: _____ ☐ Other action: _____

Section F Emergency Procedures

Emergency Actions:

Fire: Fight small incipient fires with portable fire extinguisher. If fire is too large, evacuate the area and notify ASI Security by telephone at 911. If a telephone is not available, contact "Cactus" (ASI Security) on Sandia Net via radio. Do not hang up or sign-off until told to do so by the operator.

PPE: N/A

Explosion: Evacuate the area and notify ASI Security by telephone at 911. If a telephone is not available, contact "Cactus" (ASI Security) on Sandia Net via radio. Do not hang up or sign-off until told to do so by the operator.

PPE: N/A

Weather: Retreat to TTR facilities in inclement weather or danger of flash flooding.

PPE: N/A

Injury: Stabilize individual, apply first aid if necessary. Notify ASI Security by telephone at 911. If a telephone is not available, contact "Cactus" (ASI Security) on Sandia Net via radio. Do not hang up or sign-off until told to do so by the operator.

PPE: Surgical gloves for first aid and a micro-shield for CPR. Place all used equipment/ materials in a Bio/bag which can be obtained from the first aid kit.

Spill: Absorbent materials should be kept on site for small inadvertent spills which may occur during refueling operations. If the spill is too large, summon appropriate authorities.

PPE: Chemical resistant gloves.

EMERGENCY COMMUNICATIONS

Police: Dial 911 or contact "Cactus" on Sandia Net via radio
Fire: Dial 911 or contact "Cactus" on Sandia Net via radio
Medical: Dial 911 or contact "Cactus" on Sandia Net via radio

Additional Emergency Communications:

Title	Name/Telephone
DOE NV ERP H&S Manager:	Roxanne Danz/(702) 295-7723
DOE Project Manager:	Kevin Cabble/(702) 295-5000, pager (702) 794-
IT Project Manager:	Randy Dubiskas/(702) 794-1700, pager (702) 794-6354
IT Health and Safety Officer::	Brian Klenk/(702) 794-1700, pager (702) 794-6241

Section F Emergency Procedures (continued)

Exposure Actions:

Substance	Symptoms of Exposure	Treatment	TWA	STEL	*Source	IDLH
Nitroaromatics	■ Acute ☐ Chronic Irritation of eyes, dizziness, shortness of breath.	Eyes: Flush with water for a minimum of 15 minutes. Ingestion: Drink large quantities of water. Get medical attention for discomfort.	N/A		PEL TLV REL	
Explosives	■ Acute ☐ Chronic No acute symptoms.	Eyes: Flush with water for a minimum of 15 minutes. Ingestion: Drink large quantities of water. Get medical attention for discomfort.	N/A		PEL TLV REL	
Diesel	■ Acute ☐ Chronic Dizziness, lightheaded, irritated skin and mucus membranes.	Remove contaminated clothing, flush exposed area(s) with water for a minimum of 15 minutes, seek medical attention. Remove victim to fresh air.	500 ppm		PEL TLV REL	
Gasoline	■ Acute ☐ Chronic Irritation of the eyes and skin, dermatitis or other skin disorders. Respiratory irritation, bronchopneumonia, dizziness, central nervous system depression.	Remove contaminated clothing, flush affected area for a minimum of 15 minutes. Remove victim to fresh air. Summon medical attention.	300 ppm		PEL TLV REL	
Alconox®	■Acute ☐Chronic Inhalation of powder may prove locally irritating to mucous membranes. Ingestion may cause discomfort and/or diarrhea.	Eyes: Flush with water for a minimum of 15 minutes. Ingestion: Drink large quantities of water. Get medical attention for discomfort.	N/A	N/A	PEL TLV REL	N/A
	☐ Acute ☐ Chronic				PEL TLV REL	
					PEL TLV REL	

TWA = Time Weighted Average (8 hour)
STEL = Short Term Exposure Limit
IDLH = Immediately Dangerous to Life or Health
N/A = Not Applicable

*PEL (OSHA)
TLV (ACGIH)
REL (NIOSH)

Section F Emergency Procedures (continued)

Primary Hospital/Infirmary

Name: Area 3 Medic

Telephone No.: (702) 295-8345 or 295-8290

Address: Area 3 Building 0369

Specific Directions: The Area 3 medic is located in Building 0369.

Refer to Figures B-1 and B-2

Alternate Hospital/Infirmary

Name: Nye Regional Medical Center (located in the City of Tonopah)

Telephone No.: (702) 482-6233

Address: 825 South Main Street

Specific Directions: Go northwest from the TTR main gate for 32 miles to Highway 6, go west 12 miles to Highway 95, go north approximately 1/2 mile, turn left to the Nye Regional Medical Center. The Center will be on the west side of the Main Street.

Other Emergency Information: A Flight for Life helicopter is available through 911. Flight for Life is based in Las Vegas. The helicopter has a range of 150 miles, and will need to refuel at the Air Force facilities; therefore, allow approximately 1 1/2 hours to 2 hours for arrival. There is room for two persons laying down and one sitting up. There are no weight restrictions. The helicopter contains facilities for both ER and ICU; however, 911 will need to know all information about the patient so that proper supplies are included (i.e., snakebite anti-venom). 911 will need to know the exact location of the person and where the helicopter can land. Due to the possibility of UXO, the landing area will need to be a road. For the emergencies at or near the Bomblet Pit, the helicopter should be instructed to land on Bunker 2 Road or Main Road North near the intersection of Main Road North and Bunker 2 Road.

Section G Personnel Information

1) Name: Richard A. Dubiskas	2) Position/Title: IT Project Manager
3) Duties: Manages all aspects of the project	4) Reports to: Kevin Cabble [Frank Czajkowski (while on-site)]
5) 24 hours Supervised Field Experience? ☒Yes ☐No	
6) Initial Training Date: 10/22/89	12) Special Training: Radiological Worker II-10/06/93 CPR-03/16/94 First Aid-04/14/94
7) Refresher Training in the last 12 months Type: Hazard and Protection Limited Date Completed: 02/24/94	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: 08/19/92	
9) Last Physical Date: 09/24/94 / 10) Restrictions? ☐ Yes ☒ No	11) Restriction: N/A

1) Name: Frank Czajkowski	2) Position/Title: Site Supervisor
3) Duties: Oversees site operations and ensures site safety/competent person	4) Reports to: Richard A. Dubiskas
5) 24 hours Supervised Field Experience? ☐Yes ☒☐No	
6) Initial Training Date: 08/17/90	12) Special Training: EOD/UXO School Excavation Safety 01/31/95
7) Refresher Training in the last 12 months Type: 8 hr Refresher Training Date Completed: 10/10/94	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: 09/30/93	
9) Last Physical Date: 03/17/94 / 10) Restrictions? ☒ Yes ☐ No	11) Restriction: color blindness and hearing protection required when noise levels reach or exceed 85 dBA

Section G Personnel Information

1) Name: Mike Fahrenhorst		2) Position/Title: Team Leader
3) Duties: UXO Supervisor/Team Leader responsibilities		4) Reports to: Frank Czajkowski
5) 24 hours Supervised Field Experience? ☐ Yes ☒ No		
6) Initial Training Date: 07/18/94		12) Special Training: EOD/UXO School Excavation Safety 01/31/95
7) Refresher Training in the last 12 months Type: -- Date Completed:		
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: --		
9) Last Physical Date: 07/94	10) Restrictions? ☐ Yes ☒ No	11) Restriction: N/A

1) Name: Robert Parsons		2) Position/Title: UXO Specialist
3) Duties: UXO removal/disposal		4) Reports to: Frank Czajkowski
5) 24 hours Supervised Field Experience? ☒ Yes ☐ No		
6) Initial Training Date: 08/04/94		12) Special Training: US Naval EOD School-09/76 Excavation Safety 01/31/95
7) Refresher Training in the last 12 months Type: -- Date Completed:		
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: --		
9) Last Physical Date: 08/12/94	10) Restrictions? ☐ Yes ☒ No	11) Restriction: N/A

Section G Personnel Information

1) Name: Brian Sunderman	2) Position/Title: UXO Assistant
3) Duties: Identify and remove UXO	4) Reports to: Frank Czajkowski
5) 24 hours Supervised Field Experience? ☒Yes ☐No	
6) Initial Training Date: 12/09/93	12) Special Training: US Naval Explosive Ordnance Disposal Basic Assistant-11/06/84 US Army Explosive Ordinance Disposal Course-09/21/84 Excavation Safety 01/31/95
7) Refresher Training in the last 12 months Type: Date Completed:	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: --	
9) Last Physical Date: 10/28/94 / 10) Restrictions? ☐ Yes ☒ No	11) Restriction: N/A

1) Name: Cheryl L. Swaton	2) Position/Title: Project Team Member
3) Duties: Document field activities, maintain an inventory of UXO disposal	4) Reports to: Frank Czajkowski
5) 24 hours Supervised Field Experience? ☒ Yes ☐ No	
6) Initial Training Date: 05/25/90	12) Special Training: Bloodborne Pathogens Training-01/17/94 CPR-04/27/94 First Aid-05/13/93 Radiological Worker II-07/23/93 Excavation Safety 01/31/95
7) Refresher Training in the last 12 months Type: Hazard and Protection Limited Date Completed: 07/14/94	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: 03/26/91	
9) Last Physical Date: 07/07/94 / 10) Restrictions? ☐ Yes ☒ No	11) Restriction: N/A

Section G Personnel Information

1) Name: Brian G. Klenk	2) Position/Title: Health and Safety Manager
3) Duties: Provide support to field operations regarding H&S issues	4) Reports to: Kevin Cabble [Frank Czajkowski (while on-site)]
5) 24 hours Supervised Field Experience? ☒ Yes ☐ No	
6) Initial Training Date: 07/05/87	12) Special Training: CPR-04/13/94 First Aid-04/15/93 Radiation Hazards Training (GERT)-04/27/93 Excavation Safety 01/31/95
7) Refresher Training in the last 12 months Type: Hazard and Protection Limited Date Completed: 02/24/94	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: 08/19/94	
9) Last Physical Date: 09/30/94 / 10) Restrictions? ☐ Yes ☒ No	11) **Restriction: N/A**

1) Name: Kevin Cabble	2) Position/Title: DOE Project Manager
3) Duties: Observe site operations	4) Reports to: Steve Mellington [Frank Czajkowski (while on-site)]
5) 24 hours Supervised Field Experience? ☒ Yes ☐ No	
6) Initial Training Date: 03/24/88	12) Special Training: Hazardous Materials Workshop-01/23/87 Radiation Safety Officer-09/12/88 Radioactive Materials Course-02/87 Transportation of Hazardous Materials-01/88
7) Refresher Training in the last 12 months Type: Hazardous Waste Site Worker Date Completed: 06/29/94	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: 01/27/89	
9) Last Physical Date: 06/94 / 10) Restrictions? ☐ Yes ☒ No	11) **Restriction: N/A**

Accident/Injury/Near Miss Checklist

ame of Person(s): _____

Date of Incident: _____ Time: _____

Exact location of incident: _____

Job Title: _____ Job Number: _____

Supervisor : _____ _____

Printed Name Signature

Site Supervisor's Accident/Injury/Near Miss Checklist		
Step	**Action/Requirement**	**Date/Time** (24 hr clock)
1	Perform first aid/CPR, as appropriate, and get injured/ill to medical care immediately, if required.	
2	Isolate and protect scene of accident (non-automobile). If automobile accident, clear personnel and vehicles from roadway and/or place warning devices.	
3	Report incident by phone to Lead Organization Project Manager and NV ERP H&S Manager, and Employer immediately after situation is under control.	
4	Complete appropriate form(s) as required by Employer/DOE	
5	Perform Accident/Incident Investigation as soon as possible, and complete accident investigation report.	
6	Submit accident investigation report to DOE-NV via required reporting mechanisms (ORPS, etc.)	
7	Turn this form in to Nevada ERP Health and Safety Manager	

NOTE: All workers are required to report all injuries, illnesses, accidents, and near misses.

EMERGENCY NOTIFICATION (continued)

TITLE:	IT UXO Manager
NAME:	Jim Pastorick
OFFICE PHONE:	(703) 793-1357
HOME PHONE:	(703) 549-7133
RESPONSIBILITIES:	Director of UXO Operations

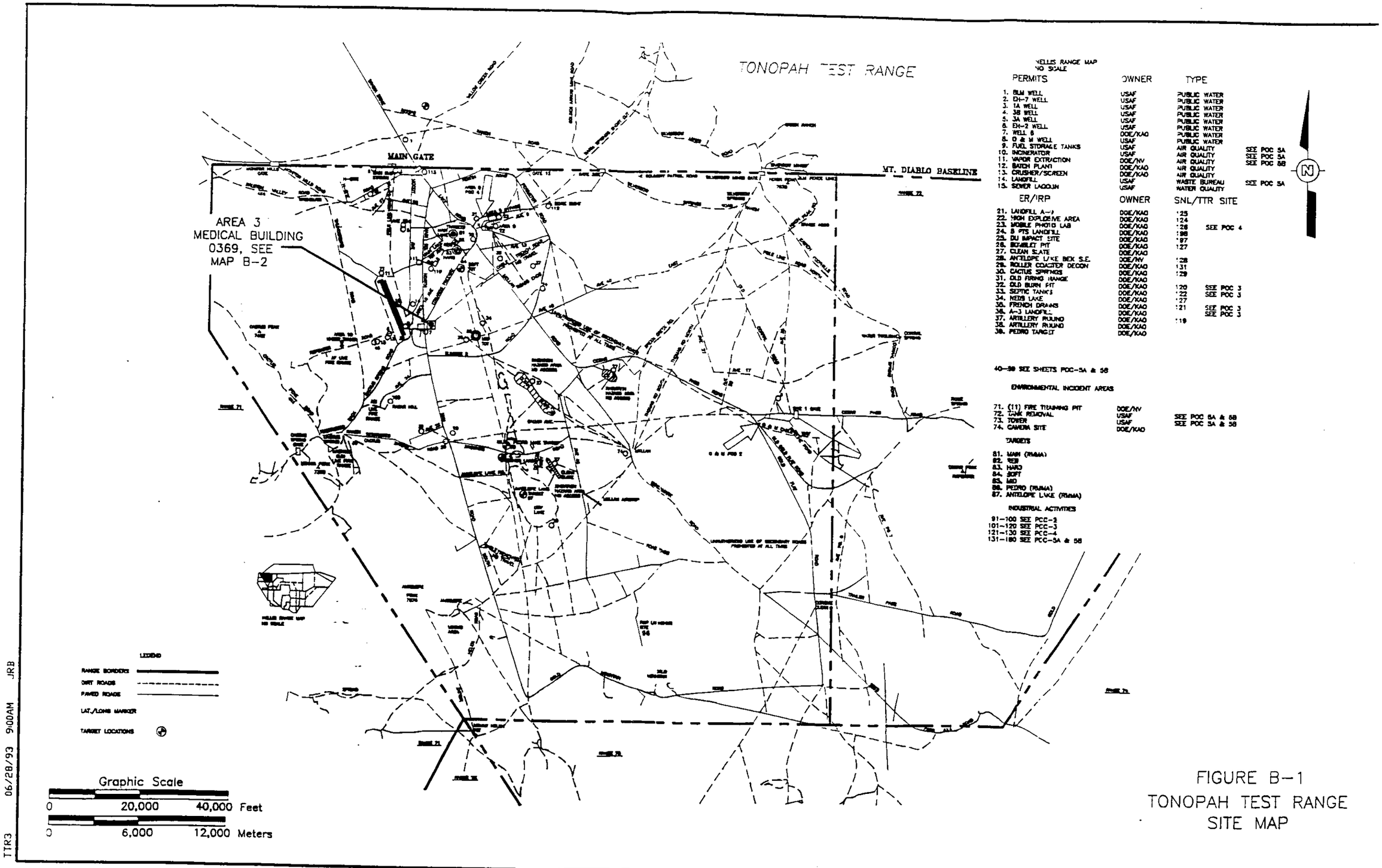
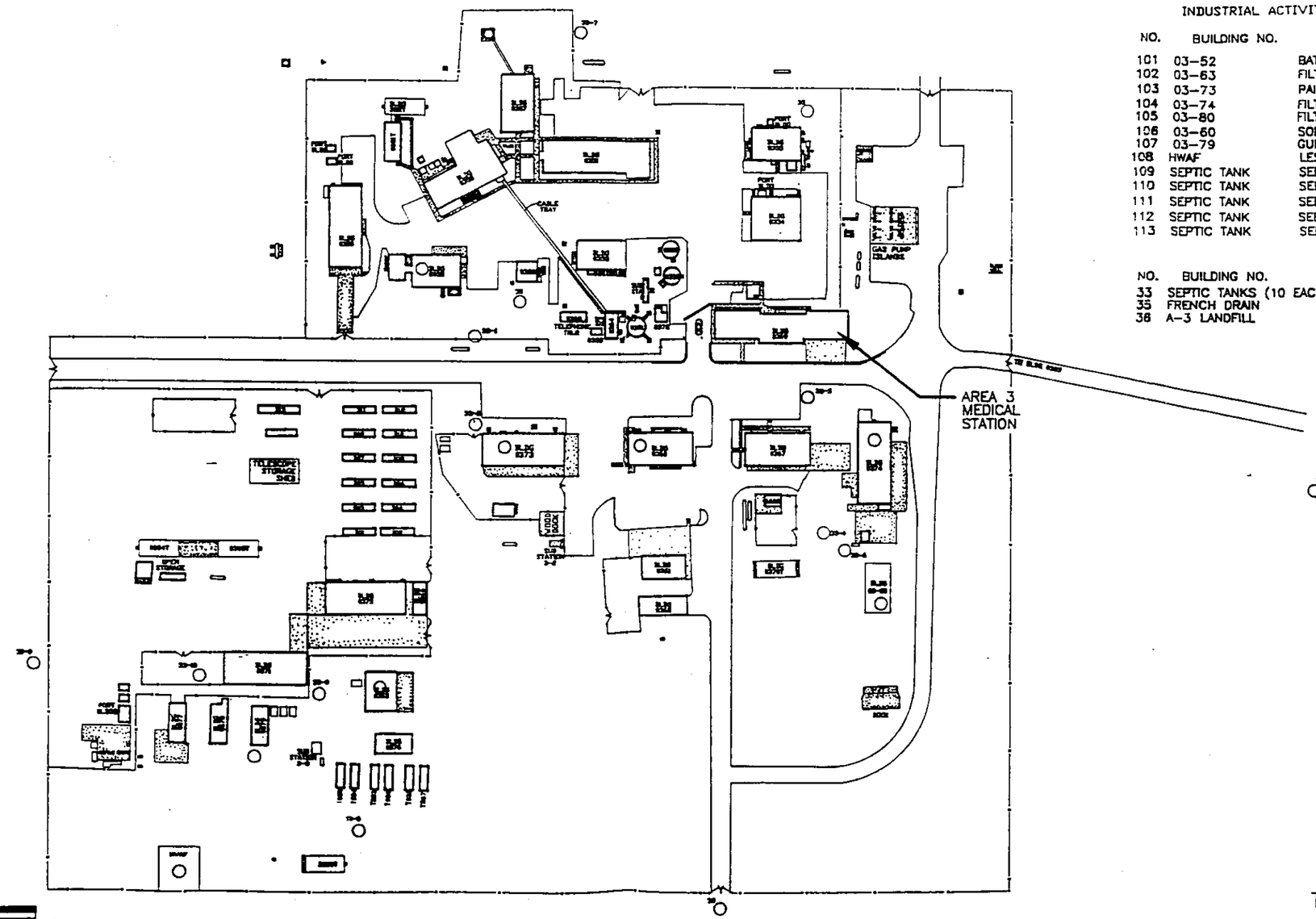


FIGURE B-1
TONOPAH TEST RANGE
SITE MAP



INDUSTRIAL ACTIVITIES

NO.	BUILDING NO.	WASTE TYPE
101	03-52	BATTERIES
102	03-63	FILTERS
103	03-73	PAINT RELATED MATERIAL
104	03-74	FILTERS
105	03-80	FILTERS
106	03-60	SOLVENT RECYCLE
107	03-79	GUN CLEANING
108	HWAF	LESS THAN 90 DAY STORAGE
109	SEPTIC TANK	SEE POC 1
110	SEPTIC TANK	SEE POC 1
111	SEPTIC TANK	SEE POC 1
112	SEPTIC TANK	SEE POC 1
113	SEPTIC TANK	SEE POC 1

NO.	BUILDING NO.	RESTORATION PROJECTS
33	SEPTIC TANKS (10 EACH)	
35	FRENCH DRAIN	
36	A-3 LANDFILL	

FIGURE B-2
TONOPAH TEST RANGE
AREA 3 SITE MAP

PDC-2A 06/28/93 2:00PM JRB

Appendix C

Site-Specific Health and Safety Plan for the Five-Points Landfill, Roller Coaster Sanitary Sewage Lagoons, Area 9 Landfill, and the Area 9 Construction Debris Disposal Area at the Tonopah Test Range

Site-Specific Health and Safety Plan

Project Name: Tonopah Test Range

Project Number: 301975.02010000

Site: Bomblet Pit

Lead Organization: IT Corporation, Las Vegas

Proposed Dates of Project: Beginning Date:_____ Ending Date: _____

Lead Organization
Project Manager: Richard A. Dubiskas Signature: Richard A. Dubiskas Date: 1-31-95

Author: Cheryl Swaton Signature: [illegible] Date: 1/31/95

Concurrences:

Name: _____ Signature: _____ Date:_____ Organization:_____

Name: _____ Signature: _____ Date:_____ Organization:_____

Name: _____ Signature:__ Date:_____ Organization:_____

Name: _____ Signature:_____ Date:_____ Organization:_____

I have read and approved this Health and Safety Plan (HASP) with respect to present hazards, regulations, requirements, and site procedures.

Name: Brian G. Klenk, CIH CSP Signature: [illegible] Date: 1/31/95
Lead Organization
Health & Safety
Representative

i:\ttr\bphsp7.hsp_01/30/95

DECLARATION OF UNDERSTANDING

Site Health and Safety Plan Acknowledgement

I have read and understand this Health and Safety Plan (HASP), and agree to abide by the procedures and limitations specified here and in the NV ERP Health and Safety Plan. Personnel unable to read this document must have their supervisor explain the contents of this document prior to working on the site. Individuals who have questions on information found in this plan should discuss their questions with their supervisor for clarification.

Name	Signature	Employer	Employee Number	Date
1)				
2)				
3)				
4)				
5)				
6)				
7)				
8)				
9)				
10)				

NOTES:

1. All personnel signing above must appear in part G, *Personnel Categorization*.
2. All sub-contractors must abide by the specifications and limitations contained in this HASP.
3. All personnel working on-site must sign this form.
4. This HASP is to be used in conjunction with the NV ERP Health and Safety Plan and Tailgate Safety Briefing form.

DECLARATION OF UNDERSTANDING

Site Health and Safety Plan Acknowledgement

I have read and understand this Health and Safety Plan (HASP), and agree to abide by the procedures and limitations specified here and in the NV ERP Health and Safety Plan. Personnel unable to read this document must have their supervisor explain the contents of this document prior to working on the site. Individuals who have questions on information found in this plan should discuss their questions with their supervisor for clarification.

Name	Signature	Employer	Employee Number	Date
11)				
12)				
13)				
14)				
15)				
16)				
17)				
18)				
19)				
20)				

NOTES:

1. All personnel signing above must appear in part G, *Personnel Categorization*.
2. All sub-contractors must abide by the specifications and limitations contained in this HASP.
3. All personnel working on-site must sign this form.
4. This HASP is to be used in conjunction with the NV ERP Health and Safety Plan and Tailgate Safety Briefing form.

Section A General Project Information

Investigative Objective/Activity Description:

Five Points Landfill: Removal activities will consist of surface debris removal and segregation and venting of at least one observed UXO. The UXO will be vented in place using a shaped charge. Once vented, the UXO will be inspected to verify that adequate venting has occurred and that it can safely be removed from the pit. Removal activities will be conducted using a backhoe or a front-end loader and by manual labor.

Roller Coaster Sanitary Sewage Lagoons: Removal activities will occur at the two sewage lagoons and the ancillary pit. Surface debris consisting largely of aircraft targets made of welded together 55-gallon drums, and construction debris will be removed. UXO that are encountered during removal activities will be vented in place using shaped charges. Due to the size and depth of the lagoons and the pit, removal activities may be performed using a crane.

Area 9 Landfill: Removal activities will occur at the open pit in the Area 9 Landfill. The pit contains mostly rocket booster parts, 55-gallon drums, and construction debris. There are two 155-mm artillery rounds that appear to be unfuzed. If verified in the field that the two rounds are unfuzed, they will be moved from the pit with a backhoe and placed in a predesignated processing area and vented using shaped charges, otherwise the rounds will be vented in place using shaped charges. After venting, the rounds will be inspected to verify that complete venting occurred. The remaining debris in the pit will be removed using a backhoe.

Area 9 Construction Debris Disposal Area: The disposal area contains construction debris and one MK84 2,000-lb bomb with the inert filler exposed and several inert 20-lb practice bombs lying at the eastern edge of the construction debris pile. The MK84 2,000-lb bomb may require additional venting if the decision is made in the field that the opening in the bomb is not adequate exposure of the inert filler. A similar decision could be made for the 20-lb practice bombs. Venting will be performed in place using shaped charges. Once vented, the bombs will be moved to a scrap metal pile. After the removal of the vented bombs, the construction debris will be manually removed.

General Information:

Once processed and/or determined to be safe and certified to be free of explosives by the UXO supervisor, all ordnance will be rendered into scrap by REECo through the use of a cutting torch or other means if processing has not accomplished this objective.

All debris removed from the sites, including the scrapped ordnance, will be segregated into recyclable and nonrecyclable materials and disposed accordingly.

Project Background Review:	☒ Complete	☐ Not Available	☐ Preliminary	☐ Further Study Required

29 CFR §1910.120 Regulated Site:	☒ Yes	☐ No	☐ Unknown

Section A General Project Information (continued)

Project HASP Summary

Level(s) of Protection: ☐ A ☐ B ☐ C ☒ D ☐ Mixed ☒ Modified

Overall Hazard Estimate: ☐ High ☐ Moderate ☒ Low ☐ Unknown

Additional Documentation Attached: ☐ TLV Table ☐ Full HASP ☐ Sampling Methods ☐ Radiological Work Permit

☒ Other: TTR Explosive Materials Sheet (Attachment 1)

Section B Site/Material Characteristics

Material/Waste Type(s): ☐ Liquid ☒ Solid IN ☐ Drums ☐ Tanks ☒ Soil ☐ Surface Water ☐ Gas ☐ Sludge ☐ Groundwater ☐ Other _____

Characteristics: ☐ Ignitable ☐ Corrosive ☐ Toxic ☐ Reactive ☐ Radioactive ☒ Explosive

Facility: Type: One ordnance debris disposal landfill, two sewage lagoon disposal pits, one general landfill, and one construction debris disposal pit.

☐ Open? ☒ Closed? When? Abandoned in the 1970's or 1980's

Size: *Five Points Landfill:* 436-ft long x 108-ft wide x 10-ft deep;
Roller Coaster Sanitary Sewage Lagoons and ancillary pit: 135-ft long x 75-ft wide x 10-ft deep and 105-ft x 45-ft x 10-ft deep, respectively; the sides to the lagoons are fairly steep;
Area 9 Landfill: The landfill itself covers approximately 2.3 acres, the pit is approximately 45-ft long x 20-ft wide
Area 9 Construction Debris Disposal Area: This site covers approximately one acre.

Terrain: Level valley, sparsely vegetated.

Indoors? ☐ Yes ☒ No

Confined Spaces (Describe):
None anticipated.

NOTE: ***Inspection/Test form completion required if confined space involved.***
☐ Additional Information Attached

Investigation Derived Waste (IDW) handling:
Discarded PPE and decontamination rinsate will be drummed accordingly and left on location until closure verification sampling of the four sites has been completed. Upon receiving the sampling results, the decon rinsate and discarded PPE will either be characterized for waste disposal classification or disposed as trash.

All debris removed from the four sites will be segregated into recyclable and nonrecycleable materials piles and disposed of accordingly. Prior to transportation and disposal, the debris will be screened to ensure that it is not radiologically contaminated.

Site History:
Five Points Landfill: The Five Points Landfill was used for disposal of ordnance and debris generated from Range cleanup operations. All debris was dumped in an open excavation which has not been covered. There are no buried objects at the Five Points Landfill.

Section B Site/Material Characteristics (continued)

Roller Coaster Sanitary Sewage Lagoons: The sewage lagoons once received liquid sanitary wastes. When no longer in use as sewage lagoons, the two sewage lagoons and the ancillary pit were used as disposal pits for range cleanup operations.

Area 9 Landfill: The Area 9 Landfill consists of an open pit and four covered landfill cells. The open pit is the subject of the UXO removal activities. The pit has been used for the disposal of construction debris and debris from range cleanup operations.

Area 9 Construction Debris Disposal Area: The disposal area was mainly used for the disposal of construction debris. There is no evidence that anything was buried at this site.

Section C Hazard Analysis

Evaluation of the principal hazards for each site and operation identified in the operational planning document(s).

Chemical Substances:
High explosives residual products may have adverse health effects.

Physical Agents:
Possible detonation of UXO and the fragmentation hazard radius associated with each type of UXO: the fragmentation hazard radius associated with the different types of UXO is given in Section 3.0 of the VCA Work Plan and is to be followed during all removal and processing operations.

Explosive hazards of the high explosives to be used for UXO processing and disposal operations: Section 5.0 of the IT DOP ITLV-TTR-005 will be followed for the storage, handling, and transportation of high explosives.

Communication equipment: such equipment have the potential to inadvertently detonate UXO; therefore, all communication equipment will be checked by the UXO site supervisor and/or the TTR UXO specialist prior to operation on site.

Heavy equipment used for large debris removal and for anomaly excavations: heavy equipment will be inspected daily and preferably prior to the start of each shift. Frayed cables, leaking hydraulic hoses, missing lock pins, and other deficiencies which may cause unsafe conditions will be corrected prior to operation.

It is imperative that all site personnel follow the IT UXO Supervisors instructions.

Extreme caution should be used when moving any of the vented ordnance to avoid back injury or being crushed by one of the heavy bombs (i.e., a 2,000-lb bomb).

Caution should be used when driving (1) at night to avoid colliding with wild horses or other animals which roam freely over the range and (2) in freezing conditions as ice or black ice may have formed on the roadways.

Slopes of the Disposal Pits: Caution should be used when walking around the edges of the disposal pits and while entering the pits to prevent falling.

Radiological:
Radioactive contamination is not anticipated. If field screening indicates radiological contamination, operations will cease and be reevaluated.

Biological:
Snakes, poisonous spiders, and scorpions may be encountered when removing debris from any of the

sites. Avoid crevices, shrubs and other areas where these animals may be found. Use caution when moving debris. Additionally, hantavirus may be of concern (See Attachment 2).

Environmental: ("Physical" elements contributing to the potential for accidents)
The desert environment presents slip, trip, and fall hazards. Flash flooding is a hazard even from seemingly remote rain events. Also, rain, humid conditions, and cold can cause site workers to be irritable, and error prone, and lead to cold stress.

Cold stress: prolonged exposure to cold without proper attire. Wind chill should be taken into consideration when determining work duration and clothing.

Snow will make identification of UXO difficult if not impossible. If there is snowfall and it becomes impossible to identify UXO, UXO removal operations should stop. Operations should start back up only when identification of UXO is possible in the opinion of the UXO Supervisor.

Noise from heavy equipment operations will hinder hearing considerably. Remain in line of site of equipment at all times. Pinch and crush hazards are of concern during removal activities. **A spotter and hearing protection are required during backhoe operations.**

Cold Stress
Site workers should be protected from exposure to cold so that the deep core temperature does not fall below 36°C (98°F). Lower body temperatures will very likely result in reduced mental alertness, reduction in rational decision making, or loss of consciousness with the threat of fatal consequences. To prevent such occurrence, the following measures will be implemented:

- Site workers shall wear warm clothing, such as mittens, heavy socks, etc., when working below 45°F. Protective clothing, such as Tyvek or other disposable coveralls, may be used to shield employees from the wind.

- When air temperature is below 35°F, additional clothing for warmth will be worn by employees. This may include:

  - Insulated suits, such as whole body thermal underwear
  - Wool socks over polypropylene socks to keep moisture off the feet
  - Insulated gloves
  - Insulated head cover such as a knit cap
  - Insulated parka, with good and wind and water resistant outer layer, and
  - Insulated safety boots.

- At air temperatures below 35°F, the following work practices must be implemented:

  - If a site worker's underclothing becomes wet in any way, the worker must change into dry clothing immediately. If the clothing becomes wet from perspiration (and the employee is not uncomfortable), the employee may finish the task at hand prior to changing into dry clothing.

- Site workers will be provided with a warm (65°F or above) break area. A heated truck cab may suffice, if necessary.

- Hot liquids such as soups or warm sweet drinks should be consumed during breaks. The intake of coffee and tea should be limited, due to their circulatory and diuretic effects. Meals should be taken at 4 to 6 hour intervals to assist in temperature regulation.

- The buddy system shall be practiced at all times on site. Any site worker observed with severe shivering shall leave the work area immediately.

- Site workers should dress in layers, with thinner lighter clothing worn next to the body.

- Site workers should avoid overdressing when going into warm areas or when performing strenuous activities. In addition, work should be planned and executed so as to minimize sweating.

Symptoms of Hypothermia

Mild Hypothermia (Core temperature 35°C)
Pallor
Shivering
Lack of coordination or weakness
Dulled mental state

Moderate Hypothermia (Core temperature 34-30°C)
Pallor
Reduced/no shivering
Slow, weak pulse
Weak breathing (<30 breaths per minute)
Unconsciousness between 32-30°C core temperature

Severe Hypothermia (Core temperature <30°C)
Unconsciousness
Skin very cold to touch
Extreme pallor
Generalized rigidity of limbs, neck
Slow or no pulse
Blue patches of skin
Puffy appearance of skin
Minimal breathing

Treatment varies for hypothermic patients. Application of warm blankets and *immediate medical treatment* is critical to the survival of the victim. Any signs of hypothermia should be treated as a medical emergency.

Section D Site Control

Personal Protection Required:

☐ Anti-C ☐ A ☐ B ☐ C ☒ D ☐ Mixed ☒ Modified

Note: *Minimum Level D equipment includes a hardhat, safety-toe boots, safety glasses, and substantial work clothing. All hardhats, glasses, and boots, must be ANSI approved.*

Mixed (Areas/Levels):
None anticipated.

Modified (Action Levels/Modifications):
Modified Level D PPE will be worn by site personnel.

Sturdy leather work gloves will be added to the Level D PPE for all personnel handling scrap debris. The gloves will be left in the work area at all times and disposed in a drum identified for used PPE at the end of the each work shift.

Additional Personal Protective Equipment Information:
When handling and working with explosives or UXO, EOD personnel will wear the PPE described in Section 5.0 of ITLV-TTR-005.

Face shield and PVC raingear are to be worn when using decontamination sprayers (high and low pressure).

Surveillance Equipment:

☐ PID (9.8eV ☐ 10.2eV ☐ 11.7eV ☐) ☐ FID ☐ Detector Tubes ☐ Types: _____

☐ Oxygen ☐ Explosimeter ☒ TLD ☒ Radiation ☒ Types: Alpha/Beta/Gamma

☐ Diffusion ☐ Toxic Gas (Gas:) ☐ Particulate Sampling ☐ Heat Stress (Area ☐ Personal ☐)

☐ Other: _____

NOTES: A Geiger-Mueller (Pancake) probe and Count Rate Meter with an Alpha Scintillator will be used.

Section D Site Control (continued)

Site Surveillance/Monitoring

Instrument	Surveillance Frequency	Monitoring Location	Calibration
Geiger-Mueller (Pancake) Probe and Survey Meter	☐ Every ____minutes ☐ Hourly ☒ Daily at Shift End ☐ Daily at Shift Start ☒ Other: To be performed on personnel or equipment leaving the exclusion zone.	☐ Breathing Zone ☒ Other: Equipment tires and other parts that were in contact with the debris being removed and the outer layer of clothing.	☐ Manufacturer Specs Per SOP #: ☒Start of Shift ☐ End of Shift Check ☒ Source Check
Count Rate Meter with Alpha Scintillator Probe	Every ____minutes ☐ Hourly ☒ Daily at Shift End ☐ Daily at Shift Start ☒ Other: To be performed on personnel or equipment leaving the exclusion zone.	☐ Breathing Zone ☒ Other: Equipment tires and other parts that were in contact with the debris being removed and the outer layer of clothing.	☐ Manufacturer Specs Per SOP #: ☒ Start of Shift ☐ End of Shift Check ☒ Source Check
	Every ____minutes ☐ Hourly ☐ Daily at Shift End ☐ Daily at Shift Start ☐ Other:	☐ Breathing Zone ☐ Other:	☐ Manufacturer Specs Per SOP #: ☐ Start of Shift ☐ End of Shift Check ☐ Source Check
	Every ____minutes ☐ Hourly ☐ Daily at Shift End ☐ Daily at Shift Start ☐ Other:	☐ Breathing Zone ☐ Other:	☐ Manufacturer Specs Per SOP #: ☐ Start of Shift ☐ End of Shift Check ☐ Source Check
	Every ____minutes ☐ Hourly ☐ Daily at Shift End ☐ Daily at Shift Start ☐ Other:	☐ Breathing Zone ☐ Other:	☐ Manufacturer Specs Per SOP #: ☐ Start of Shift ☐ End of Shift Check ☐ Source Check

Section E Site Operations/Documentation

Initial Hotline Location: Outside of the 3,000-ft exclusion zone.

Initial Command Post Location: Outside of the 3,000-ft exclusion zone.

NOTES:

Decontamination:

Light Equipment	1	Wash hand tools with soap and water.	4	If rad survey is positive, repeat steps 1-3 until the survey is negative.
	2	Rinse with tap water.	5	
	3	Perform radiological survey for Beta/Gamma.	6	
Heavy Equipment	1	N/A	4	
	2		5	
	3		6	
Personnel Decon:	1	Wash hands, forearms, and face with soap and water.	4	
	2	Perform radiological survey for Beta/Gamma.	5	
	3	If the rad survey is positive, repeat steps 1-2 until the survey is negative.	6	

Special Facilities Required: A break trailer where site workers may retreat to in inclement weather or need a warm place to rest.

Section E Site Operations/Decontamination (continued)

Site Entry Procedure:
A 3,000-ft radius exclusion zone will be established around the site and controlled by ASI Security during operations involving explosives. Only personnel essential to the removal operations will be allowed inside the exclusion zone.

In addition to the exclusion zone, a fragmentation hazard radius will be established for all explosive and potentially explosive operations. Personnel will **not** be allowed in this area during explosive operations.

Team Size: 10-15 **Pre-field Briefing Date:** TBA

Work Schedule: The work schedule consists of five 10-hour-days per week for approximately four to six weeks. The work will be conducted Mondays through Fridays.

Work will be conducted during daylight hours only.

No more that 15 hours per day (includes portal to portal) will be worked.

Other Information:
For heavy equipment operations, 2-each 20-lb classified ABC fire extinguishers are to be present on site and readily accessible during field activities.

Section E (Continued)

Action Levels

Parameter	Value	Action
Geiger-Mueller (Pancake) Probe and Survey Meter	☒ Greater than 2 x background ☐ Less than _____ ☐ Equal to _____	☐ Upgrade to: _____ ☐ Downgrade to: _____ ☐ Evacuate: _____ ☒ Stop and notify: DOE Sub-Project Manager & Site Supervisor ☒ Other action: Do not leave area until rad survey is negative, or RCT says to leave.
Count Rate Meter with Alpha Scintillator	☒ Greater than 20 dpm/cm^2 ☐ Less than _____ ☐ Equal to _____	☐ Upgrade to: _____ ☐ Downgrade to: _____ ☐ Evacuate: _____ ☒ Stop and notify: DOE Sub-Project Manager & Site Supervisor ☒ Other action: Do not leave area until rad survey is negative, or RCT says to leave.
	☐ Greater than _____ ☐ Less than _____ ☐ Equal to _____	☐ Upgrade to: _____ ☐ Downgrade to: _____ ☐ Evacuate: _____ ☐ Stop and notify: _____ ☐ Other action: _____

Section F Emergency Procedures

Emergency Actions:

Fire: Fight small incipient fires with portable fire extinguisher. If fire is too large, evacuate the area and notify ASI Security by telephone at 911. If a telephone is not available, contact "Cactus" (ASI Security) on Sandia Net via radio. Do not hang up or sign-off until told to do so by the operator.

PPE: N/A

Explosion: Evacuate the area and notify ASI Security by telephone at 911. If a telephone is not available, contact "Cactus" (ASI Security) on Sandia Net via radio. Do not hang up or sign-off until told to do so by the operator.

PPE: N/A

Weather: Retreat to TTR facilities in inclement weather or danger of flash flooding.

PPE: N/A

Injury: Stabilize individual, apply first aid if necessary. Notify ASI Security by telephone at 911. If a telephone is not available, contact "Cactus" (ASI Security) on Sandia Net via radio. Do not hang up or sign-off until told to do so by the operator.

PPE: Surgical gloves for first aid and a micro-shield for CPR. Place all used equipment/ materials in a Bio/bag which can be obtained from the first aid kit.

Spill: Absorbent materials should be kept on site for small inadvertent spills which may occur during refueling operations. If the spill is too large, summon appropriate authorities.

PPE: Chemical resistant gloves.

EMERGENCY COMMUNICATIONS

Police: Dial 911 or contact "Cactus" on Sandia Net via radio

Fire: Dial 911 or contact "Cactus" on Sandia Net via radio

Medical: Dial 911 or contact "Cactus" on Sandia Net via radio

Additional Emergency Communications:

Title	Name/Telephone
DOE NV ERP H&S Manager:	Roxanne Danz/(702) 295-7723
DOE Project Manager:	Kevin Cabble/(702) 295-5000, pager (702) 794-
IT Subproject Manager:	Randy Dubiskas/(702) 794-1700, pager (702) 794-6354
IT Health and Safety Officer::	Brian Klenk/(702) 794-1700, (702) 794-6241
IT UXO Manager:	Jim Pastorick/(703) 739-1357

Section F Emergency Procedures (continued)

Exposure Actions:

Substance	Symptoms of Exposure	Treatment	TWA	STEL	*Source	IDLH
Nitroaromatics	■ Acute ☐Chronic Irritation of eyes, dizziness, shortness of breath.	Eyes: Flush with water for a minimum of 15 minutes. Ingestion: Drink large quantities of water. Get medical attention for discomfort.	NA		PEL TLV REL	
Explosives	■ Acute ☐Chronic No acute symptoms.	Eyes: Flush with water for a minimum of 15 minutes. Ingestion: Drink large quantities of water. Get medical attention for discomfort	NA		PEL TLV REL	
	☐ Acute ☐Chronic				PEL TLV REL	
	☐Acute ☐Chronic				PEL TLV REL	
	☐Acute ☐Chronic				PEL TLV REL	
	☐Acute ☐Chronic				PEL TLV REL	
					PEL TLV REL	

TWA = Time Weighted Average (8 hour)
STEL = Short Term Exposure Limit
IDLH = Immediately Dangerous to Life or Health

*PEL (OSHA)
TLV (ACGIH)
REL (NIOSH)

Section F Emergency Procedures (continued)

Primary Hospital/Infirmary

Name: Area 3 Medic

Telephone No.: (702) 295-8345 or 295-8290

Address: Area 3 Building 0369

Specific Directions: The Area 3 medic is located in Building 0369.

Refer to Figures B-1 and B-2

Alternate Hospital/Infirmary

Name: Nye Regional Medical Center (located in the City of Tonopah)

Telephone No.: (702) 482-6233

Address: 825 South Main Street

Specific Directions: Go northwest from the TTR main gate for 32 miles to Highway 6, go west 12 miles to Highway 95, go north approximately 1/2 mile, turn left to the Nye Regional Medical Center. The Center will be on the west side of the Main Street.

Other Emergency Information: A Flight for Life helicopter is available through 911. Flight for Life is based in Las Vegas. The helicopter has a range of 150 miles, and will need to refuel at the Air Force facilities; therefore, allow approximately 1 1/2 hours to 2 hours for arrival. There is room for two persons laying down and one sitting up. There are no weight restrictions. The helicopter contains facilities for both ER and ICU; however, 911 will need to know all information about the patient so that proper supplies are included (i.e., snakebite anti-venom). 911 will need to know the exact location of the person and where the helicopter can land. Due to the possibility of UXO, the landing area will need to be a main road.

Section G Personnel Information

1) Name: Richard A. Dubiskas	2) Position/Title: IT Project Manager
3) Duties: Manages all aspects of the project	4) Reports to: Kevin Cabble [Frank Czajkowski (while on-site)]
5) 24 hours Supervised Field Experience? ☒Yes ☐No	
6) Initial Training Date: 10/22/89	12) Special Training: Radiological Worker II-10/06/93 CPR-03/16/94 First Aid-04/14/94
7) Refresher Training in the last 12 months Type: Hazard and Protection Limited Date Completed: 02/24/94	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: 08/19/92	
9) Last Physical Date: 09/24/94 / 10) Restrictions? ☐ Yes ☒ No	11) **Restriction: N/A**

1) Name: Frank Czajkowski	2) Position/Title: Site Supervisor
3) Duties: Oversees site operations and ensures site safety/competent person	4) Reports to: Richard A. Dubiskas
5) 24 hours Supervised Field Experience? ☐Yes ☒☐No	
6) Initial Training Date: 08/17/90	12) Special Training: EOD/UXO School Excavation Safety 01/31/95
7) Refresher Training in the last 12 months Type: 8 hr Refresher Training Date Completed: 10/10/94	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: 09/30/93	
9) Last Physical Date: 03/17/94 / 10) Restrictions? ☒ Yes ☐ No	11) **Restriction: color blindness and hearing protection required when noise levels reach or exceed 85 dBA**

Section G Personnel Information

1) Name: Mike Fahrenhorst	2) Position/Title: Team Leader
3) Duties: UXO Supervisor/Team Leader responsibilities	4) Reports to: Frank Czajkowski
5) 24 hours Supervised Field Experience? ☐ Yes ☒ No	
6) Initial Training Date: 07/18/94	12) Special Training: EOD/UXO School Excavation Safety 01/31/95
7) Refresher Training in the last 12 months Type: -- Date Completed:	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: --	
9) Last Physical Date: 07/94 / 10) Restrictions? ☐ Yes ☒ No	11) Restriction: N/A

1) Name: Robert Parsons	2) Position/Title: UXO Specialist
3) Duties: UXO removal/disposal	4) Reports to: Frank Czajkowski
5) 24 hours Supervised Field Experience? ☒ Yes ☐ No	
6) Initial Training Date: 08/04/94	12) Special Training: US Naval EOD School-09/76 Excavation Safety 01/31/95
7) Refresher Training in the last 12 months Type: -- Date Completed:	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: --	
9) Last Physical Date: 08/12/94 / 10) Restrictions? ☐ Yes ☒ No	11) Restriction: N/A

Section G Personnel Information

1) Name: Brian Sunderman	2) Position/Title: UXO Assistant
3) Duties: Identify and remove UXO	4) Reports to: Frank Czajkowski
5) 24 hours Supervised Field Experience? ☒Yes ☐No	
6) Initial Training Date: 12/09/93	12) Special Training: US Naval Explosive Ordnance Disposal Basic Assistant-11/06/84 US Army Explosive Ordinance Disposal Course-09/21/84 Excavation Safety 01/31/95
7) Refresher Training in the last 12 months Type: Date Completed:	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: --	
9) Last Physical Date: 10/28/94 / 10) Restrictions? ☐ Yes ☒ No	11) Restriction: N/A

1) Name: Cheryl L. Swaton	2) Position/Title: Project Team Member
3) Duties: Document field activities, maintain an inventory of UXO disposal	4) Reports to: Frank Czajkowski
5) 24 hours Supervised Field Experience? ☒ Yes ☐ No	
6) Initial Training Date: 05/25/90	12) Special Training: Bloodborne Pathogens Training-01/17/94 CPR-04/27/94 First Aid-05/13/93 Radiological Worker II-07/23/93 Excavation Safety 01/31/95
7) Refresher Training in the last 12 months Type: Hazard and Protection Limited Date Completed: 07/14/94	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: 03/26/91	
9) Last Physical Date: 07/07/94 / 10) Restrictions? ☐ Yes ☒ No	11) Restriction: N/A

Section G Personnel Information

1) Name: Brian G. Klenk	2) Position/Title: Health and Safety Manager
3) Duties: Provide support to field operations regarding H&S issues	4) Reports to: Kevin Cabble [Frank Czajkowski (while on-site)]
5) 24 hours Supervised Field Experience? ☒ Yes ☐ No	
6) Initial Training Date: 07/05/87	12) Special Training: CPR-04/13/94 First Aid-04/15/93 Radiation Hazards Training (GERT)-04/27/93 Excavation Safety 01/31/95
7) Refresher Training in the last 12 months Type: Hazard and Protection Limited Date Completed: 02/24/94	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: 08/19/94	
9) Last Physical Date: 09/30/94 / 10) Restrictions? ☐ Yes ☒ No	11) Restriction: N/A

1) Name: Kevin Cabble	2) Position/Title: DOE Project Manager
3) Duties: Observe site operations	4) Reports to: Steve Mellington [Frank Czajkowski (while on-site)]
5) 24 hours Supervised Field Experience? ☒ Yes ☐ No	
6) Initial Training Date: 03/24/88	12) Special Training: Hazardous Materials Workshop-01/23/87 Radiation Safety Officer-09/12/88 Radioactive Materials Course-02/87 Transportation of Hazardous Materials-01/88
7) Refresher Training in the last 12 months Type: Hazardous Waste Site Worker Date Completed: 06/29/94	
8) Site Supervisor Training Required? ☐ Yes ☒ No Date Completed: 01/27/89	
9) Last Physical Date: 06/94 / 10) Restrictions? ☐ Yes ☒ No	11) Restriction: N/A

Accident/Injury/Near Miss Checklist

Name of Person(s): _____

Date of Incident: _____ Time: _____

Exact location of incident: _____

Job Title: _____ Job Number: _____

Supervisor : _____ _____

Printed Name Signature

Site Supervisor's Accident/Injury/Near Miss Checklist		
Step	**Action/Requirement**	**Date/Time** (24 hr clock)
1	Perform first aid/CPR, as appropriate, and get injured/ill to medical care immediately, if required.	
2	Isolate and protect scene of accident (non-automobile). If automobile accident, clear personnel and vehicles from roadway and/or place warning devices.	
3	Report incident by phone to Lead Organization Project Manager and NV ERP H&S Manager, and Employer immediately after situation is under control.	
4	Complete appropriate form(s) as required by Employer/DOE	
5	Perform Accident/Incident Investigation as soon as possible, and complete accident investigation report.	
6	Submit accident investigation report to DOE-NV via required reporting mechanisms (ORPS, etc.)	
7	Turn this form in to Nevada ERP Health and Safety Manager	

NOTE: All workers are required to report all injuries, illnesses, accidents, and near misses.

EMERGENCY NOTIFICATION

In the event of an emergency (serious injury, serious illness, fatality, serious property damage, serious spill, etc.) notify the following personnel at once in the following order:

DOE Project Manager:

NAME: Kevin Cabble
OFFICE PHONE: (702) 295-5000, pager (702) 794-
HOME PHONE: (702) 645-6049

(DOE Project Manager to notify DOE NV ERP Project Manager and DOE NV ERP H&S Manager)

IT Project Manager:

NAME: Randy Dubiskas
OFFICE PHONE: (702) 794-1700, pager (702) 794-6354
HOME PHONE: (702) 451-1013

DOE NV ERP H&S Manager:

NAME: Roxanne Danz
OFFICE PHONE: (702) 295-7723
HOME PHONE: (702) 645-0512

(DOE NV ERP H&S Manager to advise Contractor and DOE NV ERP Project Managers on proper course of action and coordinate notification of other governmental agencies, as necessary)

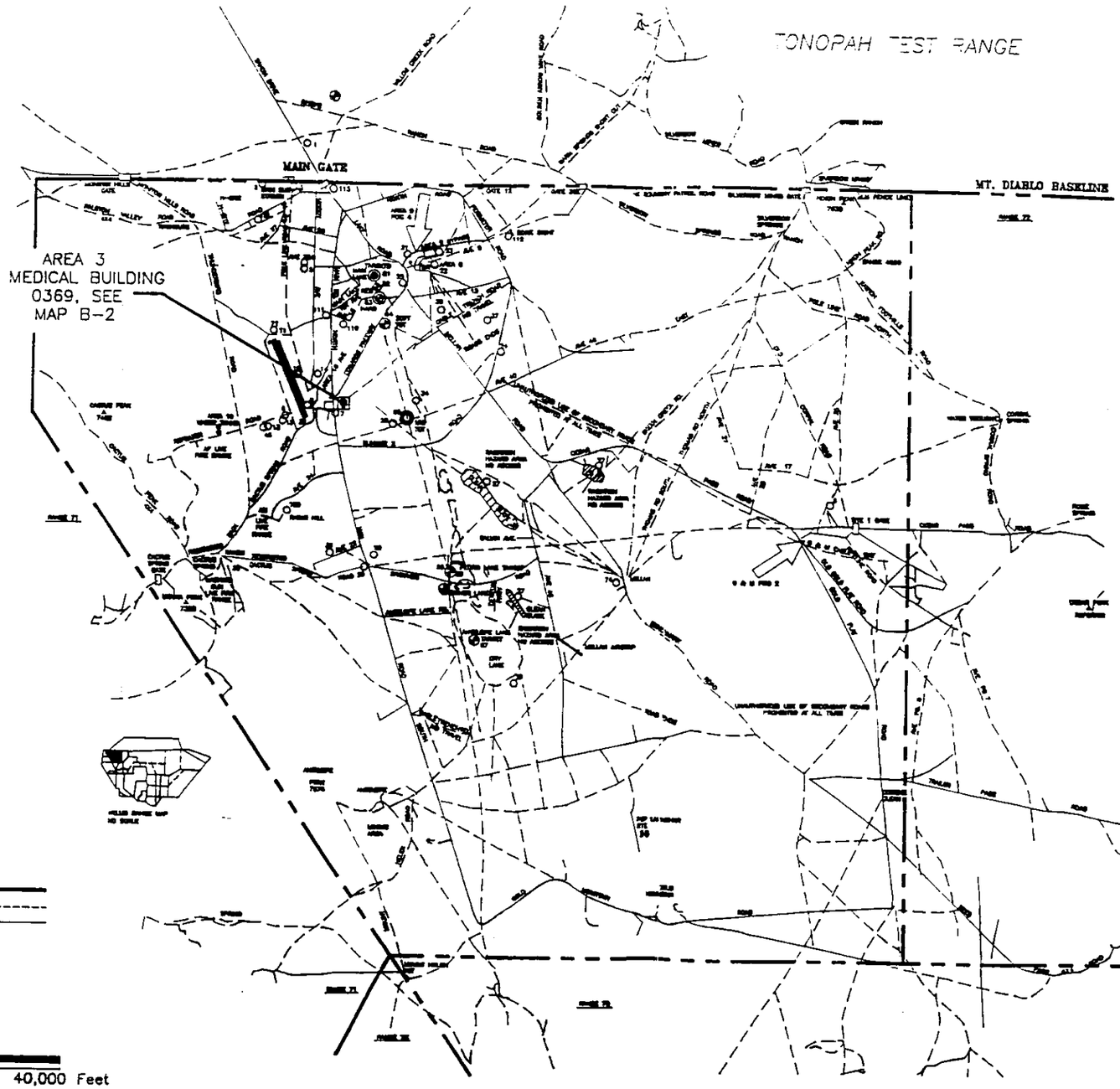
Other:

TITLE: TTR Site ES&H Coordinator
NAME: Roger Smith
OFFICE PHONE: (702) 295-8411; beeper (702) 794-6040
HOME PHONE: (702) 293-1250
RESPONSIBILITIES: Manager of Range operations and safety.

TITLE: IT Health and Safety Manager
NAME: Brian G. Klenk, CIH CEM
OFFICE PHONE: (702) 794-1700
HOME PHONE: Pager: (702) 794-6241 Cellular: (702) 271-9756 (Both 24 hrs)
RESPONSIBILITIES: Advise and assist IT Project Manager and Site Supervisor in health and safety related issues.

EMERGENCY NOTIFICATION (continued)

TITLE:	IT UXO Manager
NAME:	Jim Pastorick
OFFICE PHONE:	(703) 793-1357
HOME PHONE:	(703) 549-7133
RESPONSIBILITIES:	Director of UXO Operations



WELLS RANGE MAP
NO SCALE

PERMITS	OWNER	TYPE	
1. SUM WELL	USAF	PUBLIC WATER	
2. EH-7 WELL	USAF	PUBLIC WATER	
3. 1A WELL	USAF	PUBLIC WATER	
4. 3B WELL	USAF	PUBLIC WATER	
5. 3A WELL	USAF	PUBLIC WATER	
6. EH-2 WELL	USAF	PUBLIC WATER	
7. WELL 8	DOE/KAO	PUBLIC WATER	
8. O & M WELL	USAF	PUBLIC WATER	
9. FUEL STORAGE TANKS	USAF	AIR QUALITY	SEE POC 5A
10. INCINERATOR	USAF	AIR QUALITY	SEE POC 5A
11. VAPOR EXTRACTION	DOE/NV	AIR QUALITY	SEE POC 6B
12. BATCH PLANT	DOE/KAO	AIR QUALITY	
13. CRUSHER/SCREEN	DOE/KAO	AIR QUALITY	
14. LANDFILL	USAF	WASTE BUREAU	SEE POC 5A
15. SEWER LAGOON	USAF	WATER QUALITY	

ER/IRP	OWNER	SNL/TTR SITE	
21. LANDFILL A-1	DOE/KAO	125	
22. HIGH EXPLOSIVE AREA	DOE/KAO	124	
23. MOBILE PHOTO LAB	DOE/KAO	126	SEE POC 4
24. 6 PITS LANDFILL	DOE/KAO	98	
25. DU IMPACT SITE	DOE/KAO	97	
26. BOMBLET PIT	DOE/KAO	127	
27. CLEAN SLATE	DOE/KAO		
28. ANTELOPE LAKE BEX S.E.	DOE/NV	128	
29. ROLLER COASTER DECON	DOE/KAO	131	
30. CACTUS SPRINGS	DOE/KAO	129	
31. OLD FIRING RANGE	DOE/KAO		
32. OLD BURN PIT	DOE/KAO	120	SEE POC 3
33. SEPTIC TANKS	DOE/KAO	122	SEE POC 3
34. NEDS LAKE	DOE/KAO	127	
35. FRENCH DRAINS	DOE/KAO	121	SEE POC 3
36. A-3 LANDFILL	DOE/KAO		SEE POC 3
37. ARTILLERY ROUND	DOE/KAO	119	
38. ARTILLERY ROUND	DOE/KAO		
39. PEDRO TARGET	DOE/KAO		

40-69 SEE SHEETS POC-5A & 5B

ENVIRONMENTAL INCIDENT AREAS

71. (11) FIRE TRAINING PIT	DOE/NV	
72. TANK REMOVAL	USAF	SEE POC 5A & 5B
73. TOWER	USAF	SEE POC 5A & 5B
74. CAMERA SITE	DOE/KAO	

TARGETS

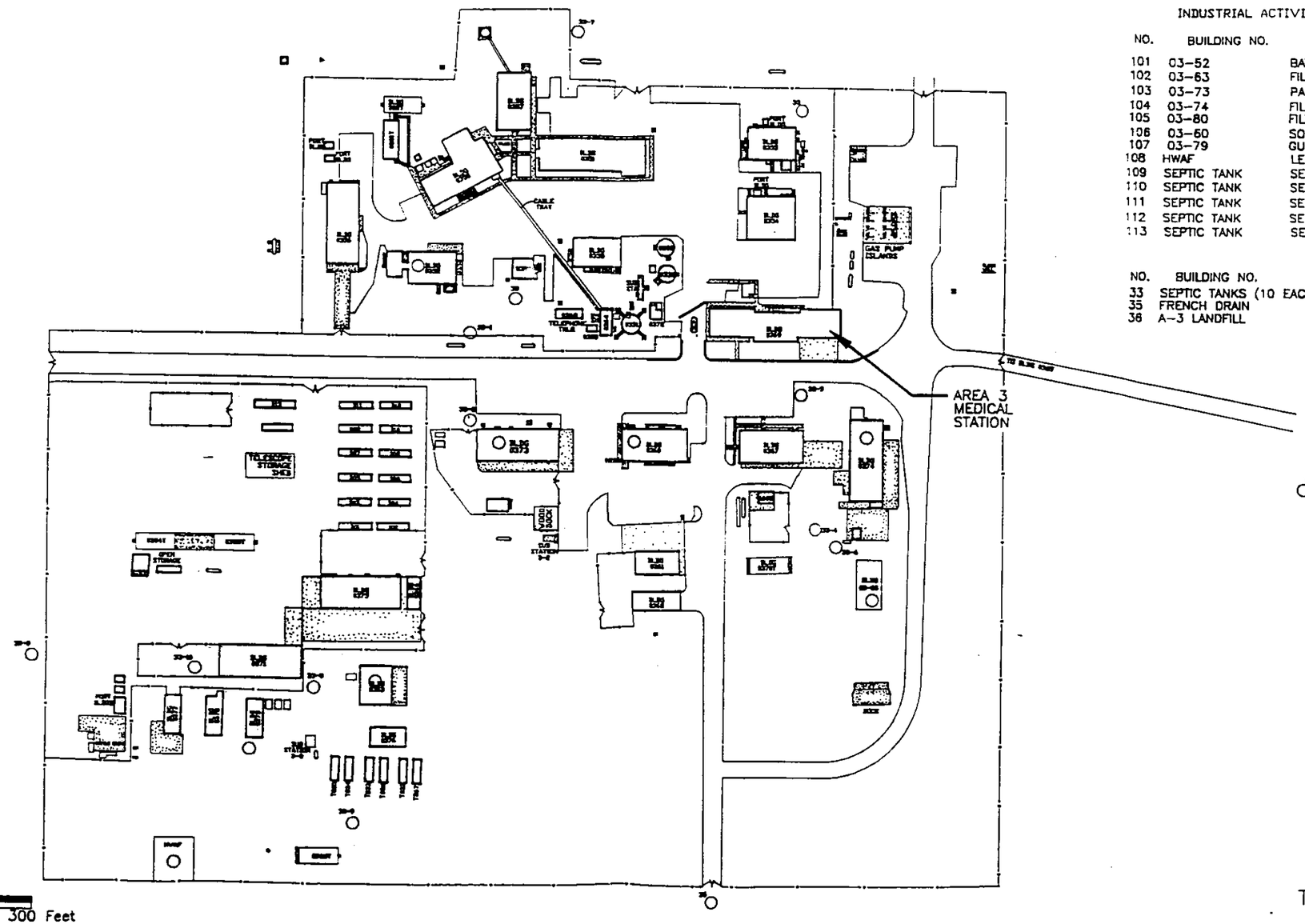
81. MAIN (R6MA)
82. RED
83. HARD
84. SOFT
85. MID
86. PEDRO (R6MA)
87. ANTELOPE LAKE (R6MA)

INDUSTRIAL ACTIVITIES

91-100 SEE POC-2
101-120 SEE POC-3
121-130 SEE POC-4
131-180 SEE POC-5A & 5B

FIGURE B-1
TONOPAH TEST RANGE
SITE MAP

TTR3 06/28/93 9:00AM JRB



INDUSTRIAL ACTIVITIES

NO.	BUILDING NO.	WASTE TYPE
101	03-52	BATTERIES
102	03-63	FILTERS
103	03-73	PAINT RELATED MATERIAL
104	03-74	FILTERS
105	03-80	FILTERS
106	03-60	SOLVENT RECYCLE
107	03-79	GUN CLEANING
108	HWAF	LESS THAN 90 DAY STORAGE
109	SEPTIC TANK	SEE POC 1
110	SEPTIC TANK	SEE POC 1
111	SEPTIC TANK	SEE POC 1
112	SEPTIC TANK	SEE POC 1
113	SEPTIC TANK	SEE POC 1

NO.	BUILDING NO.	RESTORATION PROJECTS
33	SEPTIC TANKS (10 EACH)	
35	FRENCH DRAIN	
36	A-3 LANDFILL	

FIGURE B-2
TONOPAH TEST RANGE
AREA 3 SITE MAP

POC-2A 06/28/93 2:00PM JRB

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Richard A. Dubiskas, Project Manager IT Corporation 4330 South Valley View, Suite 114 Las Vegas, Nevada 89023	3
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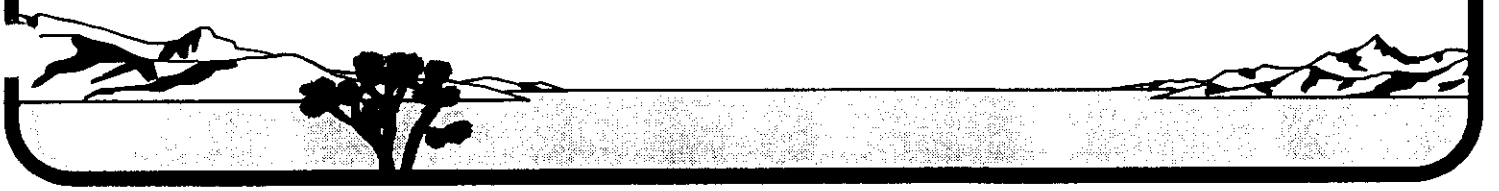
CORPORATION

DOE/NV/10972-131
UC-700

Safety Assessment for Ordnance Removal from Five Disposal Sites at the Tonopah Test Range

January 1995



DOE/NV/10972--131
UC-700

SAFETY ASSESSMENT FOR ORDNANCE REMOVAL FROM FIVE DISPOSAL SITES AT THE TONOPAH TEST RANGE

Prepared by

IT CORPORATION
4330 South Valley View Boulevard, Suite 114
Las Vegas, Nevada 89103

Work Performed Under Contract No.
DE-AC08-92NV10972

January 1995

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SAFETY ASSESSMENT FOR
ORDNANCE REMOVAL FROM FIVE DISPOSAL SITES
AT THE TONOPAH TEST RANGE

Approved: _____ Date 1/31/95
ITLV Program Manager

Approved: Richard A. Dubiskas Date 1-31-95
ITLV Project Manager

Approved: Cheryl J. Dixton for Brian Klenk Date 1/31/95
ITLV Health and Safety Manager

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List of Acronyms and Abbreviations

AEC	U.S. Atomic Energy Commission
BLM	U.S. Bureau of Land Management
CBU	cluster bomb unit
CFR	Code of Federal Regulations
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE/AL-KAO	U.S. Department of Energy, Albuquerque, Kirtland Area Office
DOE/NV	U.S. Department of Energy Nevada Operations Office
DOP	Detailed Operating Procedure
ERD	Environmental Restoration Division
ft	foot
g	gram
gal	gallon
in.	inch
IT	IT Corporation
kg	kilogram
km	kilometer
km^2	square kilometer
lb	pound
LSC	linear shaped charge
m	meter
mi	mile
mi^2	square mile
MIL-STD	Military Standard
mm	millimeter
NAFR	Nellis Air Force Range
NV ERP	Nevada Environmental Restoration Project
OSHA	Occupational Safety and Health Administration
RETRVIR	Remote Telerobotic Vehicle for Intelligent Retrieval
RCRA	Resource Conservation and Recovery Act
REECo	Reynolds Electrical & Engineering Co., Inc.
SA	Safety Assessment
SAR	Safety Assessment Report

List of Acronyms and Abbreviations *(Continued)*

SNL	Sandia National Laboratories
SOP	Standard Operating Procedure
TTR	Tonopah Test Range
USAF	U.S. Air Force
UXO	unexploded ordnance
VCA	Voluntary Corrective Action

1.0 Introduction

This Safety Assessment (SA) covers proposed U.S. Department of Energy (DOE) activities in conjunction with the Voluntary Corrective Action (VCA) Work Plan for Ordnance Removal from Five Disposal Pits at the Tonopah Test Range (TTR). The SA has been prepared in accordance with the requirements of DOE Order 5481.1B, Safety Analysis and Review System; Order AL 5481.1B, Safety Analysis and Review System; Order 5480.1B, Environment, Safety, and Health Program for Department of Energy Operations; and *DOE Explosives Safety Manual* (1994a), with additional guidance from the U.S. Department of Defense (DoD), Military Standard (MIL-STD-) 882C, System Safety Program Requirements (1993). The SA was completed to determine hazards and risks associated with ordnance removal operations set forth in the VCA Work Plan.

The objective of the VCA Work Plan is to detail the activities required to conduct the removal of unexploded ordnance (UXO) from five sites at the TTR. The sites are a high priority for several reasons: the safety hazard to on-site personnel posed by the UXO that may be live, the concentration of UXO at the sites, and the site priority rankings of the sites under the DOE Nevada Environmental Restoration Program (NV ERP). These five disposal sites were documented through the Environmental Restoration Sites Inventory process. Additional UXO is known to be scattered throughout large areas of TTR; however, this problem is beyond the scope of the VCA and will be addressed in subsequent actions through the use of remote sensing techniques. All five sites are to be free of UXO after the VCA activities. Closure of the sites will require verification sampling to confirm that no substances regulated under the Resource Conservation and Recovery Act (RCRA) remain at the sites. Closure verification is beyond the scope of the VCA Work Plan and will be addressed in later documents.

The results of the risk analysis discussed in this document indicate that hazard mitigation and controls are sufficient to provide an acceptable level of risk for the project; thus, a Safety Analysis Report (SAR) is not necessary, and the project may be conducted.

2.0 Summary and Conclusions

The result of this SA is that, for the activities planned for this project, the risks associated with most of the activities are improbable or have a remote probability of occurrence or a negligible (extremely low) consequence. Activities in these probability and consequence ranges fall within the evaluation criteria designated as acceptable with or without review by the Managing Activity, i.e., DOE Nevada Operations Office, (DOE/NV) Environmental Restoration Division (ERD), with concurrence from the DOE/NV Safety Division and assistance from the DOE Albuquerque Office, Kirtland Area Office (DOE/AL-KAO), according to MIL-STD-882C. Several planned activities fall within the occasional and remote probabilities of occurrence with critical to catastrophic consequences that then place the activities in the undesirable (decision necessary) category according to MIL-STD-882C. This category requires a decision by the Managing Activity with respect to whether the risk is acceptable. Three out of four of these activities involve the use of the Sandia National Laboratories' (SNL) Remote Telerobotic Vehicle for Intelligent Retrieval (RETRVIR) during the handling of bomblets and excavation of subsurface anomalies. In these cases, the potential consequence of the applicable hazards is related to damage of the RETRVIR system through unplanned detonation of UXO. The RETRVIR system is being used to reduce the risk to personnel and, in that light, it is deemed preferable to expose the RETRVIR to risks that would have greater consequences were personnel exposed. One planned activity that poses an undesirable risk to personnel is the manual excavation of subsurface anomalies. This activity will be avoided, if at all possible, through the use of the RETRVIR system for excavation. However, if the RETRVIR system is not capable of excavating the anomalies, it will be necessary to excavate them manually. Manual excavation of such subsurface anomalies is not uncommon in UXO operations such as this and will be conducted by UXO experts; however, there is always an inherent risk in such activities.

Projected impacts are strictly on site and negligible off site with regard to injury to personnel or damage to equipment or the environment. The highest consequence items identified in the SA are associated with the unplanned detonation of UXO or processing explosives. Unplanned detonation is generally related to jarring or movement of UXO, which will be conducted remotely, and thus poses no threat to personnel, misidentification of UXO, nonconformance with applicable Standard Operating Procedures (SOPs) and Detailed Operating Procedures (DOPs), or natural phenomena (e.g., lightning strikes during processing explosive or UXO handling) that cannot be controlled. These risks can be detected and mitigated through strict compliance with SOPs and DOPs. The highest probability items

identified are generally associated with difficulties in identifying UXO or the unplanned disturbance of UXO. Here again, these items shall be mitigated through adherence to the SOPs and DOPs, which require the use of remote handling equipment for most UXO handling, resulting in a negligible consequence in case of detonation.

According to MIL-STD-882C, none of the identified hazards is unacceptable, although some require review or decision by the Managing Activity. Those hazards that have been determined to be undesirable, based most often on the potential damage to remote equipment, require a decision by the Managing Activity and tracking by the contractor for possible corrective action. In this case, it has been determined, with respect to the possible undesirable hazards, that a risk to equipment is more acceptable than a risk of equal or worse severity to personnel. Based on the results of this SA, it is concluded that the preparation of a SAR is not necessary and the planned activities present an acceptable risk for the following reasons:

- All operations will be conducted with strict adherence to SOPs and DOPs designed for UXO and explosive identification and handling and with the DOE Explosives Safety Manual.
- Work will be immediately halted for any change in circumstances that may result in a change or increase in hazards (e.g., discovery of previously unidentified UXO, potential hazardous wastes, and potential low-level wastes).
- The most dangerous of the planned activities will be conducted remotely.
- All work will be directed and/or conducted by qualified IT Corporation (IT) personnel with extensive experience in handling UXO and explosives.

The analysis that supports the conclusions of this SA is presented in Section 6.0.

3.0 Site Description and Assessment

The TTR covers an area of approximately 1,350 square kilometers (km^2) (520 square miles [mi^2]) in Nye County, Nevada, on the northern portion of the Nellis Air Force Range (NAFR) (Figure 3-1). It is approximately 225 kilometers (km) (140 miles [mi]) northwest of Las Vegas by air and approximately 64 km (40 mi) southeast of Tonopah by road (DOE, 1992). The TTR is bordered on the south, east, and west by the NAFR and on the north by sparsely populated public land administrated by the U.S. Bureau of Land Management (BLM) and the U.S. Forest Service (DOE, 1992).

In November 1956, a Memorandum of Understanding between the U.S. Air Force (USAF) and the U.S. Atomic Energy Commission (AEC) (predecessor agency to the DOE) provided 369,280 acres (the TTR) to the AEC (BLM, 1979). Construction at the TTR began in 1956, and SNL has operated the facility for the DOE since 1957 (DOE/USAF, 1988).

In 1957, the TTR was established to field test conventional and nuclear weapons, research rockets, and artillery. It was made a permanent facility in 1958 (Ecology and Environment, Inc., 1989). Activities vary from tests of hardware components or systems needing limited support to rocket launches or air drops of test vehicles requiring full range support for the USAF, U.S. Army, and U.S. Navy operational and test groups and some defense contractors (ERDA, 1975).

The TTR is divided into a classified number of areas (Figure 3-2) with generally indistinct boundaries. Areas 3 and 9 and a Test Area are under SNL control and are the main centers of SNL activities. Area 3 is the Control Point Area, which contains support facilities for maintenance and operations. Area 9 is the center for rocket and gun firings, ordnance storage, and related test support operations, with impact areas to the southeast. The Test Area is a series of dry lakes that begins at Main Lake near Area 9, continues south for about 21 km (13 mi), and ends with Antelope Lake (ERDA, 1975). Area 10 and other remote parts of the range are under USAF (Nellis) control.

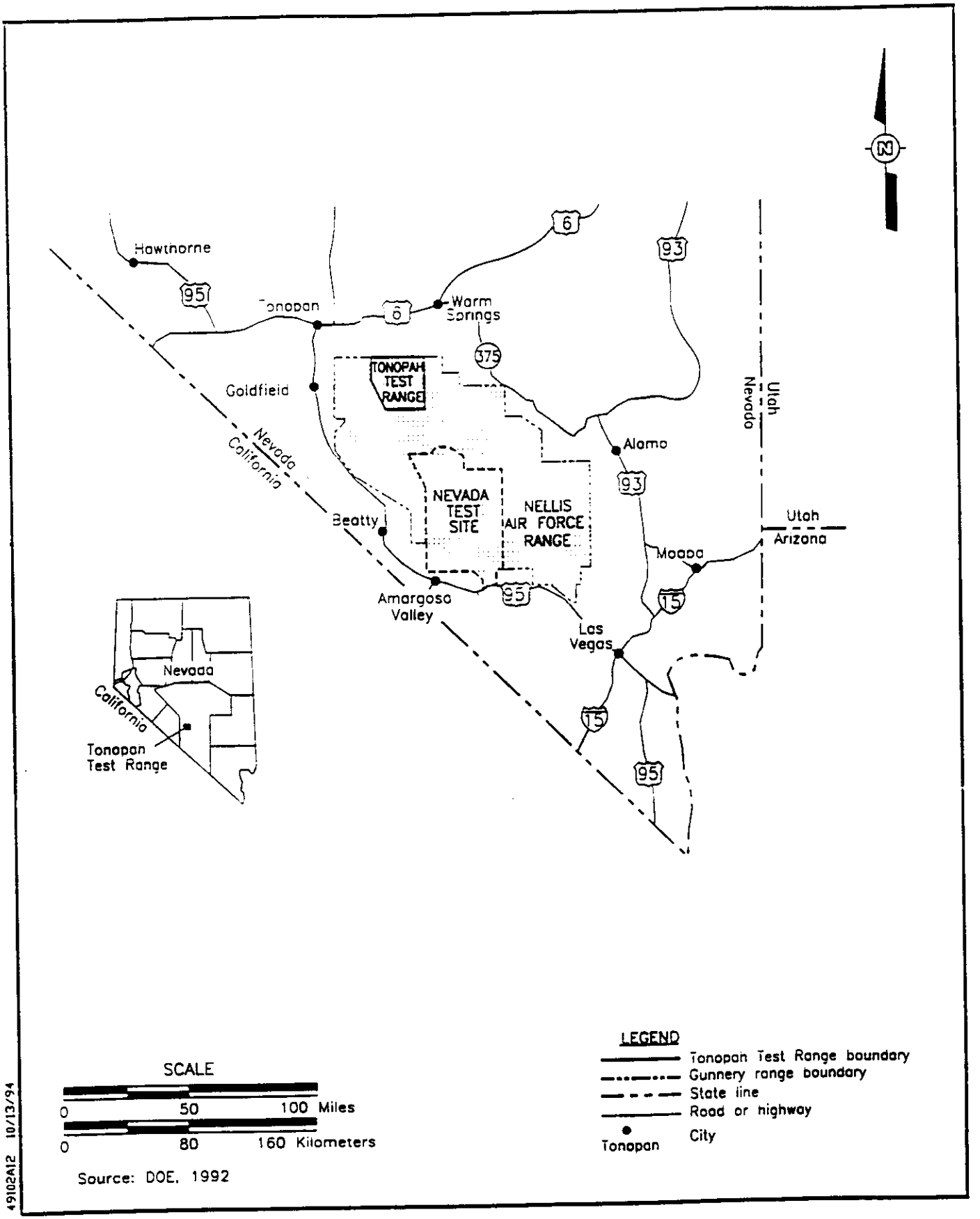

Figure 3-1
Location Map Tonopah Test Range

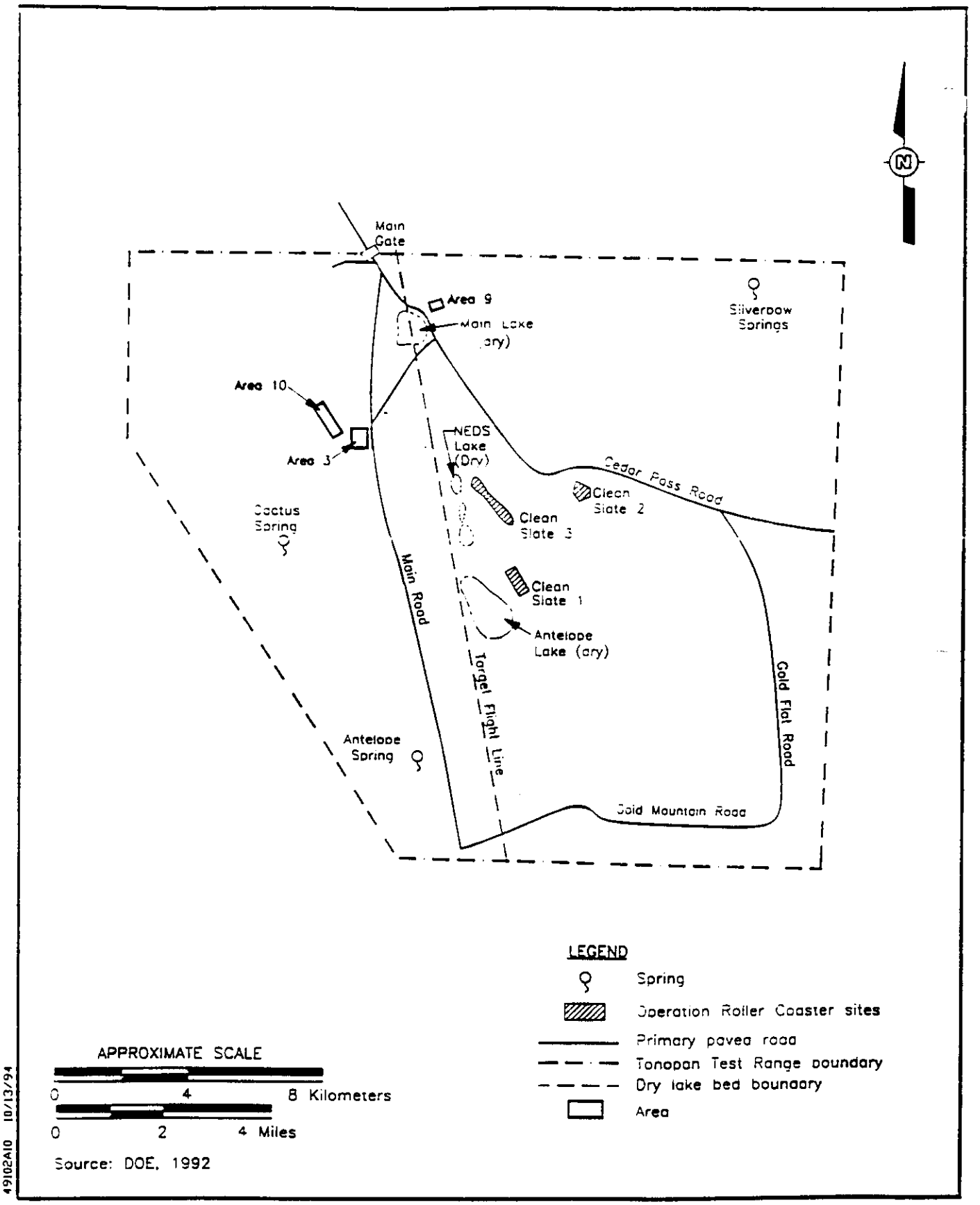

Figure 3-2
Tonopah Test Range Layout

4.0 Description of Facility

The VCA Work Plan addresses the removal of UXO and other debris from five sites on the TTR (Plate 1). The sites are referred to as the Bomblet Pit, the Roller Coaster Sewage Lagoons, the Five Points Landfill, the Area 9 Landfill, and the Area 9 Construction Debris Pit. These sites have been used as collection locations for debris that has been accumulated from various testing areas during periodic range clean-up efforts by SNL. The five sites contain conventional UXO, spent solid-fuel rocket boosters, target drums, and construction debris.

4.1 Bomblet Pit

The Bomblet Pit is located approximately one mile northwest of Bunker 2 Road, as shown in Plate 1. The pit, which is surrounded by a fence, contains many bomblets (or cluster bomb units [CBUs]), bomblet-dispenser clamshell sections, spent rocket motors, and other assorted debris (see Figure 4-1). The number of bomblets in the pit ranges from an estimated 400 to 1,000 CBUs. An observed dispenser section identified its former contents as "inert BLU-63 w/mod M219E fuze." This identification denotes a bomblet that was not filled with an explosive main charge, but did have a live fuze containing less than 1 gram (g) of explosives. All visible dispensers in the pit are clearly marked as inert submunitions with M219E1 fuzes (Czajkowski, 1994). Assuming each fuze to be intact with 1 g of explosives, the pit could collectively contain a maximum of 1 kilogram (kg) of explosives if all the bomblets in the pit are of the inert BLU-63 w/mod M219E fuze type. However, because of the numerous different types of bomblets used on the TTR in the past, it is possible, if not likely, that other types of bomblets that may contain larger amounts of explosives or be live loaded, are present in the pit. Other UXO observed in the Bomblet Pit includes two MK84 2,000-pound (lb) bombs that appear to be unfuzed. Because of the quantity of UXO, the Bomblet Pit has the highest priority for action during this project.

The Bomblet Pit was used for disposal of debris from antipersonnel and antivehicular CBU tests. These tests were conducted between the north end of Antelope Lake and Mid-Target (Plate 1) during the 1970s. Each test involved the aerial drop of one or more dispensers containing hundreds of bomblets. These bomblets had fuzes that were armed during free fall (West, 1993). Mid-Target, located adjacent to the Bomblet Pit, is a known training range used for inert munitions.

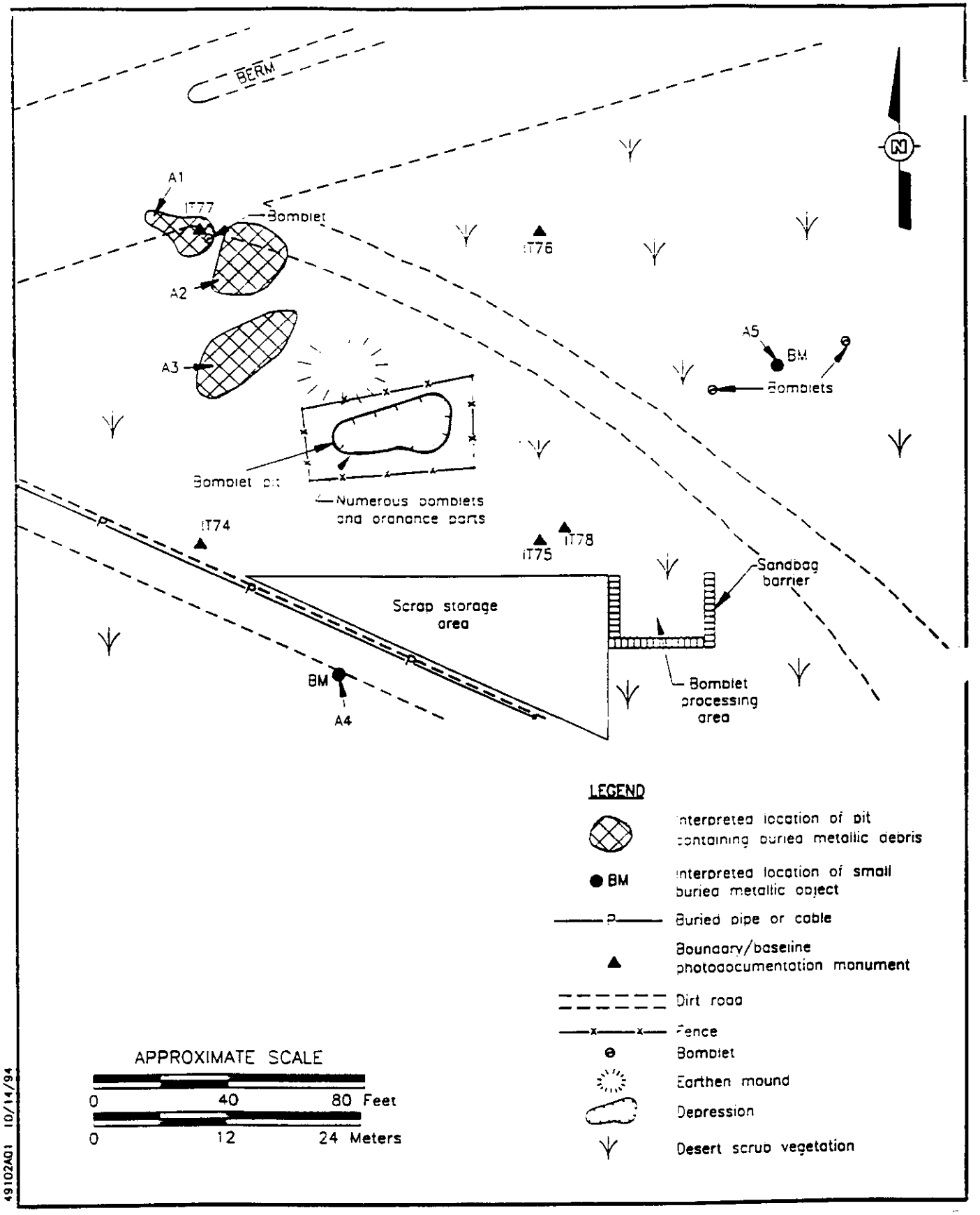

Figure 4-1
Site Map, Bomblet Pit, Tonopah Test Range

The open Bomblet Pit is approximately 11 meters (m) (35 feet [ft]) long, 3 m to 5 m (10 ft to 15 ft) wide, and 1 m (3 ft to 4 ft) deep. A small mound of earth is located on the north side of the fence (Figure 4-1). A geophysical investigation conducted at this site found five anomalies (labeled as A1 through A5 on Figure 4-1) that were identified as buried metallic debris (DOE, 1994b). In addition to these anomalies, three bomblets have been identified on the surface outside the fenced area. Buried pipes and/or cables were identified at the site during the geophysical investigation (DOE, 1994b).

4.2 Roller Coaster Sanitary Sewage Lagoons

The Roller Coaster sanitary sewage lagoons and ancillary disposal pit are located approximately 8 km (5 mi) south of Area 3 along South Main Road (Plate 1). The sewage lagoons received liquid sanitary wastes from the main camp for DOE/NV personnel who worked on Operation Roller Coaster in 1963. The lagoons are presently dry and have been filled with debris consisting of spent rocket motors; empty propellent containers; aircraft targets, made by welding six 55-gallon (gal) drums together to form a pyramid; construction debris; cable spools; pallets; and some UXO (DOE, 1994b). The ancillary disposal pit contains similar types of debris. The ancillary disposal pit is 32 m long by 14 m wide by 3 m deep (105 ft long by 45 ft wide by 10 ft deep) and is located approximately 80 ft north of the sewage lagoons (Figure 4-2).

4.3 Five Points Landfill

The Five Points Landfill is located approximately 2 km (1 mi) north of the Five Points intersection along Perimeter Road (Plate 1). The site consists of a fenced depression approximately 130 m long by 35 m wide by 3 m deep (440 ft long by 110 ft wide by 10 ft deep) with a mostly flat bottom. Numerous large missile sections and venturi, at least one 1,000-lb bomb that appears to be an MK83, a 250-lb practice bomb, other practice bombs, two possible 5-inch (in.) Zuni rockets, spent rocket motors, soil piles, concrete fragments, lumber, steel fence posts, large steel-plate structures, and wires are found mostly along the slopes of the depression (DOE, 1994b).

There is also a large graded area that extends approximately 200 m (650 ft) east of the fenced area, which was investigated using surface geophysical methods (Figure 4-3). Surface geophysical surveys, including surface conductivity and magnetometer surveys, were completed in 1993 (DOE, 1994b). The geophysical surveys indicate that no buried disposal cells exist at this site east of the fenced area.

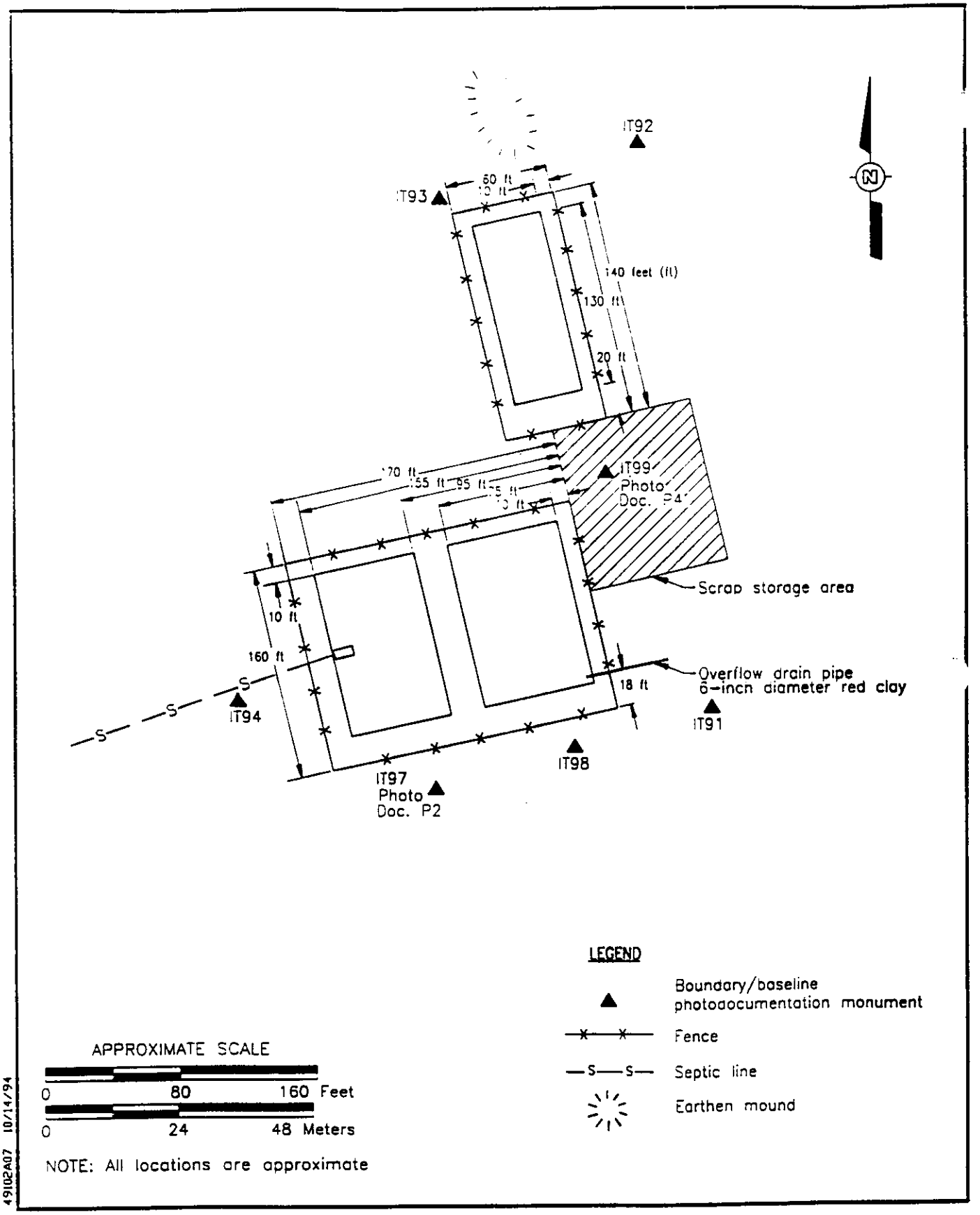

Figure 4-2
Site Map, Roller Coaster Sanitary Sewer System and Lagoons, Tonopah Test Range

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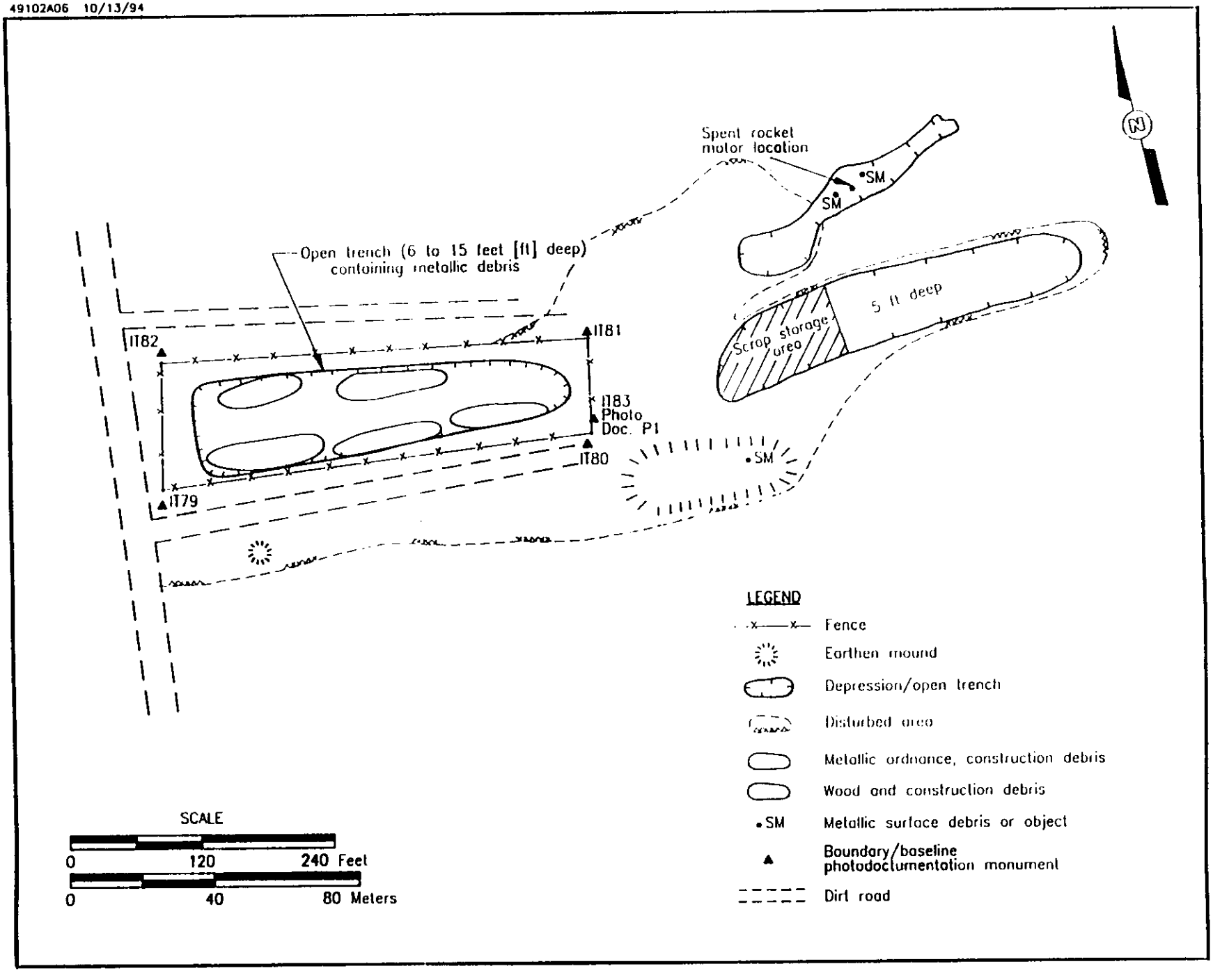

Figure 4-3
Site Map, Five Points Landfill, Tonopah Test Range

4.4 Area 9 Landfill

The Area 9 Landfill covers approximately 2.3 acres and is located along the Area 9 Bypass Road northwest of Area 9 (Plates 1 and 2). This site consists of an open pit approximately 14 m long by 6 m wide (45 ft long by 20 ft wide) and 4 covered landfill cells, the largest of which is 81 m long by 12 m wide (260 ft long by 40 ft wide) (Figure 4-4). The open trench is the subject of the VCA activities. It contains spent-rocket booster parts, 155-millimeter (mm) ammunition canisters (empty), two 155-mm artillery rounds that appear to be unfuzed, 55-gal drums, practice bombs, insulated cables, reinforced concrete, and other construction debris (IT, 1993). The covered cells received residues from the burning of high explosives, gun propellants, electrical igniters, and solid-fuel rocket motors (ERDA, 1975). They also received construction debris, trash from Area 9, debris from range cleanup, and possible ordnance. The cells were also reportedly used as burn pits (Karas, 1993). The location of the covered trenches was verified by surface geophysical surveys (DOE, 1994b).

4.5 Area 9 Construction Debris Disposal Area

The Area 9 Construction Debris Disposal Area is located east of Main Lake along Lake Road (Plates 1 and 2). This site covers approximately one acre and contains broken reinforced concrete with conduits running through it, wood scraps, and plastic pipe. Ordnance at this site consists of one MK84 2,000-lb bomb with its inert filler exposed and several inert 20-lb practice bombs lying at the eastern edge of the construction debris pile. There is no evidence that anything was buried at this site, and no prior investigations have been conducted.

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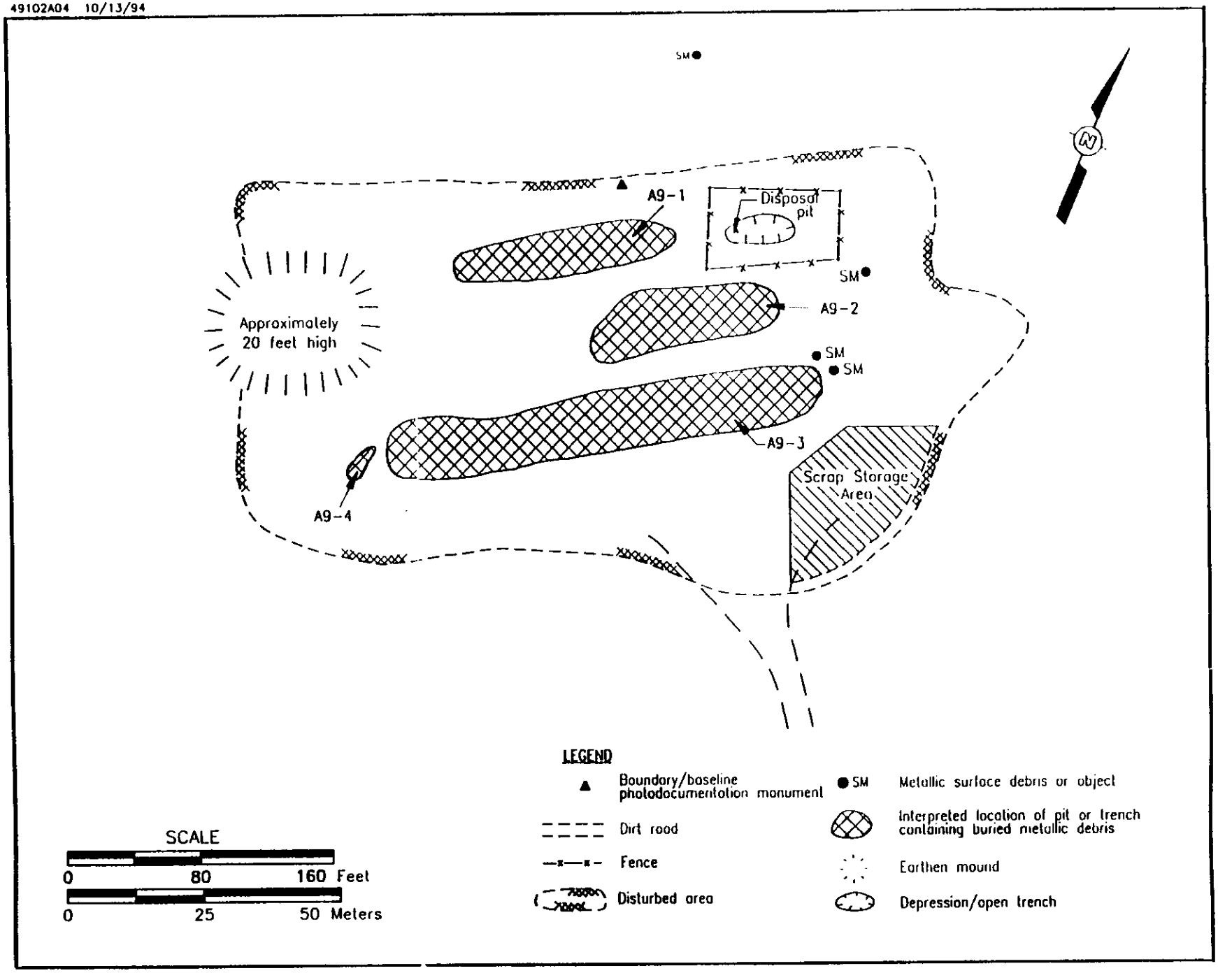

Figure 4-4
Site Map, Area 9 Landfill, Tonopah Test Range

5.0 Description of Operations

The potential hazards to be analyzed are those associated with the identification, removal, and processing of UXO; natural phenomena; and occupational accidents. It is expected that the planned activities and postulated events discussed in the following sections will be required or encountered in the course of completing this project. The planned activities for the project are discussed in the SA in the following sections. Additional details on the procedures that will be used to conduct the planned activities are presented in the VCA Work Plan, ITLV-TTR-004, UXO Removal, Handling, Processing, and Disposal at the Tonopah Test Range Ordnance Disposal Pits, and ITLV-TTR-005, Explosives Handling, Transportation, and Storage at the Tonopah Test Range.

5.1 Unexploded Ordnance Identification

Much of the debris that is the subject of the removal action is UXO. The IT UXO specialists will remove and dispose the UXO. This operation will be facilitated by the fact that most of the items observed during the site survey were determined to be inert and do not present an explosive hazard. However, in the interest of project safety, this observation cannot be considered to be an indication that all UXO present at the five sites is inert. Therefore, all UXO will be considered live and extremely hazardous until proven otherwise. The UXO will be examined for explosive hazards before removal from the debris pile. The UXO will then be classified into the following three categories:

Free from Explosives and Vented
UXO that does not contain any explosive hazards and has an opening in the case exposing the inert filler. These items present no explosive hazard and are ready for processing as scrap.

Inert But Requiring Processing
An inert UXO may still require processing prior to being considered as nonhazardous scrap. All sealed cases and components must be vented prior to processing as scrap. These items include the intact bomblets in the Bomblet Pit. Even though the UXO may be identified as inert, it must still be treated by explosive venting.

Explosively Hazardous UXO
Explosively Hazardous UXO other than bomblets will be processed in place without prior movement. Bomblets will be remotely moved to a nearby bomblet processing area for processing by detonation.

A decision-tree diagram for UXO segregation operations is included as Figure 5-1.

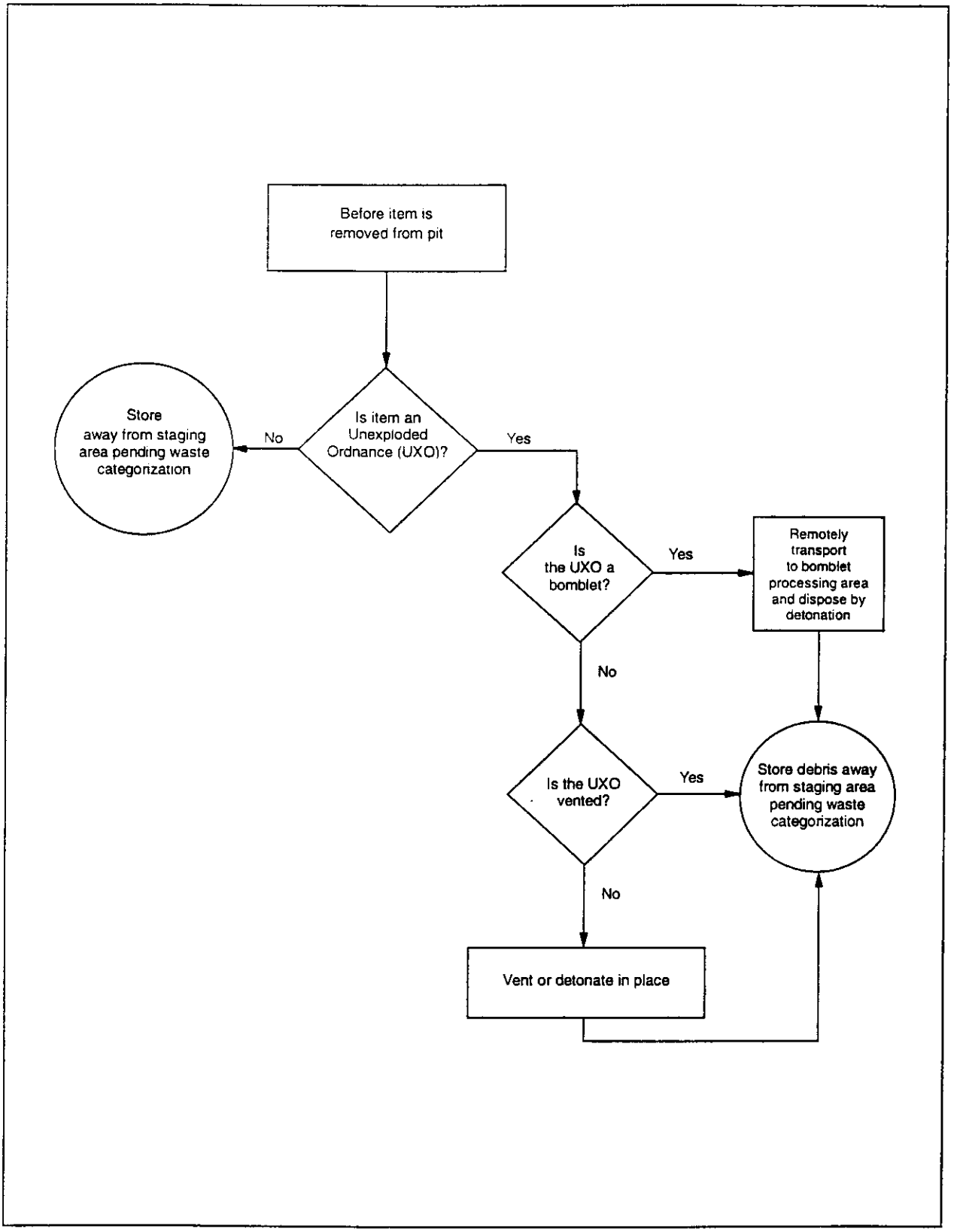

Figure 5-1
Decision Tree for Unexploded Ordnance Segregation Operations

5.2 Unexploded Ordnance Removal

Each of the five sites is a separate project site and will be addressed independently. Site exclusion and support zones will be established and marked with wooden stakes and flagging tape. Any local hazards (e.g., suspected buried objects and ditches) will also be clearly marked with flagging tape for easy identification. Additional information on UXO removal may be found in Section 3.2 of the VCA Work Plan and specific procedures for removal in Sections 5.2 and 5.4 of ITLV-TTR-004.

5.2.1 Remote Operations

The SNL RETRVIR system may be used to remotely handle some UXO. However, because of its size and lifting capacities, the RETRVIR system will likely be limited to the removal of bomblets on the surface and possibly in the shallow subsurface. Because of their small size, variability of hazard, and large numbers, all bomblets, regardless of hazard status, will be removed using the RETRVIR system. The RETRVIR system will be used to remove bomblets from the pit and remotely place them into prepared bomblet-handling tubes that will be used for processing the bomblets.

The RETRVIR system will use a remote-control manipulator arm and various system-mounted, real-time video cameras to locate and pick up individual bomblets. Once grasped, the manipulator arm will lift the bomblet and turn to place the bomblet into a shielded bin attached to the side of the vehicle. The bomblet bin will be designed to carry approximately 30 bomblets and will be shielded to protect the vehicle in the event of a detonation within the bin. The goal is to require little or no movement of the RETRVIR vehicle subsystem during the removal of individual bomblets and to utilize as many repetitive movements as possible (e.g., placement of bomblets into the handling bin) that can be programmed into the systems for efficiency.

Once the RETRVIR's bin is loaded, the vehicle will exit the bomblet pit and proceed to the nearby bomblet processing area. The processing area will be set up with groups of four (or more) bomblet-handling tubes that are situated at an angle on a ramp constructed of sandbags. The handling tubes will consist of 5-ft lengths of 4-in.-diameter cardboard pipe that has been capped on one end and finished to a 45-degree angle on the other. The pipes will be mounted at an approximate 45-degree angle to facilitate the movement of the bomblets to the bottom of the pipe when dropped into the handling tube by the RETRVIR system (see Figure 5-2). Processing explosives, consisting of linear-shaped charges (LSC), will be

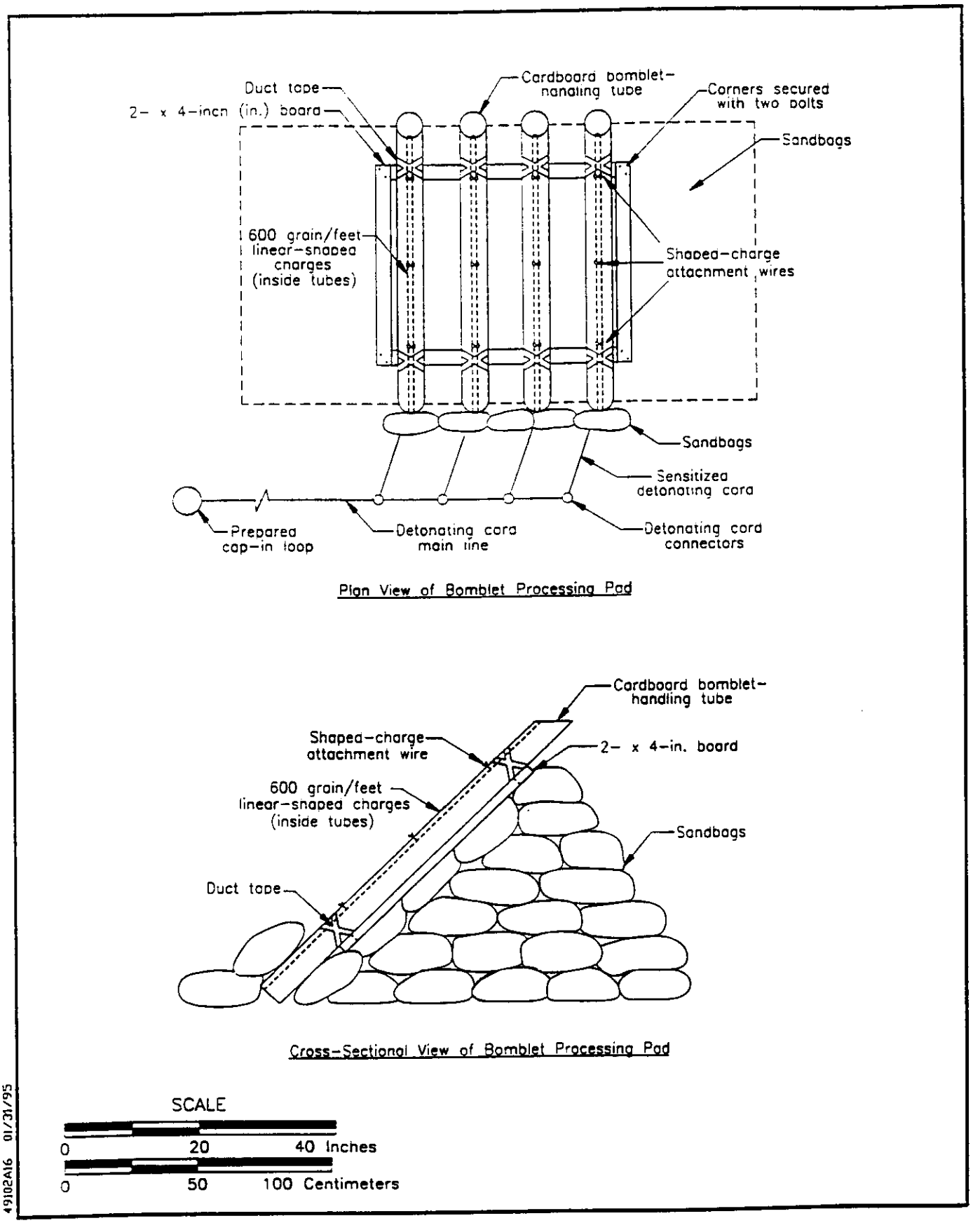

Figure 5-2
Bomblet Processing Pad Design

mounted on the bomblet-handling tubes prior to the loading of the tubes. Once off-loaded, the RETRVIR will return to the Bomblet Pit to collect another load of bomblets. Detonation of the processing explosives shall be conducted after each group of four bomblet-handling tubes is full and the RETRVIR vehicle has been removed from the fragmentation hazard area.

Proper and safe use of the RETRVIR system is discussed in SNL SOP SP472561, RETRVIR Mobile Manipulation System. That SOP requires that a Principle User or an Authorized User, with specific and extensive training, operate the system. In this case, the system will be operated by SNL personnel who have developed, and are most familiar with, the system.

5.2.2 Surface Removal

The UXO and potential UXO will first be removed from surface locations generally located in and around pits. The UXO specialists from IT will work in two-person teams to identify, remove, and process UXO from the sites. Reynolds Electrical & Engineering Co., Inc. (REECo), personnel requiring access to the sites for radiological screening will be escorted by a UXO specialist. No UXO will be moved manually unless it can be positively identified and determined to be safe.

The UXO team will approach the pit and attempt to positively identify as many UXO as possible. The positively identified UXO that are safe can then be removed from the debris pile and segregated from other UXO that may be explosively hazardous.

The UXO may be moved remotely if the UXO is determined to be unsafe, is unidentified, or if movement would possibly disturb additional UXO in the surrounding area that could not be positively identified. When potentially hazardous UXO is being moved, all nonessential site personnel will be evacuated from the work area. Remote movement of UXO will be conducted from a position outside the fragmentation-hazard radius of a potential high-order detonation as determined through the use of the net explosive weight in conjunction with the equation and table for determining the fragmentation radius presented in Section 5.1.1 and Attachment A of ITLV-TTR-004.

The larger items will be removed first from the Bomblet Pit to ensure that no larger and more explosively hazardous items will be encountered during the bomblet removal. After the larger UXO is removed, the bomblets will be removed remotely by the RETRVIR system.

5.2.3 Subsurface Removal

Subsurface anomalies thought to represent buried UXO have been identified in the area of the bomblet pit through the use of surface geophysical techniques (e.g., Gem Systems, Inc., Gem GSM-19 station magnetometer and Gem GSM-19 walking gradiometer; EG&G Geometrics G822-L magnetometer; Schonstedt Instrument Company GA-72CV magnetic locator/ordnance locator; Metrotech Corporation Model 810 utility locator; Risher Research Laboratory, Inc., TW-6 metal detector; Geonics Limited EM-31DL terrain conductivity meter; and GSSI System 10 ground-penetrating radar) (DOE, 1994b). Excavation will be required to remove the three known large anomalies northwest of the Bomblet Pit and the two smaller anomalies south and east of the pit. These anomalies are expected to contain additional buried bomblets. The nature of the anomalies will be determined by excavation followed by visual identification.

The exact location of the anomalies will be determined by using a magnetometer to locate their outer boundaries. The outer boundaries will be marked using pin flags and flagging tape.

Excavation of the anomalies themselves will be accomplished using hand and/or mechanical techniques. Mechanical excavation will be initiated by the RETRVIR system at the location of the anomaly. If successful, the RETRVIR system will fully excavate the anomaly. If the RETRVIR system is unable to excavate the anomaly, then a backhoe will be used to excavate a trench two feet outside the boundary of an anomaly and continue until the excavated area has reached a depth below the top of the anomaly, as determined by frequent inspection with the magnetometer.

Attempts to remove the remaining two feet of earth separating the anomaly from the mechanically-excavated area will be made using the RETRVIR system first. If RETRVIR is unsuccessful, then the remaining earth will be removed using manual excavation techniques. Based on geophysical studies, the anomalies are suspected to be relatively shallow. The excavation will be sloped in accordance with Occupational Safety and Health Administration (OSHA) requirements (see Title 29 Code of Federal Regulations [CFR] Part 1926 Subpart P, Excavations) prior to being entered by the excavation team. All personnel expected to enter an excavation or trench will be properly trained in excavation and trenching safety per the OSHA requirements. The excavation team, consisting of two UXO specialists, will enter the excavation and carefully remove the earth separating them from the anomaly while frequently checking the area with the magnetometer to determine their proximity to the anomaly.

Using progressively smaller and more delicate tools to remove the soil as they get nearer to the anomaly, the excavation team will expose the contents of the anomaly in the wall of the excavation for inspection and identification without moving or disturbing its contents. Once identified, the contents of the anomaly will be removed and processed, as described for the Bomblet Pit in Section 3.2.3 of the VCA Work Plan.

5.3 Unexploded Ordnance Processing

The UXO will be processed as discussed in the following sections based on its identification as discussed in Section 5.1. Additional information on UXO processing may be found in Section 3.2.2 of the VCA Work Plan and specific procedures for processing in Sections 5.2 and 5.4 of ITLV-TTR-004.

5.3.1 Unexploded Ordnance Free from Explosives and Vented

The UXO that does not contain any explosive hazards and has an opening in the case exposing the inert filler presents no explosive hazard and is ready for processing as scrap. Items ready for off-site disposal as scrap will be certified free of explosives by the UXO Supervisor according to the requirements of the DOE Explosives Safety Manual, Section 19.5a-b (i.e., XXXXX [5X] Rule; DOE, 1994a) and turned over to REECo for off-site disposal.

5.3.2 Unexploded Ordnance Inert But Requiring Processing

Inert UXO with sealed cases and components may still require processing prior to being considered nonhazardous scrap. All sealed cases and components must be explosively vented prior to processing as scrap even though the UXO may be identified as inert. Inert UXO that will require venting include the 2,000-lb. bombs and intact bomblets in the Bomblet Pit. Once processed, items ready for off-site disposal as scrap will be certified free of explosives by the UXO Supervisor according to the requirements of the *DOE Explosives Safety Manual*, Section 19.5a-b (i.e., XXXXX [5X] Rule, DOE, 1994a) and turned over to REECo for off-site disposal.

Processing of inert UXO will be done using the following general procedures:

- All UXO will be positively identified and classified into explosively hazardous and nonhazardous categories by the UXO specialist from IT.
- UXO identified as nonhazardous will be further inspected by the UXO specialist to determine if venting is required. All UXO with sealed cases require venting to ensure that explosions are not caused by the sudden release of expanding gases if the UXO is heated

during recycling. Nonvented items requiring further processing will be identified and segregated from items that are already vented and have exposed fillers.

- Nonvented UXO, other than bomblets, will be processed in place. Bomblets will be processed in a designated bomblet processing area. The bomblet processing area will be located in a previously-disturbed area that has been surveyed for the presence of UXO. The area will be clearly marked with flagging tape and signs. Processing of UXO will be accomplished by explosively cutting the case of the UXO to expose the filler.

- Small UXO, such as the bomblets, will be remotely placed in a cardboard pipe and cut in half by detonating a length of LSC positioned above the UXO. Larger UXO, such as inert bomb bodies, will be vented by puncturing the case in at least three locations (e.g., the main case, nose, and tail booster wells) with a shaped-charge penetrator.

- Following the successful demolition procedure, the UXO will be inspected to ensure that the inert filler is visible and that no hazardous components or fuzes remain. After successful venting and inspection, the item will be placed in the area designated for nonhazardous and vented scrap ready for off-site disposal.

5.3.3 Explosively Hazardous Unexploded Ordnance

Any UXO that is considered potentially hazardous or explosively loaded shall be disposed by detonation. All UXO, except bomblets, will be detonated in place in order to avoid the potential hazards associated with moving the UXO. Bomblets will be moved remotely using the RETRVIR system. The bomblets will be moved to the designated bomblet processing area for disposal by detonation. When moving UXO remotely, all required precautions, such as evacuation of all personnel to the determined safe distance, will be taken in preparation for a possible unplanned detonation. The site-specific ITLV-TTR-004 and ITLV-TTR-005 will be followed when conducting disposal detonations.

Electric initiation of detonations will be used to allow the maximum degree of control and timing of the disposal detonation. Explosives will be stored in the magazines at Area 9 with the initiators and main charges stored in separate magazines. Site personnel will coordinate with the TTR Explosives Officer, or his designee, to ensure that all regulations specific to the facility are followed. Once detonated, remaining scrap ready for off-site disposal will be certified free of explosives by the UXO Supervisor according to the requirements of the DOE Explosives Safety Manual (DOE, 1994a) and turned over to REECo for further metal working and off-site disposal.

5.4 Other Activities - Nonordnance Debris Removal

Once processed and/or determined to be safe, all ordnance will be rendered into scrap through the use of a cutting torch or other means if detonation processing has not accomplished this objective. Much of the debris at each of the sites consists of nonordnance construction debris, such as wooden pallets, target drums, steel ducting, concrete, and paper. While ordnance processing is not required to handle this type of debris, the proximity of ordnance at each of the sites requires that debris removal be performed under the direction of the UXO specialists. Nonordnance debris shall be staged separately from ordnance. All ordnance will be removed from the sites prior to any nonordnance debris removal by REECo.

5.5 Operational Safety Requirements

The following conditions or requirements must be met in order for UXO operations to be conducted:

- All persons expected to work in close proximity to the UXO and processing explosives will be trained in accordance with all applicable requirements (see ITLV-TTR-004 and ITLV-TTR-005).

- All remote activities (e.g., remote UXO handling or detonation of processing explosives) shall be conducted outside the fragmentation hazard radius as determined from the net explosive weight (see the VCA Work Plan, Section 3.2.1.1, or ITLV-TTR-004, Section 5.1.1, for information on calculating the fragmentation hazard radius).

- The exclusion zone will be established at a radius of 3,000 ft from the work area and will be enforced for all nonproject personnel.

- The TTR Lightning Threat Warning System, as described in TTR SOP SP471969, Issue A, TTR Lightning Threat Warning System, must be operable and indicate that atmospheric conditions are not conducive to lightning strike.

- In order for a UXO to be moved, it must be both positively identified and known to be safe to be moved. Any UXO that does not meet those two criteria must be moved remotely without exposing any personnel to the theoretical fragmentation range (see Sections 5.1.1 and 5.1.2 of ITLV-TTR-004) in the event of a high-order detonation.

- Explosive storage and transportation will be conducted in accordance with the requirements of ITLV-TTR-005, Explosives Handling, Transportation, and Storage at TTR, as well as the ITLV-TTR-004. Explosives will be stored in existing storage structures at TTR.

- Demolition procedures will be conducted in accordance with ITLV-TTR-004 and ITLV-TTR-005. These procedures include approved guidance on equipment and procedures for initiating explosives.

6.0 Accident Assessment

This section addresses hazards that may exist during the planned UXO identification, removal, and processing activities at the TTR. Table 6-1 presents an example of the acceptability matrix used to evaluate the data from this assessment (the shaded areas represent unacceptable risk according to MIL-STD-882C). Tables 6-2 and 6-3 present the qualitative probability and consequence ranges used for this assessment. Tables 6-4 and 6-5 identify and classify the potential hazards that are to be given consideration during the planning phases and on-site activities associated with this project. Table 6-4 classifies the hazards with respect to their probability of occurrences and consequences without the benefit of prevention and mitigation features in place. Table 6-5 classifies the potential hazards with respect to the planned prevention and mitigation features that are detailed in the table. The potential individual hazards in these tables could occur in one or more of the planned activities on site. Table 6-6 presents an analysis of the planned activities with respect to their potential hazards.

With the exception of the identified hazards associated with UXO and high explosives, other hazards identified in Tables 6-4 and 6-5 may be commonly encountered during the performance of construction/demolition-type projects in desert conditions. The accident prevention features identified for UXO handling are based on performing remote hazardous operations with all personnel outside the hazard area in the event of a high-order detonation. The accident prevention features for working with high explosives are the types of explosives used, combined with approved SOPs and DOPs and strict adherence thereto.

The probability and consequence ranges assigned to the individual potential hazards are shown on Tables 6-4 and 6-5. The potential hazards associated with the planned activities are shown on Table 6-6. This information has been developed through expert knowledge with respect to UXO, explosives, and general industrial hygiene combined with available specifications on the UXO identified and processing explosives planned for use on the site. This expertise and information has been used to assign qualitative probability and consequence ranges based on the qualitative descriptions of probability presented in DOE AL5481.1B and consequence presented in MIL-STD-882C. Quantitative values of probability of occurrence were not available for the individual hazards or planned activities since there is no previous data upon which to base these values. Thus, the quantitative ranges of probability presented in DOE AL5481.1B could not be used for this analysis. Tables 6-2 and 6-3 provide the criteria for assigning the qualitative probability and consequence ranges.

Table 6-1
Example Acceptability Matrix

Acceptability Matrix					
PROBABILITY	Frequent A	1A	2A	3A	4A
	Probable B	1B	2B	3B	4B
	Occasional C	1C	2C	3C	4C
	Remote D	1D	2D	3D	4D
	Improbable E	1E	2E	3E	4E
		1 Catastrophic (High)	2 Critical (Medium)	3 Marginal (Low)	4 Negligible (Extremely Low)
CONSEQUENCE					

Table 6-2
Probability Ranges

CATEGORY	LEVEL	DESCRIPTION
Frequent	A	Likely to occur frequently
Probable	B	Will occur several times in the life of an item
Occasional	C	Likely to occur sometime in the life of the item
Remote	D	Unlikely, but possible to occur in the life of the item
Improbable	E	So unlikely that it can be assumed that occurrence may not be experienced

Table 6-3
Consequence Ranges

CATEGORY	LEVEL	DESCRIPTION
Catastrophic	1	(High) Serious impact on or off site. May result in death or the loss of the facility/operation.
Critical	2	(Medium) Major impact on site and/or minor impact off site. Severe injury, severe occupational illness, or major facility damage.
Marginal	3	(Low) Minor on-site with no off-site impact. Possible minor injury, minor occupational illness, or minor damage.
Negligible	4	(Extremely Low) Less than minor injury, occupational illness, or system damage.

Table 6-4
Identification and Classification of Potential Hazards without Prevention or Mitigation Features

Event	Event Description	Causes	Method of Detection	Probability of Occurrence*	Consequences*	
					Impact on Systems	Health and Safety
E1	Unplanned detonation of unexploded ordnance (UXO)	Movement of armed UXO causes functioning of fuze	Visual, audible	Occasional (C)* based on UXO specifications, age, and condition	Critical (2)* based on possible damage to RETRVIR system	Catastrophic (1)* based on potential impact to personnel
E2	Unplanned detonation of processing explosives	Heat Shock Radio transmissions Electric current (lightning or static)	Visual, audible	Improbable (E) based on explosive types and season	Critical (2) based on possible damage to unprotected systems	Catastrophic (1) based on potential impact to personnel
E3	Detonation of explosive-contaminated UXO scrap	Incomplete UXO processing/decontaminating, heat applied to scrap (e.g., torch cutting and incineration)	Visual, audible	Occasional (C) based on no proper processing of UXO and the expected small amount of live UXO or fuzes present	Critical (2) based on potential impact to off-site systems	Catastrophic (1) based on potential impact to off-site personnel
E4	Occupational Injury Due to Construction or Light Industrial Accident	Operator Error, Equipment Failure, Procedural Error	Health and safety audits and oversight	Occasional (C) based on site conditions and planned activities	Negligible (4) based on lack of impact to systems	Marginal (3) based on potential impact to personnel
E5	Heat stress, dehydration	Performing physical labor in high-temperature, low-humidity environment	Observance of workers by supervisors, industrial hygiene monitoring	Remote (D) based on season	None	Marginal (3) based on potential impact to personnel
E6	Cold stress	Performance of outdoor activities in low-temperature, windy environment	Observance of workers by supervisors, industrial hygiene monitoring	Occasional (C) based on season	None	Marginal (3) based on potential impact to personnel
E7	Biohazards (e.g., snake bites and insect stings)	Snake or insect bite, contact with plants	Notification by worker	Remote (D) based on season	None	Marginal (3) based on potential impact to personnel
E8	Wind-Driven flying debris	Natural phenomena	Visual, audible	Probable (B) based on average weather conditions	None	Marginal (3) based on potential impact to personnel
E9	Lightning strike	Natural phenomena	Visual, audible	Improbable (E) based on historic record and season	None	Catastrophic (1) based on potential impact to personnel
E10	Earthquake	Natural phenomena	Ground motion	Improbable (E) based on historic record and area geology	None	Marginal (3) based on potential impact to personnel

* Probability of occurrence and consequence ranges are for worst case, i.e., no prevention or mitigation features in place. See Tables 6-2 and 6-3 for an explanation of probability and consequence ranges.

Table 6-5
Classification of Potential Hazards with Prevention and Mitigation Features in Place
(Page 1 of 2)

Event	Event Description	Causes	Prevention Features		Mitigation Features		Probability of Occurrence*	Consequences*	
			Design	Administration	Design	Administrative		Impact on Systems	Health and Safety
E1	Unplanned detonation of unexploded ordnance (UXO)	Movement of armed UXO causes functioning of fuze	Detonation of most UXO in place with no movement required prior to detonation	Implementation of proven procedures for UXO identification and remote handling	RETRVIR system, observance of proper fragmentation radii	Strict enforcement of Detailed Operating Procedures (DOPs) for remote handling and personnel safety	Remote (D)* based on prevention features, UXO specifications, experience of UXO specialists, observation of UXO by UXO specialists	Critical (2)* based on possible damage to RETRVIR system	Negligible (4)* based on limitation of personnel in the area
E2	Unplanned detonation of processing explosives	Heat	Use of commercial explosives formulated for insensitivity, separation of initiators and main-charge explosives, conducting explosive activities in remote areas away from established TTR facilities	Implementation of explosives-handling and storage DOPs, including prohibition on smoking	Proper fragmentation hazard radii and exclusion zones	Minimization of personnel during explosives-handling operations	Improbable (E) based on prevention features, explosive types, and season	Marginal (3) based on planned location of processing areas	Negligible (4) based on limitation of personnel in the area during explosive activities
		Shock		Implementation of explosives-handling and storage DOPs, including training requirements					
		Radio transmissions		Limitation or shut down of radio transmitters during processing activities, implementation of explosives-handling and storage DOPs, including training requirements					
		Electric current (lightning or static)		Stop operations during high-risk periods, implementation of established lightning detection and warning system and demolition DOP, including grounding requirements, implementation of explosives-handling and storage DOPs, including training requirements					
E3	Detonation of explosive-contaminated UXO scrap	Incomplete UXO processing/decontaminating, heat applied to scrap (e.g., torch cutting and incineration)	High-energy detonating explosives used for processing all UXO	Adherence to the requirements of the DOE Explosives Safety Manual, inspection of all scrap prior to release	Burning of all UXO scrap identified as containing explosive residues	Thorough inspection and certification of all scrap prior to release for disposal	Improbable (E) based on explosive venting and/or detonation of UXO planned	Critical (2) based on potential impact to off-site systems	Catastrophic (1) based on potential impact to off-site personnel
E4	Occupational injury due to construction or light industrial accident	Operator error, equipment failure, procedural error	Use of protective equipment	Implement and enforce approved work rules/site safety program, correction of potential hazards, effective communications among working groups	Personal safety equipment	Implementation of health and safety plan, emergency procedures, and proper response to emergencies	Remote (D) based on prevention features, health and safety experience of team, health and safety oversight	Negligible (4) based on lack of impact to systems	Marginal (3) based on potential impact to personnel
E5	Heat stress, dehydration	Performing physical labor in high-temperature, low-humidity environment	Personal protective equipment (e.g., cool packs), available shelter	Implementation of health and safety plan, worker monitoring, availability of shade and water	None	Implementation of health and safety plan, emergency procedures, and proper response to emergencies	Remote (D) based on prevention features, season, health and safety experience of team members, health and safety oversight	None	Marginal (3) based on potential impact to personnel

Table 6-5
Classification of Potential Hazards with Prevention and Mitigation Features in Place
(Page 2 of 2)

Event	Event Description	Causes	Prevention Features		Mitigation Features		Probability of Occurrence*	Consequences*	
			Design	Administration	Design	Administrative		Impact on Systems	Health and Safety
E6	Cold stress	Performance of outdoor activities in low-temperature, windy environment	Personal protective equipment (e.g., insulated coveralls), available shelter	Implementation of health and safety plan, worker monitoring, availability of shelter and warm liquids	None	Implementation of health and safety plan emergency procedures, proper response to emergencies	Remote (D) based on prevention features, season, health and safety experience of team members, health and safety oversight	None	Marginal (3) based on potential impact to personnel
E7	Biohazards (e.g., snake bites and insect stings)	Snake or insect bite, contact with plants	Level D clothing (e.g., gloves, boots, and long pants)	Implementation of health and safety plan	None	Implementation of health and safety plan, proper response to emergencies	Remote (D) based on prevention features and season	None	Marginal (3) based on potential impact to personnel
E8	Wind-Driven flying debris	Natural phenomena	None	Restrict or stop work during high-wind periods (>XX mph or as determined by UXO Supervisor)	None	Good housekeeping practices at work site, no explosive activities during high winds (> XX mph of as determined by UXO Supervisor)	Improbable (E) based on prevention features	None	Negligible (4) based on lack of potential impact to personnel due to housekeeping and work stoppage requirements
E9	Lightning strike	Natural phenomena	None	Stop work during high-risk periods	TTR Lightning Detection System, use of approved grounding devices	Procedures to protect or evacuate personnel during high potential periods as determined by the Lightning Threat Warning System (ITLV-TTR-005)	Improbable (E) based on historic record	None	Catastrophic (1) based on potential impact to personnel
E10	Earthquake	Natural phenomena	None	None	None	Equipment and facilities will be set up according to standard TTR specifications	Improbable (E) based on historic record and area geology	None	Negligible (4) based on analysis of planned work site

* See Tables 6-2 and 6-3 for an explanation of probability and consequence ranges.

Table 6-6
Risk Associated with Planned Activities and Postulated Events
(Page 1 of 2)

Item	Planned Activities and Postulated Events	Associated Hazard(s)*	Controls	Probability of Associated Hazards	Consequence of Associated Hazards	Risk
UNEXPLODED ORDNANCE (UXO) IDENTIFICATION						
I-1	UXO cannot be positively identified/key features obscured or obliterated	E1	ITLV-TTR-005 requires remote handling and disposal procedures or disposal in place for all UXO.	Probable (B)**; UXO has been subjected to weather and corrosion.	Negligible (4)**; remotely operated equipment will be used to handle all small UXO and large UXO will be disposed in place.	4B
UXO REMOVAL						
R-1	Unplanned disturbance of UXO.	E1	ITLV-TTR-005 requires the use of remote equipment and procedures under these conditions.	Occasional (C) because of the cluttered nature of the open pits, this may occasionally occur.	Negligible (4); removal operations will be done using remote methods whenever the possibility of disturbing unknown or unidentified UXO exists.	4C
R-2	Movement of unstable UXO	E1	ITLV-TTR-005 requires the use of remote equipment and procedures under these conditions.	Occasional (C) because of the large number of bomblets that will be moved.	Negligible (4); removal operations will be done using remote methods whenever the possibility of moving unstable UXO exists.	4C
R-3	Unplanned disturbance of subsurface UXO	E1	ITLV-TTR-005 requires the use of remote equipment for most operations and the use of remote sensing and field screening of the subsurface prior to using the surface for any purpose.	Improbable (E); subsurface anomalies in the areas of the disposal sites have been previously mapped and will be marked in the field. Field screening activities will also be conducted.	Negligible (4); areas of subsurface anomalies will be marked on the ground and most activities in their vicinity will be conducted remotely	4E
R-4	Removal of surface UXO (i.e., bomblets) using RETRVIR system	E1	RETRVIR operator experienced in object manipulation, shielding of RETRVIR's bomblet bin.	Occasional (C) because of possible instability of UXO and jarring by RETRVIR system during grasping of bomblets and placement of bomblets into bomblet bin or bomblet-handling tubes.	Critical (2); RETRVIR system or subsystem could be damaged by detonation. Bomblet bin will be shielded to provide protection during bin loading.	2C
R-5	Removal of subsurface UXO using RETRVIR system	E1	Remote sensing has been used to determine approximate location and depth of anomalies.	Occasional (C); because of possible instability of subsurface UXO and jarring by RETRVIR system during excavation.	Critical (2); RETRVIR system manipulator arm could be damaged by detonation.	2C
R-6	Placement of bomblets into bomblet-handling tubes by RETRVIR in the bomblet processing area	E1, E2, E9	ITLV-TTR-005 requires remote handling of UXO and strict adherence to exclusion zones and fragmentation hazard radii during all explosive operations.	Remote (D); placement of bomblets by RETRVIR into bomblet-handling tubes could result in detonation of live or live-fuze-only bomblets.	Marginal (3); bomblet-handling tubes could be damaged by detonation.	3D
R-7	Critical failure of RETRVIR system or subsystem (e.g., manipulator arm)	E1, E4	RETRVIR systems testing, preactivity verification of RETRVIR systems, RETRVIR SOPs, and design.	Improbable (E); extensive testing and limited application of the RETRVIR system to date has failed to produce critical failures that would significantly effect RETRVIR's continued performance.	Critical (2); RETRVIR will be fitted with an easily-removable bomblet bin that can be detached remotely in the event of a failure that would prevent the system from completing its task	2E
R-8	Removal of subsurface UXO using hand techniques	E1, E5, E6	Hand excavation techniques will only be used as a last resort (e.g., if the RETRVIR system is unsuccessful) and will be conducted in strict accordance with ITLV-TTR-005 and any other applicable safety procedures.	Remote (D) because of experience of UXO team in conducting such operations; however, possible instability of subsurface UXO and jarring during excavation could result in detonation.	Catastrophic (1); possible death of personnel excavating the UXO.	1D
R-9	Lightning strike while handling UXO	E1	Implementation of the TTR Lightning Warning System. Stop work during high-risk periods as determined by the warning system procedures (ITLV-TTR-005).	Improbable (E); UXO handling will not be conducted in conditions conducive to lightning strike (as determined by the Lightning Threat Warning System [ITLV-TTR-005]). TTR lightning warning procedures will be followed.	Catastrophic (1); extremely serious personnel injury and equipment/facility damage possible.	1E

Table 6-6
Risk Associated with Planned Activities and Postulated Events
(Page 2 of 2)

Item	Planned Activities and Postulated Events	Associated Hazard(s)*	Controls	Probability of Associated Hazards	Consequence of Associated Hazards	Risk
UXO PROCESSING						
P-1	Detonation of UXO in place	E1, E2, E4, E7, E9	ITLV-TTR-005 requires strict adherence to exclusion zones and fragmentation hazard radii during all explosive operations.	Improbable (E); based on the lack of movement of the UXO, the processing explosives to be used, and implementation of standard health and safety procedures	Negligible (4); strict adherence to exclusion zones and fragmentation hazards radii during all explosive operations.	4E
P-2	Detonation of bomblets in the bomblet processing area	E1, E2, E9	ITLV-TTR-005 requires remote handling of UXO and strict adherence to exclusion zones and fragmentation hazard radii during all explosive operations	Remote (D); placement of bomblets by RETRVIR into bomblet-handling tubes could result in detonation of live or live-fuze-only bomblets.	Marginal (3); bomblet-handling tubes could be damaged by detonation.	3D
P-3	Processing explosives handling	E1, E2	Adherence to ITLV-TTR-005, including implementation of the TTR Portable Lightning Warning System, use of commercial explosives that are less sensitive to electric shock, separation of initiators from main-charge explosives. Stop work during high-risk periods.	Improbable (E); explosives handling will not be conducted in conditions conducive to lightning strike. TTR lightning warning procedures will be followed	Catastrophic (1), extremely serious personnel injury and equipment/facility damage possible.	1E
P-4	Necessity to approach prepared explosives due to failure to detonate (misfire).	E1, E2, E4	ITLV-TTR-005, Explosives Handling, Transportation, and Storage at the Tonopah Test Range, and ITLV-TTR-004, UXO Removal, Handling, Processing, and Disposal at the TTR Ordnance Disposal Sites	Remote (D); the IT DOP Explosives Handling, Transportation, and Storage at the Tonopah Test Range (ITLV-TTR-005) requires check out of blasting equipment and supplies prior to use	Marginal (3); standard misfire procedure will be implemented, as directed by the IT DOP Explosives Handling, Transportation, and Storage at the Tonopah Test Range (ITLV-TTR-005)	3D
P5	Removal of UXO and other scrap metal to offsite facility for recycling	E3	Use of high-energy detonating explosives for UXO processing and inspection/decontamination per the DOE Explosives Safety Manual.	Improbable (E); all UXO will be explosively processed and decontaminated in compliance with the DOE Explosives Safety Manual.	Catastrophic (1), extremely serious off-site personnel and equipment/facility damage possible	1E
GENERAL OPERATIONS						
G-1	Construction of sandbag barriers	E1, E4	Implementation of ITLV-TTR-005, which requires UXO surface and subsurface screening prior to any activities. Implementation of the Site Safety Plan; training of personnel; use of personal protective equipment.	Remote (D); all areas will be screened for surface and subsurface UXO prior to construction activities.	Negligible (4); standard health and safety procedures will be followed along with UXO screening requirements.	4D
G-2	Trenching	E1, E4	Implementation of ITLV-TTR-005, which requires UXO surface and subsurface screening prior to any activities. Implementation of the health and safety plan; training of personnel; use of personal protective equipment.	Remote (D); all areas will be screened for surface and subsurface UXO prior to construction activities	Negligible (4); standard health and safety procedures will be followed along with UXO screening requirements.	4D
G-3	General construction site hazards	E6, E7, E8, E9, E10	Implementation of the health and safety plan; training of personnel; use of personal protective equipment.	Remote (D); should be typical of general construction activities; minimal construction equipment will be used; personnel will be trained in site safety; implementation of the Site Safety Plan.	Marginal (3); personnel will be trained in avoiding injuries on construction sites.	3D

* See Tables 6-4 and 6-5 for discussion of specific hazards

** See Tables 6-2 and 6-3 for an explanation of probability and consequence ranges

6.1 Risk Analysis

6.1.1 Methodology

This analysis will evaluate risk by qualitatively analyzing the probability of occurrence and the possible consequences associated with the occurrence. Hazard frequency ranges from improbable to frequent and consequence ranges from negligible (extremely low) to catastrophic (high) have been adopted from DOE AL5481.1B and/or MIL-STD-882C. These ranges are evaluated together in an acceptability matrix in order to develop a measure or qualitative picture of potential risk with respect to the planned operations.

6.1.2 Assessment of Risk

The suggested criteria for evaluating the hazard risks, as presented in MIL-STD-882C and determined from the matrix, are presented in Table 6-7. Table 6-6 presents an analysis of the risk of the planned activities and postulated events, giving consideration to the identified potential hazards that can be associated with such activities. Information is presented on the planned controlling actions that will contribute to the reduction of risk. The controlling actions listed are in conjunction with any hazard prevention and mitigation features listed for the individual hazards listed in Tables 6-4 and 6-5. Table 6-8 provides a list of the procedures used for guidance and control of project activities. Copies of these SOPs and DOPs are referenced in the VCA Work Plan and are located in Appendices A, B, and C of that plan. The procedures may be cited as a control mechanism in the assessment of potential hazards.

Table 6-7
Suggested Criteria for Evaluating Hazard Risks

Hazard Risk Index	Suggested Criteria
1A, 1B, 1C, 2A, 2B, 3A	Unacceptable
1D, 2C, 2D, 3B, 3C	Undesirable (decision required)
1E, 2E, 3D, 3E, 4A, 4B	Acceptable with review
4C, 4D, 4E	Acceptable without review

Table 6-8
Safety and Operating Procedures

Number	Title
SP472561	RETRVIR Mobile Manipulation System (SNL)
ITLV-TTR-004	UXO Removal, Handling, Processing, and Disposal at the Tonopah Test Range Ordnance Disposal Sites (ITLV)
ITLV-TTR-005	Explosives Handling, Transportation, and Storage at the Tonopah Test Range

A limited number of IT personnel (i.e., the UXO specialists) will need to be trained in the use of all of the above-referenced DOPs. All IT personnel on site will need to be familiar with or briefed on the contents of SNL SOP SP472647, Site-Specific Safety Information for Tonopah Test Range. Only SNL personnel responsible for the use of the RETRVIR system will be trained on the requirements of SOP SP472561, RETRVIR Mobile Manipulation System.

6.2 Discussion of Potential Hazards

Potentially hazardous activities for this project fall into three general categories: those associated with identification of the UXO, those associated with the removal of UXO, and those associated with the processing of UXO. A few other issues that are generally typical of field activities and activities on the TTR will also be addressed.

6.2.1 Unexploded Ordnance Identification

The main hazard associated with UXO identification is the inability to positively identify the UXO. This is likely to occur because the UXO may be in a deteriorated condition from exposure to the elements or the UXO may be an uncommon or prototype variety. In the event that the UXO cannot be positively identified, it will be considered to be live, armed, and unsafe to move. This assumption will require any movement of the item to be done remotely with all personnel outside the hazard area. The analysis of this planned activity is shown in Table 6-6 and the analysis of the associated hazard(s) are shown in Tables 6-4 and 6-5.

6.2.2 Unexploded Ordnance Removal

The hazards associated with removal of UXO are primarily related to the unplanned detonation of UXO due to disturbance of unstable UXO on the surface or in the subsurface during movement of the UXO or nearby UXO and debris. There are also some hazards associated with failure of the RETRVIR system and general outdoor activities on the TTR.

The analysis of the individual hazards associated with UXO removal (i.e., E1, E3, E4, and E5) and unplanned disturbance of UXO are shown in Tables 6-4 and 6-5. Depending on the specific situation at each site, movement of a UXO may cause other nearby items to be disturbed. The hazard of unplanned detonation is generally minimized by moving all UXO remotely unless it can be established that the UXO being moved, and any other objects potentially disturbed by the movement, are positively identified and safe to move. Hazards associated with possible subsurface UXO are minimized through the definition of subsurface anomalies through remote sensing and the use of the RETRVIR system for excavation, if possible. Testing of the RETRVIR system to date has shown that a critical failure of the system or subsystems is unlikely, and the vehicle will be fitted with a remotely removable bomblet bin that can be separated from the vehicle in case of a failure. The RETRVIR will also be provided with shielding to protect it from detonations in the bomblet bin.

6.2.3 Unexploded Ordnance Processing

The analysis of UXO processing hazards are shown in Table 6-6, Items P-1 through P-4. The primary hazards associated with UXO processing are related to unplanned detonation of UXO and/or processing explosives. Lesser hazards include occupational injury and wind-driven debris. During UXO removal, procedures for the processing of UXO require the use of remote methods (e.g., remote UXO handling or electronic detonation of processing explosives from outside the fragmentation radius). Lightning and wind hazards are mitigated through the use of the lightning detection system and work stoppages during periods of high risk from lightning or high wind. Procedures for recognizing conditions conducive to lightning strike and a warning system are already established and functioning at TTR. High winds, which are likely to affect visibility or activity safety (e.g., causing an increased risk of flying debris), will be evaluated at the time of the activities by the UXO Supervisor, who will then be responsible for suspending activities during periods deemed unsafe. TTR procedures for misfire have also been established and will be followed. Once detonated, remaining scrap ready for off-site disposal will be certified free of explosives by the UXO Supervisor according to the requirements of the DOE Explosives Safety Manual and turned over to REECo for off-site disposal.

6.2.4 General Operations

Hazards associated with general construction activities (e.g., high wind, trenching, sandbag barrier construction, and snake or insect bite), as well as construction activities in UXO areas (e.g., accidental detonation of unidentified UXO), are shown in Table 6-6, Items G-1 through G-3. These hazards are generally controlled through adherence to, and training on, standard

health and safety and industrial hygiene practices along with requirements for prescreening of any areas planned for use during the site operations. High winds likely to affect visibility or activity safety (e.g., causing an increased risk of flying debris) will be evaluated at the time of the activities by the UXO Supervisor who will then be responsible for suspending activities during periods deemed unsafe.

6.3 Results of the Assessment

The potential hazards identified fall into the 1E, 3D, 4B, and 4C categories of risk as represented by the shaded area on the acceptability matrix (Table 6-9) below.

Table 6-9
Acceptability Matrix for the Planned Activities and Postulated Events
(shaded areas represent assessment results)

Acceptability Matrix					
PROBABILITY	Frequent A	1A	2A	3A	4A
	Probable B	1B	2B	3B	4B
	Occasional C	1C	2C	3C	4C
	Remote D	1D	2D	3D	4D
	Improbable E	1E	2E	3E	4E
		1 Catastrophic (High)	2 Critical (Medium)	3 Marginal (Low)	4 Negligible (Extremely Low)
CONSEQUENCE					

The result of this safety analysis is that, for the activities planned for this project, the risks associated with most of the activities either have a remote or improbable probability of occurrence or a negligible (extremely low) consequence. Activities in these probability and consequence ranges fall within the evaluation criteria of acceptable although some may require review by the Managing Activity according to MIL-STD-882C. Several planned activities fall within the occasional and remote probabilities of occurrence with critical to catastrophic consequences, which then place the activities in the undesirable (decision necessary) category according to MIL-STD-882C. This category requires a decision by the Managing Activity with respect to whether the risk is acceptable. Three out of four of these activities involve the use of the RETRVIR system during the handling of bomblets and excavation of subsurface anomalies. In these cases, the potential consequence of the applicable hazards is related to damage of the RETRVIR system through unplanned

detonation of UXO. The RETRVIR system is being used to reduce the risk to personnel; it is deemed preferable to expose the RETRVIR to risks that would have greater consequences were personnel exposed. One planned activity that poses an undesirable risk to personnel is the manual excavation of subsurface anomalies. This activity will be avoided if at all possible through the use of the RETRVIR system for excavation. However, if the RETRVIR system is not capable of excavating the anomalies, it will be necessary to excavate them by hand. Hand excavation of such subsurface anomalies is not uncommon in UXO operations such as this and will be conducted by UXO experts; however, there is always an inherent risk in such activities.

Projected impacts are strictly on site and negligible off site with regard to injury to personnel or damage to equipment or the environment. The highest consequence items identified in the SA are associated with the unplanned detonation of UXO or processing explosives. Unplanned detonation is generally related to jarring or movement of UXO, which will be conducted remotely and thus poses no threat to personnel or from misidentification of UXO, nonconformance with applicable SOPs and DOPs, or natural phenomena (e.g., lightning strikes during processing explosive or UXO handling). Natural phenomena cannot be controlled, but can be detected and mitigated through SOPs and DOPs. The highest probability items identified are generally associated with difficulties in identifying UXO or the unplanned disturbance of UXO. These items are mitigated through adherence to the SOPs and DOPs, which require the use of remote handling equipment for most UXO handling, resulting in a negligible consequence in case of detonation.

According to MIL-STD-882C, none of the identified hazards is unacceptable although some require review or decision by the Managing Activity, i.e., DOE/NV ERD, with concurrence from the Safety Division and assistance from DOE/AL-KAO. Those hazards that have been determined to be undesirable, most often based on the potential damage to remote equipment, require a decision by the Managing Activity and tracking by the contractor for possible corrective action. In this case, it has been determined, with respect to the possible undesirable hazards, that a risk to equipment is more acceptable than a risk of equal or worse severity to personnel. Based on the results of this SA, it is concluded that the preparation of a SAR is not necessary and the planned activities and postulated events present an acceptable risk.

7.0 References

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LANL

Environmental Restoration Site Summary

Site: Los Alamos National Laboratory

Links to Additional Site Information
Los Alamos National Laboratory Home Page
Los Alamos National Laboratory Environmental Restoration Project
1996 Baseline Environmental Management Report Site Narrative
Los Alamos National Laboratory Environmental Restoration Project Management Action Process Document (Draft)

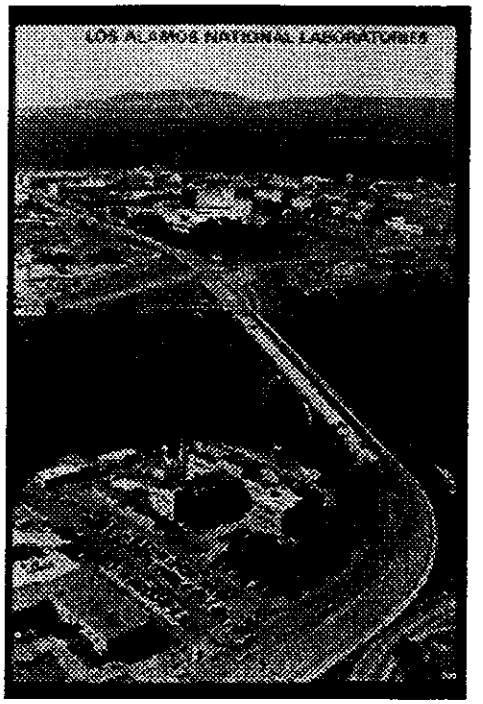
Background

The Los Alamos National Laboratory is located in north-central New Mexico, about 60 miles north-northeast of Albuquerque and 25 miles northwest of Santa Fe. The site occupies about 43 square miles.

The Laboratory was established in 1943 for the design, development, and testing of nuclear weapons. Supporting this mission were research programs in nuclear physics, hydrodynamics, conventional explosives, chemistry, metallurgy, radiochemistry, and biology. From 1945 to 1978, the Laboratory also processed plutonium metal and alloys from the nitrate solutions feedstock provided by other production facilities. Although the Laboratory's current mission remains focused on national defense, it has been broadened to include research in medium-energy physics, space nuclear systems, controlled thermonuclear fusion, lasers, nuclear safeguards, space physics, biomedicine, computational science, and environmental management. Past operations at the Laboratory have resulted in the contamination of facilities and, in some cases, the surrounding environment with radioactive and hazardous materials.

Approximately 2,100 potential release sites have been identified at the laboratory. These sites have been grouped into six field units (1-6) for investigation and remediation. To date, approximately 50 sites have been remediated, no further action has been proposed for 300 sites, and 1,100 sites have been slated for investigation and possible cleanup.

* Received email from Roy Michelotti 1-28-97 referred to:
Don Hickmott - sent email 1-28-97
Don Krier - sent email 1-27-97
Gene Gould - sent email 1-27-97



Los Alamos National Laboratory

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About This Document

Last Updated 01/29/1997 (mhp)

1996 BEMR

Los Alamos National Laboratory

HOME BEMR CONTENTS U.S. MAP

Los Alamos National Laboratory and the neighboring residential areas of Los Alamos and White Rock are located predominantly in Los Alamos County, north-central New Mexico, approximately 96 kilometers (60 miles) north-northeast of Albuquerque and 40 kilometers (25 miles) northwest of Santa Fe. The 111.8-square kilometer (43-square mile) Laboratory and adjacent communities are situated on the Pajarito Plateau, which consists of a series of finger-like mesas separated by deep canyons containing ephemeral and intermittent streams that run from west to east. Mesa tops range in elevation from approximately 2,379 meters (7,800 feet) on the flank of the Jemez Mountains to approximately 1,891 meters (6,200 feet) at their eastern termination above the Rio Grande. The eastern margin of the plateau stands 91.5 to 274.5 meters (300 to 900 feet) above the Rio Grande. The Department of Energy controls the area within the Laboratory's boundaries and has the option of completely restricting access.

LOCALITY MAP

Estimated Site Total

(Thousands of Current Year Dollars)						
	FY 1996	**1997**	**1998**	**1999**	**2000**	
Nuclear Material and Facility Stabilization	279	287	296	305	314	*Grey shaded area reflects annual cost estimates for the first five years of the site BEMR Base Case (as of October 1995) and includes 3% annual inflation, see Readers' Guide.*
Environmental Restoration	70,653	53,241	51,157	50,729	54,857	
Waste Management	64,310	53,647	67,752	59,774	76,721	
Total	135,242	107,175	119,205	110,808	131,893	
1996 Appropriation	128,608			*These levels reflect the current estimates for compliance with applicable statutes and agreements (as of March 1996), see Readers' Guide.*		
1997 Congressional Request		118,117				

(Five-Year Averages, Thousands of Constant 1996 Dollars)							
	FY 1996-2000	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Nuclear Material and Facility Stabilization	279	3,101	4,138	4,276	1,511		
Environmental Restoration	53,146	43,487	25,610	1,354	1,134		
Waste Management	60,625	48,524	52,095	54,962	48,862	48,862	48,862
Total	114,050	95,112	81,844	60,592	51,507	48,862	48,862
	FY 2035	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**
Nuclear Material and Facility Stabilization							

Environmental Restoration								
Waste Management	46,765	38,379	38,379	38,379	38,379	38,379	38,379	
Total	46,765	38,379	38,379	38,379	38,379	38,379	38,379	
	FY 2070	**2075**	**2080**	**2085**	**2090**	**2095**	**2100**	**Life Cycle***
Nuclear Material and Facility Stabilization								66,529
Environmental Restoration								623,650
Waste Management	38,379							3,391,053
Total	38,379							4,081,231

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

FACILITY MISSION

Los Alamos National Laboratory was established in 1943 to design, develop, and test nuclear weapons. Research programs in nuclear physics, hydrodynamics, conventional explosives, chemistry, metallurgy, radiochemistry, and life sciences supported this mission.

In addition to research, an important function of the Laboratory has been processing plutonium metal and alloys from nitrate solution feedstock provided by other production facilities. Processing plutonium metal took place from 1945 to 1978. Other operations included reprocessing nuclear fuel, processing polonium and actinium, and producing nuclear weapons components.

Although the Laboratory's present mission remains focused on national security, it has broadened to include research in medium-energy physics, space nuclear systems, controlled thermonuclear fusion, lasers, nuclear safeguards, space physics, biomedicine, computational science, materials science, and environmental management. Because of its position between academic and industrial research, the Laboratory plays an important role in expediting development and commercialization of emerging technologies. This mission is expected to continue into the foreseeable future. The current landlord for the facility is the Department of Energy's Office of Defense Programs. This report assumes that Defense Programs will remain the landlord and will remain responsible for all associated landlord costs.

Because Los Alamos National Laboratory has an ongoing research and development mission, the Environmental Management program will continue to assist Defense Programs' operational mission by providing waste management support. For outyears of this estimate, Defense Programs' waste generation rates represent an annualized average based on current waste generation rates.

SITE MAP

Many of the Laboratory's operations required hazardous chemicals and radioactive materials such as plutonium and uranium. Use of these materials resulted in the contamination of facilities, and in some cases, of the surrounding environment. A major source of environmental contamination was waste being discharged into the environment or buried in material disposal areas. In addition to hazardous chemicals and radioactive materials, the contaminants of concern include explosive residues, unexploded ordinance, and asbestos. Although it is no longer used, asbestos is generated as a waste during facility modification and decommissioning activities.

In support of the Laboratory's mission, the Environmental Management program is also investigating approximately 2,100 sites to determine if cleanup is needed. These sites range in size from less than 1 square meter to tens of hectares (a few square feet to tens of acres). Potential residual contamination may exist at these sites as the result of 50 years of Laboratory operation. Contaminants may include radionuclides, organic solvents, metals, and high explosives. Residual contamination may exist in more than 7 million cubic meters (9.1 million cubic yards) of environmental media, primarily soils and sediments.

FUTURE USE

The Laboratory's site development plan outlines a 30-year window for the future use of Laboratory land to continue its nuclear stewardship mission. Current projections of land and facility requirements indicate the Laboratory needs to retain most of the 112 square kilometers (43 square miles) of its site, either for structures, roads, utilities, firing sites, or for a buffer area used for environmental research. The Department of Energy is considering the transfer of up to 2,800 hectares (7,000 acres) to Los Alamos County for Industrial use. These parcels are deemed to be in excess of programmatic needs. The Laboratory's requirements for land are being reviewed by the Future Site Use Integration Team, which in consultation with the general public, may recommend transfer or retention for various parcels of land, particularly in the buffer area.

For the purposes of risk-based decisionmaking in the Environmental Restoration program, this report assumes that future Laboratory land use will follow the projections of the Laboratory's Site Development Plan, which is Industrial/Commercial. This approach is based on ongoing discussions with the Environmental Protection Agency, the New Mexico Environment Department, and the public.

NUCLEAR MATERIAL AND FACILITY STABILIZATION

The facility stabilization and maintenance process began at the Los Alamos National Laboratory in 1995. Defense Programs provides current funding for stabilization and maintenance. Transfer of facilities to the Environmental Management program is anticipated to occur in FY 2002. Forty-five Los Alamos facilities are currently slated to undergo this process. Thirty-five facilities have already begun stabilization, including an accelerator building, four laboratories, a cooling system building, and numerous storage facilities. This report assumes the remaining ten facilities, which include a laboratory, a contaminated surge tank, drainage basins, and a contaminated waste pit, will begin stabilization and maintenance activities in 1996.

NUCLEAR MATERIAL AND FACILITY STABILIZATION MAP

The resulting waste types are expected to include hazardous, transuranic, low-level, and low-level mixed waste. This estimate assumes that the stabilization and maintenance process at Los Alamos will be completed by 2010. Funding profiles and facility activities were generated through parametric modeling, using data from other Department of Energy facilities.

Nuclear Material and Facility Stabililzation Activities Cost Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	2005	2010	2015	2020	2025	2030	Life Cycle*
Nuclear Material and Facility Stabilization	279	3,101	4,138	4,276	1,511			66,529
** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*								

ENVIRONMENTAL RESTORATION

Environmental Restoration has identified approximately 2,100 potential release sites. The principal mechanism for potential release of contaminants is surface-water runoff, which can carry potentially contaminated sediments, and erode soil, resulting in exposure of buried waste. The primary potential pathways for released contaminants to reach beyond the Laboratory's boundaries are surface runoff, infiltration into alluvial aquifers, and airborne dispersion of particulate matter. Los Alamos has implemented ground-water and air monitoring programs to identify releases that could pose a health risk to surrounding communities. This surveillance and monitoring program is operated by the site landlord, Defense Programs. This activity and its associated costs will also encompass any long-term surveillance and monitoring required following the completion of remedial action. The monitoring data gathered so far indicates that risks are minimal to the health and safety of the public.

ENVIRONMENTAL RESTORATION MAP

By the end of FY 1995, about 100 of the approximately 2,100 potential release sites had been remediated; in addition, No Further Action was proposed for approximately 900 sites, and 1,100 sites were slated for further investigation or accelerated cleanup. All cleanup activities are expected to be completed by FY 2015.

cleanup. All cleanup activities are expected to be completed by FY 2015.

Whenever warranted and possible, Los Alamos will apply the accelerated cleanup approach, which permits a site-specific remediation to be planned, designed, and implemented without proceeding through the entire corrective action process. More complicated actions, such as remediating former material disposal areas, will employ the conventional corrective action process to evaluate exposures, compare alternatives, and prepare detailed plans and specifications for the action.

Waste resulting from environmental restoration remedial activities will be transferred to the Waste Management program or offsite for treatment, storage, and disposal. Current plans are for the Environmental Restoration program to fund treatment, storage, and disposal.

During the corrective measures study phase, remediation options such as corrective action management units and temporary units, which the Environmental Restoration program manages, may be selected. Waste minimization techniques will be used during site characterization and remediation.

Corrective actions and remedial designs will meet requirements of the Laboratory's Resource Conservation and Recovery Act operating permit. The State of New Mexico issued the Laboratory's Resource Conservation and Recovery Act permit and has authority over the Hazardous and Solid Waste Amendments portion of the permit. The permit became effective in November 1989 and will expire in December 1999.

Environmental Restoration at Los Alamos is subdivided into field units, which are generally defined geographically with some functional distinctions. For example, Field Unit 1 contains all offsite properties, Field Unit 5 contains all active waste management areas, Field Unit 4 contains all canyon areas, and Field Unit 6 encompasses decommissioning.

Major Environmental Restoration Activity Milestones

REMEDIATION	COMPLETION DATE Fiscal Year
Field Unit 1	2006
Field Unit 2	2004
Field Unit 3	2004
Field Unit 4	2015
Field Unit 5	2011*
Field Unit 6	2004

Field Unit 1

Field Unit 1 consists of 670 potential release sites associated with 18 technical areas. It includes potential release sites located on Los Alamos County, private, commercial, National Forest Service, and Laboratory property. The sites under investigation include the following: material disposal areas, former firing sites, an inactive firing range, landfills, underground storage tanks, septic systems, outfalls, a former plutonium processing facility, waste treatment plants, vehicle decontamination facilities, motor-pool facilities, acid waste lines, incinerators, mortar impact areas, and radioactive waste disposal pits.

The primary constituents of potential concern are radionuclides, volatile organic compounds, and inorganic compounds (including heavy metals). Unexploded ordnance have been found at a few sites.

Sites in the Los Alamos townsite were occupied by a wide range of former Laboratory facilities, including administrative buildings, warehouses, workshops, laboratories, and research facilities. During their operational history, many of these facilities handled and potentially released radioactive and hazardous organic and inorganic substances. Radioactive structures and contamination were removed from the townsite in the 1960s, thereby avoiding release to Los Alamos County and private owners. The objectives of the present investigations are to confirm that radioactive waste was cleaned up to meet current standards and to verify that hazardous waste is not present at these sites.

In addition to the townsite potential release sites, Field Unit 1 includes potential release sites located on current or former Laboratory sites and in nearby canyons. Operations conducted at these sites vary widely. For example, Technical Area 10, also referred to as the Bayo Site, was used from 1943 to 1961 as firing site to conduct experiments using high explosives, in

also referred to as the Bayo Site, was used from 1943 to 1961 as firing site to conduct experiments using high explosives, in conjunction with research on nuclear weapons; Technical Area 45 was used as an industrial waste discharge area from 1944 to 1951 and subsequently served as the Laboratory's first radioactive liquid waste treatment facility from 1951 to 1964; Technical Area 21 was used for both chemical research and plutonium metal production from 1945 to 1978; Technical Area 3 currently contains the core of the Laboratory's operational facilities, including administration buildings, warehouses, workshops, and the Chemistry and Metallurgy Research Building; and Technical Area 73, a landfill located at the current Los Alamos airport, received hazardous waste from the Laboratory and Los Alamos County from 1946 to 1973.

ASSESSMENT

In this field unit, the Laboratory has completed initial site investigations on 558 potential release sites (83 percent), and the Laboratory is presently assessing 65 additional sites. Investigation has been completed at 40 percent of the sites. No Further Action has been formally proposed for 133 sites to the Environmental Protection Agency through permit modification proposals. No Further Action is proposed for 116 additional sites in work plans and investigation reports. Projected activities for FY 1996 include Phase I investigations on 42 sites and Phase II investigations on 6 sites. In 1996, approximately 20 investigation reports at 145 sites will be submitted to the Environmental Protection Agency. Nearly 40 sites are likely to be proposed in 1996 for No Further Action. Assessment will be completed in FY 2006, assuming continued funding and regulatory approvals.

REMEDIAL ACTION

In the past, most remedial actions consisted of removing contaminated materials, limited treatment to reduce waste volumes, and turnover to the Waste Management program for final disposition. Future remedial actions will also involve these steps. Over the life of this field unit it is anticipated that about 4,521 cubic meters (5,900 cubic yards) of low-level radioactive waste, and 130 cubic meters (175.5 cubic yards) of radioactive mixed will be generated. Materials to be removed consist primarily of surface soils and near-surface bedrock; some materials such as septic tanks, pipelines, and other structures are involved at some sites. To date, over 30 sites have been cleaned up, including approximately 12 underground storage tanks. These cleanups have been voluntary corrective actions for those sites not containing Resource Conservation and Recovery Act-regulated substances. Other sites on the Resource Conservation and Recovery Act permit have been remediated as expedited cleanups that have been approved by the Environmental Protection Agency. Eleven sites are being considered for accelerated cleanup in FY 1996. Some sites, such as the large material disposal areas, will require a full Environmental Protection Agency-approved corrective measures study and implementation process. No sites have been subject to this process thus far.

To date, no sites have been stabilized in place. It is likely that the six large material disposal areas at Technical Area 21 will be considered for stabilization in place. The nature and number of stabilizations will depend upon Environmental Protection Agency approval of corrective measures proposals in the latter years of the program. Remediation activities in this field unit will be completed in FY 2006.

Field Unit 2

Field Unit 2 consists of 301 potential release sites associated with 14 technical areas. This unit includes active and inactive firing sites, a facility for research on nuclear criticality, and a 0.8-kilometer (0.5-mile) long linear proton accelerator with associated experimental research areas. The primary constituents of potential concern are radionuclides, high explosives, organic compounds, and heavy metals.

Beginning in the 1940s, the now inactive firing sites were used for experiments involving explosive charges ranging from a few kilograms to several Metric Tons (from a few pounds to two tons). More than 30,000 test shots have been performed at one of the active firing sites, expending an estimated 1.0 to 2.0 Metric Tons (1.1 to 2.2 tons) of depleted uranium. All the experiments have been above-ground detonations. The resulting waste varies widely in terms of particle size, from fine dust to shrapnel. Larger pieces of shrapnel have traveled up to 915 meters (3,000 feet). Metal pieces that were projected downward penetrated the ground to a depth of several meters (yards). In other tests, projectiles were fired at targets. In some cases, projectiles penetrated the target and were embedded in adjacent canyon walls.

Nuclear criticality experiments were conducted in three separate buildings. In one of the buildings, mockup studies of fission reactors and studies of a plasma-core power reactor were performed. This site remains active and is used for development of treaty verification technology.

development of treaty verification technology.

The 0.8-kilometer (0.5-mile) long linear proton accelerator is used for basic research on subatomic particles, isotope production, and accelerator technology development. Site characterization is presently conducted in all areas of the field unit except for two, which are scheduled to begin characterization next year.

ASSESSMENT

To date, 40 percent of the sites have completed investigations; 96 sites have made formal proposals to the Environmental Protection Agency for No Further Action, and 15 have made informal proposals. Investigation reports have been submitted to the Environmental Protection Agency for 18 sites. During FY 1996, Phase I investigations will address 39 sites and Phase II investigations will begin at 13 sites. Investigation reports submitted to the Environmental Protection Agency in 1996 will address 82 sites. It is likely that proposals for No Further Action will be made for 33 sites in 1996. The assessment phase for this field unit will be complete in FY 2000, assuming continued funding and regulatory approval.

REMEDIAL ACTION

Most remedial action in the past and future consists of removing contaminated material, limited treatment to reduce waste volumes, and transfer to Waste Management for final disposition. Over the life of this field unit, it is anticipated that approximately 1,600 cubic meters (2,100 cubic yards) of low-level radioactive waste and 845 cubic meters (1,100 cubic yards) of mixed waste, will be generated. Materials to be removed consist primarily of surface soils and near-surface bedrock; some materials such as septic tanks, pipelines, and other structures are involved at some sites. To date, five sites have been cleaned up, including three underground storage tanks. These cleanups have been voluntary correction actions for those sites not containing Resource Conservation and Recovery Act-regulated substances. Other sites on the Resource Conservation and Recovery Act permit have been remediated as expedited cleanups that have been approved by the Environmental Protection Agency. Thirty-nine sites are being considered for accelerated cleanup in FY 1996.

To date, no sites have been stabilized in place. Few sites in this field unit are likely candidates for stabilization in place. The nature and number of stabilizations will depend on Environmental Protection Agency approval of corrective measures proposals in the latter years of the program. Remediation activities in this field unit will be completed in FY 2004. Long-term surveillance and monitoring will be turned over to the landlord, Defense Programs.

Field Unit 3

Field Unit 3 consists of 555 potential release sites associated with ten technical areas. It includes sites where high explosives were developed and processed, initiators for nuclear weapons were tested, and reactor components were developed. The primary constituents of concern are radionuclides, high explosives, volatile and semi-volatile organic compounds, polychlorinated biphenyls, asbestos, pesticides, and herbicides.

Much of the contamination in this field unit resulted from operations established during World War II to develop, fabricate, and test explosive components for nuclear weapons. Various other facilities included areas for photo-fission experiments, a mortar impact area, an air gun firing range, gun firing sites, a burning ground, laboratories, storage buildings, sumps, and material disposal areas. In many of the experiments, beryllium-containing weapons initiators were tested, and in some experiments uranium components were used. A high-pressure tritium facility was also in operation until 1990.

One site in this field unit was used to develop nuclear reactors for propulsion of space rockets. Experiments included structural testing of fuel elements made of uranium-loaded graphite, which were tested until they failed. The site also was used to develop methods for uranium isotope separation and to test lasers for exciting uranium hexafluoride gas of various enrichments. Experimental solar buildings and solar ponds, which have since been converted to sanitary waste lagoons, were built later.

ASSESSMENT

To date, investigations at all sites have been completed (approximately 82 percent), except for Technical Area 16. Formal proposals for No Further Action have been forwarded to the Environmental Protection Agency for 105 sites; informal

proposals have been submitted for 89 sites. In FY 1996, investigations will begin at about 60 sites; it is unlikely any sites will be proposed for No Further Action; and reports covering investigation of about 25 sites will be submitted to the Environmental Protection Agency. Assessment within this field unit will be completed by FY 2002.

REMEDIAL ACTION

In the past, most remedial action consisted of removing contaminated material, limited treatment to reduce waste volumes, and turnover to Waste Management for final disposition. Future remedial actions will also involve these steps. Over the life of this field unit it is anticipated that 1 cubic meters (1.3 cubic yards) of low-level waste, 1,300 cubic meters (1,755 cubic yards) of hazardous waste, and no radioactive mixed waste, will be generated. Approximately 31,000 additional cubic meters (41,850 cubic yards) of hazardous waste substances will also be generated during the closure of Area P at Technical Area 16, within the boundaries of this field unit. Materials to be removed consist primarily of surface soils and near-surface bedrock; some materials such as septic tanks, pipelines, and other structures are involved at some sites. To date, approximately six sites have been cleaned up. These cleanups have been voluntary correction actions for those sites not containing Resource Conservation and Recovery Act-regulated substances. Other sites on the Resource Conservation and Recovery Act permit have been cleaned as expedited cleanups the Environmental Protection Agency has approved. Approximately 24 sites are candidates for accelerated cleanup, in FY 1996.

To date, no sites have been stabilized in place. A few sites in this field unit are likely candidates for stabilization in place, particularly two material disposal areas in Technical Area 33. The nature and number of stabilizations will depend on Environmental Protection Agency approval of corrective measures proposals in the latter years of the program. Remediation activities in this field unit will be completed in FY 2004.

Field Unit 4

Field Unit 4 consists of 260 potential release sites and 19 canyons on the Pajarito Plateau, a reactor site, and various heavily industrialized sites. The primary constituents of potential concern are radionuclides, high explosives, volatile and semi-volatile organic compounds, and inorganics, including heavy metals. Most of the contamination resulted from operations dating from as early as 1944 and is associated with facilities such as: surface impoundments and disposal areas, experimental reactors, wastewater treatment and septic systems, above-ground and underground storage tanks, sanitary and industrial waste effluent lines, transformers, firing sites, incinerators, chemical processing sites, and shops for machining radioactive materials.

The Pajarito Plateau consists of finger-like mesas extending from the Jemez Mountains, with canyons between each mesa. Contamination from various Laboratory operations may be present in 19 canyons, both on the mesas and within the canyons themselves. Many canyons extend beyond Laboratory boundaries and eventually drain into the Rio Grande. The Resource Conservation and Recovery Act permit requires technical studies to determine quantitative and qualitative descriptions of the canyons' geologic and hydrologic systems. This data is required to estimate the potential for offsite transport of contaminants.

ASSESSMENT

Radioactive constituents (primarily tritium, cesium-137, and strontium-90) have been detected in alluvial ground water downgradient of two sites located in one of the main canyons within the Laboratory's boundaries. One of the sites houses the Omega West Reactor. This 8-megawatt water-cooled reactor, which is no longer operational, was fueled with highly enriched uranium, which was used for basic research in nuclear physics. The other site was used to develop weapons-boosting systems and to conduct long-term studies on weapons subsystems.

To date, 28 percent of the sites have completed investigations and 74 sites that have been proposed for No Further Action in work plans or investigation reports have been submitted to the Environmental Protection Agency for removal from the Laboratory's Resource Conservation and Recovery Act operating permit. In FY 1996, Phase I investigations for 12 sites will begin and 24 sites will be subject to Phase II investigations. Fifty-nine sites within this field unit are candidates for No Further Action in 1996. Assessment activities in this field unit will be completed in FY 2008.

REMEDIAL ACTION

In the past, most remedial action consisted of removing contaminated material, treating it to reduce waste volumes, and turnover to the Waste Management program for final disposition. Future remedial actions will also involve these steps. Over the life of this field unit, it is anticipated that 220 cubic meters (290 cubic yards) of hazardous waste will be generated. Estimates for other waste streams are currently unavailable. Materials to be removed consist primarily of surface soils and near-surface bedrock; some materials such as septic tanks, pipelines, and other structures are involved at some sites. To date, six sites have been cleaned up, including several underground storage tanks. These cleanups have been voluntary correction actions for those sites not containing Resource Conservation and Recovery Act-regulated substances. Other sites on the Resource Conservation and Recovery Act permit have been cleaned as expedited cleanups that have been approved by the Environmental Protection Agency. In FY 1996, approximately 19 sites are considered candidates for accelerated cleanup. Remediation activities in this field unit will be completed in FY 2015.

To date, no sites have been stabilized in place. Few sites in this field unit are likely candidates for stabilization in place. The nature and number of stabilizations will depend on Environmental Protection Agency approval of corrective measures proposals in the latter years of the program.

Field Unit 5

Field Unit 5 consists of 313 potential release sites associated with several areas used for explosives development, waste management facilities, and one offsite area located on land owned by the U.S. Forest Service and leased by the Department of Energy. Many of the Laboratory's material disposal areas also are located within this field unit. The primary contaminants of potential concern are radionuclides, high explosives, volatile organic compounds, and metals. Much of the contamination in this field unit resulted from high explosives research and development and from testing at above-ground and underground firing sites. Contamination also resulted from research into various methods for assembling fissionable material to produce nuclear bombs and the testing, developing, and producing bomb detonators.

This unit contains many of the Laboratory's retired and operating waste management facilities, other than the early landfills, which are part of Field Unit 1. Established in 1948, one of the retired sites consists of several pits and shafts that contain a diverse mixture of contaminants, including low-level, transuranic, hazardous, and mixed waste. The Laboratory's low-level radioactive disposal area is also part of this field unit. A material disposal area in this field unit was used in the early 1960s for experimental purposes and presently contains large amounts of various waste materials, including plutonium and lead. This unit contains the Laboratory's Radioactive Liquid Waste Treatment Facility, which was built in 1963.

Located 59.2 kilometers (37 miles) west of the Laboratory, the Fenton Hill site was formerly used for research on geothermal energy. The site is located on land leased by the Department of Energy. A few potential release sites have been identified at Fenton Hill.

ASSESSMENT

To date, 27 percent of the sites have completed investigations. At the end of FY 1995, 80 sites had been formally proposed to the Environmental Protection Agency for No Further Action. Approximately 10 sites have been proposed for No Further Action in investigation reports submitted to the Environmental Protection Agency. Three candidate sites will be proposed for No Further Action in 1996. Phase I investigations are planned in FY 1996 to address 56 sites. The assessment phase for this field unit will be completed in FY 2002.

REMEDIAL ACTION

In the past, most remedial action consisted of removing contaminated material, treating it to reduce waste volumes, and turnover to Waste Management for final disposition. Future remedial actions will also involve these steps. Over the life of this field unit it is anticipated that 2,800 cubic meters (3,780 cubic yards) of low-level radioactive waste, 1,480 cubic meters (1,936 cubic yards) of hazardous waste, and 1,000 cubic meters (1,380 cubic yards) of asbestos will be generated. Materials to be removed consist primarily of surface soils and near-surface bedrock; some materials such as septic tanks, pipelines, and other structures are involved at some sites. To date, about ten sites have been cleaned up. These cleanups have been voluntary correction actions for those sites not containing Resource Conservation and Recovery Act-regulated substances.

Other sites on the Resource Conservation and Recovery Act permit have been cleaned as expedited cleanups that have been approved by the Environmental Protection Agency. Approximately 13 sites are candidates for accelerated cleanup in FY 1996. Remediation activities in this field unit will be completed in FY 2011.

To date, no sites have been stabilized in place. This field unit contains approximately six candidate sites for stabilization in place. These include material disposal areas at Technical Areas 6, 49, and 54. In FY 1996, stabilization activities are scheduled to begin at Area F in Technical Area 6 and Area AB in Technical Area 49. The nature and number of stabilizations will depend on Environmental Protection Agency approval of corrective measures proposals in the latter years of the program.

Field Unit 6

Field Unit 6 covers activities related to decommissioning obsolete facilities. Decommissioning is the removal of contamination and the actions taken to demolish facilities. When it is determined that a contaminated facility is no longer needed for its original purpose, the decommissioning program decontaminates the facility but does not demolish it if it can be used for another purpose. If the building cannot be used for another purpose, it is demolished. Decommissioning projects include: the former plutonium-uranium processing facility (discussed as part of field unit 1), which was used from the late 1940s to the early 1970s; a phase separator pit used from the mid-1960s through the early 1990s; a former tritium facility used from the mid-1950s through the late 1980s; abandoned buildings contaminated with high explosives and used from the 1950s to the 1980s; and the Omega West Reactor (discussed under Field Unit 4), which was used from the mid-1950s to the early 1990s.

To date, approximately two dozen structures have been removed under the decommissioning program, including pipelines, ventilation systems, buildings, foundations, reactor vessels, and stacks. All of these actions have been under the authority of the Atomic Energy Act. During FY 1996, the decommissioning program plans to remove 18 structures. Approximately 6,500 cubic meters (8,000 cubic yards) of low-level radioactive waste, 600 cubic meters (810 cubic yards) of hazardous waste, and 600 cubic meters (810 cubic yards) of asbestos waste, will be generated during planned activities. The last decommissioning activities, the contaminated facilities in Technical Area-53, are currently planned for completion in FY 2019.

WASTE MINIMIZATION/POLLUTION PREVENTION

Low-level radioactive metals were diverted from the former Plutonium Processing Facility and Sigma Building and decontamination and decommissioning activities provided for remelt/reuse.

The Environmental Management program at the Laboratory instituted a charge-back program, which assesses a fee on generated waste and encourages waste minimization/pollution prevention actions.

Waste minimization/pollution prevention support to the Chemical Metallurgy Research Facility upgrades project resulted in avoiding 12,312 cubic meters (16,200 cubic yards) of waste to date, representing savings of about $50 million

Environmental Restoration Activities Cost Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	2005	2010	2015	2020	2025	2030	Life Cycle*
Field Unit 1								
Assessment	4,180	952	1					25,666
Remedial Action	7,584	7,727	939					81,253
Field Unit 2								
Assessment	854							4,271
Remedial Action	5,488	2,371						39,295
Field Unit 3								
Assessment	2,192	530						13,608
Remedial Action	2,938	1,189						20,633
Field Unit 4								
Assessment	2,983	3,041	2,760					43,919
Remedial Action	3,657	7,925	7,775	1,041				101,992
Field Unit 5								
Assessment	3,241	394						18,177
Remedial Action	2,916	4,920	11,573	177				97,928
Field Unit 6								
Assessment					150			750
Facility Decommissioning	5,639	4,373			870			54,410
Direct Program Management/Support	11,473	10,066	2,561	135	113			121,748
Total	53,146	43,487	25,610	1,354	1,134			623,650

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

Direct Program Management/Support

Program management provides strategic leadership and direction for Environmental Restoration. It provides effective customer interface with internal and external customers. Program management includes planning for the cost-effective use and management of resources to accomplish project goals, prioritization of activities, direction of budget expenditures and schedules, and accountability to the Department of Energy. Program management also provides health and safety and regulatory compliance oversight for Environmental Restoration activities.

STAKEHOLDER INTERACTIONS

The Albuquerque Operations Office conducted public participation activities for the following New Mexico sites: Inhalation Toxicology Research Institute, Los Alamos National Laboratory, Sandia National Laboratories (and Holloman Air Force Base), South Valley Site, Albuquerque Operations Office, and the Waste Isolation Pilot Plant (and National Transuranic Waste Program Office). Stakeholder activities included a presentation on basic information concerning costs and activities at the sites at the Quarterly Environmental Restoration/Waste Management Public Meeting and a briefing to the Sandia National Laboratory/Department of Energy/Inhalation Toxicology Research Institute Citizens Advisory Board. Los Alamos National Laboratory provided, and will continue to provide, information to the public about activities specified in the Baseline Report, incorporating public involvement efforts into existing activities performed by the Community Involvement and Outreach Office and coordinating them with the Albuquerque Operations Office and the Los Alamos Area Office. No site-specific activities were conducted at the Waste Isolation Pilot Plant because of that site's pre-disposal status. If you would like more information about the report or have questions about the results for these sites, please contact:

Albuquerque Operations Office			Los Alamos Area Office
Public Participation Chris Houston (505)845-5483 chouston@doeal.gov	**Technical Liaison** Jim Orr (505) 845-4734 jorr@doeal.gov	**Public Affairs** Tami Toops (505) 845-5264 ttoops@doeal.gov	**Public Participation** Greg Sahd (505) 665-5025 gsahd@doe.lanl.gov

WASTE MANAGEMENT

The Waste Management program at Los Alamos provides treatment, storage, and disposal support to the Office of Defense Programs mission, as well as the remediation activities at the site. New and ongoing Laboratory programs and projects consist of activities and operations that generate waste at 33 technical areas. Examples include isotope separation, manufacturing, research and development programs in basic research and manufacturing explosives, chemically contaminated equipment cleanup, and radioactive materials work. The Waste Management program provides waste management services to Laboratory waste generators. This estimate assumes the waste generator costs include characterization and packaging; the Waste Management estimate includes transportation, treatment, storage, and disposal of waste.

Cost estimates are based on recent agreements: The Federal Facility Compliance Act Land Disposal Restriction Agreement with the Environmental Protection Agency, and a Compliance Order with the State of New Mexico for the transuranic pad remediation project. Additionally, the Department initiated work for the conceptual design of a new Radioactive Liquid Waste Treatment Facility to replace a 30-year old facility.

Because Los Alamos National Laboratory is an operating research and development facility with new defense-related activities with the potential to generate significant additional waste, the Waste Minimization program is striving to tie their activities more closely to research and development waste volume projections through a formalized system.

Major Waste Management Activity Milestones

TASK	COMPLETION DATE Fiscal Year
Transuranic Waste Inspectable Storage Project	2004
Radioactive Liquid Waste Treatment Facility	2011

WASTE MANAGEMENT MAP

The waste types generated at the Laboratory include: transuranic waste, and mixed transuranic waste, low-level and low-level mixed, hazardous chemical waste; biological waste; medical waste; and sanitary solid and liquid waste.

The Laboratory does not generate high-level radioactive waste. Some spent nuclear fuel is kept in interim storage, but the Office of Defense Programs provides funding for its management; therefore, spent fuel is not included in the activities described in this estimate.

Major Waste Management Projects Cost Estimate*

(Five-Year Averages, Thousands of Constant 1996 Dollars)

	FY 1996-2000	2005	2010	2015	2020	2025	2030	
Low-Level Rad. Waste Disposal	6,262	4,499	4,499	4,499	4,499	4,499	4,499	
Rad Liquid Waste Treatment - TDD 4171	5,921	2,339	3,000	1,500				
Thermal Destruction - TDD 4170	498							
TRU Solid Waste Storage Operations	3,457	2,483	2,483	2,483	2,483	2,483	2,483	
TRU Waste Charact & Treat Ops	5,559	5,314	7,988	12,000	12,000	12,000	12,000	
	FY 2035	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	
Low-Level Rad. Waste Disposal	4,499	4,499	4,499	4,499	4,499	4,499	4,499	
Rad Liquid Waste Treatment - TDD 4171								
Thermal Destruction - TDD 4170								
TRU Solid Waste Storage Operations	2,186	1,000	1,000	1,000	1,000	1,000	1,000	
TRU Waste Charact & Treat Ops	10,200	3,000	3,000	3,000	3,000	3,000	3,000	
	FY 2070	**2075**	**2080**	**2085**	**2090**	**2095**	**2100**	**Life Cycle****
Low-Level Rad. Waste Disposal	4,499							346,241
Rad Liquid Waste Treatment - TDD 4171								63,801
Thermal Destruction - TDD 4170								2,489
TRU Solid Waste Storage Operations	1,000							137,705
TRU Waste Charact & Treat Ops	3,000							490,307

** Project costs represent a subset of total Waste Management costs.*

*** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

The facilities generating waste are responsible for ensuring that each waste type meets appropriate acceptance criteria for storage or disposal. This responsibility entails determining the characteristics of the waste, packaging it, and labeling the packages.

The site projects the generation of large volumes of waste, including 279,969 cubic meters (20,382 cubic yards) of low-level waste, 102,917 cubic meters (6,443 cubic yards) of hazardous waste, 1,581 cubic meters (2,255 cubic yards) of mixed waste, 272 cubic meters (186 cubic yards) of transuranic waste, and 278 cubic meters (364 cubic yards) of mixed transuranic waste.

During remediation, treatment and segregation of waste streams will be conducted to reduce waste volumes, particularly for those waste streams that are hazardous, radioactive, or radioactive mixed. Where appropriate, waste will be recycled (for example, steel or concrete) or used as clean backfill. Other waste will be transferred to the Waste Management program for final treatment and disposition. During environmental restoration work, alternative strategies will be developed with the regulator to minimize volumes of waste. These will include evaluating corrective action management units and temporary units to receive Environmental Restoration program-generated waste.

Transuranic Waste

TREATMENT

Transuranic mixed waste contains both long-lived transuranic radionuclides and hazardous chemical constituents as defined under the Resource Conservation and Recovery Act. Until 1991, when the waste profiling system was instituted at Los Alamos National Laboratory, transuranic mixed waste was not separated from transuranic waste. The characterization of transuranic solid waste in storage will better define mixed from nonmixed transuranic waste, thereby providing information to address treatment of mixed transuranic waste. The need to treat this waste and the degree of treatment will be driven by the Waste Isolation Pilot Plant Waste Acceptance Criteria and/or the Site Treatment Plan and the Federal Facilities Compliance Order.

The site assumes a volume of 55,000 0.2-cubic meter (55-gallon) drum equivalents of mixed transuranic waste. It assumes that 90 percent of the combustible and noncombustible drums will require repackaging, and that core sampling of 600 homogeneous drums will qualify 16,500 drums for acceptance at the Waste Isolation Pilot Plant.

Newly generated waste which amounts to 1,000 0.2-cubic meter (55-gallon) drums per year will meet the Waste Isolation Pilot Plant waste acceptance criteria and will only require real-time radiography, radioassay, and headspace gas sampling prior to shipment.

The construction of a new Transuranic Waste Characterization and Processing Facility for remote-handled transuranic waste is tentatively planned for FY 2003. However, this report assumes that the construction of this facility will not occur and no treatment to land disposal restriction requirements or handling of remote-handled waste will occur. It is further assumed additional characterization and repackaging activities can occur (in addition to those of the Waste Characterization, Reduction, and Repackaging Facility) in currently existing facilities. Two additional facilities will be converted to repackaging use in 2009, assuming increased funding that year, enabling work-off of backlog waste by 2034. Transportation costs for this report assume loading of TRUPACT shipping casks in an existing facility. Transportation and disposal costs are presented in the Waste Isolation Pilot Plant site summary.

Liquid transuranic waste is produced at the Los Alamos Plutonium Facility (Technical Area 55), where it is transported by a pipeline to the Radioactive Liquid Waste Treatment Facility at Technical Area 50. This facility consists of a primary chemical treatment plant and a pre-treatment plant for removing plutonium and other actinides. The pre-treatment plant has demonstrated removal of more than 99 percent of the actinides from the waste stream. Transuranic waste sludge is produced by the treatment of the influent. This sludge is solidified in 0.2-cubic meter (55-gallon) polyethylene-coated steel drums. The industrial pipeline that transports the liquid transuranic waste from the plutonium facility to the treatment plant was recently replaced with a double-wall piping system that will be in service as soon as some modifications are made at the Plutonium Facility. The existing Radioactive Liquid Waste Treatment Facility is 30 years old and is to be replaced with a new facility, which was expected to start operating in FY 2004; however, because of a reduction in funding, construction will be delayed and this report assumes that operation of the new facility will to start in FY 2011.

The program for treating solid transuranic waste has the following objectives: characterizing existing transuranic waste to determine that it meets the criteria for acceptance at the Waste Isolation Pilot Plant; certifying that all newly generated transuranic waste meets these acceptance criteria; and reducing the volume of the waste, stabilizing the waste, and repackaging it. Many of these functions will be performed at a new treatment facility the Laboratory expects to construct and operate.

The existing Waste Characterization, Reduction, and Repackaging Facility was originally designed to repackage and reduce the volume of metallic waste gloveboxes and process equipment. This facility is being modified to perform waste characterization. The modifications consist of installing a glovebox to perform detailed characterization of drummed, heterogeneous, transuranic waste; and installing a glovebox to core solid, homogeneous, transuranic waste.

Future plans include the development of a new facility to characterize and process transuranic solid waste. The new facility will have the capability of repackaging, stabilizing, and characterizing contact-handled transuranic waste; this accounts for most of the transuranic waste. As planned, Phase I (characterization, sorting, and repackaging) of the new facility is expected to be fully operational by FY 2006, and Phase II (processing to meet Waste Isolation Pilot Plant Waste Acceptance Criteria) operational by FY 2009. Phase I may be brought online as early as FY 1998.

MOBILE TRANSURANIC ASSAY SYSTEM

The Segmented/Tomographic Gamma Scanner Assay System, a fully mobile assay system, was delivered and has been fielded at both Los Alamos National Laboratory and Rocky Flats to support transuranic characterization and storage activities.

STORAGE

The solidified transuranic waste is transported to Technical Area 54, Area G for interim storage.

The Laboratory currently stores solid transuranic waste in four configurations at Technical Area 54, Area G. Transuranic solid waste generated before 1979 is stored in below-ground arrays in pits and trenches. Waste generated from 1979 to 1991 was placed in "bermed" storage, a method of storing drums on asphalt pads in dense-pack arrays under earthen cover. Some of the waste generated after 1985, and all of the waste generated after 1991, is stored in tension-support fabric domes in inspectable arrays, as required by the Resource Conservation and Recovery Act. Remote-handled transuranic waste, which requires storage with radiation shielding, is kept in canisters lowered into shafts at Area G.

In January 1993, the State of New Mexico issued a Compliance Order to the Laboratory to bring the bermed-stored transuranic waste into complete compliance with the Resource Conservation and Recovery Act. To comply with this order, the Laboratory initiated the Transuranic Waste Inspectable Storage Project to retrieve the waste stored under earthen cover at Pads 1, 2, and 4 at Area G and place it into inspectable storage. The project consists of four phases. The first phase of the project requires the construction of a retrieval dome and two storage domes, which were completed in FY 1995. The project is scheduled for completion in FY 2004.

DRUM VENTING AND CORING

The Drum Venting System was completed and tested. A drum coring system was designed to obtain core samples of homogeneous transuranic waste for detailed characterization to meet both the New Mexico Environment Department and Waste Isolation Pilot Plant requirements.

DISPOSAL

The transuranic solidified waste is destined for disposal offsite in the Waste Isolation Pilot Plant near Carlsbad, New Mexico. The Los Alamos cost estimate includes characterization and packaging and storage until the Waste Isolation Pilot Plant opens. The Waste Isolation Pilot Project estimate includes transportation and disposal.

Low-Level Mixed Waste

Under the Federal Facility Compliance Act, Los Alamos National Laboratory issued a Site Treatment Plan. The State of New Mexico issued a Unilateral Order requiring compliance with the Site Treatment Plan.

STORAGE

Low-level radioactive mixed waste is presently segregated, packaged, and stored at the Radioactive Storage and Disposal Facility (solids) and Technical Area 54, Area L (liquids) in inspectable arrays. The solids are stored in tension-support fabric domes. A dome for liquids is scheduled for completion in FY 1996. The Laboratory is pursuing a strategy to treat and dispose of as much of this waste as possible using offsite Department of Energy and private sector capability. Therefore, the proposed line items, the Mixed Waste Receiving and Storage Facility and the Hazardous Waste Treatment Facility, are being reconsidered.

TREATMENT

As a result of the land disposal restrictions of the Resource Conservation and Recovery Act, the Laboratory is striving to

identify and/or develop capabilities to treat the low-level radioactive mixed waste currently in storage. To treat low-level radioactive mixed waste, the Laboratory plans to use offsite commercial facilities to the extent that they are cost-effective, approved by the New Mexico Environment Department, and comply with other regulatory requirements. The Department of Energy has initiated a Feasibility Study for commercial treatment capabilities. As these capabilities emerge, they will be included for evaluation in the work-off plans for low-level radioactive mixed waste at the Laboratory. However, a potential offsite treatment will not be considered a capability until all of the operational, regulatory, and political issues are resolved (that is, waste actually could be loaded on a truck for shipment to that facility).

ELECTROCHEMICAL TREATMENT

The Laboratory demonstrated the use of the electrochemical treatment process to treat heavy metal-contaminated low-level mixed waste using bench-scale testing on surrogate waste.

Onsite treatment capability, as reflected in the Site Treatment Plan, is based on the use of mobile treatment units (skids), as specified in the Albuquerque Mixed Waste Treatment Plan prepared by the Department of Energy Albuquerque Operations Office. This plan has recently been reviewed and several mobile treatment units have been downsized or eliminated. The Hazardous Waste Treatment Facility, which is the proposed facility for housing the mobile treatment units, is currently on hold and undergoing review to determine if it can be scaled-down or replaced by a modified existing facility.

Low-level radioactive mixed waste will be treated by the Laboratory, using a combination of offsite treatment, treatability studies, and onsite (including downsized mobile treatment units) capabilities. The selection of the technology and capability will be based on a cost evaluation of the competitive technologies, with consideration of regulatory requirements and the milestones in the Site Treatment Plan.

DISPOSAL

Under current planning assumptions, low-level radioactive mixed waste will be disposed of offsite.

LOW-LEVEL MIXED WASTE INVENTORY REDUCED

In FY 1995, Los Alamos National Laboratory reduced its low-level mixed waste inventory by over 70 tons through manual decontamination and also through the use of the Laboratory's lead decontamination trailer.

LOW-LEVEL MIXED WASTE TREATMENT AND DISPOSAL

Los Alamos National Laboratory shipped 15 drums of radioactively contaminated scintillation cocktails for treatment and disposal at an offsite facility.

Low-Level Waste

TREATMENT

The primary treatment facility for low-level liquid radioactive waste is the chemical treatment plant at the Radioactive Liquid Waste Treatment Facility. Liquid waste is transported from Laboratory facilities via a double-walled pipeline to the treatment facility. The chemical treatment process separates actinides and other radionuclides from the influent waste stream. This 30-year-old facility is projected to be replaced by a new treatment facility in FY 2011.

Low-level solid radioactive waste is currently not treated at the Laboratory. However, a 200 ton compactor is expected to become operational in September 1996 for volume reduction.

DISPOSAL

Low-level radioactive sludge produced by the Radioactive Liquid Waste Treatment Facility is packaged in drums and disposed of in Technical Area 54, Area G.

Low-level solid radioactive waste has been landfilled since 1957 in shafts and large pits at the Radioactive Disposal and Storage Facility. The shafts are 0.3 to 3.7 meters (1 to 12 feet) in diameter and up to 19.8-meters (65-feet) deep and may be lined or unlined. Shafts are used for waste requiring special handling or for waste with high dose rates. Los Alamos National Laboratory disposes of radioactive waste contaminated with tritium, mixed fission products and mixed activation products, highly activated pieces of equipment, solids contaminated with polychlorinated biphenyls, animal tissue, beryllium, graphite powders, asbestos, and high-efficiency particulate air filters.

Approximately 70 percent of the waste is noncompactible, and this waste is placed directly into pits, which are 122 to 183-meters (400 to 600 feet) long, 7.6 to 30.5-meters (25 to 100-feet) wide, and 7.6 to 19.8 meters (25 to 65 feet) deep. These pits are also used to dispose certain nonreactive, non-Resource Conservation and Recovery Act-regulated chemical waste such as beryllium residues, polychlorinated biphenyls, asbestos, and empty pesticide containers. Approximately 4,800 cubic meters (6,300 cubic yards) of low-level radioactive waste is buried annually at Area G.

The current disposal facility at Area G has a remaining capacity of 22,800 cubic meters (29,700 cubic yards). At the current rate of waste generation and minimization, Area G has an operational life of three years. If Environmental Restoration cleanups are curtailed, Area G will reach its useful design life by the end of FY 2003. Continued construction at Area G depends on decisions associated with the Laboratory's Site-Wide Environmental Impact Statement. Continued construction will provide for approximately 50 years of additional capacity. The Laboratory is exploring other options for the offsite disposal of low-level radioactive waste.

Hazardous Waste

TREATMENT

Nearly all of the Laboratory's hazardous waste is treated at commercial offsite facilities, except barium sands, which are treated at the Laboratory. In the future, hazardous waste that cannot be handled by commercial facilities will be treated at the Hazardous Waste Treatment Facility or an alternative facility.

Current treatment does not remove dissolved constituents. As a result, compliance issues are often associated with the National Pollutant Discharge Elimination System permit. The Laboratory is under an administrative order from the Environmental Protection Agency to treat all high explosives wastewater by September 1997 and is complying with this requirement. To meet this obligation, the Laboratory is developing a high explosives wastewater treatment facility that will collect and treat these wastewaters with stepped filtration. The ultimate goal for this facility is zero discharge with complete recycling of the system water. Construction is scheduled for completion in FY 1997. The high explosives waste slurry that accumulates in the bottom of the sumps is trucked to sand filters near the burn grounds at Technical Area 16. Periodically, the slurry remaining on top of the sand filter is dried and burned in place under the Laboratory's Open Burning/Open Detonation permit. Initially, there were 17 such outfall discharges from widespread technical areas that process high explosives. Waste consolidation and minimization efforts will reduce the number of outfalls to two.

SOIL TREATMENT
The Laboratory completed pilot testing of a polymer soil washing process for treatment of lead-contaminated soils.

STORAGE

Hazardous chemical waste is stored at Technical Area 54, Area L in accordance with the Resource Conservation and Recovery Act permit. This facility will continue to package, bulk, and prepare hazardous chemical waste for offsite treatment and disposal. In the future, this storage area and its associated activities may be moved to the new Technical Area 63. However, at this time, the line-item Hazardous Waste Treatment Facility is on hold.

Hazardous waste treatment, storage, and disposal operations are also being evaluated for possible outsourcing. The estimate does not include costs for the facility.

DISPOSAL

Hazardous chemical waste includes Resource Conservation and Recovery Act-hazardous waste, non-Resource Conservation and Recovery Act oil and chemical waste, infectious/medical/biological waste, asbestos, and

polychlorinated biphenyls waste. The disposal of this waste is achieved by shipping it to commercial treatment and disposal facilities. This mechanism of waste handling has proved highly successful and will continue to be used for the foreseeable future.

The ash and sand mixture resulting from high explosives burning is sent to Technical Area 54 for treatment and disposal. If this material contains Resource Conservation and Recovery Act-regulated levels of barium sulfate, it is managed as a Resource Conservation and Recovery Act-listed hazardous waste. All the costs associated with high explosives material are included in the hazardous waste estimate for Los Alamos.

Sanitary Waste

The costs for this activity are included in the site's landlord estimate, which is maintained by the Office of Defense Programs, and are beyond the scope of this report. Costs for administratively controlled waste, waste that contains classified material, is also included in the landlord program.

Waste Management Activities Cost Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)

	FY 1996-2000	2005	2010	2015	2020	2025	2030
Transuranic Waste							
Treatment	5,559	5,314	7,988	12,000	12,000	12,000	12,000
Storage and Handling	7,088	5,091	5,888	7,083	2,483	2,483	2,483
Low-Level Mixed Waste							
Treatment	205	715	715	715	715	715	715
Storage and Handling	3,209	1,785	1,785	1,785	1,785	1,785	1,785
Disposal	191						
Low-Level Waste							
Treatment	12,586	7,748	7,848	6,348	4,848	4,848	4,848
Disposal	6,262	4,499	4,499	4,499	4,499	4,499	4,499
Hazardous Waste							
Treatment	1,419	32	32	32	32	32	32
Storage and Handling	3,380	3,380	3,380	3,380	3,380	3,380	3,380
Disposal	4,486	4,486	4,486	4,486	4,486	4,486	4,486
Direct Program Management/Suppor	16,240	15,474	15,474	14,634	14,634	14,634	14,634
Total	60,625	48,524	52,095	54,962	48,862	48,862	48,862
	FY 2035	2040	2045	2050	2055	2060	2065
Transuranic Waste							
Treatment	10,200	3,000	3,000	3,000	3,000	3,000	3,000

Storage and Handling	2,186	1,000	1,000	1,000	1,000	1,000	1,000	
Low-Level Mixed Waste								
Treatment	715	715	715	715	715	715	715	
Storage and Handling	1,785	1,785	1,785	1,785	1,785	1,785	1,785	
Disposal								
Low-Level Waste								
Treatment	4,848	4,848	4,848	4,848	4,848	4,848	4,848	
Disposal	4,499	4,499	4,499	4,499	4,499	4,499	4,499	
Hazardous Waste								
Treatment	32	32	32	32	32	32	32	
Storage and Handling	3,380	3,380	3,380	3,380	3,380	3,380	3,380	
Disposal	4,486	4,486	4,486	4,486	4,486	4,486	4,486	
Direct Program Management/Suppor	14,634	14,634	14,634	14,634	14,634	14,634	14,634	
Total	46,765	38,379	38,379	38,379	38,379	38,379	38,379	
	FY 2070	**2075**	**2080**	**2085**	**2090**	**2095**	**2100**	**Life Cycle***
Transuranic Waste								
Treatment	3,000							490,307
Storage and Handling	1,000							208,926
Low-Level Mixed Waste								
Treatment	715							51,076
Storage and Handling	1,785							140,993
Disposal								957
Low-Level Waste								
Treatment	4,848							439,290
Disposal	4,499							346,241
Hazardous Waste								
Treatment	32							9,334
Storage and Handling	3,380							253,500
Disposal	4,486							336,450
Direct Program Management/Suppor	14,634							1,113,979
Total	38,379							3,391,053

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

Direct Program Management/Support

The Waste Management program directly funds several support functions. Program management and administration provides overall program direction and strategy development and primary customer interface. The project control system provides the means for developing and maintaining scope, schedule, and cost estimates; for tracking and reporting progress; and for analyzing and taking corrective action for significant variations from planned activities.

DESCRIPTION OF PERSONNEL

Current Composition

The current composition of federal and contractor Full-Time Equivalent employees is presented in the table below. The federal work force is made up of professionals, engineers, and administrative personnel. The contractor work force consists mostly of engineers, technicians, scientists, professionals, and administrative personnel.

Full-Time Equivalent Composition Table*

LABOR CATEGORY	FEDERAL FTEs			CONTRACTOR FTEs						TOTAL FTEs		
				DIRECT			INDIRECT					
	1996	1997	1998	1996	1997	1998	1996	1997	1998	1996	1997	1998
General Managers, Exec., Pl. Supp.	0	0	0	27	23	23	6	6	6	33	29	29
Gen. Admin. Sup., and Clerical	0	0	0	69	58	57	45	42	42	114	100	99
Admin. and Other Professionals	0	0	0	66	44	44	33	28	28	99	72	72
Engineers	0	0	0	133	116	117	52	47	47	185	163	164
Scientists	0	0	0	79	67	68	18	18	18	97	85	86
Technicians	0	0	0	161	124	127	48	34	34	209	158	161
Crafts	0	0	0	11	10	9	3	2	2	14	12	11
Laborers and Other Gen. Workers	0	0	0	17	16	16	1	1	1	18	17	17
Operators	0	0	0	6	5	4	0	0	0	6	5	4
TOTAL	19	19	19	589	484	477	206	187	186	794	690	682

* The Projections for Full-Time Equivalent employees are based on FY 1996 planning baselines (see Reader's Guide).

Site Management Structure

The University of California is the management and operating contractor for the Laboratory. The University of California operates the laboratory for a management fee as a not-for-profit organization or a cost reimbursable contract. This contract expires in October 1997.

The Environmental Restoration program management team consists of the manager, technical consistency leader, regulatory compliance leader, and six field unit leaders. The project manager, technical and regulatory leaders, and their staffs constitute the Environmental Restoration Project Office. Environmental Restoration has two primary subcontractors for assessments and planning and four for remediation and decommissioning. Other subcontractors provide additional specialized support such as risk analysis and drilling.

The Waste Management program is organized as follows: the Waste Management Program Office manages the Waste Management and Waste Minimization/Pollution Prevention programs at the Laboratory to accomplish program goals, budget and schedules. The Waste Management Program Office is also the single point of contact and unified voice to customers outside the Laboratory. The Waste Management Program Office negotiates for technical and facility operations expertise with Los Alamos National Laboratory divisions to execute waste management requirements, and contracts are established to execute work. Additionally, the Waste Management Program Office manages task order contracts (that is, placement and maintenance) to augment Los Alamos National Laboratory technology expertise where needed.

CONTRACTING OPPORTUNITIES

If you would like more information about performing work for the Department of Energy's Environmental Management program at this site, please contact:

Major Procurements	**Small Business Procurements**
William Meyers	Greg Gonzales
Director	Contracts and Procurement Division
Contracts and Procurement Division	United States Department of Energy
United States Department of Energy	Albuquerque Operations Office
Albuquerque Operations Office	P.O. Box 5400
P.O. Box 5400	Albuquerque, NM 87185-5400
Albuquerque, NM 87185-5400	p: (505) 845-6182
p: (505) 845-5777	f: (505) 845-4210
f: (505) 845-4210	

Future Full-Time Equivalent Needs

In the future it is anticipated that the number of laborers and technicians will increase in Environmental Restoration as the work becomes dominated by remediation. Management and administration Full-Time Equivalents will probably remain level, with some changes in the mix of scientists and engineers as the nature of the work changes. The staffing mix in Waste Management is anticipated to remain level.

FUNDING ESTIMATE

The following two tables present estimated funding information for the Los Alamos National Laboratory.

Defense Funding Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)

	FY 1996-2000	2005	2010	2015	2020	2025	2030	
Nuclear Material and Facility Stabilization	279	3,101	4,138	4,276	1,511			
Environmental Restoration	52,618	43,062	25,610	1,354	1,134			
Waste Management	48,225	38,337	42,469	45,336	39,236	39,236	39,236	
Total	101,122	84,501	72,218	50,966	41,881	39,236	39,236	
	FY 2035	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	
Nuclear Material and Facility Stabilization								
Environmental Restoration								
Waste Management	37,139	28,753	28,753	28,753	28,753	28,753	28,753	
Total	37,139	28,753	28,753	28,753	28,753	28,753	28,753	
	FY 2070	**2075**	**2080**	**2085**	**2090**	**2095**	**2100**	**Life Cycle***
Nuclear Material and Facility Stabilization								66,529
Environmental Restoration								618,891
Waste Management	28,753							2,652,430
Total	28,753							3,337,850

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

Nondefense Funding Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	
Environmental Restoration	527	424						
Waste Management	12,400	10,187	9,626	9,626	9,626	9,626	9,626	
Total	12,927	10,611	9,626	9,626	9,626	9,626	9,626	
	FY 2035	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	
Environmental Restoration								
Waste Management	9,626	9,626	9,626	9,626	9,626	9,626	9,626	
Total	9,626	9,626	9,626	9,626	9,626	9,626	9,626	
	FY 2070	**2075**	**2080**	**2085**	**2090**	**2095**	**2100**	**Life Cycle***
Environmental Restoration								4,758
Waste Management	9,626							738,623
Total	9,626							743,381
** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*								

COMPARISON WITH PREVIOUS ESTIMATE

The 1996 life-cycle cost estimate for Los Alamos National Laboratory is approximately 5 percent lower than the 1995 estimate. Waste Management program estimates increased because of a revision in the assumption of how long the program will operate. The 1995 report assumed that the program would cease operation in FY 2030. In 1996, the life-cycle was defined to extend to FY 2070. Low-level mixed waste was scheduled to be treated in mobile treatment units that have since been canceled in favor of other more cost-effective treatment technologies. Waste Management program activity costs increased by approximately 25 percent.

The Environmental Restoration program cost estimates decreased by about 26 percent, reflecting a move away from assessment to remediation, accelerated cleanups, and No Further Action determinations. The definition of assessment has changed to shift characterization toward final action into the remediation category. Also, the Department believes that more sites can be moved to final action with less characterization.

The Nuclear Material and Facility Stabilization program costs were reduced by approximately 40 percent because a considerable amount of the parametric modeling data was refined by incorporating site analytical data.

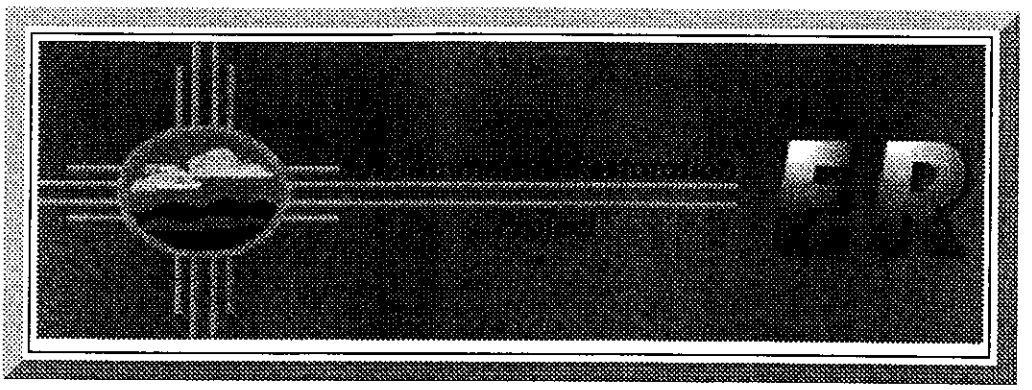
Comparison Table

Activity	FY 1995 Life Cycle	FY 1995 Only [1]	FY 1996 Life Cycle	Change in Dollars	Change in Percent
	Thousands of Dollars				
Nuclear Mat. & Fac. Stab.	111,854	0	66,529	-45,325	-41
Environmental Restoration	910,104	72,160	623,650	-214,294	-26
Waste Management	2,762,363	59,160	3,391,053	687,850	25
Landlord	-	-	-	-	-
Program Management [2]	661,093	32,830	-	-	-
Site Total	4,445,415	164,150	4,081,231	-200,034	-5

1 The FY 1995 life-cycle and annual costs are provided to determine the corrected FY 1995 cost.
2 Program Management was reported in an independent cost table last year, but is reported as a line item in the relevant program (Nuclear Material and Facility Stabilization, Environmental Restoration, and Waste Management) activity cost estimate tables for the FY 1996 Baseline Report.

About This Document

Posted 08/15/1996 (fr)



Organizational Information

ER Project Directory

Organization Chart

ER Project Management Team

The ER Project's management team consists of the project manager, regulatory compliance manager, project consistency manager, and field project leaders (FPLs) for each of six field units. Because of the number and complexity of the regulations and guidance that the ER Project must heed, the project manager is supported in his responsibilities for projectwide oversight by the regulatory compliance manager and project consistency manager. In addition, because overseeing the cleanup of 2,100 PRSs would be too large a task for a single individual, this responsibility has been divided among the six FPLs, five of whom oversee RCRA/HSWA activities and the sixth decommissioning activities. This team meets once or twice weekly to review schedules and budgets and to resolve problems.

ER Project Management Team Directory				
Name	**Mail Stop**	**Phone**	**Fax**	**Email**
Jorg Jansen, Project Manager	M992	7-0808	5-4747	jansen@lanl.gov
Dave McInroy, Regulatory Compliance	M992	7-0819	5-4747	mcinroy@lanl.gov
Tracy Glatzmaier, Project Consistency	M992	5-2613	5-4747	tglatzmaier@lanl.gov
Garry Allen, Field Unit 1	E525	7-3394	5-4632	garry@lanl.gov
Gene Gould, Field Unit 2	G787	7-0402	5-1976	gould@esa.lanl.gov
Roy Michelotti, Field Unit 3	E525	5-7444	5-4632	roym@lanl.gov
Allyn Pratt, Field Unit 4	M992	5-2613	5-4747	pratt_a@lanl.gov
Don Krier, Acting, Field Unit 5	D462	5-7834	5-3285	krier@lanl.gov
Miguel Salazar, Decommissioning	M769	5-3056	7-9710	miguels@erproject.lanl.gov

Field Units

505-66

In addition to the FPL, each field unit team consists of specialists in the following fields: geology, hydrology, risk assessment, statistics, geochemistry, and technical editing. Horizontal communications among field unit representatives of each of these disciplines are provided by coordinating councils, described immediately following this section.

Click on the desired Field Unit to access a brief description.

Field Unit 1 Home Page

Field Unit 2 Home Page

Field Unit 3 Home Page

Field Unit 4 Home Page

Field Unit 5 Home Page

Field Unit 6 Home Page

Coordinating Councils

Another mechanism used by the ER Project to ensure consistency in approach projectwide is coordinating councils, consisting of the Earth Sciences Council (geology, geochemistry, and hydrology), the Decision Support Council (human and ecological risk assessment, chemistry, and statistics), and Document Preparation Council (writing, editing, and compiling). The delegates to these councils from their respective field units meet periodically to discuss problems and approaches and to develop policies for submittal to the project consistency manager and/or the management team.

Records Processing Facility

The HSWA Module of the Laboratory's permit to operate under RCRA requires that the ER Project develop a records management plan and maintain a records management program in accordance with that plan. Thus, the ER Project established a Records-Processing Facility (RPF) as the repository for all its documentation. The RPF's functions are to process, manage, store, and protect records relevant to work conducted by the ER Project for use by all ER Project participants and stakeholders, including DOE, EPA, NMED, and the public. The facility collects, organizes, indexes, stores, and protects all relevant information, both manually and by automated methods, for this diverse group of users. More information on the RPF is available on the home page for the Records-Processing Facility.

Project Planning and Control

The Los Alamos National Laboratory Environmental Restoration Project uses a suite of commercially available software products, including Primavera Project Planner, G2, and Microsoft Excel, as the core elements of its planning, scheduling, and reporting Program Management Tool. Seamlessly interfacing through various Excel/Visual Basic and Clipper utilities, these programs are used to develop, maintain, and analyze success oriented plans supporting the characterization and cleanup of several hundred potential release sites throughout the 1700 acre Los Alamos compound.

Field Support Facility

- manages the packaging, shipping, and tracking of samples to analytical laboratories,
- establishes and administrates contracts with analytical laboratories for performing analysis of ER samples,
- manages the ER Projects electronic data management system,
- manages field contractor contracts and schedules drilling and coring activities,
- manages the mobile analytical facilities (Rad vans and Chem vans),

- identifies the costs of these field support functions for use by the Field Project Leaders in their budgeting and planning functions.

This section is currently under construction. However, the Environmental Sample Tracking System Home Page is up and running, so click on the Field Support Facility link to reach this home page.

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Contact: kathya@lanl.gov - URL: http://www-emp.lanl.gov/er/projectoffice/organizational.html - Revision Date: 9/9/96

Return-Path: roym@lanl.gov
X-Sender: u092225@pobox1663.lanl.gov
Date: Tue, 28 Jan 1997 13:07:44 -0700
To: Kory Edelmayer <KEdelmayer@SCIENTECH.Com>
From: Roy Michelotti <roym@lanl.gov>
Subject: Re: Request for Bombs and Bullets information

Kory,
LANL has very little if any UXO problem. However, there is significant HE contamination in soils and/or water at several locations. A contact would be Don Hickmott, dhickmott@lanl.gov. Other possible LANL contacts include Don Krier and Gene Gould, but I expect that you have already contacted them as they are my peers. Good luck.
Roy

>Roy, I sent you an email message on January 24, 1997 to receive some
>information on UXO at LANL facility. My return email address has been
>changed to KEdelmayer@SCIENTECH.Com. I apologize if this has caused any
>inconvenience. Thank you again for your time.
>Kory Edelmayer
>Environmental, Engineering & Safety
>SCIENTECH, INC.
>Idaho Falls, ID
>Phone: (208) 523-9552
>Fax: (208) 523-9380

Return-Path: deba@alice.lanl.gov
X-Sender: deba@alice.lanl.gov
Date: Wed, 29 Jan 1997 10:19:33 -0700
To: KEdelmayer@SCIENTECH.Com
From: Deba Daymon <deba@alice.lanl.gov>
Subject: Request for LANL HE Info

Hi - Allyn Pratt asked me to respond to your email for LANL info. Allyn is in charge on Field Unit 4 at LANL and I am his field team manager. We have no UXO in field unit 4. We may encounter HE in soils at some of our firing ranges, but we have not investigated those areas completely yet and so have no cleanups planned. Before coming to LANL I worked for MK at the INEL and helped with the UXO remediation (in fact worked with some of the folks at Scientech). I don't have much info on the other Field Units UXO/HE plans here at the lab. You would need to contact the LANL person in charge.
Field Unit 1 = Garry Allen
Field Unit 2 = Gene Gould
Field Unit 3 = Brad Martin
Field Unit 5 = Don Krier

Welcome to the Los Alamos National Laboratory Environmental Restoration Field Unit 1 Home Page.

FIELD UNIT 1

Field Unit 1 consists of 664 potential release sites. It includes all of the Los Alamos County townsite potential release sites that are on land no longer owned by the Department of Energy. It also includes sites at the old plutonium-processing facility, those at the main technical area, and other sites at various technical areas. In addition, this field unit contains several of the Laboratory's old material-disposal areas as well as the Los Alamos municipal sanitary landfill. The primary potential contaminants of concern are radionuclides, volatile organic compounds, and inorganics, including heavy metals.

Some of the early Laboratory sites included administrative buildings, laboratories, and research facilities, many of which handled radioactive and hazardous organic and inorganic substances. These areas were cleaned of radioactive material in the 1960s before being released to the county of Los Alamos or sold to private owners. However, with the more-stringent laws governing hazardous waste, they are subject to reinvestigation and remediation as part of environmental restoration.

The main technical area of the Laboratory includes potential release sites associated with the principal administration buildings, shops, warehouses, several large laboratory buildings housing diverse programs, and numerous smaller buildings serving specialized functions. Also included are the gas-fired electrical generation plant, gas station and garage, and sewage-treatment plant.

The field unit includes Technical Areas 0, 1, 3, 10, 19, 21, 26, 30, 31, 32, 43, 59, 60, 61, 64, 73, and 74.

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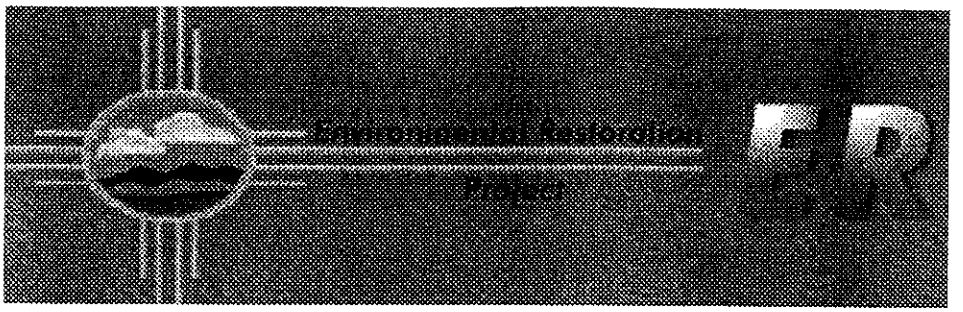

Welcome to the Los Alamos National Laboratory Environmental Restoration Project Field Unit 2 Home Page.

FIELD UNIT 2

Field Unit 2 consists of 301 potential release sites associated with 14 technical areas. This unit includes active and inactive firing sites, a facility for research on nuclear criticality, a 0.5-mile-long linear proton accelerator, and associated experimental research areas. The primary contaminants of concern are radionuclides, high explosives, organics, and heavy metals.

The inactive firing sites were used for experiments involving explosive charges of a few pounds up to 2 tons and were used starting the early 1940s. At one of the active firing sites more than 30,000 test shots were performed, with an estimated 2,200 to 4,400 pounds of depleted uranium expended. All of the experiments were aboveground detonations. The resulting waste products vary widely in terms of particle size, from fine dust to shrapnel. Larger pieces of shrapnel have traveled up to 3,000 feet. Metal pieces that were projected downward penetrated the ground to a depth of several yards. In other tests projectiles were fired at targets. In some cases, the projectiles penetrated the target and were embedded into the adjacent canyon walls.

The 0.5-mile-long linear proton accelerator, still in operation, is used for basic research on subatomic particles, isotope production, and accelerator-technology development.

The field unit includes Technical Areas 12, 14, 15, 18, 20, 27, 30, 36, 39, 53, 65, 67, 68, 71, and 72.

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Welcome to the Los Alamos National Laboratory Environmental Restoration Project Field Unit 3 Home Page.

FIELD UNIT 3

Field Unit 3 consists of 555 potential release sites associated with 10 technical areas. It includes old sites where high explosives were developed and processed; initiators for nuclear weapons were tested, and reactor components were developed. The primary contaminants of concern are radionuclides, high explosives, volatile and semivolatile organics, Polychlorinated Biphenyls (PCBs), asbestos, pesticides, and herbicides.

Much of the contamination in this field unit resulted from operations established during World War II to develop, fabricate (cast and machine), and test explosive components for nuclear weapons. Various other facilities included areas for photofission experiments, a mortar-impact area, an air-gun firing range and other gun-firing sites, a burning ground, laboratories, storage buildings, sumps, and MDAs. In many of the experiments, beryllium-containing weapons initiators were tested, and in some experiments uranium components were used. A high-pressure tritium facility was also in operation until 1990.

One site in this field unit was used to develop nuclear reactors for the propulsion of space rockets. Experiments included the structural testing of fuel elements made of uranium-loaded graphite, which were tested until they failed. The site was also used to develop methods for uranium-isotope separation and test lasers for exciting uranium hexaflouride gas of various enrichments. Experimental solar buildings and solar ponds were built later; these ponds have since been converted to sanitary waste lagoons.

The field unit includes Technical Areas 11, 13, 16, 24, 25, 28, 33, 37, 46, and 70.

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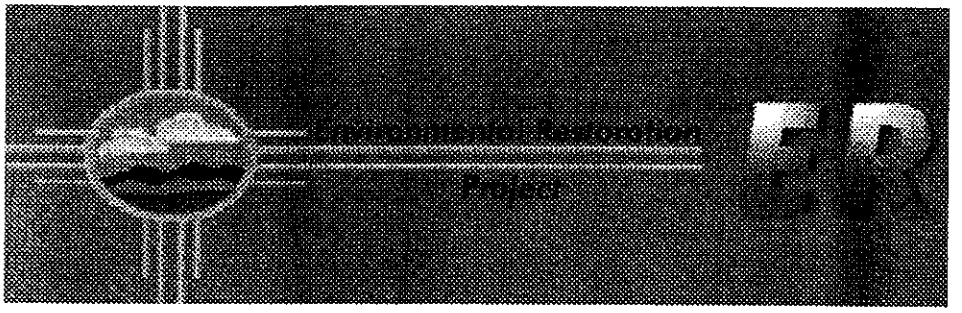

Welcome to the Los Alamos National Laboratory Environmental Restoration Project Field Unit 4 Home Page

FIELD UNIT 4

Field Unit 4 consists of 260 potential release sites and 19 canyons on the Pajarito Plateau, a reactor site, and various heavily industrialized sites. The primary contaminants of concern are radionuclides, high explosives, volatile and simivolatile organic compounds, and inorganics, including heavy metals. Most of the contamination resulted from various operations dating as early as 1944 and are associated with such facilities as surface impoundments and disposal areas, experimental reactors, wastewater treatment and septic systems, aboveground and underground storage tanks, sanitary- and industrial-waste effluent lines, PCB transformers, firing sites, incinerators, chemical processing, and shops for machining radioactive materials.

The Pajarito Plateau is a system of fingerlike mesas extending from the Jemez Mountains, with canyons between each mesa. Contamination my have occurred in 19 canyons from various Laboratory operations on the mesas and within the canyons themselves. Many of the canyons extend beyond the current boundaries of the Laboratory and eventually drain into the Rio Grande in New Mexico. The environmental restoration project will investigate any potential offsite contamination from potential release sites that discharge into the canyons.

Radioactive contaminants (primarily tritium, cesium 137, and strontium 90) have been detected in alluvial ground water downgradient of two sites located in one of the main canyons within the Laboratory's boundaries. One of the sites houses the Omega West Reactor. This reactor, no longer operational, was an 8-megawatt water-cooled reactor fueled with highly enriched uranium, it was used for basic research in nuclear physics. The other site was used in developing weapons-boosting systems and conducting long-term studies on weapon subsystems.

The field unit includes Technical Areas 2, 4, 5, 35, 41, 42, 48, 52, 55, 63, 66, and the canyons.

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TA-4 TA-5 Descriptions

Site Location and Physical Description

Alpha Site, a firing site, was located at the former site of TA-4, which was abandoned in the late 1940s. Former TA-4 lies within the current boundaries of TA-63 and TA-52; however, all the SWMUs designated for TA-4 are located within the boundaries of TA-52.

Physical Site Description

In 1944, Alpha Site was established as a test firing site for use by the Manhattan Project personnel (Ahlquist 1983, 04-0011; Montoya 1985, 04-0159; LASL 1945, 04-0134; LASL 1947, 0460; DOE 1988, 0491). Construction at Alpha Site was initiated in May 1945 (LASL no date, 0402). By the end of the summer in 1945, structures in the technical area included: a double magazine (TA-4-1); two magazines (TA-4-2 and TA-4-8); a laboratory control building (TA-4-3); a battery building (TA-4-4); a storage building (TA-4-5); a process and trimming building (TA-4-6); a guard building (TA-4-9); a water tank (TA-4-10); a fire tool house (TA-4-11); a siren tower (TA-4-12); a hutment (TA-4-13); three road blocks (TA-4-14, TA-4-15, and TA-4-16); a latrine (TA-4-17); and a firing pit (TA-4-18) (LASL no date, 0402; LASL 1945, 04-0134; LASL 1947, 0460). The darkroom and photography laboratory building (TA-4-7) was relocated from TA-20 in March 1948 (LASL no date, 0402). The contaminated pit (TA-4-19), now known as Material Disposal Area (MDA)C, which was located adjacent to the TA-4 road turnoff, was listed briefly as an Alpha Site structure but was later redesignated as TA-0-900 (LASL 1949, 04-0139; DOE 1988, 0491). MDA-C is now part of TA-50, which is included under OU 1147. The approximate former locations of these structures are shown in Figure 3-1. Table 3-1 contains detailed descriptions of these Alpha Site structures.

Historical Overview

Alpha Site was established in 1944 to provide a test firing site for small charges (LASL 1947, 0460). Alpha Site was used as a firing site for implosion studies using the "electric" method of detonation wave determination (LASL 1947, 0461; Ahlquist et al. 1985, 04-0019; DOE 1988, 0491; Scholl 1989, 0485). The maximum charges fired were 200 lb (LASL 1947, 0460). Other documented studies at Alpha Site include smaller tests of the "pin shot" and "magnetic" methods of studying implosions and "equation of state" experiments (Ahlquist et al. 1985, 04-0020; Ahlquist et al. 1985, 04-0019). Groups G-3 and M-4 conducted these tests before their move to R Site (LASL 1947, 0461; Ahlquist et al. 1985, 04-0019).

Alpha Site was abandoned in 1946 (DOE 1988, 0491; Scholl 1989, 0485). The guard building (TA-4-9) was relocated to TA-16 in February or March 1952. The TA-4-16 road block was redesignated as TA-0, ULR-3, in January 1950, and removed in March 1952 (LASL no date,

0402). In 1955, TA-4 structures were surveyed for radioactivity, and all but the darkroom and laboratory (TA-4-7) were found to be free of detectable radioactive contamination. The contaminated floor in TA-4-7 was removed and the building subsequently released along with the other buildings for removal "in the near future" (H-Division 1955,0625). The Zia Company removed all Alpha Site structures except TA-4-1 in December 1956 (LASL no date, 0402). TA-4-1 was the only building intact before the start of the 1985 Los Alamos Site Characterization Program (LASCP) (Scholl 1989, 0485). TA-4-1 was demolished in July 1985, and the site was leveled and contoured to the existing terrain (Montoya 1985, 04-0159). In 1988, the only evidence of TA-4 structures was traces of wire and other surface debris, including two projectiles and pieces of shrapnel found in the firing pit area (TA-4-18) (Shafer circa 1989, 04-0187).

Description of TA-5, beta site Site Location and Physical Description

The present TA-5 includes the site of former TA-4, a firing site called Beta Site. Beta Site is no longer in operation and was decontaminated and decommissioned in 1985.

Physical Site Description

In 1944, Beta Site was established as an adjunct test firing site to Alpha Site (former TA-4) for Manhattan Project personnel (LANL 1990, 0145; LASL 1947, 0460; LASL 1947, 0461; Ahlquist 1983, 04-0011; Scholl 1989, 0485; Scholl Fritz 1985, 04-0082). By the end of 1945, structures present in the TA included a control building (TA-5-4), two day magazines (TA-5-2 and TA-5-3), a shop and darkroom (TA-5-5), a laboratory building (TA-5-6), two steel barricades at Firing Pits No. 1 and No. 2 (TA-5-7 and TA-5-15), a storage building (TA-5-8), an X-unit chamber (TA-5-9), and a latrine (TA-5-10) (LASL no date, 0402; LASL 1945, 04-0134). In addition, the following structures were constructed or relocated to Beta Site over succeeding years: a laboratory building (TA-5-1), an underground water tank (TA-5-11), an underground pump house (TA-5-12), a septic tank (TA-5-13), log and/or earthen barricades (TA-5-14 and TA-5-16); an experimental concrete wall (TA-5-17), platforms (TA-5-18 and TA-5-19), a calibration facility (TA-5-20), a maintenance building (TA-5-21), and a transformer station (TA-5-22) (LASL no date, 0402). The approximate locations of these structures are shown in Figure 3-2. Table 3-5 provides detailed descriptions of Beta Site structures.

Storage building TA-5-8 was removed in April 1950, and barricade TA-5-14 was removed in July 1952 (LASL circa 1967, 04-0144; LASL no date, 0402). In September 1952, the water tank, pump house, and septic tank (TA-5-11, TA-5-12, and TA-5-13, respectively) were returned to ENG-3 for disposition (Vogt 1952, 04-0196). Platform TA-5-18 was relocated near TA-15-44 in July 1957 (LASL 1967, 04-0144; LASL no date, 0402). The transformer station, TA-5-22, was renumbered TA-53-99 in January 1971. The remaining TA-5 structures were abandoned in place in 1959 (LASL no date, 0402). The following structures were destroyed by fire in March 1960: two day magazines (TA-5-2, TA-5-3); control building (TA-5-4); shop and darkroom (TA-5-5); laboratory building (TA-5-6), and latrine (TA-5-10) (LASL no date, 0402 ; LANL 1989, 04-0129). Structures TA-5-1, TA-5-2, TA-5-3, TA-5-4, TA-5-5, TA-5-7, TA-5-9, TA-5-11, TA-5-12, TA-5-14, TA-5-15, and TA-5-17 were addressed during 1985 LASCP D&D activities.

Historical Overview

Beta Site was originally established as a test firing site in 1944 and was used as such until 1947 (Ahlquist et al. 1985, 04-0019). In 1944, G-Division began using Beta Site as a firing site for implosion studies using the "pin" or "electric" method of detonation wave determination

(Ahlquist et al. 1985, 04-0019). Firing site tests typically involved about 50 lb of high explosives per test. The site was also used to fire larger charges than those tested at Alpha Site (former TA-4) using the "magnetic method." Two large tests involving approximately 2,000 lb of high explosives were conducted at the site for confirmatory measurements in preparation for the Trinity event (DOE 1987, 0264). As at TA-4, a shop and darkroom were used to process photographs of implosion activities conducted at the site.

After firing activities at TA-5 were halted, several Laboratory groups used the site for a variety of experiments. In 1952, J-Division temporarily used the shop and darkroom (TA-5-5) for calibration of high-range meters (Vogt 1952, 04-0196). Beta Site was used in the summer of 1953 for experiments conducted to study hydrogen fires. Also in 1953, Beta Site was used to conduct studies on the effects of radiation on E. coli and cell surface adsorption of radioactive compounds (H-Division 1953, 0466). A 1955 report indicates that Group H-4 conducted animal radiation experiments using 30 Ci of ^{60}Co (H-Division 1955, 0467). A 1957 report describes an experiment the US Air Force requested to determine if a burning plane carrying significant amounts of beryllium would cause hazardous air or ground contamination. A piece of beryllium was suspended above a large amount of jet engine fuel that was ignited. The metal reached a temperature of 950$^{deg.}$Celsius (C) and, although air sampling was performed in the smoke cloud and at various distances downwind, no air or soil contamination was detected (H-Division 1957, 0489).

In October 1959, the Nuclear Criticality Safety Committee (NCSC) approved Group J-12 to operate an experimental reactor, "Little Eva," at Beta Site (Reider 1959, 04-0174). Field measurements of Little Eva were made at Beta Site in January 1960. Radiation levels taken inside a control trailer located 800 ft from Little Eva were measured at 12 mR/hr using the Hurst proportional counter and at 83 mR/hr using a converted Pee Wee (H-Division 1960, 0481; LASL circa 1960, 04-0141). Because of these findings, the trailer was moved to a distance of 1,612 ft from Little Eva (H-Division 1960, 0481; LASL circa 1960, 04-0141). In November 1959, the NCSC approved Group J-16 to use another experimental reactor, "Godiva," at the Beta Site (Reider 1959, 04-0174). No data are available on possible soil contamination from operation of these reactors.

Beta Site was officially abandoned in 1959 (Scholl Fritz 1985, 04-0082; Russo 1959, 04-0177; Montoya 1976, 04-0163; Montoya 1985, 04-0159) but was used periodically for testing until the 1970s. In the 1960s and early 1970s, tests using radiation calibration sources were conducted (DOE 1987, 0264). A magnetometer was installed at Beta Site in July 1967 to record variations in the geomagnetic field (LASL 1967, 04-0144). Group A-2 conducted an experiment using neutron sources with no environmental contamination in 1972 (Russo 1972, 04-0180; Ahlquist 1985, 04-0014). Group P-10 conducted a "solar experiment" at Beta Site in 1979 (Montoya 1985, 04-0158).

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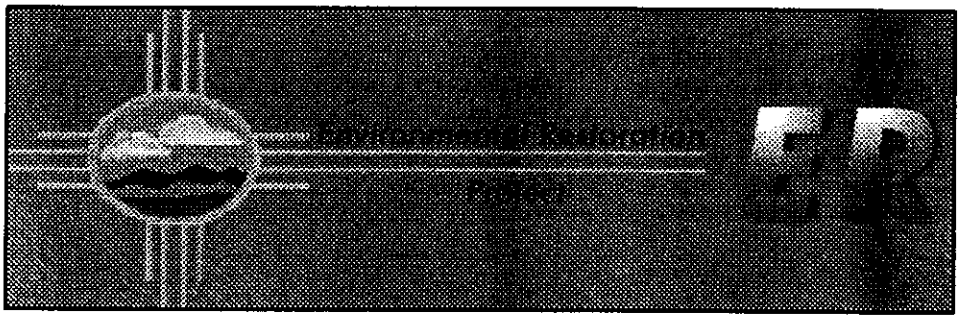

Field Unit 5

Departments				
What's New 10/1/96	Directory 10/1/96	Field Unit 5 Meetings 12/9/96	Field Work 12/9/96	RFI Reports 12/9/96
Data Status 12/9/96		Dates of Training Courses (LANL only) 10/1/96	Photo Album 2/25/96	Items of Interest 1/11/96

General Information about Field Unit 5

Field Unit 5 is a part of the Los Alamos Environmental Restoration Project. It includes 313 waste sites in Technical Areas 6, 7, 8, 9, 22, 23, 40, 49, 50, 51, 54, 57, 58, 62, and 69. We are assessing these waste sites for possible remediation under the Hazardous Waste Amendments of the Resource Conservation and Recovery Act. The 313 waste sites include hazardous and radioactive waste landfills (also called materials disposal areas, or MDAs), decommissioned areas formerly used for explosives development, systems (such as septic systems) that received sanitary and process waste, and storage areas where stored wastes may have leaked.

Field Unit 5 includes several teams who sample soil, drill to sample the subsurface, write reports on what has been found in the investigations, and manage early cleanups of waste sites.

Field Unit 5 maintains this WWW server to provide information to its personnel, its customers and other interested parties regarding Field Unit 5's current activities and findings. Information is updated weekly.

Site Information and Activities

Technical Area 6: Two-Mile Mesa South Site **1/4/96**	Technical Area 7: Gomez Ranch Site **1/4/96**	Technical Area 8: Anchor Site West **1/4/96**	Technical Area 9: Anchor Site East **1/4/96**	Technical Area 22: Trap Door Site **1/4/96**
Technical Area 23: Nu Site	Technical Area 40: DF Site **1/4/96**	Technical Area 49: Frijoles Mesa Site **1/4/96**	Technical Area 50: Waste Management Site **1/4/96**	Technical Area 51: Environmental Research Site
Technical Area 54: Waste Disposal Site **3/14/96**	Technical Area 57: Fenton Hill Site **1/4/96**	Technical Area 58: Two-Mile North Site	Technical Area 62: Northwest Site	Technical Area 69 **1/4/96**

Where to go from here

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FIMAD Home Page	Carol LaDelfe's Home Page
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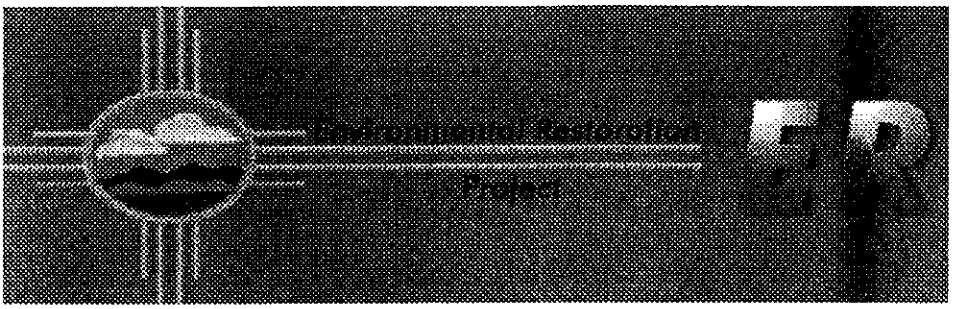

Welcome to the Los Alamos National Laboratory Environmental Restoration Project Field Unit 6 Home Page

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FIELD UNIT 6

Field Unit 6 covers activities related to decontaminating and decommissioning facilities that are no longer needed. Decontamination is the removal of contamination, whereas decommissioning consists of actions taken to demolish facilities. When it is determined that a contaminated facility is no longer needed for its original purpose, the decontamination and decommissioning program decontaminates the facility but does not demolish it if it can be used for another purpose. If the building cannot be used for another purpose, it is demolished.

The decommissioning projects include buildings from the former plutonium-processing facility (discussed as part of field unit 1), which was used form the late 1940s to the early 1990s, a former tritium facility used from the mid-1950s through the late 1980s, many abandoned buildings contaminated with high explosives and used in the 1950s to 1980s, and the Omega West Reactor (discussed under field unit 4), which was used from the mid-1950s to the early 1990s.

As funding becomes available and other sites are identified as excess, the decommissioning project will decontaminate and decommission those buildings. The decommissioning project coordinates closely with environmental restoration program in identifying potential contaminants in and around buildings slated for decontamination and decommissioning.

LOS ALAMOS NATIONAL LABORATORY
Operated by the University of California for the US Department of Energy

Contact: kathya@lanl.gov - URL: http://www-emp.lanl.gov/er/fu4homepage.html - Revision Date: 9/9/96

The Laboratory has developed a list of 40 sites around the Lab and in Los Alamos County that will be cleaned this fiscal year as part of its environ-mental restoration effort. The cleanup effort began this month — the last step in a lengthy and expensive procedure to restore potentially contaminated sites — and continues through early November, weather permitting. The Department of Energy earlier this month estimated total environ-mental restoration costs to the Lab at $1.2 billion and $230 billion at plants and labs nationwide. The Lab's 1995 fiscal year budget for environmental restoration is approx-imately $90 million, which pays for assessing sites, writing reports and conducting actual cleanups, said Jorg Jansen, project manager for Environmental Restoration. Disposal of contaminated soils and other materials is paid for directly by the Lab's Waste Management Program. The Environmental Restoration Project (EM/ER), is part of Environmental Management Programs at the Lab. It is charged with analyzing sites around the Lab and the county that are potentially contaminated, making a determination on how to proceed with cleanup or other reme-dies, such as stabilization in place, and conducting the actual cleanup, said Jansen. The Lab obtained its Hazardous and Solid Waste Amendments Module to its Resource Conservation and Recovery Act operating permit in May 1990. Other DOE- and Department of Defense-operated facilities nationwide had begun preparing for cleanups in the mid- to late-1980s. But Congress became impatient with the lack of cleanup progress at these facilities. Consequently, DOE encouraged national labs, at the urging of Congress, to accelerate their cleanup efforts. DOE's Albuquerque Operations Office asked the Lab, Sandia National Laboratoties and Pantex in Texas to prepare action plans for improving the efficiency of the labs' cleanup efforts. After reviewing the Lab's action plan, the Department of Energy has allowed the Lab to continue managing its Environmental Restoration Project only after threatening to bring in private firms to do the work and intimating the Lab hasn't moved quickly enough to identify, analyze and clean up potentially contaminated areas at the Lab and in the county. The Lab has until October 1996 to meet performance-based goals for environmental restoration agreed upon by DOE and the Lab, Jansen said, or have the cleanup work done by private contractors. Some 2,100 sites around the Lab and in the county were identified by the Environmental Restoration Project team as "potential areas of concern," said Tracy Glatzmaier, project consistency manager. She emphasized that not all of the 2,100 sites are contaminated. However, federal Resource Conservation Recovery Act regulations mandate that "any site that may have remotely been contaminated be identified as a potential area of concern," she said. The Lab's Solid Waste Management Unit report was written in 1988, said Glatzmaier. The report details sites, and includes maps in some cases, and provides descriptions of types of possible contamination. "A lot of people at that time thought we should put all kinds of sites in it," Glatzmaier said of the report. Defining the history of the 2,000-plus sites was a researchers nightmare, Glatzmaier said. It included conducting lengthy interviews with former Lab employees and retirees, many now living out of state, and researching archived newspaper articles, maps, documents and photographs. "We have done a very, very detailed archival search, gone out of town if we had to, talked on the phone and done everything we could possibly do," said Glatzmaier. The federal Environmental Protection Agency reviewed the report and concluded that there are now 1,100 sites that are high priority and gave the Lab a schedule to analyze the sites, including determining the risk posed by the site to human health and to the environment, said Glatzmaier. The Environmental Restoration team has since developed work plans to address all 2,100 sites and created field teams responsible for cleaning assigned geographic areas of the Lab and county. "In doing that we've realized that many of the 2,100 aren't a problem," Glatzmaier said. For example, trans-formers removed from telephone poles and left on the ground for one day were included in the list of potential contami-Page

 nation sites. Another site included on the list of potentially contaminated sites is based on a worker recalling another worker emptying a bucket out of their back door, she said. "More than half we don't think are any problem at all," said Glatzmaier. Of the high priority sites, the Lab has asked the EPA for permission to remove 89 sites that preliminary review has determined aren't contaminated (see sidebar, Page 6). Earlier this month, Jansen said the Environmental Restoration Project team submitted its cleanup plans to DOE and EPA, he said. The agencies must approve the plans before actual cleanup begins. The Lab hires private firms to do the actual cleanup work, Glatzmaier said. Depending on the type and extent of contamination, the Lab has several options for disposing of the contamination: it can be taken to Technical Area 54, the Lab's waste-disposal site; it can be removed to other special waste-disposal sites around the country; it can be left undisturbed if the contamination doesn't pose a health threat; or it can be treated in place using sophisticated technologies to reduce the contamination and amount of waste. For example, the project team is looking at using microorganisms to alter the chemical makeup of high explosives. Field unit personnel, Glatzmaier said, must wear personal protective equipment, or PPE, depending on the extent of the contamination, to prevent human exposure. After a site has been cleaned, Glatzmaier continued, the Lab must submit another report and take "confirmatory samples" at cleanup sites. The report describes the actual cleanup activities, while the confirmatory samples provide further evidence that a contaminated site has been assessed for contamination and restored, she explained. The EPA reviews the report and can accept it or ask the Lab to return to a site and conduct a second cleanup if not satisfied. If the report is approved, said Glatzmaier, the Lab can remove the site from its list of poten-tially contaminated sites. And while the process is lengthy, Glatzmaier said it is necessary to assure the public that a potentially contami-nated site is safe and poses no future health hazard. "If we've cleaned up a site, the poten-tial for migration is elimi-nated," she said. "The Lab is committed to restoring its environment while also meeting the performance goals agreed upon with DOE," said Jansen. —Steve Sandoval

Bayo Canyon access corridor reopened

Hikers, bikers and horseback riders can again traverse the length of Bayo Canyon, which had been under restricted access since December as members of the Laboratory's Environmental Restoration Project cleaned up shrapnel from decades-old explosives tests. The shrapnel cleanup by the environmental restoration team began nearly a year ago within a fenced-off area around the central explosives test area, an access corridor allowed people to skirt the cleanup area and travel through the canyon. In December, the environmental restoration team found shrapnel fragments, some with low levels of radioactivity, outside of the fenced-off work area. Under an agreement with Los Alamos County, the team closed the access corridor, preventing any through traffic in Bayo Canyon, and expanded its cleanup activity outside of the existing work area. The cleanup has focused on the surface of the canyon bottom, the slopes of the canyon walls within the access corridor and the ephemeral stream bed to the boundary of San Ildefonso Pueblo. A total of about 125 acres were surveyed with metal detectors and had surface shrapnel removed. Approximately 20,000 individual pieces that were clearly linked to the former explosives activity were removed by the team; of those pieces, fewer than 1 percent had residual radioactive contamination. The canyon cleanup was expanded to include the tops of Otowi and Kwage mesas, which frame the canyon. Shrapnel was found on both mesa tops directly above the canyon firing site; about 200 pieces in all were removed from the mesas. The environmental restoration team will continue its work characterizing Bayo Canyon in the area of the former experimental facilities. That information will be used by the Department of Energy to determine additional, future cleanup in the canyon. The central work area for the team's activity will continue to be fenced off until this process is completed. In addition, up the canyon from the central work area, the environmental restoration team found what appears to be an undocumented landfill. A fence has been erected around the approxi-mately 1.5-acre area. The landfill contains building debris, which could have come from temporary shelters built around the firing site, but no extensive characterization of the contents has been undertaken yet. —John R. Gustafson

Lab and DOE will hold public hearings

The Laboratory and the Department of Energy will conduct two public hearings May 9 seeking comment on a request to remove some sites from cleanup because they pose no human health or safety risk. The meetings are from 4 to 6 p.m. and 7 to 9 p.m. in the Pojoaque High School gymnasium located at the U.S. 84-285 and NM 502 intersection. The Lab has asked the federal Environmental Protection Agency for permission to remove 89 sites from the Hazardous and Solid Waste Amendments Module (HSWA) of its Resource Conservation and Recovery Act (RCRA) permit for cleanup of potentially contaminated sites. The HSWA module requires the Lab to investigate potentially contaminated sites and if the site is determined to pose a threat to human health and the environ-ment, propose a remedy for the site. Sites can be removed from the HSWA module if there is proof that the site never contained hazardous waste, the site has no history of release, special laws apply to the site or the site already has been cleaned. Interested individuals also can submit written comments on the permit modification request to Barbara Driscoll at the Environmental Protection Agency, RCRA Permits Branch, 1445 Ross Ave., Dallas, TX 75202. Driscoll's telephone number is (214) 665-7441. Copies of the permit modification request also are available for review at the Lab's Community Reading Room next to the Bradbury Science Museum, the San Ildefonso Pueblo Governor's Office, and public libraries in Los Alamos, Santa Fe and Española.Field unit team members take samples from a ground monitoring well to test for potential contaminants.

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www-emp.lanl.gov/er/projectoffice/erinnews.html

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RFI Phase Report

Operable Unit 1071, SWMU Aggregate 0-D

Ordnance Impact Areas

Los Alamos National Laboratory
Los Alamos, NM

March 1994

Environmental Restoration Program
Los Alamos National Laboratory

RFI Phase Report

Operable Unit 1071, SWMU Aggregate 0-D
Ordnance Impact Areas

Executive Summary

This report presents the results of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) field work conducted at Operable Unit (OU) 1071, Solid Waste Management Unit (SWMU) Aggregate 0D, ordnance impact areas. This aggregate contains five Potential Release Sites (PRSs): SWMUs 0-011(a), (c), (d), and (e); and Area of Concern (AOC) C-0-020. These areas were either known or possible ordnance impact sites used by the U.S. Army in the 1940s where potentially unexploded ordnance (UXOs) and ordnance explosive waste (OEW) could have been present. The goal of the RCRA process for this SWMU aggregate was to (1) ensure that all UXOs and OEW were located and removed and (2) determine if any chemical contaminants, derived from the degradation of the ordnance fragments or high explosives (HE) are present in concentrations above the screening action levels (SALs) for those contaminants.

Field Program

OU 1071 RFI field activities at the five PRSs consisted of a search by a team of certified master explosive ordnance disposal (EOD) technicians. The sites were systematically scanned with ordnance detection equipment following standard military ordnance clearance procedures. Following the EOD team sweep, a team of geophysicists conducted a second survey of the PRSs using magnetic and/or electromagnetic survey instruments. The geophysical surveys provided a quality control measure to ensure that the areas were cleared of all UXOs and significant sized OEW fragments The EOD and geophysical surveys were conducted so as to ensure that every square foot of the PRSs were covered.

Geomorphic mapping of each PRS with OEW was completed to map the soils and extent of drainage channels within the site that would be likely pathways for the surficial transport of contaminants away from the impact zones. Sediment catchment sites along drainage channels were prioritized for sampling, because they represented areas with the highest probability of containing contaminants being removed from the site by surface runoff. All soil/sediment samples were screened for gross alpha, gross beta, and gross gamma activity. In addition, all samples were analyzed for target analyte list (TAL) metals and for HE. Metals results were evaluated with respect to background levels and screening action levels (SALs). HE results were analyzed with respect to SALs only.

Results

SWMU 0-011(a)

SWMU 0-011(a) is located on Department of Energy (DOE) property about 0.4 miles east of the Sportsman's Club firing range in Rendija Canyon. Before the RFI site investigation began, the SWMU was thought to be delimited by a barbed-wired fence (and marked with warning signs) erected to keep individuals out of the site. However, the EOD surveys found that the impact area extended to the south, well beyond the fence, increasing the size of the SWMU from approximately 7 acres to approximately 28.5 acres. SWMU 0-011(a) was the only PRS where live HE mortar rounds with live fusings were found. Additionally, approximately 2400 pieces of ordnance fragments including tail fins and fuses, and approximately three-times as much scrap material were recovered. Following geomorphologic mapping, 19 soil samples were collected from sediment storage locations within the drainage channels that drained the areas of high fragment concentration. The data quality and screening assessments of the analytical results concluded that, despite some QA difficulties, there was no indication the HE was present in any of the samples. Concentration of all inorganics are comparable to regional background. Given the extremely thorough UXO and OEW search and retrieval operation and absence of any contaminants in the soil or sediments, if is recommended that the site be designated as a no further action (NFA) PRS and be approved for residential land use. Additionally, it is

recommended that DOE remove the fence.

SWMU 0-011(c)

SWMU 0-011(c) is an elongate-shaped area extending southeast to northwest, located on DOE and U.S. Forest Service property in Cabra Canyon, a tributary to Rendija Canyon. The sole indication that a SWMU might be present at this site was the presence of two deteriorating danger signs warning of explosives. The ordnance surveys of the SWMU did not locate any UXOs or even a single fragment EOW. The complete absence of these materials indicates that this site was never used as an ordnance impact area. It is therefore recommended that SWMU 0-011(c) be designated for no further action (NFA) and approved for residential land use.

SWMU 0-011(d)

SWMU 0-011(d) is in Bayo Canyon just northeast of the intersection of San Ildefonso Road and Diamond Drive. The area is well fenced and marked. Materials recovered from the SWMU were restricted to OEW fragments of 23.6-inch bazooka rounds. Following geomorphologic mapping, 20 soil/sediment samples were collected during two sampling events. The data quality and screening assessments of the analytical results show that there is no HE present at the site and the concentrations of all inorganics except lead are comparable to regional background. The lead levels are, however, far below the SAL of 500 ppm. Given the extremely thorough UXO and OEW search and removal operation and absence of any significant contaminants in the search and removal operation and absence of any significant contaminants in the soil or sediments, it is recommended that the site be designated as a NFA PRS and be approved for residential land use. Additionally, it is recommended that Los Alamos County take down the fence.

SWMU 0-011(e)

SWMU 0-011(e) is located on DOE and U.S. Forest Service land north-northeast of the Sportsman's Club in Thirty-Seven Millimeter Canyon, a tributary of Rendija Canyon. Materials recovered during the ordnance sweep of this SWMU included two 20 mm rounds, 102 armor-piercing (AP) rounds, and fragments of 37 mm HE rounds. Other materials found included 350 pieces of OEW fragments and expended bullets. Following geomorphologic mapping, nine soil samples were collected from sediment storage locations within the drainage channels that drained the areas of high fragment concentration and along the major channel that drained the site into Rendija Canyon. Analysis of the samples shows that HE is not present at the site and concentrations of all inorganics are comparable to regional background levels. Given the extremely thorough UXO and OEW search and removal operation and absence of any contaminants in the soil or sediments, it is recommended that the site be designated as a NFA PRS and approved for residential land use. Additionally, it is recommended that DOE and the U.S. Forest Service take down the fence.

AOC C-0-020

AOC C-0-020 is located in a tributary of Rendija Canyon west of the Guaje Pines Cemetery. It was thought that the U.S. Army fired mortar rounds from Barranca Mesa into this area, although it is poorly marked, and some doubt existed that it was ever an active site. An ordnance team from Fort Bliss did not encounter any ordnance in a preliminary site survey in 1991. The ordnance surveys of this AOC did not locate any UXOs or OEW. The complete absence of these materials indicates that this site was never used as an ordnance impact area. It is therefore recommended that AOC C-0-020 be designated for NFA and approved for residential land use.

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1.0 Introduction

1.1 SWMU Aggregate 0-D Description

This report presents the results of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) field work conducted at Operable Unit (OU) 1071, Solid Waste Management Unit (SWMU) Aggregate 0-D, ordnance impact areas. This aggregate, described in Section 5.3 of the OU 1071 RFI Work Plan (LANL 1992a), contains five Potential Release Sites (PRSs): SWMUs 0-011(a), (c), (d), and (e); and Area of Concern (AOC) C-0-020. Locations are shown in Figure 1. The archival search conducted for preparing the OU RFI work plan documented that SWMU 0-011 (b) and 0-011 (e) are the same site, so the 0-011 (b) designation was dropped. The Potential Release Sites (PRSs) are areas that were either known or possible ordnance impact sites used by the U.S. Army in the 1940s. All of them, therefore, were sites with potentially unexploded ordnance (UXOs) and ordnance explosive waste (OEW). Three of the sites [0-011(a), (d), and (e)] were fenced and posted with warning signs in the early 1960s.

1.2 RFI Objectives

The OU 1071 RFI Work Plan identifies four PRSs in Rendija Canyon and one in a tributary of Bayo Canyon as areas that could contain UXOs, OEW, and associated contamination due to the presence of high explosives and/or metals in the soil. The most likely and significant hazard to site visitors was the possible presence of UXOs. Decomposed ordnance could also spread contaminants through infiltration into the vadose zone or by water entrainment and dispersion into the environment downstream. Human receptors may be exposed to these contaminants through ingestion or dermal contact.

The goal of the RCRA process for this SWMU aggregate was to ensure that all UXOs and OEW were located and removed and determine if either or both metals and high explosive (HE) are present in the soil above the cleanup levels for these contaminants.

2.0 Investigation Program

2.1 Field Program

2.1.1 Activities

OU 1071 RFI field activities at the five Potential Release Sites (PRSs) consisted of searching for and removing any UXOs and OEW, geomorphologic mapping, and collecting shallow surface soil samples. The ordnance search at SWMU 0-011(d), at the west end of Barranca Mesa, was conducted in September and October 1992. Activities at AOC C-0-020 and SWMUl 0-011 (c) were completed in the spring of 1993 and at SWMUs 0-011 (a) and 0-011 (d) by late September 1993.

A detailed surface and subsurface sweep for UXOs and OEW was conducted at each PRS by a team of certified master explosive ordnance disposal (EOD) technicians. The sites were systematically scanned with ordnance detection equipment following standard military ordnance clearance procedures. The number of pieces of OEW in each subarea/lane was recorded by the team to develop a data set on the distribution and density of OEW in the impact areas.

Following the EOD team sweep, a team of licensed land surveyors marked a 100 ft. square grid on the ground surface at each PRS. The grid provided location reference points for the geophysics team that conducted a follow on sweep of the PRS. This procedure reduced the time required by the geophysics team to conduct its surveys. The grid for the first PRS investigated, SWMU 0-011 (d), was not surveyed in for the geophysics team, requiring the team to devote a significant amount of time to accurately locate reference markers. The surveyors also mapped the boundaries of the PRSs.

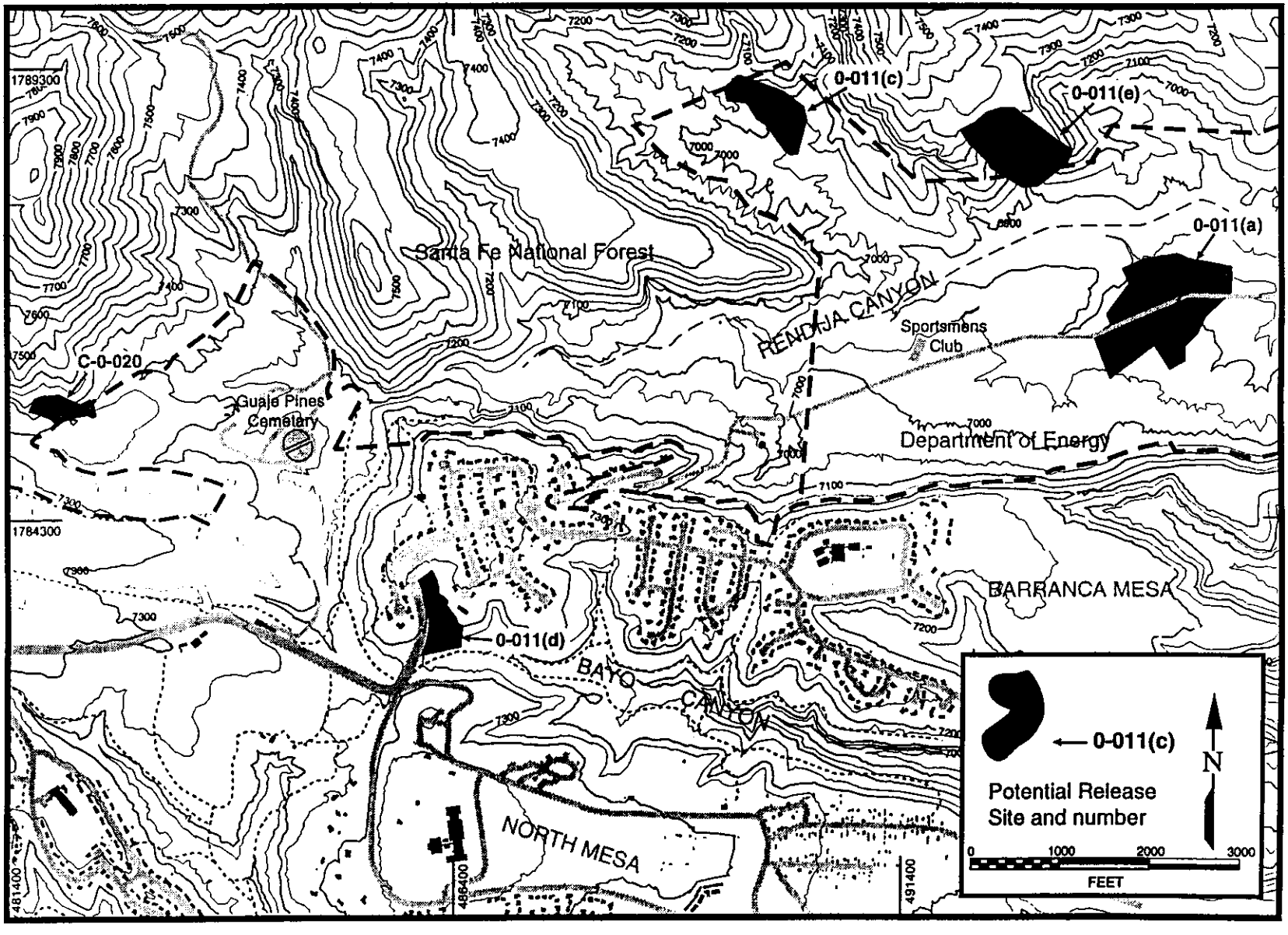

Figure 1. Map showing locations of possible and known ordnance impact areas in TA-0.

A team of geophysicists conducted a survey of the PRSs using magnetic and electromagnetic survey instruments. The geophysical surveys provided a quality control measure to ensure that the areas were cleared of all UXOs. Additionally, they identified OEW fragments missed by the EOD team. Each geophysical anomaly identified by the geophysics team was investigated by the EOD team.

Once all UXOs and OEW were removed, a site map was prepared showing the surficial deposits, the drainage channels within the site, and concentrations of OEW. These maps were then used to identify the most likely areas for contaminants from the ordnance to be concentrated and to select topographically biased sampling locations with a high likelihood of identifying the occurrence of contaminants, if present, at these sites. The surveyors precisely located these soil sample collection points.

Soil samples were collected following Los Alamos National Laboratory (the Laboratory) Environmental Restoration (ER) Program procedures for the collection of surface soil samples. Detailed information on the type and characteristics of the soil was also gathered.

2.1.2 Procedures

2.1.2.1 Ordnance Search

The purpose of the EOD team's ordnance search was to detect, excavate, and remove all UXOs and, within the detection capability of their equipment, all OEW one inch in diameter or larger to a depth of 1 meter. This depth was selected, based on the types of ordnance and their maximum depths of penetration in sediments and soils in the impact areas and the surface geologic processes (burial and erosion) at these sites over the past 50 years. It was determined that 1 meter would be a highly conservative estimate of the maximum depth at which UXOs or OEW would be present. The fact that no ordnance fragments were found at any of the sites below a depth of about one helf meter lends credence to this determination.

The EOD team consisted of UXO-trained personnel, including personnel trained and certified as Master EOD Technicians under the requirements of the U.S. Army Corps of Engineers and the U.S. Army Toxic and Hazardous Materials Agency (USATHMA). The team members met all requirements for work at uncontrolled hazardous waste sites as described in 29 CFR 1920.120 and related regulations. On-site documentation for each member of the team included certification of 40-hour OSHA training, 8-hour refresher training (if applicable), a respirator fit test, proof of medical monitoring, and 8-hour supervisor training for the field team manager. All team members attended Laboratory health and safety and administrative training prior to the start of field work and complied with all applicable health and safety requirements.

For the ordnance surveys, lanes were set up on each site. The average lane width was eight feet, and the lanes were marked off with ropes which were laid out parallel to each other. After one lane was completed, the outside line was moved over to form the next lane (see Figure 2). This was continued until all of the lanes in each section were finished.

The orientation of the lanes was largely determined by the terrain. Lanes were oriented to allow the EOD team personnel to perform their work in the most efficient and safest manner. On steep slopes, for example, this meant orienting the lanes parallel to the slope direction. If this was not possible, then the last lane of a series of parallel lanes would be marked with flags so that no confusion would exist between the areas that were complete and areas that still needed to be completed. The lanes were swept up one side and down the other in 5 feet arcs that would overlap with the last pass (Figure 2). The lane

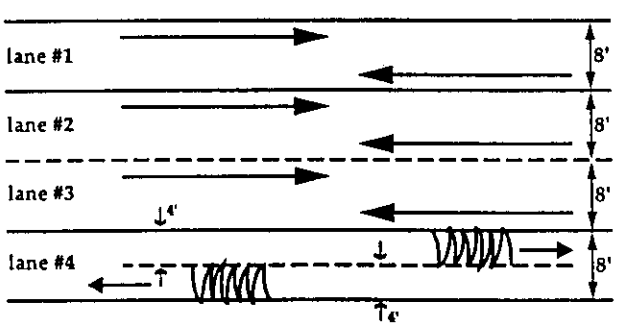

Figure 2. Explosive ordnance disposal team ordnance search pattern. Instrument movement shown by irregular lines in lane #4.

layout and instrument movement paths were designed to ensure that every square foot of each PRS was surveyed.

Magnetometers, which can readily locate mortar, bazooka, and 37 mm UXOs at the 1 meter target depth, and metal detectors were moved across the lanes so as to completely sweep the entire ground surface. Within each lane, the number of recovered pieces of OEW was recorded and notations made on the areas with the highest densities of OEW. No UXOs or OEW was found at any site below a depth of about 1/2 meter.

A complicating factor to the surveys was the unexpected finding that sizable parts of the Bandelier Tuff have significant magnetic properties. This increased the time of the surveys, because buried cobbles and boulders frequently gave false positive magnetic anomalies. Every anomaly was checked to verify the presence/ absence of ordnance, resulting in numerous rocks being excavated. Upon completion of the EOD sweep and clearance, the geophysical team performed a survey to verify that all buried UXOs and OEW had been found. The EOD team then investigated any anomalies identified by the geophysics team.

UXOs were detonated at the SWMUs where they were found. All OEW recovered at the sites was removed and flashed at TA-16 in a permitted open burn site to destroy any residual HE and then buried in the Area J administrative landfill at TA-54. Approximately seven cubic yards of OEW were removed from the sites.

2.1.2.2 Geophysics — Quality Control Measure

Geophysical surveys were conducted over each PRS as a quality control (QC) measure to ensure that all UXOs and OEW one inch in diameter or larger had been located. This step in the investigation process is not done at Department of Defense facilities where ordnance impact areas have been cleaned up. By including the geophysical surveys, there is virtually a 100% confidence level that all UXOs were located.

At the first PRS to be investigated, SWMU 0-011 (d), state-of-the-art magnetometers and wide band electromagnetic instruments were employed in the investigation. Because the results for this site showed that the electromagnetic (EM) instrument did not detect any OEW not previously located by a magnetometer, EM surveys were not performed at the other four PRSs.

Magnetic geophysical surveys were conducted at all the sites. The surveys were conducted on a 5-ft spacing. The magnetic survey consisted of two parts: (1) collecting discrete data points on a 5-ft grid spacing, and (2) slowly sweeping an area continuously to locate smaller objects. The survey for the discrete data points resulted in a single gradient value recorded for each position and later contouring of the data for interpretation.

A land survey team defined a coordinate system marked on 100-ft increments. The markers placed in the field served as the registration points for the data collection. To ensure complete coverage of the sites, each 100-ft by 100-ft segment was subdivided into a series of 10-ft wide lanes marked by ropes. Each rope was 100 ft in length with flagging marking every 10 ft increment (see Figure 3). Two surveys were conducted simultaneously using this system of rope grids: (1) a continuous digital sweep designed to bring the sensor within 1 ft of all surface positions, and (2) digital data acquisition on a 5-ft interval. Working within a lane, the operator walked perpendicular to the long axis of the lane, sweeping the instrument back and forth. Additional digital data points were recorded at 5-ft intervals within the lane.

Areas of rock outcrop and cliff faces were not surveyed by the geophysics team. For areas where the rope grid could not be used the survey was visually controlled. These included ditches, steep terrain, and borders of sites. Upon detection of geophysical anomalies that could represent potential buried ordnance or OEW, the geophysics team flagged the anomalies for investigation by the EOD team.

Surveyors and geophysics team personnel met all requirements for work at uncontrolled hazardous waste sites as described in 29 CFR 1910.120 and related regulations. On-site documentation for each member of

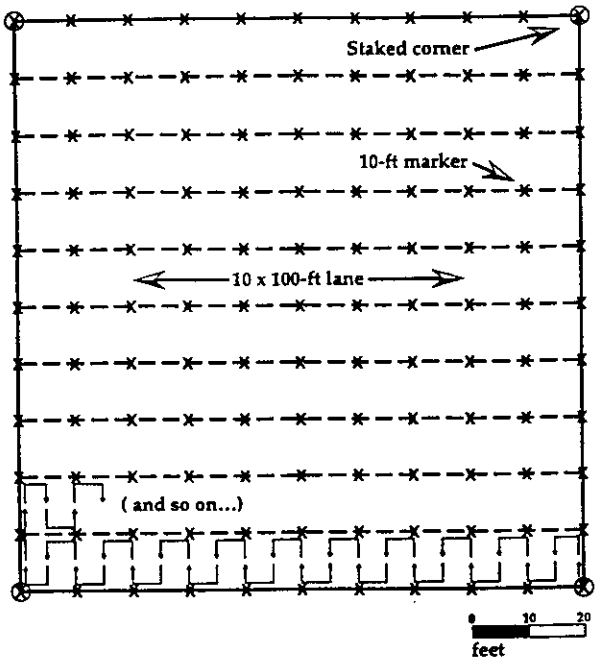

Figure 3. Geophysics team ordnance search pattern.

the team included certification of 40-hour OSHA training, 8-hour refresher training (if applicable), a respirator fit test, and proof of medical monitoring. All team members attended Laboratory health and safety and administrative training prior to the start of field work and complied with all applicable health and safety requirements.

2.1.2.3 Geomorphology and Hydrology

Geomorphic mapping of the ordnance impact areas was completed in order to: (1) identify and map the extent and type of surficial, unconsolidated sediment in which the ordnance could be buried, or/and (2) map the extent of drainage channels within the site that would be likely pathways for the surficial transport of contaminants away from the impact zone. These drainage channels include both the small drainage channels that drain the hillslopes within the impact areas and any main (axial) drainage channel into which these small channels flow. Sediment catchment sites along these drainage channels were prioritized for sampling, because they were identified as sites with the highest probability of containing contaminants being removed from the site by surface runoff.

Rendija Canyon heads on the Pajarito Plateau just west of the townsite and is a tributary to Guaje Canyon approximately 2 miles east of SWMU 0-011(a). Rendija Canyon is an alluvium-floored drainage cut through the Tschicoma Formation, the Bandelier Tuff, and the Cerro Toledo Rhyolite. Thirty-Seven Millimeter Canyon and Cabra Canyon are small northern tributary canyons formed in Bandelier Tuff that join Rendija Canyon in its midreach. Surface flow in Rendija Canyon and its tributaries is intermittent and derived solely from storm runoff and spring snowmelt.

Bayo Canyon heads on the flanks of Barranca Mesa and North Mesa and flows east southeast approximately 11 miles before entering Los Alamos Canyon. Bayo Canyon is also an alluvium floored drainage cut through Bandelier Tuff into the underlying Puye Formation. Intermittent surface flow is generated in Bayo Canyon from spring snowmelt and storm runoff.

2.1.2.4 Sampling

Only those PRSs in which ordnance or ordnance fragments were found were sampled because it was concluded that if no UXOs or OEW were present, then the PRS was not an impact area. At PRSs where ordnance fragments were found, the areas with highest densities of OEW were mapped. Additionally, the first-order drainages and surficial deposits were also included on this map. These maps provided the basis for selecting soil and sediment sample locations that would have the greatest possibility of containing contaminants from the ordnance, if they were present.

Samples were collected from the uppermost 6 inches of surface material at each sampling point, following procedures described in LANL-ER-SOP-06.09, Spade and Scoop Method for Collection of Soil Samples. Each sample was screened and analyzed.

2.2 Analytical Methodology

All soil samples were routinely screened for gross alpha and beta activity using a Berthold low-level counter and for gamma activity using a deep well counter before they were submitted with chain-of-custody

documentation to the sample coordination facility (SCF) for analysis. Soil samples were analyzed for target analyte list (TAL) metals by flame atomic absorption (FAA), electrothermal vaporization atomic absorption (ETVAA), cold vaporization atomic absorption (CVAA), and inductively coupled plasma emission spectroscopy (ICPES) (EPA 6010).

Soil samples were examined for high explosives (HE) using high performance liquid chromatography (HPLC), EPA approved, modified SW846 Method 8330 which uses a different calibration procedure.

2.3 Evaluation Methodology

Two assessment steps were followed for each set of analytical data from soil samples at the ordnance impact sites: 1) Data quality assessment; and 2) Screening assessment. Further data evaluation (e.g., risk assessment) would have been performed if the results of these preliminary assessments had identified contaminants at a site. This was not the case for any of the sites discussed in this report.

Analytical data assessment consists of either a tiered or a complete review of analytical results and includes completeness checks: the evaluation of blanks, matrix spikes, and other QA samples; and the verification that holding times were not exceeded. Where problems are noted, further evaluation of their impact on the useability of the data to make the proposed decisions is required.

Screening assessment is carried out to determine if any observation or group of observations suggests any cause for concern, in terms of risk to human health or the environment, about the site. As described in the Installation Work Plan (IWP) (LANL 1993, Rev. 3), screening assessment involves the comparison of individual observations to screening action levels (SALs) whose derivation is described in Appendix J of the IWP. For this purpose, results from analyses performed following EPA procedures (e.g. SW-846) are appropriate.

In this report, the observations of naturally occurring inorganic constituents are compared to background levels. Results obtained using the SW846 procedures are generally biased downward relative to published background values that are based on analytical procedures requiring no sample preparation (such as neutron activation) or on total sample dissolution methods incorporating hydrofluoric acid as well as nitric acid.

3.0 RFI Phase Investigations

3.1 SWMU 0-011(a)

3.1.1 Background

3.1.1.1 Description and History

SWMU 0-011(a) is located on DOE property about 0.4 miles east of the Sportsman's Club firing range in Rendija Canyon (Figure 1). Before the RFI site investigation began, the SWMU was thought to be delimited by a barbed-wire fence (and marked with warning signs) erected to keep individuals out of the site. However, the EOD surveys found that the impact area extended to the south, well beyond the fence (Figure 4). Because Rendija Canyon is open to the public, the unfenced part of the impact area has been used by visitors for a variety of activities.

3.1.1.2 Geology and Hydrology

SWMU 0-011(a) is situated on an alluvial terrace. The underlying bedrock, which does not crop out within the site boundaries, is the volcanic Bandelier Tuff. The area has low relief with significant hillslope gradients only near the main drainage channel of Rendija Canyon. Because of the generally low relief and because much of the site area has been disturbed by human activity, the smaller channels that drain much of the site are neither prominent nor maturely developed.

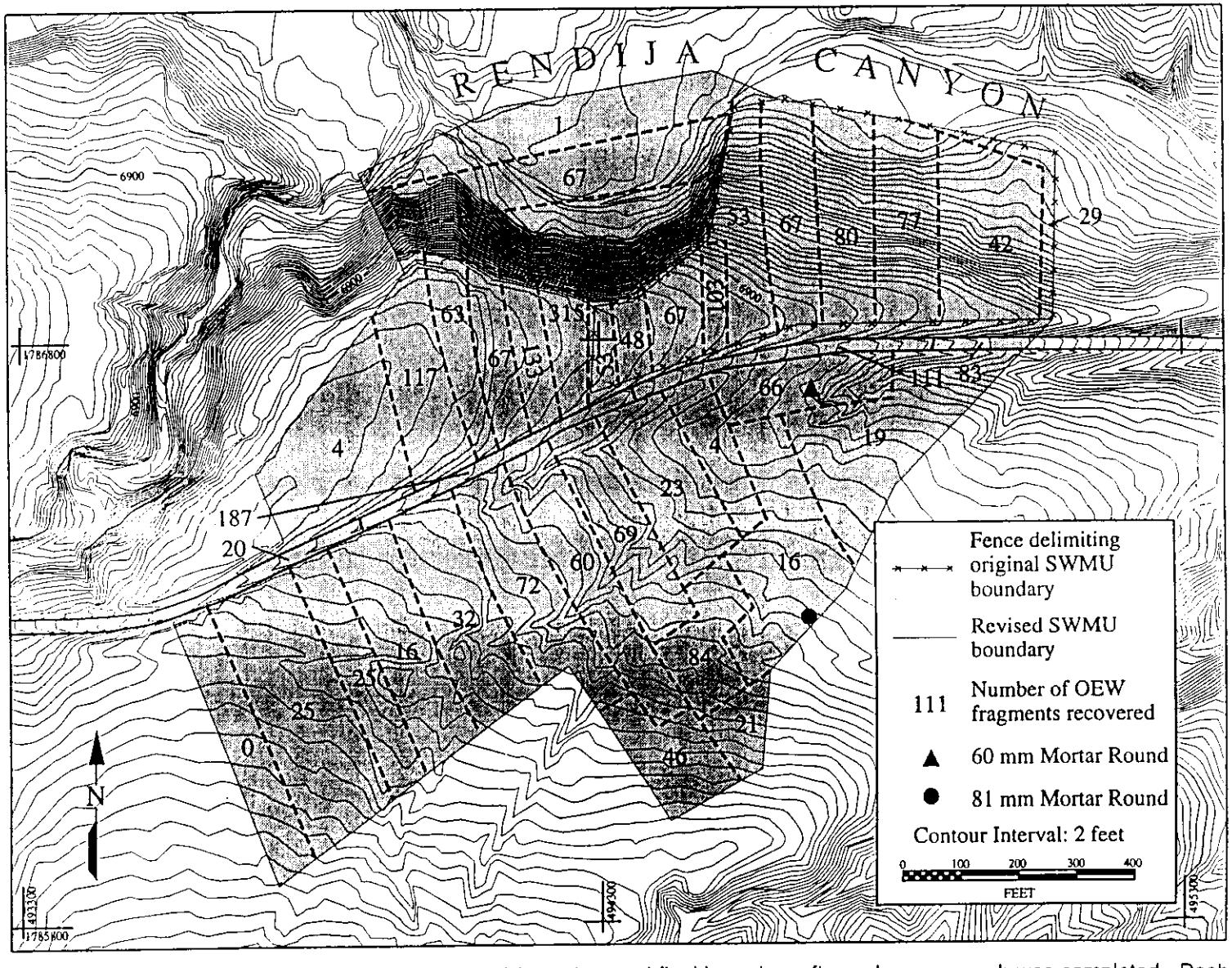

Figure 4. Map of SWMU 0-011(a) showing the original (fenced) boundary and final boundary after ordnance search was completed. Dashed lined delineate EOD team area subdivisions. The numbers in the subdivisions are the total number of pieces of OEW recovered within each area.

3.1.2 Site Investigation and Analytical Results

3.1.2.1 Ordnance

Initially, the fenced area was swept for UXOs and OEW (see Figure 4 for area subdivisions). Because ordnance fragments were found up to the southwest corner of the fenced area and immediately outside it, the ordnance search was expanded. The procedure for determining the boundary of the SWMU involved adding new lanes until no ordnance was found in the outermost lane and no OEW was found within 50 feet in all directions of those OEW fragments farthest out. If no OEW was found then the inner-most edge of the land was considered the final boundary. If OEW/UXO was found during the EOD sweep or during the geophysical survey, the entire lane would be reswept and the boundaries adjusted, as necessary. By following this procedure to delineate the final boundary of the impact area, approximately 21 acres were added to the original 7 acres for a total of about 28.5 acres. The expanded boundary was surveyed in by the land survey crew to accurately determine its position (see Figure 4).

Two live HE mortar rounds were found and destroyed. An 81-mm mortar round was found (Figure 5) early on 16 June 1993 and detonated later that morning. The detonation was performed electrically so that the security of the area could be maintained. Representatives from the Laboratory's Emergency Management Office (EMO) and Environmental Safety and Health (ESH-5) were on-site, and officials with Los Alamos County's fire and police stations, the Department of Energy, and ERM/Golder were notified. The detonation followed EOD and Laboratory EMO-Hazardous Devices Team (HDT) standard procedures and occurred without incident. A second detonation took place on the morning of 23 July 1993. A 60-mm mortar round found (Figure 5) late the previous day was detonated in a manner similar to the first detonation. The same authorities were contacted, and the mortar round was discharged without incident. In both cases, the resulting OEW fragments were recovered and removed from the site.

Other materials recovered during the ordnance sweep of the SWMU included almost 2400 pieces of ordnance fragments such as tail fins and other OEW. Three times as much scrap material was found. The locations of recovered fragments indicate that there was more than one firing point and that these firing points were located on the south side of the canyon floor.

The geophysics survey identified 640 anomalies of which 132 were found to be related to OEW. All anomalies identified in the geophysics survey were investigated by the EOD team. Field work at the site was completed by September 1, 1993.

3.1.2.2 Geomorphology and Sample Locations

Geomorphic mapping of SWMU 0-11 (a) included the mapping of all drainage channels that drained the area enclosed within the final boundaries of the site and the areas of high concentration of ordnance fragments. Because of the generally low relief of the site and because much of the site area has been disturbed by human activity, the drainage channels that drain the site are neither prominent nor maturely developed. Thus, detailed mapping of the drainage within the site was necessary prior to selection of surface sampling sites, including the larger drainage channels on or adjacent to the site, into which the smaller channels discharge. Sampling locations were selected from sediment storage locations within the drainage channels that drained the areas of high fragment concentration (Figure 5).

Soil investigations indicate that four major soil-geomorphic settings characterize areas where sampling activities have been conducted:
(1) Thin (<20 cm thick) pedogenically unmodified, very recent fine-grained sediment deposited in shallow swales or channels inset into young fluvial deposits or into an older gravelly to bouldery fluvial /debris flow deposit that underlies the terrace surface on which the site is located.
(2) Residual moderately to strongly developed soil on an older gravelly fill terrace surface, possibly partly modified by agricultural activity.

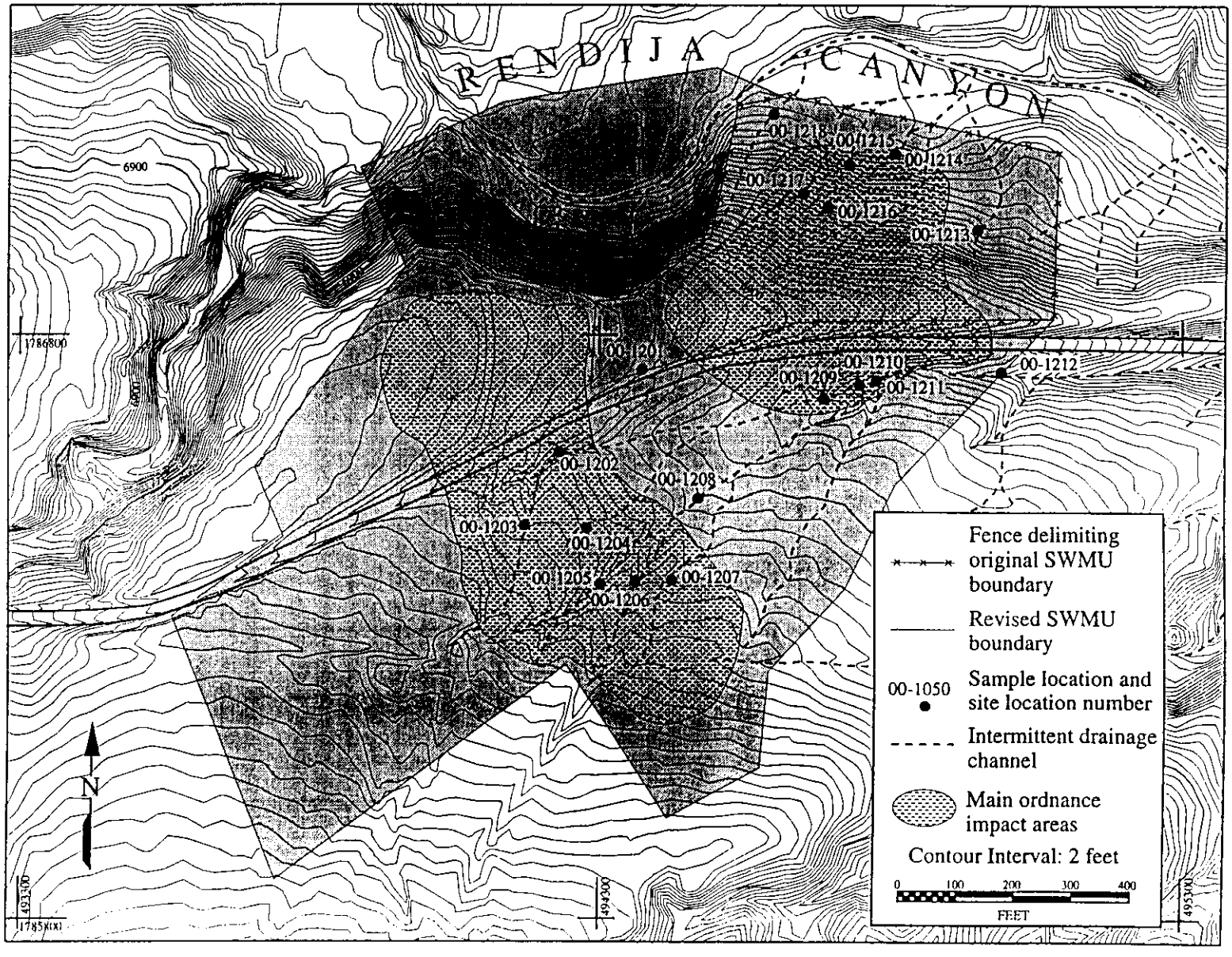

Figure 5. Map of SWMU 0-011(a) showing areas of greatest OEW concentrations, drainage pattern, and sample (site) locations.

(3) Thin (<10 cm) very recent pedogenically modified fine-grained sheetwash sediment derived from erosion of older deposits underlying the fill terrace that has accumulated in small drainages on hillslopes.
(4) Organic-rich, fine-grained sediment that has accumulated at the base of moderately steep hillslopes.

3.1.2.3 Chemistry and Data Quality

Soil samples were analyzed for metals and HE. Radiation screening results (gross alpha, gross beta, and gross gamma) were uniformly below detection limits.

Nineteen soil samples were collected on 23 September, 1993 (AAA 6099, 6101, 6103, 6112-6113, 6115, 6118-6120, 6122-6123, 6125-6129, 6131, and 6133-6134). Inorganic measurements were made by group Chemical Science and Technology (CST-9) (formerly Environmental Management [EM-9]) following the SW846 procedures for ICPES (most elements), FAA (Ag), and ETVAA (As and Se). Results are shown in Table 1.

All of the quality control (QC) data for the metals were "under control" except for Fe and Sb. Fe is not an analyte of interest in the soil and therefore is not a concern. The Sb, however, is an analyte of interest. The analytical result for Sb in the QC sample was 0.029 mg/l, while the QC value was 0.04 mg/l. This makes the analytical result about 28% low. The result for Sb in all of the samples was <0.1 mg/kg while the SAL for Sb is 32 mg/kg. Therefore, the fact that the analytical result for Sb in the QC sample is 28% low does not affect the status of Sb being below SAL. This is because all reported Sb values for the samples are at least a factor of 320 below the SAL.

The organic compounds associated with HE were analyzed by the International Technology Analytical Services, St. Louis, MO using HPLC, a modified SW846 Method 8330. The compounds analyzed for were: 1,3-Dinitrobenzene; 2,4-Dinitrotoluene; 2,6-Dinitrotoluene; HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine); Nitrobenzene; m-Nitrotoluene; o-Nitrotoluene; p-Nitrotoluene; RDX (1,3,5-Trinitrohexahydro-1,3,5-triazine); Tetryl (Methy-2,4,5-trinitrophenylnitramine); 1,3,5-Trinitrobenzene; and 2,4,6-Trinitrotoluene. The results of these analyses were that no HE analytes were detected in the 19 samples, i.e. all analyses were below detection limits for all analytes. Therefore, the data are not presented in a table.

The contract analytical laboratory had two problems with the HE analyses. One was that the holding times for the analyses were missed by 2 days. The samples were extracted within 7 days but were not analyzed for 42 days (exceeding the 40 day limit). However, it was concluded that the data are still accurate because: (1) The report by the U. S. Army Environmental Center entitled "Experimental Assessment of Analytical Holding Times for Nitroaromatic and Nitramine Explosives in Soil" (special report 93-11, June 1993) shows that exceeding the holding times (up to 56 days after extraction) does not cause a loss of HE analytes, nitramines, and possibly nitroaromatics. (2) HE sample results were below detection limits for all analytes. (3) No peaks were detected that could have been degradation products from any HE that may have biodegraded (per analytical laboratory).

Another problem encountered by the analytical laboratory was surrogate and matrix spike/matrix spike duplicate (MS/MSD) recoveries. The surrogate recoveries ranged from 66% to 280%, while the MS/MSD recoveries ranged from 29% to 296% causing the CST-9 reviewer to qualify the data as "UJ" (undetected, estimated quantity). However, all analytes were below detection and no peaks from biodegradation products were present.

3.1.3. Data Assessment

No TAL metals exceeded their SALs except for arsenic and beryllium, for which the SALs are below background concentrations (Table 2). Concentrations of all Table 2 elements are comparable to regional background values, allowing for the bias in methods discussed in Section 2.3. No high explosives (HE) or byproducts were detected in any sample. This is significant because even if all of the samples had the lowest recoveries and contaminants were present at a concentration equal to the highest detection limit within the sample set,

TABLE 1. Results of Inorganic Analysis of Soils for 0-011a in ppm.

Location ID	Sample #	Al	Ag	As	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	Hg	K	Mg	Mn	Na	Ni	Pb	Sb	Se	Tl	V	Zn
00-1201	AAA6118	14000	<1	3.9	120	1	2100	<0.4	6	11	6.8	12000	<0.1	1900	2400	340	87	10	17	<0.1	0.3	0.3	22	34
00-1202	AAA6119	10000	<1	2.5	110	0.7	1400	<0.4	6.3	7.9	4	9600	<0.1	1500	1600	430	92	6	17	<0.1	0.6	0.1	18	32
00-1203	AAA6134	10000	<1	2.7	96	0.75	1500	<0.4	6	7.4	4.1	9800	<0.1	1500	1600	350	98	5	14	<0.1	0.5	0.1	17	30
00-1204	AAA6123	12000	<1	3.6	130	1	2200	<0.4	6.6	10	5.6	13000	<0.1	1600	2300	410	89	9	16	<0.1	0.3	0.3	23	34
00-1205	AAA6129	10000	<1	3.3	120	0.91	1700	<0.4	6.8	8	5.6	11000	<0.1	1700	1800	410	74	6	16	<0.1	0.4	0.3	18	30
00-1206	AAA6131	9400	<1	3	120	0.9	1800	<0.4	5.3	7	6	9900	<0.1	1700	1700	390	70	5	15	<0.1	0.3	0.3	16	32
00-1207	AAA6133	12000	<1	3.2	120	0.88	1500	<0.4	5.3	8.5	5.8	11000	<0.1	1900	1900	400	82	7.6	17	<0.1	0.4	0.1	20	33
00-1208	AAA6101	16000	<1	3.5	180	1.2	2200	<0.4	8.8	11	7.9	14000	<0.1	2500	2600	640	79	9	19	<0.1	0.6	0.3	24	40
00-1208	AAA6122	17000	<1	3.7	150	1.2	2200	<0.4	5.9	12	8.2	14000	<0.1	2500	2600	430	80	8	18	<0.1	<0.2	0.3	24	41
00-1209	AAA6125	10000	<1	3.3	120	0.91	2000	<0.4	5	8.2	6	10000	<0.1	2100	1800	360	70	6	29	<0.1	0.4	0.3	17	34
00-1210	AAA6126	12000	<1	3.4	110	0.97	1900	<0.4	6	8.7	6.1	11000	<0.1	1800	2000	330	74	9	17	<0.1	0.3	0.3	17	32
00-1211	AAA6120	11000	<1	3.2	120	0.93	1900	<0.4	8	9	6	11000	<0.1	1700	1900	460	84	9	18	<0.1	0.5	0.3	17	30
00-1212	AAA6099	11000	<1	2.8	110	0.93	2000	<0.4	4.3	8.4	6.4	10000	<0.1	1700	1900	300	77	7	18	<0.1	0.8	0.3	17	30
00-1213	AAA6127	5100	<1	2	44	0.41	750	<0.4	3	5	3.2	5800	<0.1	620	840	200	98	4	7	<0.1	0.6	<0.1	10	17
00-1214	AAA6115	5700	<1	2	59	0.44	910	<0.4	3.5	5.3	3.7	6300	<0.1	930	990	220	100	5	9	<0.1	0.5	<0.1	11	17
00-1215	AAA6103	9300	<1	2.2	94	0.73	1400	<0.4	5	8.7	4.2	9000	<0.1	1300	1500	310	81	7.6	10	<0.1	0.8	0.1	17	23
00-1216	AAA6128	9300	<1	3.3	110	0.82	1600	<0.4	5.4	7.4	4.8	9300	<0.1	1200	1600	340	70	6.4	14	<0.1	0.4	0.1	18	23
00-1217	AAA6113	6300	<1	3.6	83	0.64	1000	<0.4	6	5.3	4	8000	<0.1	940	1200	470	77	5	18	<0.1	0.8	0.1	17	18

TABLE 2. Summary of Inorganic Results from 0-011(a)

	min	mean	median	max	SAL	background
Ag	<1		<1.0	<1.0	400.0	1.16
Al	5100	10368	10000	17000	—	50,000-144,000
As	1.70	2.99	3.20	3.90	0.4	1.2-10.8
Ba	44	108.5	110	180	5600.0	125-830
Be	0.41	0.84	0.9	1.2	0.16	1.0-4.4
Ca	750	1645	1700	2200	—	1900-80,400
Cd	<0.4		<0.4	<0.4	80	1.2-1.7
Co	3.0	5.6	5.9	8.8	—	0.4-23
Cr	5.0	8.1	8.2	12.0	400	2-71
Cu	2.4	5.3	5.6	8.2	3000	2-18*
Fe	5800	10094	10000	14000	—	10,000-48,600
Hg	<0.1			<0.1	24.0	0.007-0.029*
K	620	1584	1700	2500	—	10,400-48,000
Mg	840	1754	1800	2600	—	1331-16,800
Mn	200	374	360	640	8000.0	190-1600
Na	70	83.3	81	100	—	2700-36,300
Ni	3.5	6.74	6.4	10.0	1600.0	1.6-19*
Pb	7	15.7	17	29	500.0	<14-44
Sb	<0.1		<0.1	<0.1	32.0	0.3-1.6
Se	<0.2	0.47	0.5	0.8	400.0	0.26†
Tl	<0.1	0.18	0.3	0.3	6.4	<0.2-0.9
V	10.0	17.5	17.0	24.0	560.0	12-113
Zn	17.0	29.2	30.0	41.0	24000.0	20-146

— No SAL for analyte.
All units in parts per million.
Background values are from Longmire et al. (1993) unless otherwise indicated.
* = Ferenbaugh et al. (1990).
† = Shacklette and Boerngen (1984)

the adjusted values would be well below SALs. At worst, the reported level of <0.31 mg/kg for 2-,6-dinitrotoluene (see Table 3) is lower than the SAL by a factor of more than 3200. Thus, for the compound to be even a potential problem, recovery would have to be 0.031%, far lower than indicated by any surrogate or MS measurement.

3.1.4 Conclusions and Recommendations

This site has been cleaned of all UXOs and OEW fragments to the smallest size possible using state-of-the-art instruments. In addition to a very careful search conducted by an EOD team, the site underwent an extremely thorough quality control check by a geophysics team to ensure that no UXOs of significant sized OEW fragments remained.

Judgementally selected soil and sediment samples, chosen to maximize the possibility of finding contaminants (metals or HE) from the ordnance, showed that all TAL metals at the site are in the range of background values and that HE is not present at the detection limits of analytical instruments. Therefore, the soils and sediment at the site do not contain HE above SALs.

Given the location and removal of all UXOs and significant sized OEW at the site and the absence of any significant contaminants in the soils and sediment, it is recommended that the fence be taken down from what was the original SWMU. Additionally, it is recommended that the site be designated as a no further action PRS and be approved for future residential use.

Table 3. Comparison of Analytical Data and SALs for HE Sample Analyses for 0-011a

Analyte	SAL (mg/kg)	HV (mg/kg)	Factor	%Recovery
"1,3-Dinitrobenzene"	8	<0.0003	27000	33-165
"2,4-Dinitrotoluene"	1	<0.0003	3000	33-296
"2,6-Dinitrotoluene"	1	<0.00031	3000	55-165
HMX	4000	<0.0026	1540000	32-153
Nitrobenzene	5.3	<0.00031	17000	35-160
m-Nitrotoluene	-	<0.0003	-	57-147
o-Nitrotoluene	-	<0.0003	-	53-120
p-Nitrotoluene	-	<0.0003	-	61-139
RDX	64	<0.0012	53000	35-147
Tetryl	800	<0.00078	1030000	44-172
"1,3,5-Trinitrobenzene"	4	<0.0003	13000	31-175
"2,4,6-Trinitrotoluene"	40	<0.0003	130000	29-183

HV = Highest Value from the analytical results for particular analyte.
"Factor = SAL/HV, the factor HV is below SAL."
% Recovery - range in % recovery for MS/MSD.

3.2 SWMU 0-011(c)

3.2.1 Background

3.2.1.1 Description and History

SWMU 0-011(c) is an elongated area extending southeast to northwest just north of the Sportsman's Club in Cabra Canyon, a tributary of Rendija Canyon (Figure 1). It is largely on DOE land but also is partly in the Santa Fe National Forest. The sole indication that a SWMU might be present at this site are two deteriorating signs warning of danger of explosives. They are both on trees at the locations shown on Figure 6. The final boundary of the SWMU and area to be searched was established by taking into consideration the positions of the two signs, the topography, and the location of a known ordnance impact area [0-011(d)] in a similar topographic setting. The boundary was marked with flagging and surveyed in by a geodetic crew.

3.2.1.2 Geology and Hydrology

SWMU 0-011(c) lies athwart the drainage channel of a small tributary of Cabra Canyon, which in turn flows into Rendija Canyon. The relief of this area is moderate, consisting mostly of gentle to moderately steep hillslopes and the alluvial channels that drain the site. These drainage channels, although not deep, are well formed and their identification is not difficult. The bedrock of the area consists primarily of the Bandelier Tuff, but also includes some of the dacitic rocks of the Tschicoma Formation. The hillslopes are thinly mantled with unconsolidated colluvial material, and the alluvium fills the drainage channels within the site.

3.2.2 Site Investigation and Analytical Results

The ordnance sweep at SWMU 0-011(c) took approximately 14 days. Ordnance surveys at the site resulted in no findings except for scrap metal, such as bailing wire. Using a 100 feet grid surveyed and staked by the geodetic crew, a geophysics team conducted a follow-on QC sweep, and located 14 anomalies. The subsequent check by EOD personnel determined that the anomalies were rocks and some small pieces of

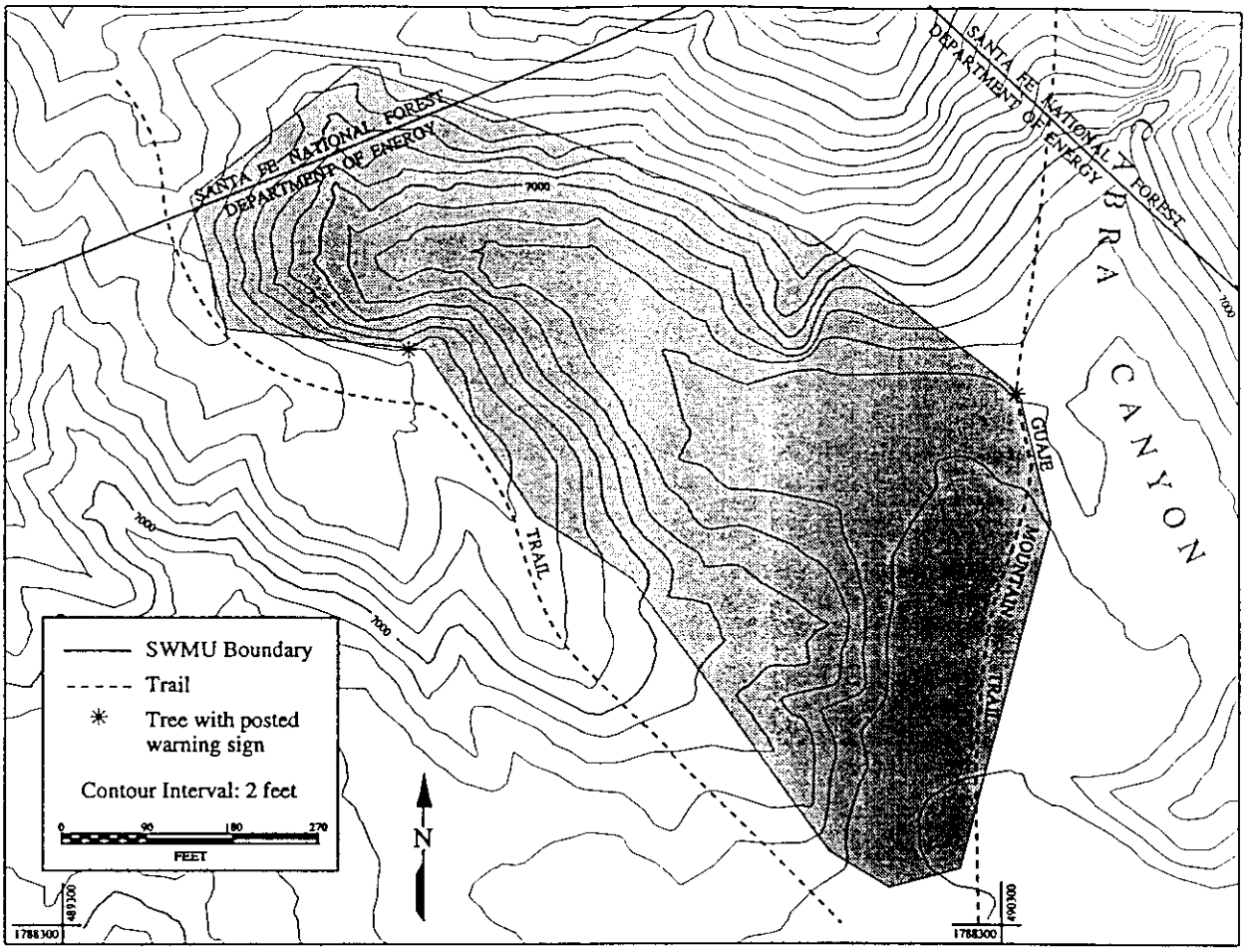

Figure 6. Map of SWMU 0-011(c).

wire and tin cans. Field work at the site was completed by 23 June 1993. No ordnance or ordnance fragments were found.

3.2.3 Conclusions and Recommendations

This site, identified as a possible former ordnance impact area, was thoroughly surveyed for OEW. Not a single piece of OEW was found during the EOD or geophysical surveys. This procedure, of having a follow-on geophysical survey, ensured that a careful quality control check was made of each square foot of the area. The complete absence of OEW shows that this site was never used as an ordnance impact area. The two signs on the perimeter of the site (see Figure 6) may have been placed there by the U.S. Army personnel at Los Alamos in the early 1940s with the expectation of using the site as an ordnance impact area, an expectation that never materialized.

Given that the extremely detailed and careful search for OEW at this SWMU did not result in even a single fragment of OEW being found, demonstrating that the site is not a former ordnance impact area, it is recommended that the site be designated for NFA.

3.3 SWMU 0-011(d)

3.3.1 Background

3.3.1.1 Description and History

SWMU 0-011(d) is in a small north-trending tributary of Bayo Canyon northeast of the intersection of San Ildefonso Road and Diamond Drive (Figure 1). The eastern side of this tributary is a cliff, while the west side is a moderately steep slope of fill that resulted from the construction of San Ildefonso Road (Figure 7). The area is fenced and marked by warning signs. It is almost entirely on Los Alamos County land, but a very small part of the fenced area includes private property.

3.3.1.2 Geology and Hydrology

SWMU 0-011(d) occupies a small canyon along the southern flank of Barranca Mesa. The site is rimmed on the north and eastern edges by cliffs formed in the Bandelier Tuff, the bedrock unit that underlies this site. The lower cliff slopes, down to the axial drainage, are veneered by colluvium, and the drainage channels contain small quantities of alluvial material. The only well-established drainage channel on the site is the axial channel of this small canyon that flows into the axial channel of Bayo Canyon just downstream of the site boundary.

3.3.2 Site Investigation and Analytical Results

3.3.2.1 Ordnance

The entire area bounded by the fence at SWMU 0-011(d) was surveyed for UXOs and OEW. The SWMU was subdivided into six subareas by the EOD team to facilitate their survey. The subareas were delineated solely on the basis of topography (see Figure 7). Lanes were layed out by the EOD team in each of these subareas to guide their survey, except for the cliff where complete coverage was visually controlled by features on the cliff's surface. Access to the cliff was by a combination of climbing and repelling.

All of the OEW recovered from the site was found in an area about 160 feet by 80 feet along the base of the cliff (see Figure 7). The OEW was entirely 23.6 inch bazooka fragments except for one partly intact round. The material included tail fin assemblies, motors, bullets, and other fragments. The OEW was all found in the subsurface. Approximately one-half cubic meter of ordnance fragments were recovered. The geophysical survey identified over 100 ferrous objects. All objects identified in the geophysics survey were investigated by the EOD team. The field work at this site was completed in September, 1992.

3.3.2.2 Geomorphology and Sample Locations

Geomorphic mapping of the ordnance impact area included: (1) mapping the surficial, unconsolidated sediment at the site, and (2) mapping the drainage channels that would be likely pathways for the surficial transport of contaminants away from the impact zone. These drainage channels include both the small drainage channels that drain the hillslopes within the impact area and the main (axial) drainage channel into which the small channels flow (Figure 8). Sediments in the channels have a thin upper coarse sand to pebble layer ranging in thickness from about one to several centimeters which overlies a clay-rich layer.

Sampling in the fall of 1992 involved the collection of soil from the surface and selected sediment trap locations for evaluation of HE and TAL metals. Sediment catchment sites along both the drainage channels on the hillslope below the cliff and along the axial drainage channel were selected for sampling, because they are sites with the highest probability of containing contaminants that are being removed from the impact zone by surface runoff (Figure 8). Additional sampling was conducted on 14 June 1993 for metals and HE.

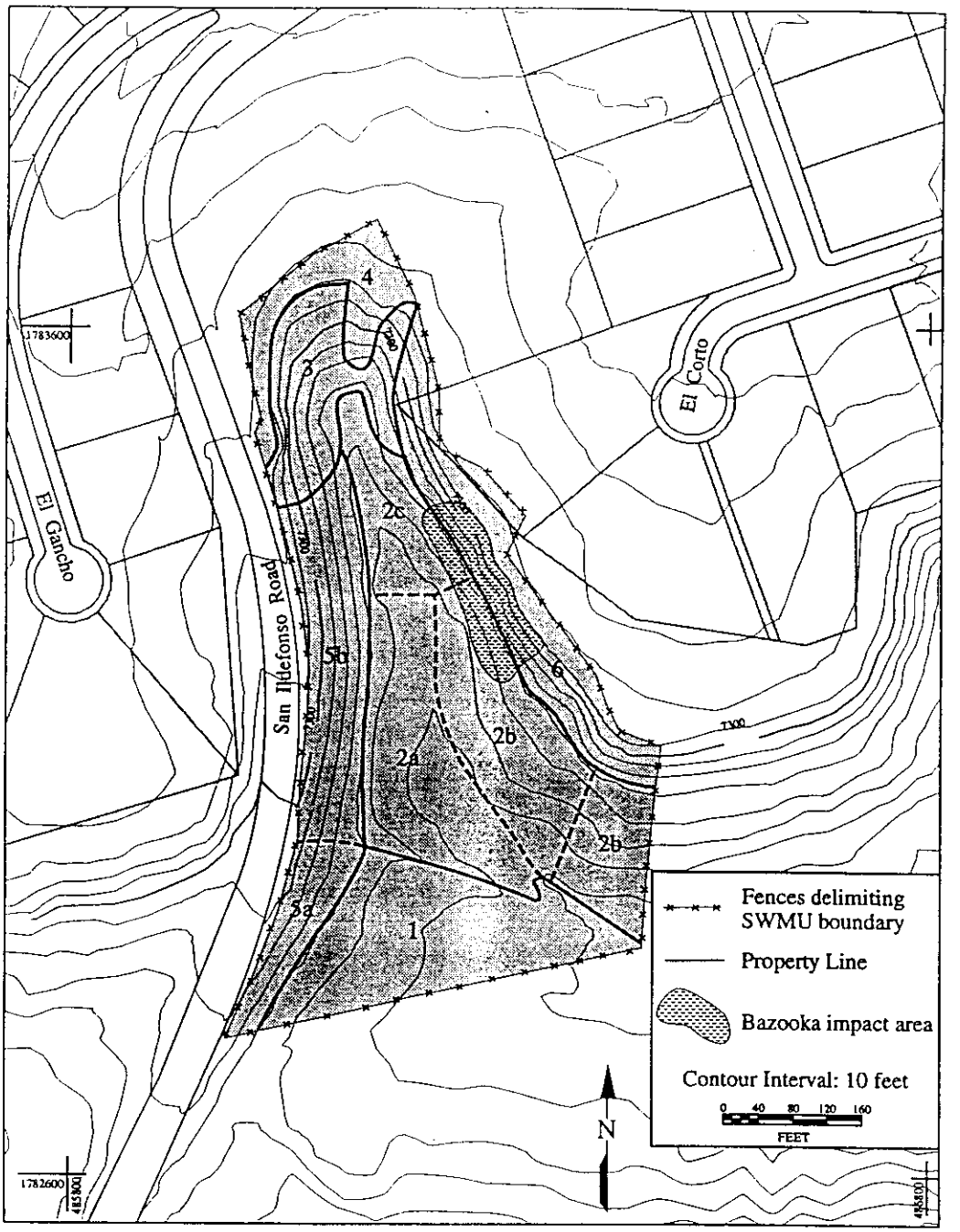

Figure 7. Map of SWMU 0-011(d) showing the fenced boundary, the area of subdivisions of the EOD team, and the bazooka impact area where all of the OEW was recovered.

Altogether, a total of 20 samples were collected: 9 samples were analyzed for HE, and 8 were analyzed for TAL metals (4 samples collected from the sediment traps were analyzed for both).

3.3.2.3 Chemistry and Data Quality

Soil samples were analyzed for metals and HE. Radiation screening results (gross alpha, gross beta, and gross gamma) were uniformly below detection limits. Following the RFI sampling plan, seven soil samples were collected on 10 October, 1992 (samples AAA 1727-1733):

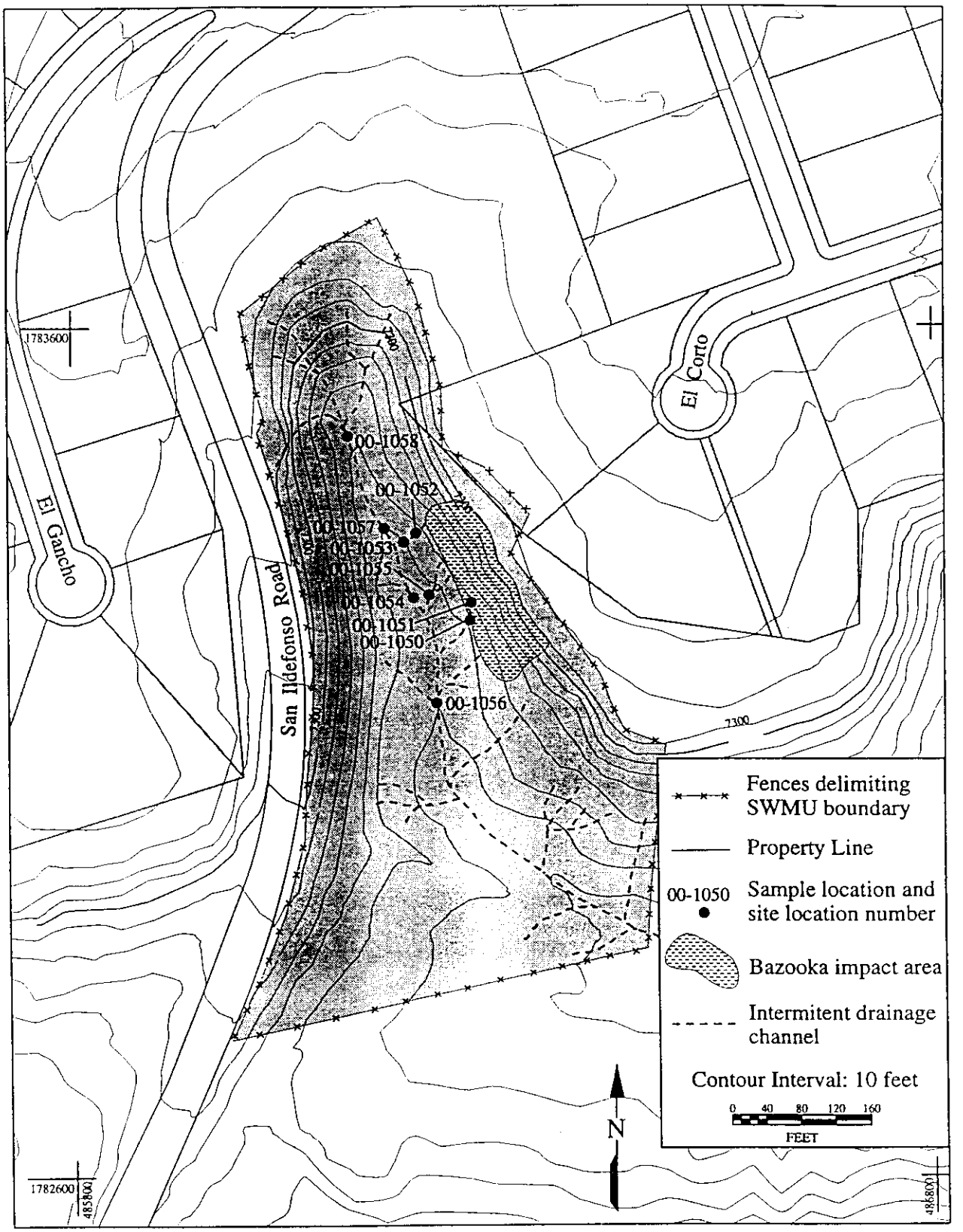

Figure 8. Map of SWMU 0-011(d) showing bazooka impact area, drainage pattern, and sample (site) locations.

Inorganic measurements were made following the SW846 procedures for ICPES (most elements), FAA (Ag), and ETVAA (As and Se). The results show three samples with Pb above background levels but well below the SAL (see Table 4). The holding times for HE was missed by several months so the data could not be used.

Thirteen additonal soil and sediment samples (AAA 2961-2964, 2966-2974) were collected on 14 June 1993. The primary purpose of these samples was to obtain good HE data, but they were also collected to answer a question concerning Pb levels in some of the initial seven samples. Although the Pb levels were low and of no health concern, the question remained whether the elevated Pb reflected contributions from the OEW or a sedimentary layer with higher than normal background. Thus, when sampling at the two locations with the higher levels, separate samples were taken of the upper granular layer and underlying clay-rich layer. Additionally, two samples of each layer were taken at two new locations upstream from the impact zone. Thus, a total of 8 samples were taken at four locations to assess the source of the elevated Pb (locations 00-1056, 00-1054, 00-1057, and 00-1058 on Figure 8). Nine samples were analyzed for HE from the original 7 locations, 5 from the hillslope and four from locations 00-1054 and 00-1056. The holding times were met in the second group of samples.

Two different methods were used to extract the soil samples listed in Table 4 for inorganic analyses. A total dissolution procedure including the addition of hydrofluoric acid was used on the October 1992 samples, while the June 1993 samples were extracted using nitric acid, which results in only partial dissolution of the sample. Consequently, the two sets of results are not readily comparable to each other, nor is either set of results necessarily comparable to background as reported by Longmire et al. (1993) although the hydrofluoric dissolution process generally provides more nearly comparable results. Results obtained using the nitric acid procedure, which is the procedure generally prescribed for site contamination assessment (SW 846), are generally biased downward relative to the traditional total measurements, although for most minor and trace elements this bias is quite small (less than 30-50%).

The organic compounds associated with HE were sampled by CST-9 and analyzed by the Environmental Science & Engineering Laboratory, Gainesville, Florida, using HPLC, a modified SW846 Method 8330. The compounds analyzed for were: 4-Amino-2,6-dinitrotoluene; 2-Amino-4,6-dinitrotoluene; 1,3-Dinitrobenzene; 2,4-Dinitrotoluene; 2,6-Dinitrotoluene; HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine); Nitrobenzene; m-Nitrotoluene; o-Nitrotoluene; p-Nitrotoluene; RDX (1,3,5-Trinitrohexahydro-1,3,5-triazine); Tetryl (Methy-2,4,5-trinitrophenylnitramine); 1,3,5-Trinitrobenzene; and 2,4,6-Trinitrotoluene. All analyses were below detection limits for all analytes.

3.3.3 Data Assessment

No high explosives (HE) or byproducts were detected in any sample. No inorganic constituents exceeded their SALs except for arsenic and beryllium, for which the SALs are below background concentrations. In these cases, we compared the observations to background (see Table 5). Concentrations of arsenic and beryllium were within background ranges.

Two samples (one from each sampling event) had slightly elevated concentrations of lead, in the range of 110 to 160 ppm. For the purposes of comparing these observations with background figures, we note that for lead, nitric acid sample dissolution introduces only a small bias (5-10%) relative to dissolution using hydrofluoric acid. These isolated lead observations are thus well below levels of concern (500 to 1000 ppm). There were also several observations in the range of 50 to 70 ppm, which is somewhat high compared to the developed soils analyzed by Longmire et al. (1993) (see Table 6), but more comparable to observations from tuff in that same study. As many of the samples from SWMU 0-011(d) were comprised of coarse, granular material derived from tuff rather than well-developed soils, these results are not surprising. There was one above-background copper measurement, at 300 ppm. This is 10% of the SAL for copper. Concentrations of remaining elements appear to be comparable to regional background values, allowing for the bias in methods.

TABLE 4. Results of Inorganic Analysis of Soils for 0-011d in ppm.

Location ID	Sample #	Al	Ag	As	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	Hg	K
00-1050	AAA1727	68414	<1	0.9	155	3	2735	<1	4	3	<5	15562	nd	38230
00-1051	AAA1728	68468	<1	0.9	135	3	2829	<1	4	3	14	16618	nd	38045
00-1052	AAA1729	61358	<1	0.4	142	2	2147	<1	3	2	<5	10424	nd	34992
00-1053	AAA1730	68550	<1	0.8	175	3	2217	<1	3	3	13	10828	nd	37989
00-1054	AAA1731	55421	<1	1.1	482	2	5471	<1	8	16	<5	14165	nd	26016
00-1054	AAA2962	4700	<1	0.2	51	0.41	2200	<0.4	5.1	9.5	5.7	8700	<0.1	790
00-1054	AAA2964	8000	<1	2.6	69	0.67	1400	<0.4	4.3	7	2.8	11000	<0.1	1000
00-1055	AAA1732	61310	2.6	0.8	174	2	2597	<1	3	4	<5	11824	nd	33450
00-1056	AAA1733	62371	<1	3.4	515	2	4878	<1	18	21	<5	19132	nd	24969
00-1056	AAA2961	12000	<1	3.4	160	0.91	4100	<0.4	9.1	13	8.5	12000	<0.1	1700
00-1056	AAA2963	16000	<1	3.4	150	1	2600	<0.4	5.4	13	300	14000	<0.1	2000
00-1059	AAA2971	6100	<1	2.2	49	0.78	1400	<0.4	7.3	7.7	2.7	11000	<0.1	950
00-1059	AAA2972	4300	<1	1.6	44	0.4	1400	<0.4	3.7	9.5	3.6	7800	<0.1	750
00-1059	AAA2973	14000	<1	4.7	150	0.96	2300	<0.4	12	12		14000	<0.1	1700
00-1059	AAA2974	2900	<1	1.3	34	0.37	2100	<0.4	4.8	14	5.2	12000	<0.1	570

Location ID	Sample #	Li	Mg	Mn	Mo	Na	Ni	Pb	Sb	Se	Sr	Tl	V	Zn
00-1050	AAA1727	29	765	538	4	31445	<2	33	<10	<0.2	37	<5	7	88
00-1051	AAA1728	29	835	501	3	30888	<2	34	<10	<0.2	30	<5	7	86
00-1052	AAA1729	24	484	407	2	28537	<2	31	<10	<0.2	32	<5	4	58
00-1053	AAA1730	28	715	432	2	30894	<2	44	<10	<0.2	39	<5	7	61
00-1054	AAA1731	21	2325	444	<1	18128	8	156	<10	<0.2	123	<5	28	79
00-1054	AAA2962	4.7	1700	250	2.3	290	11	73	<0.07	0.3	8.8	<0.04	16	83
00-1054	AAA2964	8.6	1100	330	1.4	180	6	26	<0.07	0.3	11	0.08	14	40
00-1055	AAA1732	26	947	395	2	27004	<2	32	<10	<0.2	39	<5	8	60
00-1056	AAA1733	27	3441	867	<1	16259	12	68	<10	<0.2	110	<5	45	60
00-1056	AAA2961	11	2200	630	1.7	160	10	110	<0.07	<0.2	20	0.07	23	72
00-1056	AAA2963	12	2600	300	1	130	9	30	<0.07	<0.2	26	0.08	28	38
00-1059	AAA2971	6	920	330	2	250	3.9	68	<0.07	<0.2	7.7	<0.04	12	59
00-1059	AAA2972	nd	950	230	nd	280	4	68	<0.07	<0.2	nd	<0.04	12	65
00-1059	AAA2973	11	2300	nd	<1	330	8.9	33	<0.07	<0.2	11	0.1	29	37
00-1059	AAA2974	nd	1100	210	nd	180	6.1	58	<0.07	<0.2	nd	<0.04	24	68

nd = not determined
Samples 1727-1733 were analyzed after HF extraction
Samples 2961-2974 were analyzed after HNO3 extraction

TABLE 5. Summary of Inorganic Results from 0-011(d)

	October, 1992				June, 1993					
	min	mean	median	max	min	mean	median	max	SAL	background
Ag	<1		<1	2.6	<1			<1	400.0	1.16
Al	55421	63699	62371	68550	2900	8500	7050	16000	—	50,000-144,000
As	0.4	1.19	0.9	3.4	0.2	2.43	2.4	4.7	0.4	1.2-10.8
Ba	135	254	174	515	34	88.4	60	160	5600.0	125-830
Be	2.0	2.43	2.0	3.0	0.37	0.69	0.73	1.0	0.16	1.0-4.4
Ca	2147	3268	2735	5471	1400	2188	2150	4100	—	1900-80,400
Cd	<1			<1	<0.4			<0.4	80	1.2-1.7
CN					<0.05		<0.05	0.15	1600.0	
Co	3.0	6.14	4.0	18.0	3.70	6.46	5.25	12.0	—	0.4-23
Cr	2.0	7.43	3.0	21.0	7.00	10.71	10.75	14.0	400.0	2-71
Cu	-5.0		-5.0	14.0	2.70	46.9	5.2	300	3000.0	2-18*
Fe	10424	14079	14165	19132	7800	11313	11500	14000	—	10,000-48,600
Hg					<0.1			<0.1	24.0	0.007-0.029*
K	24969	33384	34992	38230	570.	1183	975	2000	—	10,400-48,000
Li	21.0	26.29	27.0	29.0	4.7	8.9	9.8	12.0	—	
Mg	484.	1359	835	3441	920	1609	1400	2600	—	1331-16,800
Mn	395	512	444	867	210	326	300	630	8000.0	190-1600
Mo	<1.0		2.0	4.0	<1.0		1.55	2.3	—	
Na	16259	26165	28537	31445	130	225	215	330	—	2700-36,300
Ni	<2.0		<2.0	12.0	3.90	7.36	7.50	11.0	1600.0	1.6-19*
Pb	31.0	56.86	34.0	156.0	26.0	58.3	63.0	110	500.0	<14-44
Sb	<10			<10	<0.07			<0.07	32.0	0.3-1.6
Se	<0.2			<0.2	<0.2		<0.2	0.3	400.0	0.26†
Sr	30.0	58.6	39.0	123.0	7.7	14.1	11.0	26.0	—	170-242
Tl	<5			<5	<0.04		0.015	0.1	6.4	<0.2-0.9
V	4.0	15.1	7.0	45.0	12.0	19.8	19.5	29.0	560.0	12-113
Zn	58.0	70.3	61.0	88.0	37.0	57.8	62.0	83.0	24000.0	20-146

— No SAL for analyte.
All units in parts per million.
Background values are from Longmire et al. (1993) unless otherwise indicated.
* = Ferenbaugh et al. (1990).
† = Shacklette and Beorngen (1984).

3.3.4 Conclusions and Recommendations

This site has been cleaned of all UXOs and OEW fragments to the smallest size possible using state-of-the-art instruments. In addition to a very careful search conducted by an EOD team, the site underwent an extremely thorough quality control check by a geophysics team to ensure that no UXOs or significant sized OEW fragments remained. It is important to emphasize that the EOD search of the cliffs included a complete visual search supported by magnetometers to check holes and cracks, and the mesa top above the cliff to the fence that defines the SWMU boundary.

Judgementally selected soil and sediment samples, chosen to maximize the possibility of finding contaminants (metals or HE) from the bazooka rounds showed that all TAL metals are within the range of background except for lead in several samples, and they were far below the 500 ppm SAL. HE was not detected in any of the samples.

TABLE 6. Results of Inorganic Analysis of Soils for 0-011e in ppm.

Location ID	Sample #	Al	Ag	As	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	Hg
00-1219	AAA6121	3100	<1	0.4	21	0.24	1100	<0.4	<0.5	1.7	2.7	3000	<0.1
00-1220	AAA6114	610	<1	0.4	8.5	0.23	290	<0.4	<0.5	0.7	0.5	2200	<0.1
00-1221	AAA6109	1100	<1	0.6	17	0.39	700	<0.4	<0.5	<0.5	4.3	2700	<0.1
00-1221	AAA6108	1500	<1	0.7	18	0.45	800	<0.4	<0.5	0.9	4.6	4200	<0.1
00-1222	AAA6116	2600	<1	1.1	23	0.41	1000	<0.4	<0.5	1.8	2.4	3900	<0.1
00-1223	AAA6117	2500	<1	0.5	24	0.2	2200	<0.4	0.7	2.5	1.7	2600	<0.1
00-1224	AAA6100	860	<1	<0.2	9.5	0.13	580	<0.4	<0.5	1.1	<0.5	2500	<0.1
00-1225	AAA6130	840	<1	<0.2	7.3	0.09	610	<0.4	<0.5	1.5	<0.5	3800	<0.1
00-1226	AAA6124	1500	<1	<0.2	14	0.2	530	<0.4	<0.5	1.7	1.3	2400	<0.1

Location ID	Sample #	K	Mg	Mn	Na	Ni	Pb	Sb	Se	Tl	V	Zn
00-1219	AAA6121	550	710	90	430	<2	3.6	<0.2	<0.2	<0.2	4	80
00-1220	AAA6114	320	160	100	58	<2	3.1	<0.2	<0.2	<0.2	<0.5	22
00-1221	AAA6109	490	310	140	76	<2	6.4	<0.2	<0.2	<0.2	2.3	33
00-1221	AAA6108	430	370	200	100	<2	7	<0.2	<0.2	<0.2	3	28
00-1222	AAA6116	610	570	160	98	<2	6	<0.2	<0.2	<0.2	4.5	32
00-1223	AAA6117	330	1000	67	430	<2	1.6	<0.2	<0.2	<0.2	4.1	18
00-1224	AAA6100	<70	360	73	120	<2	1.7	<0.2	<0.2	<0.2	2.3	30
00-1225	AAA6130	<70	440	130	67	<2	1.2	<0.2	<0.2	<0.2	2.5	41
00-1226	AAA6124	360	390	81	100	<2	3.2	<0.2	<0.2	<0.2	3.4	22

Given the identification and removal of all UXOs and OEW and the absence of any significant contaminants in the soil and sediment, it is recommended that the site be approved for residential use and designated for NFA. Additionally, it is recommended that Los Alamos County remove the fence from the site and open the area to the public.

3.4 SWMU 0-011(e)

3.4.1 Background

3.4.1.1 Description and History

SWMU 0-11(e) is an area that extends north along a tributary of Rendija Canyon to the top of the cliff face that is the head waters of the tributary drainage and is the north drainage divide of Rendija Canyon. The designators for this SWMU [0-011(b) and (e)] were originally thought to designate two separate units. SWMU 0-011(b), north-northeast of the Sportsman's Club, is fenced and labeled Thirty-Seven Millimeter Canyon on a 1962 range clearance map (LASL 1962) (Figure 1). This is the same SWMU that is referred to as "e" in the SWMU report (LANL 1990). The designator 0-11(e) was retained for this SWMU location. The SWMU 0-11(e) is largely on Santa Fe National Forest land except for a small segment at the southern boundary which is on DOE land.

U.S. Army personnel, operating tanks firing 37-mm rounds, used the canyon for training in the mid- to late 1940s (IT Corporation 1991). Not all of the area designated on the range clearance map was fenced, so the exact size of the SWMU was not known before field activities began. The northern unfenced boundary of the SWMU was established as the top of the cliff face (Figure 9).

3.4.1.2 Geology and Hydrology

Thirty-Seven Millimeter Canyon is a northern tributary to Rendija Canyon. The area includes the headwaters of the tributary drainage as well as extensive near vertical cliffs formed on the Bandelier Tuff, which comprises the bedrock of this site. Hillslope colluvium and alluvial materials along drainage channels comprise the relatively thin surficial materials of the area. The axial channel of Thirty-Seven Millimeter Canyon is the principal drainage channel of the site and collects all surficial drainage of the site before its discharge into Rendija Canyon.

3.4.2 Site Investigation and Analytical Results

3.4.2.1 Ordnance

The area within the fence, the cliff, and the mesa top to a line about 100 meters back from the cliff were surveyed for UXOs and OEW. The SWMU was subdivided (see Figure 9) by the EOD team to facilitate their survey. Within each subdivision lanes were layed out to guide the surveys, except for the cliff face where complete coverage was visually controlled by features on the cliff face. Because the terrain was particularly rough, the EOD team was required to rappel down the cliff face. This activity took about four days and resulted in locating only one round. The team used civilian climbing equipment, including safety lines, and performed the work in accordance with applicable regulations and general practices of mountaineering safety.

The ordnance sweep at SWMU 0-011(e) took approximately 5 weeks. Materials recovered were primarily 37 mm rounds and fragments. Because of the uncertainty of whether each of these rounds were HE or armor-piercing (AP) they were placed in shallow pits and explosives then packed over them and detonated, a practice referred to as "shots." These detonations/shots were performed for several reasons: (1) to ensure positive identification of the rounds (deterioration of the rounds could result in mistakes in identification), (2) to ensure the materials were inert (EOD procedures prohibit bringing live rounds out of the survey area),

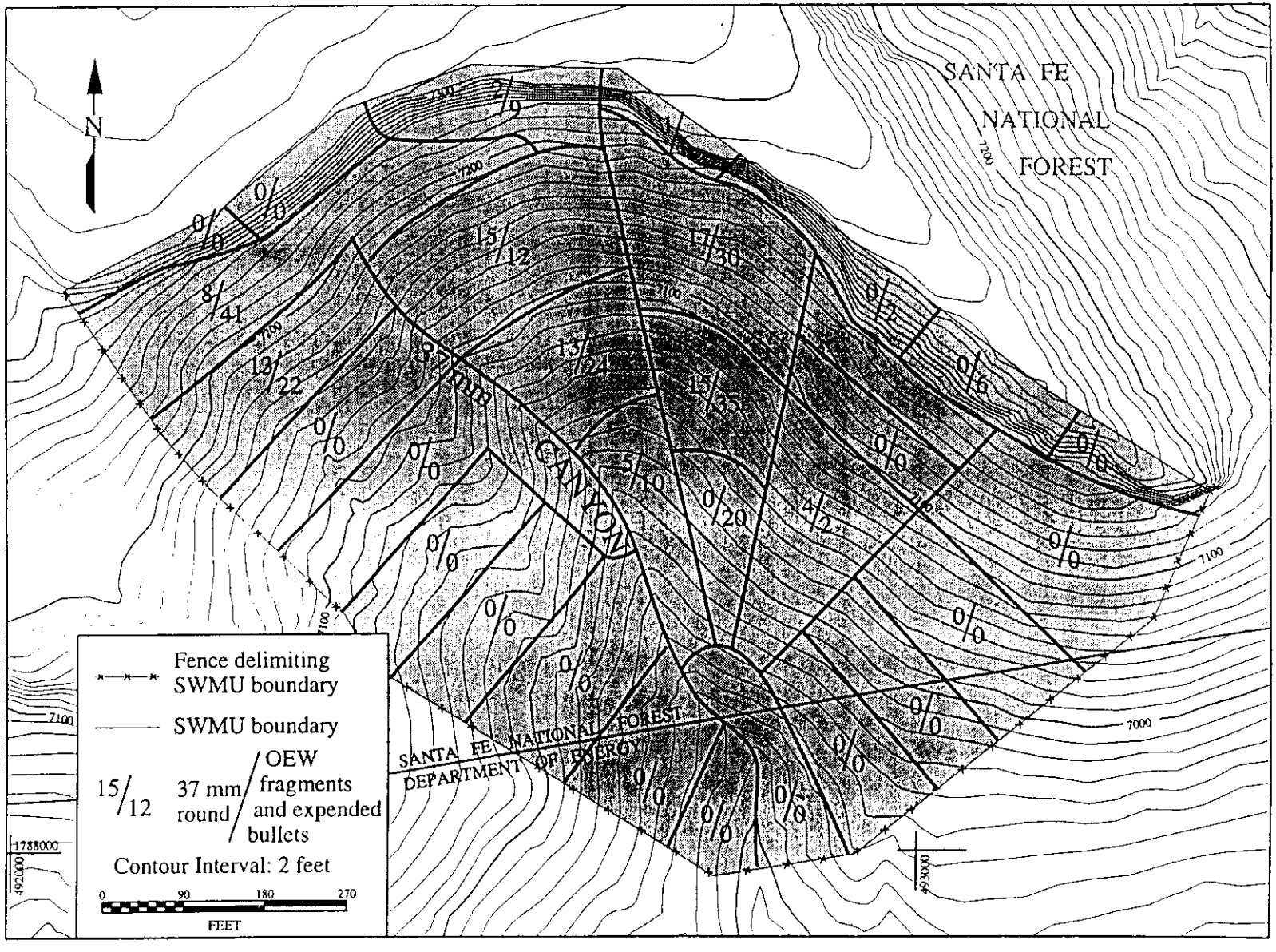

Figure 9. Map of SWMU 0-011(e) showing the fence on the southern boundary of the area. Dashed lines delineate EOD team area subdivisions, with the number of 37 mm rounds and number of OEW fragments found in each subdivision.

and (3) to facilitate safe disposal. The shots were fired non-electrically because of the difficulty of access to the area and t' ɜ inability to visually maintain site security. Seven separate shots involving a total of 102 37 mm rounds were fired on 13 July 1993, 30 July 1993, and 23 August 1993. They were all fired within the main ordnance impact area of the site. After each of the detonations, the resulting EOW was recovered. All of the 37 mm rounds were confirmed to be AP.

Materials found in the ordnance sweep included two 20-mm rounds, 102 AP rounds, and fragments of an indeterminate number of 37-mm HE rounds (nose cones and fusing). All 350 pieces of EOW fragments and expended bullets (small caliber, both military and civilian) were found. The geophysics survey flagged 48 anomalies of which 27 were found to be ordanance related. The EOD team investigated all geophysical anomalies. Field work at the site was completed on September 24, 1993.

3.4.2.2 Geomorphology and Sample Locations

Geomorphic mapping of SWMU 0-11 (e) included the mapping of all drainage channels that drained the area enclosed within the final boundaries of the site and (2) the areas of high concentration of ordnance fragments. Detailed mapping of the drainage within the site was necessary prior to selection of surface sampling sites, because of the generally high relief of the site and the concentration of ordnance in a relatively small segment of the site. Mapping included the larger drainage channels on or adjacent to the site, into which the smaller channels discharge (Figure 10). Soil investigations indicate two major soil-geomorphic settings characterize areas where sampling activities have been conducted: 1) Larger channels in which pedogenically unmodified , gravelly, sandy sediment has recently accumulated, and 2) recently deposited, pedogenically modified angular gravelly to sandy colluvium deposited in swales on steep hillslopes below steep cliffs formed in the Bandelier Tuff.

Sampling in fall of 1993 involved the collection of soil from the surface and selected sediment traps for evaluation of HE and TAL metals. Sediment catchment sites along the drainage channels of the hollslope below the cliff and within and directly below the main impact zone were selected for sampling because they are sites with the highest probability of the containing contaminants that are being removed from the SWMU (Figure 10).

3.4.2.3 Chemistry and Data Quality

Following the RFI sampling plan, nine soil samples were collected on 24 September, 1993 (samples AA 6100, 6108-6109, 6114, 6116-6117, 6121, 6124 and 6130). Soil samples were analyzed for metals and HE. Radiation screening results (gross alpha, gross beta, and gross gamma) were uniformly below detection limits. Analyses of metals were made by group CTS-9 following the SW846 procedures for ICPES (most elements), FAA (Ag), and ETVAA (As and Se). Results for inorganics (Table 6) were obtained using the nitric acid sample dissolution procedures prescribed by EPA (SW 846) together with ICPES, ICPMS and AA instrumental techniques.

Be and As are above SALs, but fall well within the background range. All of the QC data for the metals were "under control" except for Hg which was "out of control." The analytical result for Hg in the QC sample was 2 µg/g while the QC value was 5 µg/g. This makes the analytical result about 60% low. The result for Hg in all of the samples was <0.1 mg/kg while the SAL for Hg is 24 mg/kg. Therefore, the fact that the analytical result for Hg in the QC sample is 60% low does not affect the status of Hg being below SAL. This is because all reported Hg values for the samples are at least a factor of 240 below the SAL.

The organic compounds associated with HE were analyzed by the International Technology Analytical Services, St. Louis, MO using HPLC, a modified SW846 Method 8330. The compounds analyzed for were: 1,3-Dinitrobenzene; 2,4-Dinitrotoluene; 2,6-Dinitrotoluene; HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine); Nitrobenzene; m-Nitrotoluene; o-Nitrotoluene; p-Nitrotoluene; RDX (1,3,5-Trinitrohexahydro-1,3,5-triazine); Tetryl (Methy-2,4,5-trinitrophenylnitramine); 1,3,5-Trinitrobenzene; and 2,4,6-Trinitrotoluene. All analyses were below detection limits for all analytes.

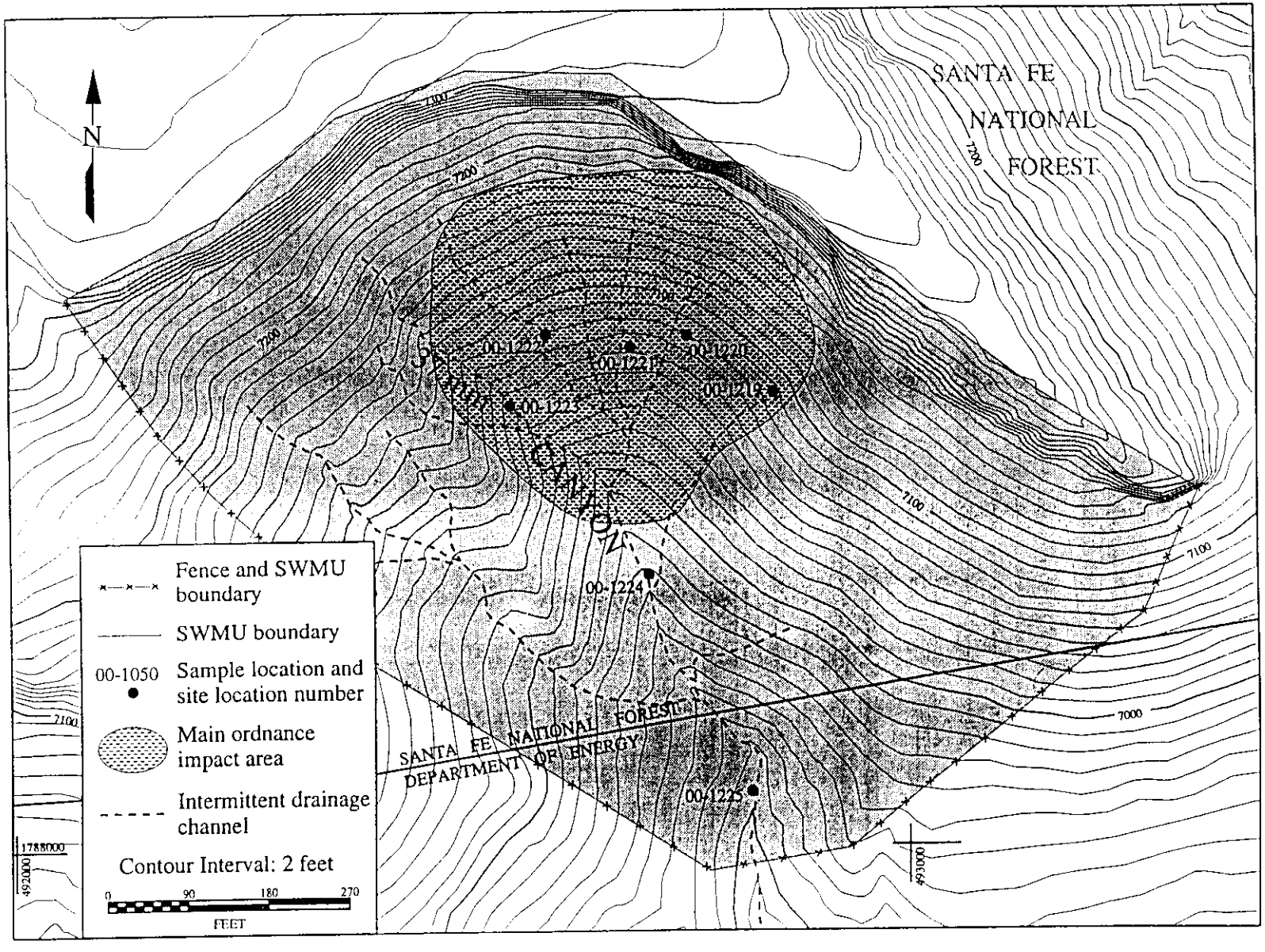

Figure 10. Map of SWMU 0-011(e) showing the main ordnance impact area, drainage pattern, and sample (site) locations.

The analytical laboratory had several problems with the HE analyses. One was that the holding times for the analyses were missed by 6 days. The samples were extracted within 7 days but were not analyzed for 46 days (exceeding the 40 day limit required by the SW 846 Method 8330). However, it was concluded that the data are still accurate because: (1) a recent report by the U. S. Army Environmental Center entitled "Experimental Assessment of Analytical Holding Times for Nitroaromatic and Nitramine Explosives in Soil" (special report 93-11, June 1993) indicates that exceeding holding times (up to 56 days after extraction) does not cause a loss of HE analytes, nitramines, and possibly nitromatics, (2) HE sample results were below detection limits for all analytes, and (3) No peaks were detected that could have been degradation products from any HE that may have biodegraded (per analytical laboratory).

Another problem encountered by the analytical laboratory was surrogate and MS/MSD recoveries. The surrogate recoveries ranged from 66% to 280% while the MS/MSD recoveries ranged from 29% to 296%, causing the CST-9 reviewer to qualify the data as "UJ" (undetected, estimated quantity). However, all analytes were below detection and no peaks from biodegradation products were present.

3.4.3 Data Assessment

No TAL metals exceeding their SALs except for arsenic and beryllium, for which the SALs are comparable to background concentrations (Table 7). Concentrations of all elements appear to be comparable to regional

TABLE 7. Summary of Inorganic Results from 0-011(e)

	min	mean	median	max	SAL	background
Ag	<1			<1	400.o	1.16
Al	610	1623	1500	3100	—	50,000-144,000
As	<0.20	0.34	0.40	1.10	0.4	1.2-10.8
Ba	7.3	15.8	17.0	24.0	5600.0	125-830
Be	0.09	0.26	0.23	0.45	0.16	1.0-4.4
Ca	290	868	700	2200	—	1900-80,400
Cd	<0.4			<0.4	80.0	1.2-1.7
Co	<0.5		<0.5	0.70	—	0.4-23
Cr	<0.5	1.27	1.50	2.50	400.0	2-71
Cu	<0.5	1.83	1.70	4.60	3000.0	2-18*
Fe	2200	3033	2700	4200	—	10,000-48,600
Hg	<0.1			<0.1	24.0	0.007-0.029*
K	<70	328	360	610	—	10,400-48,000
Mg	160.00	478.89	390.00	1000.00	—	1331-16,800
Mn	67.00	115.67	100.00	200.00	8000.0	190-1600
Na	58.00	164.33	100.00	430.00	—	2700-36,300
Ni	<2			<2	1600.0	1.6-19*
Pb	1.20	3.76	3.20	7.00	500.0	<14-44
Sb	<0.2			<0.2	32.0	0.3-1.6
Se	<0.2			<0.2	400.0	0.26†
Tl	<0.2			<0.2	6.4	<0.2-0.9
V	<0.5		3.00	4.50	560.0	12-113
Zn	18.0	34.0	30.0	80.0	24000.0	20-146

— No SAL for analyte.
All units in parts per million.
Background values are from Longmire et al. (1993) unless otherwise indicated.
* = Ferenbaugh et al. (1990).
† = Shacklette and Beorngen (1984).

background values, allowing for the bias in methods discussed in Section 2.3. No high explosives (HE) or byproducts were detected in any sample. This is significant because even if all of the samples had the lowest recoveries and contaminants were present at a concentration equal to the highest detection limit within the sample set, the adjusted values would still be well below SALs (see Table 8 and discussion in Section 3.1.3)

3.4.4 Conclusions and Recommendations

This site has been cleaned of all UXOs and OEW fragments to the smallest size possible using state-of-the-art instruments. In addition to a very careful search conducted by an EOD team, the site underwent an extremely thorough quality control check by a geophysics team to ensure that no UXOs or significant sized OEW fragments remained. It is important to emphasize that the EOD search of the high cliff, which formed a backstop for the 37 mm rounds that were fired into the amphitheater, included a complete visual search supported by magnetometers to check holes and cracks. The mesa top above the cliff, to about 100 meters back from the rim, underwent the same careful search.

Judgementally selected soil and sediment samples, chosen to maximize the possibility of finding contaminants (metals or HE) from the 37 mm rounds, showed that all of the TAL metals at the site are within background values and that HE is not present at the detection limits of the analytical instruments. Therefore the soils and sediment at the site do not contain HE above SALs.

Given the location and removal of all UXOs and significant OEW fragments at the site and the absence of any significant contaminants in the soils and sediment, it is recommended that the site be approved for residential use and designated for NFA. Additionally, it is recommended that the DOE and US Forest Service remove the fence that delineates the southern boundary of the SWMU.

TABLE 8. Comparison of Analytical Data and SALs for HE Sample Analyses for 0-011e

Analyte	SAL (mg/kg)	HV (mg/kg)	Factor	%Recovery
"1,3-Dinitrobenzene"	8	<0.0003	27000	33-165
"2,4-Dinitrotoluene"	1	<0.0003	3000	33-296
"2,6-Dinitrotoluene"	1	<0.00031	3000	55-165
HMX	4000	<0.0026	1540000	32-153
Nitrobenzene	5.3	<0.00031	17000	35-160
m-Nitrotoluene	-	<0.0003	-	57-147
o-Nitrotoluene	-	<0.0003	-	53-120
p-Nitrotoluene	-	<0.0003	-	61-139
RDX	64	<0.0012	53000	35-147
Tetryl	800	<0.00077	1030000	44-172
"1,3,5-Trinitrobenzene"	4	<0.0003	13000	31-175
"2,4,6-Trinitrotoluene"	40	<0.0003	130000	29-183

HV = Highest Value from the analytical results for particular analyte.
"Factor = SAL/HV, the factor HV is below SAL."
% Recovery = range in % recovery for MS/MSD.

3.5 AOC C-0-020

3.5.1 Background

3.5.1.1 Description and History

AOC C-0-020 is located in a tributary of Rendija Canyon west of the Guaje Pines Cemetery (**Figure 11**). Most of the site lies within the national forest except for a small area on the south eastern edge which is private property. Before the RFI site investigation began, it was thought that the U.S. Army fired mortar rounds from Barranca Mesa into this area (IT Corporation 1991). An ordnance team from Fort Bliss found no ordnance in a preliminary survey in 1991, thereby casting doubt that it was ever an active site.

3.5.1.2 Geology and Hydrology

AOC C-0-020 lies along the north valley wall of Rendija Canyon into which all the drainage from this site discharges. The site also includes a small northern tributary of Rendija Canyon. The bedrock of the site consists primarily of dacitic rocks of the Tschicoma Formation with minor outcrops of the Bandelier Tuff. Additionally, the hillslopes are thinly veneered with hillslope colluvium and the valleys floors are covered with alluvial materials. Drainage channels on the hillslopes within the site are small channels that drain into the tributary of, or directly into, Rendija Canyon.

3.5.2 Site Investigation and Analytical Results

The ordnance sweep at AOC C-0-020 took about one week during the first part of May 1993. The area was designated an AOC based on deteriorated signs found at what was defined as the west corner and along the southern boundary of the AOC. The northern boundary was delimited on the basis of topography, so as to match the elevation of the ridge forming the southern boundary. As a result, the site was approximately 30 acres in size. The land surveyors set boundary angle points and staked a 100-foot grid (400 feet by 900 feet). The ordnance sweep of the portion of the SWMU thought most likely to have been an ordnance impact area resulted in findings of a few pieces of debris and scrap metal; no ordnance, OEW, or UXOs were located.

The geophysics team's survey found 11 anomalies. The subsequent QA investigation found that these anomalies were rocks and some pieces of tin. Field work at the site was completed by 05 June 1993.

3.5.3 Conclusions and Recommendations

This site, identified as a possible former ordnance impact area, was thoroughly surveyed for OEW. Not a single piece of OEW was found during the EOD or geophysical surveys. This procedure, of having a follow-on geophysical survey, ensured that a careful quality control check was made of each square foot of the area. The complete absence of OEW shows that this site was never used as an ordnance impact area. The three signs on the perimeter of the site (**see Figure 11**) may have been placed there to keep people away from the down-range side of the former small arms range located on the east.

Given that the extremely detailed and careful search for OEW at this AOC did not result in even a single fragment of OEW being found, demonstrating that the site is not a former ordnance impact area, it is recommended that the site be designated for NFA and approved for residential land use.

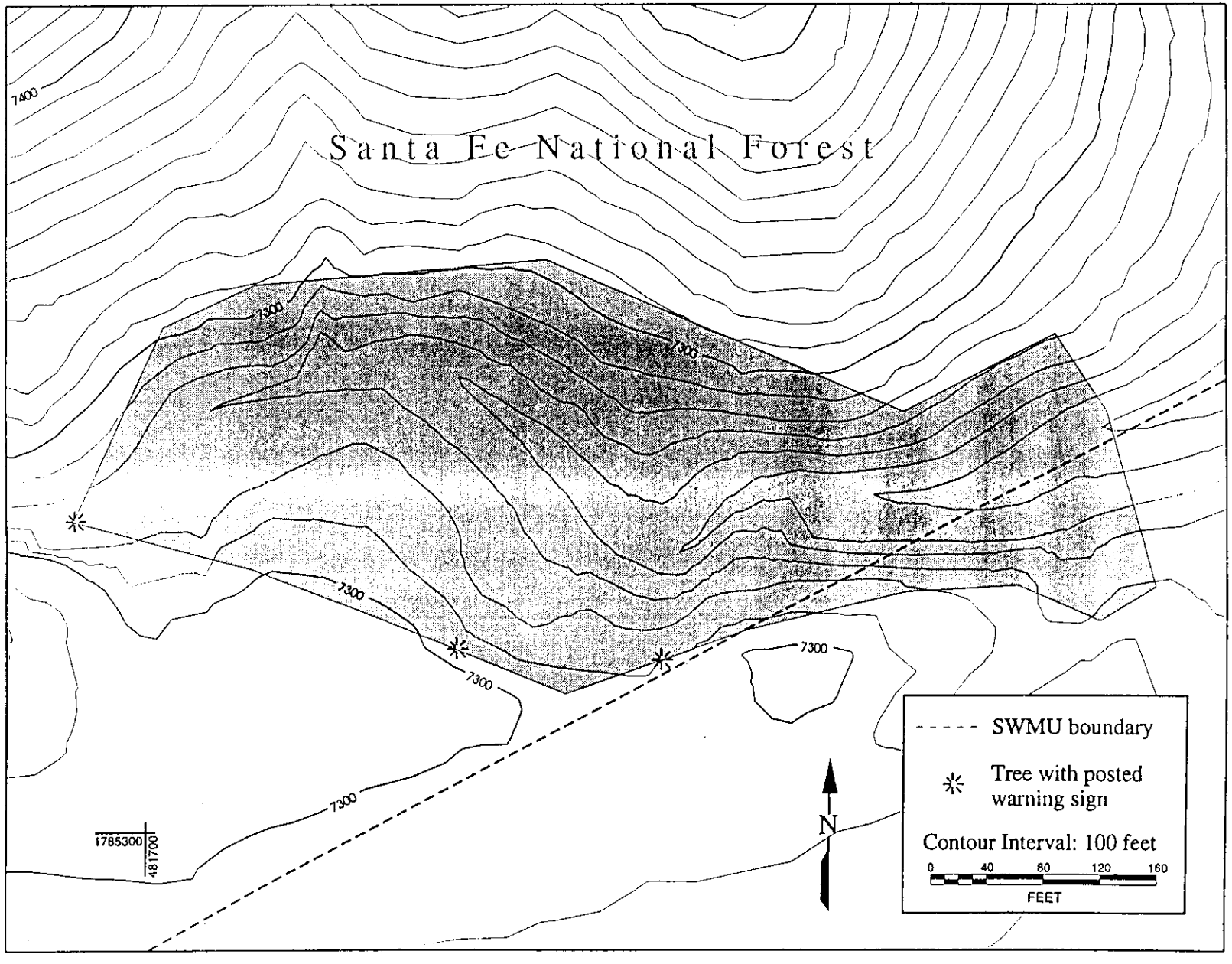

Figure 11. Map of AOC C-0-020.

3.6 References

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Sandia

Environmental Restoration Site Summary

Site: Sandia National Laboratories - NM

Links to Additional Site Information
Sandia National Laboratories - New Mexico Home Page
1996 Baseline Environmental Management Report Site Narrative
Management Action Process Document for Sandia National Laboratories -New Mexico

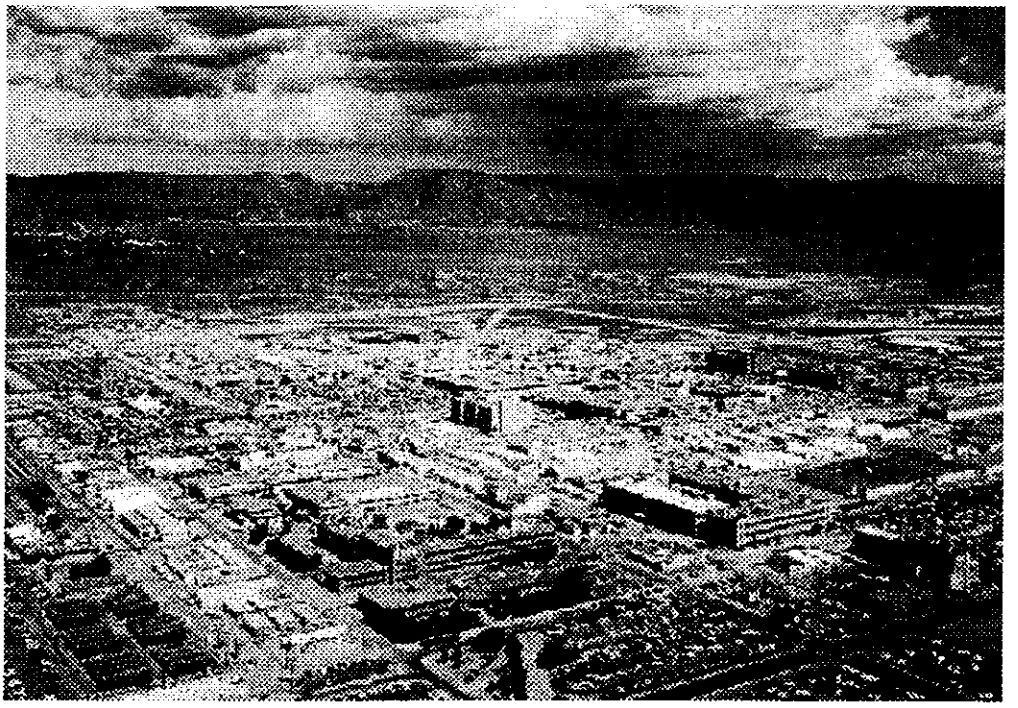
Background

The Sandia National Laboratories - New Mexico site is located in central New Mexico on the Kirtland Air Force Base, just south of Albuquerque. The site occupies 2,820 acres.

The site was established to conduct research and development in the interest of national security, with emphasis on nuclear weapons development and engineering. The site has since evolved into a multi-program laboratory with expertise in a broad range of scientific and technical fields, including fundamental energy research, energy conservation and renewable energy, nuclear reactor safety and reliability, nuclear waste management, and magnetic-confinement fusion. Past firings conducted to test weapons and weapons components, discharges of radioactive liquids and hazardous chemicals into the environment, oil spills, and disposal of radioactive waste and hazardous chemicals in landfills have all contributed to the contamination of facilities, soils and ground water at the site.

One hundred seventeen areas of potential contamination have been identified at the site. For the purposes of environmental restoration these areas have been grouped into four geographic areas: North Technical Areas, South Technical Areas, Firing Ranges, and the Thunder Range. Remediation activities are currently underway in all of these areas.

* 1-27-97 contacted Mike E. Young. Must ask to send information.
* 1-29-97 Caroline Bird contacted - works w/ Mike E. Young
  she will send information
* 2-11-97 left message w/ Mike E. Young 505 284 2595
  to determine status of requested info



Sandia National Laboratories - New Mexico

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About This Document

Last Updated 11/25/1996 (mhp)

1996 BEMR

Sandia National Laboratories/New Mexico

HOME BEMR CONTENTS U.S. MAP

Sandia National Laboratories/New Mexico is located in Bernalillo County, 10.4 kilometers (6.5 miles) east of downtown Albuquerque. The laboratories consist of five technical areas and several remote areas covering 1,128 hectares (2,820 acres) in the eastern half of the 306.8-square kilometer (118-square mile) Kirtland Air Force Base. The base has a mean elevation of 1,642 meters (5,385 feet). It is situated on two broad mesas bisected by the Tijeras Arroyo and bound by the Manzano Mountains to the east and the Rio Grande to the west.

LOCALITY MAP

Estimated Site Total

(Thousands of Current Year Dollars)

	FY 1996	1997	1998	1999	2000
Nuclear Material and Facility Stabilization					
Environmental Restoration	27,132	18,038	17,664	16,929	15,127
Waste Management	14,848	13,252	9,688	9,685	9,644
Total	41,980	31,290	27,352	26,613	24,771
1996 Appropriation	45,905				
1997 Congressional Request		33,091			

Grey shaded area reflects annual cost estimates for the first five years of the site BEMR Base Case (as of October 1995) and includes 3% annual inflation, see Readers' Guide.

These levels reflect the current estimates for compliance with applicable statutes and agreements (as of March 1996), see Readers' Guide.

(Five-Year Averages, Thousands of Constant 1996 Dollars)

	FY 1996-2000	2005	2010	2015	2020	2025	2030
Nuclear Material and Facility Stabilization		4,241	2,934	1,355	569		
Environmental Restoration	18,045	25,000		831	2,359		
Waste Management	10,856	16,117	18,413	17,934	19,636	18,227	17,934
Total	28,901	45,359	21,346	20,120	22,563	18,227	17,934

	FY 2035	2040	2045	2050	2055	2060	2065
Nuclear Material and Facility Stabilization							
Environmental Restoration							
Waste Management	17,934	17,934	17,934	17,934	17,934	17,934	17,934
Total	17,934	17,934	17,934	17,934	17,934	17,934	17,934

	FY 2070	2075	2080	2085	2090	2095	2100	Life Cycle*
Nuclear Material and Facility Stabilization								45,493
Environmental Restoration								231,178
Waste Management	18,227							1,314,403
Total	18,227							1,591,074

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

FACILITY MISSION

Sandia National Laboratories, which is part of the Department of Energy' s national laboratory complex, was established in the 1940s as the engineering arm of the nuclear weapon development program. In 1945, it represented a small part of Los Alamos Laboratory, called Z-Division, providing technical support to the U.S. Army. Sandia also operates a test range on the island of Kauai, Hawaii.

SITE MAP

Sandia/New Mexico has evolved into one of the country's largest technical resources. It is a multiprogram national laboratory with research and development programs in a broad range of scientific and technical fields, including fundamental energy research, energy conservation and renewable energy, nuclear reactor safety and reliability, nuclear waste management, and magnetic-confinement fusion. Recent mission changes have resulted in a decline in weapons research and development and an increase in work on nuclear safeguards and security, environmental sciences, biomedical systems engineering, advanced manufacturing technology, electronics, information and computational technology, transportation infrastructure and energy technology, and technology transfer to private industry in support of U.S. industrial competitiveness. New activities include the Medical Isotope Production Program and the Neutron Generator Production Facility.

The Office of Defense Programs is the landlord of Sandia National Laboratories/New Mexico and is expected to continue to use the property in support of its missions. The Environmental Restoration program is responsible for assessing and remediating environmental contamination at Sandia that has occurred from a wide variety of past or historical activities. All treatment, storage, and disposal costs are included with Environmental Restoration program estimates. Sandia's Waste Management Program conducts fully functioning waste operations for hazardous, radioactive, and mixed waste in support of Environmental Management and Office of Defense Programs activities.

FUTURE USE

Sandia assumes its mission will continue for the foreseeable future and current institutional controls will remain in place. Therefore, the Future Land-Use Working Group, in collaboration with all major stakeholders (U.S. Air Force, U.S. Forest Service, regulatory authorities, and the Citizens Advisory Board), has proposed future land-use designations for Sandia be Industrial for high density building/worker areas and Recreational for more remote areas. These designations are being used to establish risk-based cleanup standards and do not necessarily reflect actual current usage (e.g., Recreational use does not mean the land is presently available to the public. It means that it could reasonably be made available for such use in the future). If land uses are significantly changed, it may be necessary for the Federal Government to include deed restrictions for certain sites if they do not meet acceptable risk-based standards for the proposed use(s).

FUTURE USE MAP

NUCLEAR MATERIAL AND FACILITY STABILIZATION

The facility stabilization and maintenance process began at the Sandia National Laboratories in 1995. The Office of Defense Programs provides current funding for stabilization and maintenance. This report assumes that facilities will be transferred to the Environmental Management program in FY 2002. Twelve Sandia facilities are currently slated to undergo this process. Eleven facilities, including laboratories and storage facilities, have already begun stabilization. This report assumes the remaining facility, which is a corrugated burn structure, will begin stabilization and maintenance activities in FY 1996 and the cost is not included in this estimate. The Department expects the resulting waste types will include hazardous, transuranic, low-level, and low-level mixed waste. All waste generated by the Nuclear Material and Facility Stabilization program will be managed by the Waste Management program, and costs for treatment, storage, and disposal are included in the Waste Management section of this site narrative. This report assumes the stabilization and maintenance process at Sandia will be completed by FY 2018. Funding profiles and facility activities were generated through parametric modeling, using data from other Department of Energy facilities.

Nuclear Material and Facility Stabilization Activities Cost Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	2005	2010	2015	2020	2025	2030	Life Cycle*
Nuclear Material and Facility Stabilization		4,241	2,934	1,355	569			45,493

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

ENVIRONMENTAL RESTORATION

The Environmental Restoration program is responsible for assessing and cleaning up environmental contamination at Sandia that has occurred from a wide variety of historical activities. The principal contamination sources include firings conducted over many years to test weapons and weapons components; discharges of radioactive liquids and hazardous chemicals; oil spills; disposal of radioactive waste and hazardous chemicals in landfills; rocket launches; and burning of certain wastes, such as high explosives. The wide range of contaminated facilities includes reactors, artillery ranges, and scrap yards. Based on current knowledge, these contaminated or potentially contaminated sites identified for assessment and possible remediation pose no known immediate threat to either workers or the local public. See the site map for environmental restoration activity locations. See the Site Map for Environmental Restoration program activity locations.

Environmental restoration activities at Sandia began formally in 1984. The Department identified 117 sites with potential

contamination. The U.S. Environmental Protection Agency conducted a similar investigation in 1987. These programs ultimately defined a working inventory of potential "solid waste management units" that are included in Sandia's Part B operating permit issued by the Environmental Protection Agency under the Hazardous and Solid Waste Amendments of the Resource Conservation and Recovery Act. The Region VI Office of the Environmental Protection Agency presently regulates the Sandia Environmental Restoration Project. This report expects Hazardous and Solid Waste Amendments authority will be granted to the Environment Department of the State of New Mexico in FY 1996.

Current investigations are intended to determine the nature and extent of hazardous and radioactive contamination and to restore sites where such contamination poses a threat to human health or the environment. During FY 1995, Sandia submitted 65 sites for Proposed No Further Action status, had 13 No Further Actions approved as modifications to the Resource Conservation and Recovery Act Part B permit, and conducted 37 voluntary corrective measures. A number of new potential release sites have been identified, including 20 septic systems that are being added to Sandia's Part B permit.

The cost estimate still assumes 41 sites will be remediated following the full corrective measures process. It also assumes all other sites require No Further Action or they can be remediated using the voluntary-corrective-measures process. All costs associated with treating, storing, and disposing of waste generated by environmental restoration activities are included in the remedial action estimates.

The primary treatment, storage, and disposal strategy at Sandia includes establishing a Temporary Unit (permitted by the Environmental Protection Agency) in FY 1996 for storing hazardous waste for up to one year, followed by a Corrective Action Management Unit (also permitted by the Environmental Protection Agency).

For hazardous waste at excavated sites, which this report assumes to be all but the mixed waste landfill and certain vadose zone plumes, activities will include site preparation (clearing and grubbing), followed by excavation and landfill disposal. Toxic metals will be immobilized prior to landfill disposal in the permitted Corrective Action Management Unit.

For radionuclides and metals, activities will include site preparation, followed by excavation. Soil washing to remove metals and reduce volumes will be performed when practicable before landfill disposal, which this report assumes will be done at the Nevada Test Site.

For mixed radionuclides and organics or radionuclides with metals and organics, activities will include site preparation, followed by excavation. The waste will be treated, using low-temperature thermal desorption and soil washing (when practicable), and then disposed as hazardous waste in the onsite Corrective Action Management Unit or as low-level waste at the Nevada Test Site.

The Department plans to dispose of treatment concentrate residues offsite in commercial disposal facilities. It will dispose of "clean" nonregulated residues onsite, probably as fill material. It will ship low-level radioactive waste offsite to the Nevada Test Site or to an approved commercial facility. Other waste, such as polychlorinated biphenyls, will be treated and disposed offsite.

During FY 1995, Sandia implemented a site-based Environmental Restoration program, effectively eliminating artificial geographic segregations of sites into operable units. Consequently, Sandia no longer uses any geographic subgroupings. However, to maintain consistency with last year's report, this report delineates cost by operable unit.

Major Environmental Restoration Activity Milestones

TASK	COMPLETION DATE Fiscal Year
North Technical Area Landfill Corrective Measure	1997
Firing Range Remediation	2001
Thunder Range Remediation	2003
South Technical Area Remediation	2005

North Technical Areas

ASSESSMENT

The North Technical Areas include Technical Areas I and II and seven buildings that require decommissioning. Technical Area I, which contains office buildings and laboratories and houses most of Sandia's staff, has been in existence since 1945. It contains 15 environmental restoration sites, including a motor pool, a tank farm, a waste oil tank, a reclamation yard, a wastewater treatment plant, an acid-waste sewer line, and miles of sanitary sewer lines. Potential contaminants include petroleum hydrocarbons, polychlorinated biphenyls, heavy metals, radionuclides, and organic compounds. Initial soil sampling indicates contaminants such as petroleum-fuel hydrocarbons and heavy metals are restricted to the soils above the water table. The depth to ground water is approximately 146 meters (480 feet).

Technical Area II is an active 17-hectare (43-acre) explosives testing facility. Potential sources of contamination include a chemical disposal pit, a radioactive waste landfill, a classified waste landfill, seven septic systems, a storage yard for radioactive materials, a decommissioning site, uranium calibration pits, firing sites, and an explosives burn pit. Sampling to date indicates contamination with volatile and semivolatile organic compounds, high explosive compounds, polychlorinated biphenyls, and radionuclides. Contamination is mainly confined to the surface soils, but trace trichloroethylene (a chlorinated solvent) was found recently in perched ground water. The contamination is well below risk-based action levels, but bears additional evaluation to identify its source. The depth to ground water is approximately 91.5 meters (300 feet).

The Department has conducted preliminary site characterization in both Technical Areas. In FY 1995, assessment activities focused on completing characterization (including surface and subsurface geophysical and environmental investigations); conducting voluntary corrective measures at Buildings 838 and 839 in Technical Area I and at site 114 in Technical Area II, and carrying out remediation activities.

The Department will use the one-pass voluntary corrective measure approach to assess and remediate the remaining sites. In this approach, assessment work will be limited to sampling in sufficient detail to allow safe remediation. When necessary, corrective measures will be implemented in concert with the limited assessment activities. At the conclusion of the combined assessment/remediation process, verification samples will be taken to ensure cleanup objectives have been achieved. The Department will then submit a modified Resource Conservation and Recovery Act Facility Investigation report that includes voluntary corrective measure results and verification sampling data to the regulatory authorities, with a request for No Further Action (Class III Permit Modification).

Eighteen sites will be assessed in 1996. If contaminants are found to be below levels of regulatory concern, the Department will submit a request for approval of No Further Action. One landfill will undergo a voluntary corrective measure that will start in FY 1996 and conclude in FY 1997.

In FY 1995, remediation activities included completing voluntary corrective measures at Buildings 838 and 839 in Technical Area I and at site 114 in Technical Area II, and carrying out remediation activities. As described above, the one-pass assessment and corrective action approach will be implemented for the 18 remaining sites.

Several buildings and structures have been identified as posing potential, though not immediate, risk to human health and the environment (e.g., Building 863 in Technical Area I and Buildings 901, 906, 907, 919, 935, and 940 in Technical Area II). Although the Department will eventually need to decommission these buildings, current Department of Energy/Environmental Management funding levels have precluded quantifying the total scope of stabilization and deactivation.

The estimate assumes Environmental Management program activities in this area will generate 30 cubic meters (39 cubic yards) of low-level waste, 54 cubic (71 cubic yards) of low-level mixed waste and 5,784 cubic meters (7,565 cubic yards) of hazardous waste.

South Technical Areas

South Technical Areas include Technical Areas III and V, the chemical waste landfill, the mixed waste landfill, and the liquid waste disposal system. The Department has used technical Areas III and V, which consist of about 770 hectares (1,920 acres), to test nuclear and nonnuclear weapons components since 1953. These areas contain 20 active and inactive environmental restoration sites, including burial sites, oil spills, sump and drain releases, two rocket sled tracks, storage and salvage yards, and a gas cylinder disposal pit. Contamination, which includes volatile organic contaminants, semivolatile

organic contaminants, metals, high explosive compounds, polychlorinated biphenyls, and radionuclides, is mainly restricted to the soils above the water table.

At the chemical waste landfill, which covers about 0.76 hectares (1.9 acres), approximately 15,300 cubic meters (20,000 cubic feet) of chemical and hazardous waste was buried in unlined pits and trenches from 1962 to 1985. The depth to ground water is approximately 152 meters (500 feet). Trichloroethylene has been detected in ground water at very low levels, but at levels high enough to warrant additional assessment and possible remedial action. Chromium has also been detected, but it may be a natural constituent of the ground water. In FY 1995, a section of the chemical waste landfill was made available for an Office of Technology Development pilot test for Thermally Enhanced Vapor Extraction System technology. The test concluded near the end of FY 1995 and results are still being analyzed.

At the mixed waste landfill, which consists about 1 hectare (2.6 acres), approximately 2,800 cubic meters (3,700 cubic feet) of low-level radioactive waste was buried in unlined pits and trenches from 1959 to 1988. The depth to ground water is approximately 152 meters (500 feet). Contamination from volatile organic compounds and tritium is restricted to the vadose zone sediments above the water table.

Between 1963 and 1971, the liquid waste disposal system, which consists of a below-grade drain field, three holding tanks, and two surface impoundments, received liquid radioactive discharges from the Sandia Experimental Reactor Facility. This reactor cooling water included short-lived radioactive elements from activation products. Extensive sampling of ground water and soils at this site shows the radiation level is not higher than that of the natural background. At one of the surface impoundments, polychlorinated biphenyls are present in sludge. Trichloroethylene has been found in ground water near the liquid waste disposal system at levels slightly above detection limits.

The remaining sites will undergo assessment and remediation using the one-pass voluntary corrective measure approach. Assessment work will be limited to sampling in sufficient detail to allow safe remediation. When necessary, corrective measures will be implemented in concert with the limited assessment activities. At the conclusion of the combined assessment/remediation process, verification samples will be taken to ensure that cleanup objectives have been achieved. The Department will then submit a modified Resource Conservation and Recovery Act Facility Investigation report that includes voluntary corrective measure results and verification sampling data to the regulatory authorities, with a request for No Further Action (Class III Permit Modification).

Depleted uranium, scattered along both rocket sled tracks, was removed from the short sled track in October 1994 and the long sled track in early 1995. Also in FY 1995, a voluntary corrective measure at the gas cylinder disposal pit involved the removal of gas cylinders, thermal batteries, and various debris. Future remediation activities in the South Technical Areas will include a voluntary corrective measure at the chemical waste landfill beginning in mid-FY 1996 to remove the source terms for trichloroethylene and other possible contaminants. This estimate assumes remediation activities in these areas will be complete in FY 2005. The estimate also assumes Environmental Restoration program activities will generate 10 cubic meters (13 cubic yards) of low-level waste, 847 cubic meters (1,108 cubic yards) of low-level waste, and 34,585 cubic meters (45,234 cubic yards) of hazardous waste.

Firing Ranges

Sites of concern at the Firing Ranges include septic tanks and drain fields and the Foothills, Canyons, and Central Coyote Test Areas. Twenty-three environmental restoration sites have been identified for the 42 separate septic and drainage systems scattered across the Sandia site. These systems were used mainly for liquid and sanitary waste and are currently being evaluated for chemical contamination. From 1958 to 1991, they received waters from facilities conducting weapons components tests. Potential contaminants, most likely restricted to the vadose zone sediments, include radionuclides, solvents, high explosive compounds, metals, and photochemicals. The depth to ground water varies from approximately 15 to 150 meters (50 to 500 feet). It is shallower toward the mountains in the east.

The Foothills Test Area, which consists of 10 inactive environmental restoration sites, has been used for field testing since the late 1950s. A wide range of contaminants, including organic compounds, metals, high explosive materials, and radionuclides may be present. The depth to ground water across the area probably varies from 15 to 30 meters (50 to 100 feet).

The Canyons Test Area consists of 14 environmental restoration sites (9 active, 5 inactive) and 4 proposed sites at scattered locations within three large canyons in the Manzanita Mountains at the eastern end of the Kirtland Air Force Base, on land

withdrawn from the U.S. Forest Service. Potential sources of contaminants include burn sites, rocket-launch sites, dumps, and a surface impoundment. Principal contaminants include depleted uranium, metals, jet fuel, and other organic compounds. The depth to ground water is estimated to vary across the area from 15 to 30 meters (50 to 100 feet).

The Central Coyote Test Area contains 14 inactive sites that include six test sites, two burn sites, an artillery range, a trash dump, a borrow pit, two scrap yards, and an unstaffed seismic observatory. The principal contaminants include residual high explosive compounds, metals (including depleted uranium), jet fuel, other volatile organic compounds, and asbestos. The depth to ground water across the area is estimated to vary from 15 to 30 (50 to 100 feet).

The Department will use the one-pass voluntary corrective measure approach to assess and remediate the remaining sites. Assessment work will be limited to sampling in sufficient detail to allow safe remediation. When necessary, corrective measures will be implemented in concert with the limited assessment activities. At the conclusion of the combined assessment/remediation process, verification samples will be taken to ensure that cleanup objectives have been achieved. A modified Resource Conservation and Recovery Act Facility Investigation report that includes voluntary corrective measure results and verification sampling data will then be submitted to the regulatory authorities with a request for No Further Action (Class III Permit Modification).

Future remediation activities at the firing ranges will include voluntary corrective measures and remediation. Voluntary corrective measures have been or will be carried out at the following sites: septic tanks and drain fields; sites 58 and 8, Building 9990, and the TRUPACT "boneyard" in the Foothills Test Area (the "boneyard" is a storage area for the remnants of the TRUPACT transportation casks for transuranic waste that were subjected to various destructive tests); sites 10 and 60 in the Canyons Test Area; and sites 11, 47, 57B, 68, 21, and 22 in the Central Coyote Test Area. This report assumes assessments for all areas will be complete in FY 2001 and remediation activities will be complete in FY 2001. Activities are assumed to generate 3,968 cubic meters (5,200 cubic yards) of hazardous waste, 198 cubic meters (260 cubic yards) of low-level mixed waste and 318 cubic meters (416 cubic yards) of low-level waste.

Thunder Range

Thunder Range includes projects in the Tijeras Arroyo and the Southwest Test Area. The Tijeras Arroyo has 17 environmental restoration sites (7 active, 10 inactive) distributed over several miles of the arroyo and its tributaries that together drain thousands of hectares of the Kirtland Air Force Base and the Sandia site. The main channel, which is approximately 30 meters (100 feet) deep and 1.6 kilometers (1 mile) wide, empties into the Rio Grande River less than 3.2 kilometers (2 miles) from the Sandia site boundary. A wide range of contaminants, including metals, radionuclides, and organic compounds may be present in low concentrations. The depth to ground water is estimated to be about 150 meters (500 feet).

The Southwest Test Area, which has been used for field testing explosives since the 1960s, contains 24 environmental restoration sites (11 inactive, 13 active). A wide range of contaminants such as metals, high explosive compounds, radionuclides, and organic compounds may be present. The depth to ground water is approximately 150 meters (500 feet).

The Department has conducted preliminary site characterization. There are nine No Further Action sites, and two voluntary corrective measures are planned to be completed during FY 1996. The estimate assumes all assessments will be completed in FY 2001 and remediation activities for all sites in this area will be complete in FY 2003. This report also assumes Environmental Restoration program activities will generate 35,288 cubic meters (46,153 cubic yards) of low-level waste, 645 cubic meters (844 cubic yards) of low-level mixed waste and 1,959 cubic meters (2,562 yards) of hazardous waste.

The Department will use the one-pass voluntary corrective measure approach to assess and remediate the remaining sites. Assessment work will be limited to sampling in sufficient detail to allow safe remediation. When necessary, corrective measures will be implemented in concert with the limited assessment activities. At the conclusion of the combined assessment/remediation process, verification samples will be taken to ensure that cleanup objectives have been achieved. A modified Resource Conservation and Recovery Act Facility Investigation report that includes voluntary corrective measure results and verification sampling data will then be submitted to the regulatory authorities with a request for No Further Action (Class III Permit Modification).

Site-Wide Characterization

This project seeks to integrate regional, rather than site-specific, geologic and hydrologic information into a sitewide hydrogeologic framework for all the environmental restoration sites distributed across the Kirtland Air Force Base and the Sandia site. This project does not include responsibility for characterizing or remediating individual environmental restoration sites. The resulting framework will be used as the primary basis on which to evaluate site-specific information with respect to natural elemental background concentrations and to complete risk assessments. The estimate assumes this activity will be complete in 2001.

Temporary Unit/Corrective Action Management Unit

In late FY 1995, the Sandia Environmental Restoration Project added a new baseline work scope for the permitting, design, construction, and operation of a Temporary Unit, to be completed in FY 1996, for short-term storage of waste generated by the Environmental Restoration Project, and a Corrective Action Management Unit, scheduled to be operational in FY 1997 for long-term management of Environmental Restoration waste, including treatment of hazardous waste. The Corrective Action Management Unit will remain active until the Environmental Restoration Project ends. At that time, if the resulting disposal cells are built, they will be capped and the surface facilities will be decommissioned. The Temporary Unit and Corrective Action Management Unit can only be used for only hazardous waste generated by the Environmental Restoration Project. The Temporary Unit permit is for one year only. After that, if it is approved by the regulatory authority, it will be incorporated into the Corrective Action Management Unit. This unit will close in FY 1996 and there will be no long-term surveillance and monitoring activities associated with the unit.

Offsite Areas

Pending approval of No Further Action requests, this estimate assumes no additional work will be required by Environmental Management at Offsite Areas. Stabilization, treatment, storage, disposal, and surveillance and monitoring activities are not applicable to the Offsite Areas project.

Environmental restoration activities at the Tonopah Test Range have been formally transferred to the Nevada Operations Office and costs for these activities are included within the Nevada estimate. No further environmental restoration activities are expected at the Kauai Test Range. However, waste management activities associated with testing at these two sites are the responsibility of Sandia.

The Kauai Test Facility is located on the western coast of the island of Kauai in Hawaii within the Navy's Pacific Missile Range Facility. The 73-hectare (182-acre) site is operated by Sandia National Laboratories/New Mexico and supports Department of Energy research and development activities, including rocket launches of nonnuclear payloads. The Kauai Test Facility has been in operation since the mid-1970s, conducting an average of three or four tests per year. The Department suspected contamination in three potential release sites that include the rocket launch pads, a drum storage area, and a photography laboratory. In 1994, the Department conducted soil and ground-water sampling to determine the extent of contamination. Results proved below regulatory concern and a No Further Action report was submitted to the regulators. Regulators have verbally agreed to this approach and formal documentation is expected in the near future. Therefore, this report does not anticipate any further work for Kauai and includes no costs for further environmental restoration activities.

Salton Sea Test Base, located in Imperial County, California was used for Atomic Energy Commission/Sandia National Laboratories test activity from the mid-1940s through the early 1960s. Test activity in these years contributed to environmental contamination at approximately 23 sites within Salton Sea Test Base. The test base is a Comprehensive Environmental Resource Compensation and Liability Act site and is the subject of accelerated base realignment and closure activity to return properties to local communities. None of these sites was determined to be related to activities undertaken by Sandia National Laboratories; therefore, a request has been made to remove Sandia from the list of potentially responsible parties.

The Sandia Offsite Areas also include one building at Holloman Air Force Base in southern New Mexico where laboratory activities generated a variety of waste. The Department plans to turn over this site to the U.S. Air Force for any future action. Assessment activities are assumed to be complete in FY 1996.

Environmental Restoration Activities Cost Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	2005	2010	2015	2020	2025	2030	Life Cycle*
Offsite - Holloman Air Force Base								
Assessment	14							71
North Technical Areas								
Assessment	195	689		173	490			7,731
Remedial Action	618	11,706						61,621
Facility Decommissioning	828	122		575	1,633			15,791
Sitewide Characterization								
Assessment	574	32						3,028
South Technical Areas								
Assessment	1,022							5,111
Remedial Action	1,088	5,492						32,897
Thunder Range								
Assessment	432	18						2,247
Remedial Action	674	188						4,310
Firing Ranges								
Assessment	1,074	18						5,459
Remedial Action	1,405	19						7,117
Corrective Action Management Unit	2,295	2,657						24,758
Long-Term Surveil. and Monitoring	328	7						1,677
Direct Program Management/Support	7,499	4,054		83	236			59,360
Total	18,045	25,000		831	2,359			231,178

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

Current plans call for implementing surveillance and monitoring activities at sites where potential for future contaminant migration to the water table cannot be dismissed or mitigated. Examples include historic landfills that are capped and sites with known releases. Whenever feasible, the source(s) of released contamination will be removed as part of the remedial action prior to closure and surveillance and monitoring. Surveillance and monitoring activities will be conducted in accordance with requirements of the Resource Conservation and Recovery Act and regulatory agencies, typically for a 30-year period after the completion of remedial action. However, this estimate includes long-term surveillance and monitoring costs only to FY 2000.

Direct Program Management/Support

General program support activities are those functions critical but ancillary to the mission of the Environmental Management programs at Sandia. They include strategic planning, program management, quality assurance, administrative support, information services, training, facilities management/engineering and maintenance, safeguards and security, logistics support, utilities, procurement, contract management, legal support, and human resources. Specific program support activities include environmental safety and health, permitting, regulatory compliance, waste minimization/pollution prevention, technology development, and stakeholder-related and information/outreach activities.

Most program management support activities for Sandia's Environmental Restoration program are integrated within the Environmental Operations Center, an organizational element of the Laboratories Services Division. These support activities include project management systems (project controls), stakeholder involvement, information management services (records, technical reference, computer resources, financial affairs), and compliance assessment/regulatory support (legal support, audit management). Other centers within the Laboratories Services Division provide additional program

management support activities. Examples include strategic planning, emergency management, security and safeguards, facilities planning, facilities construction, health and safety oversight, and shipping and receiving.

STAKEHOLDER INTERACTIONS

The Albuquerque Operations Office conducted public participation activities for the following New Mexico sites: Inhalation Toxicology Research Institute, Los Alamos National Laboratory, Sandia National Laboratories (and Holloman Air Force Base), South Valley Site, Albuquerque Operations Office, and the Waste Isolation Pilot Plant (and National Transuranic Waste Program Office). Stakeholder activities included a presentation on basic information concerning costs and activities at the sites at the Quarterly Environmental Restoration/Waste Management Public Meeting and a briefing to the Sandia National Laboratory/Department of Energy/Inhalation Toxicology Research Institute Citizens Advisory Board. No site-specific activities were conducted at the Waste Isolation Pilot Plant due to that site's pre-disposal status. If you would like more information about the report or have questions about the results for these sites, please contact:

Albuquerque Operations Office **Public Participation** Chris Houston (505)845-5483 chouston@doeal.gov	**Technical Liaison** Jim Orr (505) 845-4734 jorr@doeal.gov	**Public Affairs** Tami Toops (505) 845-5264 ttoops@doeal.gov

WASTE MANAGEMENT

Sandia produces waste from a variety of sources. As of May 1995, the laboratories included over 1,000 active waste generators, 902 for hazardous waste, 105 for radioactive waste, and 25 for mixed waste. Most produce small quantities of waste associated with ongoing mission-related research and development activities. Other sources include nuclear material and facility stabilization waste, historical inventory, and other Department of Energy facilities (e.g., the Inhalation Toxicology Research Institute and Sandia/California). Additional radioactive and hazardous waste will be generated by Sandia's Neutron Generator Production Program and its Medical Isotope Production Program, which are expected to come on line in FY 1996 and FY 1997, respectively.

The Offices of Environmental Management and Defense Programs provide funding to manage Sandia's waste. Defense Programs is responsible for funding Sandia's solid waste facilities (See site map for location of waste management facilities). Both Environmental Management and Defense Programs provide overhead funds to manage waste operations associated with weapons waste, including neutron generators and solid waste. In addition, the Office of Nuclear Energy will be responsible for funding the Medical Isotope Production Program and associated waste Environmental Management is responsible for funding Sandia's transuranic waste; low-level waste; low-level mixed waste; hazardous waste, including polychlorinated biphenyls, asbestos, and explosives; and special case waste. As noted in their respective discussions, all treatment, storage, and disposal costs for nuclear material and facility stabilization activities are included in the Waste Management program estimates. All treatment, storage, and disposal costs associated with cleanup are contained in the Environmental Restoration estimates.

Sandia has no high-level waste or spent nuclear fuel. Because the Office of Defense Programs is responsible for solid waste (industrial and commercial sanitary solid waste), lead/reapplication, medical waste, and other waste (oil, non-regulated waste, weapons waste) at Sandia, these waste streams are not included within the scope of this estimate.

In recent years, Sandia has constructed facilities to handle hazardous, radioactive, and mixed waste; initial operational capability for these facilities will be achieved during FY 1996. Subsequent full capability is expected by FY 1999. FY 1996 facilities activities include the startup of operations at the Radioactive/Mixed Waste Management Facility and the initial phases of upgrades to this facility to accommodate mobile treatment units to treat waste in accordance with the Site Treatment Plan Compliance Order. The Department will maintain and upgrade all waste treatment and storage facilities to comply with applicable regulations. Equipment for treating industrial wastewater and low-level waste will also be maintained, and capital equipment will be purchased as needed. Activities for outyears to FY 2070 will include pursuing new and existing treatment options for low-level mixed waste, updating the equipment for the mobile treatment units, and maintaining or upgrading existing treatment facilities as needed.

To facilitate risk- and cost-reduction within the Waste Management program, Sandia developed a Waste Minimization/Pollution Prevention Program with the objectives of eliminating or minimizing the generation of waste through source-reduction techniques, identifying recycling options for waste materials that cannot be eliminated or minimized, and identifying treatment options to reduce volume, toxicity, or waste mobility prior to storage or disposal. Waste minimization activities include conducting Pollution Prevention Opportunity Assessments to identify viable pollution reduction alternatives, creating a Chemical Information System to track the purchase and use of all chemicals, using a Pollution Prevention Team to enhance employee awareness, promoting source reduction and recycling initiatives, and establishing a chargeback system that taxes waste generators to fund pollution prevention implementation.

Major Waste Management Activity Milestones

TASK	COMPLETION DATE Fiscal Year
Radioactive and Mixed Waste Management Facility	1996
Mixed Waste Sort and Survey Project	1996
Low-Level Waste Treatment Development	1999
Begin Low-Level Mixed Waste Treatment	2010

Transuranic Waste

GENERATION AND HANDLING

Transuranic waste contains radionuclides with an atomic number greater than uranium, a half-life greater than 20 years, and alpha activity exceeding 100 nanocuries per gram of waste. Sandia manages transuranic waste operations with support from a commercial subcontractor. The Inhalation Toxicology Research Institute, operated for the Department of Energy Biomedical and Environmental Research Institute in Albuquerque, generates most of Sandia' s transuranic waste. In April 1995, Sandia was directed by the Department of Energy to accept the Institute's transuranic waste to consolidate storage and reduce redundant waste management costs. On May 10, 1995, 26 drums containing 5.45 cubic meters (7.35 cubic yards) were accepted and transported to Sandia. The 26 drums were transported to the Manzano Bunkers on Kirtland Air Force Base for storage pending disposal at the Waste Isolation Pilot Plant.

Annual generation of transuranic waste is expected to remain at very low levels not exceeding one drum (0.2 cubic meter [.27 cubic yards]) per year from the Research Institute and one drum from ongoing Sandia mission work.

TREATMENT

No sampling or treatment of transuranic waste is scheduled to be performed at Sandia. However, according to Sandia's Site Treatment Plan for Mixed Waste, mixed transuranic waste will to be processed and certified to meet the Waste Isolation Pilot Plant waste acceptance criteria by December 31, 2010.

STORAGE

Currently, Sandia stores approximately 5.5 cubic meters (7.1 cubic yards) of transuranic waste at the Manzano Facility. Annual additions are expected to remain low, not exceeding one drum (.2 cubic meter [.3 cubic yards]) per year from the Institute and one drum from ongoing Sandia work. The Department will periodically inspect and certify stored waste, as required, until FY 1998 when the Waste Isolation Pilot Plant near Carlsbad, New Mexico, will begin to receive transuranic waste.

DISPOSAL

This report assumes Sandia's transuranic waste will be disposed at the Waste Isolation Pilot Plant near Carlsbad, New Mexico. Stored transuranic waste is not expected to be disposed until FY 2009. Mixed transuranic waste is scheduled for disposal by FY 2011. This estimate assumes 5.4 cubic meters (7.0 cubic yards) of waste will be disposed until the current backlog is worked off.

Transuranic waste from both the Inhalation Toxicology Research Institute and Sandia activities is packaged in accordance with Department of Transportation regulations and Department of Energy Orders and transported to the Manzano Bunkers for storage. Eventually, the Department will use overland truck transporters to ship transuranic waste to the Waste Isolation Pilot Plant for deep geologic disposal. The Waste Isolation Pilot Plant estimate includes the cost for transporting and disposing all transuranic waste. The Sandia estimate includes costs to characterize and package the waste in order to meet the Waste Isolation Pilot Plant waste acceptance criteria.

Low-Level Mixed Waste

GENERATION AND HANDLING

Low-level mixed waste is waste that contains both radioactive and hazardous components as defined by the Atomic Energy Act and the Resource Conservation and Recovery Act. Sandia manages mixed waste operations with support from a commercial subcontractor. Waste Operations crews collect the waste, complete the generator location verification form, and apply bar code labels. The Disposal Request Forms/Travelers are used for onsite transportation documentation. The waste is delivered to the High-Bay Waste Storage Facility for storage, pending treatment in accordance with the Site Treatment Plan Compliance Order issued on October 4, 1995, by the State of New Mexico.

Mission-related activities generate approximately 4.8 cubic meters (6.3 cubic yards) of mixed waste each year. Additional volumes will be generated by the removal of radioactive legacy waste, the decontamination of the Hot Cell Facility to prepare for startup of the Medical Isotope Production Program in FY 1997, and other decommissioning activities.

Culminating a three-year process in response to the Federal Facility Compliance Act, the State of New Mexico issued an Order implementing Sandia's *Site Treatment Plan for Mixed Waste* on October 4, 1995. This plan consolidates Sandia's 192 mixed waste streams (as listed in the Mixed Waste Inventory Report) within 16 treatability groups, simplifying tracking and reducing reporting time. During FY 1996, Sandia will complete a Mixed Waste Sort and Survey Project that began in FY 1995 to validate all historical mixed waste, reduce inventory wherever possible, and assign waste to approved treatability groups.

LOW-LEVEL MIXED WASTE SUCCESS STORY
Within the first three months of the Mixed Waste Sort and Survey Project, Sandia validated 954 batteries as nonradioactive and removed them from the mixed waste inventory. This activity saved approximately $500,000.

As a further cost- and time-reducing measure, Sandia transferred Sandia/California's mixed waste to its New Mexico site. This transfer avoided the necessity of a separate California-based Site Treatment Plan and reduced planning and reporting requirements because Sandia will have to report on only one site to one state. Sandia/California shipped approximately 15 cubic meters (20 cubic yards) of mixed waste to Sandia/New Mexico; additional small volumes will be shipped periodically in the future.

TREATMENT

The Site Treatment Plan provides overall schedules for achieving compliance with Land Disposal Restriction requirements for treatment and storage of mixed waste. The plan includes a schedule for the submittal of permit applications, construction of treatment facilities, technology development, offsite transportation for treatment, and the treatment of mixed waste. Annual updates to the plan are due March 31 of each year. Implementation of the plan incorporates an integrated approach that relies heavily on the treatment capacity being developed at the Mobile Treatment Units at Sandia and other Department of Energy sites. Preferred treatment options include deactivation, macroencapsulation, neutralization followed by stabilization, amalgamation, incineration, thermal desorption, deactivation followed by stabilization, evaporative oxidation, oxidation, and hydrothermal processing. All historical low-level mixed waste at Sandia is scheduled to be treated by May 10, 2002. After treatment, this waste will become either low-level or hazardous waste for certification, transportation, and disposal.

Sandia also has approximately 0.4 cubic meters (0.5 cubic yards) of suspect mixed transuranic waste. For this waste, the Site Treatment Plan provides a treatment development milestone of June 30, 1999, and a treatment milestone of December 31, 2010.

The Radioactive and Mixed Waste Management Facility, expected to start operations in January 1996, will provide the means to open, treat, and repackage low-level mixed waste. Treatment capacity will vary with the treatment process, but the facility may accommodate 55 cubic meters (72 cubic yards) of low-level and low-level mixed waste per year.

TECHNOLOGY DEVELOPMENT

Because of Sandia's relatively small volumes of waste, it relies primarily on commercial technologies to meet waste management needs. However, when treatment methods are unavailable or difficult, Sandia supports technology development. The site performs treatability studies and participated in the design and construction of the Department of Energy's packed-bed reactor Mobile Treatment Unit, which will be moved from site to site to treat low-level mixed waste in compliance with the Federal Facility Compliance Act of 1992.

STORAGE

Over 65 cubic meters (85 cubic yards) of low-level mixed waste are currently in storage at Sandia. The waste is packaged according to specific mixed waste requirements, stored, and inspected on a regular basis. Both the High-Bay Waste Storage Facility (Building 6596) and the Chemical Waste Storage Facility (Building 920) are used for mixed waste storage.

After assessment, Sandia expects approximately 80 percent of currently generated mixed waste will be placed into temporary storage and subsequently certified for transportation to a commercial treatment and disposal facility; 20 percent will be retained onsite for treatment, using methods prescribed in the Site Treatment Plan.

DISPOSAL

Waste that has been treated and separated into its radioactive and hazardous components will be disposed according to the methods described under radioactive (or transuranic) and hazardous waste respectively. Approximately 32 cubic meters (42 cubic yards) will be transferred to the Sandia, New Mexico facility from Sandia National Laboratory-California with the remaining 1.5 cubic meters (2 cubic yards) assumed by this life-cycle estimate being shipped to offsite commercial disposal facilities.

Low-Level Waste

GENERATION AND HANDLING

Low-level waste is generated by almost all Sandia activities involving radioactive material and exists in a variety of forms such as contaminated paper, plastic, rubber, organic matter, aqueous liquids, and sludges. Sandia manages low-level waste operations with support from a commercial subcontractor. The waste is then identified, classified, and collected. If necessary, it is sampled, and routed as required for radiography at the Real-Time Radiography Facility or assay at the Waste Assay Facility. It is then minimally treated and either stored or packaged, certified, and transported to the Nevada Test Site or other facility for disposal.

Ongoing low-level waste generation has averaged approximately 51 cubic meters (67 cubic yards) per year over the past six years. In the near future, the following new production and special generation activities will significantly increase this annual generation figure.

TREATMENT

Sandia has conducted limited treatment of its low-level waste. The Radioactive and Mixed Waste Management Facility is expected to start operating in FY 1996 and will provide the means to open, treat, and repackage low-level waste. Potential

treatment processes include screening, crushing, shredding and baling, compaction, and solidification. Treatment capacity will vary with the treatment process, but the facility may accommodate 55 cubic meters (72 cubic yards) of low-level and low-level mixed waste per year.

STORAGE

Currently, low-level waste is transported to an interim storage site. After Sandia's Radioactive/Mixed Waste Management Facility comes on-line during FY 1996, the Department will transport stored waste, as well as newly generated waste, to the new facility. Waste is sampled as needed and routed as required for radiography at the Real-Time Radiography Facility or assay at the Waste Assay Facility. It is then stored, pending packaging, certification, and transportation, to the Nevada Test Site or other facility for disposal.

Over 314 cubic meters (411 cubic yards) of low-level waste is currently in storage at Sandia. Additional storage volumes will be accumulated by Sandia because no regulatory driver exists and funding reductions preclude treatment and disposal of low-level waste. Storage volumes will increase significantly, perhaps by as much as 15,000 cubic meters (19,650 cubic yards) by FY 2000.

DISPOSAL

During FY 1995, permission was given to ship low-level waste to the Nevada Test Site for disposal, culminating a three-year process to meet the Waste Acceptance Criteria. Sandia sent the first shipment on September 25, 1995.

Sandia will ship additional waste to the Nevada Test Site during FY 1996 and FY 1997. But from FY 1998 until FY 2009, Sandia will only store low-level waste. In FY 2009, as funding is shifted from the completed Environmental Restoration program to the Waste Management program, Sandia will resume disposal of accumulated waste and complete the process by 2021.

The Sandia disposal estimate includes transportation from collection through disposal activities. It engages commercial support contractors to conduct these operations on a daily basis. The estimate assumes 45,134 cubic meters (59,031 cubic yards) of waste will be generated.

Hazardous Waste

GENERATION AND HANDLING

Sandia separates its Environmental Management-funded hazardous waste into four waste streams: chemical, polychlorinated biphenyls, asbestos, and explosive waste. Chemical waste refers to regulated solid, liquid, or gaseous chemical waste regulated by the Resource Conservation and Recovery Act, but does *not* include radioactive or low-level mixed waste. Polychlorinated biphenyl waste and asbestos waste are regulated by the Toxic Substances Control Act and by Sandia requirements. Explosive waste is regulated by Department of Energy Orders and by the requirements of the Occupational Safety and Health Administration, the Resource Conservation and Recovery Act, the Department of Transportation, and the New Mexico Environment Department.

Research and development activities at Sandia's numerous small laboratories generate hazardous waste. These activities result in approximately 12,000 unique waste stream identification numbers. Polychlorinated biphenyl waste is generated by ongoing decontamination and decommissioning activities and by special projects, including the removal of transformers and ballasts associated with the site-wide revamping and power modernization efforts, which will continue through FY 2000. Asbestos waste is generated within two categories: facilities (waste generated by building abatement and the decontamination project) and nonfacilities asbestos (waste generated by large, high-volume articles such as safes, file cabinets, and laboratory furnaces). Explosive waste includes detonators, bulk explosives and propellants, debris contaminated with explosives, and rocket motors.

Hazardous waste at Sandia is measured by weight rather than by volume. However, for consistency, weights for the following waste streams are followed by estimated equivalent volumes (metric and English). Total projected hazardous waste generation for FY 1996 is 489,036 kilograms (383 cubic meters [502 cubic yards]). Included in this total is 124,907

kilograms (114.1 cubic meters [150 cubic yards]) of chemical waste, 18,200 kilograms (16.9 cubic meters [22.1 cubic yards]) of polychlorinated biphenyls, 202,000 kilograms (134.4 cubic meters [176 cubic yards] of asbestos, 29,429 kilograms (10.7 cubic meters [14 cubic yards]) of explosives, 60,000 kilograms (55.6 cubic meters [73 cubic yards]) of hazardous waste from the Tonopah Test Range in Nevada, 52,500 kilograms (48.6 cubic meters [64 cubic yards]) from the Neutron Generation Production Program, and 2,000 kilograms (1.6 cubic meters [12 cubic yards]) from Decontamination and Decommissioning.

Sandia manages waste operations for chemical waste, polychlorinated biphenyls, and asbestos are managed by Sandia with support from a commercial subcontractor. Sandia's Explosive Ordnance Division directs waste operations for explosives, with subcontractor support for treatment, demilitarization, and sanitization.

TREATMENT

Sandia does not treat its chemical, polychlorinated biphenyl, or asbestos waste. It does, however, treat some of its explosive waste by means of incineration at the Thermal Treatment Facility and at a commercial facility.

STORAGE

All waste regulated by the Resource Conservation and Recovery Act must be disposed within 90 days. Sandia typically disposes of its chemical, polychlorinated biphenyl, and asbestos waste within 30 days. Hazardous chemical waste generated by research, development, and testing activities, as well as polychlorinated biphenyl and nonfacilities asbestos waste, is collected from generator locations, segregated by hazard class, and transported to the Hazardous Waste Management Facility for storage. Facilities asbestos is placed directly into transportation containers at the site.

Sandia also uses offsite storage in bunkers at the Manzano storage complex, which is owned by the Department of Defense. Sandia uses these bunkers for rocket motors, other explosives, classified waste, and demilitarized waste. Approximately 1,100 rocket motors, ranging in weight from less than 50 to over 1000 kilograms, with an estimated total gross volume in excess of 1,052 cubic meters (1,378 cubic yards), are currently in storage at Sandia facilities.

DISPOSAL

As stated above, Sandia's hazardous, polychlorinated biphenyl, and asbestos waste is typically disposed within 30 days. Through its subcontractor, Sandia uses more than a dozen commercial facilities to ensure the wide variety of hazardous waste types are disposed in a timely, safe, and compliant manner. Polychlorinated biphenyl waste is packaged into 0.2 cubic meter (55-gallon) drums and disposed at one of three offsite permitted commercial disposal facilities. Asbestos waste is disposed offsite at a permitted commercial disposal facility. Rocket motors and associated propellants are treated and reclaimed/recycled.

During FY 1995, Sandia dispositioned 2,234 HVAR rocket motors and another 220 HAWK motors. In FY 1996, 766 Falcon rocket motors are scheduled for disposition. Sandia's goal is to disposition all rocket motors before they are declared waste, at which point they become subject to less-than-90-day Resource Conservation and Recovery Act regulations. If this occurs, the Department would have to divert funds earmarked for other waste management activities to cover these costs. Activities are under way to excess the motors by making them available for use by other government agencies.

The Sandia disposal estimate includes transportation to transport waste from collection through disposal activities. It engages commercial support contractors to conduct these operations on a daily basis.

Waste Management Activities Cost Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)							
	FY 1996-2000	2005	2010	2015	2020	2025	2030
Transuranic Waste							
Storage and Handling	63	62	62	62	62	62	62

Low-Level Mixed Waste							
Treatment	240	291	433	646	646	646	646
Storage and Handling	443	604	604	604	604	604	604
Disposal	102	265	821		701	120	
Low-Level Waste							
Treatment	29		57	142	142	142	142
Storage and Handling	418	1,128	1,488	2,028	2,028	2,028	2,028
Disposal	212	37	929		1,001	173	
Hazardous Waste							
Treatment	391	570	570	570	570	570	570
Storage and Handling	608	5,258	5,264	5,272	5,272	5,272	5,272
Disposal	1,939	3,266	3,549	3,974	3,974	3,974	3,974
Direct Program Management/Suppor	6,410	4,636	4,636	4,636	4,636	4,636	4,636
Total	10,856	16,117	18,413	17,934	19,636	18,227	17,934
	FY 2035	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**
Transuranic Waste							
Storage and Handling	62	62	62	62	62	62	62
Low-Level Mixed Waste							
Treatment	646	646	646	646	646	646	646
Storage and Handling	604	604	604	604	604	604	604
Disposal							
Low-Level Waste							
Treatment	142	142	142	142	142	142	142
Storage and Handling	2,028	2,028	2,028	2,028	2,028	2,028	2,028
Disposal							
Hazardous Waste							
Treatment	570	570	570	570	570	570	570
Storage and Handling	5,272	5,272	5,272	5,272	5,272	5,272	5,272
Disposal	3,974	3,974	3,974	3,974	3,974	3,974	3,974
Direct Program Management/Suppor	4,636	4,636	4,636	4,636	4,636	4,636	4,636
Total	17,934	17,934	17,934	17,934	17,934	17,934	17,934
	FY 2070	**2075**	**2080**	**2085**	**2090**	**2095**	**2100**	**Life Cycle***
Transuranic Waste							
Storage and Handling	62						4,655
Low-Level Mixed Waste							
Treatment	646						43,582
Storage and Handling	604						44,496
Disposal	120						10,635
Low-Level Waste							
Treatment	142						8,950
Storage and Handling	2,028						136,850

Disposal	173	12,629
Hazardous Waste		
Treatment	570	41,855
Storage and Handling	5,272	371,969
Disposal	3,974	282,212
Direct Program Management/Suppor	4,636	356,570
Total	18,227	1,314,403

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

Direct Program Management/Support

General Program Support activities are those functions that are critical but ancillary to the mission of the Environmental Management Programs at Sandia. They include strategic planning, program management, quality assurance, administrative support, information services, training, facilities management/engineering and maintenance, safeguards and security, logistics support, utilities, procurement, contract management, legal support, and human resources. Specific program support activities include environmental safety and health, permitting, regulatory compliance, waste minimization/pollution prevention, technology development, and stakeholder-related and information/outreach activities.

Most program management support activities for Sandia's Waste Management Program are integrated within the Environmental Operations Center, an organizational element of the Laboratories Services Division. These support activities include project management systems (project controls), stakeholder involvement, information management services (records, technical reference, computer resources, financial), and compliance assessment/regulatory support (legal support, audit management). Other centers within the Laboratories Services Division provide additional program management support activities. Examples include strategic planning, emergency management, security and safeguards, facilities planning, facilities construction, health and safety oversight, and shipping and receiving.

WASTE MANAGEMENT COST SAVINGS

In its continuing pursuit of cost savings and program efficiency, Sandia has successfully employed "Department of Energy partnerships;" that is, it has made use of program knowledge developed at other Department of Energy sites for Project Controls and Decontamination and Decommissioning; adopted the Idaho National Engineering Laboratory Programmatic Waste Acceptance Criteria, and used various Department of Energy contracts, including the Hazardous Remedial Action Program Decontamination and Decommissioning contract and a Department of Energy/Oak Ridge radioactive waste disposal contract. These cost and other saving initiatives have enabled the Waste Management Program at Sandia to achieve its mission while undergoing a 39 percent reduction in annual funding since FY 1993.

DESCRIPTION OF PERSONNEL

Current Composition

The site personnel table provides a breakdown of current personnel composition for Sandia's Environmental Management programs. This mix includes federal, contractor and subcontractor work force. The federal staff consists of management, administrative, and engineering support. The contractor and subcontractor work force is a mix of professionals and labor that plans and conducts the day-to-day activities at the site.

Full-Time Equivalent Composition Table *

LABOR CATEGORY	FEDERAL FTEs			CONTRACTOR FTEs						TOTAL FTEs		
				DIRECT			INDIRECT					
	1998	1997	1996	1998	1997	1996	1998	1997	1996	1998	1997	1996
General Managers, Exec., Pf. Spec.	0.5	0.5	0.5	8	8	7	0	0	0	7.5	7.5	7.5
Gen. Admin. Bus., and Clerical	0.5	0.5	0.5	23	20	18	21	21	21	43.5	41.5	39.5
Admin. and Other Professionals	0.5	0.5	0.5	39	31	29	17	15	12	56.5	46.5	41.5
Engineers	1	1	1	83	52	48	0	0	0	84	53	49
Scientists	0	0	0	25	21	21	0	0	0	25	21	21
Technicians	0	0	0	58	58	46	0	0	0	58	58	46
Crafts	0	0	0	0	0	0	0	0	0	0	0	0
Laborers and Other Gen. Workers	0	0	0	0.3	0.2	0	0	0	0	0.3	0.2	0
Operators	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	4.5	4.5	4.5	217.3	188.2	164	38	36	33	259.8	228.7	201.5

* The Projections for Full-Time Equivalent employees are based on FY 1996 planning baselines (see Reader's Guide).

Site Management Structure

Sandia has established a Waste Management Project Department and an Environmental Restoration Project Department to oversee Environmental Management-funded and other activities. These departments provide direction to the technical support departments that execute the work scope of these projects.

Sandia's Environmental Management Project relies heavily on subcontractor support. Contract mechanisms include As-Ordered Agreements, Time and Materials technical support contracts, waste operations support contracts, and competitive Task Order contracts. Future contracting mechanisms will further incorporate competitive bidding approaches, and performance award fees.

Sandia Corporation, a Lockheed Martin subsidiary, is the management and operating contractor under a five-year cost-plus contract that includes performance based features. The contract is scheduled to be renewed in FY 1998.

CONTRACTING OPPORTUNITIES

If you would like more information about performing work for the Department of Energys Environmental Management program at this site, please contact:

Major Procurement	**Small Business Procurement**
William Meyers	Greg Gonzales
Director Contracts and Procurement Division	Contracts and Procurement Division
United States Department of Energy	United States Department of Energy
Albuquerque Operations Office	Albuquerque Operations Office
P.O. Box 5400	P.O. Box 5400
Albuquerque, NM 87185-5400	Albuquerque, NM 87185-5400
p: (505) 845-5777	p: (505) 845-6182
f: (505) 845-4210	f: (505) 845-4210

Future Full-Time Equivalent Needs

The Full-Time Equivalent table above provides a breakdown of future personnel needs for Sandia's Environmental Management programs.

FUNDING ESTIMATE

The following two tables present estimated funding information for the Sandia National Laboratories/New Mexico.

Defense Funding Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	2005	2010	2015	2020	2025	2030	
Nuclear Material and Facility Stabilization		4,130	2,857	1,320	554			
Environmental Restoration	18,045	25,000		831	2,359			
Waste Management	10,856	16,117	18,413	17,934	19,636	18,227	17,934	
Total	28,901	45,248	21,269	20,085	22,548	18,227	17,934	
	FY 2035	2040	2045	2050	2055	2060	2065	
Nuclear Material and Facility Stabilization								
Environmental Restoration								
Waste Management	17,934	17,934	17,934	17,934	17,934	17,934	17,934	
Total	17,934	17,934	17,934	17,934	17,934	17,934	17,934	
	FY 2070	2075	2080	2085	2090	2095	2100	Life Cycle*
Nuclear Material and Facility Stabilization								44,301
Environmental Restoration								231,178
Waste Management	18,227							1,314,403
Total	18,227							1,589,882

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

Nondefense Funding Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	*2005*	*2010*	*2015*	*2020*	*2025*	*2030*	*Life Cycle**
Nuclear Material and Facility Stabilization		*111*	*77*	*36*	*15*			*1,192*

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

COMPARISON WITH PREVIOUS ESTIMATE

Life-cycle cost estimates presented in this 1996 Baseline Environmental Management Report are significantly different from those presented in the Baseline Environmental Management Report for 1995. The life-cycle estimate for the site has increased by 35 percent, or approximately $414 million. The primary impact may be potential delays in completing environmental restoration activities.

Comparison Table

Activity	FY 1995 Life Cycle	FY 1995 Only [1]	FY 1996 Life Cycle	Change in Dollars	Change in Percent
	Thousands of Dollars				
Nuclear Mat. & Fac. Stab.	39,924	2,600	45,493	17,345	22
Environmental Restoration	242,047	23,295	231,178	73,109	6
Waste Management	703,203	12,537	1,314,403	-29,994	90
Landlord	-	-	-	-	-
Program Management [2]	237,971	7,780	-	-	-
Site Total	1,223,145	46,212	1,591,074	414,141	35

1 The FY 1995 life-cycle and annual costs are provided to determine the corrected FY 1995 cost.
2 Program Management was reported in an independent cost table last year, but is reported as a line item in the relevant program (Nuclear Material and Facility Stabilization, Environmental Restoration, and Waste Management) activity cost estimate tables for the FY 1996 Baseline Report.

Nuclear Material and Facility Stabilization

The estimate for nuclear material and facility stabilization activities is 22 percent higher than the estimate in last year's report, after accounting for FY 1995 expenditures. The principal reason for this increase is the addition of program management costs. The estimate was calculated using a parametric model.

Environmental Restoration

After accounting for FY 1995 expenditures and program management costs, the 1996 estimate is approximately six percent more than the FY 1995 estimate. Remediation costs for the North Technical Areas, South Technical Areas, Firing Ranges, and Thunder Range assume, based on currently available information, ground-water contamination is limited to one site (requiring treatment) and the standard for remediation is future Industrial or Recreational land use. Assumptions about future land use relate to human health risk assessments; thus, they control the extent of remediation and the volumetric estimate of contaminated soil. The volumes estimated for hazardous, mixed, and low-level radioactive waste generated by the Environmental Restoration program have been significantly modified based on site data obtained during FY 1995 and, to some extent, on new assumptions regarding the means to remediate some sites. Overall, the Environmental Restoration waste volume estimates have been reduced. In addition, the Environmental Restoration program now plans to use a Temporary Unit for early storage of Environmental Restoration waste and a Corrective Action Management Unit for disposal of most hazardous waste. This report expects disposal of radioactive waste will take place at the Nevada Test Site. In accordance with the site-level Memorandum of Understanding, costs for managing waste generated by the Environmental Restoration program were included within the scope of remedial costs.

Waste Management

The life-cycle cost estimate for the Waste Management program has almost doubled from the value presented in the FY 1995 report. The principal reason for the increase is that the assumed duration of support to the Office of Defense Programs almost doubled, from 40 years in the 1995 estimate to 75 years in the 1996 estimate. Applicable program management costs have also been included in the Waste Management estimate for the FY 1996 Baseline Report.

Posted 08/15/1996 (fr)

Waste Site Needs

Name: Tijeras Arroyo/Open Dumps (Arroyo del Co
Owner: Sandia National Laboratories
Country: United States
Site Image: Yes

Tij
SITE REFERENCE NAMES:

Activity Data Sheet No.: 1309
Site No.: 16
Site ID.: 00016
RFA (RCRA facility assessment) No.: 21,55

SITE DESCRIPTION:

Kathy Gaither
November 11, 1993
Tijeras Arroyo ADS 1309 - Updated Site Descriptions
The Open Dump in Arroyo del Coyote is located in the present active arroyo channel where it crosses the access road to Tech Area III/V, and extends along the arroyo both northeast and southwest of the road. The arroyo and dump are located southwest of, and parallel to Pennsylvania Blvd., SW of Manzano Base and NE of Tech Area II/V. The dump is no longer active, and the active dates are unknown. Access to the dump area is uncontrolled. The area is sparsely vegetated.
The open dump lies within the main active channel of the arroyo, and extends for a distance of approximately 1000 feet in length and 500 feet in width, but actual boundaries have not been determined. The total estimated area of the investigation for the site is 500,000 ft2 (11.5 acres).
Waste piles including concrete, rebar, wood, oil contaminated soil, foam, cans, rocket debris, and possibly small pieces of potting compounds (inert materials, such as epoxies and plastic foams), and high explosives (HE), are deposited throughout this area. Depleted Uranium (DU) may be present in a dark coating on concrete debris, and in other forms. One small (<20 gallon) drum was observed. An area of sludge was observed at the site during visual inspection of the site. A charcoal filter about 2 feet in diameter was also observed at this time. Because dumping was uncontrolled at this site,

process knowledge for the wastes are unknown, and therefore, a broad range of potential contaminants must be suspected. These include depleted uranium, high explosives, unexploded ordnance (rocket debris), organics, volatile organic compounds and semi-volatile organic compounds.
K. Gaither June 1993
Site Summary Info for HASP
This site is located immediately NW of and downstream of Site #7. It straddles the access road to TA III from Pennsylvania, and lies NW and SE of the road for a distance of at least 500' in either direction. It is likely that the dump extends farther than 500' to the NW of the road, but reconnaissance of the site is delayed until a surface radiation survey is completed. The dump lies at least 200' feet on either side of the active arroyo course. Contents of the dump are unknown, but process knowledge indicates that, at a minimum, the construction demolition debris from
facilities known to have used DU (9939, TA III Sled Track), used laser targets (concrete), rocket parts, spent smoke canisters, a large charcoal filter, potting materials, oil contaminated soil, and HE. It is likely that the majority of wastes at this site are visible on the surface, and any burial is within the small dump piles or under a thin layer of flood -generated sediment.
Potential for runoff of wastes downstream is high.
Kathy Gaither July 20, 1993
Uncontrolled dumping

SITE HISTORY:

CEARP Phase 1 September 1987:
Several open dumps for the disposal of waste concrete and various other materials are located in the Arroyo del Coyote east and northeast of Area III (Site 16). Materials deposited in the arroyo east of Area III include concrete with reinforcing rod, wood, foam, cans, oil contaminated soil, partially buried drums, rocket pieces, debris from the sled track, and possibly some small pieces of potting compounds and high explosive (Interviews 1985; PSI 1985). The northeast dump contains mostly large pieces of reinforced concrete with a dark coating. Most of the concrete is reported to be from tests at the drop tower and sled tracks. The dark coating could possibly be contaminated with depleted uranium from field tests.
CERCLA Finding -- Uncertain for FFSDIF, PA, and PSI; insufficient information is available to calculate HRS and MHRS migration mode scores.
Planned Future Action -- Additional information will be

collected during the supplementary CEARP Phase I reconnaissance sampling program. Based on these data, an evaluation will be made and further action taken as appropriate.
RCRA Facility Assessment (RFA) 1987
RFA #21
This abandoned dump is in Arroyo del Coyote, southwest of Manzano Base (Plate 13). Little is known about this site. Information was not available regarding site construction, disposal methods and volumes, size of unit or exact waste disposed.
The unit is probably in the 100-year flood plain of the arroyo.
Only a few isolated chunks of concrete and one small (less than 20 gallons) extremely weathered drum was observed at this site during the VSI. It is unknown whether other wastes are present, whether wastes were buried or if wastes were removed from this site.
Unknown.
The site is inactive. The date when waste was last received is unknown.
Exact waste types are unknown but wood, metal debris, and waste oil were disposed in this dump (9, App., B). Scrap building material is also thought to have been disposed here.
None observed during the VSI.
None reported.

Air - Due to the unknown nature of material disposed at this site, the potential for releases to air cannot be determined.
Soil - If waste oil and other liquids were disposed, the potential for a release would be high because of permeable soils in the area. Because waste containment procedures and the exact nature of materials disposed at the site are not known, the potential for release to the soil cannot be determined.
Surface Water - Since this dump is located in an arroyo, the potential for release to surface water is high.
Ground Water - Although this unit is located in an arroyo where surface water could percolate through subsurface soils. This unit is located on the plateau west of Hubbell Springs fault and the fault zone. Ground water in this area is known to be at least 450 feet or more below ground surface. Therefore, the potential for release to ground water is low.
Subsurface Gas - Due to the lack of information regarding the nature of wastes managed and construction details, the potential for release cannot be determined.

RCRA Facility Assessment (RFA) 1987
RFA #55
The building debris dump is in Arroyo del
Coyote west of Manzano Base (Plate 13). Waste disposal at
the dump site was never authorized by Sandia and has not
been supervised by SNLA personnel. Wastes were disposed
directly onto soils in Arroyo del Coyote.
Unknown.
Last dump possibly 1982 or 1983.
Concrete building debris, including rebar.
During the VSI, Sandia personnel reported that there may be
some depleted uranium in and on the concrete debris.
None observed during the VSI.
Unknown

Air - Since the wastes are not covered, the potential for
particulate releases to air is high.
Soil - Releases to soils have occurred since wastes were
disposed directly on to the soils in the arroyo. The
potential for ongoing releases is high since wastes remain
on surface soils.
Surface Water - Run-on/runoff controls do not appear to
exist at this unit. In addition, the unit is located within
an existing arroyo. Therefore, the potential for release to
surface water runoff is high.
Ground Water - Although this unit is located in an arroyo
and there is potential for surface water infiltration, this
unit is located on the plateau west of Hubbell Springs fault
and the fault zone. Ground water in this area is known to
be at least 450 feet or more below ground surface.
Therefore, the potential for release to groundwater is low.
Subsurface Gas - The potential for generation and release of
subsurface gas is minimal due to the design of this unit.

Task Leader: Nimick/Brinkman
Active: no
Regulatory Driver: RCRA 3004(u)
Restricted Access: no
Regular Site: no

Scheduled Assessment Start Date: 10/92

This site was identified under the Comprehensive
Environmental Assessments and Response Program (CEARP).

A permit has been issued allowing continued generation
and disposal of hazardous waste.

CONTAMINATION:

Contaminants:
Depleted Uranium, Petroleum Hydrocarbons, High Explosives

Additional Concerns (X = yes):
X Potential for contamination due to unconfined radioactive material
- Populated site
X Potentially contaminated with radioactive material
- Fenced site
X Potential for generation of mixed wastes
- Depleted uranium
X Unexploded ordinance (Survey date: 5-Nov-93)

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Return

Date created: *1 July, 1995*
Last updated: *17 July, 1995*

Name: Southwest Test Area/Gas Cylinder Disposa
Owner: Sandia National Laboratories
Country: United States
Site Image: Yes

Sou
SITE REFERENCE NAMES:

Activity Data Sheet No.: 1335
Site No.: 6
Site ID.: 00006
RFA (RCRA facility assessment) No.: 72, L
Building: 9966

SITE DESCRIPTION:

Caroline Byrd
November 11, 1993
Southwest Test Area ADS 1335 (formerly 1298) -
Updated Site Descriptions
The Gas Cylinder Disposal Pit at Thunder Range is located approximately 100 yards west of the west fence line of site 91, the Lead Firing Site. The former pit location appears to be distinguished by a thick growth of tumbleweeds. The pit no longer exists. Thunder Range access is controlled (general public not admitted) but access to individual sites is uncontrolled to workers.
According to an eyewitness it was used for a period of ~2 months. Gas cylinders were placed in the pit and punctured by metallic charges to let the contents escape. The cylinders were then removed and the pit was filled in. The contents of the cylinders are unknown. Metals may be present as residue from the metallic charges used to puncture the tanks. It is unlikely that contaminants from the gases in the cylinders remain in the soil. They probably dispersed to the air when the cylinders were punctured.
Photos from the CEARP in 1985 show the open pit, which has since been backfilled. The pit had approximate dimensions of 40 feet long by 10 feet wide by 8 feet deep (400 ft2). Photos also show the gas cylinders after their removal from the pit.
The site is classified as a "regular" site, with no potential for radioactive waste contamination. There is no DU or UXO hazard at the site and there are no other contaminants present due to releases from unrelated activities at adjacent sites.
Contaminants of concern are unknown since the contents of the cylinders is unknown.
The terrain is flat with some vegetation (primarily sage and tumble weeds). The shallow subsurface geology is comprised of

alluvial sediments (clay to gravel/cobble size). Depth to ground water is not known, but is estimated to be in the range of 500 feet below ground surface.
Kathy Gaither
Update of Information on ADS 1308,
Thunder Range
This information was obtained during telephone interviews conducted the weeks of August 5 and August 12, 1991. The person interviewed was Floyd Mathews, 7533. Please, add it to the database on ADS 1308. Floyd also told me that several sites were misspotted on our ER Program site map, and gave me corrected locations.
This information shows that we have incorrectly located some of the sites, and that some building numbers associated with the sites were incorrect in the CEARP descriptions. This information should be acted upon with regard to changing our maps, and they are used for day to day operations.
Site #79 Gas Cylinder Disposal Area
The CEARP description, first paragraph says that this was "An area near building 9964"...this is incorrect. It was about 400 yards west-southwest of Bldg. 9966.
A pit was dug that was 200' long by 20' wide by 6' deep and was a source of soil for other uses. It has been filled in. Health Physics was involved when cylinders were removed in about 1988. So, there should be no buried cylinders at the site now.
Debra Garcia 6/24/92
Changes to ER Program Site List
#79 - Gas Cylinder Disposal Pit (Thunder Range)
Drop #79 from site list. Site #79 is the same site as #6 - Gas Cylinder Disposal Pit (Bldg. 9966).
Kathy Gaither/From Denise Bleakly
Summary of Discussion with Floyd Mathews
concerning the ER sites in Thunder Range
On March 16, 1992, Floyd Mathews and I re-evaluated the locations of the ER sites at Thunder Range. He made notations for the locations of ER Sites at Thunder Range and signed and dated my base map. The following is a list of the items he

ER Site 6 (Gas Cylinder Disposal Pit) and ER Site 79 (Gas Cylinder Disposal Area - - Thunder Range) are the same site. Floyd Mathews located the area on our 1O = 200O base map and said that to the best of his knowledge, there was only one gas cylinder disposal pit.
CEARP Phase 1 September 1987
(CEARP Description from site #79)
An area near building 9964 was used to demonstrate the effectiveness of treating hazardous gas cylinders by shooting holes through the cylinders and allowing the gases to escape (Interviews 1985). The empty gas cylinders have been discarded (no burial) at the site (Site 79) (PSI 1985).
Finding - - Uncertain for RCRA regulated hazardous waste; insufficient information is available to calculate a HRS migration mode score.
Planned Future Action - - Additional information will be collected during the CEARP Phase 1 supplementary reconnaissance activities. Based on these data, an evaluation

will be made and further action taken as appropriate.
The RFA designation for this site is a letter designation.
Following is the section of the RFA that describes the source of the letter designation.
VII. Other Areas of Concern.
There are a number of areas at Sandia that do not meet the regulatory definition of a SWMU, but nevertheless pose a threat of environmental contamination. Releases of hazardous constituents from these areas have either been previously documented or are considered highly likely given the nature of activities in the area. These areas of concern are discussed

L. The old battery gas cylinder storage has not been confirmed. Sandia personnel plan to investigate this area further during the CEARP Phase II by sampling soils and conducting geophysics surveys in the area.

Populated
Regular

SITE HISTORY:

Task Leader: Byrd, Caroline
Active: no
Regulatory Driver: RCRA 3004(u)
Restricted Access: no
Regular Site: no

Scheduled Assessment Start Date: 10/92

This site was identified under the Comprehensive Environmental Assessments and Response Program (CEARP).

A permit has been issued allowing continued generation and disposal of hazardous waste.

CONTAMINATION:

Contaminants:
Unknown

CEARP Phase 1 September 1987
In the mid- to late 1970s, some gas cylinders buried in a 6- to 8-ft pit about three quarters of a mile south of building 9966 (Site 6). The specific contents of these cylinders were not known, but they were recalled to be poisonous by some interviewees (Interviews 1985).
CERCLA Finding -- Positive for FFSDIF, PA, and PSI; however, insufficient information is available to calculate a HRS migration mode score.
Planned Future Action -- An attempt to locate this site will be made during the supplementary CEARP Phase I reconnaissance activities. Geophysical techniques will be used as appropriate, and additional information will be

collected. Based on these data, an evaluation will be made
and further action taken as appropriate.
RCRA Facility Assessment (RFA) 1987
RFA #72
Used gas cylinders were piled outside,
adjacent to Building 9966 in the Coyote Test Field (Plate
15). The cylinders have since been removed. The contents
of the cylinders are unknown, but were thought to be toxic.
The number of cylinders and the size of the area in which
they were placed is unknown.
Mid 1970s.
The cylinders were reportedly removed
sometime in the late 1970s.
Used gas cylinders, contents unknown.
None
None reported.
Due to the lack of information regarding the
wastes managed, the potential for release cannot be
determined.
pict
15-Nov-93
11/15/93
Sites # 6, 17 west, 17 east, 17 south, 23, 55, 56, 89, 90,
91, 193, 194,
Sites were visually surveyed for surface UXO/HE and no live
ordnance/HE or associated debris was found.

Additional Concerns (X = yes):
- Potential for contamination due to unconfined radioactive material
X Populated site
- Potentially contaminated with radioactive material
- Fenced site
- Potential for generation of mixed wastes
- Depleted uranium
- Unexploded ordinance

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Return

Date created: *1 July, 1995*
Last updated: *17 July, 1995*

Name: Central Coyote Test Area/Firing Site
Owner: Sandia National Laboratories
Country: United States
Site Image: Yes

Cen
SITE REFERENCE NAMES:

Activity Data Sheet No.: 1334
Site No.: 57A
Site ID.: 00057
RFA (RCRA facility assessment) No.: G

SITE DESCRIPTION:

Firing Area
Description and History
ER Site 57 was identified as Workman Site in the HSWA Module. Firing Site covers approximately 4.22 ac on federally owned land controlled by the USAF. The past activities of the site are associated with those of ER Site 57B. This inactive site consists of an artillery firing area that was used during World War II for development work on the proximity fuseNa radar-activated, variable-timed bomb fuse used for antiaircraft defense. ER Site 57A is located on the northeast corner of the intersection of Target and Lovelace Roads. The mean elevation of the site is 5,706 ft (amsl). ER Site 57A includes a 100 cubic ft. concrete-block building (Building 9900), another small concrete building (Building 9902) having a wood observation deck; two concrete gun mounts, a concrete pad north of Building 9900 that was the foundation of a former building which housed a machine shop and a wind tunnel at various times, a concrete transformer pad located in a fenced area north of the building foundation, a small concrete-block-foundation located east of Building 9900 (Pad 1), two concrete pads (Pads 2 and 3) of unknown function located near an underground bunker, and a group of three utility poles with cables and guy wires located east of the gun mount area. The underground bunker contains a cylindrical entrance (dirt floor) attached to a concrete room with a single floor drain. A steel plate lies on the ground beneath the utility pole array. Several feet west of the utility poles, there is a rectangular concrete foundation (Pad 4) that is open in the center, and a wooden box containing two steel plates beneath the poles. It is likely that there also is an underground pipe between these fittings. The purpose of the utility poles is unknown. There are several small debris mounds and scattered debris on the ground in the northeast

portion of the site. Debris present includes a rusted 30-gallon drum, ceramic light sockets and insulators, charred wood, cinder blocks, metal fragments, and several cylindrical concrete columns. Overhead power lines cross the site, and an underground water line parallels Lovelace Road. There is a culvert under Target Road, and a depression where surface water may collect.

ER Site 57A was constructed by 1951, as documented by a 1951 aerial photograph. However, it appears to have been deactivated by 1951, because the adjacent explosive burial mounds (ER Site 11), thought to have been created during the decontamination and decommissioning of ER Site 57, are also present in the photograph (IT April 1994).

The purpose of the testing at ER Site 57A was to develop a fuse that would detonate an artillery shell near the intended target without actually hitting the target. This fuse, known as the "proximity fuse," was developed for the U.S. Navy during World War II. Testing took place from approximately 1942 to as late as 1948. This proximity fuse work was conducted to develop a method of destroying Japanese kamikaze planes and for antiaircraft defense during the Battle of Britain. Artillery was fired from ER Site 57A at targets (usually old airplane fuselages) that were suspended from the Target Area (ER Site 57B). The proximity fuses used in the shells were radar or timer fusing systems. Shells were fired from 5-in. guns located on the gun mounts at ER Site 57A. Reportedly, Building 9900 was used as the control bunker, and Building 9902 was an observation point for cameras and theodolites. Observation shelters used during these tests are located in the range between the firing area (ER Site 57A) and the target site (ER Site 57B).

The underground bunker contained several 5-gal and 10-gal containers or waste in addition to solid waste debris comprised of wood and wire. It is not known when the waste was emplaced in the bunker. All containerized waste was removed from the bunker under a VCM conducted by KAFB in June 1994.

Previous Investigations

ER Site 57A was identified during investigations conducted under the CEARP and during the RFA. The CEARP investigation reported that SNL/NM and the military conducted a cleanup of the site in the early 1980s, but no records have been located to document the cleanup. The RFA determined that the Workman Site did not meet the regulatory definition of a SWMU; nevertheless, a hazardous source may be present at the site.

In December 1993, KAFB EOD conducted a surface visual UXO/HE survey of ER Site 57A. No live UXO/HE or significant UXO/HE debris was found during this survey.

In March 1994, RUST Geotech Inc. completed a detailed surface gamma radiological survey of ER Site 57A. One point-source with up to 1,400 counts per second (cps) and two area-source anomalies were identified. The first area-source anomaly was measured on some rocks at the entrance to Building 9900. The second area-source anomaly was detected around two cylindrical cinder-block posts with flat bases, located in the northeast area of the site. Both area source anomalies had readings

varying from 110 to 160 cps, compared to a background activity of 90 cps. These anomalies appear to result from the presence of manmade materials, rather than from tests conducted with radioactive materials.
Carol Lojek
January 7, 1994
Subject ER Site 57 - Change of Site Polygon
Based on continuing site background investigation, we are revising the location of one of the Site 57 polygon. Site 57 is comprised of two polygons. One polygon defines the "Firing Area" and is located at the northeast corner of the intersection of Lovelace Road and Target Road. No change to this polygon is required.
The second polygon defines the "Target Area", and is located at the east end of Target Road, due south of the Optical Range. This polygon is currently shown as a circle approximately 630 feet in diameter as shown on the attached figure. The revised polygon encompasses a long, linear, north-south trending debris pile, and the demolished bases of two 300-foot wooden towers, that are the primary features of the Workman Site Target Area.
Carol Lojek Information Sheet Update November 16, 1993

Additional background investigations, interviews, and site visits conducted in October 1993.

The Workman Site was used during World War II (1944-1945) for development work on the proximity fuse, a radar-activated, variable-timed bomb fuse used for anti-aircraft defense. The site is comprised of an artillery firing area located on the north side of Target Road at its intersection with Lovelace Road, and a target area two miles east, at the east end of Target Road (due south of the Optical Range) (Figure 1). Artillery shells from 5-inch guns were shot eastward at aircraft suspended from two wooden towers at the target area. These tests were conducted for the Navy by Dr. John Workman of New Mexico Tech in Socorro, New Mexico, and occurred before the establishment of Sandia National Laboratories.
The firing area covers approximately 10 acres, and includes an observation bunker (Building 9902), another small concrete block building (Building 9900), two concrete gun mounts, an underground bunker (confined space), several other concrete pads, several small waste piles, a group of three utility poles, and several large sheet steel pieces lying on the ground. Near the utility poles, there are several high pressure pipe fittings sticking out of the ground that appear to connect via a subsurface pipeline. Building 9900 may have been the control bunker for the tests, with building 9902 being an instrumentation and observation point for cameras and theodolites. Deacon Palmer said that he built a wind tunnel on a concrete foundation north of Building 9900. There was also a machine shop at that location at one time.
The target area covers approximately 8 acres, and used to have two 300-foot tall wooden towers that were a prominent feature of south Coyote Test Field. Dick Jones also used the wooden towers from 1950 to 1962 for earth penetrator tests, in which

50-caliber or larger guns were fired from the top of the towers into the ground. The towers were torn down sometime between the late 1960s and mid-1980s (sources conflict on the timing) because their deteriorated condition made them a safety hazard. At present, the concrete, steel, and wood footers of the towers remain, and there is a long, thin demolition debris pile running north-south along the west side of the tower bases. There are two small metal boxes mounted on poles located between the tower bases. Weathered dry-cell battery packs lie on the ground near these boxes.
The intervening range area, between the firing and target areas, contains instrument and observation stations. These stations consist of small (approximately 10-feet by 10-feet) open structures having steel posts at the four corners, covered with sheet steel and several feet of concrete. The concrete covers may have been pyramidal in shape to deflect artillery falling vertically from above. At least four of these stations remain (Figure 1). One station at the east end of Target Road is a small steel, earth-covered bunker. Ordnance debris from the proximity fuse tests may have been left scattered throughout the range. Later, equipment from the overpressure tests conducted by the military at the Nevada Test Site was brought back by Sandia and stored at this location. Several years ago Sandia and the military conducted a cleanup of this site. ER sites 68, the Old Burn Site, and 71, Moonlight Shot, lie within the range area of the Workman Site.

Regular

SITE HISTORY:

Task Leader: Lojek, Carol
Active: no
Regulatory Driver: RCRA 3004(u)
Restricted Access: no
Regular Site: no

Scheduled Assessment Start Date: 10/92

This site was identified under the Comprehensive Environmental Assessments and Response Program (CEARP).

A permit has been issued allowing continued generation and disposal of hazardous waste.

CONTAMINATION:

Contaminants:

Additional Concerns (X = yes):
- Potential for contamination due to unconfined radioactive material
- Populated site
X Potentially contaminated with radioactive material

- Fenced site
- Potential for generation of mixed wastes
- Depleted uranium
- Unexploded ordinance

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Date created: *1 July, 1995*
Last updated: *17 July, 1995*

Name: Central Coyote Test Area/Burial Site/Ope
Owner: Sandia National Laboratories
Country: United States
Site Image: Yes

Cen
SITE REFERENCE NAMES:

Activity Data Sheet No.: 1334
Site No.: 9
Site ID.: 00009
RFA (RCRA facility assessment) No.: 43
Previous Activity Data Sheet No.: 1293

SITE DESCRIPTION:

ER Site 9NBurial Site/Open Dump
Description and History
ER Site 9, identified as Burial Site/Open Dump in the HSWA Module, lies on approximately 186 ac of federally owned land controlled by the USAF. This inactive site is located adjacent to and within an arroyo channel, approximately 1,800 ft east of the Schoolhouse Building (ER Site 61C) on the north side of Demolition Range Road, where a north-trending dirt road crosses the arroyo channel and splits into two dirt trails immediately east of the site. ER Site 9 is also located within the southwest corner of ER Site 61A. The mean elevation of the site is 5,845 ft (amsl).
ER Site 9 includes a soil-covered debris mound (debris mound 1) north of the arroyo channel, an exposed debris mound (debris mound 2) in the north bank of the arroyo channel, and debris (debris mound 3) that is scattered down the arroyo channel for a distance of up to 275 ft. Visible debris in mounds 2 and 3 consists of tangled masses of barbed wire, shells and old mortar casings, shrapnel, empty paint cans, a military bomb rack and military vehicle parts, ceramic electrical insulators, wooden crate remnants, various pieces of wood and metal, building rubble (including cinder blocks), an empty 55-gallon (gal) drum containing a grate that appears to have been used as a grill, and other miscellaneous solid waste. One piece of iron plate appears to have been bent and torn by an explosion.
Debris mound 1 contains a cavity approximately 2 to 4 ft deep. Soil has been mounded up around this cavity, which is lined with deformed corrugated metal 8 in. in diameter and partially burned wooden planks. Although the site is not fenced, it is posted as an ER Site.
The source of the material at the site is uncertain. Former

SNL/NM employees involved in explosives testing were unaware that the site existed. However, one former SNL/NM employee stated that solid wastes from Area Y field test crews were dumped at ER Site 9. Some burn and explosives testing were conducted south of the Schoolhouse Building, but material from those activities was not disposed of in this arroyo channel. The military bomb rack and military vehicle parts identified at the site may be remnants of DoD activities that probably were conducted in the vicinity.

A 1951 aerial photograph shows the first evidence of manmade features at ER Site 9. A 1967 aerial photograph shows an access road between ER Site 61A, Blast Area, and ER Site 9. A 1971 aerial photograph depicts a debris mound that is similar to current site conditions. Vegetation gradually reclaimed the roads and the site during a period of inactivity between 1975 and management units other than the three existing debris mounds.

Previous Investigations

ER Site 9 was identified during investigations conducted under the CEARP and the RFA. However, no records regarding waste disposal at this site were found during either of these investigations.

In early 1993, SNL/NM RPO personnel conducted a beta/gamma radiation survey at the site with a Geiger-Muller detector with a pancake probe. No activity above background was detected near any of the debris mounds, including the cavity containing corrugated metal located in debris mound 1. In addition, SNL/NM RPO personnel recorded no radioactivity readings above background activity at a shallow, crater-like feature northeast of debris mound 1.

In November 1993, KAFB EOD conducted a surface visual UXO/HE survey of Schoolhouse Mesa Test Site that included ER Site 9. This survey, which was completed in conjunction with ER Sites 20 and 61, did not include the areas of these sites that lie within the active KAFB EOD range. UXO/HE material identified and removed during this survey was associated with recent DoD war game exercises conducted throughout the Schoolhouse Mesa Test Site and included one live groundburst simulator and one lb of HE compounds. Ordnance debris that was collected and removed included six smoke grenades, two flare-illuminating cartridges, and three 40-mm white star parachute cartridges. No UXO/HE was found on the surface of the three debris mounds at ER Site 9.

In February 1994, RUST Geotech Inc. conducted a surface gamma radiation survey at ER Site 9. One point-source anomaly was detected at 18_R/hr in the southeast corner of debris mound 1. Background activities were measured at approximately 14_R/hr. The radioactive material is attributed to activities conducted at ER Site 61A. Yellow material near the debris mound 1 is thought to be radioactive uranium oxide. It is believed that the radioactive material was deposited over the ER Site 9 area by activities at ER Site 61A, and that radioactive material was not disposed of in the debris mounds.

Carol Lojek Information Sheet Update November 16, 1993

Additional background investigations, interviews, and site

visits conducted in October 1993.

The Burial Site/Open Dump (Schoolhouse Mesa) is located in an arroyo approximately 1,800 feet east of the old schoolhouse on the north side of Demolition Range Road, where a north-trending dirt road meets the arroyo. Wastes are strewn along the arroyo for a distance of about 300 feet. Three waste piles are also present on the north side of the arroyo. The total area of the site is approximately 1.7 acres.
Items observed during visits to the dump include a tangled mass of barbed wire, miscellaneous electrical cables and wires, an empty 55-gallon drum with a grate in it that appears to have been used as a grill, empty paint cans, shell lids and old mortar casings, shrapnel composed of iron, ceramic electrical insulators, building debris, empty wood crate remnants, military missile racks and vehicle parts, metal, wood, cinder blocks, and miscellaneous solid waste. One piece of iron plate appears to have been bent and torn by an explosion. One of the waste piles has a 4 to 5 feet deep hole that contains deformed corrugated metal and burned wooden planks. Dirt is mounded up around the hole. Radiological monitoring in 1993 with a pancake meter found no radiation above background. A circular feature approximately 6 feet in diameter, located about 35 yards northeast of the arroyo dump, had a scintillometer reading between 40-50 uRem/hr (background ranges between 10-20 uRem/hr); however this reading could not be confirmed by Sandia Radiation Protection Operations staff one month later.
No records on this disposal site have been found, and the source of material at the dump is unknown. Several Sandia personnel involved in explosives testing near the schoolhouse (Dick Jones, Floyd Mathews, Walter Hyde, and Deacon Palmer) were not aware of the dump's existence, so the dump does not appear to be related to the explosives testing conducted by Sandia. Explosives testing conducted around the schoolhouse included cratering tests using 250-pound HE charges set 40, feet underground conducted during the 1950s, and burn tests of Polaris missile re-entry vehicles conducted in 1957. Both of these types of tests were conducted south of the schoolhouse on land that is now within the KAFB-EOD range.
The schoolhouse was used as a headquarters for these tests. A former steel and concrete bunker partially covered with earth was used for explosives storage. This bunker or magazine was located just east of the schoolhouse, in the south bank of the arroyo, and was approximately 4 to 10 cubic feet in size with a capacity to hold approximately 10 pounds of HE. The use of DU or other radionuclides in the schoolhouse area has not been confirmed.
Based on the materials present, such as military bomb racks, the site appears to have originated from military activities rather than Sandia testing.
investigations to date have not indicated that there is a potential for radioactive materials to be present in the dump. Based on the well log for the nearby schoolhouse well, ground water appears to be approximately 100 feet deep.

SITE HISTORY:

CEARP Phase 1 September 1987
The area surrounding the old schoolhouse was used by Sandia explosives testing in the early days (Section V.A.3.p). A burial site and an open dump (Site 9), probably related to these early test activities, are located in the arroyo just east of the old schoolhouse. No records on this disposal site were found during the Phase I review. However, one of the individuals interviewed indicated that uranium was burned in this area (Interviews 1985). The area was surveyed during the Sandia radiometric survey, and no radioactivity levels above background were detected (Minnema n.d.).
Items observed during the PSI include barbed wire, empty drums, shrapnel, wood and a tricycle. There were also several mounds and at least one deep hole in the ground with pieces of charred wood sticking through. Although no hazardous materials were observed on the initial walk-through, there is some potential for hazardous chemicals or small pieces of depleted uranium at this site.
CERCLA Finding -- Uncertain for FFSDIF, PA, and PSI; insufficient information is available to calculate HRS and MHRS migration mode scores.
Planned Future Action -- Additional information will be collected during the CEARP Phase I supplementary reconnaissance activities. Based on these data, an evaluation will be made and further action taken as appropriate.
RCRA Facility Assessment (RFA) 1987
RFA #43
The school house site is in an arroyo south of Coyote Springs Road, adjacent to the boundary between Cibola National Forest and Sandia Military Reservation (Plate 13). Uranium was burned at this site. In addition, the site was used as unauthorized disposal area for garbage, shrapnel, miscellaneous equipment, and old wood chambers. During the VSI, barbed wire, shrapnel, empty drums, and wood were observed at the site.
It appears that some of the wastes at this site were burned and some were disposed at ground surface. SNLA personnel had no additional information on waste management at this site.
The site is currently inactive.
Late 1940s.
Inactive since the 1950s.
None.
Unknown.

Air - Uranium was burned here in the 1940s and 1950s, so the potential for prior releases is high. The potential for ongoing release of hazardous constituents to the air cannot be determined without further information regarding the composition of the wastes disposed.
Soil - The potential for a release of hazardous constituents to soil is high because wastes were disposed directly onto exposed soils.

Surface Water - Run-on/runoff controls do not appear to exist at this unit. In addition, the unit is located within an existing arroyo. Therefore, the potential for release to surface water runoff is high.
Ground Water - This unit is located within the fault zone bounded by the Hubbell Springs and Manzano faults. Ground water in this region appears to be at or near ground surface based on the presence of springs and the Travertine Hills in the vicinity. Because the depth to ground water may be very shallow, the potential for release to ground water from surface water infiltration is high.
Subsurface Gas - The current potential for release of hazardous constituents from subsurface gas at the unit is low since the site has been inactive for over 30 years. However, in the past, methane gas could have been produced by decomposing garbage. Therefore, the potential for prior subsurface gas generation and release is high.

Task Leader: Lojek, Carol
Active: no
Regulatory Driver: RCRA 3004(u)
Restricted Access: no
Regular Site: no

Scheduled Assessment Start Date: 10/92

This site was identified under the Comprehensive Environmental Assessments and Response Program (CEARP).

A permit has been issued allowing continued generation and disposal of hazardous waste.

CONTAMINATION:

Contaminants:
Depleted Uranium, Beryllium, Lead, High Explosives, Solid Waste

Additional Concerns (X = yes):
X Potential for contamination due to unconfined radioactive material
- Populated site
X Potentially contaminated with radioactive material
- Fenced site
X Potential for generation of mixed wastes
- Depleted uranium
X Unexploded ordinance (Survey date: 5-Oct-93)

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Last updated: *17 July, 1995*

Unexploded Ordnance and High Explosives Found at a Dozen SNL Sites

Initial information and visits to a number of environmental restoration sites at Sandia National Laboratories (SNL) indicated unexploded ordnance/high explosives (UXO/HE) may be present at some sites. In response to this concern, SNL has developed a program to address and control the hazards associated with UXO/HE. Visual surveys have been conducted using the Explosive Ordnance Disposal Unit at Kirtland Air Force Base to locate possible UXO/HE sites. The survey covered 2,200 acres and 89 sites. UXO/HE have been found at a dozen SNL sites. Live ordnance was removed from nine sites. The remaining sites await regulatory approval before removal and disposal can be carried out.

The UXO/HE found include high-explosive chunks, solid rocket propellant, bomb fuses, five-inch shells with recrystallized TNT seeping from threads, flares, booby traps, flash and smoke grenades, and rocket motors. During subsurface investigations, buried UXO/HE were found at one site.

For more information, contact Mike Young/SNL at (505) 848-0389.

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Posted 3/02/95 (mes)

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Return-Path: mfyoung@csua35.sandia.gov
Sender: mfyoung@csua35.sandia.gov
Date: Mon, 27 Jan 1997 08:55:51 -0700
From: "Michael F. Young" <mfyoung@csua35.sandia.gov>
To: Kory Edelmayer <KEdelmayer@SCIENTECH.Com>
Subject: Re: Request for Bombs and Bullets information
References: <199701271546.IAA32516@eaglerock.if.scientech.com>

Kory Edelmayer wrote:
>
> Michael, I sent you an email message on January 24, 1997 to receive some
> information on UXO at SNL facility. My return email address has been
> changed to KEdelmayer@SCIENTECH.Com. I apologize if this has caused any
> inconvenience. Thank you again for your time.
> Kory Edelmayer
> Environmental, Engineering & Safety
> SCIENTECH, INC.
> Idaho Falls, ID
> Phone: (208) 523-9552
> Fax: (208) 523-9380
Sorry,
I don't have any info on UXO.
Mike Young
Org. 6421

UNEXPLODED ORDNANCE/HIGH EXPLOSIVES (UXO/HE) VISUAL SURVEY OF ER SITES

FINAL REPORT

PROJECT SUMMARY

Preliminary site inspections by SNL Environmental Restoration Project (ER) personnel at SNL ER sites revealed the presence of a small amount of Unexploded Ordnance (UXO), High Explosives (HE) and ordnance debris left from prior military and SNL testing activities. The extent of the material present was not known since few sites had been inspected in detail, and this situation was considered a potential health and safety concern. The first step in the series of activities undertaken by the SNL ER Project to address this concern was to determine the extent of the UXO present on the sites. Kirtland Air Force Base (KAFB) Explosive Ordnance Disposal (EOD) unit was contracted to conduct a visual surface survey of sites with the potential for UXO.

The EOD unit surveyed 89 ER sites, the majority of which were outside the Tech Areas, with 100% coverage of surface area. Approximately 2200 acres were surveyed from September 1993 to July 1994. Live ordnance and/or HE was found at 12 sites. Ordnance debris was found on 36 sites or approximately 41% of sites surveyed (See Table 1 for individual site information). Most ordnance and ordnance debris has been removed from the sites; section 3 of this report gives further details. This survey covered surface conditions only; other survey techniques using magnetometers are being implemented when subsurface work is planned.

The vast majority of ordnance found was military in origin and was unrelated to Sandia site activities. Only 10 of the 36 sites with ordnance debris had UXO/HE debris that may have been associated with Sandia activities. Because of the large amount of ordnance and debris unrelated to Sandia testing, Sandia testing histories were inadequate to assess the potential hazards at the sites. In addition, the deposition of military ordnance and debris from training exercises on ER sites continues. The site surveys allowed the ER Project to obtain an accurate representation of the nature and extent of the current hazard and enable appropriate precautions and procedures to be developed for future site activities; such as site investigations and remediation.

SURVEY METHOD

The EOD unit covered 100% of the area of each site. In most cases the area of the UXO/HE survey was larger than the ER site area to allow for off-site mobilization areas and potential expansion of the site boundaries on sites with less detailed background information. The surveys were conducted by visually inspecting the surface of the site, looking for ordnance, HE and ordnance debris. Only live UXO/HE and ordnance debris that might pose an explosive hazard were collected and

.emoved. Shrapnel (small fragment) locations were not recorded and was not removed from the site. The location of live UXO/HE was recorded on site maps. The maps are maintained in the RFI site investigation files of the SNL ER Project Records Center.

Limitations of Survey

The surveys only cover surface UXO/HE visible at the time of the survey. Areas where war games are being conducted should be resurveyed quarterly or before any significant new activities are conducted at the site. All other sites should be resurveyed annually or before significant new activities commence on the site. Subsurface UXO/HE may surface after the survey (due to rain and wind erosion). The sites are not considered cleared of ordnance because they have been surveyed.

REMOVAL

Removal of live (non-residue producing) ordnance and some ordnance debris has been conducted at sites # 8, 61, 10, 60, 12, 27, 58, 81, 82, and 87. Removal was completed in June of 1994. Sites that still have live UXO include #: 11, 15, 28, 67, and 239 (see discussion below).

esidue Producing UXO

Ordnance and ordnance debris that would produce residues when burned or detonated cannot be treated/destroyed by KAFB EOD until their new burn facility is approved by the regulatory agencies. Most of the residue producing ordnance debris consists of expended smoke grenades. Site 239 has the only remaining live residue producing ordnance and those are a non-lethal hazard (tear gas canisters).

Non-residue Producing UXO

Sites 11, 15, 28, and 67 still have live ordnance or the potential for live ordnance to be present. These sites are grouped into two categories and are discussed below.

Ordnance has not been removed from the vicinity of sites 15, 67, and 28 (in the vicinity of sites 15 and 67 only) since this area is in a shell impact area from Navy research during World War II. This area is being returned to military responsibility. Sandia will keep sites # 15, 67, and 28 but will not investigate or remove the ordnance hazard in the surrounding area.

In addition site # 11 has been found to contain buried ordnance in several mounds on site. This site should be treated as having live ordnance until it has been excavated and the buried ordnance assessed. This site contains five mounds in 3 fenced areas and posted with ER ite signs.

ENVIRONMENTAL, SAFETY AND HEALTH MEASURES IMPLEMENTED BY THE ER PROJECT

As a result of the UXO survey information, the SNL ER Project has implemented a number of measures to ensure the health and safety of its personnel and contractors.

1. UXO/HE awareness training is required for all ER Project personnel and contractors.

2. "ES&H Standard Operating Procedure, Control of Unexploded Ordnance (UXO) At Sandia/NM Environmental Restoration (ER) Sites", was written to cover future ER project activities that may involve UXO/HE.

3. Development of a UXO site status map and list, which is maintained by GIS. This list details any site restrictions due to UXO/HE (see the special restriction column on Table 1).

4. A magnetometer was purchased by the ER project for use in clearing sites before any intrusive work is conducted on the site.

ER SITES AND UXO AREAS MAP

The ER project has developed a map for ER project use that illustrates the current knowledge about the level of hazard from UXO/HE at locations on KAFB and the lands withdrawn from the U.S. Forest Service. The map was developed from KAFB EOD records of past activities and UXO/HE response activities they conducted. ER site histories and the UXO/HE survey results have been utilized to characterize ER site and the surrounding area UXO/HE hazard levels.

White areas on the map represent areas where no information on the UXO/HE hazard is available. Green areas represent areas were the UXO/HE hazard level has been assessed and judged to be of low hazard. Yellow areas are areas of known historical or present ordnance/HE use. These areas have not been surveyed or were surveyed and considered of moderate hazard. The red areas on the map are considered high potential hazard areas from UXO/HE. These areas are current and/or historical ordnance/HE use areas. The survey and or historical information dictate the classification as a potential high hazard area.

This map is intended for ER Project use only. The information used to compile this map is incomplete and historical accounts may be inaccurate. No area on KAFB or the Forest Service Withdrawn Area should be considered free of potential UXO/HE concerns. Each area

nould be assessed based on proposed activities to determine whether UXO/HE concerns are actually present in a given area.

A current survey map is available for review by calling Denise Bleakly, 848-0359. Copies of the map may be obtained by calling Dick Thomas at 848-0354.

ADDITIONAL ACTIVITIES

Subsurface investigation of selected ER sites is on-going. Activities planned include metal detector surveys, exploratory trenching and removal of buried subsurface UXO. KAFB EOD unit has other UXO/HE activities underway and should be consulted about any UXO/HE concern. The KAFB phone # is 846-2229.

SURVEY RESULTS

The results of these surveys are summarized in Table 1(attached). Sites surveyed are discussed in more detail below.

No live UXO/HE or significant UXO/HE debris was found at the following sites.

Sites # 6, 7, 14, 17 west, 17 east, 17 south, 22, 23, 38, 45, 46, 47, 48, 50, 54, 55, 56, 57 (excluding impact area) 64, 69, 70, 85, 86, 89, 90, 91, 103, 108, 109, 112, 115, 117, 191, 193, 194, 227, 228, 229, 230, 231, 232, 233, 235, 236, 237, 238, 242 and the Containment Technology Test Facility.

Sites # 8

<u>Live ordnance:</u>

13 live bomb fuzes
2 partially filled illuminator trip flares
2 live 12 gauge practices shotgun shells
2 20mm cartridges with primer
5 lbs (approximately) partially burned HE chunks

<u>Ordnance debris:</u>

2 HVAR rocket motors - empty
several pieces of a 3" experimental rockets
4 Mk 13 signal smokes - expended
5 smoke grenades - expended
34 20mm practice cartridges/projectiles - expended
6 30mm cartridges/projectiles - expended
2 bomb fuzes - empty
1 projectile ballistic windshield - empty

3 flash tubes of powder bags - expended
1 40mm airburst cartridge - expended
4 12-gauge practice shells - expended
numerous 5.56mm and 7.62mm blank ammunition - expended
1 6" experimental penetrator - empty

Sites #9, 20, 61 (sites surveyed as one site)

Live Ordnance:

1 groundburst simulator
2 pound of high explosives

Ordnance Debris:

6 M18 screening smoke grenades - expended
2 slap flare illuminating cartridges - empty
3 40mm white star parachute cartridges - empty

Site # 10/60

Live ordnance:

One live ground burst simulator was found (and removed).

Ordnance debris:

12 expended smoke grenades
2 practice 40mm grenades
3 expended smoke pots
5 empty white star parachute containers
1 empty home made booby trap
1 empty Molatov Cocktail
various pieces of unidentified rockets
expended blank 7.62 and 5.56mm ammunition

Sites # 11

Four mounds were surveyed at this site. Although radiation warning signs were posted, no elevated radiation levels were detected according to EOD. EOD found buried ordnance just under the surface of the mounds. A Mark 26 detector was used to detect ordnance and a large amount of ordnance debris was located. EOD is recommending extreme caution around this site until the buried items are uncovered, identified and certified safe.

Sites # 12, 13, 65, 94 and 219

The New Burn Site area was visually surveyed for surface UXO/HE. Heavy metal fragments from explosions from previous testing at the burn site were found on the hills surrounding the site.

Sites # 12, 13, 65, 94 and 219 (continued)

Live ordnance:

One trip flare

Ordnance debris:

One slap flare
One rifle propelled illuminator round

Sites # 15, 67 and 28 (mines in the vicinity of Sites # 15 and 67)

Live Ordnance:

one live fuze

EOD indicates that the area has live ordnance, and is between two areas to the east and west that contain a high density of ordnance, some of which is live.

Ordnance debris:

numerous fired shells and fuzes

Site # 16

Ordnance Debris:

10 experimental Jet Assist Take Off (JATO) rocket motors - expended

Site # 19

Ordnance debris:

6 expended M18 smoke grenades
1 slap flare - empty
6 12-gauge shotgun shells -empty
numerous expended small arms shells

Sites # 21, 62 and 88 (surveyed as one site)

Ordnance debris:

10 smoke grenades
2 40mm white star cartridges
1 booby trap simulator
12 gauge shells
numerous expended rifle casings

Site # 27 and 49

Live ordnance:

1 40mm practice cartridge
1 clip of 5.56mm blanks

Ordnance debris:

50 40mm cartridges - empty
3 M18 smoke grenades - expended
1 40mm illuminating - expended
2 12 gauge shotgun shells practice - expended
4 booby trap simulators (whistling) - expended

te # 58

Live Ordnance:

1 clip of 5.56mm blanks

Site # 59

Ordnance debris:

15 empty 3.5 inch rocket motor containers.

Site # 63

Ordnance Debris:

One expended igniter
3 expended Redeye or SA-7 launch motors

Site # 66

Ordnance debris:

Numerous 5-inch rocket motor parts and debris

.te # 68 and 71

Ordnance Debris:

7 projectile fuzes electric (type unknown) - expended
3 5"/38 projectile base assemblies - empty
1 5"/38 projectiles spotting smoke - empty
1 75mm practice projectile - empty

Site # 68 and 71 (continued)

1 75mm ballistic projectile - concrete filled
1 projectile fuze booster - empty

Site # 72

No live ordnance or ordnance debris found, however ordnance debris was found across the road from the site and the area is an active training area.

Site # 81

Live ordnance:

2 experimental flares

Ordnance debris:

Several hundred expended rocket motors and rocket parts.

Site # 82

Live ordnance:

One uncased solid rocket propellant motor grain (~30 pounds)

Ordnance debris:

3 5-inch projectiles
52 expended Zuni rocket motors
4 2.75-inch rocket motors

Site # 84

Ordnance debris:

one ballistic projectile
one 5 inch shell - empty

Site # 87

Live Ordnance:

one M800 Al High Explosive 57mm round with a M13 fuze dummy (this is not a normal configuration)

Sites # 92

Site # 92 was surveyed and no live UXO/HE or significant recognizable UXO/HE debris was found. Heavy fragments from previous testing were found on the perimeter of the site.

Site # 93 Rocket Launcher Pads

Ordnance debris:

Expended slap flares and smoke grenades were found. This area is still being used for war games and caution should be exercised.

Site # 239

Live Ordnance:

Six live tear gas shells or rockets
One flash bang booby trap
The live ordnance was flagged and left on site.

Site # 239 Continued

Ordnance debris:

Two 55-gallon drums full of expended tear gas ordnance were collected. Three 155mm steel ejection projectiles (non-explosive) were also found.

Site Wide Well Locations # 1, 2, 3, and 4

Both surface and subsurface investigations have been conducted at these sites. No ordnance or ordnance debris was found.

Pantex

Environmental Restoration Site Summary

Site: Pantex Plant

Links to Additional Site Information
Pantex Plant Home Page
Pantex Plant Environmental Restoration Program
1996 Baseline Environmental Management Report Site Narrative
Pantex Plant Environmental Restoration Management Action Process Document

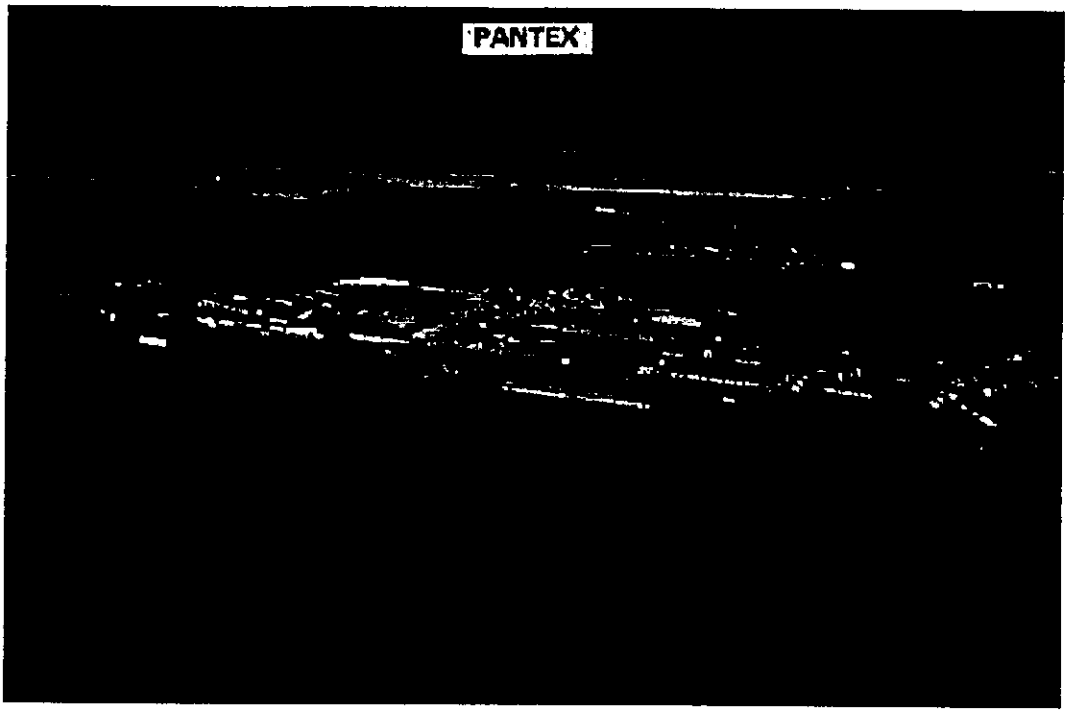
Background

The Pantex Plant is located in the Texas panhandle, about 17 miles northeast of the City of Amarillo. The site covers about 16,000 acres.

The Plant was built by the U.S. Army in 1942 as a conventional bomb plant. In the 1950s, the plant was modified to manufacture high explosives used in nuclear weapons and for the final assembly of nuclear weapons. During the mid-1960s, the plant's mission was expanded to include maintaining and evaluating nuclear weapons in the stockpile and dismantling nuclear weapons as they are retired from the stockpile. The Pantex Plant continues to be the only facility used for the dismantlement and maintenance of the nation's nuclear weapons stockpile. Past production activities at the plant have resulted in the contamination of soils and possibly the ground water with hazardous materials. The Pantex Plant was placed on the Environmental Protection Agency National Priorities List in 1994.

For the purposes of environmental restoration, the plant's 144 solid waste management units have been grouped into 15 operable units. One of the units has since been completed, while two others require no further actions. Remediation activities continue on the remaining units.

* contacted Kevin DaVae 918 669 9149
  sending information 1-28-97
* Contacted by email Edward Engelke COE Tulsa Dist.
  to obtain info on UXO cleanup @ Pantex. 2-5-97
* contacted Kevin DaVae - totally forgot about sending
  info. - will locate requested information and
  call back - 2-11-97



Pantex Plant

Go to the Office of Environmental Restoration Home Page

About This Document

Last Updated 11/25/1996 (mhp)

1996 BEMR

Pantex Plant

HOME BEMR CONTENTS U.S. MAP

Pantex Plant is located in the Texas Panhandle, approximately 27 kilometers (17 miles) northeast of downtown Amarillo. The site consists of approximately 6,500 hectares (16,000 acres).

LOCALITY MAP

Estimated Site Total

(Thousands of Current Year Dollars)								
	FY 1996	1997	1998	1999	2000			
Nuclear Material and Facility Stabilization						*Grey shaded area reflects annual cost estimates for the first five years of the site BEMR Base Case (as of October 1995) and includes 3% annual inflation, see Readers' Guide.*		
Environmental Restoration	14,152	9,650	7,254	11,045	6,376			
Waste Management	12,110	11,058	9,566	9,514	9,344			
Total	26,262	20,708	16,821	20,560	15,720			
1996 Appropriation	24,984			*These levels reflect the current estimates for compliance with applicable statutes and agreements (as of March 1996), see Readers' Guide.*				
1997 Congressional Request		20,122						
(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	2005	2010	2015	2020	2025	2030	
Nuclear Material and Facility Stabilization		2,978	4,426	5,128	1,474			
Environmental Restoration	9,226	1,102						
Waste Management	9,774	7,458	7,315	7,315	7,315	7,315	7,315	
Total	19,001	11,539	11,741	12,443	8,789	7,315	7,315	
	FY 2035	2040	2045	2050	2055	2060	2065	
Nuclear Material and Facility Stabilization								
Environmental Restoration								
Waste Management	7,315	7,315	7,315	7,315	7,315	7,315	7,315	
Total	7,315	7,315	7,315	7,315	7,315	7,315	7,315	
	FY 2070	2075	2080	2085	2090	2095	2100	Life Cycle*
Nuclear Material and Facility Stabilization								70,034
Environmental Restoration								51,642
Waste Management	7,315							561,638
Total	7,315							683,313
** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*								

FACILITY MISSION

Pantex Plant was built by the United States Army in 1942 as a conventional bomb plant. It was decommissioned after World War II and sold to Texas Tech University as excess government property. In the 1950s, the Atomic Energy Commission recovered 4,000 hectares (10,000 acres) of the site, renovated portions of the plant, and constructed new facilities for the manufacture of high explosives used both in nuclear weapons and for the final assembly of nuclear weapons. During the mid-1960s, the plant was expanded to assume weapons maintenance and modification tasks from plants closed in San Antonio, Texas and Clarksville, Tennessee. The last expansion occurred when a sister plant in Burlington, Iowa closed in 1975. Pantex Plant has been the only plant of its type since that time.

SITE MAP

The mission of Pantex Plant involves fabricating high explosives for nuclear weapons, assembling nuclear weapons, maintaining and evaluating nuclear weapons in the stockpile, and dismantling nuclear weapons as they are retired from the stockpile. At present, the principal operation is disassembly of nuclear weapons.

Most of the waste generated at Pantex Plant is generated from the assembly and disassembly operations. The primary objective of the Waste Management program at Pantex Plant is to manage all waste generated at the plant in an environmentally sound manner and in compliance with all applicable federal, state, and local laws and regulations. The program*s primary responsibility is the proper management of all plant waste generated, treated, stored, and packaged for

disposal.

Under the current Environmental Restoration scope of work, Pantex Plant is to assess the contaminants present, remediate the problem through treatment, and remove waste to an approved facility (or store it within capped facilities). In some cases, the contaminant concentrations are low enough that No Further Action is required to meet Texas Natural Resources Conservation Commission requirements or Environmental Protection Agency regulations. In the case of the ground water, the treatment facilities will render the water below drinking water standards, but the water will likely be used for industrial purposes. Some sites will require further monitoring after a treatment plan has been initiated. The contaminants are not addressed individually in this summary; they are, however, addressed at some length within associated portions of this document.

The Waste Management and Environmental Restoration programs are managed within the same division at Pantex Plant. The organizational structure allows both programs to draw on the resources available to obtain the specific expertise required. Funding for environmental management activities began in 1987. The Waste Management program is involved in the characterization and certification of waste generated by environmental restoration. The principal regulatory drivers at the Pantex Plant include: the Resource Conservation and Recovery Act, the Comprehensive Environmental Response Compensation and Liability Act, the Toxic Substances Control Act, and Department of Energy Order 5400.1 (General Environmental Protection Program).

FUTURE USE

The plant's basic mission is not expected to change in the foreseeable future. Pantex Plant will continue to be the only facility used for the dismantlement and maintenance of the nation's nuclear weapons stockpile. It will also provide interim storage for plutonium until the Department of Energy reaches a final decision on its disposition. If the government suspends all further operations, the Industrial site might be leased to industry for operations that can use the plant's specialized security functions and facilities. The surrounding area may continue to be used for Agricultural operations. This report assumes that the future use of the industrial area will be Industrial/Commercial, while the future use of the rest of the site will be Agricultural.

FUTURE USE MAP

NUCLEAR MATERIAL AND FACILITY STABILIZATION

Facility stabilization and maintenance began at Pantex Plant in 1995. The Office of Defense Programs currently provides funding for stabilization and maintenance. Transfer of facilities to the Environmental Management program is anticipated to occur in FY 2002. Eight facilities have already begun stabilization, including a chlorinating building, a digester, explosives machining, a synthesis building, and an electrical substation. This report assumes that the remaining facility (a sewage tank) will begin stabilization and maintenance activities in FY 1996. The resulting waste types are expected to include: radioactive process water, liquid and solid low-level waste, sanitary waste, heavy metals, and solvents. This report assumes the stabilization and maintenance process at Pantex Plant will be completed by FY 2010. Funding profiles and facility activities were generated through parametric modeling, using data from other Department of Energy facilities.

Nuclear Material and Facility Stabilization Activities Cost Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	2005	2010	2015	2020	2025	2030	Life Cycle*
Nuclear Material and Facility Stabilization		2,978	4,426	5,128	1,474			70,034

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

ENVIRONMENTAL RESTORATION

The production of explosives components for nuclear weapons has resulted in the contamination of soils primarily by organic solvents and explosives. In addition, tests of weapons components have contaminated some areas with explosives and heavy metals. The contaminants have gradually migrated to subsurface soils and the perched ground water. Ground-water contamination has been detected in the perched aquifer, which is located a few hundred feet above the Ogallala Aquifer, the primary water source for the region. Because of this contamination, the Environmental Protection Agency placed Pantex Plant on its National Priorities List in May 1994. The Department of Energy/Amarillo Area Office is currently negotiating a Tri-Party Federal Facilities Agreement with the Environmental Protection Agency and the Texas Natural Resources Conservation Commission. See the Site Map for the location of environmental restoration related activities.

Environmental restoration activities at Pantex are conducted in compliance with a Resource Conservation and Recovery Act permit that the Texas Water Commission (which has since become part of the Texas Natural Resources Conservation Commission) issued in April 1991. Activities began in 1992 and are expected to be completed during FY 2000.

Surveillance and monitoring will be performed to comply with regulatory drivers (as discussed in the AFacility Mission@ section above) once the site is remediated or decommissioned. A number of ground-water wells will be monitored for constituents of concern. Air monitoring will consist of radiological and nonradiological constituents analysis. Ecological/biota monitoring and surveillance will continue for those constituents that potentially pose a risk. This report assumes that these activities will continue for 30 years after remediation is complete.

The assessment activities at 12 of the 15 operable units have shown that most of the waste material generated is nonhazardous. In situ remediation will be the primary technology used for remediation of the hazardous portion of the waste. As a result, hazardous waste sent to the Waste Management program for disposal will be minimal.

Pantex Plant has implemented strategies to reduce the amount of waste generated during investigations, as well as the amount of waste handled, treated, or disposed of during site cleanups. A key point of this strategy is minimizing the amount of waste generated during remedial feasibility investigations by sonic drilling, geophysical and soil gas survey techniques, and other survey methods that generate minimal volumes of waste.

Waste investigated is sampled, and the samples are sent to a laboratory for analysis. Upon receipt of the validated analytical data, the investigative materials are classified appropriately. Solid waste (for example, construction debris) classified as Class III is disposed onsite in a permitted landfill. Class II solid waste is disposed of offsite in a permitted landfill in Amarillo. Class II liquids, personal protective materials, and Class I or hazardous waste is disposed of offsite at a permitted treatment disposal facility. If any interim waste storage handling is required, secondary containment of liquids is ensured.

Major Environmental Restoration Activity Milestones

TASK	COMPLETION DATE Fiscal Year
Operable Unit PX-1 (Burning Ground Sites)-Remediation	1996
Operable Unit PX-3 (Former Cooling Tower)	1997
Operable Unit PX-5 (Fire Training Area Burn Pits) Remediation	1996
Operable Unit PX-6 (Zone 12 Ground Water)- Remediation	2000
Operable Unit PX-7 (Landfills)-Remediation	1999
Operable Unit PX-8 (Ditches And Playas)- Remediation	1997
Operable Unit PX-9 (Firing Sites)- Remediation	1997
Operable Unit PX-11 (Miscellaneous High Explosives)- Remediation	1997
Operable Unit PX-12 (Miscellaneous Chemical Releases)- Remediation	1996

The plant's 144 solid waste management units are grouped into 15 operable units for investigation and cleanup activities associated with them. The operable units included 114 potential release sites. Resource Conservation and Recovery Act Facility Investigations have been initiated for all operable units. For Operable Units PX-3 (Former Cooling Tower) and PX-4 (Old Sewage Treatment Plant Sludge Beds), work is being performed for chromium contamination. Unit PX-15, the Hypalon Pond, was closed in 1995. Currently, voluntary corrective actions are being taken at several sites, and No Further Action is planned at several other sites. Brief descriptions of the active operable units follow.

Waste Management and Environmental Restoration are cooperating to ensure coordination of work and personnel to accomplish the necessary tasks. A staff of Environmental Restoration program, planning, analysis and control personnel provides program management/support for all the operable units discussed below. The Environmental Restoration program estimate includes management of waste including characterization, packaging, treatment, storage and disposal of waste generated by Environmental Restoration program activities. Waste Management will assume the responsibility for waste generated from environmental restoration activities beginning in FY 1997, and the estimate includes characterization, packaging, treatment, storage, and disposal costs for Environmental Restoration program waste.

Operable Unit PX-1: Burning Ground Sites

The Burning Grounds in the north-central portion of Pantex Plant comprises approximately 140 hectares (58 acres). Operation at the Burning Grounds began as early as 1952. The site is used for the demilitarization of high explosive components and treatment of high explosive-contaminated material. Disposal of solvents is ongoing. Active units in the Burning Grounds include burn trays, racks, and demonstration-detonation sites. Closure plans for burn cages and flashing pits have been submitted to the Texas Natural Resources Conservation Commission. Inactive units yet to be investigated include the solvent evaporation pit and pans, the former chemical burn pit, burn pads, and the Burning Grounds landfills. The potential contaminants of concern are high explosives, solvents, volatile organic compounds, asbestos, polychlorinated biphenyls and small amounts of radionuclides. The Phase 1 fieldwork consisted of a geophysical survey, soil samples, and a ground-water investigation. This investigation was conducted from March through May 1994. Final data packages detailing

the Resource Conservation and Recovery Act Facility Investigation have been submitted to the Texas Natural Resources Conservation Commission for review. Response from the Texas Natural Resources Conservation Commission initiated a Phase 2 investigation to determine the lateral extent of high explosures. In addition, a Risk Assessment of the Burning Grounds was also conducted. The results of this Phase 2 investigation will be incorporated into the Resource Conservation and Recovery Act Facility Investigation as an Addendum, and results of the risk assessment will be used to determine the possibility of No Further Action or additional remediation actions to be conducted at the Burning Grounds for closure.

ASSESSMENT

No Further Action is assumed for all closed sites associated with the Burning Grounds, except for the flashing pits and selected landfills. A Phase 2 assessment will be completed in FY 1996 to characterize waste in several inactive landfills not investigated during Phase 1. Additional Phase 2 work, a Resource Conservation and Recovery Act Facility Investigation, and a risk assessment will be conducted during FY 1996. Completion of work at PX-1 is scheduled for the fall of 1997. Cleanup of the site may be deferred until the Burning Grounds becomes inactive.

To prevent migration of contaminants beyond the landfill boundaries, limited landfill capping is assumed. These proposed basic caps will prevent runon and runoff of surface drainage.

Decommissioning of the two burning cages and the burn pit pans will occur in FY 1996. This report assumes that all waste generated during final cleanup will be treated and disposed of at a permitted facility.

Ongoing activities at the Burning Grounds will preclude closure activities of the Burning Grounds Solid Waste Management Units until these activities cease. Monitor wells have been installed in both the Perched and Ogallala aquifers at the Burning Grounds. Currently anticipated activities for Interim Corrective Measures or voluntary corrective action will include modification of the landfill surface for runoff control and removal and control of burrowing animals. Upon closure of the Burning Grounds, closure activities of existing solid waste management units will begin. This estimate includes no cost for remediation.

Operable Unit PX-2: High Priority Potential Release Sites

Various industrial operations supporting the Pantex Plant mission had the potential for release of hazardous constituents to the environment. These releases are associated with nine sites, collectively referred to the High Priority Potential Release sites Solid Waste Management Unit grouping. The Phase 1 fieldwork consisted of soil gas sampling and soil boring samples. The fieldwork was completed in February 1994. Three interim corrective measures were performed in the summer of 1995. Closure plans for all three of the interim corrective measures have been submitted to Texas Natural Resources Conservation Commission.

ASSESSMENT

The principal contaminants of concern for the High Priority Potential Release sites are high explosives, volatile organic compounds, and metals. These contaminants are present at levels both above and below Risk Reduction Standard 2 as defined under Texas Administrative Code Title 30, Section 335, Subparts A and S. No further assessment activities are required at this time. No Further Action is recommended for the nine High Priority Potential Release sites. Accordingly, a recommendation of No Further Action has been submitted to the Texas Natural Resources Conservation Commission. The Texas Natural Resources Conservation Commission is currently reviewing the request for No Further Action. This estimate also assumes assessment activities will generate 250 cubic meters (325 cubic yeards) of hazardous waste.

REMEDIAL ACTION

Three interim corrective measures were implemented during the summer of 1995. These consisted of: 1) removal of the sump and pond liner, including underlying sediment, at the evaporation pond adjacent to Firing Site 16; 2) removal of the concrete sump and adjacent soil at Building 12-68; and 3) removal of the container [the breach section of a 40-centimeter (16-inch naval gun)] from Firing Site 22. Requests for closure have been submitted to the Texas Natural Resources Conservation Commission. This report assumes no further action will be needed.

Operable Unit PX-3: Former Cooling Tower

The site includes Area of Concern Number 13 and is located in the east-central portion of the Pantex Plant, in a high-security area in Zone 12. The tower was used for water cooling from 1950 to 1964 for high explosives machining operations in nearby buildings. A large adjacent concrete basin was used as a water reservoir system. Contamination could have potentially resulted from the overflow of the water reservoir, leakage through or adjacent to the foundation, continuous dripping/leaking, and blow-down water.

ASSESSMENT

No Further Action was recommended to the Texas Natural Resources Conservation Commission in October 1993 based on low levels of contamination found in the soil. The Texas Natural Resources Conservation Commission Risk Reduction Standards state that contamination at these levels does not pose a threat to human health or the environment. Regulatory approval of the recommendation for No Further Action is pending. However, in March 1995, an investigation of ancillary piping that supplied water to the former cooling tower revealed the presence of chromium-contaminated soil under the piping. The extent of contamination has not been defined. In FY 1996, additional investigation of this site will define the vertical and lateral extent of this contamination.

REMEDIAL ACTION

This report assumes that an interim corrective measure will be performed in FY 1997 to remove immediate contamination of the chromate plume. In FY 1996, remediation activities will be performed under PX-6, Ground Water, to remediate the chromium ground-water contamination.

Operable Unit PX-4: Old Sewage Treatment Plant Sludge Beds

The Old Sewage Treatment Plant sludge beds are located in Zone 13 in the extreme northeast corner of Pantex Plant. The Old Sewage Treatment Plant was in operation from 1942 until 1987 and is now out of service. The facility treated wastewater from the Pantex Ordnance Plant, Amarillo Air Force Base, and Pantex Plant. The Old Sewage Treatment Plant consists of six rectangular, sloped, concrete-lined units filled with pea-sized gravel. Each bed is approximately 12 meters by 30 meters (40 feet by 100 feet). Sludge from the anaerobic sludge digester was discharged to the individual beds. Sludge residue was retained on top of the gravel, while excess liquid trickled through the gravel. The liquid then flowed along the sloped concrete liner surface and was collected in sumps at the edge of each bed before returning to the plant for processing.

ASSESSMENT

Regulatory approval is pending because of the levels of contamination in the soil that were very low. No Further Action for the Old Sewage Treatment Plant Sludge Beds was recommended to the Texas Natural Resources Conservation Commission in September 1993. This report assumes No Further Action is required.

Operable Unit PX-5: Fire Training Area Burn Pits

The Fire Training Area Burn Pits site is located northwest of Zone 12, adjacent to south 13th Street and the Pantex Plant Fire Training Center. The Resource Conservation and Recovery Act Facility Investigation area occupies approximately 1.7 hectares (4.25 acres). The main features of interest at the site are two underlined burn pits, (Pit 1 and Pit 2), which were used to contain training fires staged at the site, a crawl tube formerly used in fire/smoke training exercises, a former tank and storage area for drums of waste solvents and fuels used to set training fires, and a shallow unlined drainage ditch that periodically received runoff from the pits and surrounding areas.

The nature and volume of materials used in the past fire training exercises are only partially documented. Waste solvents, as well as fuels and oils (some possibly containing polychlorinated biphenyls), were reportedly burned in Pit 1. Before 1985, approximately 208 liters (55 gallons) of toluene, and 380 liters (100 gallons) of dimethylefromanide were reportedly burned in Pit 2. The extinguishing agents used included protein foam, ABC-type dry chemical mixtures, 1211 Halon, Aqueous Film-Forming Foam, and water. The Fire Training Area Burn Pits site was used from 1973 until 1990 for Pantex Plant Fire Department personnel training exercises. The site was used approximately twice a year.

An interim corrective measure was initiated to remove the upper 0.6 meters (two feet) of contamination (primarily pesticides and metals) during the summer of 1995. Hot spots (isolated areas that exceed acceptable levels of contamination) were removed to meet Risk Reduction Standards. After excavation, appropriate offsite disposal of contaminated soil was followed by confirmation sampling to document compliance with the Risk Reduction Standards cleanup levels. Approximately 1,041.2 cubic meters (1,370 cubic yards) of soil were removed. Additional Resource Conservation and Recovery Act Facility Investigation Phase 2 sampling was performed to complete characterization of the nature and extent of contamination at the Fire Training Area Burn Pits. The remediated area was backfilled with material obtained from the Pantex Plant Borrow Area. Reseeding of the area was done using native grasses. The Draft Final Interim Corrective Measures Closure report was submitted to regulators in November 1995. This estimate assumes No Further Action will be required.

Operable Unit PX-6: Ground Water in Zone 12

The Ground Water Operable Unit manages all perched aquifer contamination at the Pantex Plant which originated from various widespread sources within the plant. This report assumes that the major portion of the contamination in the perched aquifer originated in the industrial portion of the plant, which includes Zones 11 and 12. These zones include, or have

included administrative and support facilities, vehicle and high explosives, operations, chemical and photographic laboratories, cooling towers, and other industrial operations.

ASSESSMENT

Argonne National Laboratory conducted an expedited site characterization. Three additional wells for monitoring perched aquifers and one well for monitoring the Ogallala aquifer were proposed as part of Phase 2 fieldwork. These Phase 2 wells were completed in 1995. An Accelerated Site Assessment Project was conducted in 1995. This project included both onsite and offsite exploratory drilling to determine the extent of the perched aquifer contamination. High explosives contamination was found offsite to the east of the plant.

REMEDIAL ACTION

Phase 2 fieldwork is complete. The Resource Conservation and Recovery Act Facility Investigations report has been prepared and submitted to regulators. The expedited site characterization was completed and a report of the findings was submitted in August 1995. The Accelerated Site Assessment Project was completed in November 1995. This project included the drilling of up to ten additional test holes to determine the extent of contamination within the perched aquifer, both onsite and offsite.

A treatability study for the perched aquifer on Pantex Plant was conducted in FY 1995. This study included the extraction and treatment of the contaminated perched ground water. The treatability system will be located east of Zone 12 and will include three ground-water extraction wells and a treatment unit.

Several alternatives are being studied to determine a beneficial reuse of the treated wastewater from the treatability system. These alternatives include: 1) reuse of water for steam generation, 2) sale of treated water to Texas Tech for irrigation purposes, and 3) discharge of treated water to Playa 4 for wetlands enhancement. Ground water will also be reinjected to enhance remediation.

All of the alternatives referenced above will reduce the Pantex Plant dependency on the Ogallala Aquifer for operations. This report assumes that remediation will be complete in FY 2000. It also assumes that activities will generate 3.4 million cubic meters (4.4 million cubic yards) of hazardous waste.

Operable Unit PX-7: Landfills

Since Pantex Plant was established in 1942, virtually all sanitary and industrial solid waste generated at Pantex Plant has been disposed of in landfills located throughout the facility. Twenty-three landfills exist at Pantex Plant, 16 of which are included in this group. The major types of waste that have been buried in the landfills are sanitary waste (waste from cafeteria and other general trash, such as paper, plastic, empty containers and food), construction debris (materials such as metal scrap, lumber, roofing materials, concrete, railroad ties/rails, drums, insulation, plastic, and wire), high explosive-contaminated waste, chemical waste, used batteries, residual ash, pesticides, and other miscellaneous trash and debris. These practices have been discontinued. Phase 1 fieldwork was completed in 1994 with the submittal of preliminary data packages in 1994 as well. Phase 2 fieldwork was completed in 1995 with the Draft Final Resource Conservation and Recovery Act Facility Investigation reports to be completed in 1996 (January and June, respectively).

The contaminants detected in the Phase 1 landfill investigation were: volatile organic compounds, semi-volatile organic compounds, metals, pesticides, polychlorinated biphenyls, and asbestos.

ASSESSMENT

The principal contaminants of concern for the landfills are high explosives, semi-volatile organic compounds, metals, pesticides, and asbestos. These contaminants are present at levels both above and below Risk Reduction Standard 2 as defined under Texas Administrative Code Title 30, Section 335, Subparts A and S. No further assessment activities are required at this time. Currently, the Resource Conservation and Recovery Act Facility Investigation reports are being prepared for submission to the Texas Natural Resource Conservation Commission.

REMEDIAL ACTION

Analysis of the data from the assessment phases is being reviewed to ascertain the applicability of interim corrective measures. Landfill 3, and possibly other landfills, will require a corrective measures study. Any remediation activities for Landfill 3 will be incorporated into the ground-water remediation activities currently under way (see Operable Unit 6). Closure strategies for the landfills are currently being reviewed, with emphasis placed on Risk Reduction Standard 2 and Risk Reduction Standard 3 closures. This report assumes that remediation will be complete in FY 1999.

Operable Unit PX-8: Ditches and Playas

This Solid Waste Management Unit grouping consists of the manmade ditches and natural flow system that drains the plant area. Pantex Plant rainfall and runoff enters the ditches and natural drainage system and ultimately flows to four onsite playas. Historically, drainage was also diverted offsite to Pantex Lake, located northeast of the Pantex Plant. In the past, the industrial operations in Zones 11 and 12 caused chemical releases that potentially entered the drainage ditches and playas located at the plant. Surface runoff from the Burning Grounds flowed into Playa 3, and effluent treated at the Old Sewage Treatment Plant (inactive since 1987) was pumped to Pantex Lake. The specific contamination at each site depends on the history of the site. However, some of the compounds being evaluated are volatile organic compounds, semi-volatile organic compounds, metals, high explosives, pesticides, polychlorinated biphenyls, and nitrites-nitrates. Interim corrective measures for the ditches are planned for the spring of 1996.

ASSESSMENT

Phase 1 Resource Conservation and Recovery Act Facility Investigation activities included surface and subsurface soil sampling for five of the six flow systems within this operable unit. The sixth flow system, ground water, had monitoring wells installed in a perched aquifer.

Based on the Phase 1 results, three of the six water flow systems in this operable unit required surface and subsurface sampling. Two of the others required sampling of surface areas only. The required samples were obtained on Phase 2 fieldwork during the spring of 1995. The sixth flow system requires the drilling of additional monitoring wells. This drilling was added to the Zone 12 ground-water (Operable Unit 6) assessment conducted during the summer of 1995. As part of the Phase 2 fieldwork, a number of samples were collected and analyzed in undisturbed areas offsite to determine background concentrations of naturally occurring constituents. The main contaminants of concern include metals, semi-volatile organic compounds, high explosives, and pesticides/herbicides. Site characterization is complete. The Resource Conservation and Recovery Act Facility Investigation report was submitted to the regulators in September 1995.

REMEDIAL ACTION

The Environmental Restoration staff is currently correlating flow system processes, including low flow conditions and pooling areas, with contaminant concentrations to delineate interim corrective measure candidate sites. Once identified, remedial actions to be employed include excavation and disposal, or in situ remediation, which will be conducted concurrently with additional site characterization. It is anticipated that all remedial activity will be completed in FY 1996.

Operable Unit PX-9: Firing Sites

The Firing Sites are located in the north-central portion of the Pantex Plant and were operational as early as 1952. The sites historically were used for the testing of high explosives in connection with quality control and research and development activities. Some radioactive materials, primarily depleted uranium, were involved in the testing program. The potential contaminants of concern include high explosives, metals and small amounts of radionuclides. Phase 1 fieldwork was completed in August 1995. This investigation included a radiological survey, and a surface and subsurface soil investigation. Since some of the sites are still active, only the inactive Firing Sites 5, 6 and 15 were included in this investigation. The remaining sites will be closed and investigated once the operational life is completed. Costs for these sites were not included in this estimate.

ASSESSMENT

Soil investigations for Firing Sites 5, 6, and 15 were completed in the summer of 1995. Firing Sites 6 and 15 will be closed, using the Risk Reduction guidelines promulgated by the Texas Natural Resources Conservation Commission. This estimate assume there are some assessment activities in FY 1996 and FY 1997 at Site 5.

REMEDIAL ACTION

At Firing Site 5 a pilot study is surveying and recovering visible depleted uranium from surface and near-surface soils. This interim corrective measure will also include surveying and removing visible depleted uranium within the berm area. The type of waste generated from decommissioning of the Firing Sites is low-level mixed. This estimate assumes that remediation will be completed FY 1997 and will generate 53 cubic meters (69 cubic yards) of low-level waste.

Operable Unit PX-10: Leaking Underground Storage Tanks

The site includes Area of Concern 6, which comprises two gasoline release sites, and Buildings 12-35 and 16-1.

Underground storage tanks have been removed from both of these locations, and leaks are known to have occurred. From 1951 to 1976, five underground steel tanks were installed for storing gasoline, diesel, and motor oil southeast of Building 12-35. Two gasoline leaks occurred in 1974 or 1975 and 1985. As a result, all tanks were removed by 1988. In 1980, two fiberglass tanks were installed south of Building 16-1 to store diesel fuel and unleaded gasoline. One diesel fuel leak occurred in 1985. As a result, both tanks were removed in 1989.

ASSESSMENT

Phase 1 and 2 fieldwork has been completed. No significant soil contamination from underground storage tanks leaks was detected at Building 16-1.

REMEDIAL ACTION

On the basis of the Resource Conservation and Recovery Act Facility Investigation, no corrective actions have been recommended for the site of the underground storage tanks at Building 16-1 and the estimate includes no cost for remediation

Operable Unit PX-11: Miscellaneous High Explosives/Radiation Sites

This operable unit comprises several solid waste management units at 13 different sites. Each of the site's operations at one time generated waste from high explosives processing, high explosives treatment, stored radioactive/high explosives material or treated high explosives wastewater. Most of the sites contain high explosives, metals, semi-volatile organic compounds, volatile organic compounds, and soil contamination caused mainly by the discharge of wastewater activities.

ASSESSMENT

This operable unit comprises 13 sites. A number of surface and subsurface soil samples were collected during the Resource Conservation and Recovery Act Facility Investigation report. Contaminants of concern include high explosives, metals, and limited semi-volatile organic compounds/volatile organic compounds. A Resource Conservation and Recovery Act Facility Investigation report was submitted to the regulators in January 1996.

REMEDIAL ACTION

Data documents are complete, and an interim corrective measure is planned. It will combine in situ bioremediation, soil removal, and offsite disposal. Additional soil sampling was completed to delineate interim corrective measure candidate sites; the data is pending analysis. No Further Action will be recommended for other sites. However, based on the investigation material, some of the soil contamination involves hazardous waste. This estimate assumes a volume of 10,000 cubic meters (13,100 cubic yards) from the interim corrective measures remediation activities.

In situ remediation is planned for many of the sites. Those areas requiring excavation will be either Class I nonhazardous waste, which will be shipped offsite to an approved Department of Energy disposal facility; or Class II nonhazardous, which will be placed at the permitted environmental landfill cell at Pantex. This estimate assumes that remediation of this operable unit will be complete in FY 1997.

Operable Unit PX-12: Miscellaneous Chemical Spills and Release Sites

The miscellaneous Chemical Spills/Release sites consist of several locations at Pantex Plant where spills or releases occurred or may have occurred during routine plant operations. These sites are located in Zones 4, 10, 11, and 12, and in the central and southern portions of Pantex Plant. The Chemical Spills site has been or is currently being used for a variety of purposes, including: storage of scrap and salvageable materials; storage and recharging of batteries; collection and disposal of process waste; storage of transformers and other electrical equipment containing polychlorinated biphenyls; boiler house operations; storage and disposal of sulfuric acid; storage of solvents; mixing of pesticides/herbicides and rinsing of pesticide application equipment; and collection of wastewater, sludge, and solvents from degreasing and machine shop operations. Most of the spills/releases occurred between 1950 and 1980.

ASSESSMENT

Phase 1 soil investigations are complete. The results indicated Phase 2 soil sampling was necessary, and it was conducted during the summer of 1995. The Draft Final Resource Conservation and Recovery Act Facility Investigation was submitted to the regulators in August 1995. In November 1995, additional sampling was performed at nine sites to characterize risk drivers to background and to obtain data to facilitate closure. Chemical sample analyses included pesticides, polychlorinated biphenyls, lead, explosives, mercury, semi-volatiles, and synthetic precipitate leaching procedure for pesticides and lead.

REMEDIAL ACTION

No Further Action is recommended for six sites, one of which remains active. Closure will be deferred until the building is decontaminated and decommissioned. Another site was closed subsequent to a records search and a visual inspection which indicated no contamination. The results of synthetic precipitate leaching procedures support a recommendation of No Further Action; therefore, the estimate includes no remediation costs.

Operable Unit PX-13: Supplemental Verification Sites

The Supplemental Verification sites Solid Waste Management Unit grouping is made up of eight landfills and other miscellaneous surface sites throughout the facility that are known or suspected of receiving hazardous constituents or present unknown potential for contaminant risk, requiring verification. Various operations and maintenance activities at the Pantex Plant have resulted in onsite chemical usage, incidental disposal of spent material, and demolition of structures with disposal in onsite rubble landfills.

ASSESSMENT

The principal contaminants of concern for the supplemental verification sites are polynuclear aromatic hydrocarbons, semi-volatile organic compounds, metals, and pesticides. No further assessment activities are required at this time. Currently, the Resource Conservation and Recovery Act Facility Investigation reports are being prepared for submission to the Texas Natural Resource Conservation Commission.

REMEDIAL ACTION

No Further Action has been recommended; therefore, no remediation costs were included in this estimate. Further consideration of any potential remedial action will proceed upon receipt of the Draft Resource Conservation and Recovery Act Facility Investigation report. All waste generated during site investigation and has been shipped offsite for disposal.

Operable Unit PX-14: Underground Storage Tanks at Other Locations

Four underground storage tanks (7, 9, 38, 39) were located in Zone 12 and one at the existing Vehicle Maintenance Facility. One of the five underground storage tanks (Number 30) is identified as Solid Waste Management unit 133. All of the underground storage tanks except Number 30 contained diesel fuel for emergency power generators. Underground storage tank Number 30 contained waste oils generated from vehicle maintenance activities. The remaining four are included because their investigation is warranted due to the potential release of hydrocarbons. All five tanks have been removed.

ASSESSMENT

Phase 1 and 2 fieldwork has been completed. Potential constituents of concern included benzene, toluene, ethylbenzene, and xylene, and total petroleum hydrocarbons. Two corrective action reports were submitted to the regulators. The Draft Final Corrective Action report for underground storage tanks 7, 30, 38, and 39 was submitted on October 14, 1994, while the report for underground storage tank 9 was submitted on April 24, 1995. This report assumes no corrective action nor further investigation is warranted for all sites in this operable unit.

Operable Unit PX-15: 11-14 Hypalon Pond

This site consists of a former surface impoundment (11-14 Pond) located at Building 11-14. Constructed in 1975, the pond treated acidic wastewaters from high explosives operations in Building 11-36. Pond operations were discontinued as a hazardous waste treatment unit in March 1989. The existing wastewater sludge residues were removed and disposed of at an offsite hazardous waste disposal facility. The pond was backfilled and graded in May 1990. The former pond was approximately 9.2-meters (30-feet) wide, 30.5-meters (100-feet) long, and 2.3- meters (7.5-feet) deep from the top of the surrounding berm. At times, wastewater containing residual concentrations of solvents was discharged into the pond.

Resource Conservation and Recovery Act Closure activities began in 1992 and consisted of soil sampling along the pipe trench, borings drilled in the center of the former pond, and the installation of four perched zone monitoring wells. Wastewater, sludge residues, and the hypalon liner were removed from the pond and disposed of at a permitted facility. The pond was backfilled and graded in March 1990. Regulatory approval was granted for the pond closure on May 19, 1995, with the completion of deed certification in the Carson County Registry of Deeds.

Environmental Restoration Activities Cost Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)								
	FY 1996-2000	2005	2010	2015	2020	2025	2030	Life Cycle*
Burning Ground								
Remedial Action	20							100
High Priority Potential Release Sites								
Assessment	12							62
Old Sewage Treat. Plant Sludge Beds								
Assessment	8							40
Fire Training Area Burn Pits								
Assessment	2							10
Remedial Action	2							9
Ground Water in Zone 12								
Assessment	1,683							8,416
Remedial Action	2,641							13,207
Landfills								
Assessment	149							745
Remedial Action	791							3,956
Ditches and Playas								
Assessment	22							109
Remedial Action	95							474
Firing Sites								
Assessment	45							226
Remedial Action	115							576
Leaking Underground Storage Tanks								
Assessment	16							82
Misc. High Explosive/Rad. Sites								
Assessment	48							241
Remedial Action	599							2,996
Misc. Chemical Spills and Release Sites								
Assessment	24							121
Remedial Action	140							698
Supplemental Verification Sites								
Assessment	12							60
Direct Program Management/Support	2,801	1,102						19,514
Total	9,226	1,102						51,642

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

WASTE MANAGEMENT

Pantex Plant operations generate various types of waste. The waste produced by the assembly and disassembly of weapons includes high explosives and solvents. These operations also produce radioactive process water, debris contaminated with radioactive materials, low-level waste, low-level mixed waste, hazardous waste, sanitary waste, heavy metals, and solvents. Waste is also produced by various support operations such as the chemistry laboratories, maintenance, and the vehicle fleet.

Pantex Plant does not generate high-level waste or transuranic waste during routine operations. Three drums of transuranic waste generated from an isolated event are being stored at the plant on an interim basis until they can be shipped to the Waste

Isolation Pilot Plant for disposal or to another Department of Energy site for interim storage. Storage and inspection costs are extremely small and not included in the estimate. Transportation costs to the Waste Isolation Pilot Plant are in the Waste Isolation Pilot Plan estimate.

In the future, the volume of operations-generated waste is expected to decrease as a result of waste minimization efforts and reduced dismantlement levels. As operations-generated waste decreases, the backlog of stored waste will be disposed.

Although the overall totals for the waste generation forecast are expected to have a fairly high confidence factor, several factors cause the level of confidence in the forecast figures for individual waste streams to be low. Pantex Plant uses waste stream descriptions to match waste types defined by the State of Texas. Because of changes made by the State of Texas, effective January 1994, the historical reference period of waste generation is relatively short for the current descriptions. Additionally, the waste minimization effort continues to provide benefits that reduce the amount of hazardous or mixed waste generated, but thereby often increase the amount of nonhazardous or low-level waste. Because the waste minimization effort continues at a good pace, the benefits can be expected to accumulate, but the effect will be to change the categories where waste generation is reported, and consequently the figures for individual waste streams are less accurate than the overall totals. Improvements are expected in the confidence factor for individual waste streams as additional background information is collected.

Major Waste Management Activity Milestones

TASK	COMPLETION DATE Fiscal Year
Hazardous Waste Staging Facility Construction	1996
Burning Grounds Upgrade	1997
Hazardous Waste Treatment and Processing Facility Construction	1998
Hazardous Waste Treatment and Processing Facility Start of Operations	2000

Low-Level Mixed Waste

GENERATION AND HANDLING

Pantex Plant produced a Site Treatment Plan, as required by the Federal Facility Compliance Act, resulting in a Consent Order with the State of Texas. The Consent Order governs schedules and milestones for low-level mixed waste treatment. Waste Management is involved in developing waste management plans for the disassembly of weapons to minimize the amount of waste generated.

The Office of Defense Programs (assembly and disassembly of weapons) and environmental restoration activities generate low-level mixed radioactive waste at Pantex Plant. After the generator initially characterizes and packages the waste, it will be transferred to the Waste Management program. Waste Management will not assume responsibility for environmental restoration-generated waste until FY 1997. Prior to FY 1997, treatment, storage, and disposal costs related to waste generated by environmental restoration activities are included in the remedial action costs of the Environmental Restoration program.

Onsite generation of low-level mixed radioactive waste was 9,429 kilograms (20,954 pounds) in FY 1995. This estimate assumes that 4,649 cubic meters (6,080 cubic yards) of waste will be generated in the life cycle.

TREATMENT

Pantex Plant developed a Site Treatment Plan for low-level mixed radioactive waste as required by the Federal Facility Compliance Act. The plan calls for the development and use of (1) existing onsite facilities, (2) commercial treatment, and (3) onsite treatment using mobile treatment units. The engineering and design of the mobile treatment units will start in FY 1996. Validation and startup will occur in FY 1999, with regular treatment operations beginning in FY 2001. Mobile treatment units are expected to require upgrading every 12 years (FY 2010 and FY 2022). Not all waste streams are ready for treatment, and disposal facilities will not be available in FY 1996.

The proposed Hazardous Waste Treatment and Processing Facility is designed for low-level waste, low-level mixed waste, and hazardous waste. It will also accommodate the mobile treatment units. Construction is expected to be completed in FY 1998, with processing beginning in FY 2000. See the Site Map for the location of Waste Management program activities.

STORAGE

Low-level mixed waste is currently being stored onsite in compliance with the Federal Facility Compliance Act Order and Compliance Plan, which the Department of Energy and the Texas Natural Resources Conservation Commission negotiated.

The waste will be stored pending development of approved treatment technologies.

A Resource Conservation and Recovery Act hazardous waste staging facility has been designed, and completion in FY 1996 is planned. This facility will provide storage for 1,600 drums of hazardous, mixed, and low-level radioactive waste. The estimate assumes that the staging facility will require upgrading in FY 2026. At the end of FY 1995, Pantex Plant had approximately 67,000 kilograms (147,800 pounds) of low-level mixed waste in storage.

DISPOSAL

Low-level mixed waste is disposed at offsite commercial disposal facilities. Waste Management program costs for disposal, offsite transportation, and onsite support including review of the waste against the Waste Acceptance Criteria of the receiving facility. The estimate assumes 4,702 cubic meters (6,150 cubic yards) of waste will be disposed.

WASTE MINIMIZATION/POLLUTION PREVENTION

Hazardous waste generation at Pantex Plant has been reduced for the last seven consecutive years. The 1994 hazardous waste generation rates were 98 percent less than the rates in 1988.

From the baseline year in 1992, the reductions in waste generation have been: mixed waste, 69 percent; hazardous waste, 80 percent; Toxic Substances Control Act waste, 92 percent; Class 1 waste, 20 percent; and low-level waste, 12 percent.

Four plant-funded projects were implemented with an excellent return on investment. These projects will save the plant an estimated $1.7 million on the investment of only $315,000. Over 13,000 kilograms (28,660 pounds) of hazardous waste and 1.8 million kilograms (4 million pounds) of Class 1 waste have already been eliminated.

These projects include the following: 1) Grind and reuse asphalt and concrete in September 1995, 2) install digitial photographic equipment in December 1995, and 3) implement thermal decontamination of tritium-contaminated weapons parts in February 1995.

Low-Level Waste

GENERATION AND HANDLING

The Waste Management program is involved in developing waste management plans for the disassembly of weapons to minimize waste generated.

Low-level radioactive waste at Pantex Plant is generated by the Office of Defense Programs (assembly and disassembly of weapons) and environmental restoration activities. Waste Management will assume the responsibility for Environmental Restoration-generated waste beginning in FY 1997. After initial characterization and packaging are performed by the generator, waste is transferred to the Waste Management program. Prior to FY 1997, the estimate includes characterization and packaging costs in the generator's estimate. After FY 1997, the waste management estimate includes characterization and packaging, as well as treatment, storage, and disposal.

Low-level radioactive waste is divided into two categories: 1) waste approved for shipment to Nevada Test Site for disposal, which is routinely shipped when appropriate shipping increment quantities are accumulated; and 2) waste not yet approved for shipment to the Nevada Test Site, which is stored onsite pending approval for shipmentto the Nevada Test Site or other offsite disposal facility.

Onsite generation of low-level waste was approximately 53,000 kilograms (116,900 pounds) in FY 1995. This estimate assumed that 8,544 cubic meters (11,175 cubic yards) will be disposed.

TREATMENT

Treatment for low-level waste consists of stabilization and solidification to meet the acceptance criteria for the Nevada Test Site. Also included is the separation of liquid waste from solid waste.

STORAGE

Pantex Plant provides for onsite storage of low-level radioactive waste generated at Pantex Plant that is not approved for

disposal at the Nevada Test Site. This includes operation of the waste tracking system data base; issuance of waste containers, labels and markings; maintenance of waste disposition forms; generation of inventory reports; monthly, quarterly, and annual waste summary reports for submittal to the Texas Natural Resource Conservation Commission; monthly inspections of low-level radioactive storage areas; loading and off-loading of waste at the storage facilities; and documentation of cradle-to-grave tracking of low-level radioactive waste.

A Resource Conservation and Recovery Act hazardous waste staging facility has been designed with completion expected in FY 1996. This facility will provide storage for 1,600 drums of hazardous, mixed, and low-level waste. The estimate assumes that the staging facility will require upgrading in FY 2026.

At the end of FY 1995, Pantex Plant had 190,600 kilograms (420,000 pounds) of low-level waste in storage.

DISPOSAL

In the near future, two shipments of low-level waste will be made to the Nevada Test Site quarterly.

Pantex Plant shipped approximately 24,300 kilograms (53,700 pounds) of low-level waste to offsite commercial disposal facilities in FY 1995. The Department will continue to evaluate commercial facilities for cost-effective disposal.

Hazardous Waste

GENERATION AND HANDLING

The Department of Energy's Office of Defense Programs (assembly and disassembly of weapons) and environmental restoration activities generate hazardous waste at Pantex Plant. Various support operations such as chemistry laboratories, maintenance, and the vehicle fleet also produce hazardous waste. After initial characterization and packaging are performed by the generator, waste will be transferred to the Waste Management program. Waste Management will not assume responsibility for environmental restoration-generated waste until FY 1997. Beryllium waste will be disposed in FY 1996, and no further generation of beryllium waste is anticipated.

Approximately 81,700 kilograms (190,100 pounds) of hazardous waste was generated onsite in FY 1995.

TREATMENT

The proposed Hazardous Waste Treatment and Processing Facility is designed for low-level waste, mixed waste, and hazardous waste. It will also accommodate the mobile treatment units. Construction is expected to be completed in FY 2000, with processing beginning in FY 2001.

Waste contaminated with high explosives is treated at the Pantex Plant Burning Grounds. Residual ash from the Burning Grounds is packaged and disposed of offsite. In FY 1995, approximately 25,400 kilograms (56,000 pounds) of waste contaminated with high explosives was treated at the Burning Grounds.

The Burning Grounds are scheduled to be upgraded pending approval of Resource Conservation and Recovery Act permit application. The upgrade is expected to be complete in FY 1997. Alternatives to burning, such as base hydrolysis and molten salt extraction, are being explored. However, this estimate assumes the burning grounds will continue to be used.

STORAGE

Pantex Plant provides for the compliant onsite storage of hazardous and non-Resource Conservation and Recovery Act regulated waste generated at Pantex. A Resource Conservation and Recovery Act hazardous waste staging facility has been designed, and completion is planned for FY 1996. This facility will provide storage for 1,600 drums of hazardous, mixed, and low-level radioactive waste. The staging facility will require upgrading in FY 2026.

At the end of FY 1995, Pantex Plant had approximately 15,100 kilograms (33,300 pounds) of hazardous waste in storage.

DISPOSAL

Hazardous waste is shipped monthly to offsite commercial disposal facilities. Costs associated with disposal, offsite transportation, and onsite support by waste operations personnel are included in the Waste Management program estimate.

Pantex Plant shipped approximately 91,000 kilograms (200,600 pounds) of hazardous waste to offsite commercial disposal

facilities in FY 1995. The estimates assume 15,647 cubic meters (20,500 cubic yards) will be disposed within the life cycle.

Sanitary Waste

GENERATION AND HANDLING

Sanitary waste at Pantex Plant is generated by Office of Defense Programs (assembly and disassembly of weapons), environmental restoration activities, and various support operations, such as the cafeteria, the chemistry laboratories, maintenance, and the vehicle fleet. In FY 1995 there was 2.5 million kilograms (5.5 million pounds) of nonhazardous/sanitary waste generated. Environmental restoration-generated sanitary waste is not the responsibility of the Waste Management program in FY 1996, and in FY 1997 it will become the responsibility of Defense Programs. Thus, no costs for sanitary waste disposal have been included after FY 1996.

DISPOSAL

Nonhazardous/sanitary waste is either disposed of offsite at commercial facilities (Texas Class II waste to Amarillo Landfill) or onsite (wastewaters discharged to playa, and construction debris waste to the onsite Class III landfill). In FY 1995 there was 2.7 million kilograms (6 million pounds) of nonhazardous/sanitary waste disposed of at onsite and offsite landfills. This figure does not include wastewater discharged to the playa. The costs include the operation of heavy equipment to move and cover waste, as necessary; receiving and weighing incoming waste loads; validating that incoming waste meets the landfill's waste acceptance criteria; developing and maintaining operating logs and disposal records; and ensuring compliance with Texas Natural Resource Conservation Commission regulations concerning landfill operations.

Direct Program Management/Support

All program management activities are performed within the budgets for waste management and environmental restoration activities. For FY 1996 through FY 2001, program management activities at the site account for approximately 20 percent of the total budget.

Under an Agreement-in-Principle between the Department of Energy and the State of Texas, payments to local communities and state and federal agencies are made by the Department of Energy Amarillo Area Office.

STAKEHOLDER INTERACTIONS

The Amarillo Area Office distributed site-specific data about the report at quarterly and ad hoc public meetings for Pantex Plant stakeholders. Site-specific information, such as assumptions and costs, was provided to the public. No issues or concerns were raised. If you would like more information about the report or have questions about the results for this site, please contact:

Public Participation	**Technical Liaison**	**Public Affiars**
Tom Walton (806) 477-3120 twalton@pantex.com	Jim Orr (505) 845-4734 jorr@doeal.gov	Tami Toops (505) 845-5264 ttoops@doeal.gov

Waste Management Activities Cost Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)

	FY 1996-2000	2005	2010	2015	2020	2025	2030
Low-Level Mixed Waste							
Treatment	329	278	278	278	278	278	278
Storage and Handling	357	328	328	328	328	328	328
Disposal	152	59	59	59	59	59	59
Low-Level Waste							
Treatment	222	216	216	216	216	216	216
Storage and Handling	383	358	358	358	358	358	358

Disposal	504	402	402	402	402	402	402
Hazardous Waste							
Treatment	53	53	53	53	53	53	53
Storage and Handling	590	547	547	547	547	547	547
Disposal	1,712	1,471	1,471	1,471	1,471	1,471	1,471
Sanitary Waste							
Disposal	22						
Direct Program Management/Support	5,449	3,746	3,603	3,603	3,603	3,603	3,603
Total	9,774	7,458	7,315	7,315	7,315	7,315	7,315
	FY 2035	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**
Low-Level Mixed Waste							
Treatment	278	278	278	278	278	278	278
Storage and Handling	328	328	328	328	328	328	328
Disposal	59	59	59	59	59	59	59
Low-Level Waste							
Treatment	216	216	216	216	216	216	216
Storage and Handling	358	358	358	358	358	358	358
Disposal	402	402	402	402	402	402	402
Hazardous Waste							
Treatment	53	53	53	53	53	53	53
Storage and Handling	547	547	547	547	547	547	547
Disposal	1,471	1,471	1,471	1,471	1,471	1,471	1,471
Sanitary Waste							
Disposal							
Direct Program Management/Support	3,603	3,603	3,603	3,603	3,603	3,603	3,603
Total	7,315	7,315	7,315	7,315	7,315	7,315	7,315
	FY 2070	**2075**	**2080**	**2085**	**2090**	**2095**	**2100**
Low-Level Mixed Waste							
Treatment	278						
Storage and Handling	328						
Disposal	59						
Low-Level Waste							
Treatment	216						
Storage and Handling	358						
Disposal	402						
Hazardous Waste							
Treatment	53						
Storage and Handling	547						
Disposal	1,471						
Sanitary Waste							
Disposal							
Direct Program Management/Support	3,603						
Total	7,315						

	Life Cycle*
Treatment	21,106
Storage and Handling	24,743
Disposal	4,892
Low-Level Waste	
Treatment	16,229
Storage and Handling	26,977
Disposal	30,659
Hazardous Waste	
Treatment	3,975
Storage and Handling	41,240
Disposal	111,532
Sanitary Waste	
Disposal	112
Direct Program Management/Support	280,173
Total	561,638

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

DESCRIPTION OF PERSONNEL

Current Composition

Pantex Plant Environmental Management staff consists of individuals who represent a number of professions, disciplines, and specialties. These include: biology, chemistry, general science, health physics, geology, engineering, technical project management, Geographical Information System operation, hydrology/ground-water modeling, contaminant fate and transportation modeling, environmental protection, and waste management integration. Current staffing requirements are presented in the table below.

Full-Time Equivalent Composition Table *

* The Projections for Full-Time Equivalent employees are based on FY 1996 planning baselines (see Reader's Guide).

Site Management Structure

Federal procurement reform legislation has mandated changes in the contracting process to increase use of competitive awards, enhance socioeconomic diversity and increase the use of fixed price contracts. The Federal Acquisition Streamlining Act, which revised the Federal Acquisition Regulation, has been implemented at Pantex Plant to increase procurement of commercial items, implement electronic procurement through the use of a credit card system, implement changes in the guiding principles for certification of cost and price data to $500,000 purchases, and raise the small business set aside threshold to $100,000. Other contract reform changes include development of effective performance criteria measures tied to the procurement evaluation plans in source selection. Pantex Plant has also implemented a cost incentive and cost avoidance (cost savings) program. Currently, Pantex Plant procurement personnel are investigating mechanisms to manage effectively uncosted balances of Fiscal Year-end funds.

The Management and Operations contractor is Mason and Hanger, Inc., who holds a cost plus award fee contract. The contract expires at the end of FY 1996 and negotiations are currently under way to extend the contract beyond FY 1996.

CONTRACTING OPPORTUNITIES

If you would like more information about performing work for the Department of Energy's Environmental Management program at this site, please contact:

Major Procurements	Small Business Procurements
William Meyers	Greg Gonzales
Director Contracts and Procurement Division	Contracts and Procurement Division
United States Department of Energy	United States Department of Energy
Albuquerque Operations Office	Albuquerque Operations Office
P.O. Box 5400	P.O. Box 5400
Albuquerque, NM 87185-5400	Albuquerque, NM 87185-5400
p: (505) 845-5777	p: (505) 845-5777
f: (505) 845-4210	f: (505) 845-4210

Future Full-Time Equivalent Needs

In the future, it is anticipated that the number of laborers and technicians will decrease slightly in Environmental Restoration as more sites reach the point of closure. The numbers of management and administrative Full-Time Equivalents will also decrease slightly as the management duties decrease because of the closures. There will be changes in the mix of scientists and engineers as the nature of the work changes. The staffing mix in waste management is anticipated to remain level.

FUNDING ESTIMATE

The following tables present estimated funding information for the Pantex Plant.

Defense Funding Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)

	FY 1996-2000	2005	2010	2015	2020	2025	2030	
Nuclear Material and Facility Stabilization		2,928	4,351	5,041	1,449			
Environmental Restoration	9,226	1,102						
Waste Management	9,774	7,458	7,315	7,315	7,315	7,315	7,315	
Total	19,001	11,488	11,666	12,356	8,764	7,315	7,315	
	FY 2035	2040	2045	2050	2055	2060	2065	
Nuclear Material and Facility Stabilization								
Environmental Restoration								
Waste Management	7,315	7,315	7,315	7,315	7,315	7,315	7,315	
Total	7,315	7,315	7,315	7,315	7,315	7,315	7,315	
	FY 2070	2075	2080	2085	2090	2095	2100	Life Cycle*
Nuclear Material and Facility Stabilization								68,843
Environmental Restoration								51,642
Waste Management	7,315							561,638
Total	7,315							682,123

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

Nondefense Funding Estimate

(Five-Year Averages, Thousands of Constant 1996 Dollars)

	FY 1996-2000	2005	2010	2015	2020	2025	2030	Life Cycle*
Nuclear Material and Facility Stabilization		51	75	87	25			1,191

** Total Life Cycle is the sum of the annual costs in constant FY 1996 dollars.*

COMPARISON WITH PREVIOUS ESTIMATE

There are no major changes in the FY 1996 estimated total from the FY 1995 Report. However, the individual programs have changed significantly.

Comparison Table

Activity	FY 1995 Life Cycle	FY 1995 Only [1]	FY 1996 Life Cycle	Change in Dollars	Change in Percent
	Thousands of Dollars				
Nuclear Mat. & Fac. Stab.	62,007	2,530	70,034	10,557	18
Environmental Restoration	139,572	18,947	51,642	-68,983	-57
Waste Management	449,920	13,008	561,638	124,726	29
Landlord	-	-	-	-	-
Program Management [2]	133,637	5,952	-	-	-
Site Total	785,136	40,437	683,313	-61,386	-8

1 The FY 1995 life-cycle and annual costs are provided to determine the corrected FY 1995 cost.
2 Program Management was reported in an independent cost table last year, but is reported as a line item in the relevant program (Nuclear Material and Facility Stabilization, Environmental Restoration, and Waste Management) activity cost estimate tables for the FY 1996 Baseline Report.

The Environmental Restoration program estimate is 57 percent lower because technical assumptions regarding remediation life-cycle costs have changed based on data from the assessment program. In addition, the site will apply a regulatorily required risk-based approach to remediation that will result in lower life-cycle costs.

The most notable Waste Management program change is that the duration of support to the Office of Defense Programs has increased from 40 years to almost 75 years. This increase in costs has been somewhat offset by cost reductions associated with low-level mixed waste treatment. Schedules for developing mobile treatment units have also been enhanced, thereby increasing confidence in the cost estimates.

About This Document

Posted 08/19/1996 (fr)

2.0 OPERABLE UNIT AL-PX-1, BURNING GROUNDS (ADS 1232)

The Burning Grounds is located in the north central portion of Pantex, approximately 2,000 ft south of FM 293 (the northern boundary of Pantex Plant) and adjacent to the eastern side of Playa 3. The Burning Grounds is composed of approximately 58 acres and began operations as early as 1952 (possibly earlier). The site is used for the demilitarization and sanitization of HE components and disposal of waste HE, HE-contaminated waste, and various HE-contaminated liquids and solvents. Disposal of solvents at the site was discontinued in the early 1980s.

SWMUs located within the Burning Grounds include the burn trays (SWMUs 28 through 36), burn racks and pits (SWMU 52), landfills (SWMUs 37 through 44), burn cages (SWMUs 45 and 46), and the demonstration/detonation facility (unnumbered). Inactive SWMUs include the former chemical burn pit and solvent extraction facilities (SWMU 47), burn pads (SWMUs 14 through 27), and the solvent pans (SWMUs 48 through 51).

RFIs were conducted on the following: SWMU 47, Evaporation Pit; SWMUs 14-27, Burn Pads; and SWMUs 37-44, Landfills.

International Technology Corporation conducted an investigation of the Burning Grounds during 1994. A total of 64 soil borings were drilled: 17 waste characterization borings, 31 shallow borings, 12 intermediate borings, and 4 deep borings. A total of 568 soil and waste samples were collected and analyzed. Additionally, 66 quality assurance (QA) samples, 67 quality control (QC) samples, 52 equipment blanks, 2 field blanks, and 10 trip blanks were collected and analyzed. Three new monitoring wells were drilled and installed (two to the perched aquifer and one to the Ogallala Aquifer), and a total of eight groundwater samples from these three wells and three existing monitoring wells were collected and analyzed.

Surface geophysical surveys were performed at the Burning Grounds to define the locations and boundaries of the landfill trenches. These surveys consisted of electromagnetic induction, magnetic, and ground penetrating radar. Downhole geophysical logs were run in deep soil boring PTX01-2062 and the three monitoring wells (both pre- and post-well construction).

The draft final preliminary data package has been submitted by the contractor and is under review (data validation). This document will be updated on completion of this data validation.

2.1 EVAPORATION PIT (SWMU 47)

2.1.1 Description

The solvent evaporation pit and former chemical burn pit are located on the west side of the Burning Grounds, adjacent to Playa 3 and immediately south of the area used for the solvent evaporation pans. This SWMU consists of four unlined soil pits, approximately 20 ft square by 3 ft deep. It was operated from 1954 until the early 1980s, when it was backfilled and covered with soil. Waste oils and solvents contaminated with HE were transported to the pit and allowed to evaporate. Periodically, the liquids/residues in the pit were burned.

Through process knowledge, the pit is known to have overflowed on occasion with runoff flowing to

Playa 3 (approximately 500 ft downgradient of the pit). The pit was replaced with a series of metal pans used for evaporation and burning of HE-contaminated solvents. Solvents are disposed of offsite. Constituents evaporated at the facility included acetone, HE, toluene, and volatile organic compounds (VOCs).

2.1.2 Past Investigations

The former chemical burn pit has been the subject of several investigations:

Final Environmental Impact Statement (DOE 1983) - In this investigation, soil samples from three boreholes ranging from 23 to 48 ft deep were taken. Soil samples were collected from land surface and then at 5-ft intervals to the bottom of the borehole. Samples were analyzed for toluene, VOCs (specifically dimethylformamide and tetrahydrofuran), and acetone. Analytical results indicated that acetone was present in one of the boreholes below the caliche layer in the silty clays between 13 and 43 ft. In the deepest sample collected, acetone was not detected. The presence of toluene, dimethylformamide, and tetrahydro-furan was also undetectable.

Battelle (January 1988) - Three boreholes were drilled in the vicinity of the former chemical burn pit. Analytical results of one of the bore-holes drilled directly through the pit indicated the presence of organic vapors.

Weston Co. (September 1988) - Nine boreholes were drilled. Analytical results of the investigation indicate the presence of toluene directly beneath the former chemical burn pit. Indications of acetone were also noted. (It is note-worthy that acetone was also found in the QC samples, which may be indicative of a laboratory contaminant.) Trace or low concentrations of VOCs, such as acetone and toluene, were detected at scattered sampling points and depths in soil samples obtained from the study area.

USACE (1990) - Sampling of Ogallala Aquifer monitoring wells was conducted. Analyti-cal results showed no organic contaminants detected. Metals, radionuclides, anions, and conventional parameters were all consistent with naturally occurring levels found in Ogallala groundwater.

2.2 EXPLOSIVE BURN PADS (SWMUs 14-27)

2.2.1 Description

Twenty-two explosive burn pads that operated from 1952 (or earlier) until 1988 have been identified at the Burning Grounds. In 1988, they were replaced with nine explosive burn trays (SWMUs 28-36) that were constructed on top of the respective explosive burn pads. Waste is no longer placed directly on the explosive burn pads and the pads are considered to be inactive. The individual pads were constructed of a 1-ft-thick clay layer over an approximately 15- by 15-ft area. The pads are located approximately 75 ft apart. In preparing for a burn, the pads were reportedly checked for cracks in the soil and "sealed" as required. For wet explosives, tar paper or plastic sheeting was placed below the waste to be burned.

Materials routinely burned on the pads include HE wastes and HE-contaminated sludge. These wastes

and sludges include ignitable and reactive wastes as well as listed wastes (spent nonhalo-genated solvents, HE-contaminated wastewater sludges, spent carbon-containing explosives, former acid, and hexahydrobenzene).

2.2.2 Past Investigations

No investigations particular to the explosive burn pads have been conducted.

2.3 LANDFILLS (SWMUs 37-44)

2.3.1 Description

The Burning Grounds landfills are located in the northern half of the Burning Grounds area. The landfills consist of at least eight unlined, closely spaced burial trenches, approximately 100 ft (possibly 200 ft) long by 20 ft wide and 15 to 22 ft deep. Several of the trenches have been covered and locations are based on aerial photographs, electromagnetic surveys, and surface depressions.

The burial trenches received waste ash and residue from explosive burn pads (SWMUs 14-27) and trays (SWMUs 28-36), burn cages (SWMUs 45 and 46), and solvent evaporation pit and former chemical burn pit (SWMU 47) and pans. Process knowledge indicates that the landfills may also contain paint cans and drums, chemical cans and drums, oil cans and drums, transformers, and construction debris, including asbestos-type insulation and tiles. Past practice indicates that burning was conducted within the confines of the trenches. There is evidence to indicate that low-level radioactive ash and residue were placed in the landfill.

Constituents believed to be disposed of in the landfills include:

Acetone
Asbestos
Construction debris
HE waste/sludge
Paint and chemical cans
Polychlorinated biphenyls (PCBs)
Radionuclides
Toluene
VOCs.

2.3.2 Past Investigations

Electromagnetic and magnetometer surveys (September 1988) were conducted in the vicinity of the Burning Grounds landfills. The surveys provided a rough estimate of the landfill cell locations. The exact extent of the landfills could not be determined due to the wide survey station spacings. There have been no sampling and analysis investigations of this site.

2.4 BURN TRAYS (SWMUs 28-36)

2.4.1 Description

Nine burn trays were installed in 1988 at the locations of the former burn pads (SWMUs 14-27), for purposes of burning waste HE materials. The burn trays are approximately 75 ft long by 10 ft wide by 1 ft deep and raised 2 ft aboveground. The trays are constructed of fire brick-lined carbon steel pans. Sand is placed in the bottom of the trays and is changed about once every 6 months. Spent sand is disposed of in the Burning Grounds landfills (SWMU 37-44) along with ash and residue from the burn trays. Materials routinely burned in the trays include HE waste and HE-contaminated sludge.

2.4.2 Past Investigations

No investigations particular to the explosive burn pads have been conducted.

2.5 BURN RACKS AND FLASHING PITS (SWMU 52)

2.5.1 Description

The burn racks have been active since approximately 1981 and are removed to separate HE from depleted uranium by burning. Typical operation involves placing a composite HE-depleted uranium weapons part on a burning rack and igniting the HE to separate it from the part.

Based on aerial photographs, the flashing pits were in use prior to 1967 for the decontamination of HE-contaminated metals. "Flashing" involves the exposure of HE-contaminated items to a flame source of sufficient heat to burn the HE residues. This is accomplished by placing the items on a bed of combustibles in unlined pits and igniting them. After flashing, the materials are either retrieved for salvage or disposed of elsewhere. Materials routinely ignited in the racks and pits include HE and radionuclides associated with the HE.

2.5.2 Past Investigations

There have been no investigations targeted at the burn racks or flashing pits.

2.6 BURN CAGES (SWMUs 45 and 46)

2.6.1 Description

Aerial photographs indicate that the burn cages became operational between 1959 and 1967. HE-contaminated trash was collected and placed in the burn cages, combined with flammable liquid, and ignited. After the burn, the residual ash was inspected to ensure that all HE had been destroyed. The ash was then disposed of in the Burning Grounds landfills (SWMUs 37-44).

The burn cages are metal cages supported by concrete piers and floors and are cubic structures with sides of about 16 ft. They are constructed of carbon and stainless steel with an I-beam and angle frame that is covered with 9- to 11-gage flattened expanded steel. The steel grating on the sides and top of the cage allows unobstructed airflow into the fire and controlled emissions of combustion products. Materials routinely burned in the cages included HE-contaminated paper and plastics and solvent-contaminated materials. This waste was disposed of as a hazardous waste.

2.6.2 Past Investigations

There have been no investigations targeted at the Burning Grounds burn cages.

2.7 DEMONSTRATION FACILITIES (SWMU Number Unassigned)

2.7.1 Description

Demonstration/detonation facilities are used for the demonstration and detonation of blasting caps, primer cord, and up to 5-lb charges of HE. The start-up date of these units is not known. They are located in the northeast portion of the Burning Grounds site. Materials detonated included HE waste and sludge.

2.7.2 Past Investigations

There have been no investigations targeted at the demonstration/detonation facility.

3.0 OPERABLE UNIT AL-PX-2, HIGH PRIORITY POTENTIAL RELEASE SITES (ADS 1219)

As a result of industrial operations in support of the mission (Section 1), the release of hazardous constituents was suspected to have occurred at nine sites in this operable unit. These releases were believed to have resulted in contamination of sediment, soil, and/or groundwater in and around these sites. This operable unit consists of five SWMUs, one AOC, and three firing sites (FS). The location of each site within the operable unit is depicted in Figures 3-1 through 3-3.

An RFI work plan was prepared in 1993. This plan included an investigative approach to confirm the presence of contamination or document that contamination did not occur. If contamination was detected, the nature and extent was to be defined to the point that a corrective action was recommended or the need for further investigative activities identified. Implementation of the RFI was completed in February 1994. A draft RFI report for eight of the nine sites was completed in August 1994. The conclusions drawn in the report included closure/NFA at six of the sites and voluntary corrective action (VCA) at two of the sites. The ninth site (SWMU 109) was recommended for additional study and not included in the draft RFI report.

3.1 BUILDING FS-16 SURFACE IMPOUND- MENT IN ZONE 5 (SWMU 11)

3.1.1 Description

This unit is an active surface impoundment area located in the northern portion of the facility in the center of Zone 5 next to Building FS-16. The impoundment receives filtered cooling water from the operations in Building FS-16 (a high-speed explosive machining building). The machining involves the use of various HE and organic solvents. The discharge consists of spent "wash-down" water from dust control following the dry machining of HE. The spent water exits the building via a metal-covered, 3-in. by 3-in. concrete drainage channel to a concrete 2-ft cylin-drical sump located outside of the building and adjacent to the impoundment. The sump contains a pump and filter system. The spent water is filtered prior to discharge to the surface impoundment via a 1-in. PVC pipe, where it is allowed to evaporate. Building FS-16 and the impoundment are used intermittently and were last used in 1990.

The surface impoundment is constructed with dual Hypalon liners, separated by approximately 2 ft of clean compacted soil. The impoundment is approximately 26.5 by 36 by 8 ft and is surrounded by berms and a 3-ft-high chain-link fence. Dates of operation are not known.

Chemical constituents believed to have been discharged to this unit include

- Acetone
- Barium
- HE (HMX)
- Mercury
- Silver
- Tetrahydrofuran.

3.1.2 Past Investigations

3.1.2 Past Investigations

Water and sediment samples were taken from the impoundment in 1989 by M&H and analyzed for HE, and VOCs. No detectable concentrations of these contaminants were found.

During the 1993-94 RFI, two 40-linear-ft angle borings were drilled and sampled, the waste-water sump and adjacent surface soils were sampled, and the impoundment wastewater and sediments were sampled. Analyses performed included metals, VOCs, HE, and nitrate/nitrite. Analyses confirmed a minor release of HE and metals from the sump or drainage channel.

3.1.3 RFI

The draft RFI report recommended perform-ing an ICM to remove the sump and impoundment and perform confirmation sampling of the area. The ICM was performed July 1995.

3.2 SOLAR EVAPORATION POND (SWMU 13)

3.2.1 Description

This unit is an inactive, lined, solar evapo-ration pond located in Zone 11, approximately 40 ft southeast of Building 11-51. From 1980 to 1986, the pond received discharges of liquid waste from sinks and drains in the chemistry laboratories of the Weapons Materials Analytical Laboratory (Building 11-51). The laboratory discharges entered the pond from the north via a sewer pipe. Laboratory HE waste was not disposed of into this unit. The unit was closed and backfilled in 1986. There is little visual evidence of the existence of the former pond at this location. Liquid effluents from Building 11-51 are now routed to the onsite sanitary sewer system.

The square pond had sloped banks and was 94 ft long at the surface and 50 ft at the base with a depth of 10 ft. The pond was constructed with a Hypalon liner, overlaying a 2-in. layer of clean sand. Frequent overflow occurred via two 6-in. overflow pipes to a surface ditch draining to Playa 4.

Constituents believed to have been discharged to this unit include acetone, heavy metals, HE, and organic solvents (dioxane, methyl, ethyl, and isopropyl alcohols).

3.2.2 Past Investigations During the 1993-94 RFI, 14 borings were drilled and sampled. A total of 56 soil samples were collected for laboratory analysis. Analyses performed included metals, fluoride and sulfate, VOCs, and nitrate/nitrite. Analyses confirmed limited and low-level releases of metals and common anions to the environment.

3.2.3 RFI

The draft RFI report recommended NFA at this site.

3.3 BUILDING 12-68 CONCRETE SUMP (SWMU 109)

3.3.1 Description

This unit is a belowground concrete sump, located on the northeast side of Building 12-68 (an electroplating facility on the east side of Zone 12). The sump is 7 ft sq and 11 ft 11 in. deep. This two-chamber unit is constructed with 8-in. thick concrete (with a 0.25-in.-thick chemical-resistant liner) and a 9.5-in.-thick acid-resistant brick interior. Access to the neutralization chamber is through a manhole that is protected by a steel cover. An adjacent locked manhole covers an overflow valve access chamber.

The neutralization chamber was used for the treatment of electroplating wastewater effluent from the Electroplating Waste Retention Basin between 1976 and 1986. Effluent was treated by manually adding caustic (usually sodium carbonate or sodium bicarbonate) through the manhole of the chamber. Treated effluent was discharged from the sump through a 6-in. PVC pipe to a sanitary sewer system. Solids settled to the bottom of the neutralization chamber and were periodically removed, drummed, and disposed of offsite.

During this period, the sump would occasionally overflow through the top of the sump cover. In addition, temporary waste neutralization operations were conducted on the east side of the building adjacent to the sump. Acid spills resulted from these temporary operations in 1986 when troughs used for the neutralization leaked onto the ground surface. Electroplating waste consisted primarily of chromic acid and heavy metals.

3.3.2 Past Investigations

A spill of approximately 500 gal of liquid chromium waste occurred in October 1986, requiring the excavation and removal of approxi-mately 5,000 ft^3 of contaminated soils in 1987. M&H analytical results showed the soil contained chromium and lead.

In 1988, M&H installed and sampled four boreholes. Soil samples were found to contain lead and total chromium concentrations that exceeded the extraction procedure (EP) toxicity limits. Hexavalent chromium concentrations were found to be below the EP toxicity limit. Results of the RFI have not been received to date.

3.3.3 RFI

Further investigation (Phase II RFI) has been recommended based on the initial RFI findings.
The ICM was performed Summer 1995.

3.4 BUILDING 12-59 SUBSURFACE LEACHING SYSTEM (SWMU 136)

3.4.1 Description

This unit is an abandoned, unlined subsurface leaching bed or septic system used for liquid waste discharged from the chemistry laboratories located in Building 12-59. The unit was initially con-structed in 1968 with a 2-ft-diameter, 12-ft-deep concrete pipe filled with gravel. The waste line was removed and

in 1968 with a 2-ft-diameter, 12-ft-deep concrete pipe filled with gravel. The waste line was removed and discontinued from Building 12-59 in 1974, and the drains were connected to the Pantex drainage system. This unit received acidic and solvent waste from the chemistry laboratory. The specific quantity of waste discharged and its chemical constituents are unknown.

The waste types generated in the laboratory and possibly discharged to the leaching system include heavy metals, HE, and solvents, e.g., acetone and pyridine.

3.4.2 Past Investigations

During the 1993-94 RFI, 10 borings (five hand-augered) were drilled and sampled. Thirty-eight soil samples were collected for laboratory analysis. Analyses performed included metals, HE, VOCs, and nitrate/nitrite. Analyses confirmed limited and low-level releases of metals to the environment.

3.4.3 RFI

The draft RFI report recommended NFA at this site.

3.5 FS-10 PHOTOPROCESSING LEACHING BED (SWMU 139)

3.5.1 Description

This unit is located adjacent to Building FS-10 in the northern portion of the facility. Six yellow fenceposts southeast of Building FS-10 mark the initial location of the leaching bed in an area measuring approximately 8 by 8 ft. This unit was installed in 1964 and consisted of a 1-in. waste line leading from the building to a general leach bed of an unknown size and depth. Photoproces-sing chemicals typically used and possibly discharged to the leaching bed include heavy metals (e.g., silver) and solvents.

3.5.2 Past Investigations

During the 1993-94 RFI, six borings were drilled and sampled. Thirty soil samples were collected for laboratory analyses. Analyses included metals, semivolatile organic compounds (SVOCs), and VOCs. Analyses concluded that detected compounds were below action levels.

3.5.3 RFI

The draft RFI report recommended NFA at this site.

3.6 BUILDING 12-5D SOLVENT DISPOSAL PIT (AOC 12)

3.6.1 Description

This is a former solvent disposal pit located in the northeastern corner of Zone 12 near Building 12-5D

This is a former solvent disposal pit located in the northeastern corner of Zone 12 near Building 12-5D (used as a paint booth and shop), which was removed in 1990. The size of the pit and its exact location are unknown. Chemicals that may have been discharged to this unit include metals, VOCs, and SVOCs.

3.6.3 Past Investigations

In 1988, soil samples were taken in the disposal pit. VOCs, SVOCs, and lead were detected in the soil samples.

During the 1993-94 RFI, a soil gas survey was performed and five borings were drilled and sampled. Analyses performed included metals, VOCs, and SVOCs. Analysis concluded that no significant levels of contamination were present.

3.6.3 RFI

The draft RFI report recommended NFA at this site.

3.7 FS-1, UNLINED LANDFILL

3.7.1 Description

FS-1 is an unlined landfill located in the northern portion of Pantex east of Playa 3 and north of Zone 4. The landfill is approximately 5 ft deep, and was believed to contain HE residual ash and depleted uranium. The dates of operation of the landfill are unknown; however, it was reportedly closed in the late 1960s. (It should be noted that no direct evidence or confirmation of this landfill exists.) This unit is not identified as a SWMU to be investigated, but it is included because investigation may be warranted. Potential contaminants that may have been disposed of in this landfill include HE, heavy metals, and radionuclides (e.g., uranium).

3.7.2 Past Investigations

During the 1993-94 RFI, a geophysical survey was conducted near Building FS-1 in an attempt to locate the landfill. The survey did not indicate the presence of a landfill in the area. As earlier infor-mation indicated that the landfill may also be in the area of Building FS-10, an additional geophys-ical survey was conducted, and three borings were drilled and sampled. Analyses performed included metals, VOCs, HE, nitrite/nitrate, and gross alpha/beta. Results indicated there was not a landfill present in this area.

3.7.3 RFI

The draft RFI report recommended NFA for this site.

3.8 FS-22, CONTAINER

3.8.1 Description

FS-22 is located in the northern portion of the facility east of Playa 3 and north of Zone 4. FS-22 was used for the testing of explosives within a bermed area. A large cylindrical container (the breach end of a ship-mounted gun), measuring approximately 4 ft long with a 3-ft outside diameter, was used during several tests. Test blasts involving mineral oil as a dampening agent for electrical charges were performed. The test area is represented by a patch of stained soil. This unit is not identified as a SWMU to be investigated, but it is included because investigation may be warranted. The contaminants related to FS-22 include heavy metals, HE, and waste oil.

3.8.2 Past Investigations

During the 1993-94 RFI, two surface soil samples and one sediment sample were collected at the site. Analyses included metals, VOCs, HE, and nitrate/nitrite. Lead was detected at high levels (exceeding action levels).

3.8.3 RFI

The draft RFI report recommended performing an ICM to remove the container and perform confirmation sampling of the area. The ICM was performed Summer 1995.

3.9 FS-24, CONCRETE SUMP

3.9.1 Description

This unit is located in the northern portion of the facility east of Playa 3 and north of Zone 4. FS-24 has a sump collection system composed of an outdoor sump on the south side of the building, which is designated to receive wastewater from the indoor firing chamber sump. There are two firing chambers at FS-24 located inside a building. A concrete sump, covered by a metal grate at floor level, is located beneath the firing chambers. The sump was constructed so that the underneath side of the chambers could be inspected.

The sump underneath the two firing chambers drains via a concrete conduit to an outdoor concrete sump that is covered with a metal lid. The size of the outdoor sump is approximately 6 ft square by 7 ft deep and is part of the poured foundation of the FS building. This unit is not identified as a SWMU to be investigated, but it is included because investigation may be warranted. The contaminants associated with the FS include heavy metals and HE.

3.9.2 Past Investigations

During the 1993-94 RFI, one boring adjacent to the sump was drilled and sampled and one sump liquid sample was collected and analyzed. Analyses included metals, VOCs, HE, nitrate/ nitrite, and gross alpha/beta. Results indicated trace levels of HE.

3.9.3 RFI

4.0 OPERABLE UNIT AL-PX-3, FORMER COOLING TOWER (ADS 1207)

The former cooling tower was a cooling tower that operated from 1950 to 1964. The unit was dismantled, and the site (SWMU 13) now consists of a rectangular concrete foundation (approximately 25 by 120 ft). The former cooling tower used a large concrete-lined basin as a reservoir system. This concrete basin is partially dismantled.

4.1 DESCRIPTION

The former cooling tower site is located in Zone 12 in the east-central portion of Pantex Plant, near Buildings 12-17 and 12-19. Zone 12 is a highly developed industrial area with buildings that contain the HE machining operations. From these buildings, water was circulated to the cooling tower for cooling and pumped back to the machining operations in these buildings via a closed-loop system. Cooling water was circulated via a pressurized system and did not come into contact with possible contaminants used in operations and processing activities conducted in Buildings 12-17 and 12-19.

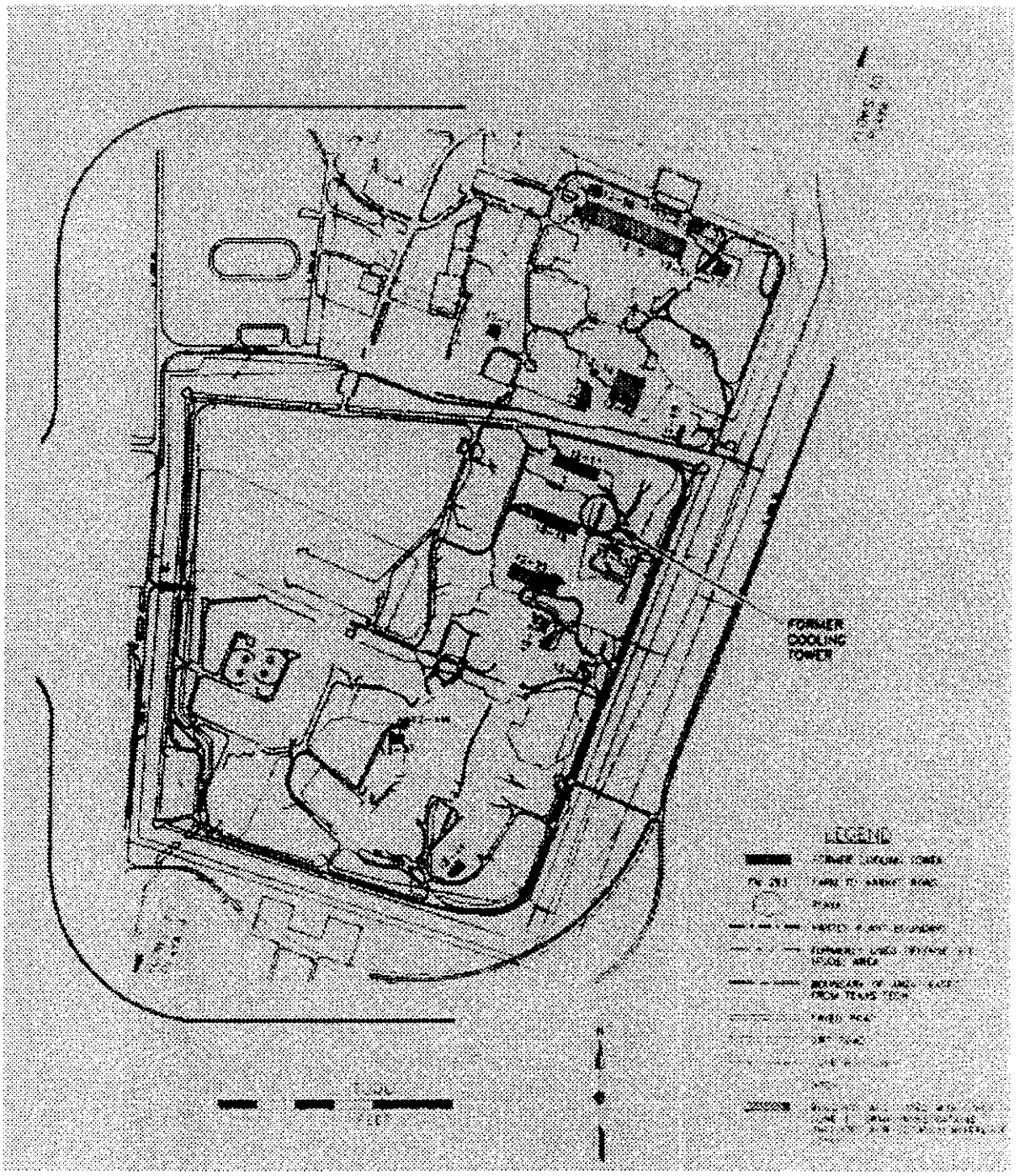


Figure 4-1 Former Cooling Tower Site

Contamination resulting from the operation of the cooling tower could have occurred from overflow of the water reservoir, leakage through or adjacent to the foundation, or from air-blown dispersion of the cooling water. Cooling water may have overflowed from the reservoir system to a ditch flowing east from the area into Playa 1. Specific composition of the cooling water is not known, but chromates, sulfuric acid, and sodium hydroxide salts were probably used to control and remove algae and calcium deposits from cooling tower condenser systems. PCB-containing oils may have been used as lubricants in the cooling tower mechanical systems.

4.2 PAST INVESTIGATIONS

The cooling tower site has been the subject of several investigations:

- Dyess Testing Laboratories (September 1986) - Three boreholes were drilled at a location approximately 300 ft west of the former cooling tower (south of Building 12-17A). The boreholes were drilled as part of a geotechnical investigation to define soil and foundation design parameters. The boreholes were drilled to a depth of 20 ft, and soil samples were collected for soil classification and determination of physical properties, e.g., permeability and moisture content. No chemical analyses were conducted on the samples.

- M&H (April 1987) - Samples of the concrete foundation and the underlying soils were collected. The samples were analyzed for total chromium, and analyses revealed that the founda-tion has essentially the same chromium concen-tration as natural background. Downward and lateral extents of potential contamination in surrounding and underlying soils were not determined.

- Weston Co. (January 1988) - An initial reconnaissance investigation was conducted in the vicinity of Building 12-19 (located approximately 300 ft southwest of the former cooling tower). The investigation was designed to assess potential releases of contamination from Building 12-19, used during World War II for HE operations. Nine boreholes were drilled to a depth of 15 ft each.

  Chemical analysis results from samples collected during drilling near Building 12-19 indicated the presence of VOC, SVOC, total chromium, hexavalent chromium, and HE (particularly RDX).

- Weston Co. (September 1988) - Ten boreholes were drilled and samples were collected in the immediate vicinity of the former cooling tower. Depths of the boreholes ranged from 88 to 93 ft. Selected soil samples were collected from the surface to 93 ft and analyzed for VOC, SVOC, pesticides, PCBs, metals, and HE.

  Results indicated elevated concentrations of total and hexavalent chromium, total copper, and total zinc to a depth of <4 ft below ground surface in the vicinity of the former cooling tower. Concentrations of these metals appear to be near natural background levels in samples taken at depths of 37.0 and 75.7 ft. A perched aquifer monitoring well (PTX06-1010) was drilled in close proximity to the former cooling tower during the Zone 12 groundwater assessment. Elevated levels of total and hexavalent chromium were detected in the perched groundwater in this well.

- EPA Assessment (1989) - A wastewater sample assessment was conducted. The waste- water in ditches leading from Buildings 12-17 and 12-19 was sampled during March and June of 1988. Results indicated that the primary VOC found in wastewater samples collected were acetone, toluene, and tetrahydrofuran. The only HE detected was HMX. Silver, barium, and mercury were also detected.

For Building 12-17, samples collected from the north ditch indicated no detectable concentrations of VOCs or HE. Low concentra-tions of silver and barium were found, but were well below EP toxicity limits. Surface samples from the south ditch indicated no detectable concentrations of VOCs. Detectable levels of trichloroethene (TCE) and HMX were reported in the March and June samples, respectively. Low concentrations of barium were also detected.

For Building 12-19, samples from the south ditch indicated no detectable concentrations of VOCs or HE. Low levels of silver and barium were detected but, below EP toxicity limits. The sample from the discharge of the frotocone in Building 12-19 indicated a concentration of acetone and a low concentration of HMX. Low concentrations of silver and barium were noted. An isolated occurrence of the VOC bromoform was noted but is considered anomalous due to the lack of a source for the compound in the area.

4.3 RFI

The RFI activities consisted of shallow boreholes drilled to depths of 50 to 60 ft. One deep borehole, PTX03-2006, was drilled to a depth of approximately 298 ft and completed as a perched aquifer monitoring well. This monitoring well is located in Zone 12 and is being used in the Zone 12 north groundwater assessment; it has been redesignated as PTX06-1010.

Results from the sample analysis revealed low levels of metals, VOCs, SVOCs, nitrogen series (as nitrate and nitrite), and HE in the near-surface and subsurface soils.

NFA was recommended to the TNRCC in the RFI report in October 1993. This recommenda-tion was based on the low levels of contamination found in the soil. Based on the TNRCC Risk Reduction Standards, these contamination levels do not pose a threat to human health and the environment. Regulator approval of this request is pending.

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7.0 OPERABLE UNIT AL-PX-6, ZONE 12 NORTH GROUNDWATER (ADS 1230)

Zone 12 is located in the southeastern portion of Pantex and covers approximately 280 acres, with the southern portion of the zone being a high-security area.

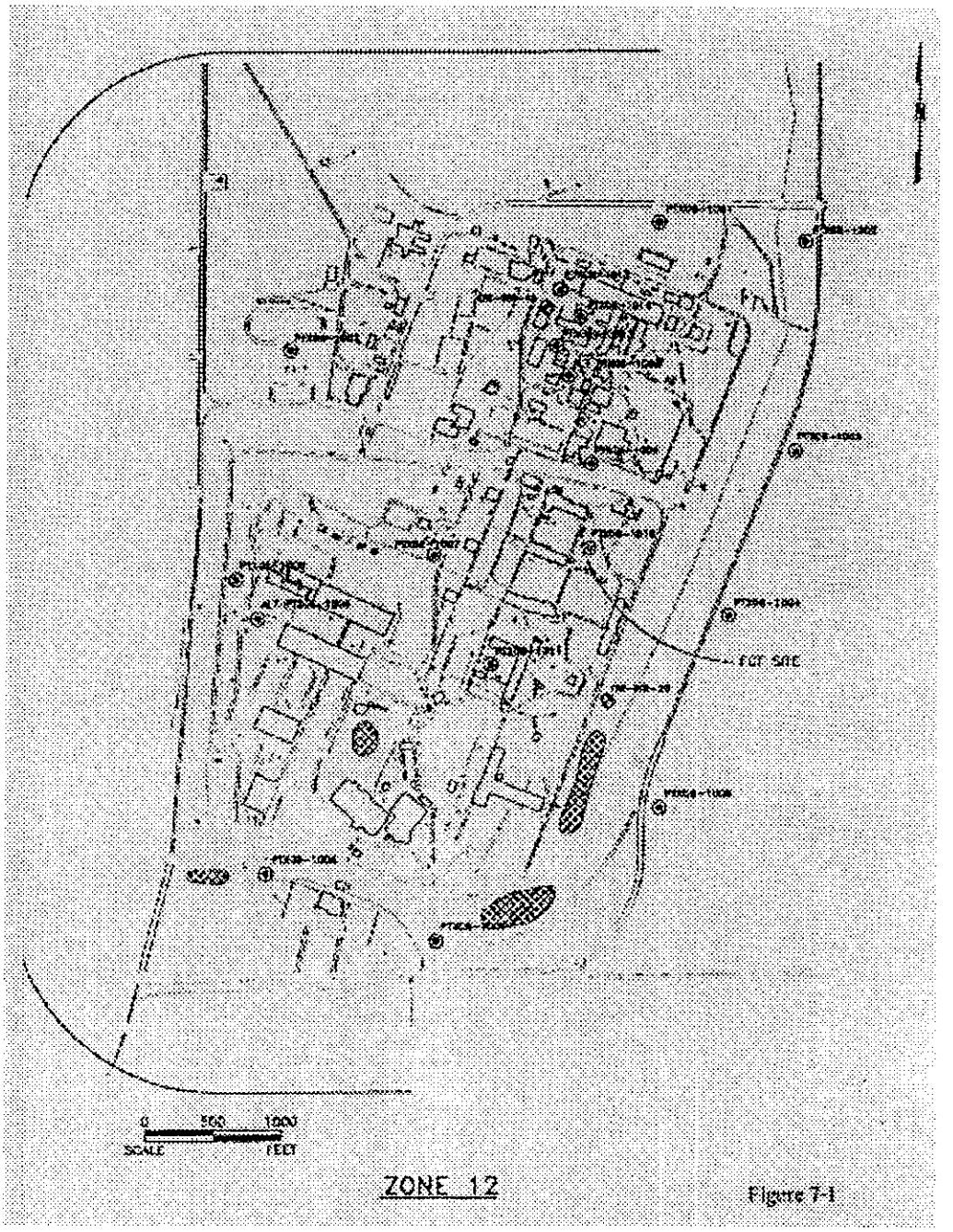

Figure 7-1 Zone 12

7.1 DESCRIPTION

The buildings in Zone 12 are used for admin-istration and support facilities, vehicle mainte-nance, HE-

machining and synthesis operations, chemical and photographic laboratories, and other various industrial operations. Also present in and around the perimeter of Zone 12 are abandoned landfills. Solvents, metals, pesticides, PCBs, petroleum, hydrocarbons, acids, inorganics, and HE are used in operations in Zone 12.

7.2 PAST INVESTIGATIONS

Since 1980, several environmental investiga-tions have been conducted by the DOE and its contractors at Pantex Plant that resulted in wastewater discharge, surface water, sediment, and soil sampling being conducted in many areas in Zone 12.

The ditches in and leading out of Zone 12 have been investigated under the RFI for the Ditches and Playas Operable Unit.

- Ongoing Waste Management Program Activities - Aqueous waste streams that discharge outside Buildings 12-17, 12-19, and 12-43 are sampled and analyzed periodically for metals, VOCs, and HE. The limited amount of data and the ephemeral nature of the wastewater discharges indicate a varying concentration range expectation depending on operational conditions.

- Surface Water Sampling (1987) - Sampling was performed in ditches adjacent to Buildings 12-17, 12-19, and 12-43. Samples were analyzed for pH, temperature, conductivity, VOCs, SVOCs, metals, and HE. Results were published in the 1988 DOE Pantex sampling and analysis document.

- Sediment Sampling (1987) - Sediments in ditches near Buildings 12-43, 12-41, 12-51, and a soil area near Building 12-81 were sampled. The samples were analyzed for VOCs, SVOCs, metals, pesticides, dioxins/furans, and HE. Results were published in the 1988 DOE Pantex sampling and analysis document.

- Soil Sampling - Boreholes were drilled near five buildings in Zone 12. Parameters investigated included metals, VOCs, SVOCs, and HE. Low-level contaminants (solvents, metals, HE) detected were attributed to operations associated with Buildings 12-35, 12-79, and the former cooling tower.

7.3 RFI

The objective of the RFI was to determine the presence or absence of contaminants in the ground- water beneath Zone 12 and to characterize the source, extent, and rate of migration of those hazardous constituents present. Eleven perched aquifer monitoring wells were drilled and completed in and around Zone 12. One of the 11 wells encountered no perched groundwater.

The RFI was conducted during 1992 and 1993. Results indicate contaminants are present in the perched aquifer. The major contaminants identified include chlorinated solvents (trichloroethene, 1-1-dichloroethene, and tetra-chloroethene), benzene, HE (HMX and RDX), and total and hexavalent chromium. These 11 wells are sampled quarterly in an ongoing effort to monitor the hydrogeologic conditions of the perched aquifer underlying Zone 12.

Phase II fieldwork was to include 13 additional perched aquifer monitoring wells and three Ogallala aquifer monitoring wells. Because Argonne National Laboratory was to perform an expedited site characterization (ESC), this number was reduced to three perched aquifer and one Ogallala Aquifer monitoring wells. Phase II fieldwork is ongoing. Results of this fieldwork will be submitted in late FY95.

The goal of the ESC at Pantex is characterization of a perched water table within Zone 12. The ESC at Zone 12 is designed to address the following:

- Extent and flow direction of perched water table
- Distributions of contaminants in perched water table
- Mechanism of recharge process for perched water table and migration pathways for contaminants from surface
- Locations where perched water zone may transmit contaminants to lower drinking water aquifer
- Stratigraphy of perched aquifer and underlying perching layer as it relates to control of contaminant distribution and movement.

The ESC was completed in 1995. A report of the findings was submitted in August 1995.

The Accelerated Site Assessment Project (ASAP) will also be completed in 1995. This project includes the drilling of up to 10 additional test holes to determine the extent of contamination within the perched aquifer both onsite and offsite.

A treatability study for the perched aquifer on Pantex Plant completed in 1995. This study included the extraction and treatment of the contaminated perched groundwater. The treatability system will be located east of Zone 12 and will include three groundwater extraction wells and a treatment unit.

Eight of the 14 RFIs have provided critical information to the assessment of the Zone 12 groundwater.

The following operable units are located in or around Zone 12 and may be associated with the contamination of the groundwater:

- Ditches and Playas
- Leaking USTs
- High Priority Release Sites
- Miscellaneous High Explosive/Radiation Sites
- Miscellaneous Chemical Spills/Releases
- USTs at Other Locations
- Former Cooling Tower
- Landfills.

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8.0 OPERABLE UNIT AL-PX-7, LANDFILLS (ADS 1200)

Virtually all of the sanitary and industrial solid waste generated at Pantex Plant has been disposed of in landfills located throughout the facility, with the majority located in Zones 11 and 12. Twenty-three landfills exist at Pantex, 17 of which are included in this operable unit (Figures 8-1 and 8-2). The landfills have been categorized as either construction debris or general purpose sanitary landfills.

Construction debris landfills (SWMUs 54 through 66) have been operated since the late 1940s. All the units are closed except for a construction debris landfill in Zone 10. The nature of operations at Pantex suggests that chemicals were placed in these landfills. Solvents such as acetone and methyl ethyl ketone, chlorinated solvents; metals such as chromium and lead, nitration compounds, paints; and an assortment of pesticides residue from empty containers may have been placed in the landfills. The units also manage inert construction-related waste such as brick, steel, concrete, sheetrock, paper, glass, and plastic. The waste may also include asbestos-covered piping and related construction material and miscellaneous waste petroleum products. The waste is generally characterized by low volatility; however, some organic constituents may be present. The sites were excavated landfills rather than above-grade landfills. All of the inactive landfills were covered with local soils at closure, but the depth of cover is unknown.

Open burning of combustible waste was allowed at the older landfills used for sanitary and general chemical waste. Many of the construction debris landfills were only open for short periods during specific building demolition projects. Prior to the use of the drum staging areas during the 1970s, drums containing residual liquids may have been placed in some of the general purpose landfills. The solvent and waste oil evaporation pit was available for disposal of liquid solvents; therefore, disposal of liquids in the landfill was unlikely.

General purpose sanitary landfills (SWMU 68) consist of the following: an original landfill (SWMU 68a); general purpose landfill 1 (SWMU 68b); general purpose landfill 2 (SWMU 68c); and an active sanitary landfill (SWMU 68d). Landfills 1 and 2 generally manage nonhazardous waste (nonchemical and non-HE solid waste such as ordinary garbage, waste paper, trash, cafeteria food discards, construction debris, and scrap).

Open burning at construction and general purpose sanitary landfills was reportedly a common occurrence during the early days of operation. During the late 1970s, 4,4'-methylenebis(1-chloroaniline) (MOCA), Sil-Gard, and dodecenyl succine anhydride chemical waste was buried in the far north-northeastern end of the active general purpose landfill. This waste was recently (1987) excavated and sent offsite for disposal.

An area at the northeast corner of the active sanitary landfill was used as a temporary hazardous waste storage area for items removed from the active sanitary landfill. The items included two gloveboxes, a mixing kettle, and three drums of MOCA. The MOCA-contaminated equipment was buried in the sanitary landfill in the 1970s prior to the designation of MOCA as a hazardous waste and was excavated in mid-1986 for offsite disposal. Mercury waste may have also been disposed of in the past at the general purpose sanitary landfills by Building 11-29 and the Building 12-94 chemistry laboratory. This waste was routinely placed in the nonhazardous dumpsters at those buildings and disposed of at the general purpose sanitary landfills. This practice was discontinued in 1987.

An RFI was conducted from April to August 1994 on SWMUs 54 through 66, construction debris landfills, and SWMU 68, general purpose sanitary landfills. A detailed scope of work of the RFI was submitted and approved by the TNRCC.

8.1 CONSTRUCTION DEBRIS LANDFILL 3 (SWMU 54)

8.1.1 Description

This unit is located in Zone 12 directly west of 15th Street and approximately 200 ft east of Building 12-29. The dimensions are approx-imately 2,247 by 170 by 20 ft (282,955 yd^3 total volume). The landfill length is parallel to 15th Street. This site was closed in 1951. The active duration for this landfill is unknown.

Chemical constituents believed to be disposed of within this unit include

- ☐ Acetone
- ☐ Asbestos
- ☐ Chlorinated solvents
- ☐ Chromium
- ☐ Lead
- ☐ Methyl ethyl ketone
- ☐ Nitration compounds.

8.1.2 Past Investigations

A passive soil gas survey was conducted by Oak Ridge National Laboratory in 1988. The soil gas was analyzed for VOCs only. Significant levels of VOCs were detected during this investi-gation. Specifically, these VOCs included chloroform, methyl ethyl ketone, and trichloro-acetic acid (TCA).

8.1.3 RFI

RFI activities at this site included active soil gas surveys, a geophysical survey, and test pits to characterize the types of waste in the landfill. Preliminary data packages have been submitted and are being reviewed.

Phase II fieldwork was completed Summer 1995.

8.2 CONSTRUCTION DEBRIS LANDFILL 4 (SWMU 55)

8.2.1 Description

This unit is located in Zone 12 south near South 15th Street and approximately 250 ft southeast of Building 12-41. The dimensions are approximately 40 by 10 by 12 ft (178 yd^3 total volume). This site was closed in 1959. The active duration for this landfill is unknown.

Chemical constituents believed to be disposed of within this unit include

- Acetone
- Asbestos
- Chlorinated solvents
- Chromium
- Lead
- Methyl ethyl ketone
- Nitration compounds.

8.2.2 Past Investigations

No sampling investigations have been conducted at Landfill 4.

8.2.3 RFI

RFI activities at this site included active soil gas surveys, a geophysical survey, and soil collec-tion and analyses. Based upon findings, a request for NFA was submitted to the TNRCC on June 28, 1995, because no landfill material was encountered during the investigation.

8.3 CONSTRUCTION DEBRIS LANDFILL 5 (SWMU 56)

8.3.1 Description

This unit is located to the southwest of the Zone 12 boundary directly south of Pershing Drive between the intersections of 13th Street and 15th Street. The dimensions are approximately 200 by 12 by 6 ft (533 yd^3 total volume). This site was closed in 1959. The active duration for this landfill is unknown.

Chemical constituents believed to be disposed of within this unit include

- Acetone
- Asbestos
- Chlorinated solvents
- Chromium
- Lead
- Methyl ethyl ketone
- Nitration compounds.

8.3.2 Past Investigations

A passive soil gas survey was conducted at this site by Oak Ridge National Laboratory in 1987. Low levels of VOCs were detected.

8.3.3 RFI

RFI activities at this site included active soil gas surveys, a geophysical survey, and soil sample collection and analyses. Based upon findings, a request for NFA will be submitted to the TNRCC.

8.4 CONSTRUCTION DEBRIS LANDFILL 6 (SWMU 57)

8.4.1 Description

This unit is located in Zone 12 South approxi-mately 200 ft northwest of Building 12-42. The dimensions are approximately 200 by 40 by 10 ft

(2,963 yd^3 total volume). The site was closed in 1976. The active duration is unknown.

Chemical constituents believed to be disposed of within this unit include

- Acetone
- Asbestos
- Chlorinated solvents
- Chromium
- Lead
- Methyl ethyl ketone
- Nitration compounds.

8.4.2 Past Investigations

No sampling has been conducted at Landfill 6.

8.4.3 RFI

RFI activities at this site included active soil gas surveys, a geophysical survey, and soil sample collection and analyses. Based upon findings, a request for NFA will be submitted to the TNRCC.

8.5 CONSTRUCTION DEBRIS LANDFILL 7 (SWMU 58)

8.5.1 Description

This unit is located between Zones 11 and 12, east of South 13th Street and approximately 0.5 mi north of Lafayette Drive. The dimensions are approxi-mately 50 by 12 by 6 ft (133 yd^3 total volume). This site was closed in 1980. The active duration for this landfill is unknown.

Chemical constituents believed to be disposed of within this unit include

- Acetone
- Asbestos
- Chlorinated solvents
- Chromium
- Lead
- Methyl ethyl ketone
- Nitration compounds.

8.5.2 Past Investigations

No sampling investigations have been conducted at Landfill 7.

8.5.3 RFI

RFI activities at this site included active soil gas surveys, geophysical surveys, and soil sample collection and analyses. Based upon findings, a request for NFA will be submitted to the TNRCC.

8.6 CONSTRUCTION DEBRIS LANDFILL 8 (SWMU 59)

8.6.1 Description

This unit is located toward the center of Zone 11, approximately 200 ft northeast of Buildings 11-53 and 11-41. The dimensions are approximately 150 by 140 by 20 ft (15,555 yd^3 total volume). This site was closed in 1977. The active duration is unknown.

Chemical constituents believed to be disposed of within this unit include

- Acetone
- Asbestos
- Chlorinated solvents
- Chromium
- Lead
- Methyl ethyl ketone
- Nitration compounds.

8.6.2 Past Investigations

No sampling has been conducted at this landfill.

8.6.3 RFI

This landfill was investigated as part of the RFI for the *Supplemental Verification Sites* (AL-PX-13), and NFA was requested.

8.7 CONSTRUCTION DEBRIS LANDFILL 9 (SWMU 60)

8.7.1 Description

This unit is located toward the center of
Zone 11. The length of the landfill lies east-west directly to the west of Building 11-5. The dimensions are approximately 620 by 14 by 4 ft (91.286 yd^3 total volume). The site was closed in 1977. The active duration is unknown.

Chemical constituents believed to be disposed of within this unit include

- Acetone
- Asbestos
- Chlorinated solvents
- Chromium
- Lead
- Methyl ethyl ketone
- Nitration compounds.

8.7.2 Past Investigations

No specific environmental sampling has been done at this site, but a passive soil gas survey was conducted by Oak Ridge National Laboratory in 1987 south of this landfill. Elevated concentra-tions of VOCs were detected during this survey.

8.7.3 RFI

RFI activities included active soil gas surveys, a geophysical survey, and soil sample collection and analyses. Based upon Phase I findings, a request for NFA will be submitted to the TNRCC.

8.8 CONSTRUCTION DEBRIS LANDFILL 10 (SWMU 61)

8.8.1 Description

This unit is located toward the center of Zone 11, parallel and to the west of the road located south of Building 11-26. The dimensions are approximately 150 by 14 by 6 ft (466 yd^3 total volume). This site

was closed in 1977. The active duration for the landfill is unknown.

Based upon Phase I findings, a request for NFA will be submitted.

Chemical constituents believed to be disposed of within this unit include

- Acetone
- Asbestos
- Chlorinated solvents
- Chromium
- Lead
- Methyl ethyl ketone
- Nitration compounds.

8.8.2 Past Investigations

No sampling has been conducted at this landfill.

8.8.3 RFI

RFI activities included active soil gas surveys, geophysical surveys, and soil sample collection and analyses. The preliminary data package will be made available after validation. Based upon Phase I findings, a request for NFA will be submitted.

8.9 CONSTRUCTION DEBRIS LANDFILL 11 (SWMU 62)

8.9.1 Description

This unit is located between Zones 4 and 11, approximately 200 ft south of Pantex Drive and 100 ft east of the road leading to Water Tower 15-21. The dimensions are approximately 300 by 12 by 6 ft (800 yd^3 total volume). This site was closed in 1969. The active duration for the landfill is unknown.

Chemical constituents believed to be disposed of within this unit include

- Acetone
- Asbestos
- Chlorinated solvents
- Chromium
- Lead
- Methyl ethyl ketone
- Nitration compounds.

8.9.2 Past Investigations

No past investigations have been conducted at this landfill.

8.9.3 RFI

RFI activities included active soil gas surveys, geophysical surveys, and soil sample collection and analyses. The preliminary data package will be made available after validation. Based upon findings, a request for NFA was submitted to the TNRCC on June 28, 1995, because no landfill material was encountered during the investigation.

8.10 CONSTRUCTION DEBRIS LANDFILL 12 (SWMU 63)

8.10.1 Description

This unit is located in Zone 5, approximately 400 ft north of Pantex Drive and 100 ft east of line between Bunkers 5 and 6. The dimensions are approximately 200 by 75 by 8 ft (3,333 yd^3 total volume). This site was closed in 1969. The active duration for the landfill is unknown.

Chemical constituents believed to be disposed of within this unit include

□□

□□

- □ Acetone
- □ Asbestos
- □ Chlorinated solvents
- □ Chromium
- □ Lead
- □ Methyl ethyl ketone
- □ Nitration compounds.

8.10.2 Past Investigations

No past investigations have been conducted at this landfill.

8.10.3 RFI

RFI activities included active soil gas surveys, geophysical surveys, and soil sample collection and analyses. The preliminary data package will be made available after validation. Based upon Phase I findings, a request for NFA will be submitted.

8.11 CONSTRUCTION DEBRIS LANDFILL 13 (SWMU 64)

8.11.1 Description

This unit is located outside the southwest boundary of Zone 5, approximately 150 ft north of Pantex Drive and 600 ft east of Building 16-7. The dimensions are approximately 300 by 200 by 22 ft (48,888 yd^3 total volume). A records search indicated the landfill was active from January to May 1972.

Chemical constituents believed to be disposed of within this unit include

- ☐ Acetone
- ☐ Asbestos
- ☐ Chlorinated solvents
- ☐ Chromium
- ☐ Lead
- ☐ Methyl ethyl ketone
- ☐ Nitration compounds.

8.11.2 Past Investigations

Oak Ridge National Laboratory conducted a soil investigation in the general area of this landfill in 1987. This investigation included the collection and analyses of three random surface soil samples in this area. One metal (calcium) was detected above background levels. Asbestos was detected in one sample. No SVOCs or HE were detected. The samples were not analyzed for VOCs.

8.11.2 RFI

The RFI activities included active soil gas surveys, a geophysical survey, and test pits to characterize the types of waste in the landfill. Preliminary data packages are being reviewed. Phase II fieldwork is under way, and results will be forthcoming.

8.12 CONSTRUCTION DEBRIS LANDFILL 14 (SWMU 65)

8.12.1 Description

Eleven construction debris landfill pits are located throughout Zone 7. The dimensions range from 80 by 80 by 7 ft to 40 by 12 by 12 ft (3,800 yd^3 total volume). This site was closed in 1979.

Chemical constituents believed to be disposed of within this unit include

- ☐ Acetone

- Asbestos
- Chlorinated solvents
- Chromium
- Lead
- Methyl ethyl ketone
- Nitration compounds.

8.12.2 Past Investigations

No past investigations have been conducted at this landfill.

8.12.3 RFI

This landfill was investigated under the RFI for the *Supplemental Verification Sites* (AL-PX-13), and NFA was requested.

8.13 CONSTRUCTION DEBRIS LANDFILL 15 (SWMU 66)

8.13.1 Description

Two construction debris landfill trenches are located in Zone 8 directly southeast of the road located between the intersection of South 6th Street and a road leading to Water Tower 15-22. The dimensions of each trench are approximately 40 by 12 by 12 ft (426 yd^3 total volume). These trenches were active between February and June 1980.

Chemical constituents believed to be disposed of within this unit include

-

  - Acetone
  - Asbestos
  - Chlorinated solvents
  - Chromium
  - Lead
  - Methyl ethyl ketone
  - Nitration compounds.

8.13.2 Past Investigations

No past investigations have been conducted at this landfill.

8.13.3 RFI

The RFI activities included active soil gas surveys, geophysical surveys, and soil sample collection and analyses. The preliminary data package for this landfill is being reviewed and will be made available after validation. Based upon Phase I findings, a request for NFA will be submitted.

8.14 ORIGINAL GENERAL PURPOSE SANITARY LANDFILL (SWMU 68a)

8.14.1 Description

The original sanitary landfill is located in the northeast portion of Pantex in Zone 15. The dimensions are unknown. The landfill was active from 1951 to 1952 and was used for a variety of waste including paint cans, adhesives, solvents, paints, potting compounds, chemicals, general garbage, cafeteria waste, paper, and other combus-tible trash. Combustible material was burned at this landfill prior to burial.

Chemical constituents believed to be disposed of within this unit include

- Adhesives
- Dodecenyl succine anhydride
- Mercury
- MOCA
- Sil-Gard
- Solvents.

8.14.2 Past Investigations

No past investigations have been conducted at this landfill.

8.14.3 RFI

The RFI activities at this landfill included active soil gas surveys, a geophysical survey, and test pits to characterize the types of waste in the landfill. The preliminary data packages for this landfill are being reviewed and will be available after validation. Phase II fieldwork is under way, and results will be forthcoming.

8.15 GENERAL PURPOSE SANITARY LANDFILL 1 (SWMU 68b)

8.15.1 Description

Sanitary Landfill 1 is located in the northeast portion of Pantex in Zone 15. It is approximately 3,500 ft north of Playa 1 and 900 ft south of water supply well 6, 540 ft south of Grant Drive, and directly east of North 14th Street. The dimensions are approximately 570 by 300 by 18 ft (114,000 yd^3 total volume). This site was closed in 1967.

Chemical constituents believed to be disposed of within this unit include

- Adhesives
- Dodecenyl succine anhydride
- Mercury
- MOCA
- Sil-Gard
- Solvents.

8.15.2 Past Investigations

Two soil investigations were conducted at landfills in the past. The first, conducted by Los Alamos National Laboratory in 1985, included the drilling of three boreholes ranging from 15 to 30 ft deep. The compounds analyzed for were near or below background levels. Two of the borings encountered debris at 2 ft below surface. The second investigation was conducted by Oak Ridge National Laboratory in 1987. This investigation included passive soil gas surveys and surface soil sample collection and analyses. Selected samples showed asbestos and low levels of VOCs.

8.15.3 RFI

RFI activities included soil gas surveys, geophysical surveys, test pits, surface soil sample collection and analyses, and groundwater sampling and analyses. The preliminary data package for this landfill has not been received, but will be made available after review and validation. Phase II fieldwork is under way, and results will be forthcoming.

8.16 GENERAL PURPOSE SANITARY LANDFILL 2 (SWMU 68c)

8.16.1 Description

Sanitary Landfill 1 is located near the southeast corner of Pantex Drive and South 13th Street. The

dimensions are approximately 420 by 105 by 18 ft (29,400 yd^3 total volume). The landfill was active from March 1967 to August 1968.

Chemical constituents believed to be disposed of within this unit include

- Adhesives
- Dodecenyl succine anhydride
- Mercury
- MOCA
- Sil-Gard
- Solvents.

8.16.2 Past Investigations

A soil investigation was conducted by Oak Ridge National Laboratory in 1987 and included soil gas surveys. Detectable levels of VOCs were found during this investigation.

8.16.3 RFI

RFI activities included soil gas surveys, geophysical surveys, test pits, surface soil sample collection and analyses, and groundwater sampling and analyses. The preliminary data package for this landfill has not been received, but will be made available after review and validation. Phase II fieldwork is currently under way and results will be forthcoming.

8.17 ACTIVE SANITARY LANDFILL 3 (SWMU 68d)

8.17.1 Description

The only active sanitary landfill is located immediately to the north of Zone 10 and is referred to as the Zone 10 landfill. It covers a rectangular parcel of approximately 32 acres, of which approximately 17 acres have been filled in and are now inactive. The landfill tract trends northeast to southwest. The northeast section of the landfill has the inactive cells, while the southwest section of the landfill (across the access road) is the action section of the landfill.

Chemical constituents believed to be disposed of within this unit include

- Adhesives
- Dodecenyl succine anhydride
- Mercury
- MOCA
- Sil-Gard
- Solvents.

8.17.2 Past Investigations

No environmental sampling has been conducted at the sanitary or construction portions of SWMU 68d.

8.17.3 RFI

RFI activities included soil gas surveys, geophysical surveys, test pits, surface soil sample collection and analyses, and groundwater sampling and analyses. The preliminary data package for this landfill has not been received, but will be made available after review and validation. Phase II fieldwork is under way, and results will be forthcoming.

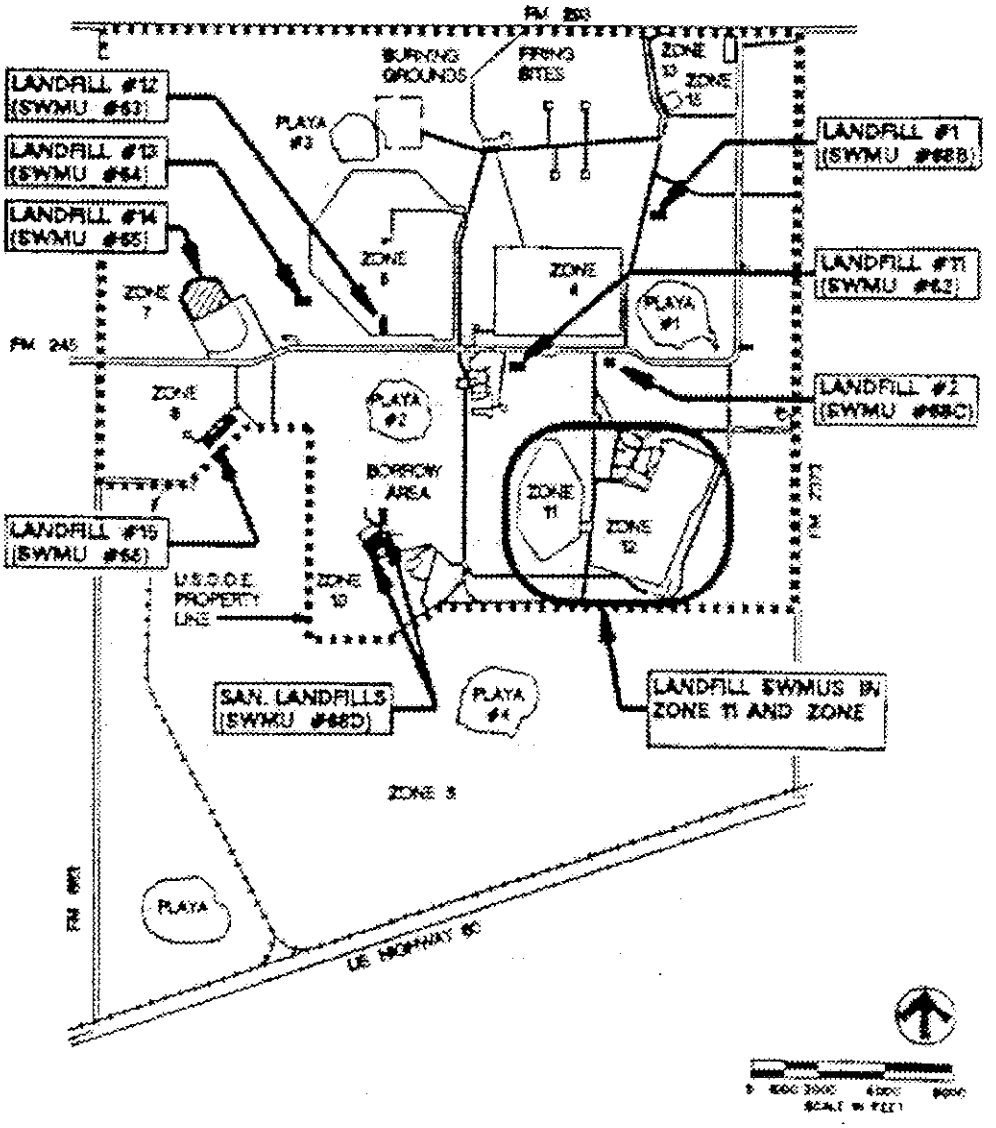

Figure 8-1. Landfill Solid Waste Management Units.

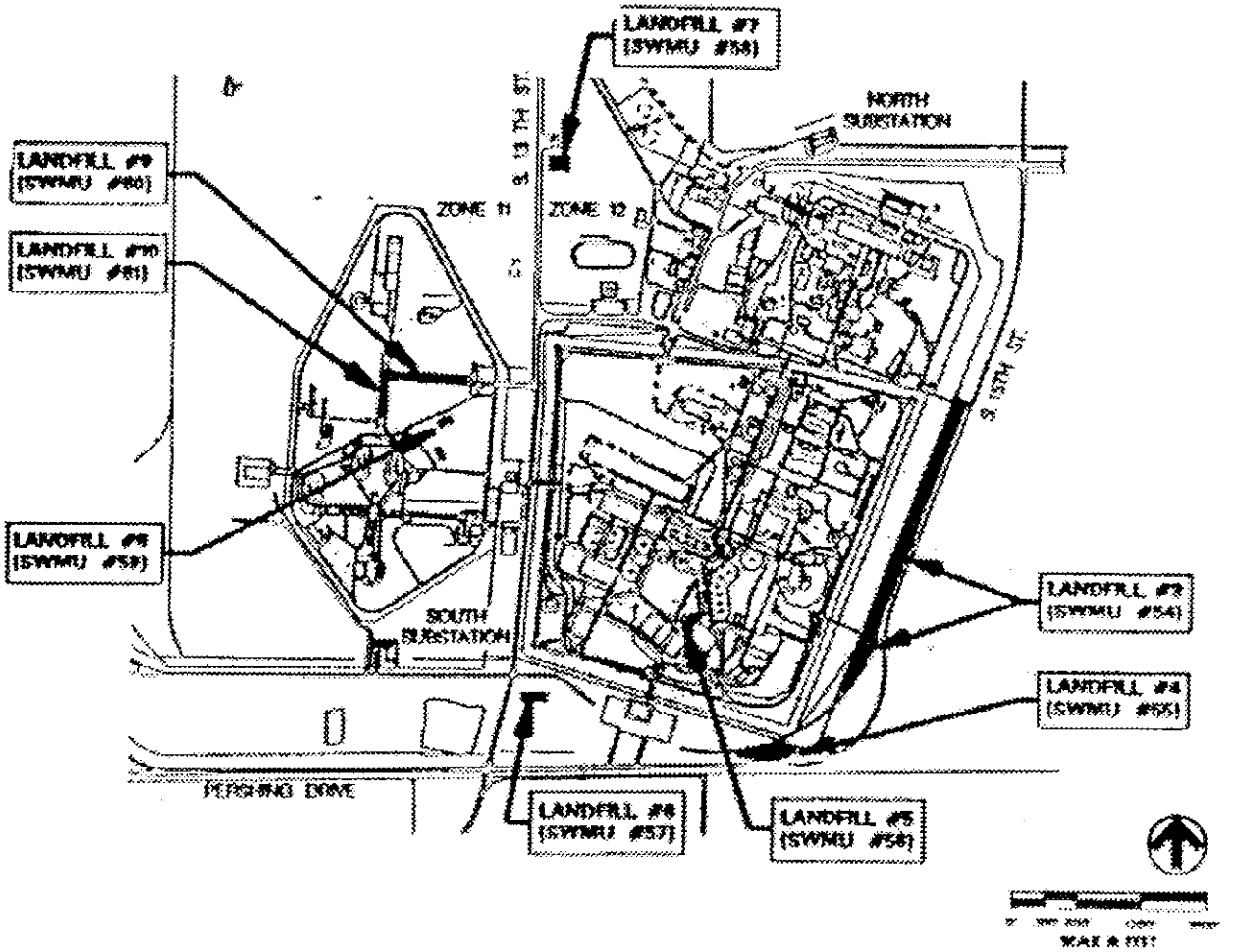

Figure 8-2. Landfills in Zone 11 and Zone 12.

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9.0 OPERABLE UNIT AL-PX-8, DITCHES AND PLAYAS (ADS 1216)

A network of man-made ditches that flow from several buildings inside Zones 11 and 12 has been constructed at Pantex. The ditches direct runoff away from structures and roads to the playas, which serve as closed collection areas for all runoff from the facility. Industrial operations at Pantex have resulted in the known or suspected discharge of various waste streams to the system of ditches and playas.

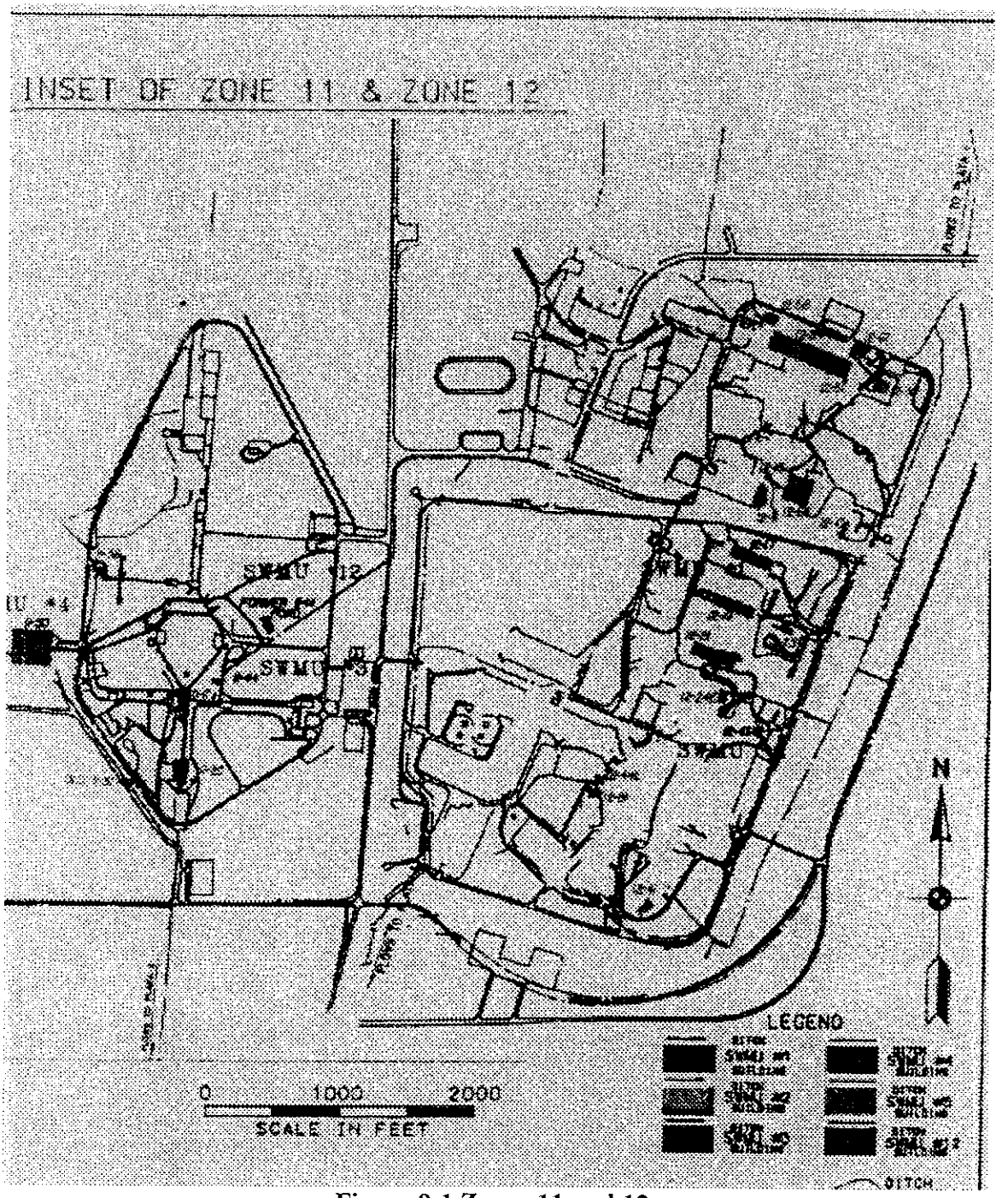

Figure 9-1 Zones 11 and 12

The RFI for this operable unit was conducted from June 1992 through March 1993 by Radian Corporation to determine if releases of hazardous waste/constituents had occurred and, if so, to define the nature and extent of the contamination. Due to the large number of SWMUs investigated (1 through 10 and 12), they were grouped into six flow systems. Each flow system contains a playa and the ditches that drain to that playa. Flow system 6 contains only groundwater data from the nine perched aquifer monitoring wells completed during the RFI. Phase I and II fieldwork was performed to characterize the sites.

Background samples were collected subsequent to the Phase II soil sampling. The background samples were necessary to establish naturally occurring levels of organic and inorganic constituents in playas, ditches, and upland areas.

Decision criteria used were risk-based screening requirements based on the toxicological properties, sample medium (e.g., surface/subsurface, groundwater, and air), and maximum concentrations.

9.1 FLOW SYSTEM 1

Flow system 1 consists of Playa 1 and the ditches that drain to this playa. A total of 272 surface (0 to 2 ft) soil samples, 161 subsurface (>2 ft) soil samples, and 10 surface water samples were collected from ditches and playas in flow system 1.

Sample analysis results showed the following compounds were present in concentrations exceeding decision criteria:

- Surface soils (0 to 2 ft) and subsurface (<2 ft)
  - metals
  - SVOCs
  - pesticides/PCBs
  - HE (HMX, RDX)
  - VOCs.

Analysis results for flow system 1 have been validated. A preliminary recommendations memo-randum for flow system 1 was received in March 1993. Subsequently, a data visualization was made that included additional sampling recommendations.

Phase II sampling took place in early 1995. Phase I and II results and recommendations have been incorporated into a draft RFIR. Some of the sites are being recommended for ICM while other sites will be addressed through a risk assessment.

9.2 FLOW SYSTEM 2

Flow system 2 consists of several unlined, man-made ditches that direct runoff and waste-water discharge away from Building 11-50 to Playa 2. Thirty-one surface and 43 subsurface samples were collected from

ditches and playas in this flow system.

Sample analysis results showed the following compounds were present in concentrations exceeding decision criteria:

- Surface (0 to 2 ft)
  - metals
  - VOCs
  - SVOCs
  - pesticides/herbicides
  - HE
- Subsurface (>2 ft) metals.

VOCs and SVOCs detected above decision criteria in flow system 2 are not well defined and further surface soil sampling was recommended. Additional background sampling is recommended to resolve uncertainty of the source of metals associated with surface runoff. This sampling occurred in late 1994.

Phase II soil sampling results recommended that NFA is necessary since none of the compounds that excluded the decision criteria exceeded the clean-up criteria.

9.3 FLOW SYSTEM 3

There is potential metals contamination of surface soils at flow system 3, composed only of Playa 3. Drainage from the Burning Grounds and the surrounding area is the potential source of contamination. Eleven surface and 33 subsurface samples were collected within and on the perimeter of this playa.

No constituents were determined to be in concentrations above the decision criteria in subsurface samples. However, one surface sample contained concentrations of lead, barium, cobalt, and nickel above the decision criteria. Sampling results from Phase II fieldwork has revealed that while strontium, dichlorodifluoromethane, barium and thallium all exceeded the decision criteria, only barium and thallium exceeded the clean-up criteria.

Based on the available data, NFA is recommended for subsurface soils. The surface soils will be addressed in a risk assessment in conjunction with the Burning Grounds investigation.

9.4 FLOW SYSTEM 4

Flow system 4 consists of several unlined, man-made ditches that direct runoff and waste-water discharge away from Zone 11 and Zone 12 south. Soil samples (104 surface and 114 subsurface) were collected from the ditches and playas in this flow system.

Phase I and II sample analysis results showed that the following compounds were present in concentrations exceeding the decision criteria:

- Surface (0 to 2 ft) metals
  - VOCs

- ☐ HE
- ☐ Subsurface (>2 ft)
  - ☐ pesticides
  - ☐ metals
  - ☐ VOCs
  - ☐ HE.

However, four of the six sites will be recommended for NFA since the concentrations did not exceed the clean-up criteria. The other two sites will require further action.

To define the actual extent of contamination, 26 additional ditch sediment samples are proposed. No additional samples are proposed for the subsurface soils.

9.5 FLOW SYSTEM 5

Flow system 5 consists of two unlined, man-made ditches that direct runoff and wastewater discharge away from the OSTP. Sixty-eight surface and 18 subsurface samples were collected from this flow system.

Sample results showed metals to be present in the surface and subsurface soils in concentrations exceeding the decision criteria. Pantex Lake will be recommended in the Final RFIR for risk assessment. The ditches that surround the OSTP will be recommended for further action and possibly followed by a risk assessment, depending on the results.

9.6 FLOW SYSTEM 6

Groundwater samples were collected from nine perched aquifer monitoring wells in flow system 6. Sample analysis results showed VOCs, metals, and HE were present in concentrations exceeding the decision criteria. No additional monitoring wells will be drilled under this RFI, but will be drilled during the Phase II field-work recommended for the Zone 12 groundwater assessment.

The data collected from all monitoring wells drilled during the various RFI will be integrated to form a better understanding of the stratigraphy of the perched aquifer and the extent and migration of contaminants within the aquifer.

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10.0 OPERABLE UNIT AL-PX-9, FIRING SITES (ADS 1205)

The firing sites (FS) are located in the north-central portion of Pantex, approximately 2 mi northeast of Zone 12. The FS have been in operation since as early as 1952. The sites were historically used for the testing of HE in connection with quality control and research and development activities. Some radioactive materials, primarily depleted uranium, were involved in the testing program. This operable unit consists of seven SWMUs. The Phase I RFI for this operable unit was completed June 1995. The ICM is scheduled for Fall 1995. The location of each site is depicted in Figure 10-1.

10.1 FIRING SITE 4 (SWMU 69)

10.1.1 Description

FS-4 is located approximately 1,000 ft north of Sheridan Drive and 2,500 ft west of North 14th Street. The approximate dimensions of this unit are 60 by 80 ft. It is constructed of bare soil, concrete, and asphalt. The unit is bermed on three sides with 10 to 15 ft of soil. A drain is located in the corner of the bermed area to drain runoff from the area. This runoff may pick up HE or radioactive material and carry it outside the FS. FS-4 began operation 30 or 40 years ago and is still active.

This unit receives waste residue from test shots. The larger pieces of waste from the unit are picked up and sent to the Burning Grounds for disposal. Smaller parts remain on the ground. FS-4 consists of a dirt or gravel surface where test shots are fired. At the center, the area is paved with concrete or asphalt.

Since 1953, FS-4 has been used for tests of the hydrodynamic behavior of simulated weapons components in combination with HE. The surface soil at FS-4 has depleted uranium as a result of past test firing shots. Chemicals potentially released from this unit include HE, radionuclides, and beryllium.

10.1.2 Past Investigations

Past investigations have included an aerial gamma radiation survey and annual environmental monitoring. Past investigations concentrated solely on quantifying radioactive materials used at the FS. Additionally, a 1979 aerial survey was conducted by EG&G. These investigations have indicated the presence of depleted uranium in the soils at FS-4. These investigations do not provide information on the kinds and amounts of HE waste that may be present.

10.1.3 RFI

FS-4 is active and will not be investigated under this RFI.

10.2 FIRING SITE 5 (SWMU 70)

10.2.1 Description

FS-5 is located approximately 2,000 ft to the south of FS-4. The approximate dimensions of FS-5 are 60 by 80 ft. It is constructed of bare soil, concrete, and asphalt. The unit is bermed on three sides with 10 to 15 ft of soil. A drain is located in the corner of the bermed area for runoff. This runoff may pick up HE or radio-active material. FS-5 was used for 37 yr but has been relatively inactive for the past 4 or 5 yr.

FS-5 was the prime location of test shots of combined HE and depleted uranium. The ground at FS-5 is contaminated with uranium-238 from a series of test firings. Since 1953, FS-5 was used for tests of the hydrodynamic behavior of simu-lated weapons components in combination with HE. Chemicals potentially released from this unit include HE and radionuclides.

10.2.2 Past Investigations

Past investigations have included an aerial gamma radiation survey and annual environmental monitoring. Past investigations concentrated solely on quantifying radioactive materials used at the FS. Exposure rates were well below maximum exposure rate of 2 mrem/hr as specified in 10 CFR 20.105(a) and (b)(1). These investigations do not provide information on the kinds and amounts of HE that may be present.

10.2.3 RFI

Phase I fieldwork was completed in FY95. Draft PDSs have been submitted and are currently being reviewed.

10.3 FIRING SITE 6 (SWMU 71)

10.3.1 Description

FS-6 was located in Zone 6. This former site was approximately 500 ft north of Pantex Drive and 1,000 ft east of Building 16-17. FS-6 was demolished sometime after 1967 along with other buildings. There is no remaining evidence of FS-6.

The approximate dimensions were 60 by 80 ft. FS-6 was constructed of bare soil, concrete, and asphalt. It was bermed on three sides with 10 to 15 ft of soil. This unit received waste residue from test shots. The larger pieces of waste from the unit were picked up and sent to the Burning Grounds for disposal. Smaller parts remained on the ground. Chemicals potentially released from this unit include HE and beryllium.

10.3.2 Past Investigations

The only previous investigation associated with FS-6 was the Plant-wide aerial gamma radia-tion survey (1979). No other records of environ-mental sampling of soils have been identified for this location. This survey indicated no increased gamma over baseline levels in soils at FS-6.

10.3.3 RFI

Phase I fieldwork was completed in FY95. Draft PDPs have been submitted and are currently being reviewed.

10.4 FIRING SITE 10 (SWMU 72)

10.4.1 Description

FS-10 is located approximately 1,200 ft west of FS-4. The approximate dimensions of this unit are 60 by 80 ft. It is constructed of bare soil, concrete, and asphalt. The unit is bermed on three sides with 10 to 15 ft of soil. The unit receives waste residue from test shots. The larger pieces of waste from the unit are picked up and sent to the Burning Grounds for disposal. Smaller parts remain on the ground. The FS consists of a dirt or gravel surface where test shots are fired. At the center, the area is paved with concrete or asphalt.

Since 1953, FS-10 has been used for tests of the hydrodynamic behavior of simulated weapons components in combination with HE. Thorium and depleted uranium were involved in test shots at this site. Chemicals potentially released from this unit include HE and radionuclides.

10.4.2 Past Investigations

Past investigations have included an aerial gamma radiation survey and annual environmental monitoring. Past investigations concentrated solely on quantifying radioactive materials used at the FS. The only previous investigation associated with FS-10 was the Plant-wide aerial gamma radiation survey (1979). Annual environmental monitoring includes collection of at least yearly soil and vegetation samples from FS-10. Darkroom activities occur at FS-10, -21, and -22. These waste streams were disposed directly into each facility's drain system.

10.4.3 RFI

FS-10 is active and will not need to be investigated under this RFI.

10.5 FIRING SITE 15 (SWMU 73)

10.5.1 Description

FS-15 is located approximately 2,200 ft west of North 11th Street and 3,700 ft north of Pantex Drive. Approximate dimensions are 60 by 80 ft. It is constructed of bare soil, concrete, and asphalt.

Soil at FS-15 is potentially contaminated with strontium-90 from tests of the bunker in 1958. A tracer of strontium-89, which was potentially heavily contaminated with strontium-90, was used for the test. The level and extent of the remaining contamination are unknown. Chemicals potentially released from this

unit include radionuclides.

10.5.2 Past Investigations

In 1987, five grab samples of surface soil were collected at FS-15. These grab samples were limited to an area within a 180-degree arc on a 64-ft radius. The aerial gamma radiation survey of 1979 indicated that there were no increases in gamma radiation.

10.5.3 RFI

Phase I fieldwork was completed in FY95. Draft PDPs have been submitted and are currently being reviewed.

10.6 FIRING SITE 21 (SWMU 74)

10.6.1 Description

FS-21 is located approximately 500 ft to the south of FS-15. The approximate dimensions of this unit are 60 by 80 ft. It is constructed of bare soil, concrete, and asphalt. This unit has been operational since the 1950s or 1960s. FS-21 receives waste residue from test shots. The larger pieces of waste from the unit are picked up and sent to the Burning Grounds for disposal. Smaller parts remain on the ground. FS-21 consists of a dirt or gravel surface where test shots are fired. At the center, the area is paved with concrete or asphalt. Darkroom activities occur at FS-21. These waste streams were disposed into each facility's drain system. Chemicals potentially released from this unit include HE.

10.6.2 Past Investigations

No results from previous investigations have been identified. No radioactive material was used at FS-21. This FS was used for testing HE only.

The aerial gamma radiation survey of 1979 indi-cated no increases in gamma radiation.

10.6.3 RFI

FS-21 is active and will not be investigated under this RFI.

10.7 FIRING SITE 22 (SWMU 75)

10.7.1 SWMU Description

FS-22 is located 945 ft west of FS-5. The approximate dimensions of FS-22 are 60 by 80 ft. The unit is constructed of bare soil, concrete, and asphalt. FS-22 was used for testing HE, and no evidence indicates that any radioactive metals were used in the test shots. It is suspected that soils at this site are

contaminated with unknown chemicals and HE residue. This unit has been operational since the 1950s or 1960s. FS-22 is similar to FS-4, -5, and -10, except that the equipment and control room is in an aboveground building. At FS-22, a section of gun barrel used in test firings appears to have leaked. Stained soil and gravel underneath the container was observed during the visual site inspection in March 1989. The section had been moved since the inspection and was located at the southeast corner of the site. Darkroom activities occur at FS-22. These waste streams were disposed directly into each facility's drain system. Chemicals possibly released from this unit include HE and heavy metals.

10.7.2 Past Investigations

The aerial gamma radiation survey of 1979 indicated no increases in gamma radiation; calculated values were at baseline levels.

10.7.3 RFI

FS-22 is active and will not be investigated under this RFI.

Figure 10-1. Location of the Firing Sites.

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12.0 OPERABLE UNIT AL-PX-11, MISCELLANEOUS HIGH EXPLOSIVES/RADIATION (ADS 1212)

The HE/radiation sites are located in Zones 4, 10, 11, and 12, and northwest of Zone 7 (Figure 12-1). Activities at these sites have involved the handling, storage, and disposal of HE/radioactive waste. A wide variety of waste and potential contaminants has been handled/disposed of at the HE/radiation sites. Phase I RFIs are scheduled for SWMUs 53, 82, 135, and 144 through 149 beginning in November 1994.

12.1 TEMPORARY HE BURN SITE (SWMU 53)

12.1.1 Description

This inactive site is a former burning ground located between Zones 6 and 7 in the northwest portion of the facility. Actual dimensions of the site are not known; however, remains of a fence are thought to outline an area approximately 120 by 60 ft. It is believed that trinitrotoluene (TNT), baritol, or other HE may have been brought to this site for open burning. The unit was active from 1951 to 1954 and again from 1959 to 1960.

Controlled burning of HE-contaminated waste, similar to operations at the Burning Grounds, occurred at this site. It is not known where the residue or ash was disposed. The amount and frequency of waste burned at this location is not known. Volatile and organic constituents may have been present in waste managed at this site.

Historical aerial photographs show two areas in each northern corner of the temporary HE burn site were distinctively scarred. Both of these areas were reported to have scattered, rust-colored stains on the surface soils and notably less vegetation than the surrounding area. During the visual site inspection, a sump or depression constructed of railroad ties was inspected, but no cement struc-ture was found. Facility representatives thought the railroad-tie depression was used as an unloading ramp.

Chemicals used at the facility and probably disposed of in this unit include baritol, HE, and TNT.

12.1.2 Past Investigations

The temporary HE burn site has been the subject of two soil sampling events.

$ A soil boring, designated as Hole 9, was drilled near the temporary HE burn site during a 1985 subsurface investigation. The boring was 15 ft deep and the exact location is unclear and not well documented. Soil samples were taken at 0, 9, and 14 ft and were analyzed for EP toxicity metals, pesticides, total organic carbons (TOC), total organic halogens (TOX), RDX, and TNT.

Analytical results indicated low concentrations of silver and pesticides were present at 0, 9, and 14 ft. TOC was found to be 22,600 ppm at the surface. RDX and TNT were not detected; TOX was reported as being within background concen-trations, and EP toxicity metals were below allowable concentrations given in 40 CFR 262.

$ In June 1987, seven grab samples were taken at locations chosen at random. The exact location of these

samples cannot be accurately determined. The analyses for the samples included anions, metals, HE, PCB, and extractable VOCs.

12.2 NUCLEAR ACCIDENT RESIDUE STORAGE LOCATED IN ZONE 4 (SWMU 82)

12.2.1 Description

This inactive site was a former landfill located in the northeast corner of Zone 4. The approxi-mate dimensions were 300 by 400 ft. The unit was operated from the 1960s to 1980. Decontami-nation of the area began in 1981 and reportedly was completed in mid-1986. No analytical data were provided to confirm that removal of waste was complete. The main feature of the landfill was a trench 15 by 165 ft by 15 ft deep in which the waste was deposited.

This area was used to store residue from hydrodynamic test shots, low-level waste (LLW) from the production line operations at Pantex, and small quantities of so-called nuclear weapon acci-dent residue (NWAR). The storage receptacles included an earthen trench and hollow, concrete cylinders embedded vertically, flush with ground level.

The trench was located in the southwest section of the disposal area and oriented east to west. Containers of NWAR were deposited in the west end, loose FS debris in the plastic-lined middle section, and containers of FS debris in the east end of the trench. The NWAR containers were large metal receptacles with a capacity of about 300 ft^3 each. They were coated with fiberglass before being placed in the trench. Dirt, gravel, and LLW made up the debris dumped into the middle section of the trench. After dumping, the middle section was backfilled with dirt. The debris containers buried in the eastern end were fiberglass-coated plywood boxes of 2 ft^3 capacity.

Hollow concrete cylinders were buried in two rows in a north-south direction on the west side of the disposal area to provide waste containment. The cylinders were 20 ft deep with a diameter of 7 ft. Pallets of LLW, NWAR, and FS debris were lowered into the cylinders.

In late 1979, the DOE Amarillo Area Office decided to retrieve all radioactive waste staged below ground at Pantex and dispose of it at an approved DOE burial ground. The decontami-nation of this site consisted of the removal of the buried radioactive waste, as well as any soil that may have been contaminated by the buried material. The radioactive waste and contaminated soil were shipped to the Nevada Test Site.

Chemicals used at the facility and probably disposed in this unit include radionuclides, HE, and beryllium.

12.2.2 Past Investigations

A ground penetrating radar survey was con-ducted in 1981 in an effort to locate seven metal waste containers. Results indicated possible reflections from several containers.

Soil samples were taken before and after site cleanup. Tritium, total uranium, and plutonium-239 were detected below the trench before cleanup. Soil analyses subsequent to the cleanup revealed low levels of the same radionuclides.

12.3 SUBSURFACE LEACHING BEDS, BUILDING 12-44 (SWMU 135)

12.3.1 Description

This abandoned inactive leaching bed is located immediately west of Building 12-44E in Zone 12. No dimensions for the leach field were available; however, the area (based on a scaled map) measures 100 by 50 ft. The date of startup is not known. The unit was removed and discontinued during the 1970s.

The leach bed received hazardous liquid laboratory waste of unknown chemical constituents from Building 12-44E. It potentially received plutonium-contaminated water from the personnel showers following an accident in 1966. The specific quantity of waste discharged and its chemical constituents are unknown. Chemicals used at the facility and probably disposed of in this unit include radionuclides, HE, and unknown laboratory chemicals.

12.3.2 Past Investigations

There are no records of past soil samples collected from the subsurface leaching beds at Building 12-44E.

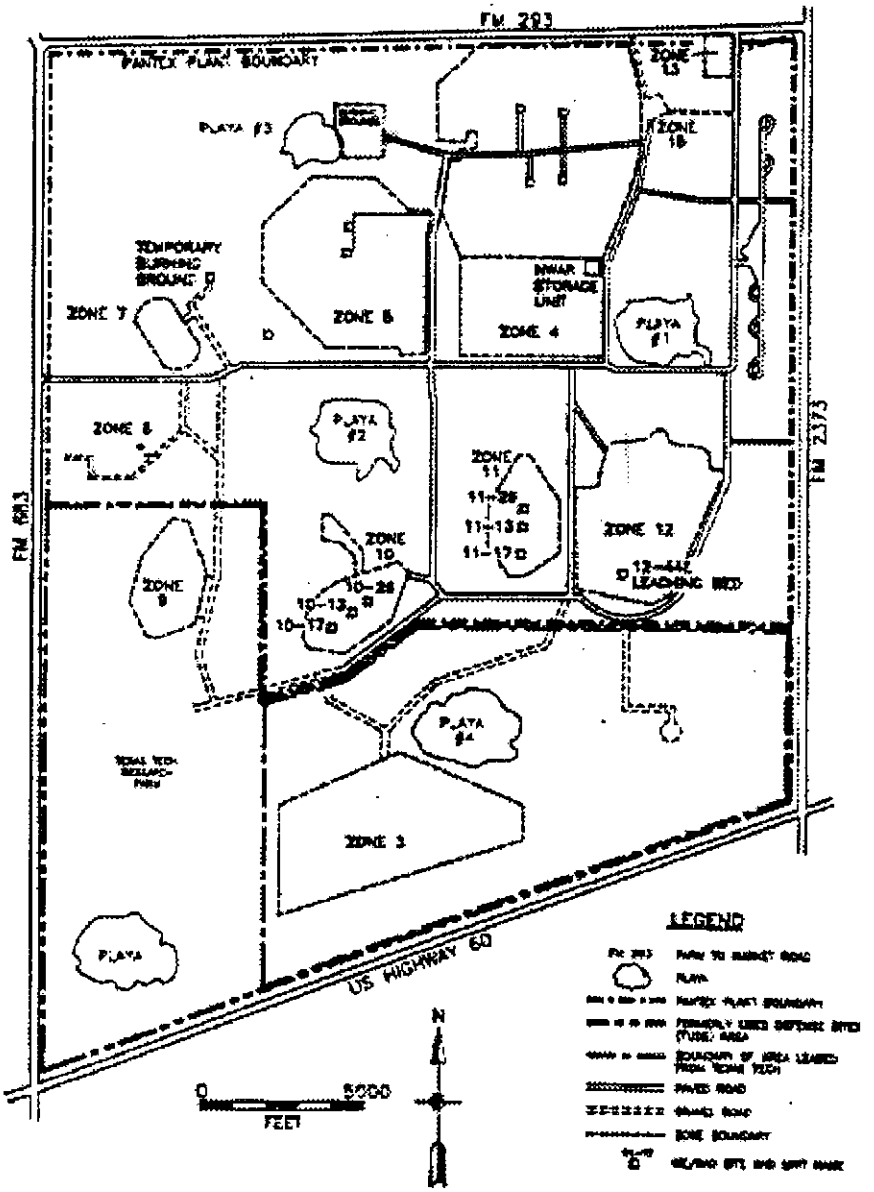

Figure 12-1. Locations of the HE/Rad Sites.

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16.0 OPERABLE UNIT AL-PX-15, 11-14 HYPALON POND (ADS 1213)

This operable unit comprises a RCRA-regulated surface impoundment located in the central portion of the facility in Zone 11. The approximate dimensions of the unit were 100 ft long by 30 ft wide by 7.5 ft deep, with a total volume of 28,000 gal. The unit was lined with three-ply hypalon. The 11-14 Pond was constructed in 1975 for use as a neutralization and settling basin for acidic wastewater generated at Building 11-36. (The unit is defined as the 11-14 Pond due to its location near Building 11-14; however, it never managed any waste from this building.) Use of the unit was discontinued in March 1989 and wastewater, sludge residues, and the hypalon liner were removed and disposed of at a permitted facility. The pond was backfilled and graded in March 1990.

An investigation was conducted in March 1990 to characterize subsurface conditions underneath the pond. Contaminants of concern were HE and residual concentrations of solvents, e.g., acetone, cyclohexane, methanol, tetrahydrofuran, and toluene. Low concentrations of acetone and barium were detected in subsurface soil samples. Based on the results of the investigation, Pantex prepared and submitted a closure plan to the TNRCC in June 1991, with regulatory approval being received in December 1991.

The closure plan was implemented in two phases. The first phase was conducted in March and April of 1992. Investigation activities included removing ancillary pipeline and collecting samples from underlying soil for chemical analysis, drilling of boreholes through the former pond and sampling subsurface soils, and constructing and sampling four groundwater monitoring wells around the perimeter of the pond. The second phase of closure activities was conducted in July 1992. The wells were resampled and additional surface soil samples were collected.

Based on site characterization, contamination of soil was observed in excess of closure plan target levels (the maximum allowable concentration of a hazardous waste constituent that can remain in soil or groundwater without posing a risk to human health or the environment) for several inorganic and organic constituents. Low concentrations of 1,2-dichloroethane and trichloroethene were detected in the groundwater samples. These same chemical constituents have been detected at similar concentrations in other Pantex groundwater monitoring wells located upgradient of the 11-14 Pond. The constituents detected in the groundwater do not appear attributable to the pond operation. Due to the spacial distribution, mobility, and toxicity of the residual soil contaminants, a risk assessment was performed and submitted to the TNRCC. Regulatory approval is pending for the closure request. The contaminants detected in the groundwater will be monitored under the Zone 12 Groundwater investigation.

This SWMU is not subject to a RCRA RFI.

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17.0 OTHER PANTEX SWMUs NOT INCLUDED IN AN OPERABLE UNIT

Several units designated as SWMUs were characterized as non-RCRA-regulated units. These units are not subject to an RFI, but will be evaluated to determine the physical and general characteristics of the site to aid in the recommendation of a final disposition action.

The physical characteristics to be documented are, but not limited to physical features of the units, signs of migration of hazardous substances, evidence of contamination, and distances from the unit to important surrounding features. The general characteristics to be documented are, but not limited to chronology of significant events at the site, chemical and waste management practices used at the site, waste types and quantities, past environmental concerns, and verbal complaints.

These non-RCRA-regulated SWMUs will be reviewed, re-evaluated, and recommended for removal or additional actions that would lead to removal of the unit from the ER Program.

The following is a list of the non-RCRA-regulated SWMUs to be evaluated:

SWMU	Site Name
076	Firing Site 18
077	Firing Site 23, Filter/Exhaust System
078	Firing Site 24, Sump Collection System
079	Container Storage, 11-7N Pad
080	Container Storage Area (Conexes 1, 2, 3, & 4)
081	Waste Storage Magazine, 4-19
083	Bldg 4-8, Container Storage Building, Asbestos Staging Area
085	MOCA Waste Accumulation Area, Bldg 12-16
086	Misc. Waste Accumulation Area, Bldg 11-14, Solvent Storage Shed
087	Misc. Waste Accumulation Area, Bldg 11-20, Solvent Storage Shed
088	Misc. Waste Accumulation Area, Bldg 11-41, Compressor Building
089	Misc. Waste Accumulation Area, Bldg 12-2, Norton Hall
090	Misc. Waste Accumulation Area, Bldg 12-9, Hall Ground Floor
091	Misc. Waste Accumulation Area, Bldg 12-9, Solvent Shed
092	Misc. Waste Accumulation Area, Bldg 12-9, Outside North

093	Misc. Waste Accumulation Area, Bldg 12-11, Paint Shop
094	Misc. Waste Accumulation Area, Bldg 12-R-13
095	Misc. Waste Accumulation Area, Bldg 12-18, Battery Charging Facility Outside, East
096	Misc. Waste Accumulation Area, Bldg 12-21, Gas Lab (E) Equip Room
097	Misc. Waste Accumulation Area, Bldg 12-34, East of 12-9
098	Misc. Waste Accumulation Area, Bldg 12-38, Solvent Storage/12-59 Chemistry Lab
099	Misc. Waste Accumulation Area, Bldg 12-41, Spray Painting
100	Misc. Waste Accumulation Area, Bldg 12-42
101	Misc. Waste Accumulation Area, Bldg 12-59, Chemistry Laboratory
102	Misc. Waste Accumulation Area, Bldg 12-68, Batch Master, NE corner
104	Misc. Waste Accumulation Area, Bldg 12-82, Assembly Bays
105	Misc. Waste Accumulation Area, Bldg 12-84, Assembly Bays
106	Misc. Waste Accumulation Area, Bldg 16-1, VMF
107	Misc. Waste Accumulation Area, Bldg 16-5, Flammable Liquid Storage Bldg
108	Batch Master at Bldg 12-68

SWMU	Site Name
110	Bldg 12-68 Concrete Drainage Sump
111	Bldg 11-36 Solvent Tank
112	Bldg 11-36 Solvent Tank
114	Bldg 11-36 Scrubber System
115	Bldg 11-36 Carbon Filter
116	Bldg 11-36 HE Sludge Filters
117	Bldg 11-44 HE Settling Tank
118	Bldg 11-44 Equalization Basin
119a	Bldg 11-44 HE Particulate Filters
119b	Bldg 12-43 HE Particulate Filters
120a	Bldg 11-44 Activated Carbon Filters
120b	Bldg 12-43 Activated Carbon Filters
121	Bldg 12-43 HE Settling Tank
122	Bldg 12-43 Equalization Basin
123	Bldg 12-43 Concrete Sump
124	Bldg 11-50 Wastewater Treatment System
125	Bldg 12-43 HE-Contaminated Charcoal Boxes (150)
126	Bldg 12-43 HE-Contaminated Waste Dumpsters (40)
127	Bldg 12-43 Nonhazardous Waste Dumpsters
128	Portable HE Wastewater Tanks
129a	HE-Contaminated Sludge Containers at Bldg 11-44
129b	HE-Contaminated Sludge Containers at Bldg 12-43
130	Portable Waste Solvent Tanks
131	Waste Oil Storage Tanks
132	Vacuum Guzzler
134	Bldg 11-29, Silver Recovery Operations
137	Bldg 12-41, Paint Shop Wastewater Tank
138	Zone 12 Paint Shop Sandblaster Collection Cone
141	Classified Waste Incinerator
142	Misc. Laboratory Hood and Filter Systems (Bldgs 11-5, 11-20, 11-22, 11-29, 11-36, 11-51, 12-02, 12-05, 12-06, 12-09, 12-11, 12-16, 12-17, 12-19E, 12-35, 12-41, 12-58, 12-59, 12-66, 12-70, 16-1, and FS 11 and 20)

 http://laurel.dc.amesl.../Pantex/PTXtab211.html

Table 2.1-1. Pantex Ordnance Production Summary 1942 to 1945.

Product	Production Dates	Quantities	Units
Adapter boosters	11/42 - 08/45	130,818	boosters
Auxiliary boosters	11/42 - 08/45	691,322	boosters
Ammonium nitrate	12/42 - 08/45	15,036,480	pounds
TNT pellets	08/44 - 08/45	1,248,650	pounds
105-mm Howitzer shells	12/43 - 08/45	6,035,008	shells
23-lb fragmentation bombs	10/43 - 08/45	1,961,391	bombs
250-lb bombs	09/42 - 12/43	116,060	bombs
500-lb bombs	10/42 - 08/45	1,987,285	bombs

Table 1.4-1. Project Team Core Members.

Organization	Name	Title	Phone	E-Mail Address
DOE-HQ	Tom Longo, Amiya Das	Prog Mgr	(301) 903-7603	thomas.longo@em.doe.gov amiya.das@em.doe.gov
DOE-AL	Mike Gardipe	Prog Engr	(505) 845-6022	mgardipe@doeal.gov
DOE-AAO	Johnnie Guelker	Lead ER and PMT	(806) 477-3183	jguelker@pantex.com
M&H/BMI	Gary Baker	WM&ER Div Mgr	(806) 477-4440	gbaker@pantex.com
M&H/BMI	N. Joseph Gantos	ER Proj Mgr	(806) 477-6342	jgantos@pantex.com

PMT = Project Management Team
WM = Waste Management

Author: kse@scientech.com_at_INTERNET at X400PO
Date: 1/24/97 6:09 PM
Priority: Normal
TO: Amiya Das at EM-45 CLF
Subject: Bombs and Bullets
---------- Message Contents ----------

X-Sender: kse@eaglerock.if.scientech.com
Return-Receipt-To: kse@scientech.com
X-Mailer: Windows Eudora Pro Version 2.1.2
Mime-Version: 1.0
Content-Type: text/plain; charset="us-ascii"

Amiya, I am working on a Benchmarking effort here at the INEL for LMITCO and DOE. This effort includes identifying other DOE sites with Unexploded Ordnance or Ordnance Explosive Waste needs. Can you tell me:

1) Does the Pantex Plant have needs for Unexploded Ordnance Cleanups as part of the ER Program?

2) Does the Pantex Plant have High Explosives contamination in the soils such as TNT or RDX?

3) If so, how can I find out what is planned for cleanup of these items and other information. Is there any printed material or technical contacts that you could give me.

Mike Gardipe
505-845-6022

I would appreciate any help you could provide.

Thanks,
Kory Edelmayer
Environmental, Engineering & Safety
SCIENTECH, INC.
Idaho Falls, ID
Phone: (208) 523-9552
Fax: (208) 523-9380

Kory: My computer is growing old and getting sick with me and will not send. So I am faxing. PX has some explosives which seeped through soil into water. Has RDX, not sure about TNT. Ground water cleanup is on going now. Please call PX project manager at Albuquerque, Mike Gardipe (505-845-6022). He may direct you to Dan Ferguson (806-477-3126) at PX if you need more details.

OPTIONAL FORM 99 (7-90)
FAX TRANSMITTAL # of pages ►

To Edelmayer	From Amiya Das
Dept./Agency	Phone # 301-903-7603
Fax # 208-523-9380	Fax # -3877

NSN 7540-01 317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

Return-Path: mgardipe@doeal.gov
From: "Gardipe, Mike" <mgardipe@doeal.gov>
To: "'Kory'" <KEdelmayer@SCIENTECH.com>
Subject: Reply to UXO Question at Pantex.
Date: Mon, 27 Jan 1997 11:12:00 -0700
Encoding: 16 TEXT

Kory-

As far as I know, there is not a need at Pantex for UXO as part of the ER Program.
We do have a problem with some of the firing sites and ranges, but they are active and not part of the ER program.

The primary contaminant of concern for soils at Pantex is HE products such as RDX and HMX and other degradation products. We have already addressed cleanup for groundwater, but could entertain new, innovative, cost effective solutions for deep soil HE contamination (30 feet and lower).

Johnnie Guelker, AAO would be a good starting point for specifics.
(806)477-3183
or jguelker@pantex.com

Return-Path: JGUELKER@pantex.com
Date: Tue, 28 Jan 1997 08:06:22 -0600
From: JOHNNIE GUELKER <JGUELKER@pantex.com>
To: KEdelmayer@SCIENTECH.Com
Cc: JGANTOS@pantex.com
Subject: Request for Bombs and Bullets information -Reply

Kory,
Pantex had some UXO cleanup performed by the COE Tulsa District. Kevin DaVae was the POC for the activity. He can be reached thru Russell Holman at 918-669-7008. We also have HE contamination in the Soils mainly RDX and also in the Perched Groundwater. Joe Gantos or Dale Stout would be the best POC for this activity at 806-477-6342 or 806-477-6327. Hopefully this will get you started, but if you run into any problems feel free to get back to me. My phone # is 806-477-3183 or use the E-mail.

Johnnie GuelkerReceived: from eaglerock.if.scientech.com by interlock.pantex.com with SMTP id AA03353
(InterLock SMTP Gateway 3.0 for <jguelker@pantex.com>);
Mon, 27 Jan 1997 10:23:23 -0600
Received: from pc-rlb.if.scientech.com (a111.if.scientech.com [198.60.85.111]) by eaglerock.if.scientech.com (8.7.4/8.7.3) with SMTP id JAA00913 for <jguelker@pantex.com>;
Mon, 27 Jan 1997 09:23:19 -0700
Message-Id: <199701271623.JAA00913@eaglerock.if.scientech.com>
X-Sender: kse@eaglerock.if.scientech.com
Return-Receipt-To: KEdelmayer%SCIENTECH.Com@internet.pantex.com
X-Mailer: Windows Eudora Pro Version 2.1.2
Date: Mon, 27 Jan 1997 10:23:19 -0600
From: Kory Edelmayer <KEdelmayer%SCIENTECH.Com@internet.pantex.com>
To: JGUELKER@pantex.com
Subject: Request for Bombs and Bullets information
Mime-Version: 1.0
Content-Type: text/plain
Content-Disposition: inline

Johnnie, I sent you an email message on January 24, 1997 to receive some information on UXO at the Pantex Plant. My return email address has been changed to KEdelmayer@SCIENTECH.Com. I apologize if this has caused any inconvenience. Thank you again for your time.
Kory Edelmayer
Environmental, Engineering & Safety
SCIENTECH, INC.
Idaho Falls, ID
Phone: (208) 523-9552

Return-Path: JGANTOS@pantex.com
Date: Tue, 28 Jan 1997 14:41:29 -0600
From: N JOSEPH GANTOS <JGANTOS@pantex.com>
To: KEdelmayer@SCIENTECH.Com
Subject: Request for Bombs and Bullets information -Reply

Kory:

It seems like Johnnie responded to most of your questions.

Let me know if you need anything else.

JoeReceived: from eaglerock.if.scientech.com by interlock.pantex.com with SMTP id AA03390
(InterLock SMTP Gateway 3.0 for <jgantos@pantex.com>);
Mon, 27 Jan 1997 10:28:41 -0600
Received: from pc-rlb.if.scientech.com (a111.if.scientech.com [198.60.85.111]) by
eaglerock.if.scientech.com (8.7.4/8.7.3) with SMTP id JAA01100 for <jgantos@pantex.com>;
Mon, 27 Jan 1997 09:28:43 -0700
Message-Id: <199701271628.JAA01100@eaglerock.if.scientech.com>
X-Sender: kse@eaglerock.if.scientech.com
Return-Receipt-To: KEdelmayer%SCIENTECH.Com@internet.pantex.com
X-Mailer: Windows Eudora Pro Version 2.1.2
Date: Mon, 27 Jan 1997 10:28:43 -0600
From: Kory Edelmayer <KEdelmayer%SCIENTECH.Com@internet.pantex.com>
To: JGANTOS@pantex.com
Subject: Request for Bombs and Bullets information
Mime-Version: 1.0
Content-Type: text/plain
Content-Disposition: inline

Joseph, I sent you an email message on January 24, 1997 to receive some information on UXO at the Pantex Plant. My return email address has been changed to KEdelmayer@SCIENTECH.Com. I apologize if this has caused any inconvenience. Thank you again for your time.

Kory Edelmayer
Environmental, Engineering & Safety
SCIENTECH, INC.
Idaho Falls, ID
Phone: (208) 523-9552
Fax: (208) 523-9380

Return-Path: JGANTOS@pantex.com
Date: Wed, 29 Jan 1997 07:18:07 -0600
From: N JOSEPH GANTOS <JGANTOS@pantex.com>
To: KEdelmayer@SCIENTECH.Com
Cc: JGUELKER@pantex.com
Subject: HE Contaminated Soils and Groundwater -Reply

Kory:

I am not sure I can answer these questions in an email. We have several documents that I can forward to you (with Johnnie's concurrence) that can address these questions.

JoeReceived: from eaglerock.if.scientech.com by interlock.pantex.com with SMTP id AA10711
(InterLock SMTP Gateway 3.0 for <jgantos@pantex.com>);
Tue, 28 Jan 1997 15:40:08 -0600
Received: from pc-rlb.if.scientech.com (a111.if.scientech.com [198.60.85.111]) by eaglerock.if.scientech.com (8.7.4/8.7.3) with SMTP id OAA11862 for <jgantos@pantex.com>;
Tue, 28 Jan 1997 14:39:59 -0700
Message-Id: <199701282139.OAA11862@eaglerock.if.scientech.com>
X-Sender: kse@eaglerock.if.scientech.com
Return-Receipt-To: KEdelmayer%SCIENTECH.Com@internet.pantex.com
X-Mailer: Windows Eudora Pro Version 2.1.2
Date: Tue, 28 Jan 1997 15:39:59 -0600
From: Kory Edelmayer <KEdelmayer%SCIENTECH.Com@internet.pantex.com>
To: JGANTOS@pantex.com
Subject: HE Contaminated Soils and Groundwater
Mime-Version: 1.0
Content-Type: text/plain
Content-Disposition: inline

Joe, I appreciate you responding to my email message. I have a few more questions that are more specific.

1) What are (or were) the land use goals or assumptions?

2) What are (or were) the Remedial Action Objectives, cleanup and screening concentration goals?

3) What were the public comments, concerns and responses by the Regulators?

4) What are (or were) the costs?

5) Lessons learned from past cleanups.

Return-Path: JGANTOS@pantex.com
Date: Wed, 29 Jan 1997 11:08:45 -0600
From: N JOSEPH GANTOS <JGANTOS@pantex.com>
To: KEdelmayer@SCIENTECH.Com
Subject: Request for documents -Reply

Kory:

Johnnie requested us to talk before exchanging documents. Can you pls.
call me at 806 477-6342. What is your phone number?

JoeReceived: from eaglerock.if.scientech.com by interlock.pantex.com with SMTP id AA14308
(InterLock SMTP Gateway 3.0 for <jgantos@pantex.com>);
Wed, 29 Jan 1997 09:26:14 -0600
Received: from pc-rlb.if.scientech.com (a111.if.scientech.com [198.60.85.111]) by
eaglerock.if.scientech.com (8.7.4/8.7.3) with SMTP id IAA30564 for <jgantos@pantex.com>;
Wed, 29 Jan 1997 08:26:04 -0700
Message-Id: <199701291526.IAA30564@eaglerock.if.scientech.com>
X-Sender: kse@eaglerock.if.scientech.com
Return-Receipt-To: KEdelmayer%SCIENTECH.Com@internet.pantex.com
X-Mailer: Windows Eudora Pro Version 2.1.2
Date: Wed, 29 Jan 1997 09:26:04 -0600
From: Kory Edelmayer <KEdelmayer%SCIENTECH.Com@internet.pantex.com>
To: JGANTOS@pantex.com
Subject: Request for documents
Mime-Version: 1.0
Content-Type: text/plain
Content-Disposition: inline

Joe, any documents or printed information that you could send to me on the
cleanup or proposed cleanup of the HE contaminated groundwater and soil
would be greatly appreciated. You can either email them to me or FED-EX
them to me. My FED-EX number is: 1807-8590-6.
Send them to:

SCIENTECH, INC.
1585 North Skyline Drive
Idaho Falls, ID 83402
Atten: Kory Edelmayer

Again, I appreciate your time in getting this information to me.

Thanks,
Kory Edelmayer

Environmental, Engineering & Safety
SCIENTECH, INC.
Idaho Falls, ID
Phone: (208) 523-9552
Fax: (208) 523-9380

MASON & HANGER CORPORATION

(PRIME CONTRACTOR FOR THE U.S. DEPARTMENT OF ENERGY)
PANTEX PLANT P.O. BOX 30020 AMARILLO, TEXAS 79120-0020

Index No. PX859
Page No. 1 of
Issue No. 3
Issue Date: 8/96

TEL: 806 477 6104

SHIPPING ORDER

SHIPPER NO. 81824

Reference Standard 1700 (PMS)

KORY EDELMAYER
SCIENTECH
1585 N. SKYLINE DRIVE
IDAHO FALLS, ID 83402

DATE PREPARED: 1-31-97

PREPAID ☐ COLLECT ☐ OTHER ☒

REC. FED-EX# 1807-8590-6

AUTHORITY FOR SHIPMENT: N.J. GANTOS

PURPOSE OF SHIPMENT: TO EXPEDITE

HIGHEST SECURITY CLASSIFICATION: UNCLASSIFIED

HAZARD INVOLVED: NONE

ORIGINATOR	DEPARTMENT	REQUIRED DEL. DATE	SS MATERIAL
N.J. GANTOS	792	2-3-97	741 NO. AWA-

QTY	TYPE	CONTROL NO.	DESCRIPTION	SEC CLS	ACCOUNTING	PRICE UNIT	PRICE EXTENSION	PKG NO.
1	PKG		DOCUMENT					

IF THE MATERIAL DESCRIBED ON THIS DOCUMENT IS CLASSIFIED, A "SIGN & RETURN" COPY OF THE SHIPPING ORDER HAS BEEN ENCLOSED. PLEASE SIGN RECEIPT FOR THE MATERIAL AS INDICATED, AND RETURN IT EXPEDITIOUSLY TO OUR COMPANY - ATTENTION: TRAFFIC SECTION, IF ANY DISCREPANCIES ARE NOTED, PLEASE MAKE THE NECESSARY CHANGES ON OUR DOCUMENT BEFORE RETURNING IT.

RECEIVED IN GOOD CONDITION (EXCEPT AS NOTED) BY: NAME, TITLE AND DATE

930565

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Index No. PX859
Page No. 1 of
Issue No. 3
Issue Date: 8/96

MASON & HANGER CORPORATION

(PRIME CONTRACTOR FOR THE U.S. DEPARTMENT OF ENERGY)
PANTEX PLANT P.O. BOX 30020 AMARILLO, TEXAS 79120-0020

TEL: 806 477 6104

SHIPPER NO. 81824

SHIPPING ORDER

Reference Standard 1700 (PMS)

KORY EDELMAYER
SCIENTECH
1585 N. SKYLINE DRIVE
IDAHO FALLS, ID 83402

DATE PREPARED: 1-31-97

PREPAID ☐ COLLECT ☐ OTHER ☒
REC. FED-EX# 1807-8590-6

AUTHORITY FOR SHIPMENT: N.J. GANTOS

PURPOSE OF SHIPMENT: TO EXPEDITE

HIGHEST SECURITY CLASSIFICATION: UNCLASSIFIED

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ORIGINATOR	DEPARTMENT	REQUIRED DEL. DATE	SS MATERIAL
N.J. GANTOS	792	2-3-97	741 NO. AWA-

QTY	TYPE	CONTROL NO.	DESCRIPTION	SEC CLS	ACCOUNTING	PRICE UNIT	PRICE EXTENSION	PKG NO.
1	PKG		DOCUMENT					

IMPORTANT INSTRUCTIONS

IF THE MATERIAL DESCRIBED ON THIS DOCUMENT IS CLASSIFIED, PLEASE SIGN THIS ACKNOWLEDGEMENT COPY AND MAIL TO: MASON & HANGER CORPORATION

ATTN: MAIL & RECORDS P.O. BOX 30020 AMARILLO, TEXAS 79120-0020
FOR: TRAFFIC SECTION

RECEIVED IN GOOD CONDITION (EXCEPT AS NOTED) BY: NAME, TITLE AND DATE

950565-A

SIGN & RETURN

U.S. DEPARTMENT OF ENERGY
PANTEX PLANT
AMARILLO, TEXAS

FINAL

RISK REDUCTION RULE GUIDANCE FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

PREPARED BY:

Mason & Hanger Corporation/Battelle Pantex
Pantex Plant

PREPARED FOR:

U.S. Department of Energy
Amarillo Area Office
Environmental Restoration Program

AUGUST 1996

EXECUTIVE SUMMARY

The risk reduction rule guidance (RRRG) document is to be used as a dynamic guide governing Resource Conservation and Recovery Act (RCRA) based closures and interim corrective measures specified in Title 30 Texas Administrative Code (TAC) § 335, Subchapter S. Risk reduction is applicable to closures of active sites or those operational sites which are addressed in the Pantex Plant Part B Hazardous Waste Permit and notice of registration (NOR) as well as past potential release sites addressed under the RCRA 3008h order.

In May 1994, Pantex Plant was included on the Environmental Protection Agency's (EPA) National Priority List (NPL). The EPA, the Texas Natural Resource Conservation Commission (TNRCC) agreed upon a RCRA and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) integration approach in which the site-wide objectives mandated by the CERCLA process are considered in the development of interim corrective measures (ICMs) and closure of inactive RCRA sites (Table 1.1). While closure of permitted RCRA Part B active sites are outside the scope of CERCLA, the U.S. Department of Energy (DOE) may consider the CERCLA site-wide objectives in active site closure to reduce the potential of having to revisit the site to meet CERCLA site-wide remediation objectives. In summary, the RRS will be the regulatory authority for all RCRA closures and an applicable or relevant and appropriate requirements (ARAR) in the CERCLA process. The RRS then may be used on (1) RCRA past potential spill sites (2) RCRA active or operational closures and/or (3) considered as an ARAR in the site-wide CERCLA investigation as discussion in the following examples.

This document presents background data and risk-based remediation levels based on current site-specific background data and recent toxicological indices. The document is to be used as a tool in planning the investigation phase in the RCRA facility investigation (RFI) and active RCRA closures. Prior to submission of a "no further action" (NFA) recommendation or a corrective measures implementation plan (CMIP), current background, as well as, toxicity data must be reviewed and used in establishing final decision criteria as specified in Title 30 TAC §§ 335.551-335.569. The investigator is required to monitor newly acquired background and toxicity data and to evaluate how those changes influence his/her investigations data quality, and overall objectives.

The TNRCC has developed, and is recommending for use, an Ecological Screening Evaluation Form to address the ecological setting and exposure pathways for RCRA sites (Table ES-1). As recommended by the TNRCC (May 30, 1996, Approval with Modifications of the RRRG Draft Final dated June 1995), the DOE may choose to apply this checklist for individual solid waste management

units (SWMUs)/releases, to multiple release sites, or the entire Plant site. Depending on the outcome of the screening evaluation, further ecological assessment may be necessary.

At many sites, RCRA ICMs will be needed to continue and complete the RFI. A subject example would be the removal of an evaporation pond liner, and subsequent sampling to determine if leakage has occurred. If sample analyses indicate that no leakage has occurred, then the site may be closed under RRS 1 or considered as RRS 2 closure if concentrations of contaminants fall below the decision criteria.

This guidance document presents the methodology for applying the Texas Natural Resource Conservation Commission (TNRCC) Risk Reduction Standards to the Resource Conservation and Recovery Act (RCRA) Facility Investigations (RFIs) being conducted at the DOE's Pantex Plant, Amarillo, Texas. The document calculates the proposed "cleanup" levels in accordance with the TNRCC regulations. It also presents the assumptions and describes the data sources used to generate the proposed media "cleanup" levels for the anticipated potential contaminants at Pantex Plant. This guidance document directly supports the current efforts of the Environmental Restoration (ER) Program for use in the conduct of the RFIs. The use of these "cleanup levels" by the DOE and its contractors will ensure consistency between all parties involved and will eliminate unnecessary duplication in effort.

"How clean is clean?" This question has haunted the country's ER community for many years. Traditionally, there have been few promulgated standards available for use in decision-making during site investigations and as eventual "cleanup" levels. Additionally, no consistent approach has been applied to determine "cleanup" levels between similar sites. These issues were a significant hindrance to the prompt completion of site investigations and remediation of contaminated sites, as the levels of "contamination" comprising the nature and extent had typically been based on background values or quantitation limits, and "cleanup" levels had been independently determined using quantitative risk assessment procedures.

The TNRCC (formerly the Texas Water Commission) took a giant step forward with the final publication of the Risk Reduction Rules, Title 30 (previously Title 31) TAC, Chapter 335, Subchapters A and S on June 15, 1993 (18 Texas Register 3814-3872). The rule was effective on June 28, 1993, and allows background [Risk Reduction Standard (RRS)1] or risk-based cleanup standards (RRS 2 and RRS 3) to be established and used as the Preliminary Remediation Goals (PRGs) during site remediation (see Subsection 2.1). It must be noted that the PRGs were developed to consider only human health risk factors and do not consider other ecological receptors and endpoints. These additional site-wide objectives will be considered in the proposed Pantex Plant Baseline Risk Assessment (BRA) that is scheduled to be performed in the near future. This document proposes RRSs 1 and 2 not only for use in determining PRGs but also for use as decision criteria for additional sampling needs at a site. It is

understood by the DOE that the BRA may indicate the need to change these PRGs and that some sites closed under these RRSs may need to be revisited to comply with these changes. It should be noted that the objective of the SWMU investigations at the Pantex Plant is to determine the extent of contamination to background or PQLs (RRS 1). In all cases, sufficient sampling will be performed during the RFI phase to warrant application of the RRSs. Therefore, the DOE proposes to use the TNRCC standards as the basis on which the extent of acceptable residual contamination is determined. Table ES-2 is a summary of the calculations presented in Section 3.0. The table presents the calculated nonresidential use PRGs for surface soil (further differentiated into drainage, uplands, and Playas), subsurface soil, and groundwater for analyses included in the Risk Reduction Rules. The PRGs represent the concentrations below which any additional site characterization or remedial action initiatives would be for the purpose of satisfying objectives other than minimizing human health risks. It should be noted that no DOE owned property at Pantex Plant is planned for excessation, but if such excessation does occur in the future or if it is determined that offsite migration of contaminants has occurred, residential PRGs will be calculated. For reasons independent of health risk, the DOE may wish to proceed with remedial actions that meet self-imposed cleanup criteria of greater stringency. For example, observations of a specific chemical hazard in excess of background (RRS 1) but within acceptable risk-based criteria (RRS 2) may be acted upon differently by the DOE under differing site-specific conditions. Contamination located at 5–10 ft below ground surface is likely to be remediated to background (RRS 1) because of the low cost and rapid execution of the cleanup, thus avoiding future liability relative to a potential changing land use classification. Conversely, for the same contaminant at the same concentration located at a depth 5–100 ft below ground level, the DOE is likely to accept the criteria outlined in RRS 2 in which technical feasibility and cost limitations preclude cleanup to background.

By virtue of 30 TAC 335.557(3), the future land use designated at Pantex Plant is nonresidential. However, in areas subject to excessation, the land use may revert to residential, thereby requiring increased scrutiny of the site to determine if risk-based criteria for a residential scenario have been satisfied. The DOE risk managers will need sufficient characterization data regarding these sites to quickly determine the most prudent closure strategy to assume, i.e., cleanup to background or to some risk-based level established for residential or nonresidential uses.

The groundwater PRGs are straightforward, with only one value for each constituent. The PRGs for surface and subsurface soils have either two identical values or, depending on the surface soil sample type, several different values for each constituent. Because background values as applicable to Pantex Plant were determined individually for surface soil [defined as the upper 2 ft consisting of sediments/soils (Subsection 2.3), and further differentiated into drainage, upland, and Playa] and for

subsurface soil (greater than 2 ft), different values based on depth are proposed if the RRS 1 (background) is selected. If RRS 2 (risk) is selected, one value, the Groundwater Protection Standard applies to all soil depths, unless the Soil/Air and Ingestion Standard value is lower, in which case the Soil/Air and Ingestion Standard value applies only to the upper 2 ft (see Subsection 2.5).

The values in Table ES-2 are based on RRS #2 with PQL and specific background considerations and are summary in nature. A more complete discussion of the derivation of the numerical values and a more detailed numerical display is presented in the following text and supporting appendices. The levels based on RRS 1 are denoted by shading, whereas the RRS 2 values are not shaded. The RRS 1 background value shown in this table is the concentration to be compared to the concentration from a discrete sample. If a representative concentration from the media of concern is to be compared, a means comparison should be performed. The many possible types of means comparisons are beyond the scope of this document and shall be proposed site by site (see Subsection 2.5.1).

This guidance document will be updated at least annually as more background information pertinent to Pantex Plant becomes available. Changes to the guidance document may occur throughout the BRA or RFI/Corrective Action process at Pantex Plant.

Table ES-1
Ecological Screening Evaluation Form

I. INTRODUCTION

The purpose of this form is to characterize the ecological setting and identify potential exposure pathways between contaminants and the environmental receptors. It is designed to aid the responsible person in determining if further ecological assessment is warranted. This screening evaluation will also be used by the TNRCC project coordinator to determine if potential environmental receptors have been adequately evaluated prior to approval of the final report. If necessary, additional information may be requested by the TNRCC pursuant to 30 TAC 335.8(c)(5) Closure and Remediation Obligations, 335.555(f) Attainment of Risk Reduction Standard 2, 335.553(b)(3) Required Information, 335.554(f) Attainment of Risk Reduction Standard 1.

This form may be voluntarily submitted prior to commencement of closure/remediation activities, or submitted with the final report for Risk Reduction Standard 2, or with the work plan or remedial investigation report for Standard 3. We recommend contacting the TNRCC project coordinator if any questions arise prior to completion of closure/remediation activities.

Due to the variety of situations to which this form is applicable, some of the requested information may appear redundant. Detailed technical explanations that have been previously submitted by the responsible person to the TNRCC may be referenced here rather than repeated. In these instances, a brief answer is appreciated.

Name of Facility _____
Site Location _____
_____
_____

Mailing Address _____
_____

(If Applicable)
TNRCC SWR# _____
TNRCC Permit #'s _____
EPA I.D. #'s _____

II. SITE CHARACTERIZATION

(1) Describe the current land use of the facility/property.

___% urban
___% rural
___% industrial (_light _ heavy)
___% commercial
___% residential
___% agricultural (crops:_____)
___% recreational
describe: note if it is a park, etc:
___% undisturbed
___% other; describe

(2) Describe the specific site of the closure/remediation activity. (For example: spill cleanup within tank farm; highway right-of-way with adjacent drainage ditch; real estate transaction in commercial area; surface impoundment closure near the boundary of a chemical manufacturing plant.)

(3) Describe the spills or releases associated with the site to be closed or remediated. If applicable, provide a brief description of waste management and materials handling activities associated with this site. Descriptions should include current and historic activities.

(4) The area surrounding the closure/remediation site is best described as (check all that apply):

__% wooded __% prairie/meadow __% urban
__% undeveloped __% commercial/industrial __% rural
__% agricultural __% residential __% wetlands
__% other, specify:

(5) The nearest surface water body is _____ feet/miles from the site to be closed/remediated. The water body is best described as a:

[ ] ditch
[ ] freshwater stream: _ perennial (has water all year)
_ intermittent (dries up for at least 2 weeks a year)
[ ] tidal stream, bay, or estuary
[ ] freshwater swamp/march/wetland:
[ ] reservoir, lake or pond: approximate surface acres:_____
[ ] Other; specify

Name the water body:_____

(6) Describe the general characteristics of the water body identified in question 5:

Date observed: _/_/_

[ ] clear [ ] cloudy/turbid
[ ] flowing [ ] stagnant
[ ] sheen present [ ] sheen absent
[ ] sludge in sediments
[ ] aquatic life observed
[ ] no aquatic life observed
[ ] other, specify:

(7) Check the proposed cleanup standard to be attained:

[ ] Risk Reduction Standard 1
[ ] Risk Reduction Standard 2
[ ] Risk Reduction Standard 3

(8) Please attach USGS topographic map(s) of the site to this form.

(9) Are aerial or other photographs available? ___ yes ___ no
If yes, please attach any available photo(s) to the checklist.

III. POTENTIAL ENVIRONMENTAL RECEPTORS

(10) Are birds, fish, other animals or plant communities sometimes present in the vicinity of the closure/remediation site?

[ ] No [ ] Yes; describe observations

(11) **a)** Are any sensitive environmental areas, such as rookeries, wetlands, wildlife preserves, wildlife management areas, state or federal parks, freshwater springs, endangered or threatened plant or animal species and their habitats, present in or near the site undergoing closure/remediation?
[ ] No, [ ] Yes, [ ] Unknown
If yes, describe:

b) Please provide the source(s) of the information used to identify these sensitive areas, and indicate their general location on the site map.

IV. POTENTIAL EXPOSURE PATHWAYS

(12) Are any visible, known, or suspected contaminants located in the area bordering the site?
[ ] No, [ ] Yes
If yes, describe the area of contamination:

(13) **a)** Have contaminants migrated from the immediate site undergoing closure/remediation to the surrounding area, including surface water?
[ ] No, [ ] Yes [ ] Unknown
Explain:

(b) Could contaminants potentially leave the immediate site to surrounding areas after closure/remediation?
[ ] No [ ] Yes [ ] Unknown
Explain:

(14) Identify all mechanism(s) or potential mechanism(s) of contaminant release to environmental media (check all appropriate responses):
___ air emissions
___ releases to surface water
___ release to soil
___ infiltration to groundwater
___ groundwater discharge to surface water
___ storm water runoff
___ flooding
___ other (describe):

(15) Have any of the contaminants associated with the site undergoing closure/remediation been detected in any of the environmental media?

___ surface water
___ groundwater
___ sediments
___ soils
___ air
[ ] not analyzed

IF "YES" TO QUESTIONS 11a, 12, 13 AND/OR 15, FURTHER (QUALITATIVE OR QUANTITATIVE) ECOLOGICAL ASSESSMENT SHOULD BE CONSIDERED. CONTACT THE TNRCC COORDINATOR FOR FURTHER INFORMATION.

V. QUALITATIVE SUMMARY

(16) Please attach a brief statement of summary based on the information you have provided in this form. This summary should address any potential threat to environmental receptors posed by the area undergoing closure/remediation. If the conclusion is that environmental receptors have not been affected, or will not be exposed to contaminants in the future, clearly state and justify this in the summary. The assessor should make the initial decision regarding further environmental evaluation based upon the results of this screening evaluation and the investigation required by 30 TAC 335.553.

If, based on this assessment or other information, the TNRCC has reason to believe that releases of contaminants at the site have contaminated, or may reasonably be expected to contaminate media which may come in contact with environmental receptors, the potential for exposure is considered to exist and additional environmental evaluation may be necessary. The development of additional numeric cleanup criteria which are protective of environmental receptors pursuant to 30 TAC 335.556(b); 335.559(d)(4); 335.559(h); 335.562(c)(3); and 335.563(j)(3) may be required. Compliance with the clean-up standards in accordance with the Risk Reduction Rules does **not** release the responsible person from other spill and release notification obligations.

The TNRCC retains the authority to require additional information to enable the Executive Director to determine whether the closure or remediation is compliant with applicable regulations 30 TAC 335.8(b) and 30 TAC 335.8(c)(5).

I, _____, _____ *typed or printed name of responsible person*
certify that the information submitted, to the best of my knowledge and belief, is true, accurate, and complete.

_____ _____
Signature of responsible party Date

Table ES-2. Nonresidential Use Surface Soil, Subsurface Soil, and Groundwater PRGs Based on Risk Reduction Standards 1 and 2 for Pantex Plant RCRA Facility Investigations

Potential Constituents	Groundwater[1] (mg/l)	Surface Soil[1] 0-2 ft (mg/kg)			Subsurface Soil[1,2] 2-432 feet (mg/kg)
		Drainage	Playa	Uplands	
acenaphthene	6.13	613	613	613	613
acetone	10.2	1020	1020	1020	1020
acetonitrile	0.613	61.3	61.3	61.3	61.3
acetophenone	10.2	1020	1020	1020	1020
acrolein	2.04	204	204	204	204
acrylamide	0.000064	0.006	0.006	0.006	0.006
acrylonitrile	0.005_A	0.053	0.053	0.053	0.053
alachlor	0.002	0.20	0.20	0.20	0.20
aldicarb	0.003	0.30	0.30	0.30	0.30
aldicarb sulfone	0.002	0.20	0.20	0.20	0.20
aldicarb sulfoxide	0.004	0.40	0.40	0.40	0.40
aldrin	0.00004	0.0027_A**(.004)**$_x$	0.0027_A **(.0022)**$_x$	0.0027_A **(.0032)**$_x$	0.0027_A**(.0039)**$_x$
aluminum phosphide	0.041	4.09	4.09	4.09	4.09
aniline	0.0502	0.048_B	0.048_B	0.048_B	5.02
anthracene	30.7	3070	3070	3070	3070
antimony	0.006	16.0**(4.81)**	11.9 **(5.17)**	12.5 **(4.50)**	170**(45.36)**
arsenic	0.05	22.9**(8.13)**	16.2 **(7.39)**	10.2 **(6.81)**	10.3**(4.95)**
atrazine	0.003	0.30	0.30	0.30	0.30
barium	2.0	637**(183)**	1940 **(268)**	185**(143)**	1540**(230.07)**
benzene	0.005	0.50	0.50	0.50	0.50
benzidine	0.0000012	0.00012	0.00012	0.00012	0.00012

Table ES-2. Nonresidential Use Surface Soil, Subsurface Soil, and Groundwater PRGs Based on Risk Reduction Standards 1 and 2 for Pantex Plant RCRA Facility Investigations

Potential Constituents	Groundwater[1] (mg/l)	Surface Soil[1] 0-2 ft (mg/kg)			Subsurface Soil[1,2] 2-432 feet (mg/kg)
		Drainage	Playa	Uplands	
benzo(a)anthracene	0.01	0.66	0.66	0.66	0.66
benzo(a)pyrene	0.01	0.66	0.66	0.66	0.66
benzo(b)fluoranthene	0.01	0.66	0.66	0.66	0.66
benzo(k)fluoranthene	0.01	0.66	0.66	0.66	0.66
benzoic acid	409	40,880	40,880	40,880	40,880
beryllium	0.004	**2.20(1.24)**	2.23 **(1.53)**	1.61 **(1.20)**	**3.72(0.821)**
biphenyl	5.11	511	511	511	511
bis (chloroethyl) ether	0.01_A	0.66_A	0.66_A	0.66_A	0.66_A
bis (2-chloroisopropyl) ether	0.041	4.09	4.09	4.09	4.09
bis (2-ethylhexyl) phthalate	0.02	2.04	2.04	2.04	2.04
bromodichloromethane	0.10	0.946_B	0.946_B	0.946_B	10.0
bromoform	0.10	10.0	10.0	10.0	10.0
bromomethane	0.143	14.3	14.3	14.3	14.3
2-sec-butyl-4,6-dinitrophenol	0.102	10.2	10.2	10.2	10.2
cadmium	0.02	**0.972(0.327)**	1.17 **(0.489)**	1.27 **(0.364)**	2.0_D
carbofuran	0.04	4.0	4.0	4.0	4.0
carbon disulfide	10.2	23.4_B	23.4_B	23.4_B	1020_C
carbon tetrachloride	0.005	0.5	0.5	0.5	0.5
chlordane	0.002	0.20**(.0266)**$_x$	0.20 **(.0177)**$_x$	0.20 **(.0269)**$_x$	0.20**(.019)**$_x$
p-chloroaniline	0.409	40.9	40.9	40.9	40.9
chlorob[illegible]ne	0.10	10.0	10.0	10.0	10.0

Table ES-2. Nonresidential Use Surface Soil, Subsurface Soil, and Groundwater PRGs Based on Risk Reduction Standards 1 and 2 for Pantex Plant RCRA Facility Investigations

Potential Constituents	Groundwater[1] (mg/l)	Surface Soil[1] 0-2 ft (mg/kg)			Subsurface Soil[1,2] 2-432 feet (mg/kg)
		Drainage	Playa	Uplands	
chlorobenzilate	2.04	204	204	204	204
chloroethane	2.04	204	204	204	204
chloroform	0.1	0.504_B	0.504_B	0.504_B	10.0_C
2-chloronaphthalene	8.18	818	818	818	818
2-chlorophenol	0.511	51.1	51.1	51.1	51.1
chromium (total)	0.1	28.9(**19.5**)	33.2 (**23.1**)	27.7 (**20.3**)	69(**17.03**)
hexavalent chromium	0.1	10.0(**.282**)	10.0 (**.327**)	10.0 (**.317**)	10.0(**.155**)
chrysene	0.01	0.66	0.66	0.66	0.66
copper	0.04	21.5(**14.7**)	24.7 (**18.0**)	17.5 (**13.1**)	48.6(**10.94**)
cyanide	0.2	20.0	20.0	20.0	20.0
cyclo-tetra methylene tetranitramine (HMX)	5.11	511	511	511	511
cyclo-trimethylene trinitramine (RDX)	0.026	2.6	2.6	2.6	2.6
di-n-butyl phthalate	10.2	1020	1020	1020	1020
di-n-octyl phthalate	2.04	204	204	204	204
di-benz(a,h)anthracene	0.1	0.66	0.66	0.66	0.66
1,2-dibromo-3-chloropropane	0.005_A	0.02	0.02	0.02	0.02
dibromochloromethane	0.10	10.0	10.0	10.0	10.0
1,2-dichlorobenzene	0.60	60.0	60.0	60.0	60.0
1,3-dichlorobenzene	0.60	60.0	60.0	60.0	60.0
1,4-dichlorobenzene	0.075	7.5	7.5	7.5	7.5

Table ES-2. Nonresidential Use Surface Soil, Subsurface Soil, and Groundwater PRGs Based on Risk Reduction Standards 1 and 2 for Pantex Plant RCRA Facility Investigations

Potential Constituents	Groundwater[1] (mg/l)	Surface Soil[1] 0-2 ft (mg/kg)			Subsurface Soil[1,2] 2-432 feet (mg/kg)
		Drainage	Playa	Uplands	
dichlorodifluoromethane	20.4	47.9_B	47.9_B	47.9_B	2040
p,p-dichlorodiphenyl trichloroethane (DDT)	0.00084	0.0841**(.009)**$_x$	0.0841 **(.0055)**$_x$	0.0841 **(.0083)**$_x$	0.0841**(.0078)**$_x$
1,1 dichloroethane	10.2	1020	1020	1020	1020
1,2 dichloroethane	0.005	0.50	0.50	0.50	0.50
1,1 dichloroethylene	0.007	0.70	0.70	0.70	0.70
cis 1,2 dichloroethylene	0.07	7.0	7.0	7.0	7.0
trans 1,2 dichloroethylene	0.1	10.0	10.0	10.0	10.0
total 1,2 dichloroethylene	0.07	7.0	7.0	7.0	7.0
1,1-dichloroethylidene bis 4-chlorobenzene (DDE)	0.00084	0.0841**(.0014)**	0.0841 **(.0025)**	0.0841 **(.0011)**	0.0841**(.0039)**$_x$
1,1,2,2-dichloroethylidene bis 4-chlorobenzene (DDD)	0.0012	0.119**(.018)**$_x$	0.119 **(.0209)**$_x$	0.119 **(.0157)**$_x$	0.119**(.0039)**$_x$
2,4-dichlorophenol	0.307	30.7	30.7	30.7	30.7
2,4-dichlorophenoxyacetic acid	0.07	7.0	7.0	7.0	7.0
1,2-dichloropropane	0.005	0.50	0.50	0.50	0.50
dieldrin	0.00002	0.00179**(.004)**$_x$	0.00179 **(.003)**$_x$	0.00179 **(.0045)**$_x$	0.00179**(.0039)**$_x$
diethyl phthalate	81.8	8180	8180	8180	8180
diethyl hexyl adipate	0.50	50.0	50.0	50.0	50.0
dimethoate	0.0204	2.04	2.04	2.04	2.04
2,4-dimethyl phenol	2.04	204	204	204	204
1,3-dinitrobenzene	0.01	1.02	1.02	1.02	1.02
2,4-din[illegible]henol	0.204	20.4	20.4	20.4	20.4
1,4-dic[illegible]	0.15	2.6	2.6	2.6	2.6

Table ES-2. Nonresidential Use Surface Soil, Subsurface Soil, and Groundwater PRGs Based on Risk Reduction Standards 1 and 2 for Pantex Plant RCRA Facility Investigations

Potential Constituents	Groundwater[1] (mg/l)	Surface Soil[1] 0-2 ft (mg/kg)			Subsurface Soil[1,2] 2-432 feet (mg/kg)
		Drainage	Playa	Uplands	
diphenylamine	2.56	256	256	256	256
1,2-diphenylhydrazine	0.00036	0.0358	0.0358	0.0358	0.0358
disulfoton	0.00409	0.409	0.409	0.409	0.409
2,4-dinitrotoluene (DNT)	0.204	20.4	20.4	20.4	20.4
2,6-DNT	10.22	1022	1022	1022	1022
endosulfan	0.00511	0.511	0.511	0.511	0.511
endothall	0.10	10.0	10.0	10.0	10.0
endrin	0.002	0.20(**.008**)$_x$	0.20 (**.0054**)$_x$	0.20 (**.0003**)	0.20(**.0039**)$_x$
2-ethoxyethanol	40.9	4090	4090	4090	4090
2-ethoxyethanol acetate	30.7	3070	3070	3070	3070
ethyl benzene	0.7	70.0	70.0	70.0	70.0
ethylene dibromide	0.005$_A$	0.005	0.005	0.005	0.005
ethylene glycol	204	20,400	20,400	20,400	20,400
ethylene oxide	0.00028	0.028	0.028	0.028	0.028
fluoranthene	4.09	409	409	409	409
fluorene	4.09	409	409	409	409
fluoride	4.6	400	400	400	400
formaldehyde	20.4	2040	2040	2040	2040
heptachlor	0.0004	0.04(**.004**)$_x$	0.04 (**.0017**)$_x$	0.04 (**.0026**)$_x$	0.04(**.0039**)$_x$
heptachlor epoxide	0.0008$_A$	0.056$_A$(**.0009**)	0.056$_A$ (**.0018**)$_x$	0.056$_A$ (**.0004**)	0.056$_A$(**.0039**)$_x$
hexachlorobenzene	0.01$_A$	0.66$_A$	0.66$_A$	0.66$_A$	0.66$_A$

Table ES-2. Nonresidential Use Surface Soil, Subsurface Soil, and Groundwater PRGs Based on Risk Reduction Standards 1 and 2 for Pantex Plant RCRA Facility Investigations

Potential Constituents	Groundwater[1] (mg/l)	Surface Soil[1] 0-2 ft (mg/kg)			Subsurface Soil[1,2] 2-432 feet (mg/kg)
		Drainage	Playa	Uplands	
hexachlorobutadiene	0.0367	3.67	3.67	3.67	3.67
alpha hexachlorocyclohexane	0.00005	0.0045	0.0045	0.0045	0.0045
beta hexachlorocyclohexane	0.00159	0.159	0.159	0.159	0.159
gamma hexachlorocyclohexane	0.0002	0.02	0.02	0.02	0.02
hexachloroethane	0.204	20.4	20.4	20.4	20.4
indeno(1,2,3-cd)pyrene	0.01	3070	3070	3070	3070
isobutyl alcohol	30.8	3070	3070	3070	3070
lead	0.10	29.5**(16.5)**	31.3 **(19.1)**	19.3 **(14.2)**	15.2**(8.05)**
mercury	0.002	0.326**(.0513)**	0.399 **(.00958)**	0.100 **(.010)**	0.20**(.075)**
methomyl	2.56	256	256	256	256
2-methoxyethanol	0.409	40.9	40.9	40.9	40.9
methoxychlor	0.04	4.0**(.061)**$_x$	4.0 **(.054)**$_x$	4.0 **(.0016)**	4.0**(.019)**$_x$
methoxyethanol acetate	0.204	20.4	20.4	20.4	20.4
methyl ethyl ketone	5.11	511	511	511	511
methyl isobutyl ketone	5.11	511	511	511	511
methyl methacrylate	8.18	663$_B$	663$_B$	663$_B$	818$_C$
methylene chloride	0.005	0.50	0.50	0.50	0.50
2-methylphenol (o-cresol)	5.11	511	511	511	511
3-methylphenol (m-cresol)	5.11	511	511	511	511
4-methylphenol (p-cresol)	5.11	511	511	511	511
naptha'	4.09	409	409	409	409

Table ES-2. Nonresidential Use Surface Soil, Subsurface Soil, and Groundwater PRGs Based on Risk Reduction Standards 1 and 2 for Pantex Plant RCRA Facility Investigations

Potential Constituents	Groundwater[1] (mg/l)	Surface Soil[1] 0-2 ft (mg/kg)			Subsurface Soil[1,2] 2-432 feet (mg/kg)
		Drainage	Playa	Uplands	
nickel	0.10	33.2(**16.7**)	46.0 (**20.0**)	20.8 (**14.7**)	55.0(**15.15**)
nitrate	16.20	1000	1000	1000	1000
nitrite	1.0	100	100	100	100
nitrate/nitrite as N	16.20	1000(**2.81**)	1000 (**ND**)	1000 (**5.30**)	1000(**1.47**)
nitrobenzene	0.051	5.11	5.11	5.11	5.11
n-nitroso-methyl-ethyl-amine	0.01_A	0.0013	0.0013	0.0013	0.0013
n-nitroso-di-n-propylamine	0.01	0.66	0.66	0.66	0.66
n-nitrosodiethylamine	0.01	0.00019	0.00019	0.00019	0.00019
n-nitrosodimethylamine	0.01	0.00056	0.00056	0.00056	0.00056
n-nitrosopyrrolidine	0.01	0.0136	0.0136	0.0136	0.0136
2-nitrotoluene	1.02	102	102	102	102
3-nitrotoluene	1.02	102	102	102	102
4-nitrotoluene	1.02	102	102	102	102
pentachloronitrobenzene	0.011	1.1	1.1	1.1	1.1
pentachlorophenol	0.05_A	3.3_A	3.3_A	3.3_A	3.3_A
phenol	61.3	6130	6130	6130	6130
phthalic anhydride	204	20,400	20,400	20,400	20,400
phosphorus	1.0	ND[3]	ND[3]	ND[3]	ND
polychlorinated biphenyls (PCBs)	0.05	0.05	0.05	0.05	0.05
pronamide	7.67	767	767	767	767
pyrene	3.07	307_C	307_C	307_C	307_C
pyridine	0.102	10.2	10.2	10.2	10.2

Table ES-2. Nonresidential Use Surface Soil, Subsurface Soil, and Groundwater PRGs Based on Risk Reduction Standards 1 and 2 for Pantex Plant RCRA Facility Investigations

Potential Constituents	Groundwater[1] (mg/l)	Surface Soil[1] 0-2 ft (mg/kg)			Subsurface Soil[1,2] 2-432 feet (mg/kg)
		Drainage	Playa	Uplands	
selenium	0.05	8.71**(1.22)**	26.7 **(1.70)**	6.96 **(1.06)**	5.0**(.775)**
silver	0.512	51.1**(.290)**	51.1 **(.270)**	51.1 **(.395)**	51.1**(1.115)**
strontium	61.3	6130**(42.0)**	6130 **(39.2)**	6130 **(33.7)**	6130**(171.55)**
strychnine	0.04_A	3.07	3.07	3.07	3.07
styrene	0.10	10.0	10.0	10.0	10.0
1,2,4,5-tetrachlorobenzene	0.031	3.07	3.07	3.07	3.07
1,1,1,2-tetrachloroethane	0.11	11.0	11.0	11.0	11.0
1,1,2,2-tetrachloroethane	0.014	1.43	1.43	1.43	1.43
1,1,2,2-tetrachloroethylene	0.005	0.50	0.50	0.50	0.50
2,3,4,6-tetrachlorophenol	3.07	307	307	307	307
tetraethyl dithiopyrophos-phate	0.051	5.11	5.11	5.11	5.11
thallium	0.003	17.0**(6.64)**	29.7 **(6.67)**	18.5 **(6.23)**	100.0**(19.26)**
toluene	1.00	100	100	100	100
toxaphene	0.003	0.30**(.220)**$_x$	0.30 **(.031)**$_x$	0.30 **(.0478)**$_x$	0.30**(.19)**$_x$
2,4,5-TP (silvex)	0.05	5.0	5.0	5.0	5.0
1,2,4-trichlorobenzene	0.07	7.0	7.0	7.0	7.0
1,1,1-trichloroethane	0.2	20.0	20.0	20.0	20.0
1,1,2-trichloroethane	0.005	0.50	0.50	0.50	0.50
trichlor[illegible]ylene	0.005	0.50	0.50	0.50	0.50
trichlor[illegible]romethane	30.7	8.36_B	8.36_B	8.36_B	3070_C

Table ES-2. Nonresidential Use Surface Soil, Subsurface Soil, and Groundwater PRGs Based on Risk Reduction Standards 1 and 2 for Pantex Plant RCRA Facility Investigations

Potential Constituents	Groundwater[1] (mg/l)	Surface Soil[1] 0-2 ft (mg/kg)			Subsurface Soil[1,2] 2-432 feet (mg/kg)
		Drainage	Playa	Uplands	
2,4,5-trichlorophenol	10.2	1020	1020	1020	1020
2,4,6-trichlorophenol	0.026	2.60	2.60	2.60	2.60
2,4,5-trichlorophenoxyacetic acid	1.02	102	102	102	102
1,1,2-trichloropropane	0.511	51.1	51.1	51.1	51.1
1,2,3-trichloropropane	0.613	61.3	61.3	61.3	61.3
1,3,5-trinitrobenzene (TNB)	0.0073	0.511	0.511	0.511	0.511
2,4,6-trinitrotoluene	0.051	5.1	5.1	5.1	5.1
vanadium	0.307	51.8**(37.6)**	65.5 **(39.6)**	53.4 **(38.1)**	150**(36.58)**
vinyl acetate	102	10,200	10,200	10,200	10,200
vinyl chloride	0.01_A	0.0241_B	0.0241_B	0.0241_B	0.2_C
xylene	10.0	1000	1000	1000	1000
zinc	30.7	3070**(53.1)**	3070 **(68.4)**	3070 **(48.2)**	3070**(41.48)**
gross alpha (pCi/L)	20.46	ND	ND	ND	ND
gross beta (Pci/L)	18.57	ND	ND	ND	ND
radium 226 (Pci/L)	5	ND	ND	ND	ND
radium 228 (Pci/L)	5	ND	ND	ND	ND

1 *Shading denotes the numerical value was developed from the background or PQL (RRS 1). Lack of shading denotes the numerical value was developed from the risk (RRS 2).*
2 *432 feet represents the deepest background soil boring sample.*
3 *ND=not determined.*
A *PQL*
B *SAI Ind*
C *GWP Ind*
(.005) Arithmetic Mean/Background Value
$(.0005)_x$ Value derived from Maximum DL of data set

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RISK REDUCTION RULE GUIDANCE FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

LIST OF ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASURE

ASARCO	American Smeltering and Refining Company
COCs	Contaminants of Concern
DDD	1,1,2,2-dichloroethylidene bis 4-chlorobenzene (pesticide)
DDE	1,1-dichloroethenylindene bis 4-chlorobenzene (pesticide)
DDT	p,p-dichlorodiphenyl trichloroethane (pesticide)
DL	Detection Limit
DNT	2,4-Dinitrotoluene
DOE	U.S. Department of Energy
EIDL	Estimated IDL
EPA	U.S. Environmental Protection Agency
EQL	Estimated Quantitation Limit
ER	Environmental Restoration
%Fi	Percent Fines or Percent Passing a #200 Sieve
ft	feet
FY	Fiscal Year
g	gram
GW-Ind	Groundwater Standard for Industrial Use
GW-Res	Groundwater Standard for Residential Use
GWP-Ind	Groundwater Protection Standard for Industrial Use
GWP-Res	Groundwater Protection Standard for Residential Use
HE	High Explosive
HEAST	Health Effects Assessment Summary Table
HMX	Cyclo-tetramethylene tetranitramine (high melting explosive compound)

LIST OF ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASURE (Cont.)

IDL	Instrument Detection Limit
IQR	Interquartile Range
IRIS	Integrated Risk Information System
LL%	Liquid Limit in percent
M&H	Mason & Hanger Corporation
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
meq/g	Milliequivalents per gram
meq/L	Milliequivalents per liter
mg/kg	milligrams per kilogram
mg/kg/d	milligrams per kilogram per day
mg/L	milligrams per liter
MSC	Medium-Specific Concentration
NA	Not Analyzed
NC	Not Calculated
ND	Not Determined
NHHB	Not Human Health-Based
NT	Nitrotoluene (a high explosive)
PAH	Polyaromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
pCi/L	Picocuries per liter
PI%	Plasticity Index in percent
PL%	Plastic Limit in percent
ppm	Parts per million
PQL	Practical Quantitation Limit
RCRA	Resource Conservation and Recovery Act

RISK REDUCTION RULE GUIDANCE FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

LIST OF ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASURE (Cont.)

RDX	Cyclo-trimethylene trinitramine (Royal Dutch Explosive)
RFA	RCRA Facility Assessment
RfD	Chemical-Specific Oral Reference Dose
RFI	RCRA Facility Investigation
RRS	Risk Reduction Standard
SAI-Ind	Soil/Air and Ingestion Standard for Industrial Use
SF_o	Chemical-Specific Oral Cancer Slope Factor
SVOC	Semi-volatile Organic Compound
SWMU	Solid Waste Management Unit
SW-846	EPA Test Methods for Evaluating Solid Waste
TAC	Texas Administrative Code
TBEG	Texas Bureau of Economic Geology
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TNRCC	Texas Natural Resource Conservation Commission
TNB	1,3,5-Trinitrobenzene (a high explosive)
TNT	Trinitrotoluene (a high explosive)
TR	Target Risk
UCL	Upper Confidence Limit
µg/L	micrograms per liter
µg/kg	micrograms per kilogram
UTL	Upper Tolerance Limit
VOC	Volatile Organic Compound

1.0 INTRODUCTION

The Pantex Plant site background, scope of work and objectives for this guidance document, related ongoing work, and report organization are presented below.

1.1 SITE BACKGROUND

Pantex Plant is owned by the U.S. Department of Energy (DOE) and operated by Mason & Hanger Corporation (M&H) under a contract with the DOE. The DOE Amarillo Area Office, representing the DOE Albuquerque Operations Office, administers the contract. Battelle Pantex is the prime contractor to M&H for environment, safety, health, and waste management support and environmental restoration (ER) technical and budgetary oversight and contractor integration support. The U.S. Army Corps of Engineers is responsible for conducting the ER field programs.

Pantex Plant is located approximately 17 miles northeast of Amarillo, Texas (Figure 1-1). The site consists of approximately 16,000 acres, of which about one-fifth are covered by 16 operation zones surrounded by buffer and security zones (Figure 1-2). The Pantex Plant site is generally flat and is situated on the High Plains at an elevation of approximately 3,540 ft. The vegetation is characterized as mixed prairie of native and introduced grasses. Five natural playas (three on DOE property and two on Texas Tech University land leased to the DOE) are fed by rainwater and snowmelt. Additionally, Playa 1 receives treated wastewater from the Sewage Treatment Plant. The areas adjacent to Pantex Plant are primarily agricultural with residences typical of farms.

The overall Plant mission involves the development and fabrication of chemical high explosive (HE) components for nuclear weapons, assembly and disassembly of nuclear weapons, modification and repair of nuclear weapons, and surveillance testing and disposal of chemical HE. Waste has been generated from these and numerous support operations such as analytical laboratories, maintenance, machining and plating operations. Weapon component tests have resulted in HE and heavy metal contamination at some sites. Additionally, explosives and solvent contamination may have resulted from early operations during World War II (WWII). This included the manufacturing of explosives, melt and pour operations of explosives into conventional munitions, and storage of the weapons on the Plant site.

In January 1989, the U.S. Environmental Protection Agency (EPA) conducted a Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) to identify solid waste management units (SWMUs), which may require investigation and/or corrective action. A final Administrative Order on Consent was signed by the EPA and DOE in December 1990 in which 143 SWMUS were identified.

Figure 1-1

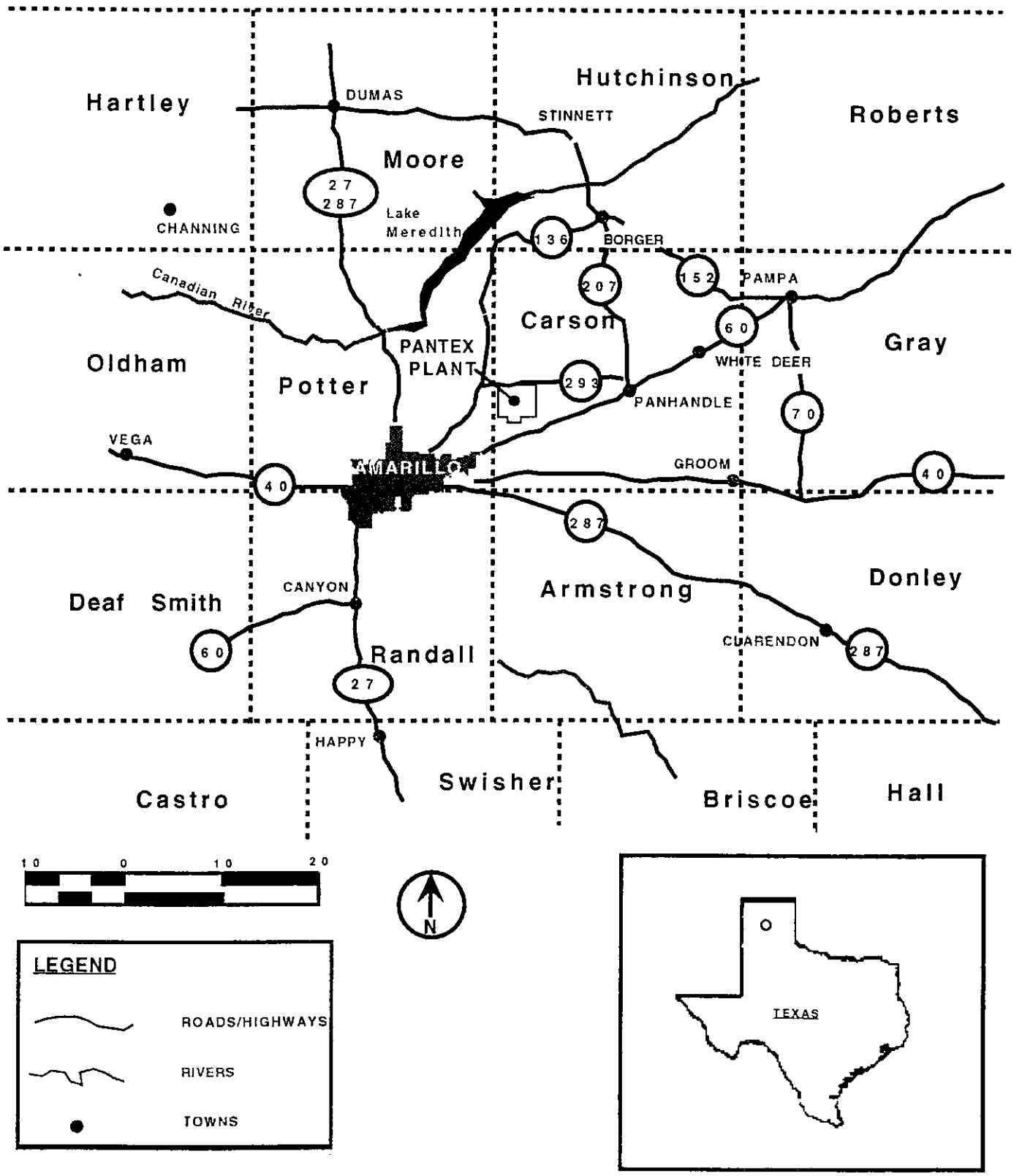


Figure 1-1 Regional Setting of PANTEX PLANT

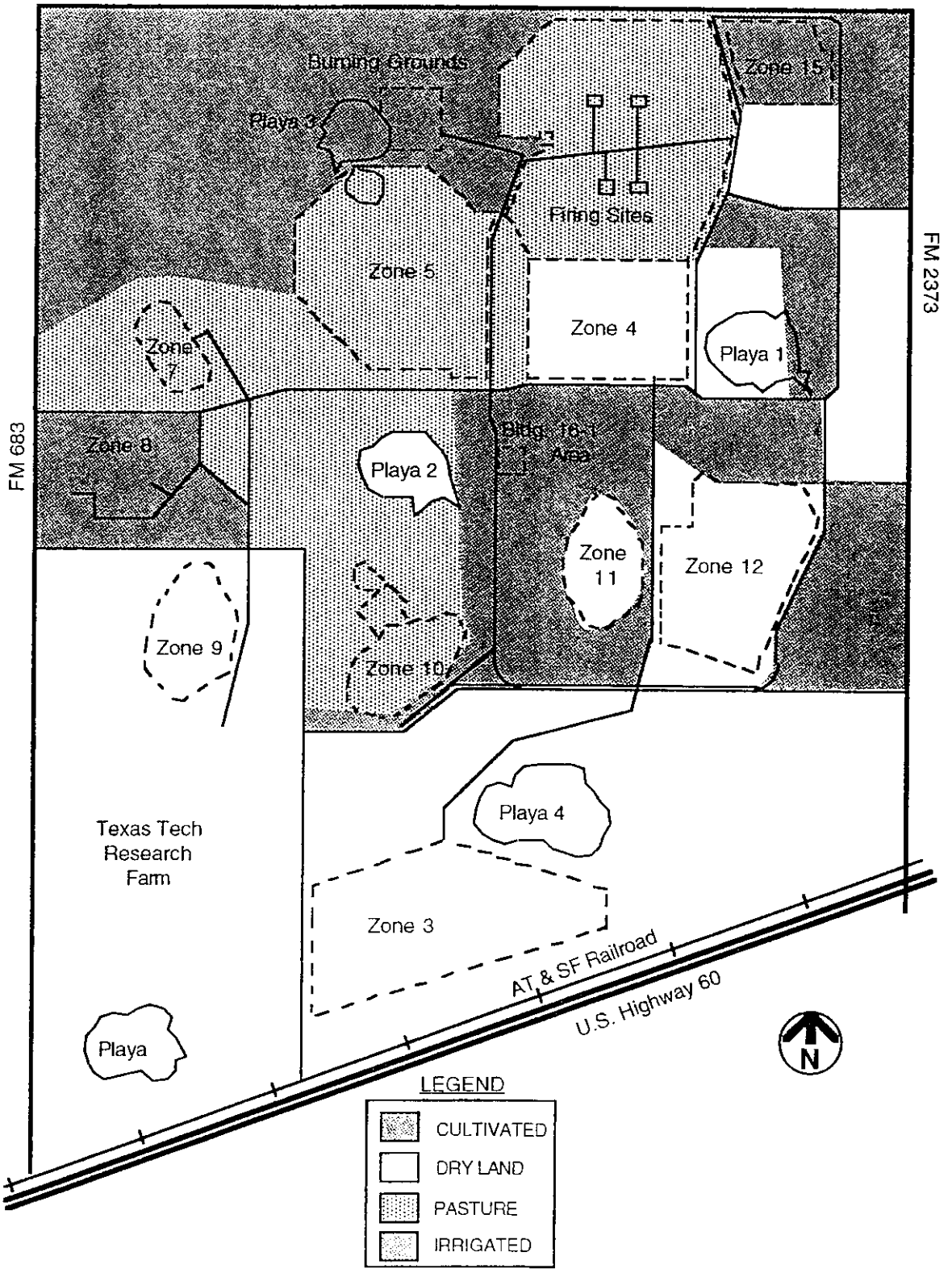


Figure 1-2 Map of PANTEX PLANT, Amarillo, TX

Figure 1-2

The SWMUs were grouped by contaminant commonality into 14 RCRA Facility Investigations (RFIs), which were to be investigated and carried through the corrective action process, as necessary, on independent schedules. A RCRA Part B Permit was issued jointly by the EPA and the Texas Natural Resource Conservation Commission (TNRCC) (formerly the Texas Water Commission) in 1992. This RCRA Part B Permit superseded the Administrative Order on Consent and required that RFIs be conducted at the Plant to determine the nature and extent of any release of contaminants of concern into the environment from the SWMUs and Areas of Concern. Corrective actions will be carried out as necessary. The RFIs and corrective actions at Pantex Plant are carried out under the ER Program. In May 1994, Pantex Plant was placed on on the National Priority List (NPL).

1.2 SCOPE OF WORK

As part of the ER Program, and to conduct the RFIs and corrective actions at Pantex Plant, cleanup levels have to be determined for use in decision-making during site investigations. Previously, few promulgated standards were available for use in decision-making during site investigations and as eventual "cleanup" levels. This was a significant hindrance to the completion of site investigations and prompt remediation of contaminated sites. Even though the purpose of the SWMU investigations at Pantex Plant is to determine the extent of contamination to background or practical quantitation limits (PQLs), the corrective action levels were based on the same limits. PQLs are defined as the lowest concentration achievable among laboratories within specified limits during routine laboratory operations. A PQL is approximately five times the method detection limit (Ref. 1). The "cleanup" levels had been independently determined using quantitative risk assessment procedures.

However, on June 15, 1993, the TNRCC published the final Risk Reduction Rules [Title 30, Texas Administrative Code (TAC), Chapter 335, Subchapters A and S], which became effective on June 28, 1993. The final rule outlines the principal steps required for calculation of relevant site "cleanup" standards as well as remediation and/or closure criteria. Due to the fact that Pantex Plant has been placed on the NPL, requiring a Baseline Risk Assessment (BRA), which addresses human health as well as ecological risk factors, the term "Preliminary Remediation Goals (PRGs)" will be used instead of "cleanup" levels as defined in the RRSs. This term is used with the understanding that certain PRGs may change during the BRA and that certain closures conducted utilizing these PRGs may have to be revisited based on these changes. This guidance document is prepared for Pantex Plant to comply with the Risk Reduction Rules and to calculate media PRGs in accordance with the TNRCC risk reduction standards (RRSs). This document also presents the assumptions and describes the sources of data used to generate the proposed media PRGs for the anticipated potential contaminants at Pantex Plant. The

document directly supports the current efforts of the ER Program for use in the conduct of the RFIs. It is intended to be general so that it is applicable to all of the RFIs at Pantex Plant. This guidance document will be updated at least annually as additional background or toxicity information pertinent to Pantex Plant becomes available. Changes may occur throughout the BRA or RFI/Corrective Action Process at Pantex Plant. The document will be maintained as a controlled document to ensure that all document users will have access to the most current document version.

1.3 OBJECTIVES

The objectives of this study are:

- To provide a common data source for properties of all potential contaminants anticipated to be found in Pantex Plant RFIs for use by the DOE and its contractors.
- To present an integrated approach for calculating media PRGs for potential contaminants identified in each site-specific RFI. This approach is consistent with the current TNRCC standards.
- To provide a dynamic guidance document for the DOE and its contractors for use in conducting RFIs and corrective actions at Pantex Plant.

Achieving these objectives will ensure consistency between all parties involved and will eliminate unnecessary duplication in effort between the various contractors working at Pantex Plant. Additionally, these risk reduction standards are proposed to be used as decision criteria for additional sampling throughout the Pantex Plant RFIs.

1.4 ONGOING WORK

A site-wide background study was initiated at Pantex Plant during fiscal year (FY) 94 in order to establish a well-documented database of background soil and groundwater values. This study will continue in FY95. As part of the groundwater study an effort to establish background data for the perched aquifer was initiated in FY94 and will continue in FY95. A limited quality assurance review has been performed and documented on the available data and calculations presented in this document. A full quality assurance review is ongoing.

1.5 REPORT ORGANIZATION

Section 2.0 presents the technical approach used in calculating the media PRGs. Subsection 2.1 briefly summarizes the current TNRCC regulations used as a guide to perform these calculations, e.g., RRSs 1, 2, and 3. Since the TNRCC identifies the PQL as a limiting number for the cleanup levels,

Subsection 2.2 defines the PQLs for the major constituents as they apply to the specific method identified by the EPA. Subsection 2.3 defines the surface soil (further differentiated into Drainage, Playa, and Uplands), subsurface soil, and groundwater as the major media characterized at Pantex Plant at this time. Subsection 2.4 provides a discussion on those contaminants that have been identified as potential contaminants of concern, or that differ significantly from RRS 1 established background values at Pantex Plant. A detailed discussion on the methodology used for RRS calculations is presented in Subsection 2.5. This includes the procedures for calculating PRGs levels for the various RRSs identified in the TNRCC regulations and for the three media types defined in Subsection 2.3.

Section 3.0 presents the calculations of media PRGs for RRSs 1 and 2 identified in the TNRCC final rule. This includes calculations for the surface soil, subsurface soil, and groundwater media. A summary table of governing PRGs for each media is given at the end of the section. Section 4.0 presents a document summary and recommendations, and Section 5.0 lists the references. Appendices A through G are provided as a reference to the material cited in the main text.

2.0 TECHNICAL APPROACH

2.1 TNRCC RISK REDUCTION STANDARDS

TNRCC RRSs represent an important step toward the adoption of a risk-based approach for determining the extent and type of cleanup and closure necessary to protect human health and the environment under hazardous waste, industrial and solid waste, superfund, and spill programs. The TNRCC has established three closure/remediation performance standards that are applicable to remedial actions undertaken in response to a release or spill. These risk reduction rules attempt to alleviate some of the disagreements, time delays, and unjustifiable differences in "cleanup" levels between similar sites in the state and speed up the investigation and remediation of contaminated sites. RRS 1 requires removal and/or decontamination of all waste, waste residues, leachate, and contaminated media to background levels unaffected by waste management or industrial activities. The equivalent of RRS 1 has historically been used to define the limits of site contamination at Pantex Plant. Postclosure care and deed recordation are not required under RRS 1. 30 TAC 335.554(d) states that "If the Practical Quantitation Limit (PQL) is greater than background, then the PQL rather than the background shall be used as the cleanup level provided that the person satisfactorily demonstrates to the executive director that lower levels of quantification of a contaminant are not possible." The PQL is the subject of Subsection 2.2.

RRS 2 requires removal and/or decontamination of all waste, waste residues, leachate, and contaminated media to standards and criteria such that any substantial present or future threat to the human health or environment is eliminated. RRS 2 requires deed recordation and monitored use of the property to ensure that no substantial change in circumstances affects the application of this standard. It is proposed that RRS 1 or PQLs be used to determine the extent of contamination at the SWMUs under investigation at Pantex Plant.

RRS 3 requires that removal, decontamination, and/or control of all waste, waste residues, leachate, and contaminated media occur to levels and in a manner such that any substantial present or future threat to human health or the environment is eliminated or reduced to maximum extent practicable. This standard requires deed recordation and in some instances postclosure care. Because of greater concentrations of contaminants that may be left at the site with RRS 3, an evaluation of the effectiveness of the proposed remedy must be submitted to the TNRCC and approved before implementation of the remedy. RRS 3 is not proposed for use as a standard for determining the extent of acceptable residual contamination at Pantex Plant.

2.2 PRACTICAL QUANTITATION LIMITS

As noted in the 1989 Standard Methods Handbook, 17th edition, discussions concerning analytical detection limits can be confusing (Ref. 1). Currently, several varieties of detection limits exist, two of which are the instrument detection limit (IDL) and the method detection limit (MDL). Another form of detection limit is the PQL. The next several paragraphs will clarify and relate these terms as they apply to this document. There are cases in which the PQL will serve as the decision criteria to perform additional sampling to complete definition of nature and extent of contamination, and eventual PRG limits.

The IDL is interpreted as the constituent concentration that produces a signal greater than five times the signal/noise ratio of the instrument and is generally the lowest amount of a substance that can be detected by an instrument. The IDL does not consider the effects that the sample matrix, handling, and preparation may have on the analysis. The MDL is interpreted as the constituent concentration that, when processed through the complete method, produces a signal with a 99% probability of being different from the blank. The MDL takes into account the reagents, sample matrix, and preparation steps applied to a sample in specific analytical methods. Occasionally the IDL is used as a guide for determining the MDL. The relationship of these detection limits is interpreted to be approximately IDL:MDL = 1:4 (Ref. 1).

The two types of quantitation limits (QLs) defined in risk assessment guidance including contract required (CRQLs) and sample (SQLs). CRQLs are not necessarily the lowest detectable levels achievable, but are levels that a Contract Laboratory Program (CLP) laboratory should routinely and reliably detect and quantitate in a variety of sample matrices. The SQL takes into account the adjustments required in the preparation or analytical method, i.e., dilution, that a specific sample may undergo for analysis. The SQL would, therefore, change from sample to sample. PQLs, which are used in this report and closely approximate the defined CRQLs, are generally defined as the lowest level (concentration) quantifiable among laboratories within specified limits during routine laboratory operations. The PQL is significant because different laboratories will produce different MDLs even though same analytical procedures, instruments, and sample matrices are used. The Standard Methods Handbook interprets a PQL to be approximately five times the MDL and represents a practical and routinely achievable detection limit with a relatively good certainty that any reported value is reliable (Ref. 1).

In the previous paragraph, numerical relationships were used to associate IDLs, MDLs, and PQLs to one another. In actuality, it is difficult to generate numerical elements that can be applied to these detection limit relationships. As discussed by L. Keith (Ref. 2), "PQL (values) may be 10 to

100,000 times greater than the MDL for a method." Due to the number of variations of sample matrices and dynamic analyte properties, IDLs, MDLs, and PQLs are difficult to relate to one another.

An attempt is made to calculate a list of generic PQL values for a number of environmental parameters (Appendix A). The SW-846 manual, which governs and guides analytical procedures applied throughout the Pantex Plant investigation, provides a basis for generating these PQL values. As will be discussed, a certain amount of work has been already accomplished regarding the reporting of PQL values.

Many of the organic parameters listed in the SW-846 manual report PQL or estimated quantitation limit (EQL) values, where the use of EQLs is assumed to approximate PQLs. However, several of the inorganic (metal) parameters do not have listed PQL values. The authors of the SW-846 manual have reported IDL and MDL values for the various metal analyses. This information, coupled with the Standard Methods numerical interpretation of the various detection limit relationships, was used to generate generic inorganic PQL values. In an attempt to corroborate this approach, detection limit values cited by two of the large analytical laboratories employed during the Pantex Plant investigations, were reported with the calculated PQL values. The highest of the three values was chosen as the PQL, unless the drinking water maximum contaminant level (MCL) or action level was exceeded. In those cases, a PQL less than the MCL or action level was chosen. These derived values will be stated as derived practical quantitation limits (DPQLs).

Specifically, the techniques described below were used to generate the selected PQL values provided in this document. PQLs are not defined for every constituent, but may be added site by site. Appendix A presents summary tables of the numerical PQL and DPQL values calculated for pesticides/polychlorinated biphenyls (PCBs), volatile organics, semivolatile organics, HE, and metals.

2.2.1 PESTICIDES, SW-846, METHOD 8080

Pesticide MDL and EQL values were reported with various multipliers dependent upon sample matrix. Table A-1 in Appendix A presents the multipliers used to calculate the pesticide/PCB PQLs and summarizes the calculated groundwater and soil PQLs.

2.2.2 VOLATILE ORGANICS, SW-846, METHOD 8240

The SW-846 manual provided a list of EQLs. As with pesticides, EQLs are assumed to approximate PQL values. Table A-2 in Appendix A presents a summary of the reported EQLs. Since PQL values were assumed to be equal to EQL values for volatile organics, Table A-2 does not list the PQLs.

2.2.3 SEMIVOLATILE ORGANICS, SW-846, METHOD 8270.

The SW-846 manual provided a list of EQLs. Again, EQLs are assumed to approximate PQL values. These values are summarized in Table A-3 in Appendix A.

2.2.4 HIGH EXPLOSIVES, SW-846, METHOD 8330

The SW-846 manual provided a list of PQL values for low and high HE concentrations in water. Soil PQL values were also listed. These values are presented in Table A-4 in Appendix A.

2.2.5 METALS, SW-846, METHODS FROM 6000 AND 7000 SERIES

The only information offered by the SW-846 manual for metals, was the reporting of estimated IDL (EIDL) values. MDL and PQL values were calculated by applying the numerical ratios cited in Reference 1. In certain cases (i.e., hexavalent chromium and mercury) actual contractor detection limit values were cited. Soil PQL values were extremely difficult to resolve. A randomly chosen factor of 10 was multiplied with the water PQL to generate soil PQL values. Comparison of contractor PQLs indicates some varying PQL ranges. The highest of the calculated PQL of the two contractors values was chosen as the PQL, unless the drinking water MCL or action level was exceeded. In those cases, a PQL less than the MCL was chosen. Table A-5 in Appendix 5 lists the EIDL, the calculated MDLs, the calculated water PQLs, the contractor 1 water PQLs (Ex. 01), the contractor 2 water PQLs (Ex. 02), the MCLs, the calculated soil PQLs, the contractor 1 soil PQLs (Ex. 01), and the contractor 2 soil PQLs (Ex. 02). The shaded values in Table A-5 denote the governing number as described above. These numbers were used as the PQLs for metals.

2.3 DEFINITION OF MEDIA FOR PANTEX PLANT

Various media are characterized by different background concentrations. The major media characterized at this time include surface soil (further differentiated into Drainage, Playa, and Uplands), subsurface soil, and groundwater. The system of soil classification used by the National Cooperative Soil Survey has six categories, beginning with the broadest category (order) and ending with the most definitive category (series) (Ref. 3). The series category consists of soils that have similar horizons in profile. The horizons are similar in color, texture, structure, and mineral and chemical composition. Various soil series occur over Pantex Plant site (Figure 2-1). The predominant soils present at Pantex Plant are the Pullman series, which make up approximately four-fifths of the nearly level High Plains part of Carson County. This series represents the soil type in which most of the background soil borings and surface samples collected at Pantex Plant were taken. In an effort to establish a more defensible

background data set for the various soil types that are encountered at Pantex Plant, additional surface samples from upland and drainage soils (Pullman Soils), as well as playa sediments (Randall Clay), were collected from the TDCJ and Bushland Playa areas to supplement the initial data set. These playa and interplaya areas have very similar surface soils types to Pantex Plant . The possibility exists that background soil and surface samples collected at Pantex Lake could have encountered the Ulysses series. The Pullman and Ulysses series horizons differ little from each other except that Ulysses soils are more calcareous than the Pullman soils.

The RRSs, which will be used as the guidelines for site evaluation, require that soils above 2 ft be considered separately because of the inhalation/ingestion considerations. The 2 foot depth is therefore a natural breakpoint for distinguishing subsurface soils from surface soils and requires no interpretation on the part of the evaluator.

2.3.1 SURFACE SOIL

Surface soil is defined as sediment/soil occurring within 2 ft of the surface. Subsurface soil is defined as soil at depths greater than 2 ft. The selection of these intervals was based on several factors. The first is the physical differences observed in the surface materials and those slightly deeper. Table 2-1 presents the average liquid limit, plasticity index, and percent by weight passing a No. 200 sieve for the surface and subsurface soils in the initial data set. A summary of the analyses performed is presented in Appendix B.

TABLE 2-1
PHYSICAL CHARACTERISTICS DISTINGUISHING SURFACE SOIL FROM SUBSURFACE SOIL

Media	Liquid Limit (LL%)	Plasticity Index (PI%)	% Passing a #200 Sieve (%Fi)
Surface Soil (0-2 feet)	47	31	89
Subsurface Soil (2-432 feet)	38	22	76

Figure 2-1

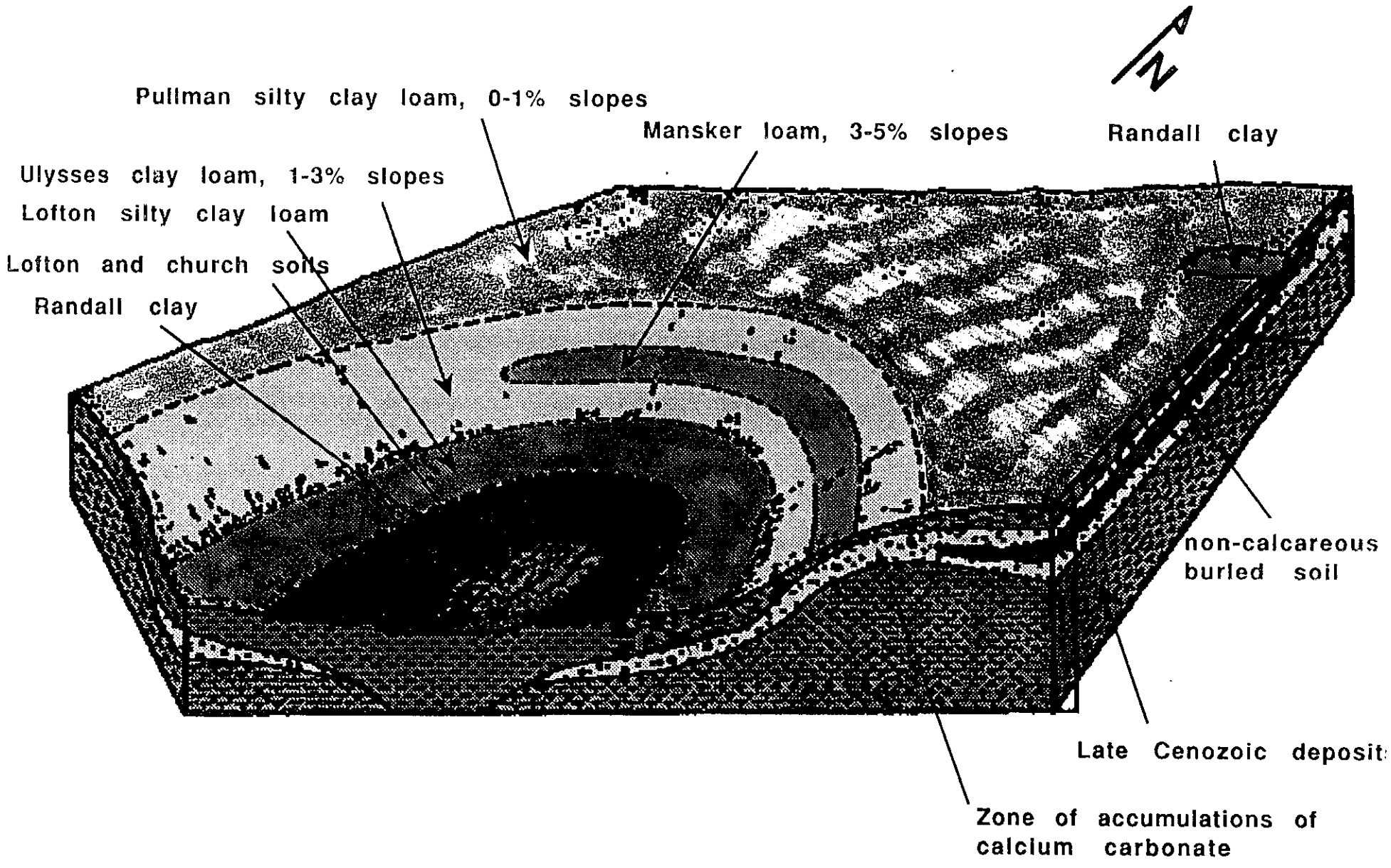


Figure 2-1 Schematic Pattern of Pullman-Randall Soils in and near a Playa

Source: Jacquot 1962

In addition, the individual results for plasticity are plotted for surface soil and subsurface soil in Figure 2-2. There is no distinct break between surface soil and subsurface soil, but, in general, surface soils analyzed have liquid limits greater than 41% and subsurface soils have liquid limits less than 41%.

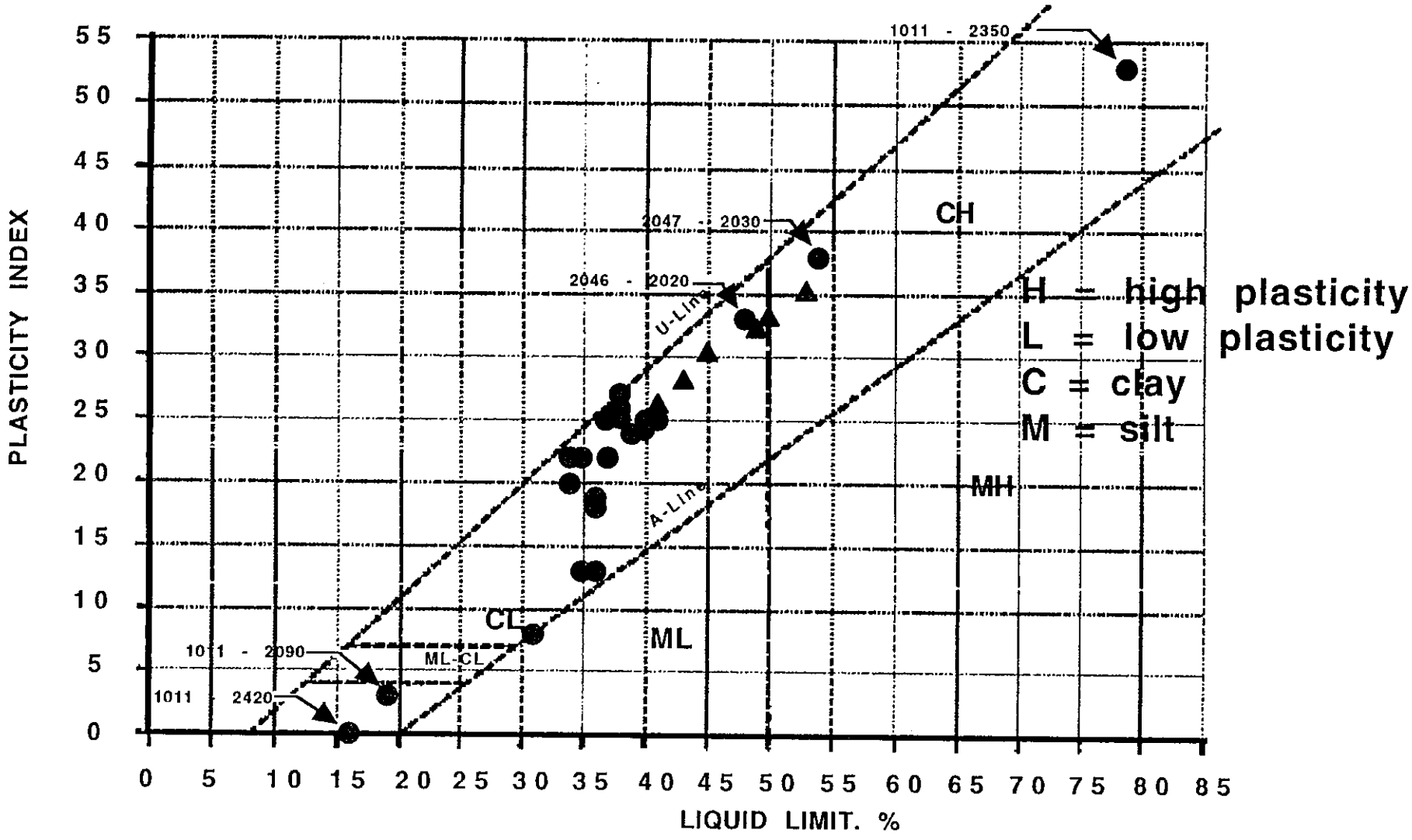
2.3.2 SUBSURFACE SOIL

In Figure 2-2, two sets of data outliers are present with the soils data including 2046-2020, 2047-2030, and 1011-2350 with liquid limits greater than 47 percent and 1011-2090 and 1011-2420 with plasticity indices close to zero. In examining the chemical analyses from four of the five samples, as shown in Table 2-2, only the 1011-2090 and 1011-2420 samples have concentrations considerably different from the average. Sample 1011-2350 was not tested for chemical constituents. Backgrounds for subsurface soils were therefore calculated two ways. The first included all data from 2-432 ft, and the second calculated the background for 2-60 ft separately. Distinction at a depth of 60 ft was made, since this depth approximated the top of the caprock and the coarser, less plastic materials were below 60 ft. The results of those two calculations are presented in Subsection 3.1.2.

2.3.3 GROUNDWATER

Data utilized in this report for the determination of groundwater background levels are derived solely from selected Ogallala Aquifer wells located in Potter and Carson Counties. An effort is currently underway to develop a background database for the perched aquifer. Data obtained from the Texas Water Development Board Ground Water Data System Report, dated April 13, 1994, and the City of Amarillo Safe Drinking Water Act Well Surveys of 1991 and 1992 were screened to eliminate known "perched aquifer" and non-Ogallala Aquifer wells. Data that were associated with known industrial sites such as the American Smeltering and Refining Company (ASARCO), located northeast of Amarillo, and the Panhandle Oil Field in northern Carson County were not used in the background-level determination due to known contamination [personal communication, William Mullican and Alan Fryar, Texas Bureau of Economic Geology (TBEG), April 1994].

Figure 2-2



	LL AVG	PI AVG	%FI AVG
● - SOIL	38	22	76.3
▲ - SEDIMENT	47	31	89.0

Figure 2-2 Pantex Background Surface Soil and Subsurface Soil Plasticity Chart in Accordance with the Unified Soil Cassification System

TABLE 2-2
COMPARISON OF CHEMICAL RESULTS OF HIGH LIQUID LIMIT AND LOW PLASTICITY SOILS WITH AVERAGES FOR SUBSURFACE SOIL[1]
(all units in mg/kg)

Boring Location/ Constituents	Soil Average[2]	2046-2020	2047-2030	1011-2090	1011-2420
Arsenic	4.93	6	6.2	1.3	2.4
Barium	230	110	140	11	15
Beryllium	0.85	0.88	1.2	0.17	0.15
Cadmium	NC[3]	<0.5	<0.49	<0.43	<0.38
Chromium	17	18	20	3.4	1.7
Lead	8	11	12	1.6	1.6
Mercury	0.07	0.093	0.088	0.072	0.047
Nickel	15	16	17	2.5	3.4
Selenium	0.81	<1.0	<0.95	<0.48	<0.71
Silver	1.02	<0.99	<0.97	<0.86	<0.76
Strontium	172	110	100	13	16
Zinc	41	43	55	7.6	5.5

1 Shading denotes that the values appear significantly different from the average.
2 Soil average taken from 28 soil borings.
3 NC = not calculated.

Geologic consideration was applied to well data to be representative of the Ogallala Aquifer beneath Pantex Plant. Groundwater data for this report were obtained from quadrants 06-41, -42, -43, -44, -45, -48, -49, -50, -51, and -52 from the Texas Water Development Board Groundwater Data System. Figure 2-3 is a location map for Ogallala wells used in the data set. The 600 Series Water Field data from the City of Amarillo geographic area of the Texas Water Development Board Ground Water Data was used; however, it is not included in their data system. Figure 2-4 from the TBEG publication, Hydrogeology and Hydrochemistry of the Ogallala Aquifer, Southern High Plains, Texas Panhandle and Eastern New Mexico, dated 1988, shows the saturated thickness of the Ogallala Aquifer in the Texas Panhandle and specifically how the Ogallala Aquifer thins dramatically southwest from Pantex Plant toward the City of Amarillo. Figure 2-5 shows the location of Pantex Plant relative to the Ogallala subcrop and the erosional effect of the Canadian River specifically in Potter County. Tierra Grande

Subdivision water well field located immediately north of the City of Amarillo was eliminated from the data set by virtue of having its water source from the Permo-Triassic Group Aquifer. This distinction between the Ogallala and the Permo-Triassic Group Aquifers can be seen in the chemical analyses from each well in that area. Sulfate (SO_4), chloride (Cl), sodium (Na), calcium (Ca), magnesium (Mg), dissolved solids, specific conductivity, and hardness ($CaCO_3$) concentrations are markedly higher in the Tierra Grande Subdivision wells than in typical Ogallala Aquifer wells in Carson and Potter Counties.

2.4 DEFINITIONS OF POTENTIAL CONTAMINANTS OF CONCERN

The decision criteria for defining contaminants of concern (COCs) for Pantex Plant requires comparison of observed contaminant concentrations at Plant locations with the following:

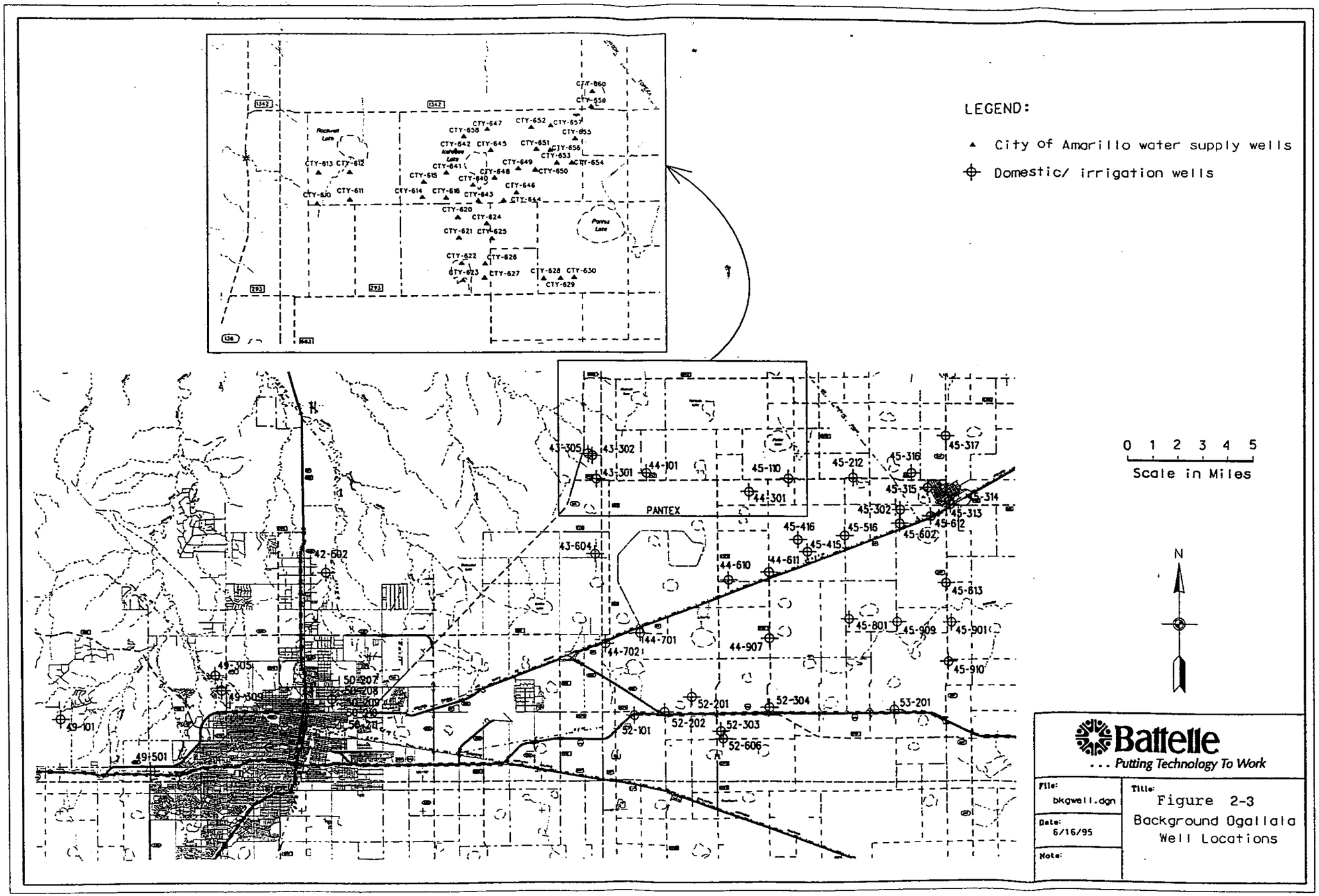
- Natural background concentrations
- PQLs.

Risk reduction guidance developed by the TNRCC requires calculation of risk-based standards pursuant to RRS 2. These toxicity or Federal Drinking Water Standard-based values are to be employed when determining remedial "cleanup" criteria unless natural background concentrations or PQLs exceed the calculated risk-based value. In these instances either the natural background concentration or analytical PQL, which ever is greater, will govern.

To ascertain the potential COCs at Pantex Plant, observed concentrations of hazardous chemicals were compared to the aforementioned factors. For those hazardous compounds observed at Pantex Plant that have exceeded each of the factors, a brief description of the historical use and transport potential has been offered. For example, several inorganic metals and metalloids are naturally occurring. For those compounds (e.g., chromium) in which observed concentrations exceed calculated risk-based levels, natural background concentrations, and PQLs, the compound was determined to represent a potential Plant COC and therefore, warranted a description of historical Plant use and transport mechanisms.

2.4.1 METALS

Natural processes, such as chemical weathering and geochemical activities, release various elements in the earth's crust, into the soil, air, and water. Transport and transformation of these elements, including metals and their salts, usually involve geochemical as well as biological processes. The influence of human activities, such as mining operations, combustion of fossil fuels, agricultural activities, and urbanization, have redistributed naturally occurring metals found in the earth's crust. As a result, some of the naturally occurring metals at Pantex Plant are in concentrations greater than background values.


LEGEND:
City of Amarillo water supply wells
Domestic/ irrigation wells
0 1 2 3 4 5
Scale in Miles
N
PANTEX
Battelle
. . . Putting Technology To Work
File: bkgwell.dgn
Date: 6/16/95
Note:
Title: Figure 2-3
Background Ogallala
Well Locations

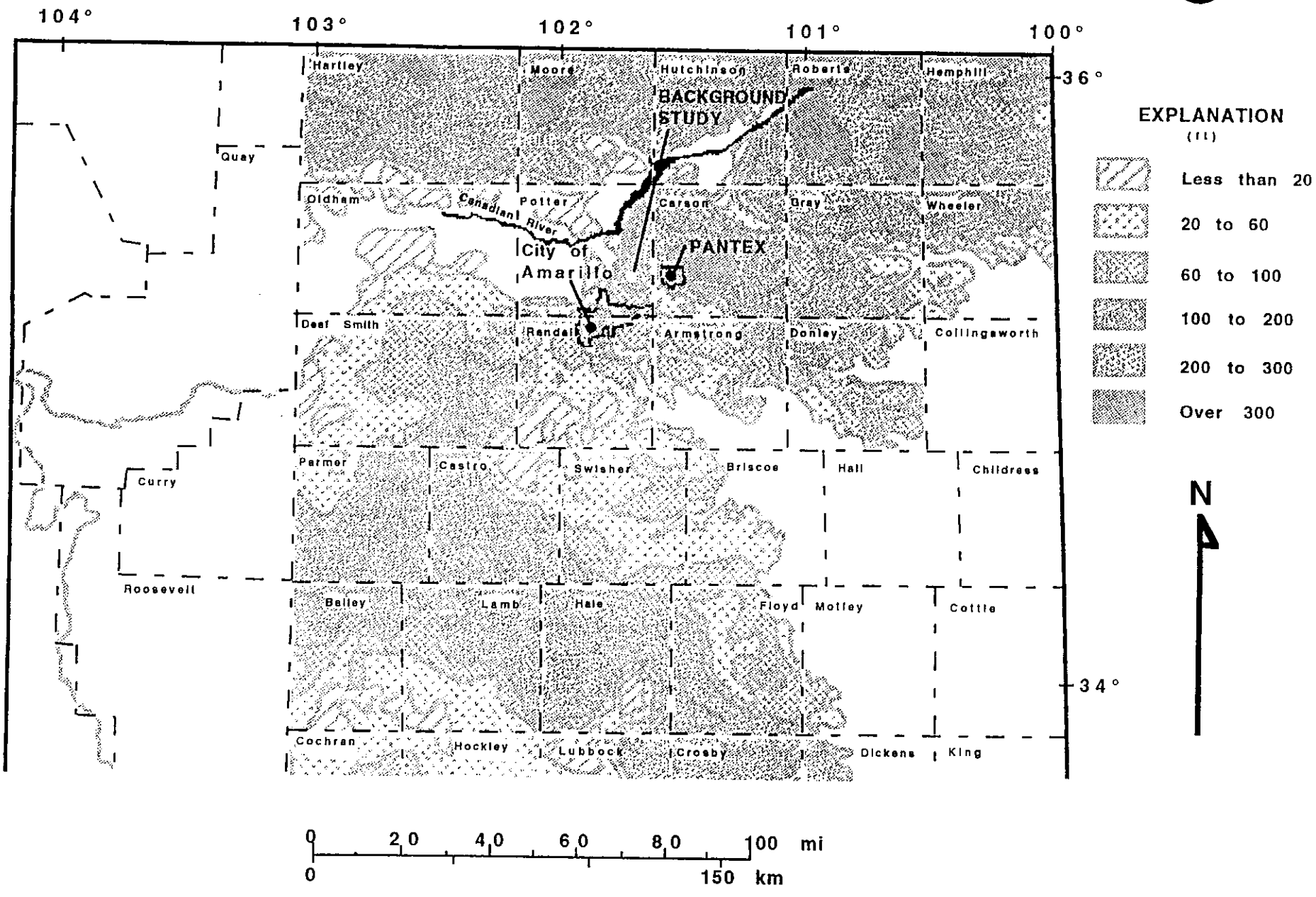


Figure 2-4 Saturated Thickness of the Ogallala Formation
Source - Texas Bureau of Economic Geology: Hydrogeology, Hydrochemistry of the Ogallala Aquifer, Southern High Plains, Texas Panhandle, Eastern New Mexico

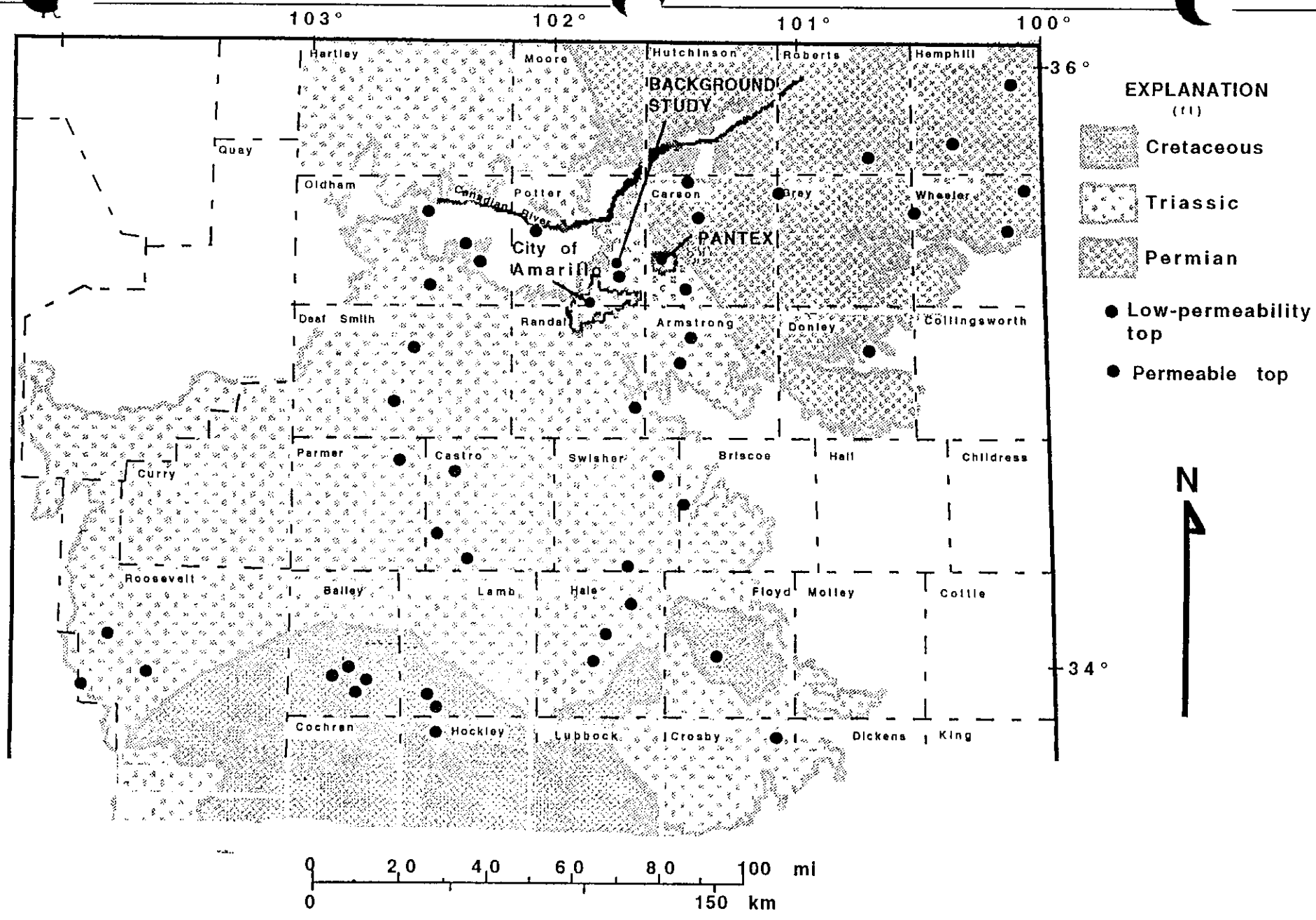


Figure 2-5 Subcrop Map at the Base of the Ogallala Formation
Source - Texas Bureau of Economic Geology: Hydrogeology, Hydrochemistry of the Ogallala Aquifer, Souther High Plains, Texas Panhandle, Eastern New Mexico

Figure 2-5

Metal concentrations in groundwater are largely governed by interactions with surrounding soils and geological materials. Three major microbial processes affect the environmental transport of metals: (1) degradation of organic matter to lower molecular weight compounds, which are more capable of complexing metal ions, (2) alterations to the physicochemical properties of the environment and chemical forms of metals by metabolic activities, e.g., oxidation-reduction potential and Ph conditions, and (3) conversion of inorganic compounds into organometallic forms by means of oxidative and reductive processes (Ref. 4).

2.4.1.1 ANTIMONY.

Antimony does not usually occur as a metal in its native state, but rather as a sulfide or an oxide, both of which are insoluble in water. Any dissolved antimony is rapidly sorbed to suspended material or precipitated as an oxide from solution (Ref. 5). The investigations at Pantex Plant have included antimony as an analyte due to the fact that antimony salts are used in the explosives industry. Concentrations of antimony in Pantex Plant soils were quantified using total method analyses for metals (SW-846) in soils. Concentrations have ranged from nondetection–50 mg/kg in surface soils and from nondetection–140 mg/kg in subsurface soils. No other investigation has revealed the elevated levels of antimony as was found in the Ditches and Playas RFI. Containers of soil with "high antimony" concentrations (based on total method analysis) were sampled and analyzed for waste characterization determinations. The samples were analyzed for antimony using the toxicity characteristic leaching procedure (TCLP). Analytical results revealed leachable antimony levels less than 1 ppm for all samples, indicating that the antimony found in Pantex Plant soils is naturally occurring in an insoluble form. Despite these results, Pantex Plant continues to screen Antimony as a COC in its investigations.

2.4.1.2 ARSENIC.

Arsenic occurs in earth's crust at an average level of 2–5 ppm. Traces of arsenic occur in some mineral waters, in the soil (1–60 ppm), and in adult humans (0–1 mg/kg) (Ref. 6). The combustion of fossil fuels, particularly coal, introduces large quantities of arsenic into the environment, much of it reaching natural waters. Arsenic occurs with phosphate minerals and enters into the environment along with some phosphoric compounds. Some pesticides, particularly those in wide use before WWII, contain highly toxic arsenic compounds (Ref. 7). From the 1930s to the 1960s, calcium arsenate was used as an insecticide, and from the 1950s to the present, arsenic acid has been applied as a cotton defoliator. Registration for use of arsenic acid as a cotton leaf desiccant was cancelled effective December 1997 (*Federal Register*, 1993) (Ref. 8). Arsenic can be absorbed by clay in the unsaturated subsurface

(Ref. 9).

One-fifth of the approximately 16,000 acres of Pantex Plant is used for operational and security purposes. Much of the remaining acreage has been farmed or used for cattle grazing. This practice continues today. Previous sampling of the perched aquifer at the Plant has shown arsenic concentrations range from nondetection–0.004 mg/L.

2.4.1.3 BARIUM.

Pantex Plant has a history of barium use in conjunction with "cast and mold" fabrication of conventional weapons. The use of barium in Baratol, a mixture of barium nitrate and trinitrotoluene, ceased in the early 1960s at Pantex Plant. After the conclusion of WWII, all Baratol use was centered in Zone 12 until cessation in the 1960s. "Cast and mold" operations in Zone 11 occurred during WWII.

Barium concentrations observed at Pantex Plant tend to increase with increasing proximity to the caliche layer found in the panhandle region. Beneath the caliche layer, barium concentrations decrease. This trend is considered to be consistent with regional geology found in the Texas and Oklahoma panhandle region. Specific concentrations at Pantex Plant have ranged from 110 to 3290 mg/kg in surface soils and from 52 to 1770 mg/kg in subsurface soils. Although barium nitrate is soluble in water, it is likely that combinations with sulfuric acid during fabrication or in postfabrication wastewater discharge would have witnessed replacement of the nitrate group with a sulfate group. Such preferential replacement substantially decreases the resultant compound solubility, mobility, and toxicity. Barium concentrations observed in the subsurface at Pantex Plant are likely to be the immobile, nontoxic sulfate form and are consistent with regional levels. Confirmation that the sulfate form predominates in the region, is the observed presence of dissolved sulfate ions and the relative absence of barium ions in groundwater.

2.4.1.4 CHROMIUM

Trivalent chromium III [Cr (III)] and hexavalent chromium [Cr (VI)] are the most common forms of chromium found in the environment. Three surveys of the environmental significance of chromium (Ref. 10) emphasize that the chemical form of this metal determines its environmental behavior and toxicity. Cr (III) is the most common form of chromium in the earth's crust; the predominant source of Cr (VI) in the environment is from human activity. Chromium compounds were used during past operations at Pantex Plant. Painting operations utilized lead and zinc chromate paints, and chromate salts were used as a part of the water treatment program at the former cooling tower. Previous groundwater sampling in the perched aquifer has shown a range of concentrations of chromium;

chromium (total) levels were from nondetection–9.53 mg/L, and Cr (VI) levels were from nondetection–1.72 mg/L.

Cr (III) is relatively insoluble and exhibits little or no toxicity (Ref. 10), while Cr (VI), the more toxic form, usually occurs as highly soluble anions. Chromium transport in aqueous systems strongly depends on sorption, chelation, and redox reactions. The redox reactions are only poorly understood, yet they are of key importance because the oxidation state of chromium dictates its sorptive and chelation behavior.

2.4.1.5 LEAD

Lead is ubiquitous in the natural environment and strongly absorbed by soils. Lead compounds have been used during past operations at Pantex Plant: painting operations utilized lead-based paints, gasoline fuels containing lead were historically used, and plating operations and landfill debris contained lead. The principal natural source of lead is the weathering of sulfide ores or, more locally, from calcareous rock (Ref. 5). Until the 1970s, motor gasoline fuels used at the Plant contained lead. Consequently, due to the by-products of the gasoline combustion, lead concentrations may be slightly elevated in the surface soils near roadways at the Plant. Two primary factors control the mobility of metals (lead) in soils: the attenuation capacity of the soil and the solubility of the metal. The soils at Pantex Plant have a large capacity to retain the naturally occurring heavy metals. Attenuation of metals by the soil is due to the high clay content (approximately 45%), a preponderance of montmorillonite in the clay fraction with resultant high cation exchange capacity (25 meq/100 g soil), neutral to alkaline pH (7 to 8), and free carbonates in the subsoil. Lead is the least mobile of heavy metal contaminants except under extreme acid conditions (Ref. 11). Additionally, with a soil pH in the range of 6.5 to 11, lead will typically be present as immobile forms such as hydroxides, carbonates, phosphates, oxides, dioxides, or divalent cations sorbed on soil solids. Lead concentrations detected at the Pantex Plant range from 5.4 tp 540 mg/kg in surface soils and from 3.1 to 150 mg/kg in subsurface soils.

2.4.2 HIGH EXPLOSIVE COMPOUNDS

Pantex Plant has a long history of fabricating various secondary chemical explosive compounds used in the manufacture of conventional and nuclear weapons. The secondary explosives manufactured at Pantex Plant are categorized in two distinct families: the older generation of nitroaromatics and the more recent nitramine formulations. The characteristics of each family are discussed below.

2.4.2.1 NITRAMINES.

The evolution of secondary chemical explosives has progressed to more sensitive, greater-yielding compounds, specifically the nitramine family which is primarily composed of cyclo-trimethylene trinitramine (RDX) and cyclo-tetramethylene tetranitramine (HMX). While both compounds have similar chemical properties and atomic compositions, HMX is less sensitive and provides a lower explosive yield. The nitramine family of compounds is considered insoluble in water (RDX = 60 mg/l at 23 degrees C, HMX = not determined) (Ref. 20 & 21) and tends not to migrate substantial distances from discharge points unless in the presence of solvents.

Pantex Plant fabricated binary explosives combining trinitrotoluene (TNT) with HMX and/or RDX. As a result of the manufacture of Composition B explosives, observations of these compounds in environmental media may be witnessed at any given release site. The greatest threat with relation to nitramines and nitroaromatics are the detonation potential when subject to friction sources, or impact thresholds, or when subject to temperatures in excess of compound initiation.

2.4.2.2 NITROAROMATICS

Of the nitroaromatic compounds, TNT is the most prevalent form developed for use in munitions manufacture at Pantex Plant. TNT use dates back to the 1940s when it was used in conventional weapon manufacture. TNT was frequently cast in a mixture with barium nitrate. Nitroaromatic use was favored because the family is less sensitive to initiation than primary explosives enabling safer material handling capabilities while fulfilling their ultimate purpose—impact detonation. Explosive compounds have recently evolved away from solely nitroaromatic use. Presently, TNT is fabricated with RDX in binary explosive formulations such as Composition B explosives.

Historic releases of TNT have impacted soil and groundwater underlying many current and former fabrication facilities at Pantex Plant. The primary compound observed in these media is the parent compound TNT. Several intermediate degradation products are also observed such as 1,3,5-trinitrobenzene (TNB), 2,4-dinitrotoluene (DNT), and 1,3-dinitrobenzene. The solubility of these intermediates are 305 mg/kg(no temperature specified), 270 mg/l at 22 degrees C, and 469 mg/k at 15 degrees C, respectively(Ref. 20 & 21). TNT is typically the predominant form observed due to its relative chemical stability. TNT is slightly soluble in water (100 mg/l at 23 degrees C), making transport in a dissolved phase unlikely. Limited aqueous solubility also tends to retard biodegradation of such compounds making them relatively persistent in the environment. The relative immobility and stability demonstrated by TNT ensure that limited degradation intermediates, if any, are observed.

2.4.3 SOLVENTS/VOLATILE ORGANIC COMPOUNDS (VOCs)

2.4.3.1 CHLORINATED SOLVENTS/CHLORINATED VOCs.

This chemical class includes seven chlorinated compounds, including methylene chloride, chloroform, carbon tetrachloride, trichloroethane, trichloroethylene, 1,2-dichloroethane, and tetrachloroethane. Methylene Chloride, chloroform, and carbon tetrachloride are chlorinated methanes. Methylene chloride is widely used as an industrial solvent and for paint stripping, vapor degreasing, and cold cleaning. It is also used in the production of aerosols, urethane foam, adhesives, and pesticides. Chloroform is used for industrial degreasing and as a solvent for fats, oils, rubber, alkaloids, waxes, and resins. Carbon tetrachloride was widely used as a household and industrial cleaning solvent; however, these uses have been discontinued because of environmental and health concerns. The other four compounds, trichloroethane (TCA), trichloroethylene (TCE), 1,2-dichloroethane (DCA), and tetrachloroethane, are chlorinated C_2 chemicals. TCA is used primarily in vapor degreasing and cold cleaning. TCE is used primarily in cleaning applications such as vapor degreasing and cold cleaning of fabricated metal parts. Volatization is the most important transport mechanism for chlorinated solvents/VOCs released to the environment. Adsorption to soils and sediment usually is insignificant, although soil organic matter often enhances adsorption affinities. These compounds are highly mobile and can partition to surface water through runoff or to groundwater through leaching.

2.4.4 SEMI-VOLATILE ORGANIC COMPOUNDS (SVOCs)

Many SVOCs were identified as COPCs at Pantex. Among the SVOCs identified, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated dibenzo-*p*-dioxins/furans (PCCD/PCDF), and pesticides represent some of the most toxic man-made compounds and may pose a serious threat to human health and the environment after release.

2.4.4.1 PCBs.

PCBs had been used as dielectric fluids in capacitors and transformers, heat transfer fluids, hydraulic fluids and cutting oils, and as additives in pesticides, paints, copying paper, carbonless copy paper, and plastics. PCBs have been released from transformers and/or switchgears onto adjacent soils on at least four occasions at Pantex Plant. These compounds strongly adsorb to soils and sediment because of their low water solubilities. Therefore, leaching of PCBs does not occur in soils under most environmental conditions unless they are in the presence of organic solvents.

2.4.4.2 PAHs.

PAHs are a group of naturally occurring or man-made compounds formed during incomplete burning of wood, coal, oil, gas, or other organic substances. PAHs have been detected at several sites at Pantex Plant including the FTA Burn Pits and drainages near Bldg. 12-43. PAHs adsorb strongly to soils and sediments because of their low water solubilities. These compounds have been detected in several areas of Pantex Plant ranging from ND to 110 mg/kg in surface soils and from ND to 12 mg/kg in subsurface soils. However, these compounds have not been detected below approximately 10 ft below surface.

2.4.4.3 PCDDs/PCDFs.

PCDDs and PCDFs are formed primarily as impurities when manufacturing chlorophenols and their derivatives and chlorinated pesticides. The production and/or use of these chemicals, improper landfilling or dumping, and insufficient incineration of wastes resulting from such manufacture will result in contamination of various media. PCDDs and PCDFs are very immobile in soils. Soil leaching experiments indicate that PCDDs and PCDFs remain strongly adsorbed even in sandy soil and leaching of these compounds from soil by rainwater in insignificant. Nevertheless, leaching or vertical movement of PCDDs and PCDFs in soil can occur under some conditions, such as saturation of the soil matrix, presence of organic solvents in soil, cracks in soil, or burrowing of animals. PCDDs and/or PCDFs were detected in surface soils in the FTA Burn Pits; in the ditch sediments near Bldg. 12-51; in the surface soil at Bldg. 12-51; and in the surface soil of the Denuded area near Playa 1. Releases of PCDDs and/or PCDFs most likely were the incidental handling of pesticides and of the burning of chemicals in the fire training areas. Most detectable concentrations have been in the ng/kg range.

2.4.4.4 PESTICIDES.

Pesticide releases at Pantex Plant occurred primarily from the Pesticide Rinse Areas at Bldg. 12-43A and 12-51, where pesticides are stored and stock solutions of these chemicals are prepared. Pesticides also were released through applications of these chemicals for weed control. In previous decades, DDT was one of the most widely used pesticides for controlling insects in agriculture. It has not been used in the U.S. since 1972. The presence of DDT in the environment is the result of contamination from past production and use. Because DDT is strongly bound to soils and is only slightly soluble in water (0.0034 mg/l), DDT is not easily displaced, nor does it leach to groundwater. DDT may persist in the environment for a long period of time. DDT ranges from ND to 0.038 mg/kg in surface soils and is ND in subsurface soils at Pantex Plant. Heptachlor is a pesticide used in the past for insect control in

homes, buildings, and on food crops. Similar to DDT, heptachlor has a strong adsorbtive affinity to soils, especially those with high organic matter. Therefore, it is not likely to leach from soils into groundwater under most environmental conditions. Heptachlor can remain in the soils for many years. When released into water, it adsorbs strongly to suspended particulate matter and bottom sediments. Heptachlor ranges from ND to 1.3 mg/kg in surface soils and from ND to 0.0035 mg/kg in subsurface soils at Pantex Plant.

2.5 METHODOLOGY FOR RISK REDUCTION STANDARD CALCULATIONS

2.5.1 PROCEDURES FOR CALCULATING PANTEX PLANT BACKGROUND FOR RISK REDUCTION STANDARD 1

RRS 1 requires that background values be achieved in a site cleanup. The background is required to be represented by results of analyses taken from media that are unaffected by waste management or industrial activities. If the PQL is greater than background, the PQL, rather than the background, shall be used as the PRG. This procedure applies to surface soil, subsurface soil, and groundwater at Pantex Plant for RRS 1.

There are two possible approaches in which comparison to "background" is made. Those are the comparisons of discrete samples to a background or the comparison of an average (or mean) concentration to a background. The focus of this report is establishment of a background to which discrete sample values can be compared. This discrete sample method is justified for the purpose of this guidance document where PRGs are calculated as guidelines for the overall Plant. Other possible techniques for comparing average or representative concentrations of a media of concern with that of the background population will be proposed case by case for each SWMU group. Discrete sample comparisons will be more conservative than a means comparison and are proposed as the initial approach.

To achieve a background value, 95% upper tolerance limits (UTLs) were calculated as the background values for the naturally occurring inorganics. The 95% UTL with 95% coverage is established as the value that contains a designated proportion of the population (% coverage) with a generally accepted degree of confidence. This is opposed to a confidence interval for the mean, which contains only the mean of the population. Therefore, the UTL is larger than the Upper Confidence Limit (UCL) and is appropriate for discrete sample comparisons.

Because any statistical or mathematical model of actual data is an approximation of reality, all statistical tests and procedures require certain assumptions for the methods to be used correctly and for

the results to have a proper interpretation. Most statistical tests assume that the data comes from a normal distribution, which is the familiar bell-shaped curve. However, data also may be distributed lognormally, exponentially, or nonparametrically.

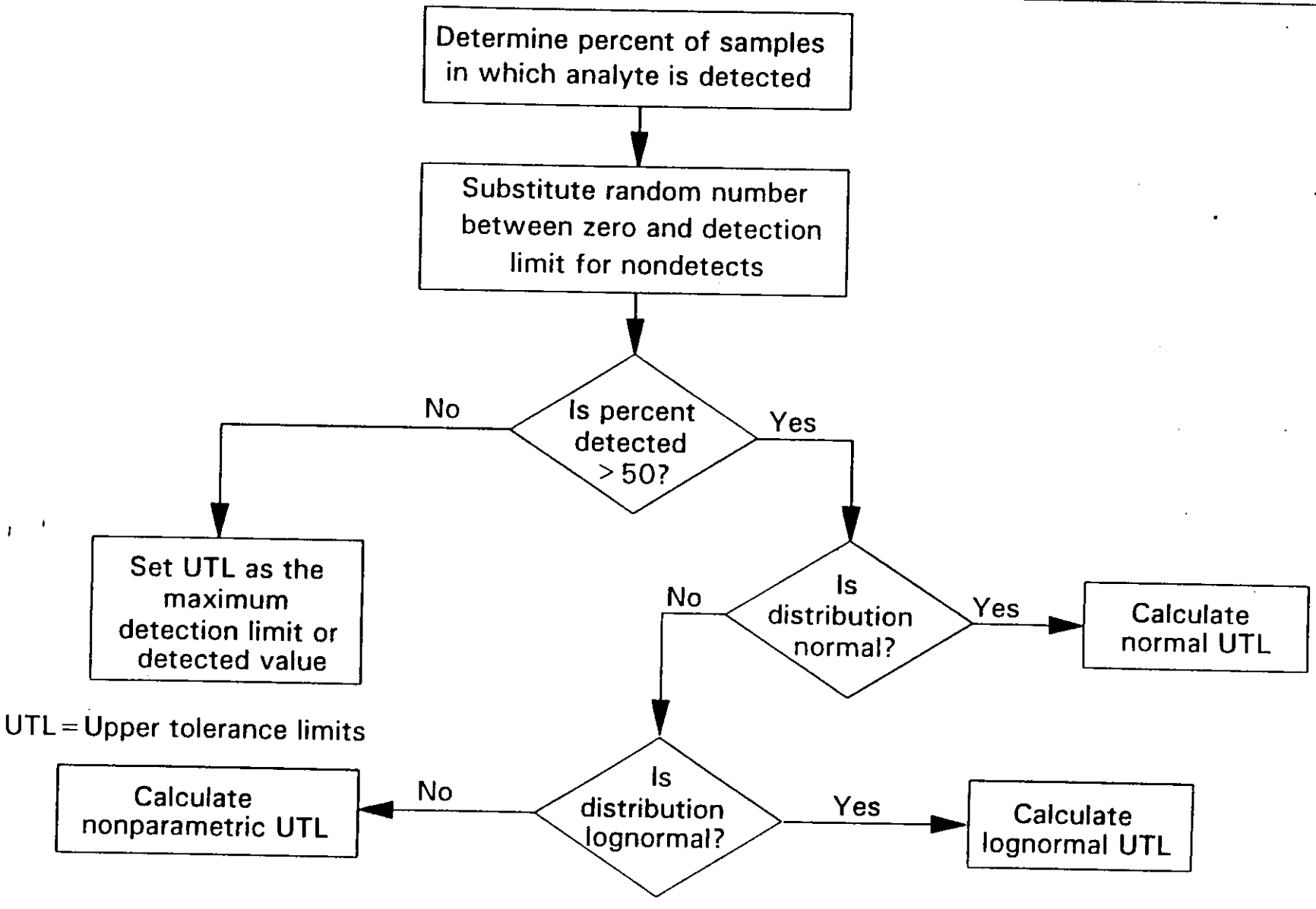
Some general rules were established for determining which type of data distribution to assume prior to calculating the 95% UTL. This is illustrated in Figure 2-6, which presents a decision tree for calculating background surface soil, subsurface soil, and groundwater UTLs. If more than 50% of the background samples for a particular constituent were above detection limits, the distribution was checked for normality and lognormality. If neither a normal or lognormal distribution existed, a nonparametric distribution was assumed. If less than 50% of the background values for a particular constituent were above detection limits, the UTL was calculated as the nonparametric limit, using the higher of either one times the highest reported detection limit, the highest measured value, or the PQL. Figure 2-6 indicates that two main assumptions were used to calculate the UTLs. The first assumption is the use of values less than detection limits. The second assumption is the procedure selected to check for normality. This is the subject of Subsection 2.5.1.1 and 2.5.1.2, respectively.

2.5.1.1 Handling of Values Less than Detection Limits.

The establishment of background for data was complicated further by the presence of a significant number of nondetects in the background samples. Random numbers were generated to place a value on the data point between the measured detection limits and zero. By providing random numbers, rather than using zero, one-half the detection limit or the detection limit, a closer representation of the spread or variance in the data was obtained. This approach is identified in several statistical publications (Refs. 12, 13, 14, and 15). The authors of these papers conclude that while there are a variety of ways to establish proxy concentrations, the uniform random distribution is reasonable when the distribution of the data is not known. Appendices D and E contain the raw data and the random numbers used to calculate the UTLs for surface soil and subsurface soil, respectively.

2.5.1.2 Shapiro-Wilk Test for Normality.

There are several ways to check for normality (Ref. 16). The method selected for surface soil, subsurface soil, and groundwater was the Shapiro-Wilk Test of Normality. A Shapiro-Wilk Statistic was calculated, and probability values <0.05 indicate non-normality/nonlognormality. Examples of normal, lognormal, nonparameteric, and corresponding calculations of UTLs are given below.



UTL = Upper tolerance limits

Figure 2-6. Decision Tree for Calculating Background UTLs

The normal distribution UTL is calculated (Figure 2-8), when 50% or more of the data are detected and are normally distributed. The normal distribution is characterized by the bell-shaped distribution curve. The normal UTL is calculated using the following equation: $95\% \text{ UTL} = X + sK$

where:

X = population mean

s = sample standard deviation

K = K-factor for the 95% confidence level and 95% coverage (Ref. 17, table reprinted in Appendix C).

An example of the histogram for normally distributed concentrations, lead in the subsurface, is shown Figure 2-7. Plotted with the histogram is the theoretical normal distribution with the same mean and standard deviation as the sample data. The 95% UTL is also shown in the figure.

The lognormal distribution UTL is calculated when 50% or more of the data are detected and are lognormally distributed (Figure 2-6). For data to be distributed lognormally, the logarithms of the data values must be normally distributed. The typical lognormal distribution curve looks similar to the normal distribution curve, but looks as though the peak has been shoved to the left and the right side stretched out. The lognormal UTL is calculated using the same equation as that for the normal UTL except the mean (X) and the sample standard deviation are calculated using the natural logarithms of the background sample concentrations. The lognormal UTL is calculated using the following equation:

$$95\% \text{ UTL} = \exp^{(\text{UTL of logged values})}.$$

An example of the histogram for lognormally distributed concentrations, beryllium in the subsurface, is shown in Figure 2-8. Plotted with the histogram is the theoretical lognormal distribution with the same mean and standard deviation as the sample data. The 95% UTL is also shown in the figure. The nonparametric UTL is calculated when either 50% or less of the data are detected or 50% or more of the data are detected, but neither the assumption of normality nor lognormality can be made. A onparametric UTL is chosen as an order statistic of the sample data. For Pantex Plant background soil calculations, either the maximum reported concentration, the maximum detection limit in the data set, or the PQL, was used as the UTL. There is no characteristic shape of a distribution curve assuming a nonparametric distribution. Once the upper limit is established, the coverage of the limit is determined by the sample size. The technique for calculating the coverage provided by the UTL at the 95% UCL is provided in Appendix C.

Histogram of Background Subsurface Soil Concentrations of Lead for Pantex
With Normal Curve

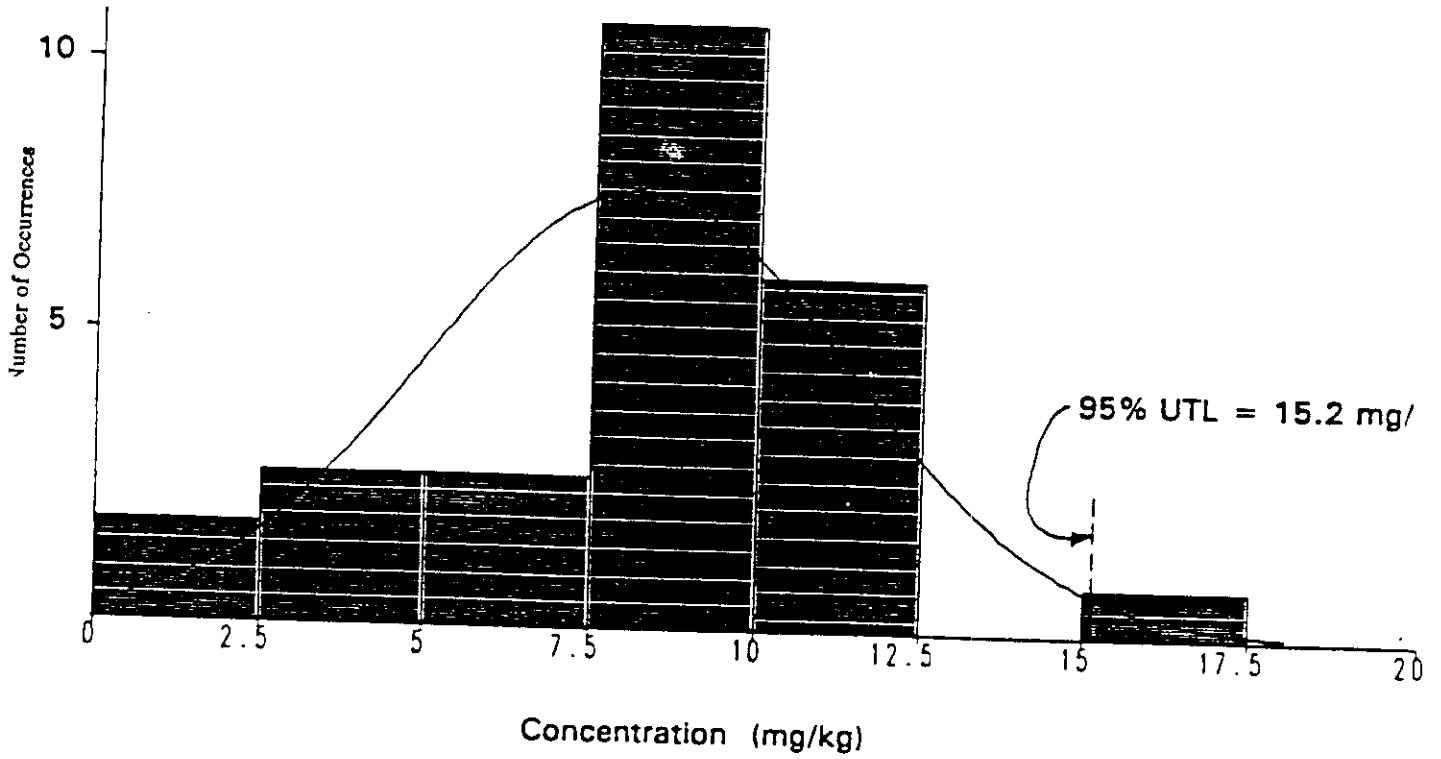


Figure 2-7. Example of Normally Distributed Data

Histogram of Background Subsurface Soil Concentrations of Beryllium for Pantex
With Lognormal Curve

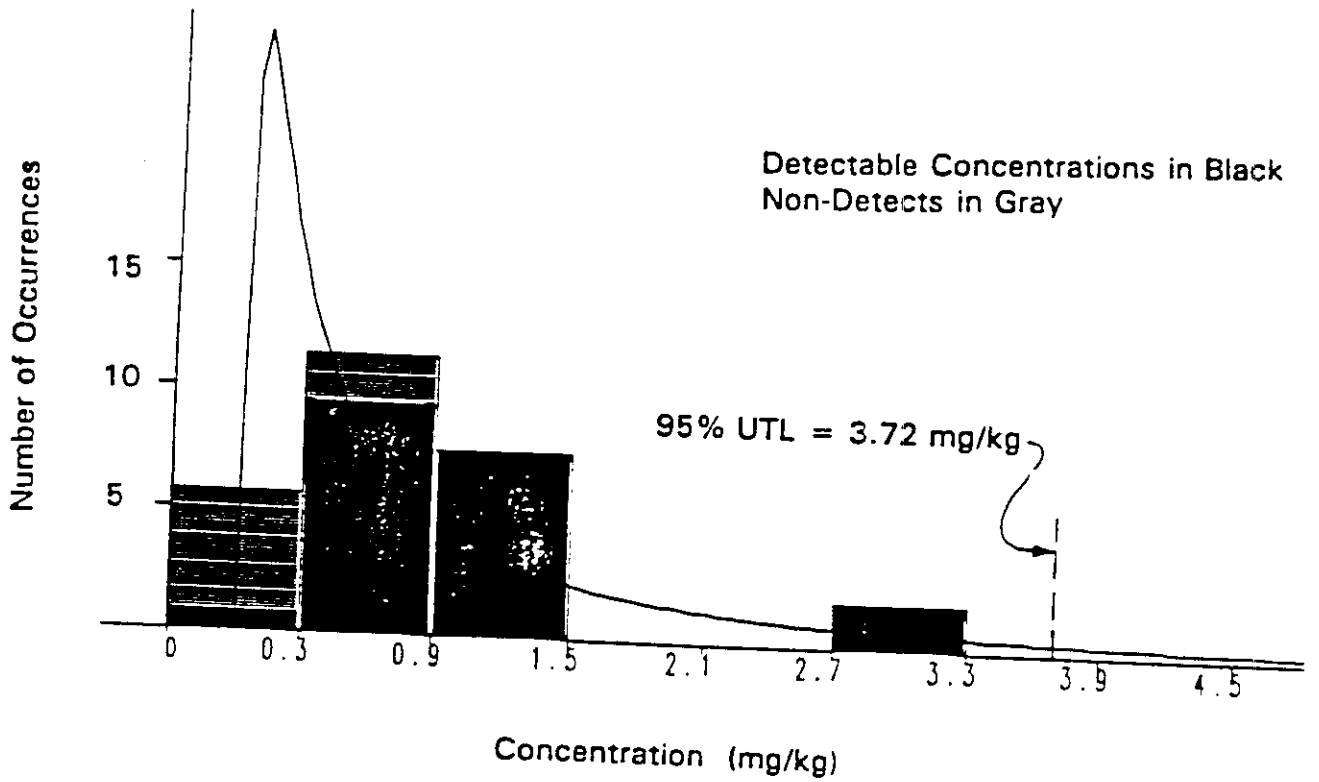


Figure 2-8. Example of Lognormally Distributed Data

2.5.2 PROCEDURE FOR CALCULATING RISK REDUCTION STANDARD 2

2.5.2.1 RISK REDUCTION STANDARD 2 FOR SURFACE AND SUBSURFACE SOILS.

RRS 2 for soil is described in 30 TAC 335.555-568. Pantex Plant is considered to have nonresidential use in accordance with 335.557(3). Examples of Medium Specific Concentrations (MSCs) are found in 335.568, Appendix II. Columns "GWP-Ind" and "SAI-Ind" are cited. When using these standards, the "SAI-Ind" is only applicable to the upper 2 ft of soil. The "GWP-Ind" numbers are applicable to the entire column of soil. The "GWP-Ind" standard was developed as a standard to be protective if cross-media contamination occurred and is literally Groundwater Protection Standard for Industrial Use. The "SAI-Ind" standard was developed to consider cross-media contamination of air and the human ingestion and inhalation pathways and is the Soil/Air and Ingestion Standard for Industrial Use. Default values were used for SAI-Ind as contained in Section 335.567 , Appendix I.

2.5.2.2 RISK REDUCTION STANDARD 2 FOR GROUNDWATER.

RRS 2 for groundwater is described in 30 TAC 335.555-568. Pantex Plant is considered to have nonresidential exposure use in accordance with 335.557(3). Therefore, the standard will be equal to the MCL if promulgated pursuant to the Federal Safe Drinking Water Act, Section 141. If no MCL has been promulgated, the groundwater standard concentration shall not exceed the water Medium-Specific Concentration (MSC) for ingestion determined pursuant to TAC 335.556, i.e., for carcinogens,

$$\text{MSC (mg/L)} = \frac{85.16\,(TR) \times 3.36}{SF_0}$$

where:

TR = Target Risk = 0.000001 for Class A & B Carcinogens or

0.00001 for Class C Carcinogens

and

SF_0 (mg/kg/d) = Chemical-specific Oral Cancer Slope Factor,

and for systemic toxicants,

$$\text{MSC (mg/L)} = 36.5\ RfD \times 2.8$$

where:

RfD (mg/kg/d) = Chemical-specific Oral Reference Dose,

but in no case shall it be less than the PQL. The PQLs were determined in accordance with Subsection 2.2 and Appendix A. In addition, the quality of the groundwater at Pantex Plant boundaries and at boundaries of land undergoing excessation must be protective for residential exposure.

3.0 CALCULATIONS OF MEDIA CLEANUP LEVELS

3.1 RISK REDUCTION STANDARD 1

As discussed in Subsection 2.5.1, the calculated values for the UTLs are presented as the values to which discrete sample concentrations will be compared. The RRS 1 or background value will be equal to the calculated UTL value. To calculate the UTLs, statistical tables were used and are included in Appendix C as a reference.

3.1.1 RISK REDUCTION STANDARD 1 FOR SURFACE SOIL

In order to develop a defensible background surface soil data set that addresses the various soil types encountered, 87 locations were sampled at Pantex Plant and the TDCJ and Bushland Playa areas at the surface or near-surface for the specific purpose of collecting and analyzing samples to establish naturally occurring concentrations of trace elements. Surface soil sample locations were chosen to be in drainage, playa, and upland areas unaffected by known or suspected industrial or disposal activities in accordance with 30 TAC 335.554(d). Surface soil samples from the Ditches and Playas investigation were used as background samples. Figures 3-1 thru 3-3 show the background surface soil sample locations from Pantex Plant, TDCJ, and Bushland Playa areas. Samples with adjacent numbers (such as 3880 and 3881) were both collected from the flowline of the ditch, one slightly downstream of the other. Samples were analyzed for nitrate and nitrite (as nitrogen), antimony, barium, beryllium, cadmium, total chromium, cobalt, copper, nickel, silver, strontium, thallium, vanadium, zinc, arsenic, hexavalent chromium, lead, mercury, selenium, pesticides/PCBs, volatile organics, and semivolatile organics.

Table 3-1 presents a summary of the final calculated background values (95% UTL) for inorganics and pesticides, and the PQLs from common analytical methods. Table 3-1 also presents the "Percent Detected" as the percentage of samples with values over the detection limits, and "Statistic Type" for the distribution method that best represented the normality of the detected values (see

Subsection 2.5.1). In all cases, the 95% UTL values were greater than or equal to the PQL and were selected as the RRS 1 for surface soil. The governing values are shaded in Table 3-1. A more detailed analysis is included in Appendix D for the pesticide and inorganic data. Appendix D also includes the data summary reports of the data sources used in the analyses.

3.1.2 RISK REDUCTION STANDARD 1 FOR SUBSURFACE SOIL

Five soil borings were conducted at Pantex Plant for the specific purpose of collecting and analyzing samples in order to establish naturally occurring concentrations of trace elements. The locations were selected in areas unaffected by known industrial or disposal facilities, in accordance with 30 TAC 335.554(d).

TABLE 3-1
RISK REDUCTION STANDARD 1 FOR SURFACE SOIL (0-2 ft)[1]

Analyte	Soil Type	N	Assumption on Data Distribution[2]	Upper Tolerance Limit[3]	PQL for Soil[4] (mg/kg)
antimony	Drainage	38	42.1% Detected	16.0	8.7
	Playa	30	.26.7% Detected	11.9	
	Uplands	19	15.8% Detected	12.5	
arsenic	Drainage	38	Nonparametric	22.9	.74
	Playa	30	Lognormality	16.2	
	Uplands	19	Normality	10.2	
barium	Drainage	38	Nonparametric	637	8.7
	Playa	30	Nonparametric	1940	
	Uplands	19	Normality	185	
beryllium	Drainage	38	Lognormality	2.20	0.2
	Playa	30	Normality	2.23	
	Uplands	19	Normality	1.61	
cadmium	Drainage	38	47.4% Detected	0.972	0.8
	Playa	30	43.3% Detected	1.17	
	Uplands	19	31.6% Detected	1.27	
chromium	Drainage	38	Lognormality	28.9	1.4
	Playa	30	Normality	33.2	
	Uplands	19	Normality	27.7	
chromium VI	Drainage	38	.. 21.1% Detected	0.670	0.3
	Playa	30	0% Detected	0.780	
	Uplands	19	5.3% Detected	0.590	
cobalt	Drainage	38	Nonparametric	36.4	1.7
	Playa	30	Nonparametric	52.3	
	Uplands	19	Normality	10.3	

Analyte	Soil Type	N	Assumption on Data Distribution[2]	Upper Tolerance Limit[3]	PQL for Soil[4] (mg/kg)
copper	Drainage	38	Lognormality	21.5	4.3
	Playa	30	Normality	24.7	
	Uplands	19	Normality	17.5	
lead	Drainage	38	Nonparametric	29.5	8.4
	Playa	30	Lognormality	31.3	
	Uplands	19	Normality	19.3	
mercury	Drainage	38	Lognormality	0.326	0.1
	Playa	30	30.0% Detected	0.0399	
	Uplands	19	21.1% Detected	0.100	
nickel	Drainage	38	Nonparametric	33.2	3.0
	Playa	30	Nonparametric	46.0	
	Uplands	19	Normality	20.8	
selenium	Drainage	38	Lognormality	8.71	0.45
	Playa	30	Lognormality	26.7	
	Uplands	19	Lognormality	6.96	
silver	Drainage	38	36.8% Detected	0.642	1.4
	Playa	30	6.7% Detected	1.43	
	Uplands	19	5.3% Detected	2.10	
strontium	Drainage	38	Lognormality	71.6	10
	Playa	30	Normality	53.5	
	Uplands	19	Lognormality	50.7	
thallium	Drainage	38	50.0% Detected	17.0	8.7
	Playa	30	33.3% Detected	29.7	
	Uplands	19	31.6% Detected	18.5	
vanadium	Drainage	38	Lognormality	51.8	1.7
	Playa	30	Lognormality	65.5	
	Uplands	19	Normality	53.4	
zinc	Drainage	38	Lognormality	89.3	1.7
	Playa	30	Normality	105.0	
	Uplands	19	Normality	70.4	
nitrite/ nitrate as N	Drainage	8	Normality	7.94	1.0

[1] Sample sizes and calculations in estimating upper tolerance bounds do not include QC samples. Only data for samples at a depth of 0-1 ft. are included in calculations.
[2] Distributional assumptions made as a result of applying the Shapiro-Wilk test to untransformed and log-transformed data (at a 0.05 significance level).
[3] Units are mg/kg for all analytes.
[4] See Appendix A for calculated PQL values.

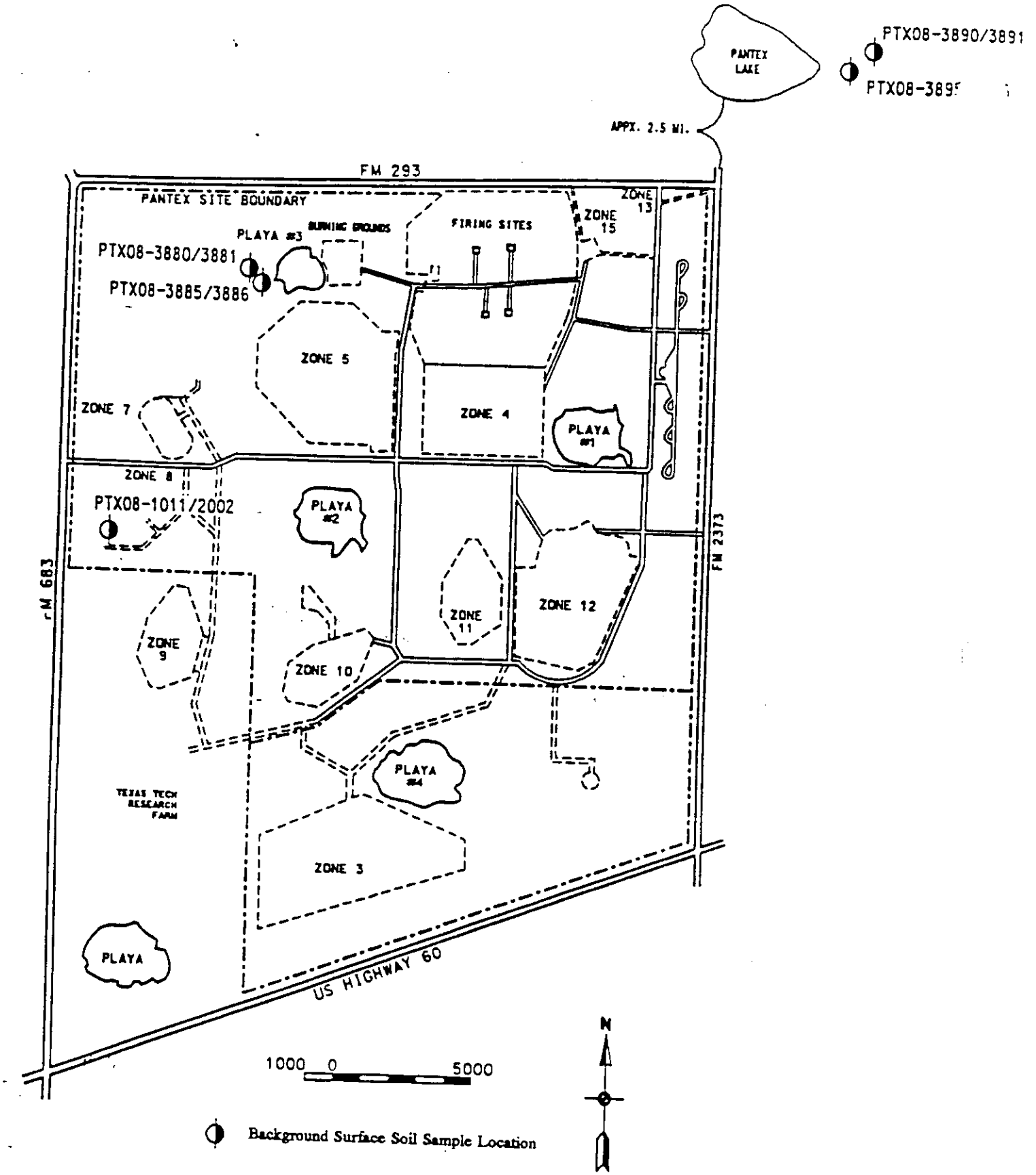


Figure 3-1. Pantex Plant Background Surface Soil Sample Locations

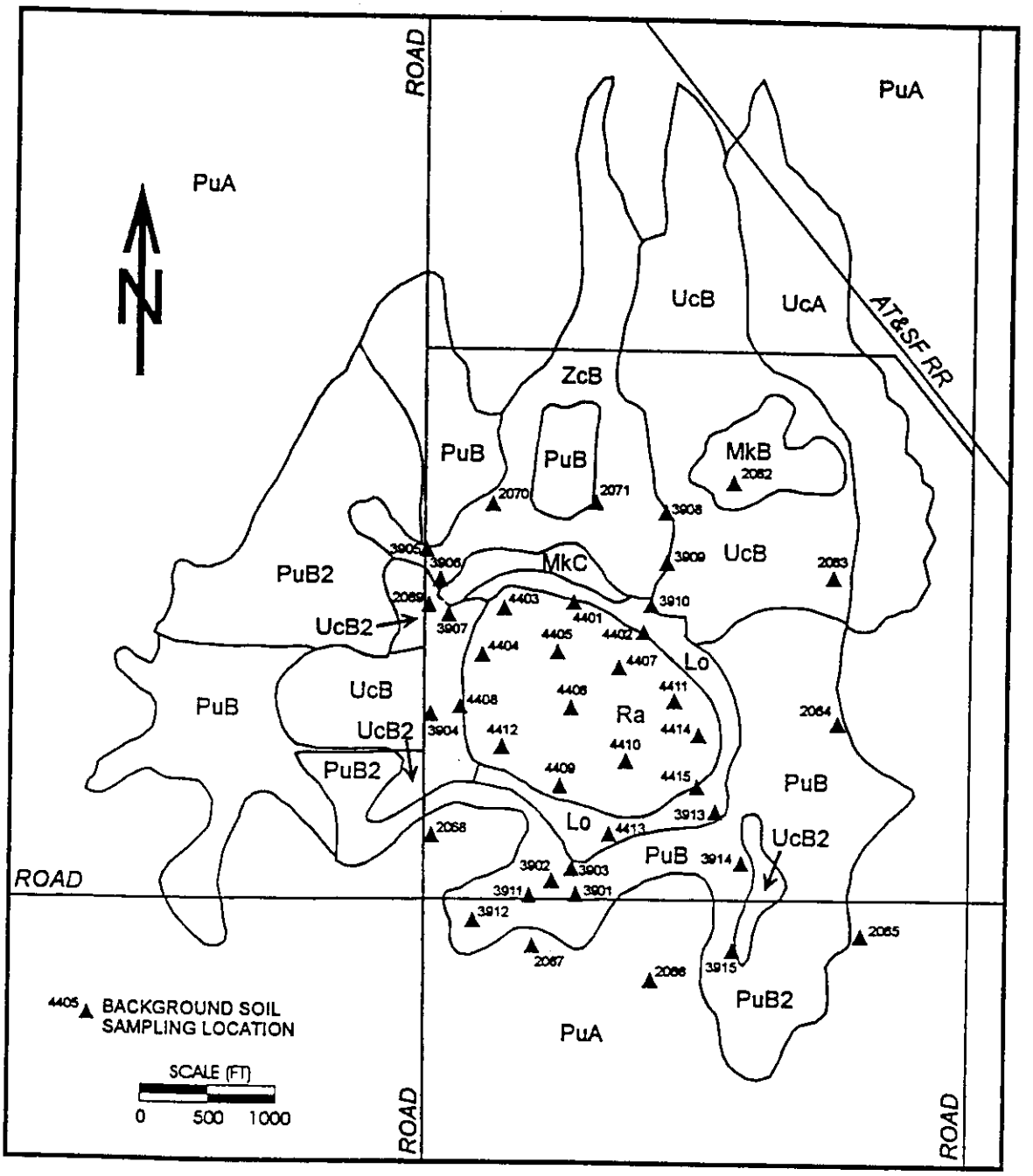


Figure 3-2 .

Surface soil sample locations at the Texas Department of Criminal Justice (TDCJ) playa. (Soil types from Carson County Soil Survey, USDA, 1962)

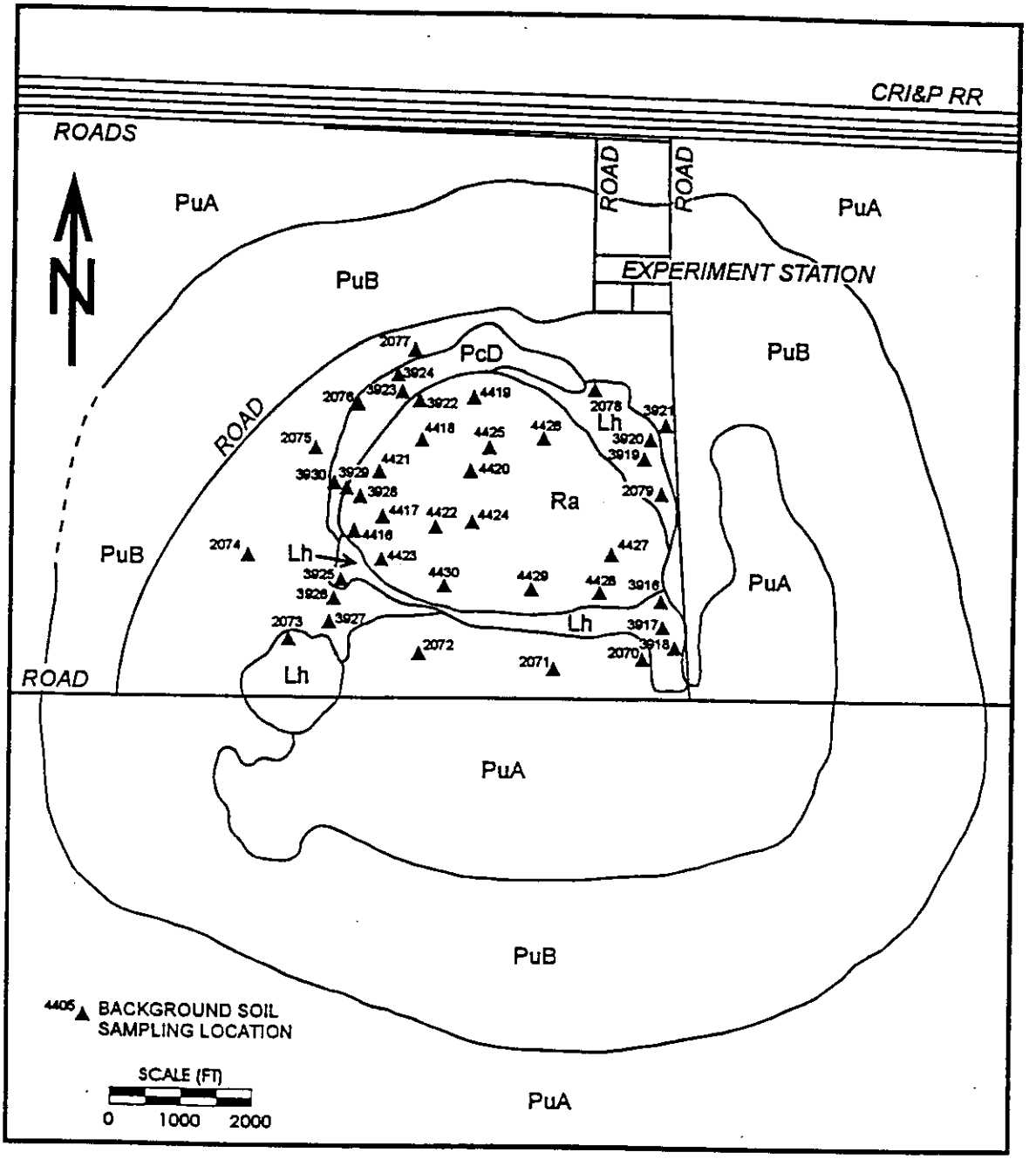


Figure 3-3

Surface soil sample locations at the Bushland playa.
(Soil types fron Potter County Soil Survey, USDA, 1980
and from Randall County Soil Survey, USDA, 1970)

A total of 27 samples resulted from the five soil borings. RRS 2 applies different criteria to the upper 2 ft to account for the inhalation/ingestion potential for contamination in that depth of soil. Samples were taken at various intervals ranging from an upper depth of 2-432 ft. Borings used were from the Ditches and Playas investigation and were numbered PTX08-2045, PTX08-2046, PTX08-2047, PTX08-2048, and PTX08-1011. Figure 3-4 presents a map showing the location of the background borings.

Background values for soils were, therefore, calculated two ways. The first included all data from 2–60 ft, and the second calculated background for 2–432 ft separately. Distinction at a depth of 60 feet was made, since this depth approximated the top of the caprock and the coarser, less plastic materials were below 60 ft. The results of those two calculations are shown in Table 3-2.

There is no significant difference between the values, and therefore, no advantage is gained by separating the deeper soil. Furthermore, in order for a unit separation to be meaningful, geologic interpretation would be required on every boring, and this subjective determination is unlikely to be made consistently by the many entities and contractors working at Pantex Plant.

Samples were analyzed for cation exchange capacity, nitrate and nitrite (as nitrogen), antimony, barium, beryllium, cadmium, total chromium, cobalt, copper, nickel, silver, strontium, thallium, vanadium, zinc, arsenic, hexavalent chromium, lead, mercury, selenium, pesticides/PCBs, volatile organics, semivolatile organics, and HE. Organics were not present in any samples above the PQLs, which was expected to be the case.

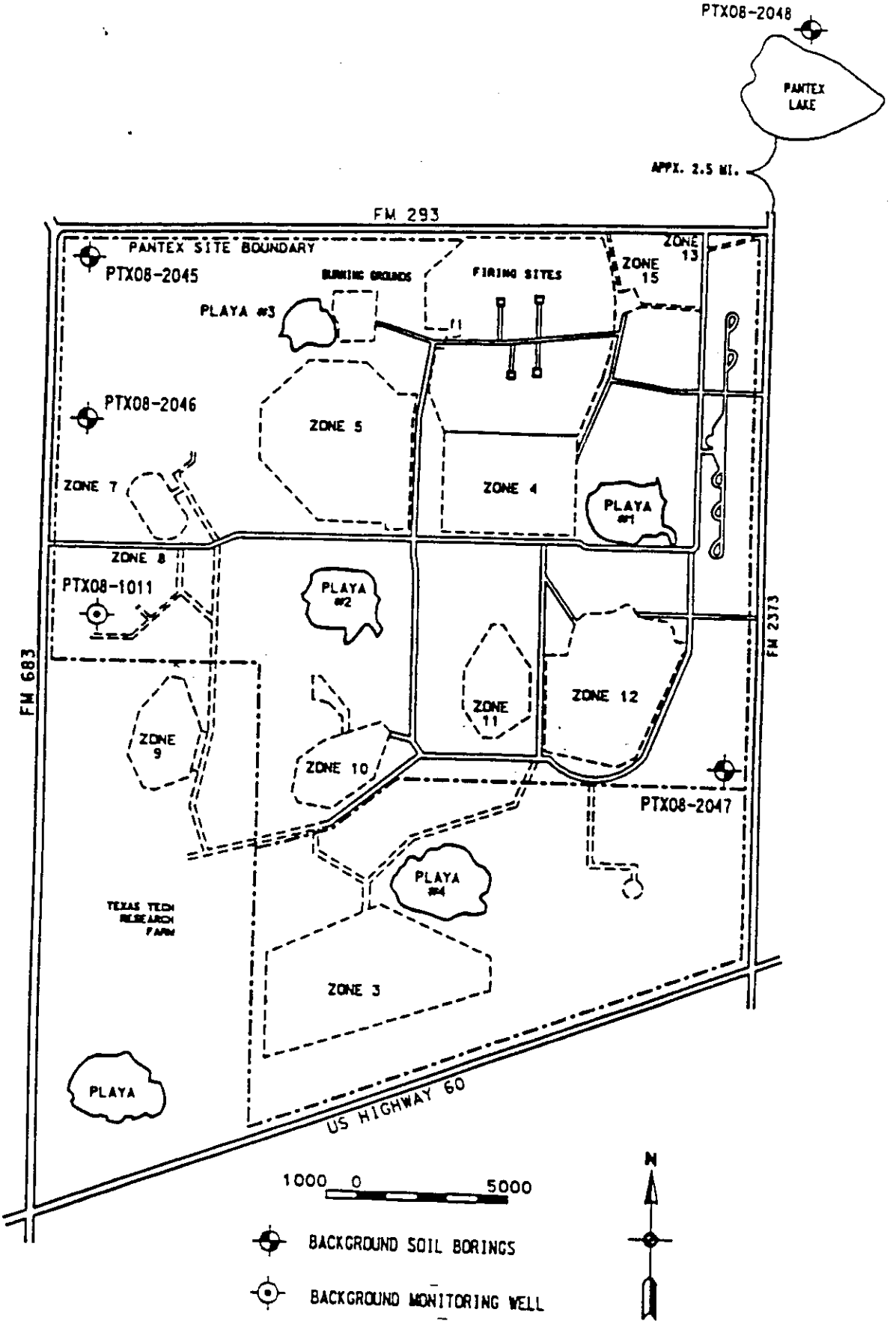


Figure 3-4 Pantex Plant Background Subsurface Soil Sample Locations

TABLE 3-2
COMPARISON OF 95% UPPER TOLERANCE LIMITS FOR SOIL—BASED ON 2-60 FT AND 2-432 FT
(All units in mg/kg)

Concentration at Depth/ Constituent	Type of Distribution	2–60 ft	2–432 ft
arsenic	normal	9.73	10.25
barium	nonparametric	780	780
beryllium	nonparametric	3.1	3.1
cadmium	nonparametric	2.0	2.0
chromium	nonparametric	69	69
copper	nonparametric	36	36
lead	normal	14.5	15.24
mercury	nonparametric	0.11	0.11
nickel	nonparametric	53	53
selenium	nonparametric	4.30	4.30
silver	nonparametric	4.0	4.0
zinc	nonparametric	160	160

1 DL = detection limit.

Table 3-3 presents only a summary of the final calculated background values (95% UTL) for the inorganics and the PQLs from common analytical methods. In all cases, the 95% UTL values were greater than the PQLs and were selected as the RRS 1 for soil. The governing values are shaded as shown in Table 3-3. As in Table 3-1, Table 3-3 presents the "Percent Detected" and the "Statistic Type." Furthermore, Table 3-3 presents the "Coverage" in percent as described in References 15 and 16. Appendix E presents a summary of the pesticide and inorganic data, the calculations of the UTL, and the data summary reports of the data used in the analyses.

TABLE 3-3
RISK REDUCTION STANDARD 1 FOR SUBSURFACE SOIL (2-432 ft)

Constituent	Percent Detected [1]	Statistic Type	UTL (mg/kg)	Coverage (%) [6]	PQL for Soil[7] (mg/kg)
antimony	29.6	nonparametric[5]	170	95	8.7
arsenic	92.6	normal[2]	10.3	95	.74
barium	100	lognormal[3]	1540	95	8.7
beryllium	74.1	lognormal	3.72	95	0.2
cadmium	0	nonparametric[4]	2.00	NA	0.8
chromium	100	nonparametric	69	89.5	1.4
hexavalent chromium	0	nonparametric[4]	0.3	NA	0.3
cobalt	100	nonparametric	32	89.5	1.7
copper	92.6	lognormal	48.6	95	4.3
lead	100	normal	15.2	95	8.4
mercury	74.1	nonparametric	0.11	89.5	0.1
nickel	100	lognormal	55.0	95	3.0
selenium	29.6	nonparametric[5]	4.30	95	0.45
silver	18.5	nonparametric[4]	4.0	95	1.4
strontium	100	nonparametric	690	89.5	10
thallium	22.2	nonparametric[5]	100.0	95	8.7
vanadium	100	nonparametric	150	89.5	1.7
zinc	100	lognormal	166	95	1.7
nitrite/ nitrate as N	14.3	nonparametric[5]	7.0	95	1.0

1 In all cases, there were 27 observations.
2 The K value for the normal distribution with 27 observations is 2.263.
3 The logarithms of the data were used in the calculations with a K value of 2.263.
4 When there were less than 10% positive detections or 50% or more of the data are detected but neither the assumption of normality nor lognormality can be made, the statistic type used was nonparametric. UTL was established as one times the maximum detection limit or the maximum detected value in the data set . DL = detection limit.
5 The nonparametric UTL is an order statistic and was selected as the highest measured value.
6 The coverage is calculated as described in References 15 and 16; the table is included in Appendix C.
7 See Appendix A for calculated PQL values.

3.1.3 RISK REDUCTION STANDARD 1 FOR GROUNDWATER

Data utilized in this report for the determination of groundwater background levels are derived solely from Ogallala Aquifer wells located in Potter and Carson counties (Appendix F). Background data for the perched aquifer will be established in the future. Data obtained from the Texas Water Development Board Ground Water Data System Report, dated April 13, 1994, and the Series 600 wells of the City of Amarillo Safe Drinking Act Well Surveys of 1991 and 1992 were screened to eliminate known "perched aquifer" and non-Ogallala Aquifer wells. Data that were associated with known industrial sites such as the ASARCO, located northeast of Amarillo, and the Panhandle Oil Field in northern Carson County were not used in the background-level determination due to known contamination (personal communication, William Mullican and Alan Fryar, TBEG, April 1994).

In general, no volatile, semivolatile, pesticide/PCB, herbicide, or HE compounds are naturally occurring, and the RRS 1 for those compounds can be considered as "less than the PQL." For that reason, only inorganic constituents are presented in Table 3-4. There is no weighting by flow rate, and the area of deleting of abnormally high values was utilized in the arithmetic averaging. No consideration for seasonal fluctuations was given. If a well had more than one data value for a particular constituent, a value was derived by averaging the sum of all values and assumed as equally weighted as another well that may have only one data value.

Table 3-4 presents only a summary of the final calculated background values (95% UTL) and the PQLs from common analytical procedures. The governing values are shaded in Table 3-4. Appendix F presents the data used, by constituent, and a summary of the statistical calculations performed.

The data analysis methods documented in Subsection 2.5 were applied to concentration data for a series of constituents. These data originate from up to 85 Ogallala Aquifer water samples, which were taken from city and other wells at locations in the vicinity of Pantex Plant purportedly unaffected by waste management or industrial activities. As a result, the data analysis leads to estimates of Plant background levels for these constituents. The background estimate for a given constituent corresponds to a 95% UTL on the concentration, or the value at which 95% of the concentrations from samples taken within this area (according to some underlying distribution) are expected to fall below this value with 95% confidence. Background levels for a total of 24 constituents were estimated in this procedure. This discussion presents the results of the background estimation for these constituents.

TABLE 3-4
ESTIMATED BACKGROUND LEVELS FOR SELECTED CONSTITUENTS FROM WATEI SAMPLING WITHIN THE OGALLALA AQUIFER

Constituent	N	UTL	Statistic Type	% Detected	p-value in Test for Normality	p-value in Test for Lognormality	PQL mg/L	% Coverage
Alkalinity	9	297.6 mg/L	Normality	100	0.139	0.366	ND[1]	95
Alpha	5	20.46 pCi/L	Normality	80.0	0.996	0.036	ND	95
Arsenic	45	0.004 mg/L	Nonparametric	66.7	0.025	0.001	0.005	93.6
Barium	45	0.432 mg/L	Nonparametric	100	<0.001	<0.001	0.04	93.6
Beta	5	18.57 pCi/l	Normality	100	0.129	0.149	ND	95
Bicarbonate	41	331.8 mg/L	Normality	100	0.844	0.351	ND	95
Calcium	67	77.83 mg/L	Lognormality	100	0.001	0.192	1.0	95
Carbonate	46	3.0 mg/L	Nonparametric[2]	4.35	<0.001	<0.001	ND	ND
Chlorides	85	151.0 mg/L	Nonparametric	100	<0.001	<0.001	ND	96.5
Chromium	44	0.005 mg/L	Nonparametric	77.3	0.005	<0.001	0.01	93.4
Fluoride	84	4.600 mg/L	Nonparametric	100	<0.001	<0.001	ND	96.5
Hardness	67	322.7 mg/L	Lognormality	100	<0.001	0.1501	ND	95
Iron	41	0.260 mg/L	Nonparametric	100	<0.001	<0.001	0.05	93
Magnesium	67	58.00 mg/L	Nonparametric	100	<0.001	0.002	1.0	95.6
Nitrate	84	16.20 mg/L	Nonparametric	100	<0.001	0.004	ND	96.5
pH	82	8.60	Nonparametric	100	<0.001	<0.001	ND	96.4
Potassium	58	7.00 mg/L	Nonparametric	100	0.005	0.001	0.03	94.9
Silica	66	76.00 mg/L	Nonparametric	100	<0.001	<0.001	ND	95.5
Sodium	68	71.33 mg/L	Nonparametric	100	<0.001	<0.001	1.0	95.7
Spc. Cond.	69	1050 umhoms	Nonparametric	100	<0.001	<0.001	ND	95.7
Strontium	8	2.173 mg/L	Normality	100	0.911	0.950	0.05	95
Sulfate	85	118.0 mg/L	Nonparametric	100	<0.001	<0.001	ND	96.5
TDS	67	557.0 mg/L	Nonparametric	100	<0.001	<0.001	ND	95.6
Zinc	44	0.286 μg/L	Nonparametric	90.9	<0.001	0.033	0.02	93.4

[1] ND=not determined.
[2] The non-parametric UTL is an order statistic and was selected as the highest measured value

The approach to estimating background levels for each constituent is documented in Subsection 2.5 and summarized in Figure 2-1. The estimates were obtained based on the distribution of observed concentrations and on the degree to which the concentrations were detected by the analytical procedure. Only one of the 24 constituents was detected in less than 10% of the samples; the procedure indicated that the estimated background level for this constituent was the constituent's detection limit. The remaining constituents were detected in over 50% of the reported samples (19 were detected in 100% of these samples), indicating that the estimated background levels for these constituents were based on whether the concentrations followed a normal distribution, a lognormal distribution, or neither of the two (i.e., nonparametric). The procedure indicated that the estimated 95% UTL for the appropriate distribution was the background-level estimate.

The estimated UTLs for the 24 constituents are presented in Table 3-4. This table illustrates that concentration data were available for as few as five samples for some of the constituents (e.g., alpha and beta), while other constituents have data for all 85 samples. In some instances, differences were observed between results for the city wells and results for the "other" wells. For example, all results for arsenic and chromium were not detected for the "other" wells, while results for the majority of city well samples were detected. Any differences in results between city and "other" wells (Appendix F) implies that the two areas differed in their underlying constituent concentration; such differences were not considered when estimating background levels. This issue raises the point that the estimated background levels from this procedure can only be interpreted in light of the type of samples from which the data originate.

Whereas the detection limit was set at 0.001 mg/L for arsenic, chromium, and carbonate, the detection limit for Zinc was 0.001 μg/L. A detection limit of 0.2 pCi/L existed for alpha. These limits were at or below all detected results for these constituents. All other constituents had 100% detected results. Whenever a result of "ND" or zero was reported for a given sample, the result was replaced by a random number between zero and the detection limit for the constituent. For example, 80% of the detected values were observed for gross alpha. Hence, one random number had to be generated between zero and the detection limit. A value of 0.162 was randomly generated and substituted for the ND value. The analysis then was carried out following the approach outlined above.

The first step to determining the background concentration estimate for a constituent with detected results greater than 50% was to test whether the concentration distribution closely resembled normality. This was done using the Shapiro-Wilk test. The significance levels of these tests are included in Table 3-4 for each constituent. If the p-value was above 0.05, then normality was assumed to hold. Otherwise, the test was repeated on the natural logarithms of the concentrations to test for

lognormality. The p-values of the tests for lognormality are also included in Table 3-4. If the p-value for lognormality was greater than 0.05, and if the p-value for normality was less than 0.05, lognormality was assumed to hold. If both p-value for normality and lognormality were less than 0.05, then neither distribution was deemed appropriate, and a nonparametric approach was taken to estimate the background level.

As a further indication of how well normality and lognormality held for a given constituent, normal and lognormal probability plots were constructed. These plots are located in Figures F-3 through F-26 (Appendix F). In these plots, the data were plotted versus normal or lognormal scores. If normality was a good estimate for the distribution, the normal probability plot would resemble a straight line. Similarly, if lognormality was a good estimate, then the lognormal probability plot would resemble a straight line. Therefore, these plots indicate the extent to which normality or lognormality estimated the underlying distribution of the constituent concentrations.

Table 3-4 shows that a nonparametric approach was taken to estimate the background level in 16 of the 24 constituents, while only five constituents used normal probability theory, and two constituents lognormality probability theory, to estimate background. The nonparametric approach indicated that the background level would be estimated by an order statistic of the sample data. If the level was to represent a 95% UTL for the distribution, the table on page C-5 of Appendix C indicated that, for sample sizes between 59 and 95, this order statistic corresponded to the maximum observed concentration. However, if less than 59 data points were reported for a given constituent, a 95% UTL could not be realized. In this situation, the maximum concentration was provided as the estimated background level, but the small sample size implies that the level may represent a UTL with coverage substantially less then 95%. This is represented as % Coverage in Table 3-4. This statistical conclusion should be considered when interpreting the background concentration estimate when a nonparametric procedure was applied.

Figures F-27 through F-50 in Appendix F present boxplots and bar charts of the observed sample concentrations for each constituent. The boxplots display percentiles and other statistics, as well as extreme data points. The lower and upper limits of the "box" portion of the boxplot represent the 25th and 75th percentiles, respectively, of the observed data distribution. The length of the box represents the data's interquartile range (IQR), or the difference between the 25th and 75th percentiles, which is an indicator of data variability. The line within the box is the 50th percentile, or median. The diamond symbol is the arithmetic mean. Lines extend from the top (or bottom) of the box to the value of the most extreme data point, which falls within 1.5 IQRs from the box. Each data point extending

from 1.5 to 3.0 IQRs from the box is plotted with a "+" symbol, while each data point extending beyond 3.0 IQRs from the box is plotted with a "*" symbol.

The boxplots and bar charts illustrate that many of the constituents have sample concentration distributions that are highly skewed toward the detection limit, while occasional high data values are observed in the upper tails of the distribution. Such a departure from the symmetric, bell-shaped distribution implies that the distribution differs considerably from the normal distribution and that a lognormal distribution is more appropriate. However, in most of these cases, the extent of skewness caused lognormality to be an unsatisfactory estimate of the distribution. As a result, the nonparametric approach, which does not require conformance to a specific distribution type, was necessary in estimating background levels of these constituents.

As a final check on the validity of the calculated UTLs presented in Table 3-4, the calculated background chemistry data were reviewed for general chemical consistency. Overall the chemistry is as expected for a hard-water aquifer. The inorganic carbon distribution as 100% carbonate is consistent with the pH of 8.6. The salt concentration is consistent with the reported conductivity.

A balance of the number of chemical equivalents of cations and anions is a fundamental requirement of "real" data. A calculation of the equivalents of cationic and anionic species was performed for an assumed chemical speciation as indicated in Table 3-5. The total equivalents of anions are then subtracted from the total equivalents of cations. The expected value of the difference between cation and anion equivalent is zero. The Cation/Anion Analysis for each individual well is shown in Table 3-6. Figure 3-5 graphically represents the data shown in Table 3-6. The chemical data for the background aquifer as presented show an excellent balance of cations and anions. Good closure of the cation and anion equivalents shows that the chemical concentration data are self-consistent as illustrated in Figure 3-6.

TABLE 3-5
CALCULATION OF THE EQUIVALENTS OF CATIONS AND ANIONS SPECIES FOR THE OGALLALA AQUIFER

Constituent	Estimated Concentration (mg/L)	Assumed Dominant Species	Charge	Concentration of Dominant Species (meq/L)
Arsenic	0.004	HAs04-2	-2	-0.00011
Barium	0.432	Ba+2	2	0.00629
Bicarbonate	331.800	HCO3-	-1	-5.43836
Calcium	77.830	Ca+2	2	3.88373
Carbonate	0.001	CO3-2	-2	-0.00003
Chlorides	151.000	Cl-	-1	-4.25916
Chromium	0.005	Cr(OH)3	0	0.00000
Fluoride	4.600	F-	-1	-0.24213
Iron	0.260	Fe(OH)2	0	0.00000
Magnesium	58.000	Mg+2	2	4.77268
Nitrate	16.200	NO3-	-1	-0.26126
Potassium	7.000	K+	1	0.17904
Silica	76.000	H4SiO4	0	0.00000
Sodium	71.330	Na+	1	3.10265
Strontium	2.173	Sr+2	2	0.04960
Sulfate	118.000	SO4-2	-2	-2.45680
Zinc	0.286	Zn+2	2	0.00875
Total				-0.65511

3.2 RISK REDUCTION STANDARD 2

3.2.1 RISK REDUCTION STANDARD 2 FOR SURFACE AND SUBSURFACE SOIL

Per Subsection 2.5.2, Table 3-7 presents the soil RRS 2 for both "GWP-Ind" and "SAI-Ind". For those constituents not listed in 30 TAC 335.568, Appendix II, provisions are made for calculation of the standard in 335.559(g)(1) and (2). Essentially, the MSC for soil is 100 times the MSC for groundwater and, again, it should in no case be less than the PQL. The shading in the table denotes the governing MSC. If the SAI-Ind value is lower than the GWP-Ind, both MSCs are applicable, one

Figure 3-5 Graphical Representation of Charge Equivalent Data from 52 Ogallala Wells Used in the Data Set

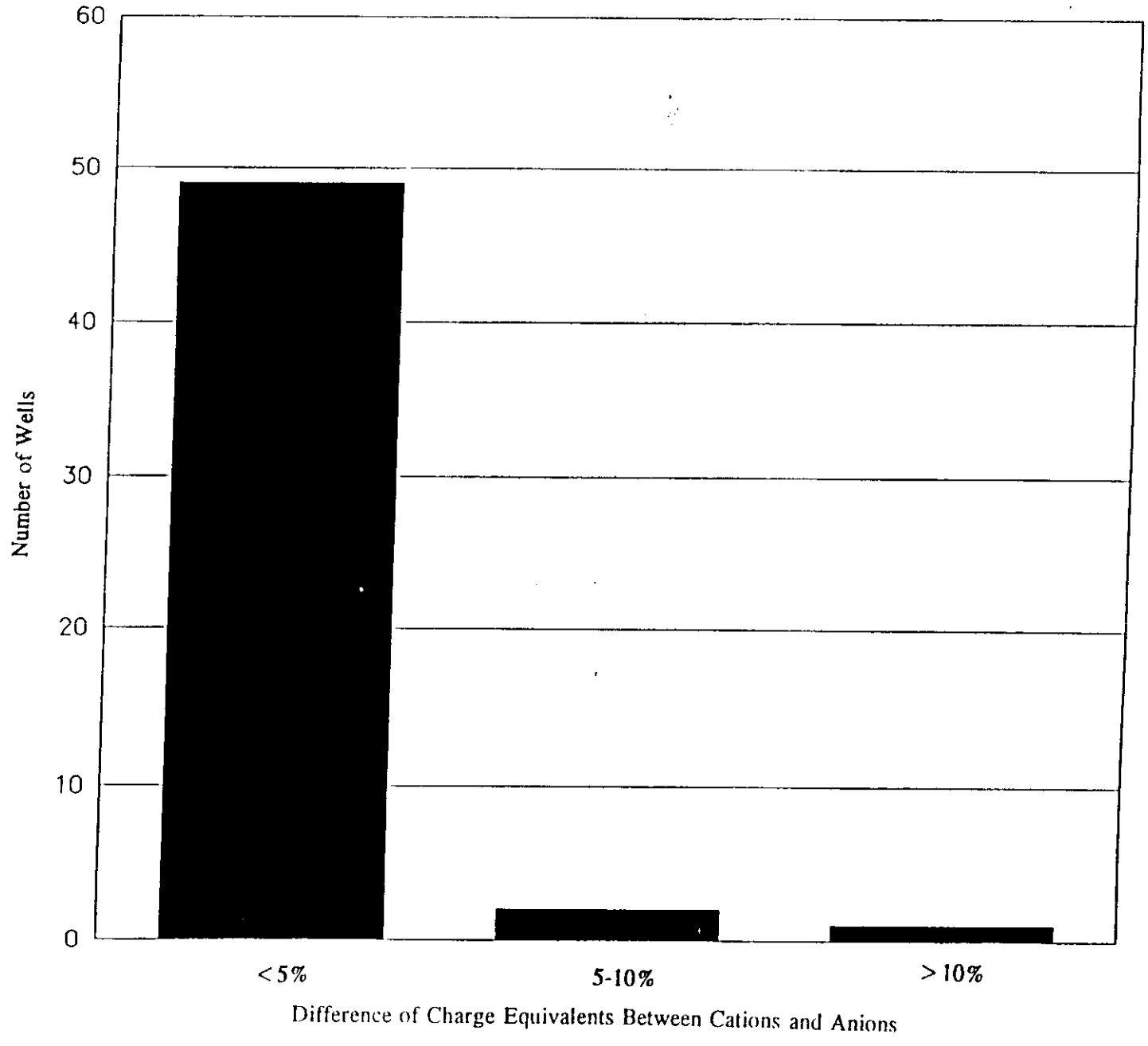


Figure 3-4

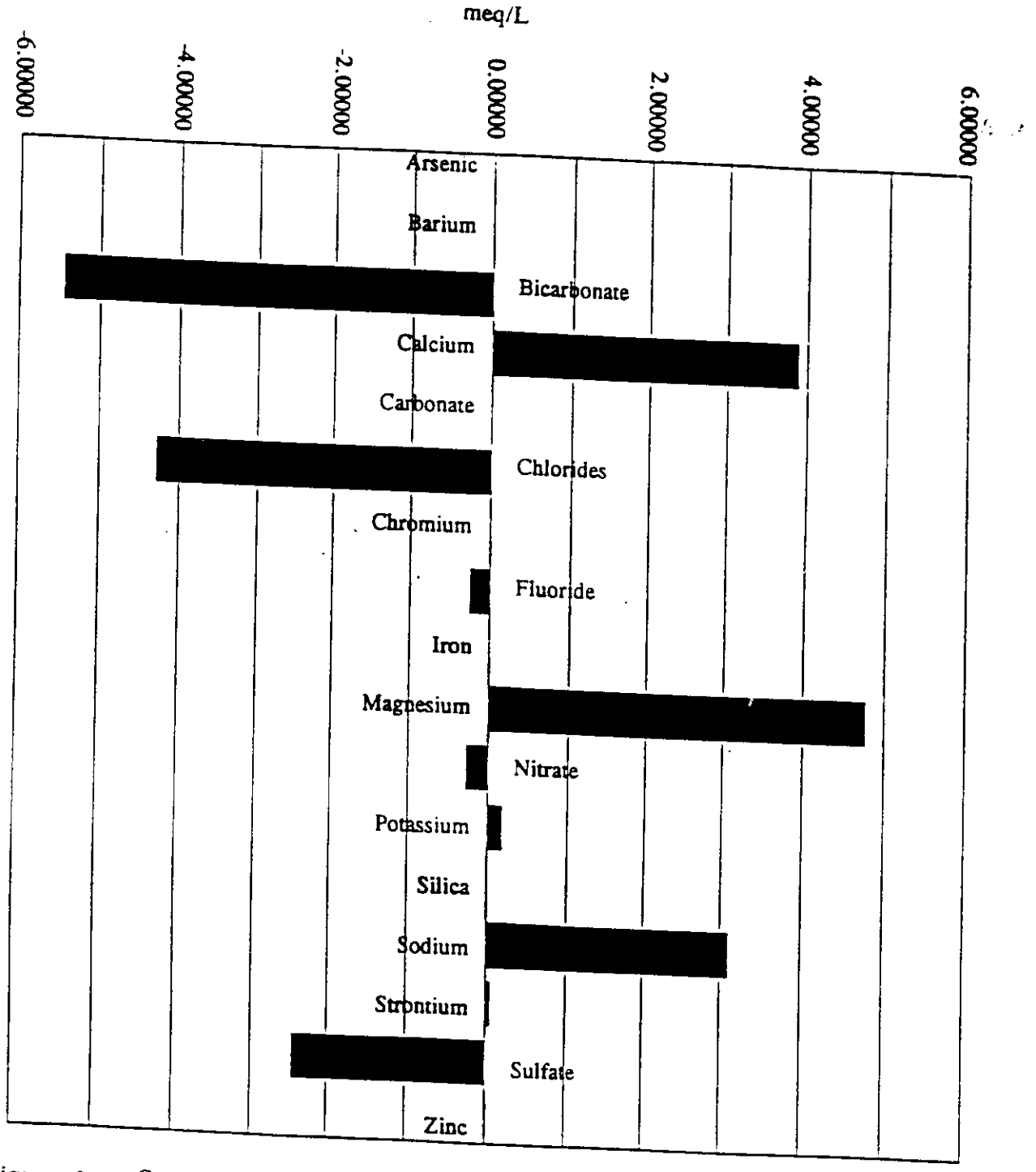


Figure 3-6 Concentration of Dominant Species for the Ogallala Aquifer

Figure 3-6

(SAI-Ind) to the materials from 0–2 ft in depth and the other, (GWP-Ind), to the materials greater than 2 ft in depth. The PQLs were determined in accordance with Subsection 2.2 and Appendix A. For total 1,2 dichloroethylene, the assumption was made that the total 1,2 dichloroethylene consisted of only cis 1,2 dichloroethylene, and its more stringent MSC was used. For compounds not listed in the Risk Reduction Rule, the standards were calculated in accordance with the equations provided. Calculations are shown in Appendix G.

Comparison to the RRS 2 value can be made with concentrations from discrete samples from the affected media or with the UTL of the sample concentrations from the affected media (See Subsection 2.5.1). A comparison table is included in Subsection 3.3.

TABLE 3-7
RISK REDUCTION STANDARD 2 FOR SURFACE AND SUBSURFACE SOIL

Constituent	PQL (mg/kg)	GWP-Ind (entire soil column) (mg/kg)	SAI-Ind (upper 2 feet) (mg/kg)
acenaphthene	0.66	613	44300[1]
acetone	0.01	1020	4160[1]
acetonitrile	0.01	61.3	12300
acetophenone	ND[2]	1020	81500
acrolein	ND	204	20400
acrylamide	ND	0.00636	1.27
acrylonitrile	ND	0.0530	0.144[1]
alachlor	ND	0.200	71.0
aldicarb	ND	0.300	409
aldicarb sulfone	ND	0.200	613
aldicarb sulfoxide	ND	0.400	409
aldrin	0.0027	0.00168	0.336
aluminum phosphide	ND	4.09	818
aniline	ND	5.02	0.0480[1]
anthracene	0.66	3070	150000
antimony	8.7	0.600	818
arsenic	.74	5.00	3.27
atrazine	ND	0.300	258
barium	8.7	200	137000
benzene	0.005	0.500	1.62[1]
benzidine	ND	0.000124	0.0249
benzo(a)anthracene	0.66	0.01	ND
benzo(a)pyrene	0.66	0.01	ND
benzo(b)fluoranthene	0.66	0.01	ND

TABLE 3-7
RISK REDUCTION STANDARD 2 FOR SURFACE AND SUBSURFACE SOIL

Constituent	PQL (mg/kg)	GWP-Ind (entire soil column) (mg/kg)	SAI-Ind (upper 2 feet) (mg/kg)
benzo(k)fluoranthene	0.66	0.02	ND
benzoic acid	3.3	40,880	ND
beryllium	0.2	0.400	1.33
biphenyl	ND	511	11100[1]
bis (chloroethyl) ether	0.66	0.0260	0.377[1]
bis (2-chloroisopropyl) ether	0.66	4.09	90.5
bis (2-ethylhexyl) phthalate	0.66	2.04	409
bromodichloromethane	0.005	10.0	0.946[1]
bromoform	0.005	10.0	724
bromomethane	0.01	14.3	24.7[1]
2-sec-butyl-4,6-dinitrophenol	ND	10.2	2040
cadmium	0.8	0.500	1020
carbofuran	ND	4.00	10200
carbon disulfide	0.10	1020	23.4[1]
carbon tetrachloride	0.005	0.500	0.513[1]
chlordane	0.009	0.200	4.40
p-chloroaniline	ND	40.9	8180
chlorobenzene	0.005	10.0	256[1]
chlorobenzilate	ND	204	40900
chloroethane	0.01	204	23000[1]
chloroform	0.005	10.0	0.504[1]
2-chloronaphthalene	0.66	818	164000
2-chlorophenol	0.66	51.1	10200
chromium (total)	1.4	10.0	5110
chromium VI	0.3	10.0	5110
chrysene	0.66	0.02	ND
cyanide	ND	20.0	40900
cyclo-tetra methylene tetranitramine (HMX)	2.2	511	ND
cyclo-trimethylene trinitramine (RDX)	1.0	2.6	ND
1,1,2,2-dichloroethylidene bis 4-chlorobenzene (DDD)	0.0074	0.119	40900
1,1-dichloroethylidene bis 4-chlorobenzene (DDE)	0.0027	0.0841	23.8
p,p-dichlorodiphenyl trichloroethane (DDT)	0.0080	0.0841	16.8

TABLE 3-7
RISK REDUCTION STANDARD 2 FOR SURFACE AND SUBSURFACE SOIL

Constituent	PQL (mg/kg)	GWP-Ind (entire soil column) (mg/kg)	SAI-Ind (upper 2 feet) (mg/kg)
di-n-butyl phthalate	ND	1020	204000
di-n-octyl phthalate	0.66	204	40900
di-benz(a,h)anthracene	0.66	0.03	ND
1,2-dibromo-3-chloropropane	ND	0.0200	4.09
dibromochloromethane	0.005	10.0	681
1,2-dichlorobenzene	0.66	60.0	8390[1]
1,3-dichlorobenzene	0.66	60.0	9990[1]
1,4-dichlorobenzene	0.66	7.50	138[1]
dichlorodifluoromethane	0.005	2040	47.9[1]
1,1-dichloroethane	0.005	1020	20400[1]
1,2-dichloroethane	0.005	0.500	0.505[1]
1,1-dichloroethylene	0.005	0.700	0.872[1]
cis-1,2-dichloroethylene	0.005	7.00	108[1]
trans-1,2-dichloroethylene	0.005	10.0	256[1]
total 1,2-dichloroethylene	0.005	7.0	108[1]
2,4-dichlorophenol	0.66	30.7	6130
2,4-dichlorophenoxyacetic acid	ND	7.00	2040
1,2-dichloropropane	0.005	0.500	0.843[1]
dieldrin	0.0013	0.00179	0.357
diethyl phthalate	0.66	8180	NHHB[3]
diethyl hexyl adipate	ND	50.0	47700
dimethoate	ND	2.04	409
2,4-dimethyl phenol	0.66	204	40900
1,3-dinitrobenzene	0.25	1.02	204
2,4-dinitrophenol	3.3	20.4	4090
1,4-dioxane	ND	2.60	23.1[1]
diphenylamine	ND	256	5110
1,2-diphenylhydrazine	ND	0.0358	7.15
disulfoton	ND	0.409	81.8
2,4-dinitrotoluene (DNT)	0.25	20.4	ND
2,6 DNT	0.26	1022	ND
endosulfan	0.0013	0.511	102
endothall	ND	10.0	40900
endrin	0.004	0.200	613
2-ethoxyethanol	ND	4090	817000

TABLE 3-7
RISK REDUCTION STANDARD 2 FOR SURFACE AND SUBSURFACE SOIL

Constituent	PQL (mg/kg)	GWP-Ind (entire soil column) (mg/kg)	SAI-Ind (upper 2 feet) (mg/kg)
2-ethoxyethanol acetate	ND	3070	613000
ethyl benzene	0.005	70.0	17000[1]
ethylene dibromide	ND	0.00500	0.0453[1]
ethylene glycol	ND	20400	NHHB[3]
ethylene oxide	ND	0.0280	0.151[1]
fuoranthene	0.66	409	81800
fluorene	0.66	409	38700[1]
fluoride	ND	400	123000
formaldehyde	ND	2040	204000
heptachlor	0.002	0.0400	1.27
heptachlor epoxide	0.056	0.0200	0.629
hexachlorobenzene	0.66	0.100	3.57
hexachlorobutadiene	0.66	3.67	733
alpha hexachlorocyclohexane	0.002	0.00454	0.908
beta hexachlorocyclohexane	0.004	0.159	31.8
gamma hexachlorocyclohexane	0.0027	0.0200	613
hexachloroethane	0.66	20.4	4090
HMX	2.2	≥511	ND
indeno(1,2,3-cd)pyrene	0.66	0.04	ND
isobutyl alcohol	0.10	3070	613000
lead	8.4	1.50	1000
mercury	0.1	0.200	613
methomyl	ND	256	51100
2-methoxyethanol	ND	40.9	8180
methoxychlor	0.118	4.00	10200
methoxyethanol acetate	ND	20.4	4090
methyl ethyl ketone	ND	511	14000[1]
methyl isobutyl ketone	ND	511	102000
methyl methacrylate	0.05	818	663[1]
methylene chloride	0.005	0.500	13.8[1]
2-methylphenol (o-cresol)	ND	511	51100
3-methylphenol (m-cresol)	ND	511	51100
4-methylphenol (p-cresol)	ND	511	51100
napthalene	0.66	409	7720[1]
nickel	3.0	10.0	20400

TABLE 3-7
RISK REDUCTION STANDARD 2 FOR SURFACE AND SUBSURFACE SOIL

Constituent	PQL (mg/kg)	GWP-Ind (entire soil column) (mg/kg)	SAI-Ind (upper 2 feet) (mg/kg)
nitrate	ND	1000	NHHB[3]
nitrite	ND	100	20400
nitrate/nitrite as N	1.0	1000	20400
nitrobenzene	0.26	5.11	106[1]
n-nitroso-methyl-ethyl-amine	ND	0.00130	0.260
n-nitroso-di-n-propylamine	0.66	0.00409	0.817
n-nitrosodiethylamine	ND	0.000191	0.0381
n-nitrosodimethylamine	ND	0.000561	0.112
n-nitrosopyrrolidine	ND	0.0136	2.72
2-nitrotoluene	0.25	102	ND
3-nitrotoluene	0.25	102	ND
4-nitrotoluene	0.25	102	ND
pentachloronitrobenzene	ND	1.10	220
pentachlorophenol	3.3	0.100	47.7
phenol	ND	6130	NHHB[3]
phthalic anhydride	ND	20400	NHHB[3]
polychlorinated biphenyls (PCBs)	0.044	0.0500	25.0
pronamide	ND	767	153000
pyrene	0.66	307	61000
pyridine	ND	10.2	2040
RDX	1.0	2.6	ND
selenium	0.45	5.00	10200
silver	1.4	51.1	10200
strontium	10	6,132	ND
strychnine	ND	3.07	613
styrene	0.005	10.0	191
1,2,4,5-tetrachlorobenzene	ND	3.07	613
1,1,1,2-tetrachloroethane	0.005	11.0	62.9[1]
1,1,2,2-tetrachloroethane	0.005	1.43	11.7[1]
1,1,2,2-tetrachloroethylene	0.005	0.500	207[1]
2,3,4,6-tetrachlorophenol	ND	307	61300
tetraethyl dithiopyrophosphate	ND	5.11	1020
thallium	8.7	.2	ND
toluene	0.005	100	3630[1]
toxaphene	0.161	0.300	5.20

TABLE 3-7
RISK REDUCTION STANDARD 2 FOR SURFACE AND SUBSURFACE SOIL

Constituent	PQL (mg/kg)	GWP-Ind (entire soil column) (mg/kg)	SAI-Ind (upper 2 feet) (mg/kg)
2,4,5-TP (silvex)	ND	5.00	16400
1,2,4-trichlorobenzene	0.66	7.00	828[1]
1,1,1-trichloroethane	0.005	20.0	14000[1]
1,1,2-trichloroethane	0.005	0.500	16.2[1]
trichloroethylene	0.005	0.500	2.85[1]
trichlorofluoromethane	ND	3070	8.36[1]
2,4,5-trichlorophenol	0.66	1020	10400[1]
2,4,6-trichlorophenol	0.66	2.60	520
2,4,5-trichlorophenoxyacetic acid	ND	102	20400
1,1,2-trichloropropane	ND	51.1	10200
1,2,3-trichloropropane	0.005	61.3	12300
1,3,5-trinitrobenzene	0.25	0.511	102
2,4,6-trinitrotoluene	0.25	5.1	ND
vanadium	1.7	30.7	ND
vinyl acetate	0.05	10200	2040000
vinyl chloride	0.01	0.200	0.0241[1]
xylene	0.005	1000	5800[1]
zinc	1.7	3066	ND

1 *The sum of concentrations of the volatile organic compounds in vapor phase in soil shall not exceed 1000 ppm by weight or volume.*
2 *ND=not determined.*
3 *NHHB = not human health-based. The SAI-Ind MSC for this compound exceeds 10 e+6 ppm, which means it is not toxic to humans when exposed to soil under these assumptions.*

3.2.2 RISK REDUCTION STANDARD 2 FOR GROUNDWATER

Per Subsection 2.5.2, Table 3-8 presents the RRS 2 for nonresidential groundwater. For total 1,2 dichloroethylene, the assumption was made that the total 1,2 dichloroethylene consisted of only cis 1,2 dichloroethylene, and its more stringent MSC was used. The PQLs were determined in accordance with Subsection 2.2 and Appendix A. The factors 3.36 and 2.8 are used to adjust the MSC from residential to nonresidential exposure, in accordance with 30 TAC 335.559. The shading in the table denotes the governing MSC. In addition, the quality of the groundwater at the facility boundaries and at the boundaries of areas of excessation must be protective for residential exposure. For compounds not listed in Appendix II of 30 TAC 335.568 standards were calculated in accordance with the equations included in that appendix. Calculations are shown in Appendix G.

Comparison to the RRS 2 value can be made with concentrations from discrete samples from the affected media or with the UTL of the sample concentrations from the affected media (see Subsection 2.5.1). A comparison table is given in the next section.

TABLE 3-8
RISK REDUCTION STANDARD 2 FOR GROUNDWATER

Potential Constituents	CAS #	PQL (mg/L)	Toxicity Class/Industrial Exposure factor[1]	GW-Res MSC (mg/L)	GW-Ind MSC (mg/L)
acenaphthene	83-32-9	0.2	NA, 2.8	2.19	6.13
acetone	67-64-1	0.1	D, 2.8	3.65	10.2
acetonitrile	75-05-8	0.1	D, 2.8	0.219	0.613
acetophenone	98-86-2	0.01	D, 2.8	3.65	10.2
acrolein	107-02-8	0.005	NA, 2.8	0.730	2.04
acrylamide	79-06-1	ND	B, 3.36	0.0000189	0.000064
acrylonitrile	107-13-1	0.005	B, 3.36	0.000158	0.00053
alachlor	15972-60-8	ND	B, 3.36	0.002 MCL	0.002
aldicarb	116-06-3	ND	D, 2.8	0.003 MCL	0.003
aldicarb sulfone	1646-88-4	ND	D, 2.8	0.002 MCL	0.002
aldicarb sulfoxide	1646-88-3	ND	D, 2.8	0.004 MCL	0.004
aldrin	309-00-2	0.00004	B, 3.36	0.000005	0.0000
aluminum phosphide	20859-73-8	ND	D, 2.8	0.0146	0.041
aniline	62-53-3	0.001	B, 3.36	0.0149	0.0502
anthracene	120-12-7	0.2	NA, 2.8	11.0	30.7
antimony	7440-36-0	0.003	D, 2.8	0.006 MCL	0.006
arsenic	7440-38-2	0.005	A, 3.36	0.05 MCL	0.05
atrazine	1912-24-9	ND	C, 3.36	0.003 MCL	0.003
barium	7440-39-3	0.04	D, 2.8	2 MCL	2
benzene	71-43-2	0.005	A, 3.36	0.005 MCL	0.005
benzidine	92-87-5	ND	A, 3.36	0.00000037	0.0000012
benzo(a)anthracene	56-55-3	0.01		0.0001 [4]	0.0001
benzo(a)pyrene	50-32-8	0.01		0.0002 MCL	0.0002
benzo(b)fluoranthene	205-99-2	0.01		0.0002 [4]	0.0002
benzo(k)fluoranthene	207-98-9	0.01		0.0002 [4]	0.0002
benzoic acid	65-85-0	0.05			408.8
beryllium	7440-41-7	0.002	B, 3.36	0.004 MCL	0.004
biphenyl	92-52-4	ND	D, 2.8	1.83	5.11
bis (2-chloroethyl) ether	111-44-4	0.01	B, 3.36	0.0000774	0.00026
bis (2-chloroisopropyl) ether	39638-32-9	0.01	C, 3.36	0.0122	0.04[1]
bis (2-ethylhexyl) phthalate	117-81-7	0.02	B, 3.36	0.00608	0.02

TABLE 3-8
RISK REDUCTION STANDARD 2 FOR GROUNDWATER

Potential Constituents	CAS #	PQL (mg/L)	Toxicity Class/Industrial Exposure factor[1]	GW-Res MSC (mg/L)	GW-Ind MSC (mg/L)
bromodichloromethane	75-27-4	0.001	B, 3.36	0.1 MCL	0.1
bromoform	75-25-2	0.005	B, 3.36	0.1 MCL	0.1
bromomethane	74-83-9	0.01	D, 2.8	0.0511	0.143
2-sec-butyl-4,6-dinitrophenol	88-85-7	0.01	D, 2.8	0.0365	0.102
cadmium	7440-43-9	0.005	D, 2.8	0.005 MCL	0.005
carbofuran	1563-66-2	0.01	D, 2.8	0.04 MCL	0.04
carbon disulfide	75-15-0	0.005	D, 2.8	3.65	10.2
carbon tetrachloride	56-23-5	0.005	B, 3.36	0.005 MCL	0.005
chlordane	57-74-9	0.00014	B, 3.36	0.002 MCL	0.002
p-chloroaniline	106-47-8	0.02	D, 2.8	0.146	0.409
chlorobenzene	108-90-7	0.005	D, 2.8	0.1 MCL	0.1
chlorobenzilate	510-15-6	0.01	D, 2.8	0.730	2.04
chloroethane	75-00-3	0.01	NA, 2.8	0.730	2.04
chloroform	67-66-3	0.005	B, 3.36	0.1 MCL	0.1
2-chloronapthalene	91-58-7	0.01	D, 2.8	2.92	8.18
2-chlorophenol	95-57-8	0.01	D, 2.8	0.183	0.511
chromium (total)	7440-47-3	0.01	NA, 2.8[2]	0.1 MCL	0.1
chromium VI	7440-47-3	0.005	NA, 2.8[2]	0.1 MCL	0.1
chrysene	218-01-9	0.01		0.0002 [4]	0.0002
m-cresol	108-39-4	0.01	NA, 2.8[2]	1.83	5.11
o-cresol	95-48-7	0.01	NA, 2.8[2]	1.83	5.11
p-cresol	106-44-5	0.01	NA, 2.8[2]	1.83	5.11
cyanide	57-12-5	0.04	D, 2.8	0.2 MCL	0.2
DDD	72-54-8	0.00011	B, 3.36	0.000355	0.0012
DDE	72-55-9	0.00004	B, 3.36	0.00025	0.00084
DDT	50-29-3	0.00012	B, 3.36	0.00025	0.00084
di-n-butylphthalate	84-74-2	0.01	D, 2.8	3.65	10.2
di-n-octylphthalate	117-81-7	0.01	NA, 2.8	0.73	2.04
di-benz(a,h)anthracene	53-70-3	0.01		0.0003 [4]	0.0003
1,2-dibromo-3-chloropropane	96-12-8	0.005	B, 3.36	0.0002 MCL	0.0002
dibromochloromethane	124-48-1	0.005	C, 3.36	0.1 MCL	0.1
1,2-dichlorobenzene	95-50-1	0.01	D, 2.8	0.6 MCL	0.6
1,3-dichlorobenzene	541-73-1	0.01	D, 2.8	0.6 MCL	0.6
1,4-dichlorobenzene	106-46-7	0.01	C, 3.36	0.075 MCL	0.075
dichlorodifluoromethane	75-71-8	0.005	D, 2.8	7.3	20.4

TABLE 3-8
RISK REDUCTION STANDARD 2 FOR GROUNDWATER

Potential Constituents	CAS #	PQL (mg/L)	Toxicity Class/Industrial Exposure factor[1]	GW-Res MSC (mg/L)	GW-Ind MSC (mg/L)
1,1-dichloroethane	75-34-3	0.005	NA, 2.8[2]	3.65	10.2
1,2-dichloroethane	107-06-2	0.005	B, 3.36	0.005 MCL	0.005
1,1-dichloroethylene	75-35-4	0.005	C, 3.36	0.007 MCL	0.007
cis-1,2-dichloroethylene	156-59-2	0.005	D, 2.8	0.07 MCL	0.07
trans-1,2-dichloroethylene	156-60-5	0.005	D, 2.8	0.1 MCL	0.1
total 1,2-dichloroethylene	75-35-4	0.005	D, 2.8	0.07 MCL	0.07
2,4-dichlorophenol	120-83-2	0.01	D, 2.8	0.11	0.307
2,4-dichlorophenoxyacetic acid	94-75-7	ND	D, 2.8	0.07 MCL	0.07
1,2-dichloropropane	78-87-5	0.005	B, 3.36	0.005 MCL	0.005
dieldrin	60-57-1	0.00002	B, 3.36	0.00000532	0.0000179
diethyl phthalate	84-66-2	0.01	D, 2.8	29.2	81.8
diethylhexyl adipate	103-23-1	ND	C, 3.36	0.5 MCL	0.5
dimethoate	60-51-5	0.02	D, 2.8	0.0073	0.0204
2,4-dimethyl phenol	105-67-9	0.01	D, 2.8	0.73	2.04
1,3-dinitrobenzene	99-65-0	0.00011	D, 2.8	0.00365	0.01
2,4-dinitrophenol	51-28-5	0.05	D, 2.8	0.073	0.204
1,4-dioxane	123-91-1	0.15	B, 3.36	0.00774	0.026
diphenylamine	122-39-4	0.01	D, 2.8	0.913	2.56
1,2-diphenyhydrazine	122-66-7	ND	B, 3.36	0.000106	0.000358
disulfoton	298-04-4	0.002	D, 2.8	0.00146	0.00409
2,4-DNT	121-14-2	0.006	D, 2.8	0.073	0.204
2,6-DNT	606-20-2	0.01	D, 2.8	3.65	10.22
endosulfan	115-29-7	0.00014	D, 2.8	0.00183	0.00511
endothall	145-73-3	ND	S, 2.8	0.1 MCL	0.10
endrin	72-20-8	0.00006	D, 2.8	0.002 MCL	0.002
2-ethoxy ethanol	110-80-5	ND	NA, 2.8	14.6	40.9
2-ethoxy ethanol acetate	111-15-9	ND	NA, 2.8	11	30.7
ethyl benzene	100-41-4	0.005	D, 2.8	0.7 MCL	0.7
ethylene dibromide	106-93-4	0.005	B, 3.36	0.00005 MCL	0.00005
ethylene glycol	107-21-1	ND	NA, 2.8	73	204
ethylene oxide	75-21-8	ND	B, 3.36	0.0000835	0.00028
fluoranthene	206-44-0	0.01	NA, 2.8	1.46	4.09
fluorene	86-73-7	0.01	D, 2.8	1.46	4.09
fluoride	7782-41-4	ND	NA, 2.8	4 MCL	4
formaldehyde	50-00-0	ND	NA, 2.8[2]	7.3	20.4

TABLE 3-8
RISK REDUCTION STANDARD 2 FOR GROUNDWATER

Potential Constituents	CAS #	PQL (mg/L)	Toxicity Class/Industrial Exposure factor[1]	GW-Res MSC (mg/L)	GW-Ind MSC (mg/L)
heptachlor	76-44-8	0.00003	B, 3.36	0.0004 MCL	0.0004
heptachlor epoxide	1024-57-3	0.0008	B, 3.36	0.0002 MCL	0.0002
hexachlorobenzene	118-74-1	0.01	B, 3.36	0.001 MCL	0.001
hexachlorobutadiene	87-68-3	0.005	C, 3.36	0.0109	0.0367
alpha hexachlorocyclohexane	319-84-6	0.00003	B, 3.36	0.0000135	0.0000454
beta hexachlorocyclohexane	319-84-6	0.00006	C, 3.36	0.000473	0.00159
gamma hexachlorocyclohexane	58-89-9	0.00004	NA, 2.8	0.0002 MCL	0.0002
hexachloroethane	67-72-1	0.01	C, 3.36	0.0608	0.204
HMX	2691-41-0	0.013	D, 2.8	1.83	5.11
indeno(1,2,3-cd)pyrene	193-39-5	0.01		0.0004	0.0004
isobutyl alcohol	78-83-1	0.05	NA, 2.8	11	30.8
lead (inorganic)	7439-92-1	0.005	(3)	0.015	0.015
mercury	7439-97-6	0.0002	NA, 2.8	0.002 MCL	0.002
methomyl	16752-77-5	ND	NA, 2.8	0.913	2.56
methoxy ethanol	109-86-4	ND	NA, 2.8	0.146	0.409
methoxychlor	72-73-5	0.002	NA, 2.8	0.04 MCL	0.04
methoxyethanol acetate	110-49-6	ND	NA, 2.8	0.073	0.204
methyl ethyl ketone	78-93-3	0.1	D, 2.8	1.83	5.11
methyl isobutyl ketone	108-10-1	ND	NA, 2.8	1.83	5.11
methyl methacrylate	80-62-6	0.005	NA, 2.8	2.92	8.18
methylene chloride	75-09-2	0.005	B, 3.36	0.005 MCL	0.005
napthalene	91-20-3	0.01	D, 2.8	1.46	4.09
nickel	7440-02-0	0.02	NA, 2.8[2]	0.1 MCL	0.1
nitrate	14797-55-8	ND	NA, 2.8	10 MCL	10
nitrite	14797-65-0	ND	D, 2.8	1 MCL	1
nitrate/nitrite as N	7727-37-9	1.0	NA, 2.8	10 MCL	10
nitrobenzene	98-95-3	0.0064	D, 2.8	0.0183	0.051
n-nitroso-methyl-ethyl-amine	10595-95-6	0.01	B, 3.36	0.00000387	0.000013
n-nitrosodi-n-propylamine	621-64-7	0.01	B, 3.36	0.0000122	0.000041
n-nitrosodiethylamine	55-18-5	0.01	B, 3.36	0.000000568	0.0000019
n-nitrosodimethylamine	62-75-9	0.01	B, 3.36	0.00000167	0.0000056
n-nitrosopyrrolidine	930-55-2	0.01	B, 3.36	0.0000406	0.000136
2-NT	88-72-2	0.012	D, 2.8	0.365	1.02
3-NT	99-08-1	0.0079	D, 2.8	0.365	1.02
4-NT	99-99-0	0.0085	D, 2.8	0.365	1.02

TABLE 3-8
RISK REDUCTION STANDARD 2 FOR GROUNDWATER

Potential Constituents	CAS #	PQL (mg/L)	Toxicity Class/Industrial Exposure factor[1]	GW-Res MSC (mg/L)	GW-Ind MSC (mg/L)
pentachloronitrobenzene	82-68-6	0.01	C, 3.36	0.00328	0.011
pentachlorophenol	87-86-5	0.05	B, 3.36	0.001 MCL	0.001
phenol	108-95-2	0.01	NA, 2.8	21.9	61.3
phthalic anhydride	85-44-9	0.10	NA, 2.8	73	204
polychlorinated biphenyls (PCB)	1336-36-3	0.00065	B, 3.36	0.0005 MCL	0.0005
pronamide	23950-58-5	0.01	NA, 2.8	2.74	7.67
pyrene	129-00-0	0.01	D, 2.8	1.1	3.07
pyridine	110-86-1	0.01	NA, 2.8	0.0365	0.102
RDX	121-82-4	0.014	C, 3.36	0.00774	0.026
selenium	7782-49-2	0.005	D, 2.8	0.05 MCL	0.05
silver	7440-22-4	0.01	S, 2.8	0.183	0.512
strontium	NA	0.05	D, 2.8	91.3	61.3
strychnine	57-24-9	0.04	NA, 2.8	0.011	0.031
styrene	100-42-5	0.005	C, 3.36	0.1 MCL	0.1
1,2,4,5-tetrachlorobenzene	95-94-3	0.01	NA, 2.8	0.011	0.031
1,1,1,2-tetrachloroethane	630-20-6	0.005	C, 3.36	0.0328	0.11
1,1,2,2-tetrachloroethane	79-34-5	0.005	C, 3.36	0.00426	0.014
tetrachloroethylene	127-18-4	0.005	C, 3.36	0.005 MCL	0.005
tetrachlorophenol	58-90-2	0.01	D, 2.8	1.10	3.07
tertraethyl dithiopyrophosphate	3689-24-5	0.01	D, 2.8	0.0183	0.051
TETRYL	479-45-8	0.004	D, 2.8	ND	ND
thallium	7440-28-0	0.003		0.002 MCL	0.002
toluene	108-88-3	0.005	D, 2.8	1 MCL	1
toxaphene	8001-35-2	0.0024	B, 3.36	0.003 MCL	0.003
2,4,5-TP (silvex)	93-72-1	0.002	D, 2.8	0.05 MCL	0.05
1,2,4-trichlorobenzene	120-82-1	0.01	D, 2.8	0.07 MCL	0.07
1,1,1-trichloroethane	71-55-6	0.005	D, 2.8	0.2 MCL	0.2
1,1,2-trichloroethane	79-00-5	0.005	C, 3.36	0.005 MCL	0.005
trichloroethylene	79-01-6	0.005	B, 3.36	0.005 MCL	0.005
trichlorofluoromethane	75-69-4	0.005	D, 2.8	11	30.7
2,4,5-trichlorophenol	95-95-4	0.01	D, 2.8	3.65	10.2
2,4,6-trichlorophenol	88-06-2	0.01	B, 3.36	0.00774	0.026
2,4,5-trichlorophenoxyacetic acid	93-76-5	0.01	D, 2.8	0.365	1.02
1,1,2-trichloropropane	598-77-6	ND	NA, 2.8	0.183	0.51
1,2,3-trichloropropane	96-18-4	0.005	D, 2.8	0.219	0.61

TABLE 3-8
RISK REDUCTION STANDARD 2 FOR GROUNDWATER

Potential Constituents	CAS #	PQL (mg/L)	Toxicity Class/Industrial Exposure factor[1]	GW-Res MSC (mg/L)	GW-Ind MSC (mg/L)
1,3,5-trinitrobenzene (TNB)	99-35-4	0.0073	NA, 2.8	0.00183	0.00511
2,4,6-trinitrotoluene (TNT)	118-96-7	0.0069	D, 2.8	0.018	0.051
vanadium	7440-62-2	0.02	D, 2.8	0.11	0.307
vinyl acetate	108-05-4	0.05	NA, 2.8	36.5	102
vinyl chloride	75-01-4	0.01	A, 3.36	0.002 MCL	0.002
xylene	1330-20-7	0.005	D, 2.8	10 MCL	10
zinc	7440-66-6	0.02	D, 2.8	11.0	30.7

1 *Per Risk Reduction Rule Guidance, constituents classified as A, B, or C carcinogens are assigned a factor of 3.36 and constituents considered systemic toxicants (D) and those not classified (NA) are considered noncarcinogens and assigned a factor of 2.8, based on the use of industrial exposure factors versus residential exposure factors.*

2 *The MSCs calculated for this compound are based on noncarcinogenic effects, in the absence of available cancer slope factor data. When oral cancer slope factor data become available, these MSCs will be revised by the TNRCC.*

3 *There is no oral reference dose or slope factor for lead. The 0.015 mg/L standard is a treatment technique action level rather than a promulgated MCL. The GW-Ind MSC is shown equal to the action level.*

4 *The values shown for six polyaromatic hydrocarbons (PAHs) are treated as MCLs, even though they were only proposed MCLs and never finalized.*

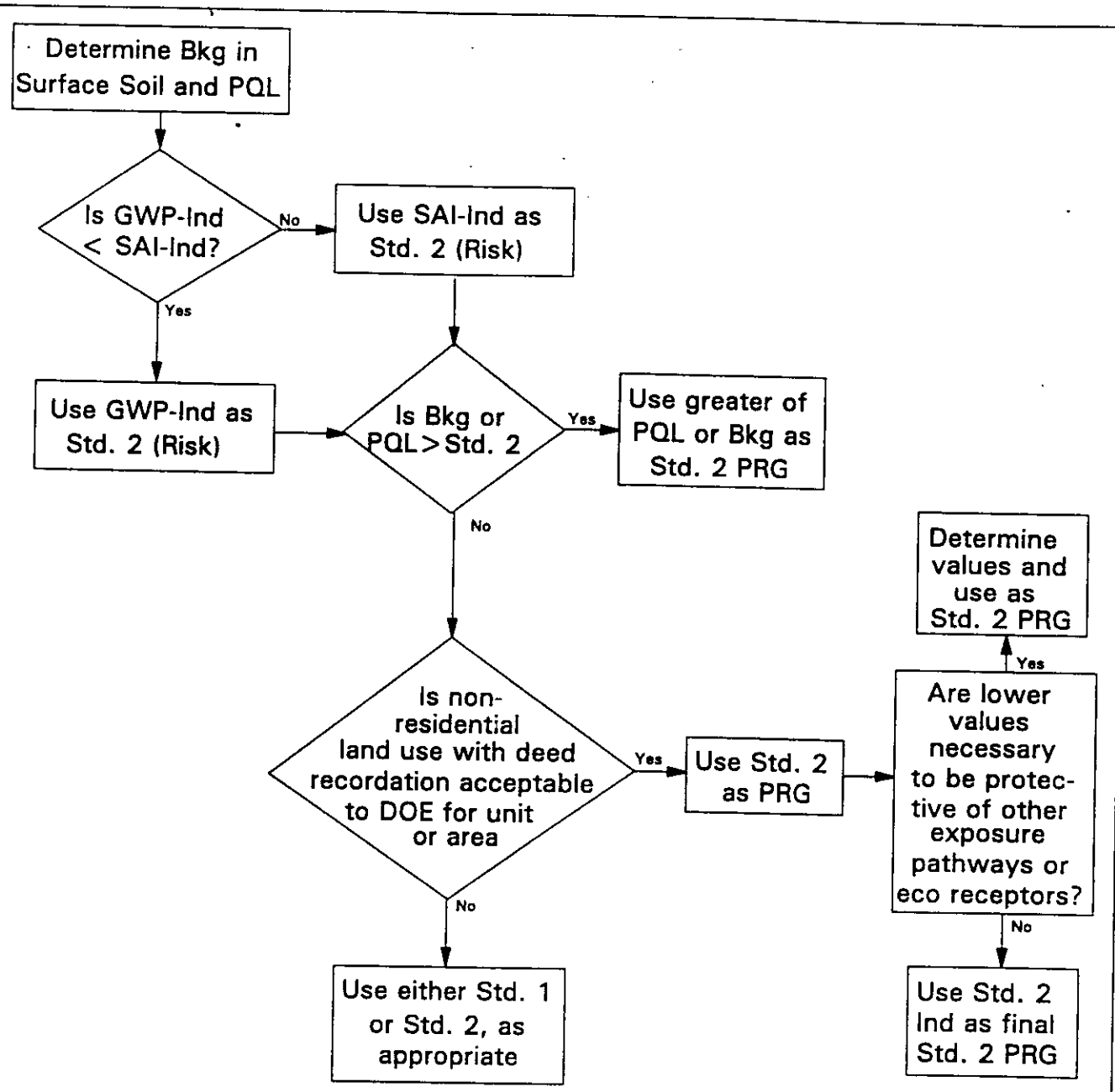
3.3 SUMMARY OF RISK REDUCTION STANDARDS 1 AND 2 CLEANUP LEVELS

Figures 3-7 and 3-8 present the decision trees for selecting the Preliminary Remediation Goals (PRGs) for surface soil, and subsurface soil and groundwater, respectively. Table 3-9 summarizes the PRGs based on RRSs 1 and 2 for surface and subsurface soil. The values presented under RRS 1 represent background concentrations. In many cases the background concentrations have not yet been determined. 30 TAC 335.554(d) states that "if the Practical Quantitation Limit (PQL) is greater than background, then the PQL rather than the background shall be used as the cleanup level provided that the person satisfactorily demonstrates to the executive director that lower levels of quantitations of a contaminant are not possible." The PQL is defined in Subsection 2.2. The values presented under RRS 2 are risk-based levels determined by the MSC rather than the SPLP test or EPA Soil Screening Levels (SSLs). Section 335.555(d)(1) states that if the PQL and/or background concentration (RRS1) for a contaminant is greater than the "cleanup" level determined under RRSs, then the greater of the PQL or background shall be used. Otherwise, the risk-based value shall be selected. Table 3-10

summarizes the PRGs based on RRSs 1 and 2 for groundwater at Pantex Plant. It must be noted that a site-wide Baseline Risk Assessment will be conducted at Pantex Plant . The results of this assessment may affect the PRGs that are currently being utilized. The results may be more or less restrictive. In any case, the PRGs will be updated at that time.

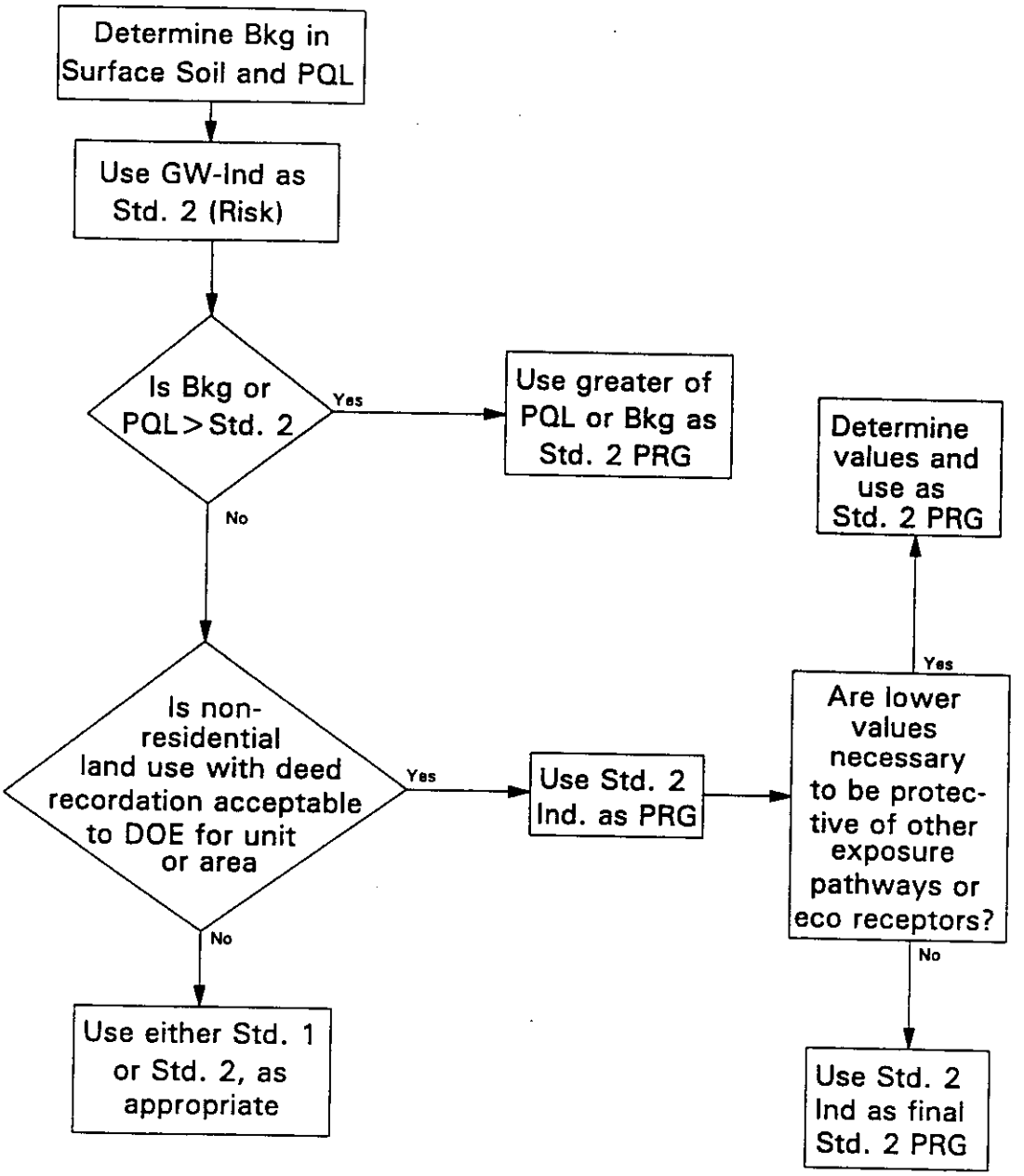
In Tables 3-9 and 3-10, the higher of RRS 1 or 2 was selected for each constituent and is denoted by shading. If the PQL was the controlling factor in establishing the selected RRSs 1 or 2 value, the PQL value was also shaded. Therefore, a combination of the RRS 1 and 2 are proposed for use.

Please note that the extent of contamination as determined from background comparisons may be somewhat broader than the extent determined solely from comparisons to RRS 2 values. In all cases, the extent of contamination will be determined to background levels. There is a benefit in determining contamination limits as defined by background, in that information relative to the nature and extent of contamination is critical to DOE risk managers charged with determining remedial strategies which may be driven by issues independent of human health risk (Figures 3-7 and 3-8). For example, observations of a specific chemical hazard in excess of background (RRS 1) but within acceptable risk-based criteria (RRS 2) may be acted upon differently by the DOE under differing site specific conditions. Contamination located at 5 to 10 ft below ground surface is likely to be remediated to background because of the low cost and rapid execution of the cleanup, thus avoiding deed recording requirements (31 TAC 335.560) and future liability relative to changing land use classification. For the same contaminant at the same concentration, the DOE is likely to accept criteria outlined in RRS 2 should the zone of contamination exist from 5 to 100 ft below ground level in which technical feasibility and cost limitations preclude cleanup to background levels.



Bkg = background
GWP-Ind = groundwater protection standard for industrial land use
SAI-Ind = soil/air and ingestion standard for industrial use
Ind = industrial land use
Res = residential land use

Figure 3-7 Decision Tree for Selection of "PRGs" for Surface Soils Under RRS2 for Non-Residential Land Use



Bkg = background
GWP-Ind = groundwater protection standard for industrial land use
SAI-Ind = soil/air and ingestion standard for industrial use
Ind = industrial land use
Res = residential land use

Figure 3-8 Decision Tree for Selection of "PRGs" for Groundwater and Subsurface Soils Under RRS2 for Non-Residential Land Use

TABLE 3-9

SURFACE SOIL and SUBSURFACE SOIL RISK REDUCTION STANDARDS 1 AND 2 FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Surface Soil [1] (0-2 ft) (mg/kg)					Subsurface Soil [1] (2-432 ft) (mg/kg)		PQL [1] (mg/kg)
	RRS 1			RRS 2 SAI	RRS 2 GWP	RRS 1	RRS 2	
	Drainage	Playa	Upland					
acenaphthene	ND [2]	ND [2]	ND [2]	44300	613	ND	613	0.66
acetone	ND	ND	ND	4160	1020	ND	1020	0.10
acetonitrile	ND	ND	ND	12,300	61.3	ND	61.3	0.10
acetophenone	ND	ND	ND	81,500	1020	ND	1020	ND
acrolein	ND	ND	ND	20,400	204	ND	204	ND
acrylamide	ND	ND	ND	1.27	0.006	ND	0.006	ND
acrylonitrile	ND	ND	ND	0.144	0.053	ND	0.053	ND
alachlor	ND	ND	ND	71.0	0.20	ND	0.20	ND
aldicarb	ND	ND	ND	409	0.30	ND	0.30	ND
aldicarb sulfone	ND	ND	ND	613	0.20	ND	0.20	ND
aldicarb sulfoxide	ND	ND	ND	409	0.40	ND	0.40	ND
aldrin	ND	ND	ND	0.336	0.0027	ND	0.0027	0.0027
aluminum phosphide	ND	ND	ND	818	4.09	ND	4.09	ND
aniline	ND	ND	ND	0.048	5.02	ND	5.02	ND
anthracene	ND	ND	ND	150,000	3070	ND	3070	0.66
antimony	16.0	11.9	12.5	818	0.60	170	0.60	8.7
arsenic	22.9	16.2	10.2	3.27	5.0	10.3	5.0	0.74
atrazine	ND	ND	ND	258	0.30	ND	0.30	ND
barium	637	1940	185	137,000	200	1540	200	8.7
benzene	ND	ND	ND	1.62	0.50	ND	0.50	0.005

TABLE 3-9

SURFACE SOIL and SUBSURFACE SOIL RISK REDUCTION STANDARDS 1 AND 2 FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Surface Soil [1] (0-2 ft) (mg/kg)					Subsurface Soil [1] (2-432 ft) (mg/kg)		PQL [1] (mg/kg)
	RRS 1			RRS 2 SAL	RRS 2 GWP	RRS 1	RRS 2	
benzidine	ND	ND	ND	0.0249	0.00012	ND	0.00012	ND
benzo(a)anthracene	ND	ND	ND	ND	0.66	ND	0.66	0.66
benzo(a)pyrene	ND	ND	ND	ND	0.66	ND	0.66	0.66
benzo(b)fluoranthene	ND	ND	ND	ND	0.66	ND	0.66	0.66
benzo(k)fluoranthene	ND	ND	ND	ND	0.66	ND	0.66	0.66
benzoic acid	ND	ND	ND	ND	40,880	ND	40,880	0.66
beryllium	2.20	2.23	1.61	1.33	0.4	3.72	0.4	0.2
biphenyl	ND	ND	ND	11,100	511	ND	511	ND
bis (chloroethyl) ether	ND	ND	ND	0.377	0.66	ND	0.66	0.66
bis (2-chloro-isopropyl)ether	ND	ND	ND	90.5	4.09	ND	4.09	0.66
bis (2-ethylhexyl) phthalate	ND	ND	ND	409	2.04	ND	2.04	0.66
bromodichloromethane	ND	ND	ND	0.946	10.0	ND	10.0	0.005
bromoform	ND	ND	ND	724	10.0	ND	10.0	0.005
bromomethane	ND	ND	ND	24.7	14.3	ND	14.3	0.01
2-sec-butyl 4,6-dinitrophenol	ND	ND	ND	2040	10.2	ND	10.2	ND
cadmium	0.972	1.17	1.27	1020	0.80	2.0	0.80	0.8
carbofuran	ND	ND	ND	10,200	4.0	ND	4.0	ND
carbon disulfide	ND	ND	ND	23.4	1020	ND	1020	0.10
carbon tetrachloride	ND	ND	ND	0.513	0.5	ND	0.5	0.005
chlordane	ND	ND	ND	4.4	0.20	ND	0.20	0.009

TABLE 3-9

SURFACE SOIL and SUBSURFACE SOIL RISK REDUCTION STANDARDS 1 AND 2 FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Surface Soil [1] (0-2 ft) (mg/kg)					Subsurface Soil [1] (2-432 ft) (mg/kg)		PQL [1] (mg/kg)
	RRS 1			RRS 2 SAL	RRS 2 GWP	RRS 1	RRS 2	
p-chloroaniline	ND	ND	ND	8180	40.9	ND	40.9	ND
chlorobenzene	ND	ND	ND	256	10.0	ND	10.0	0.005
chlorobenzilate	ND	ND	ND	40,900	204	ND	204	0.01
chloroethane	ND	ND	ND	23,000	204	ND	204	ND
chloroform	ND	ND	ND	0.504	10.0	ND	10.0	0.005
2-chloronapthalene	ND	ND	ND	164,000	818	ND	818	0.66
2-chlorophenol	ND	ND	ND	10,200	51.1	ND	51.1	0.66
chromium (total)	28.9	33.2	27.7	5110	10.0	69	10.0	1.4
hexavalent chromium	0.670	0.780	0.590	5110	10.0	0.3	10.0	0.3
chrysene	ND	ND	ND	ND	0.66	ND	0.66	0.66
copper	21.5	24.7	17.5	ND	ND	48.6	ND	4.3
m-cresol	ND	ND	ND	51,100	511	ND	511	ND
o-cresol	ND	ND	ND	51,100	511	ND	511	ND
p-cresol	ND	ND	ND	51,100	511	ND	511	ND
cyanide	ND	ND	ND	40,900	20.0	ND	20.0	ND
DDD	ND	ND	ND	40,900	0.119	ND	0.119	0.0074
DDE	ND	ND	ND	23.8	0.0841	ND	0.841	0.0027
DDT	ND	ND	ND	16.8	0.0841	ND	0.0841	0.008
di-n-butyl phthalate	ND	ND	ND	204,000	1020	ND	1020	ND
di-n-octyl phthalate	ND	ND	ND	40,900	204	ND	204	0.66
dibenz(a,h)anthracene	ND	ND	ND	ND	0.66	ND	0.66	0.66

TABLE 3-9

SURFACE SOIL and SUBSURFACE SOIL RISK REDUCTION STANDARDS 1 AND 2 FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Surface Soil [1] (0-2 ft) (mg/kg)					Subsurface Soil [1] (2-432 ft) (mg/kg)		PQL [1] (mg/kg)
	RRS 1			RRS 2 SAL	RRS 2 GWP	RRS 1	RRS 2	
1,2-dibromo-3-chloropropane	ND	ND	ND	4.09	0.02	ND	0.02	ND
dibromochloromethane	ND	ND	ND	681	10.0	ND	10.0	0.005
1,2-dichlorobenzene	ND	ND	ND	8390	60.0	ND	60.0	0.66
1,3-dichlorobenzene	ND	ND	ND	9990	60.0	ND	60.0	0.66
1,4-dichlorobenzene	ND	ND	ND	138	7.5	ND	7.5	0.66
dichlorodifluoro-methane	ND	ND	ND	47.9	2040	ND	2040	0.005
1,1 dichloroethane	ND	ND	ND	20,400	1020	ND	1020	0.005
1,2 dichloroethane	ND	ND	ND	0.505	0.50	ND	0.50	0.005
1,1 dichloroethene	ND	ND	ND	0.872	0.70	ND	0.70	0.005
cis 1,2 dichloroethene	ND	ND	ND	108	7.0	ND	7.0	0.005
trans 1,2 dichloroethene	ND	ND	ND	256	10.0	ND	10.0	0.005
total 1,2 dichloroethene	ND	ND	ND	108	7.0	ND	7.0	0.005
2,4-dichlorophenol	ND	ND	ND	6130	30.7	ND	30.7	0.66
2,4-dichloro-phenoxyacetic acid	ND	ND	ND	2040	7.0	ND	7.0	ND
1,2-dichloropropane	ND	ND	ND	0.843	0.50	ND	0.50	0.005
dieldrin	ND	ND	ND	0.357	0.00179	ND	0.00179	0.0013
diethylphthalate	ND	ND	ND	NHHB [3]	8180	ND	8180	0.66
di (2-ethylhexyl) adipate	ND	ND	ND	47,700	50.0	ND	50.0	ND
dimethoate	ND	ND	ND	409	2.04	ND	2.04	ND
2,4-dimethyl phenol	ND	ND	ND	40,900	204	ND	204	0.66

TABLE 3-9

SURFACE SOIL and SUBSURFACE SOIL RISK REDUCTION STANDARDS 1 AND 2 FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Surface Soil [1] (0-2 ft) (mg/kg)					Subsurface Soil [1] (2-432 ft) (mg/kg)		PQL [1] (mg/kg)
	RRS 1			RRS 2 SAI	RRS 2 GWP	RRS 1	RRS 2	
1,3-dinitrobenzene	ND	ND	ND	204	1.02	ND	1.02	0.25
2,4-dinitrophenol	ND	ND	ND	4090	20.4	ND	20.4	3.3
1,4-dioxane	ND	ND	ND	23.1	2.6	ND	2.6	ND
dipheylamine	ND	ND	ND	5110	256	ND	256	ND
1,2-diphenylhydrazine	ND	ND	ND	7.15	0.0358	ND	0.0358	ND
disolfoton	ND	ND	ND	81.8	0.409	ND	0.409	ND
2,4 dinitrotoluene (DNT)	ND	ND	ND	ND	20.4	ND	20.4	0.25
2,6 DNT	ND	ND	ND	ND	1022	ND	1022	0.26
endosulfan	ND	ND	ND	102	0.511	ND	0.511	0.0013
endothall	ND	ND	ND	40,900	10.0	ND	10.0	ND
endrin	ND	ND	ND	613	0.20	ND	0.20	0.004
2-ethoxyethanol	ND	ND	ND	817,000	4090	ND	4090	ND
2-ethoxyethanol acetate	ND	ND	ND	613,000	3070	ND	3070	ND
ethylbenzene	ND	ND	ND	17,000	70.0	ND	70.0	0.005
ethylene Dibromide	ND	ND	ND	0.0453	0.005	ND	0.005	ND
ethylene Glycol	ND	ND	ND	NHHB	20,400	ND	20,400	ND
ethylene Oxide	ND	ND	ND	0.151	0.028	ND	0.028	ND
fluoranthene	ND	ND	ND	81,800	409	ND	409	0.66

TABLE 3-9

SURFACE SOIL and SUBSURFACE SOIL RISK REDUCTION STANDARDS 1 AND 2 FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Surface Soil [1] (0-2 ft) (mg/kg)					Subsurface Soil [1] (2-432 ft) (mg/kg)		PQL [1] (mg/kg)
	RRS 1			RRS 2 SAI	RRS 2 GWP	RRS 1	RRS 2	
fluorene	ND	ND	ND	38,700	409	ND	409	0.66
fluorides	ND	ND	ND	123,000	400	ND	400	ND
formaldehyde	ND	ND	ND	204,000	2040	ND	2040	ND
heptachlor	ND	ND	ND	1.27	0.04	ND	0.04	0.002
heptachlor epoxide	ND	ND	ND	0.629	0.056	ND	0.056	0.056
hexachlorobenzene	ND	ND	ND	3.57	0.66	ND	0.66	0.66
hexachlorobutadiene	ND	ND	ND	733	3.67	ND	3.67	0.66
alpha hexachloro-cyclohexane	ND	ND	ND	0.908	0.0045	ND	0.0045	0.002
beta hexachlorocyclohexane	ND	ND	ND	31.8	0.159	ND	0.159	0.004
gamma hexachlorocyclohexane	ND	ND	ND	613	0.02	ND	0.02	.00027
hexachloroethane	ND	ND	ND	4090	20.4	ND	20.4	0.66
octahydro-1,3,5,7 tetranitro-1,3,5,7-tetrazocine (HMX)	ND	ND	ND	ND	511	ND	511	0.10
indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	0.66	ND	0.66	0.66
isobutyl alcohol	ND	ND	ND	613,000	3070	ND	3070	2.2
lead	29.5	31.3	19.3	1000	1.5	15.2	1.5	8.4
mercury	0.326	0.0399	0.100	613	0.20	0.11	0.20	0.056
methomyl	ND	ND	ND	51,100	256	ND	256	ND
2-methoxyethanol	ND	ND	ND	8180	40.9	ND	40.9	ND

TABLE 3-9

SURFACE SOIL and SUBSURFACE SOIL RISK REDUCTION STANDARDS 1 AND 2 FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Surface Soil [1] (0-2 ft) (mg/kg)					Subsurface Soil [1] (2-432 ft) (mg/kg)		PQL [1] (mg/kg)
	RRS 1			RRS 2 SAL	RRS 2 GWP	RRS 1	RRS 2	
methoxychlor	ND	ND	ND	10,200	4.0	ND	4.0	0.118
methoxyethanol acetate	ND	ND	ND	4090	20.4	ND	20.4	ND
methyl ethyl ketone	ND	ND	ND	14,000	511	ND	511	ND
methyl isobutyl ketone	ND	ND	ND	102,000	511	ND	511	ND
methyl methacrylate	ND	ND	ND	663	818	ND	818	0.05
methylene chloride	ND	ND	ND	13.8	0.50	ND	0.50	0.005
naphthalene	ND	ND	ND	7720	409	ND	409	0.66
nickel	33.2	46.0	20.8	20,400	10.0	55.0	10.0	3.0
nitrate	ND	ND	ND	20,400	100	ND	100	ND
nitrite	ND	ND	ND	NHHB	1000	ND	1000	ND
nitrate/ nitrite as N	7.94	NA	NA	20,400	1000	7.0	1000	ND
nitrobenzene	ND	ND	ND	106	5.11	ND	5.11	0.26
n-nitrosomethylethylamine	ND	ND	ND	0.26	0.0013	ND	0.0013	ND
n-nitroso-di-n-propylamine	ND	ND	ND	0.817	0.66	ND	0.66	0.66
n-nitrosodiethylamine	ND	ND	ND	0.038	0.00019	ND	0.00019	ND
n-nitrosodimethylamine	ND	ND	ND	0.112	0.00056	ND	0.00056	ND
n-nitrosopyrrolidine	ND	ND	ND	2.72	0.0136	ND	0.0136	ND
2-nitrotoluene	ND	ND	ND	ND	102	ND	102	0.25

TABLE 3-9

SURFACE SOIL and SUBSURFACE SOIL RISK REDUCTION STANDARDS 1 AND 2 FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Surface Soil [1] (0-2 ft) (mg/kg)					Subsurface Soil [1] (2-432 ft) (mg/kg)		PQL [1] (mg/kg)
	RRS 1			RRS 2 SAI	RRS 2 GWP	RRS 1	RRS 2	
3-nitrotoluene	ND	ND	ND	ND	102	ND	102	0.25
4-nitrotoluene	ND	ND	ND	ND	102	ND	102	0.25
pentachloro-nitrobenzene	ND	ND	ND	220	1.10	ND	1.10	ND
pentachlorophenol	ND	ND	ND	47.7	3.3	ND	3.3	3.3
phenol	ND	ND	ND	ND	6130	ND	6130	ND
phthalic anhydride	ND	ND	ND	ND	20,400	ND	20,400	ND
polychlorinated biphenyls (PCBs)	ND	ND	ND	25.0	0.05	ND	0.05	0.044
pronamide	ND	ND	ND	153,000	767	ND	767	ND
pyrene	ND	ND	ND	61,000	307	ND	307	0.66
pyridine	ND	ND	ND	2040	10.2	ND	10.2	ND
hexahydro-1,3,5-trinitro-1,3,5-triazine	ND	ND	ND	ND	2.6	ND	2.6	1.0
selenium	8.71	26.7	6.96	10,200	5.0	4.30	5.0	0.4
silver	0.642	1.43	2.10	10,200	51.1	4.0	51.1	1.4
strontium	71.6	53.5	50.7	ND	6,132	690	6,132	0.6
strychnine	ND	ND	ND	613	3.07	ND	3.07	ND
styrene	ND	ND	ND	191	10.0	ND	10.0	0.005
1,2,4,5-tetrachlorobenzene	ND	ND	ND	613	3.07	ND	3.07	ND
1,1,1,2-tetrachloroethane	ND	ND	ND	62.9	11.0	ND	11.0	0.005
1,1,2,2-tetrachloroethane	ND	ND	ND	11.7	1.43	ND	1.43	0.005
tetrachloroethylene (PCE)	ND	ND	ND	207	0.50	ND	0.50	0.005

TABLE 3-9

SURFACE SOIL and SUBSURFACE SOIL RISK REDUCTION STANDARDS 1 AND 2 FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Surface Soil [1] (0-2 ft) (mg/kg)					Subsurface Soil [1] (2-432 ft) (mg/kg)		PQL [1] (mg/kg)
	RRS 1			RRS 2 SAL	RRS 2 GWP	RRS 1	RRS 2	
2,3,4,6-tetrachlorophenol	ND	ND	ND	61,300	307	ND	307	ND
tetraethyl dithiopyrophosphate	ND	ND	ND	1020	5.11	ND	5.11	ND
tetryl	ND	ND	ND	ND	ND	ND	ND	0.065
thallium	17.0	29.7	18.5	ND	.2	100.0	.2	8.7
toluene	ND	ND	ND	3630	100	ND	100	0.005
toxaphene	ND	ND	ND	5.2	0.30	ND	0.30	0.161
2,4,5-TP (silvex)	ND	ND	ND	16,400	5.0	ND	5.0	ND
1,2,4-trichlorobenzene	ND	ND	ND	828	7.0	ND	7.0	0.66
1,1,1-trichloroethane	ND	ND	ND	14,000	20.0	ND	20.0	0.005
1,1,2-trichloroethane	ND	ND	ND	16.2	0.50	ND	0.50	0.005
trichloroethylene	ND	ND	ND	2.85	0.50	ND	0.50	0.005
trichlorofluoromethane	ND	ND	ND	8.36	3070	ND	3070	ND
2,4,5-trichlorophenol	ND	ND	ND	10,400	1020	ND	1020	0.66
2,4,6-trichlorophenol	ND	ND	ND	520	2.60	ND	2.60	0.66
2,4,5-trichloro-phenoxyacetic acid	ND	ND	ND	20,400	102	ND	102	ND
1,1,2-trichloropropane	ND	ND	ND	10,200	51.1	ND	51.1	ND
1,2,3-trichloropropane	ND	ND	ND	12,300	61.3	ND	61.3	0.005
1,3,5-trinitrobenzene	ND	ND	ND	102	0.511	ND	0.511	0.25

TABLE 3-9

SURFACE SOIL and SUBSURFACE SOIL RISK REDUCTION STANDARDS 1 AND 2 FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Surface Soil [1] (0-2 ft) (mg/kg)					Subsurface Soil [1] (2-432 ft) (mg/kg)		PQL [1] (mg/kg)
	RRS 1			RRS 2 SAI	RRS 2 GWP	RRS 1	RRS 2	
2,4,6-trinitrotoluene	ND	ND	ND	ND	5.1	ND	5.1	0.25
vanadium	51.8	65.5	53.4	ND	30.7	150	30.7	1.60
vinyl acetate	ND	ND	ND	204,000	10,200	ND	10,200	0.05
vinyl chloride	ND	ND	ND	0.0241	0.2	ND	0.2	0.01
xylene	ND	ND	ND	3,800	1000	ND	1000	0.005
zinc	89.3	105.0	70.4	ND	3066	166	3066	0.4

1 *Shading denotes the numerical value was the higher of background RRS or risk-based RRS and is selected as the action level for the particular media at Pantex Plant. If the PQL value is shaded, then the PQL determined either the RRS 1 or RRS 2 value.*

2 *ND=not determined.*

3 *NHHB=not human health based.*

4 *NA=not analyzed*

TABLE 3-10
GROUNDWATER RISK REDUCTION STANDARDS 1 AND 2
FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Groundwater[1] RRS 1 (mg/L)	Groundwater[1] RRS 2 (mg/L)	PQL[1] (mg/L)
Acenaphthene	ND[2]	6.13	0.2
Acetone	ND	10.2	0.1
Acetonitrile	ND	0.613	0.1
Acetophenone	ND	10.2	0.01
Acrolein	ND	2.04	0.005
Acrylamide	ND	0.000064	ND
Acrylonitrile	ND	0.005	0.005
Alachlor	ND	0.002	ND
Aldicarb	ND	0.003	ND
Aldicarb sulfone	ND	0.002	ND
Aldicarb sulfoxide	ND	0.004	ND
Aldrin	ND	0.00004	0.00004
Aluminum phosphide	ND	0.041	ND
Aniline	ND	0.0502	0.001
Anthracene	ND	30.7	0.2
Antimony	ND	0.006	0.003
Arsenic	0.004	0.05	0.005
Atrazine	ND	0.003	ND
Barium	0.432	2.0	0.04

TABLE 3-10
GROUNDWATER RISK REDUCTION STANDARDS 1 AND 2
FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Groundwater[1] RRS 1 (mg/L)	Groundwater[1] RRS 2 (mg/L)	PQL[1] (mg/L)
Benzene	ND	0.005	0.005
Benzidine	ND	0.0000012	ND
Benzo(a)anthracene	ND	0.01	0.01
Benzo(a)pyrene	ND	0.01	0.01
Benzo(b)fluoranthene	ND	0.01	0.01
Benzo(k)fluoranthene	ND	0.01	0.01
Benzoic acid	ND	408.8	0.05
Beryllium	ND	0.004	0.002
Biphenyl	ND	5.11	ND
Bis (chloroethyl) ether	ND	0.01	0.01
Bis (2-chloroisopropyl) ether	ND	0.041	0.01
Bis (2-ethylhexyl) phthalate	ND	0.02	0.02
Bromodichloromethane	ND	0.10	0.001
Bromoform	ND	0.10	0.005
Bromomethane	ND	0.143	0.01
2-sec-butyl 4,6-dinitrophenol	ND	0.102	0.01
Cadmium	0.02	0.005	0.005
Carbofuran	ND	0.04	0.01
Carbon disulfide	ND	10.2	0.005

TABLE 3-10
GROUNDWATER RISK REDUCTION STANDARDS 1 AND 2
FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Groundwater[1] RRS 1 (mg/L)	Groundwater[1] RRS 2 (mg/L)	PQL[1] (mg/L)
Carbon tetrachloride	ND	0.005	0.005
Chlordane	ND	0.002	0.00014
p-chloraniline	ND	0.409	0.02
Chlorobenzene	ND	0.10	0.005
Chlorobenzilate	ND	2.04	0.01
Chloroethane	ND	2.04	0.01
Chloroform	ND	0.1	0.005
2-chloronaphthalene	ND	8.18	0.01
2-chlorophenol	ND	0.511	0.01
Chromium (total)	0.005	0.1	0.01
Hexavalent chromium	ND	0.1	0.005
Chrysene	ND	0.01	0.01
Copper	0.04	ND	0.02
3-methylphenol (m-cresol)	ND	5.11	0.01
2-methylphenol (o-cresol)	ND	5.11	0.01
4-methylphenol (p-cresol)	ND	5.11	0.01
cyanide	ND	0.20	0.04
DDD	ND	0.0012	0.00011
DDE	ND	0.00084	0.00004

TABLE 3-10
GROUNDWATER RISK REDUCTION STANDARDS 1 AND 2
FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Groundwater[1] RRS 1 (mg/L)	Groundwater[1] RRS 2 (mg/L)	PQL[1] (mg/L)
DDT	ND	0.00084	0.00012
di-n-butyl phthalate	ND	10.2	0.01
di-n-octyl phthalate	ND	2.04	0.01
dibenz(a,h)anthracene	ND	0.01	0.01
1,2-dibromo-3-chloropropane	ND	0.005	0.005
Dibromochloromethane	ND	0.10	0.005
1,2-dichlorobenzene	ND	0.60	0.01
1,3-dichlorobenzene	ND	0.60	0.01
1,4-dichlorobenzene	ND	0.075	0.01
Dichlorodifluoromethane	ND	20.4	0.005
1,1 dichloroethane	ND	10.2	0.005
1,2 dichloroethane	ND	0.005	0.005
1,1 dichloroethene	ND	0.007	0.005
cis 1,2 dichloroethene	ND	0.07	0.005
trans 1,2 dichloroethene	ND	0.1	0.005
total 1,2 dichloroethene	ND	0.07	0.005
2,4-dichlorophenol	ND	0.307	0.01
2,4-dichlorophenoxyacetic acid	ND	0.07	ND

TABLE 3-10
GROUNDWATER RISK REDUCTION STANDARDS 1 AND 2
FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Groundwater[1] RRS 1 (mg/L)	Groundwater[1] RRS 2 (mg/L)	PQL[1] (mg/L)
1,2-dichloropropane	ND	0.005	0.005
Dieldrin	ND	0.00002	0.00002
Diethylphthalate	ND	81.8	0.01
Di(2-ethylhexyl) adipate	ND	0.50	ND
Dimethoate	ND	0.0204	0.02
2,4-dimethyl phenol	ND	2.04	0.01
1,3-dinitrobenzene	ND	0.01	0.00011
2,4-dinitrophenol	ND	0.204	0.15
1,4-dioxane	ND	0.15	0.01
Diphenylamine	ND	2.56	ND
1,2-diphenylhydrazine	ND	0.00036	ND
Disulfoton	ND	0.00409	0.002
2,4 Dinitrotoluene (DNT)	ND	0.204	0.006
2,6 (DNT)	ND	10.22	0.01
Endosulfan	ND	0.00511	0.00014
Endothall	ND	0.10	ND
Endrin	ND	0.002	0.00006
2-ethoxyethanol	ND	40.9	ND

TABLE 3-10
GROUNDWATER RISK REDUCTION STANDARDS 1 AND 2
FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Groundwater[1] RRS 1 (mg/L)	Groundwater[1] RRS 2 (mg/L)	PQL[1] (mg/L)
2-ethoxyethanol acetate	ND	30.7	ND
Ethyl benzene	ND	0.7	0.005
Ethylene dibromide	ND	0.005	0.005
Ethylene glycol	ND	204	ND
Ethylene oxide	ND	0.00028	ND
Fluoranthene	ND	4.09	0.01
Fluorene	ND	4.09	0.01
Fluorides	4.6	4.0	ND
Formaldehyde	ND	20.4	ND
Heptachlor	ND	0.0004	0.00003
Heptachlor epoxide	ND	0.0008	0.0008
Hexachlorobenzene	ND	0.01	0.01
Hexachlorobutadiene	ND	0.0367	0.005
alpha hexachloro-cyclohexane	ND	0.00005	0.00003
beta hexachlorocyclohexane	ND	0.00159	0.00006
gamma hexaclorocyclohexane	ND	0.0002	0.00004
Hexachloroethane	ND	0.204	0.01
Cyclo-tetra methylene tetranitramine (HMX)	ND	5.11	0.013

TABLE 3-10
GROUNDWATER RISK REDUCTION STANDARDS 1 AND 2
FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Groundwater[1] RRS 1 (mg/L)	Groundwater[1] RRS 2 (mg/L)	PQL[1] (mg/L)
Indeno(1,2,3-cd)pyrene	ND	0.01	0.01
Isobutyl alcohol	ND	30.8	0.05
Lead	0.10	0.015	0.005
Mercury	0.0004	0.002	0.0002
Methomyl	ND	2.56	ND
2-methoxyethanol	ND	0.409	ND
Methoxychlor	ND	0.04	0.002
Methoxyethanol acetate	ND	0.204	ND
Methyl ethyl ketone	ND	5.11	0.10
Methyl isobutyl ketone	ND	5.11	ND
Methyl methacrylate	ND	8.18	0.005
Methylene chloride	ND	0.005	0.005
Naphthalene	ND	4.09	0.01
Nickel	ND	0.10	0.02
Nitrate	16.20	10.0	ND
Nitrite	0.02	1.0	ND
Nitrate/ Nitrite as N	16.20	10.0	ND

TABLE 3-10
GROUNDWATER RISK REDUCTION STANDARDS 1 AND 2
FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Groundwater[1] RRS 1 (mg/L)	Groundwater[1] RRS 2 (mg/L)	PQL[1] (mg/L)
Nitrobenzene	ND	0.051	0.0064
n-nitrosomethylethylamine	ND	0.01	0.01
n-nitroso-di-n-propylamine	ND	0.01	0.01
n-nitrosodiethylamine	ND	0.01	0.01
n-nitrosodimethylamine	ND	0.01	0.01
n-nitrosopryrrolidine	ND	0.01	0.01
2-nitrotoluene	ND	1.02	0.012
3-nitrotoluene	ND	1.02	0.0079
4-nitrotoluene	ND	1.02	0.0085
Pentachloronitrobenzene	ND	0.011	0.01
Pentachlorophenol	ND	0.05	0.05
Phenol	ND	61.3	0.01
Phosphorus	1.0	ND	1.0
Phthalic anhydride	ND	204	0.10
Polychlorinated biphenyls (PCBs)	ND	0.05	0.05
Pronamide	ND	7.67	0.01
Pyrene	ND	3.07	0.01
Pyridine	ND	0.102	0.01

TABLE 3-10
GROUNDWATER RISK REDUCTION STANDARDS 1 AND 2
FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Groundwater[1] RRS 1 (mg/L)	Groundwater[1] RRS 2 (mg/L)	PQL[1] (mg/L)
Cyclo-trimethylene trinitramine (RDX)	ND	0.026	0.014
Selenium	0.02	0.05	0.005
Silver	0.02	0.512	0.01
Strontium	2.173	61.3	0.05
Strychnine	ND	0.04	0.04
Styrene	ND	0.10	0.005
1,2,4,5-tetrachlorobenzene	ND	0.031	0.01
1,1,1,2-tetrachloroethane	ND	0.11	0.005
1,1,2,2-tetrachloroethane	ND	0.014	0.005
1,1,2,2-tetrachloroethene (PCE)	ND	0.005	0.005
2,3,4,6-tetrachlorophenol	ND	3.07	0.01
Tetraethyl dithiopyrophosphate	ND	0.051	0.01
Tetryl	ND	ND	0.004
Thallium	ND	0.003	0.003
Toluene	ND	1.00	0.005
Toxaphene	ND	0.003	0.0024
2,4,5-TP (silvex)	ND	0.05	0.002
1,2,4-trichlorobenzene	ND	0.07	0.01

TABLE 3-10
GROUNDWATER RISK REDUCTION STANDARDS 1 AND 2
FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Groundwater[1] RRS 1 (mg/L)	Groundwater[1] RRS 2 (mg/L)	PQL[1] (mg/L)
1,1,1 trichloroethane	ND	0.2	0.005
1,1,2-trichlorethane	ND	0.005	0.005
Trichloroethyene	ND	0.005	0.005
Trichlorofluoromethane	ND	30.7	0.005
2,4,5-trichlorophenol	ND	10.2	0.01
2,4,6-trichlorophenol	ND	0.026	0.01
2,4,5-trichloro-phenoxyacetic acid	ND	1.02	0.01
1,1,2-trichloropropane	ND	0.511	ND
1,2,3-trichloropropane	ND	0.613	0.005
1,3,5- trinitrobenzene	ND	0.0073	0.0073
2,4,6-trinitrotoluene	ND	0.051	0.0069
Vanadium	0.046	0.307	0.02
Vinyl acetate	ND	102	0.05
Vinyl chloride	ND	0.01	0.01
Xylene	ND	10.0	0.005
Zinc	0.000286	30.7	0.02
Gross alpha (pCi/L)	20.46	15	ND
Gross beta (pCi/L)	18.57	50pCi/L (4 mrems/yr)	ND

TABLE 3-10
GROUNDWATER RISK REDUCTION STANDARDS 1 AND 2
FOR PANTEX PLANT RCRA FACILITY INVESTIGATIONS

Potential Constituents	Groundwater[1] RRS 1 (mg/L)	Groundwater[1] RRS 2 (mg/L)	PQL[1] (mg/L)
Radium 226 (pCi/L)	ND	5	ND
Radium 228 (pCi/L)	ND	5	ND

1 *Shading denotes the numerical value was the higher of background RRS or risk-based RRS 2 and is selected as the action level for the particular media at Pantex Plant. If the PQL column is shaded, the PQL is the controlling factor for the selected standard.*

2 *ND=not determined*

4.0 SUMMARY AND RECOMMENDATIONS

This guidance document presented the methodology used to calculate proposed media PRGs in accordance with the TNRCC Risk Reduction Standards. The document presented the assumptions and describes the data sources used to generate the proposed media PRGs for the anticipated potential contaminants at Pantex Plant. The work performed in this document directly supports the current efforts of the ER Program for use in the conduct of the RFIs.

This document is the first attempt by the DOE at Pantex Plant to;

- Provide a common data source for properties of all potential contaminants anticipated at Pantex Plant.
- Present an integrated approach for calculating media PRGs for potential contaminants identified in each site-specific RFI.
- Provide a dynamic guidance document for the DOE and its contractors for use in conducting RFIs and corrective action at Pantex Plant.

The use of this document by DOE and its contractors will ensure consistency between all parties involved and will eliminate unnecessary duplication in effort between the various contractors working at Pantex Plant.

Based on the work performed in the document, the following is recommended:

- To use the calculated media PRGs as standards to the decision criteria for additional sampling throughout Pantex Plant. Hence, these standards will form the basis on which the extent of contamination determinations are made. In all cases, the investigation of extent of contamination will be to background levels.

  It must also be noted that Pantex Plant will use these calculated PRGs to close sites with the understanding that some sites may need revisiting base on more stringent remediation goals developed from the BRA activity.
- To continue to perform and document a comprehensive quality assurance review on the data and calculations presented in this document.
- To continue the ongoing site-wide background study for soils and groundwater.

This guidance document will be updated at least annually as additional background information pertinent to Pantex Plant becomes available.

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SECTION 4.0

Table 4-1. Summary information on miscellaneous sites

Site Name: HASTINGS GROUNDWATER CONTAMINA
City : HASTINGS State: NE EPA Region: 7
ROD Date : 09/28/1990 EPA ID: NED980862668
NTIS Report Number: EPA/ROD/R07-90/034
Contaminant(s): ORGANICS
PAHS
METALS
ARSENIC
CHROMIUM
LEAD
TNT
Env. Media Affected: SOIL

ROD Abstract-

THE HASTINGS GROUND WATER CONTAMINATION SITE IS A CONTAMINATED AQUIFER IN AND NEAR THE CITY OF HASTINGS, ADAMS COUNTY, NEBRASKA. THE SITE CONSISTS OF SEVEN SOURCE AREAS, OR SUBSITES, CONTAMINATED WITH INDUSTRIAL CHEMICALS. THIS RECORD OF DECISION (ROD) ADDRESSES CONTAMINATED SURFACE SOIL (1-10 FEET) ON APPROXIMATELY 14 ACRES OF THE 2,600-ACRE HASTINGS EAST INDUSTRIAL PARK SUBSITE. THE SUBSITE IS ON A PORTION OF THE FORMER HASTINGS NAVAL AMMUNITION DEPOT (NAD). INVESTIGATIONS HAVE DETECTED THREE MAJOR TYPES OF CONTAMINANTS IN ONSITE SOIL, INCLUDING EXPLOSIVES SUCH AS TRINITROTOLUENE (TNT), CARCINOGENIC AND NONCARCINOGENIC POLYNUCLEAR AROMATIC HYDROCARBONS (PAHS) AND METALS.

THE REMEDY IS DESIGNED TO CONTROL THE MIGRATION OF CONTAMINANTS FROM SURFACE SOIL TO THE UNDERLYING AQUIFER. ONE OR MORE FUTURE RODS FOR THIS SUBSITE WILL ADDRESS CONTAMINATED GROUND WATER, AND POSSIBLY VADOSE ZONE REMEDIATION. THE PRIMARY CONTAMINANTS OF CONCERN AFFECTING THE SOIL ARE ORGANICS INCLUDING PAHS; METALS INCLUDING ARSENIC, CHROMIUM, AND LEAD; AND TNT.

THE SELECTED REMEDIAL ACTION FOR THIS SUBSITE INCLUDES EXCAVATING AND TREATING APPROXIMATELY 125,900 CUBIC YARDS OF CONTAMINATED SOIL. TREATMENT OF THE EXCAVATED SOIL INCLUDES ONSITE INCINERATION OF AN ESTIMATED 16,400 CUBIC YARDS OF SOIL CONTAINING HIGH LEVELS OF ORGANIC CONTAMINANTS (E.G., TNT EXCEEDING 660 MG/KG, PAHS EXCEEDING 1.8 MG/KG) WITH FINAL RESIDUE DISPOSITION BASED ON RESIDUAL ANALYSIS RESULTS; STABILIZING APPROXIMATELY 39,000 CUBIC YARDS OF METAL-CONTAMINATED SOIL FOLLOWED BY PLACING THE SOIL IN AN ONSITE RCRA SUBTITLE C HAZARDOUS WASTE LANDFILL; AND STABILIZING APPROXIMATELY 70,500 CUBIC YARDS OF SOIL WITH LOW LEVELS OF ORGANIC AND EXPLOSIVE CONTAMINATION (LESS THAN (10-4) EXCESS CANCER RISK), IF EFFECTIVE, AND PLACING THE STABILIZED SOIL IN THE CONSTRUCTED ONSITE LANDFILL. IF STABILIZING THE LOW-LEVEL ORGANIC-CONTAMINATED SOIL IS INEFFECTIVE, THE SOIL WILL BE PLACED DIRECTLY IN THE LANDFILL. IF SOIL IS RCRA CHARACTERISTIC HAZARDOUS WASTE, IT WILL BE TREATED TO THE APPROPRIATE RCRA BEST DEMONSTRATED AVAILABLE TECHNOLOGY TREATMENT STANDARD OR TO THE SOIL AND DEBRIS VARIANCE LEVELS PRIOR TO PLACEMENT IN THE LANDFILL. THE ESTIMATED PRESENT WORTH COST FOR THIS REMEDIAL ACTION IS $45,000,000, WHICH INCLUDES AN ESTIMATED ANNUAL O&M COST OF $86,000 FOR 30 YEARS.

PERFORMANCE STANDARDS OR GOALS: SOIL WITH CONCENTRATIONS EXCEEDING TNT 660 MG/KG OR PAHS 1.8 MG/KG (CARCINOGENIC RISK EXCEEDING (10-4) WILL BE REMEDIATED BY INCINERATION. CLEANUP GOALS FOR THE SURFACE SOIL

CONTAMINANTS INCLUDE TNT 2.5 MG/KG (BASED ON CARCINOGENIC RISK), TOTAL PAHS 50 UG/KG (BASED ON ANALYTICAL DETECTION LIMITS), ARSENIC 11 MG/KG (BACKGROUND LEVELS), CHROMIUM 230 MG/KG (NONCARCINOGENIC HAZARDS), AND LEAD 69 MG/KG (NONCARCINOGENIC HAZARDS).

ROD Remedy-

FUTURE ACTIVITIES WILL BE ADDRESSED IN ADDITIONAL OPERABLE UNITS. THIS OPERABLE UNIT WILL INCLUDE A ROD PRESENTING A DECISION ON POSSIBLE REMEDIATION OF CONTAMINATED GROUND WATER AND SUBSURFACE SOILS FOR THIS SUBSITE. THE MAJOR COMPONENTS OF THE SELECTED REMEDY ARE AS FOLLOWS:

* EXCAVATION OF APPROXIMATELY 125,900 CUBIC YARDS OF CONTAMINATED SOILS. THE SOILS WILL BE TESTED TO DETERMINE WHETHER THEY ARE RCRA CHARACTERISTIC HAZARDOUS WASTES. RCRA CHARACTERISTIC HAZARDOUS WASTES EXHIBIT ONE OF FOUR CHARACTERISTICS: IGNITABILITY, CORROSIVITY, REACTIVITY, OR TOXICITY.
* TREATMENT DEPENDENT ON TYPE AND CONCENTRATION OF CONTAMINANTS:

Site Name: HASTINGS GROUNDWATER CONTAMINA
City : HASTINGS State: NE EPA Region: 7
ROD Date : 09/28/1990 EPA ID: NED980862668
NTIS Report Number: EPA/ROD/R07-90/035
Contaminant(s): NONE
Env. Media Affected: NONE

ROD Abstract-

THE HASTINGS GROUND WATER CONTAMINATION SITE (FAR-MAR-CO) IS A CONTAMINATED AQUIFER IN AND NEAR THE CITY OF HASTINGS, ADAMS COUNTY, NEBRASKA. THE SITE CONSISTS OF SEVEN SOURCE AREAS, OR SUBSITES, CONTAMINATED WITH VOLATILE INDUSTRIAL CHEMICALS. THIS RECORD OF DECISION (ROD) ADDRESSES THE ZONE 2 PORTION OF THE FAR-MAR-CO SUBSITE, WHICH HAS BEEN DIVIDED INTO TWO GENERAL AREAS OF CONTAMINATION REFERRED TO AS ZONE 1 AND ZONE 2. ZONE 1, WHICH INCLUDES GRAIN ELEVATORS AND AREAS TO THE NORTH OF THE ELEVATORS, CONTAINS SOIL, SOIL-GAS, AND GROUND WATER CONTAMINATED WITH ETHYLENE DIBROMIDE AND CARBON TETRACHLORIDE ORIGINATING FROM THE DISPOSAL OF LIQUID GRAIN FUMIGANTS USED IN GRAIN ELEVATOR OPERATIONS. ZONE 1 CONTAMINATION WAS ADDRESSED IN A 1988 ROD THAT DOCUMENTED THE SELECTION OF A REMEDY TO CONSTRUCT A SOIL VAPOR EXTRACTION SYSTEM. ZONE 2, WHICH INCLUDES THE AREA SOUTH OF THE GRAIN ELEVATORS (BETWEEN THE ELEVATORS AND MANUFACTURING AND PRODUCTION BUILDINGS OWNED AND OPERATED BY THE HASTINGS IRRIGATION PIPE COMPANY (HIPCO)) CONTAINS SOIL CONTAMINATION PRIMARILY DUE TO 1,1,1-TRICHLOROETHANE (TCA) RESULTING FROM THE DISPOSAL OF CLEANING SOLVENTS USED IN THE MANUFACTURING OPERATIONS. IN DECEMBER 1989, HIPCO PERFORMED A REMOVAL ACTION EXCAVATING CONTAMINATED SOIL IN ZONE 2. SUBSEQUENT TESTING REVEALED THAT THE CONCENTRATION OF TCA IN ZONE 2 HAD BEEN REDUCED TO A PROTECTIVE LEVEL. RESPONSE ACTIONS FOR GROUND WATER CONTAMINATION NEAR THE FAR-MAR-CO SUBSITE, HOWEVER, WILL BE ADDRESSED IN SUBSEQUENT REMEDIAL ACTIVITIES.

THE SELECTED REMEDIAL ACTION FOR THIS SITE IS THAT NO FURTHER ACTION BE TAKEN AT THIS TIME WITH REGARD TO THE TCA SOIL CONTAMINATION. DUE TO THE SMALL AMOUNT OF RESIDUAL CONTAMINATION REMAINING IN THE SOIL AND THE

Site Name: ROEBLING STEEL CO
City : ROEBLING State: NJ EPA Region: 2
ROD Date : 03/29/1990 EPA ID: NJD073732257
NTIS Report Number: EPA/ROD/R02-90/100
Contaminant(s): ORGANICS
ACIDS
PCBS
METALS
LEAD
CHROMIUM
ARSENIC
OILS
Env. Media Affected: SOIL
DEBRIS

ROD Abstract-

THE 200-ACRE ROEBLING STEEL SITE IS A FORMER STEEL WIRE AND CABLE MANUFACTURING FACILITY IN THE VILLAGE OF ROEBLING, FLORENCE TOWNSHIP, BURLINGTON COUNTY, NEW JERSEY. THE SITE ABUTS THE DELAWARE RIVER TO THE NORTH AND CRAFTS CREEK TO THE EAST, AND LIES ADJACENT TO ROEBLING PARK, A PUBLIC PLAYGROUND. FROM 1906 TO 1982, THE FACILITY WAS OPERATED PRIMARILY TO PRODUCE STEEL PRODUCTS, BUT IN RECENT YEARS, PORTIONS OF THE SITE HAVE BEEN USED FOR VARIOUS OTHER INDUSTRIAL OPERATIONS THAT HAVE RESULTED IN THE ONSITE GENERATION, STORAGE, OR BURIAL OF RAW MATERIALS AND WASTES. TWO REMOVAL ACTIONS WERE PERFORMED AS A RESULT OF THESE INDUSTRIAL OPERATIONS. IN 1985, THE STATE REMOVED PICRIC ACID AND OTHER EXPLOSIVE CHEMICALS FROM ONE ONSITE LABORATORY AND DETONATED THE CHEMICALS OFFSITE. FROM 1987 TO 1988, EPA PERFORMED A SECOND REMOVAL ACTION WHICH INCLUDED THE OFFSITE DISPOSAL OF LAB PACK CONTAINERS AND DRUMS; RECYCLING/REUSE OF METALLIC MERCURY, GAS CYLINDERS, SULFURIC ACID, AND PHOSPHORIC ACID; AND ONSITE CONTAINMENT OF BAGHOUSE DUST AND EXPOSED ASBESTOS. THIS INTERIM OPERABLE UNIT WILL ADDRESS THOSE AREAS WHERE CONTAMINANT SOURCES POSE A SUFFICIENTLY IMMINENT HAZARD TO REQUIRE
EXPEDITED REMEDIATION. THESE AREAS INCLUDE THE REMAINING DRUMS AND EXTERIOR TANKS, TRANSFORMERS CONTAINING PCB-CONTAMINATED OILS, A BAGHOUSE DUST PILE, CHEMICAL PILES, TIRES, AND THE SOIL UNDER THE WATER TOWER IN ROEBLING PARK. ADDITIONAL OPERABLE UNITS WILL ADDRESS THE REMAINING SOURCES OF CONTAMINATION AND THOSE AREAS WHERE CONTAMINANT MIGRATION HAS OCCURRED. THE PRIMARY CONTAMINANTS OF CONCERN AFFECTING THE SOIL AND DEBRIS ARE ORGANICS INCLUDING ACIDS AND PCBS; METALS INCLUDING LEAD, CHROMIUM, AND ARSENIC; AND OILS.
THE SELECTED INTERIM REMEDIAL ACTION FOR THIS SITE INCLUDES OFFSITE INCINERATION AND DISPOSAL AT A RCRA-PERMITTED FACILITY OF THE CONTENTS OF 757 DRUMS; OFFSITE INCINERATION AND DISPOSAL AT A RCRA-PERMITTED FACILITY OF 67,000 GALLONS OF PCB-CONTAMINATED OIL FOUND IN 183 TRANSFORMERS; DISMANTLING AND DECONTAMINATING THE TRANSFORMERS AND DISPOSING OF THE TRANSFORMER HOUSINGS AT A RCRA-PERMITTED FACILITY; OFFSITE DISPOSAL AT A RCRA-PERMITTED FACILITY OF 150,000 GALLONS OF TANKED MATERIAL; OFFSITE STABILIZATION AND DISPOSAL AT A RCRA-PERMITTED FACILITY OF 530 CUBIC YARDS OF BAGHOUSE DUST; OFFSITE TREATMENT AND DISPOSAL AT A RCRA-REGULATED LANDFILL OF 40 CUBIC YARDS OF METAL-CONTAMINATED MATERIALS FROM 79 CHEMICAL PILES; OFFSITE DISPOSAL OF

10,000 TIRES; AND EXCAVATION OF 120 CUBIC YARDS OF SURFACE SOIL FROM ROEBLING PARK FOLLOWED BY OFFSITE STABILIZATION AND DISPOSAL AT A RCRA-PERMITTED FACILITY. THE ESTIMATED TOTAL COST FOR THIS REMEDIAL ACTION IS $5,003,400. NO O&M COSTS ARE ASSOCIATED WITH THIS OPERABLE UNIT.
PERFORMANCE STANDARDS OR GOALS: SURFACE SOIL UNDER THE WATER TOWER AT ROEBLING PARK WILL BE EXCAVATED IF LEAD LEVELS EXCEED 250 MG/KG. BECAUSE THE REMAINING COMPONENTS OF THE REMEDY INVOLVE REMOVAL OF CONTAMINANT SOURCES TO PREVENT ADDITIONAL MIGRATION, NO OTHER SPECIFIC PERFORMANCE GOALS WERE GIVEN.

ROD Remedy-
OPERABLE UNITS FOR LONG-TERM REMEDIATION OF THE SITE WILL BE DETERMINED AS APPROPRIATE. A COMPREHENSIVE REMEDIAL INVESTIGATION WILL DETERMINE THE NATURE AND EXTENT OF CONTAMINATION OVER THE ENTIRE SITE. AREAS OF CONCERN INCLUDE SOILS, SURFACE WATER, GROUNDWATER, SEDIMENTS, AIR QUALITY, AND OTHER REMAINING CONTAMINATION SOURCES.
THE MAJOR COMPONENTS OF THE SELECTED REMEDY FOR THIS FIRST OPERABLE UNIT INCLUDE THE FOLLOWING;

* DRUMS/DRUM CONTENTS; OVERPACKING AND OFF-SITE DISPOSAL
* TRANSFORMERS/TRANSFORMER CONTENTS; SHIPMENT OF TRANSFORMERS EN MASSE
* TANK CONTENTS; BULKING OF CONTENTS AND OFF-SITE DISPOSAL
* BAGHOUSE DUST; OFF-SITE TREATMENT AND DISPOSAL
* CHEMICAL PILES; OFF-SITE TREATMENT AND DISPOSAL
* TIRES; OFF-SITE DISPOSAL
* WATER TOWER SOIL; OFF-SITE TREATMENT AND DISPOSAL.

DECLARATION FOR THE RECORD OF DECISION

ROEBLING STEEL COMPANY

Site Name: CHEMTRONICS INC
City : SWANNANOA State: NC EPA Region: 4
ROD Date : 04/05/1988 EPA ID: NCD095459392
NTIS Report Number: EPA/ROD/R04-88/032
Contaminant(s): METALS
ARSENIC
ORGANICS
PESTICIDES
VOCS
BENZENE
PCE
TCE
Env. Media Affected: GROUNDWATER
SEDIMENTS
SOIL
SURFACEWATER

ROD Abstract-
THE CHEMTRONICS SITE, AN ACTIVE WASTE DISPOSAL FACILITY, IS LOCATED IN A RURAL AREA OF SWANNANOA, BUNCOMBE COUNTY, NORTH CAROLINA. THE 1,027-ACRE SITE WAS DEVELOPED AS AN INDUSTRIAL FACILITY IN 1952. SEVERAL COMPANIES OPERATED THE FACILITY PRIOR TO ITS PURCHASE BY CHEMTRONICS, INC. IN 1978. WASTE DISPOSAL OPERATIONS ONLY OCCURRED OVER APPROXIMATELY TEN ACRES OF THE SITE. EXISTING RECORDS INDICATE THE PRESENCE OF TWENTY-THREE INDIVIDUAL ONSITE DISPOSAL AREAS (DAS) WHICH ARE GROUPED INTO SIX DISCRETE AREAS; DA-6, DA-7/8, DA-9, DA-10/11, DA-23 AND THE ACID PIT. THE SITE CAN ALSO BE DIVIDED INTO TWO GEOGRAPHICAL SUBSECTIONS REFERRED TO AS FRONT VALLEY AND GREGG VALLEY. DISPOSAL PRACTICES PRIOR TO 1971 WERE NOT WELL DEFINED; HOWEVER, SOLID WASTE MATERIALS AND POSSIBLY SOLVENTS WERE INCINERATED IN PITS DUG IN AN AREA PREVIOUSLY REFERRED TO AS THE BURNING GROUND AND CURRENTLY REFERRED TO AS THE ACID PIT AREA. ADDITIONALLY, CHEMICAL WASTES WERE DISPOSED OF IN TRENCHES BESIDE THIS BURNING GROUND. WASTE MATERIALS GENERATED IN THE PRODUCTION OF THE CHEMICAL WARFARE AGENT, 3-QUINUCLIDINYL BENZILATE (BZ), AND THE TEAR GAS AGENT, O-CHLOROBENZYLIDENE MALONONITRILE (CS), WERE PLACED IN 55-GALLON DRUMS WITH A NEUTRALIZING SOLUTION, AND THEN BURIED ONSITE IN TRENCH-TYPE LANDFILLS. FROM 1971 TO 1975, SMALL VOLUMES OF LIQUID WASTES WERE DISPOSED OF IN ONSITE PITS/TRENCHES. SOLID WASTES, ROCKET MOTORS, EXPLOSIVE WASTES, AND OTHER WASTE TYPES ALSO WERE BURNED IN THE BURNING GROUND AREA. FROM 1975 TO 1979, CHEMTRONICS, INC. CONSTRUCTED PITS/TRENCHES, AS NEEDED, FOR THE DISPOSAL OF SPENT ACID AND VARIOUS ORGANIC WASTES. THESE PITS/TRENCHES WERE CONSTRUCTED IN THE BURNING GROUND AREA. IN 1980, NORTH CAROLINA ORDERED CHEMTRONICS TO DISCONTINUE ALL DISCHARGES TO SITE PITS/TRENCHES. THE PITS SUBSEQUENTLY HAVE BEEN BACK-FILLED. STARTING IN 1979, CHEMTRONICS INSTALLED A 500,000 GALLON LINED LAGOON OVER AN OLD LEACHING FIELD FOR THE BIOTREATMENT OF WASTE WATERS. THE INCOMPATIBILITY OF THE LINER WITH THE BROMINATED WASTES INTRODUCED INTO THE LAGOON CAUSED THE LAGOON TO LEACH ITS CONTENTS. THE BIOLAGOON WAS RECONSTRUCTED IN AUGUST, 1980, WITH A DIFFERENT LINER, AND DEACTIVATED IN 1984. IN SEPTEMBER 1984, THE U.S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY SAMPLED TWO DRUMS AT THE SURFACE IN DA-10/11. THESE DRUMS WERE

SUSPECTED OF CONTAINING WASTES FROM THE PRODUCTION OF BZ. ALTHOUGH NO BZ WAS FOUND, AN IMMEDIATE REMOVAL OF THESE DRUMS WAS INITIATED IN JANUARY, 1985, DUE TO HEIGHTENED PUBLIC AWARENESS/INVOLVEMENT WITH THE SITE. THE PRIMARY CONTAMINANTS OF CONCERN AFFECTING THE SOIL, SEDIMENTS, GROUND WATER AND SURFACE WATER INCLUDE VOCS, BENZENE, PCE, TCE, ORGANICS, METALS, ARSENIC, PESTICIDES, AND EXPLOSIVES.

THE SELECTED REMEDIAL ACTION FOR THIS SITE INCLUDES; MULTI-LAYER CAPPING OF DA 6, DA 7/8, DA-9, DA-10/11 AND THE ACID PIT AREA WITH FENCING, PLACEMENT OF A VEGETATIVE COVER OVER THE CAP, AND INSTALLATION OF A GAS COLLECTION VENTILATION SYSTEM, IF NECESSARY; TREATABILITY STUDIES FOR SOILS ASSOCIATED WITH DA-23 TO DETERMINE THE MOST APPROPRIATE SOIL FIXATION/STABILIZATION/SOLIDIFICATION PROCESS AND MIXING RATIOS FOLLOWED BY ONSITE CAPPING; GROUND WATER PUMP AND TREATMENT WHICH MAY INCLUDE AIR STRIPPING, CARBON ADSORPTION, OR METAL REMOVAL WITH TREATMENT AND DISCHARGE TO BE DETERMINED DURING DESIGN; SAMPLING OF POND WATER AND SEDIMENTS, AND IF NECESSARY, TREAT USING THE GROUND WATER TREATMENT SYSTEM OR THE SELECTED SOIL TREATMENT/CONTAINMENT PROCESS; AND SEDIMENT, GROUND WATER, AND SURFACE WATER MONITORING. THE ESTIMATED PRESENT WORTH COST FOR THIS REMEDIAL ACTION RANGES FROM $6,247,300 TO $8,242,900.

ROD Remedy-

MIGRATION CONTROL (REMEDIATING CONTAMINATED GROUNDWATER)

INSTALLATION OF A GROUNDWATER INTERCEPTION AND EXTRACTION SYSTEM DOWNGRADIENT OF THE DISPOSAL AREAS IN BOTH THE FRONT VALLEY AND GREGG VALLEY. THE LEVEL AND DEGREE OF TREATMENT OF THE EXTRACTED GROUNDWATER WILL DEPEND ON 1) THE ULTIMATE DISCHARGE POINT OF THIS WATER AND 2) THE LEVEL OF CONTAMINANTS IN THE EXTRACTED GROUNDWATER. THE THREE WATER DISCHARGE ALTERNATIVES FOR THE TREATED WATER ARE 1) THE LOCAL SEWER SYSTEM, 2) A SURFACE STREAM AND 3) ON-SITE IRRIGATION. THE RANGE OF TREATMENT FOR THE EXTRACTED GROUNDWATER INCLUDES AIR STRIPPING, FILTRATION THROUGH ACTIVATED CARBON FILTER AND METAL REMOVAL. THE POINT OF DISCHARGE AND THE DEGREE OF TREATMENT WILL BE DETERMINED IN THE REMEDIAL DESIGN STAGE. THE WATER DISCHARGED WILL MEET ALL ARAR'S.

SOURCE CONTROL (REMEDIATING CONTAMINATED SOILS)

CAP DISPOSAL AREA #6, DISPOSAL AREA #7/8, DISPOSAL AREA #9, DISPOSAL AREA #10/11, AND THE ACID PIT AREA WITH A MULTI-LAYER CAP WHICH INCLUDES A SYNTHETIC LINER. SECURITY FENCING, VEGETATIVE COVERS AND, WHERE DEEMED NECESSARY, A GAS COLLECTION/VENTILATION SYSTEM WILL BE INSTALLED. THE MULTI-LAYER CAP WILL MEET AS A MINIMUM, THE STANDARDS SPECIFIED UNDER 40 CFR SUBSECTION 264, SUBPARTS K-N.

DECLARATION FOR THE RECORD OF DECISION

Site Name: CHEMTRONICS INC
City : SWANNANOA State: NC EPA Region: 4
ROD Date : 04/26/1989 EPA ID: NCD095459392
NTIS Report Number: EPA/ROD/R04-89/049
Contaminant(s): VOCS
BENZENE
TOLUENE
PCE
TCE
PESTICIDES
EXPLOSIVES
ARSENIC
LEAD
CHROMIUM
Env. Media Affected: SOIL
SEDIMENT
GROUNDWATER
SURFACEWATER

ROD Abstract-

THIS RECORD OF DECISION (ROD) AMENDS THE APRIL 5, 1988, CHEMTRONICS ROD WHICH INCLUDED AN INCORRECT CALCULATION REGARDING THE CHEMICAL QUALITY OF THE GROUND WATER. THE CHEMTRONICS SITE IS AN ACTIVE WASTE DISPOSAL FACILITY LOCATED IN A RURAL AREA OF SWANNANOA, BUNCOMBE COUNTY, NORTH CAROLINA. THE 1,027-ACRE SITE WAS DEVELOPED AS AN INDUSTRIAL FACILITY IN 1952 AND WAS PURCHASED BY CHEMTRONICS, INC. IN 1978. APPROXIMATELY 10 ACRES OF THE SITE WERE USED FOR WASTE DISPOSAL OPERATIONS. RECORDS INDICATE THE PRESENCE OF 23 INDIVIDUAL ONSITE DISPOSAL AREAS (DAS) WHICH ARE GROUPED INTO SIX DISCRETE AREAS: DA-6, DA-7/8, DA-9, DA-10/11, DA-23, AND THE ACID PIT. FROM 1952 TO 1971 SOLID WASTE MATERIALS AND POSSIBLY SOLVENTS WERE INCINERATED IN PITS AND CHEMICAL WASTES, INCLUDING WASTE MATERIALS GENERATED IN THE PRODUCTION OF THE CHEMICAL WARFARE AGENT 3-QUINUCLIDINYL BENZILATE (BZ) AND THE TEAR GAS AGENT O-CHLOROBENZYLIDENE MALONONITRILE (CS), WERE PLACED IN 55-GALLON DRUMS WITH A NEUTRALIZING SOLUTION, AND THEN BURIED ONSITE IN TRENCH-TYPE LANDFILLS. FROM 1971 TO 1975 SMALL VOLUMES OF LIQUID WASTES WERE DISPOSED OF IN ONSITE PITS AND TRENCHES, AND SOLID WASTES, ROCKET MOTORS, EXPLOSIVE WASTES, AND OTHER WASTE TYPES WERE BURNED. FROM 1975 TO 1979 CHEMTRONICS, INC. CONSTRUCTED PITS AND TRENCHES AS NEEDED, FOR THE DISPOSAL OF SPENT ACID AND VARIOUS ORGANIC WASTES. IN 1980 THE STATE ORDERED CHEMTRONICS TO DISCONTINUE ALL DISCHARGES TO SITE PITS AND TRENCHES. THE PITS WERE SUBSEQUENTLY BACKFILLED. STARTING IN 1979, CHEMTRONICS INSTALLED A 500,000-GALLON LINED LAGOON OVER AN OLD LEACHING FIELD FOR THE BIOTREATMENT OF WASTEWATER. THE INCOMPATIBILITY OF THE LINER WITH THE BROMINATED WASTES INTRODUCED INTO THE LAGOON CAUSED THE LAGOON TO RELEASE ITS CONTENTS. THE LAGOON WAS RECONSTRUCTED IN AUGUST 1980, USING A DIFFERENT LINER, AND DEACTIVATED IN 1984. IN SEPTEMBER 1984, THE U.S. ARMY TOXIC HAZARDOUS MATERIALS AGENCY SAMPLED TWO DRUMS IN DA-10/11. THESE DRUMS WERE SUSPECTED OF CONTAINING WASTES FROM THE PRODUCTION OF BZ. ALTHOUGH NO BZ WAS FOUND, EPA INITIATED AN IMMEDIATE REMOVAL OF THESE DRUMS IN JANUARY 1985 DUE TO HEIGHTENED PUBLIC AWARENESS OF THE SITE. IN THE ORIGINAL ROD THE SELECTED REMEDIAL

ACTION FOR THE CONTAMINANTS AND CONTAMINATED SOIL IN DA-23 WAS SOIL FIXATION/STABILIZATION/SOLIDIFICATION, FOLLOWED BY CAPPING. THIS REMEDY HAS BEEN CHANGED TO CAPPING ONLY. THE ORIGINAL REMEDY WAS SELECTED DUE TO THE CONCENTRATION LEVEL OF THE CONTAMINANT BENZYLIC ACID A BENZOPHENONE FOUND IN THE GROUND WATER DOWNGRADIENT OF DA-23. HOWEVER, A TRANSCRIPTION ERROR WAS DISCOVERED IN THE ANALYTICAL RESULTS FOR THIS GROUND WATER SAMPLE. THE LABORATORY REPORTED THE CONCENTRATIONS AS 470 MG/L INSTEAD OF 470 UG/L. SUBSEQUENT SAMPLING VERIFIED THAT THE CORRECT CONCENTRATION WAS IN THE 0-470 UG/L RANGE. THEREFORE, EPA ELECTED TO CHANGE THE SOURCE CONTROL REMEDIAL ACTION FOR DA-23 TO CAPPING ONLY. THE PRIMARY CONTAMINANTS OF CONCERN AFFECTING THE SOIL, SEDIMENT, GROUND WATER AND SURFACE WATER ARE VOCS INCLUDING BENZENE, TOLUENE, PCE, AND TCE; OTHER ORGANICS INCLUDING PESTICIDES AND EXPLOSIVES; AND METALS INCLUDING ARSENIC, LEAD, AND CHROMIUM.

THE SELECTED REMEDIAL ACTION FOR THIS SITE INCLUDES MULTI-LAYER CAPPING OF DA-6, DA-7/8, DA-9, DA-10/11, DA-23 AND THE ACID PIT AREA; GROUND WATER PUMPING AND TREATMENT USING AIR STRIPPING, CARBON ADSORPTION, OR METAL REMOVAL WITH TREATMENT AND DISCHARGE TO BE DETERMINED DURING DESIGN; SAMPLING OF POND WATER AND SEDIMENT AND IF NECESSARY, SURFACE WATER TREATMENT USING THE GROUND WATER TREATMENT SYSTEM AND ONSITE DISPOSAL OF SEDIMENTS; IMPLEMENTATION OF INSTITUTIONAL CONTROLS AND ACCESS RESTRICTIONS; AND SEDIMENT, GROUND WATER, AND SURFACE WATER MONITORING. THE ESTIMATED PRESENT WORTH COST FOR THIS REMEDIAL ACTION IS $2,248,900 WITH AN ANNUAL O&M COST OF $501,900.

ROD Remedy-

MIGRATION CONTROL (REMEDIATING CONTAMINATED GROUNDWATER)

* INSTALLATION OF A GROUNDWATER INTERCEPTION AND EXTRACTION SYSTEM DOWNGRADIENT OF THE DISPOSAL AREAS IN BOTH THE FRONT VALLEY AND GREGG VALLEY. THE LEVEL AND DEGREE OF TREATMENT OF THE EXTRACTED GROUNDWATER WILL DEPEND ON 1) THE ULTIMATE DISCHARGE POINT OF THIS WATER AND 2) THE LEVEL OF CONTAMINANTS IN THE EXTRACTED GROUNDWATER. THE THREE WATER DISCHARGE ALTERNATIVES FOR THE TREATED WATER ARE 1) THE LOCAL SEWER SYSTEM, 2) A SURFACE STREAM AND 3) ON-SITE IRRIGATION. THE RANGE OF TREATMENT FOR THE EXTRACTED GROUNDWATER INCLUDES AIR STRIPPING, FILTRATION THROUGH ACTIVATED CARBON FILTER AND METAL REMOVAL. THE POINT OF DISCHARGE AND THE DEGREE OF TREATMENT WILL BE DETERMINED IN THE REMEDIAL DESIGN STAGE. THE WATER DISCHARGED WILL MEET ALL ARAR'S.
* A MONITORING PROGRAM, EMPLOYING BIOASSAYS, WILL BE ESTABLISHED FOR SURFACE WATER/SEDIMENT. MONITORING LOCATIONS WILL BE LOCATED ON THE UNNAMED STREAM, GREGG BRANCH AND BEE TREE CREEK. THE PURPOSE OF THIS MONITORING PROGRAM IS 1) TO INSURE NO ADVERSE IMPACT ON THESE STREAMS DURING IMPLEMENTATION OF THE REMEDIAL ACTION AND 2) TO ESTABLISH A DATA BASE TO USE TO MEASURE THE SUCCESS OF THE REMEDIAL ACTION IMPLEMENTED. THE INITIATION OF THIS MONITORING PROGRAM WILL BE CONCURRENT WITH THE REMEDIAL DESIGN ACTIVITIES.
* REVIEW THE EXISTING GROUNDWATER MONITORING SYSTEM AND INSTALL ADDITIONAL WELLS, IF NECESSARY, TO INSURE PROPER MONITORING OF GROUNDWATER DOWNGRADIENT OF EACH DISPOSAL AREA. THIS INCLUDES DISPOSAL AREAS #6, #7/8, #9, #10/11, #23, AND THE ACID PIT AREA. IN ADDITION TO THE MONITORING OF THE GROUNDWATER DOWNGRADIENT OF EACH DISPOSAL AREA IDENTIFIED ABOVE, ACTION LEVELS FOR THE CONTAMINANTS PRESENT IN THE DISPOSAL AREAS WILL BE SET SO THAT AFTER REMEDIATION

LEVELS FOR GROUNDWATER HAVE BEEN OBTAINED AND VERIFIED THROUGH MONITORING, IF THIS LEVEL IS REACHED IN ANY SUBSEQUENT SAMPLING EPISODE, A REMEDIAL ACTION TO PRESENTLY ELIMINATE THAT SOURCE OF CONTAMINATION WILL BE INITIATED.

SOURCE CONTROL (REMEDIATING CONTAMINATED SOILS)

* CAP DISPOSAL AREA #6, DISPOSAL AREA #7/8, DISPOSAL AREA #9, DISPOSAL AREA #10/11, DISPOSAL AREA #23, AND THE ACID PIT AREA WITH A MULTI-LAYER CAP WHICH INCLUDES A SYNTHETIC LINER. SECURITY FENCING, VEGETATIVE COVERS AND, WHERE DEEMED NECESSARY, A GAS COLLECTION/VENTILATION SYSTEM WILL BE INSTALLED. THE MULTI-LAYER CAP WILL MEET AS A MINIMUM, THE STANDARDS SPECIFIED UNDER 40 CFR SUBSECTION 264, SUBPARTS K-N.
* SAMPLE ON-SITE POND ON UNNAMED STREAM
  DURING THE REMEDIAL DESIGN STAGE, SAMPLE THE WATER AND SEDIMENT IN THE POND. IF THE ANALYSIS INDICATES CONTAMINANTS IN EITHER THE WATER COLUMN OR SEDIMENT, THEN THE POND WILL BE DRAINED, WITH THE WATER BEING TREATED THROUGH THE TREATMENT SYSTEM DEVELOPED FOR ADDRESSING THE EXTRACTED GROUNDWATER AND THE SEDIMENTS WILL BE TRANSPORTED TO ANOTHER DISPOSAL AREA AND CAPPED ALONG WITH THAT DISPOSAL AREA

Site Name: US DOI SANGAM CRAB ORCH NWR
City : CARTERVILLE State: IL EPA Region: 5
ROD Date : 03/30/1990 EPA ID: IL8143609487
NTIS Report Number: EPA/ROD/R05-90/163
Contaminant(s): METALS
CADMIUM
CHROMIUM
LEAD
Env. Media Affected: SOIL
SEDIMENT
DEBRIS
SLUDGE

ROD Abstract-
THE US DOI SANGAMO CRAB ORCHARD NWR SITE IS WITHIN THE CRAB ORCHARD NATIONAL WILDLIFE REFUGE, LOCATED NEAR CARTERVILLE, ILLINOIS. WITHIN THE 43,000-ACRE REFUGE, LAKES AND ADJACENT WETLANDS SUPPORT RECREATIONAL ACTIVITIES ON THE WESTERN PORTION OF THE REFUGE, WHILE THE EASTERN PORTION IS USED FOR MANUFACTURING FACILITIES. SITE FEATURES IN THE EASTERN PORTION INCLUDE A PLATING POND, A DRAINAGE POOL, AND AN INDUSTRIAL LANDFILL. THE DEPARTMENT OF DEFENSE (DOD), THE ORIGINAL ADMINISTRATOR OF THE REFUGE, LEASED PORTIONS TO MUNITIONS AND EXPLOSIVES MANUFACTURERS WHO CONTINUE TO OPERATE ONSITE. IN 1947, DOD TRANSFERRED THE ADMINISTRATION OF THE REFUGE TO THE DEPARTMENT OF THE INTERIOR (DOI). DOI LEASED PORTIONS OF THE REFUGE TO MANUFACTURERS OF PCB-CONTAINING TRANSFORMERS AND CAPACITORS, AUTOMOBILE PARTS, FIBERGLASS BOATS, PLATED METAL PARTS, AND JET ENGINE STARTERS. SOLID WASTES GENERATED FROM THESE INDUSTRIAL ACTIVITIES WERE DISPOSED OF IN ONSITE LANDFILLS, WHILE OTHER LIQUID WASTES MAY HAVE BEEN DISCHARGED INTO NEARBY SURFACE WATERS AND IMPOUNDMENTS. EPA HAS DIVIDED THE SITE INTO FOUR OPERABLE UNITS (OUS) FOR REMEDIATION. THIS ROD ADDRESSES OU1, AND FOCUSES ON THE METAL-CONTAMINATED SOIL, SEDIMENT, DEBRIS, AND SLUDGE IN THREE AREAS OF THE SITE. THESE AREAS ARE; THE AREA 7 PLATING POND (SITE 15), WHICH IS AN INACTIVE 45,000 GALLON POND CONTAINING APPROXIMATELY 280 CUBIC YARDS OF CONTAMINATED MATERIAL; THE OLD REFUGE SHOP DRAINAGE POOL AND INTERMITTENT CREEK (SITE 22), WHICH IS A COLLECTION POINT FOR RUN-OFF, AND CONTAINS APPROXIMATELY 5,200 CUBIC YARDS OF CONTAMINATED MATERIAL; AND THE FIRE STATION LANDFILL (SITE 29), A 350 BY 300 OPEN FIELD CONTAINING APPROXIMATELY 14,600 CUBIC YARDS OF CONTAMINATED MATERIAL. AT LEAST THREE OTHER OUS WILL BE ADDRESSED BY FUTURE RODS, DEPENDING ON SITE INFORMATION COLLECTED IN THE FUTURE. THE PRIMARY CONTAMINANTS OF CONCERN AFFECTING THE SOIL, SEDIMENT, DEBRIS, AND SLUDGE ARE METALS INCLUDING CADMIUM, CHROMIUM, AND LEAD.

THE SELECTED REMEDIAL ACTION FOR THIS SITE INCLUDES EXCAVATING OVER 20,000 CUBIC YARDS OF CONTAMINATED SOIL, SEDIMENT, DEBRIS, AND SLUDGE, AND TEMPORARILY STORING THE WASTE ONSITE UNTIL TREATMENT OR DISPOSAL; TREATING APPROXIMATELY 9,000 CUBIC YARDS OF SOIL, DEBRIS, AND SEDIMENT CONSIDERED TO BE RCRA CHARACTERISTIC HAZARDOUS WASTE USING STABILIZATION AND FIXATION; DISPOSING OF THE TREATED AND NON-TREATED SOIL, DEBRIS, AND SLUDGE ONSITE IN AN INDUSTRIAL (RCRA SUBTITLE D) LANDFILL; CAPPING THE LANDFILL; FILLING THE EXCAVATED AREAS WITH CLEAN SOIL; CONDUCTING ENVIRONMENTAL MONITORING OF GROUND WATER, SURFACE WATER, AND LEACHATE, AND LONG-TERM MAINTENANCE OF THE LANDFILL; AND IMPLEMENTING

INSTITUTIONAL CONTROLS, AND CONTINUING SITE ACCESS RESTRICTIONS. THE ESTIMATED PRESENT WORTH COST FOR THIS REMEDIAL ACTION IS $2,700,858, WHICH INCLUDES AN ANNUAL O&M COST OF $54,371 FOR 30 YEARS.

PERFORMANCE STANDARDS OR GOALS; CLEANUP GOALS FOR SOIL, SEDIMENT, DEBRIS, AND SLUDGE ARE BASED ON THE RISK ASSESSMENT, A (10-6) EXCESS CANCER RISK LEVEL, AND A HI LESS THAN 1. CHEMICAL-SPECIFIC GOALS INCLUDE CADMIUM 10 MG/KG, AND LEAD 450 MG/KG. AT THE AREA 7 PLATING POND, ALL SLUDGE, SOIL, AND SEDIMENT CONTAMINATED WITH CHROMIUM GREATER THAN BACKGROUND WILL BE REMOVED.

INSTITUTIONAL CONTROLS; INSTITUTIONAL CONTROLS WILL BE MAINTAINED TO RESTRICT ACCESS AND PROTECT WILDLIFE AT THE REFUGE.

ROD Remedy-

THIS OPERABLE UNIT IS THE FIRST OF SEVERAL PLANNED FOR THE SITE.

THE REMEDY FOR THE FIRST OPERABLE UNIT ADDRESSES THREE DISTINCT SITES WHICH CONTAIN SOIL AND SEDIMENT CONTAMINATED PRIMARILY WITH METALS SUCH AS CADMIUM, CHROMIUM AND LEAD. A PREFERRED ALTERNATIVE WAS SELECTED BY US EPA FOR A SECOND OPERABLE UNIT, CONSISTING OF FOUR DISTINCT SITES PRIMARILY CONTAMINATED WITH PCBS AND LEAD. PUBLIC COMMENT IS CURRENTLY BEING EVALUATED ON THE SECOND OPERABLE UNIT, AND THE FINAL REMEDY WILL BE SELECTED AFTER THE COMMENTS ARE REVIEWED. THE REMEDY SELECTED FOR THE METALS AREAS OPERABLE UNIT ADDRESSES THE PRINCIPLE THREATS POSED BY THE SITES COMPRISING THE OPERABLE UNIT. THE MAJOR COMPONENTS OF THE SELECTED REMEDY INCLUDE;

* EXCAVATION OF CONTAMINATED SOIL AND SEDIMENT;
* TREATMENT BY STABILIZATION/FIXATION OF ALL EXCAVATED SOIL AND SEDIMENT CONTAMINATED WITH METALS THAT ARE CONSIDERED RCRA HAZARDOUS BECAUSE OF EP TOXICITY TO RENDER THEM NON-HAZARDOUS;
* ON-SITE DISPOSAL OF NON-RCRA HAZARDOUS STABILIZED/FIXED MATERIAL AND UNTREATED RESIDUES EXCEEDING THE CLEAN UP TARGETS IN A LANDFILL MEETING THE REQUIREMENTS OF RCRA SUBTITLE D AND 35 ILLINOIS ADMINISTRATIVE CODE PART 807;
* ENVIRONMENTAL MONITORING DURING AND AFTER REMEDIAL CONSTRUCTION ENSURE THE EFFECTIVENESS OF THE REMEDIAL ACTION.

Site Name: W. R. GRACE & CO., INC.
City : ACTON State: MA EPA Region: 1
ROD Date : 09/29/1989 EPA ID: MAD001002252
NTIS Report Number: EPA/ROD/R01-89/040
Contaminant(s): VOCS
BENZENE
OTHER ORGANICS
METALS
ARSENIC
Env. Media Affected: SOIL
SEDIMENT
SLUDGE

ROD Abstract-

THE W.R. GRACE (ACTON PLANT) SITE IS IN ACTON AND CONCORD, MASSACHUSETTS. THE AMERICAN CYANAMID AND DEWEY & ALMY CHEMICAL COMPANIES FORMERLY OWNED THE 200-ACRE SITE WHERE THEY MANUFACTURED EXPLOSIVES, SYNTHETIC RUBBER CONTAINER SEALANT PRODUCTS, LATEX PRODUCTS, PLASTICIZERS, AND RESINS. IN 1954 W.R. GRACE & COMPANY PURCHASED THE PROPERTY AND BEGAN PRODUCING CONTAINER SEALING COMPOUNDS, LATEX PRODUCTS, AND PAPER AND PLASTIC BATTERY SEPARATORS. EFFLUENT WASTES FROM THESE OPERATIONS FLOWED INTO SEVERAL UNLINED LAGOONS AND WERE LATER BURIED IN ONSITE WASTE AREAS, INCLUDING AN INDUSTRIAL LANDFILL. AFTER A 1978 INVESTIGATION REVEALED THAT GROUND WATER IN THE VICINITY OF THE SITE WAS CONTAMINATED WITH VOCS, W.R. GRACE & COMPANY AGREED TO FULLY RESTORE THE AQUIFER. AN AQUIFER RESTORATION SYSTEM WAS INSTALLED IN 1985 WHICH RECOVERS AND TREATS GROUND WATER UNDER THE SITE'S WASTE DISPOSAL AREAS. SUBSEQUENT SAMPLINGS, HOWEVER, HAVE INDICATED THAT THE SYSTEM HAS ONLY MINIMALLY REDUCED THE GROUND WATER CONTAMINATION AT THE SITE. THIS FIRST OPERABLE UNIT PRIMARILY ADDRESSES THE SOURCE CONTAMINATION AND INCLUDES MINIMAL MODIFICATIONS TO THE AQUIFER RESTORATION SYSTEM. FURTHER GROUND WATER REMEDIATION WILL BE ADDRESSED IN A SUBSEQUENT RECORD OF DECISION. THE PRIMARY CONTAMINANTS OF CONCERN AFFECTING THE SOIL, SEDIMENT, AND SLUDGE ARE VOCS INCLUDING BENZENE AND TOLUENE, OTHER ORGANICS, AND METALS INCLUDED ARSENIC.

THE SELECTED REMEDIAL ACTION FOR THIS SITE INCLUDES EXCAVATION AND OFFSITE INCINERATION OF HIGHLY CONTAMINATED SOIL AND SLUDGE; ONSITE SOLIDIFICATION OF LESS CONTAMINATED SOIL, SLUDGE, AND SEDIMENT FOLLOWED BY ONSITE DISPOSAL IN THE LANDFILL AND CAPPING OF THE LANDFILL; COVERING AND MONITORING OTHER WASTE AREAS; MODIFICATION TO THE AQUIFER RESTORATION SYSTEM TO ADDRESS AIR STRIPPER EMISSIONS CONTROLS; AND ENVIRONMENTAL MONITORING. THE ESTIMATED TOTAL COST FOR THIS REMEDIAL ACTION IS $7,058,000, WHICH INCLUDES AN ESTIMATED O&M COST OF $2,468,000.

ROD Remedy-

THIS ROD ADDRESSES THE FIRST OF THREE PLANNED ACTIVITIES AT THE SITE. TO IMPLEMENT A COMPLETE SITE CLEANUP, EPA HAS ORGANIZED THE WORK IN THREE OPERABLE UNITS (OUS);

OU ONE; DISPOSAL AREAS AND SURFICIAL CONTAMINATION AREAS AT THE SITE.

OU TWO; RESIDUAL CONTAMINATION IN DISPOSAL AREAS AT THE SITE FOLLOWING IMPLEMENTATION OF OU ONE.

OU THREE; CONTAMINATED GROUNDWATER AND THE ESTABLISHMENT OF GROUNDWATER TARGET CLEANUP GOALS.

THE FIRST OU IS THE REMEDY SELECTED TO REMEDIATE SOURCES OF CONTAMINATION AT THE SITE. THE REMEDIAL MEASURES DESCRIBED IN THIS ROD WILL PROTECT THE DRINKING WATER AQUIFER BY MINIMIZING FURTHER CONTAMINATION OF THE GROUNDWATER AND SURFACE WATER, AND WILL ELIMINATE THE THREATS POSED BY DIRECT CONTACT WITH OR INGESTION OF CONTAMINANTS IN SOILS AND WASTE SLUDGES AT THE SITE.

THE MAJOR COMPONENTS OF THE SELECTED REMEDY INCLUDE;

* EXCAVATION AND TRANSPORTATION OFF-SITE FOR INCINERATION OF HIGHLY CONTAMINATED MATERIAL FROM THE BLOWDOWN PIT;
* EXCAVATION AND STABILIZATION OF THE REMAINING CONTENTS OF THE BLOWDOWN PIT, AS WELL AS THE CONTAMINATED SLUDGES AND SOILS OF THE PRIMARY LAGOON, SECONDARY LAGOON, NORTH LAGOON, AND EMERGENCY LAGOON;
* EXCAVATION OF CONTAMINATED SOILS FROM THE BATTERY SEPARATOR LAGOONS, BOILER LAGOON, AND TANK CAR AREA;
* PLACING BOTH THE STABILIZED AND THE NON-STABILIZED MATERIALS EXCAVATED FROM THE SITE ON THE EXISTING INDUSTRIAL LANDFILL, AND COVERING THESE MATERIALS WITH AN IMPERMEABLE CAP;
* POST EXCAVATION SAMPLING AND ANALYSIS;
* CAPPING THE BATTERY SEPARATOR CHIP PILE;
* COVERING ANY DISPOSAL AREA WHICH ATTAINS THE SOIL CLEANUP GOALS;
* MODIFYING THE AQUIFER RESTORATION SYSTEM (ARS) TO ADDRESS AIR STRIPPER EMISSION CONTROLS; AND
* ESTABLISHING LONG TERM ENVIRONMENTAL MONITORING AT EACH DISPOSAL AREA DESIGNED TO MONITOR THE EFFECTIVENESS OF THE PROPOSED REMEDY.

Site Name: BANGOR NAVAL SUBMARINE BASE
City : BANGOR State: WA EPA Region: 10
ROD Date : 09/19/1991 EPA ID: WA5170027291
NTIS Report Number: EPA/ROD/R10-91/033
Contaminant(s): ORGANICS
RDX
2,4,6-TNT
2,4-DNT
2,6-DNT
1,3,5-TNB
1,3-DNB
N-NITRATE
NITROBENZENE
Env. Media Affected: GROUNDWATER

ROD Abstract-
THE BANGOR NAVAL SUBMARINE BASE (SUBASE) IS A FORMER MUNITIONS HANDLING, STORAGE, AND PROCESSING FACILITY IN KITSAP COUNTY, WASHINGTON. LAND SURROUNDING THE SUBASE IS GENERALLY UNDEVELOPED AND SUPPORTS LIMITED RESIDENTIAL USE. THE SITE OVERLIES THE SURFICIAL SHALLOW AQUIFER AND DEEPER AQUIFERS, WHICH ARE THE PRINCIPAL WATER SUPPLIES FOR SUBASE BANGOR AND SURROUNDING COMMUNITIES. DEMILITARIZING (DEMIL) OPERATIONS WERE CONDUCTED FROM 1940 UNTIL 1978, AND INCLUDED COLLECTING CONDENSATE AND SOLID EXPLOSIVE WITHIN A HOLDING TANK, FOLLOWED BY REMOVAL OF THE SOLID MATERIAL FROM THE WASTEWATER BEFORE FINAL DISCHARGE. SITE F, A WASTEWATER LAGOON, WAS USED BETWEEN 1960 AND 1971 FOR THE DISPOSAL OF FINAL WASTEWATER SOLUTION. PERIODICALLY, THE LAGOON WAS ALLOWED TO DRAIN. WASTE MATERIALS PRESENT IN SURFICIAL SEDIMENT OF THE LAGOON WERE BURNED OFF IN PLACE WITH WASTE OILS, OR TRANSPORTED TO THE ONSITE ORDNANCE BURNING AREA FOR THERMAL DESTRUCTION. BETWEEN 1972 AND 1980, WASTEWATER WAS COLLECTED INTO 55-GALLON BARRELS AND DELIVERED TO THE SUBASE LIQUID-WASTE INCINERATOR. SEVERAL ONSITE INVESTIGATIONS OF THE DISTRIBUTION AND TRANSPORT OF WASTE CONSTITUENTS AT SITE F HAVE OCCURRED SINCE 1971. BASED ON DATA COLLECTED, IT WAS CONFIRMED THAT SOIL IN THE LAGOON AREA IS CONTAMINATED BY ORDNANCE CONSTITUENTS. IN 1972, 500 CUBIC FEET OF SOIL WAS EXCAVATED FROM THE TOP SEVERAL FEET OF THE LAGOON AND TRANSPORTED TO THE ONSITE ORDNANCE BURNING AREA FOR BURNING. IN 1980, THE LAGOON WAS FILLED IN AND COVERED WITH A LOW PERMEABILITY ASPHALT COVER. GROUND WATER QUALITY DATA COLLECTED AT SITE F DURING PRIOR STUDIES INDICATED THAT ONLY THE SHALLOW AQUIFER HAS BEEN IMPACTED BY SITE F. THIS RECORD OF DECISION (ROD) IS AN INTERIM REMEDIAL ACTION ADDRESSING GROUND WATER CONTAMINATION AT SITE F AS OPERABLE UNIT 2 (OU2). THE INTENT OF THIS REMEDY IS TO CONTAIN THE CONTAMINATED GROUND WATER PLUME. A FUTURE ROD WILL ADDRESS FINAL REMEDIATION OF BOTH SOIL AND GROUND WATER. THE PRIMARY CONTAMINANTS OF CONCERN AFFECTING THE GROUND WATER ARE ORGANICS INCLUDING RDX; 2,4,6-TNT; 2,4-DNT; 2,6-DNT; 1,3,5-TNB; 1,3-DNB; N-NITRATE; AND NITROBENZENE.

THE SELECTED REMEDIAL ACTION FOR THIS SITE INCLUDES PUMPING AND TREATMENT OF GROUND WATER FROM THE SHALLOW AQUIFER USING UV-OXIDATION; REINJECTING THE TREATED GROUND WATER ONSITE INTO THE SHALLOW AQUIFER, OR INFILTRATING IT ONSITE USING A RECHARGE BASIN; GROUND WATER MONITORING;

AND PROVIDING DESIGN INFORMATION, AS APPLICABLE, FOR THE FINAL REMEDY. IF THE UV-OXIDATION PROCESS CANNOT ACHIEVE THE SPECIFIED PERFORMANCE STANDARDS DUE TO EITHER TECHNOLOGICAL OR ECONOMIC CONCERNS, THEN CARBON ADSORPTION WILL BE COUPLED WITH THE UV-OXIDATION SYSTEM TO COMPLETE THE TREATMENT PROCESS PRIOR TO DISPOSAL. THE ESTIMATED PRESENT WORTH COST FOR THIS REMEDIAL ACTION IS $2,515,000, WHICH INCLUDES AN O&M COST OF $1,300,000 OVER 2 YEARS.

PERFORMANCE STANDARDS OR GOALS; CHEMICAL-SPECIFIC GROUND WATER CLEAN-UP GOALS ARE BASED ON MTCA CLEAN-UP STANDARDS AND INCLUDE RDX 5 UG/L, 2,4,6-TNT 3 UG/L, 2,4-DNT 0.1 UG/L, 2,6-DNT 0.1 UG/L, 1,3,5-TNB 0.8 UG/L, 1,3-DNB 2 UG/L, N-NITRATE 10,000 UG/L, AND NITROBENZENE 8 UG/L.

ROD Remedy-

THE SELECTED REMEDY FOR INTERIM REMEDIAL ACTION FOR SITE F AT THE NAVAL SUBMARINE BASE ADDRESSES THE THREAT POSED BY THE SITE BY PROVIDING GROUNDWATER CONTAINMENT AND ON-SITE TREATMENT WITH PERMANENT REDUCTION IN THE MOBILITY, TOXICITY, AND VOLUME OF CONTAMINATION.

THE ELEMENTS OF THE PREFERRED INTERIM REMEDIAL ACTION ALTERNATIVE INCLUDE;

* EXTRACT GROUNDWATER FROM THE SHALLOW AQUIFER USING EXTRACTION WELLS TO CONTAIN THE CONTAMINATION AND THEREBY CONFINE FURTHER CONTAMINANT MOVEMENT IN THE AQUIFER;
* TREAT THE EXTRACTED GROUNDWATER USING AN ULTRAVIOLET/OXIDATION PROCESS TO MEET APPLICABLE FEDERAL AND STATE REGULATIONS PRIOR TO DISPOSAL;
* DISPOSE OF THE TREATED GROUNDWATER ON-BASE BY RECHARGE OR INJECTION INTO THE SHALLOW AQUIFER; AND
* MONITOR THE EFFECTIVENESS OF THE GROUNDWATER CONTAINMENT AND GROUNDWATER TREATMENT PROCESS THROUGHOUT THE INTERIM ACTION.

DECLARATION OF
THE RECORD OF DECISION

4.2 Other Government Agency Cleanups

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

SITE EVALUATION SERVICES CONTRACT
CONTRACT NO. 1422-N651-C4-3049

FORD PERSONAL COPY

JULY 17, 1995

DRAFT FINAL
ENGINEERING EVALUATION/COST ANALYSIS REPORT

MONITE EXPLOSIVE FACILITY
CARSON CITY DISTRICT, NEVADA

CERCLIS ID # NVD980637540

MONITE

Brown & Root Environmental

C.C. JOHNSON & MALHOTRA, P.C.
ENVIRONMENTAL ENGINEERS & SCIENTISTS

DRAFT FINAL

ENGINEERING EVALUATION/COST ANALYSIS REPORT

MONITE EXPLOSIVE FACILITY

BLM CARSON CITY DISTRICT, NEVADA

CERCLIS IDENTIFICATION # NVD980637540

JULY 17, 1995

CONTRACT NUMBER 1422-N651-C4-3049

Prepared by
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Task Manager

EXECUTIVE SUMMARY

This Engineering Evaluation/Cost Analysis (EE/CA) has been prepared by Brown & Root Environmental to evaluate a possible removal action of nitroaromatic compounds at the Monite Explosive Facility (USEPA ID# NVD980637540), located just outside the city of Sparks in the Bureau of Land Management's (BLM) Carson City District, Nevada. The area of investigation is concentrated over approximately a 7 acre portion of BLM-administered lands, where previous manufacturing activities had occurred. The legal description of the site is Section 28, Township 20 North, Range 20 East (BLM, 1994a; United States Geological Survey [USGS], 1984a; 1984b).

The BLM has determined that a non-time-critical removal action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 is necessary to prevent, minimize, or mitigate damage to public health or welfare. This EE/CA was prepared in accordance with the U.S. Environmental Agency (USEPA) *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (USEPA, 1993a) and is consistent with the USEPA Region IX's Superfund Accelerated Cleanup Model process.

This EE/CA was prompted due to concerns that nitroaromatic-contaminated soils at the site could present a threat to nearby sensitive receptor populations and to persons recreating on-site. The scope of this EE/CA is limited to areas of surface soil contamination and geophysical anomalies within the fenced enclosures on-site so that an evaluation of available removal actions may be conducted. The subsequent recommendation is based on an evaluation of the removal action objectives and the effectiveness, implementability, and cost of the alternatives.

The Monite Explosive Facility started manufacturing explosives sometime in early 1930. The manufacturing process at MEF consisted of material assembly, dehydration, grinding, mixing dry material with oils, loading material in paper shells, a paraffin dip, and final packaging.

During the mid-1950s the site received and dismantled military ordnance. The ordnance was reportedly from the Hawthorne Naval Munitions Plant and included depth charges and other naval ordnance. These were cut open and the explosives (most likely TNT) hammered out (Graig, 1995; Nenzel, 1995; Robinson, 1995). The explosive materials generated through the dismantling process were repackaged

and shipped off-site (BLM, 1993a; 1994a; 1994b; 1994c). According to the former caretaker at the facility, the site ceased operations around 1955 or 1956 (Bateson, 1993).

Site activities may have resulted in the generation of wastewater which could have been released to soils at the site. Additional environmental concerns stemming from past operations include widespread surficial soil contamination and the possibility of explosives buried or discarded on-site (Dynamac Corporation, 1993).

Sampling and analysis activities have documented the presence of 2,4- and 2,6-dinitrotoluene and 2,4,6-TNT in surficial soils (0-3 inches) at the facility. Field screening results indicate two general areas of surficial soil contamination: 1) a large area in the vicinity of the former manufacturing buildings now enclosed by a fence, and 2) a second smaller area to the northwest also enclosed by a fence. Screening concentrations of TNT/dinitrotoluene across the site range from 1.2 to 26,500 mg/kg with maximum concentrations present in the large fenced enclosure. Concentrations of TNT/dinitrotoluene in the smaller fenced enclosure are significantly lower than those in the large fenced enclosure.

Laboratory analysis of soil samples by USEPA Method 8330 indicates that 2,4-dinitrotoluene, and 2,6-dinitrotoluene compounds were detected more frequently than TNT, which implies that dinitrotoluene constitutes the majority of the field screening results. The extent of TNT/dinitrotoluene contamination appears to be primarily limited to surficial soils in the western portion of the large fenced enclosure. The primary objectives of the removal action are to minimize the potential for human exposure to the contaminants and reduce migration of contaminants into the environment. The specific objectives are derived from the media under consideration, contaminants of concern, risk evaluation, and applicable or relevant and appropriate requirements (ARARs). The treatment technologies presented in detail within this document are analyzed for their ability to meet these objectives. The cost analysis provides information to compare the relative costs of remediation alternatives that are considered viable. The overall objective is to achieve all essential goals in a cost-effective manner.

Groundwater was not addressed as part of the EE/CA due to the limited mobility and solubility of the contaminants, the depth to groundwater, and the lack of groundwater use in the immediate vicinity of the site. Sediments in Orr Ditch are considered negligible as part of the EE/CA due to the limited nature of the contamination (CCJM, 1995). This EE/CA report addresses on-site contaminated soils and the investigation/removal of geophysical anomalies within the fenced enclosures. The contaminants of concern are 2,4-dinitrotoluene, 2,6-dinitrotoluene, and TNT. These three contaminants were found at high concentrations (up to 5 percent in soil) in and around the fenced enclosures.

The removal action scope is designed to minimize the actual or potential threat to nearby human populations from the contaminants present in surface soils at the site and to minimize the potential for these contaminants to migrate. The removal action will address the disposition of soils with contaminant levels above the risk-based action levels. SURFER® for Windows was used to aid in interpreting the sampling results. Contour gridding of screening data concentrations (TNT/dinitrotoluene) from over 300 sample locations for depths up to 4 feet was performed using kriging algorithms. The contouring developed a theoretical limit of the areas at various depth intervals for material exceeding the various potential action levels (1, 2.3, 6.6, 10, and 140 mg/kg).

Removal quantities were determined based upon screening results which are not compound specific. In determining the quantity, it was assumed that the screening data represented only 2,4-dinitrotoluene, which has the most conservative cleanup level (proposed @ 6.6 mg/kg). A mathematical relationship between total 2,4-dinitrotoluene concentrations (USEPA Method 8330 data) and the corresponding Toxicity Characteristic Leaching Procedure (TCLP) concentrations indicated that soils with a total 2,4-dinitrotoluene concentration above 8 mg/kg would be classified as exhibiting the RCRA characteristic of toxicity (>0.13 ppm).

The amount of soil requiring removal was determined utilizing SURFER® for Windows contouring and volumetric package as well as professional judgment. The total amount of contaminated soil above the proposed cleanup goal (6.6 ppm) is estimated to be 1,056 cubic yards (in situ). The soil contaminated above the cleanup level may be dealt with by utilizing a variety of techniques. Therefore, the volume of soil above certain benchmark concentrations is presented below.

Cleanup Goal	Estimated In-situ Volume and Weight* of Contaminated Soil
1.0 ppm	1,887 cubic yards (2,830 tons)
6.6 ppm	1,056 cubic yards (1,584 tons)
8.0 ppm	908 cubic yards (1,361 tons)
140 ppm	606 cubic yards (908 tons)

*For conversion purposes, it was assumed that the soil density is 1.5 tons per cubic yard in situ and 1.1 tons per cubic yard ex situ.

The volume of soil above the 8 mg/kg cutoff is estimated at 908 cubic yards. This would allow for disposal of a portion of the contaminated soils between 8 mg/kg and 6.6 mg/kg (~150 cubic yards or 225 tons) at a RCRA Subtitle C facility without treatment.

Many response actions, technologies, and associated process options were screened for use on this site using the general criteria of implementability, effectiveness, and cost. Several technologies and process options were briefly discussed for the general response actions presented. The selection of alternatives is consistent with National Contingency Plan (NCP) Section 300.430(e)(3), which requires evaluation of a range of alternatives and specifies further evaluation criteria.

Pertinent response actions were combined to form the following five specific alternatives. With the exception of the No Action alternative, all alternatives include dust control, investigation/removal of geophysical anomalies, and excavation. In addition, three of these alternatives include disposal to help reduce treatment costs.

- Alternative 1: No Action.

- Alternative 2: Off-site Incineration/Landfilling. This alternative includes excavation of the contaminated soil with conventional excavation equipment, testing of the soil below the excavation to verify removal of contaminants to an acceptable level or excavation to bedrock, transportation, off-site incineration, testing of the incinerated soil to confirm effectiveness, and landfilling of the incinerated soil. The disturbed area would be filled, covered with clean soil, and revegetated. Dust control and air monitoring would be used as necessary for the protection of both public and worker safety during remediation.

- Alternative 3: Off-site Biotreatment. This alternative includes excavation of the contaminated soil with conventional excavation equipment, testing of the soil below the excavation to verify removal of contaminants to an acceptable level or excavation to bedrock, off-site transportation to Hawthorne Army Depot, and probably batch treatment by windrow composting. This alternative assumes a full-scale operation on-going at Hawthorne and agreements in place to accept MEF's contaminated soil. The disturbed area would be filled, covered with clean soil, and revegetated. Dust control and air monitoring would be used as necessary for the protection of both public and worker safety during remediation.

- Alternative 4: Windrow Composting. This alternative includes excavation of the contaminated soil with conventional excavation equipment, testing of the soil below the excavation to verify removal of contaminants to an acceptable level or excavation to rock, on-site composting, testing of the composted soil to confirm effectiveness, and replacement of the composted soil in the excavation. The disturbed area would then be covered with clean soil and revegetated. Dust control and air monitoring would be used as necessary for the protection of both public and worker safety during remediation.

- Alternative 5: Slurry-phase Biotreatment. This alternative includes excavation of the contaminated soil with conventional excavation equipment, testing of the soil below the excavation to verify removal of contaminants to an acceptable level or excavation to rock, on-site treatment, dewatering of the slurry or allowing water to evaporate, testing of the treated soil to confirm effectiveness, and covering of the treatment unit. The disturbed area would then be covered with clean soil and revegetated. Dust control and air monitoring would be used as necessary for the protection of both public and worker safety during remediation.

Each alternative is analyzed in detail in Section 5.0 of this document.

Table ES-1 presents a general comparison of the alternatives and Table ES-2 presents an evaluation of the detailed alternatives against the NCP criteria. Because Alternative 1 (No Action) provides virtually no protection of human health, it has been eliminated from consideration as a viable remedial alternative. Alternative 2 (Off-site Incineration/Landfilling) provides the greatest reduction of risk with a destruction and removal efficiency (DRE) of greater than 99.99 percent of hazardous contaminants. Alternative 2 is also the most expensive alternative to implement, with a cost of approximately $2.6 million; however, this is only approximately $500,000 more than both Alternatives 4 and 5, which require on-site treatment along with some disposal options. Alternative 3 (Off-site Biotreatment) would also be protective of human health, would result in residual contaminant concentrations within acceptable risk ranges, and would likely meet ARARs (depending on results of treatability studies) at a significantly lower cost ($1.2 million).

Alternatives 2 and 3 require that all soils be taken off-site for treatment and/or disposal. The obvious advantages are that both alternatives allow for quick removal with no on-site treatment facilities. However, both involve the greatest risk of accidents during transportation. Still, if negotiations with

the U.S. Army remain positive in the current and future course of action, Alternative 3 (Off-site Biotreatment) offers the best option for the BLM in terms of cost and final disposition of soils subject to the removal action. If agreements with the U.S. Army do not appear possible, Alternative 2 (Off-site Incineration/Landfilling) should be reconsidered. If funding is available, this option (given the relatively small amount of contaminated soil) would appear to be the next best recommendation, with a total estimated cost less than 20 percent above the on-site treatment options.

Alternative 4 (Windrow Composting) and Alternative 5 (Slurry-Phase Biotreatment) are both likely to meet ARARs and would reduce contaminant concentrations to an acceptable risk (between 1×10^{-4} and 1×10^{-6}), based on recent results of pilot-scale tests. Both Alternatives 4 and 5 are very close in price; the cost of Alternative 4 is approximately $20,000 higher than Alternative 5. Treatability/optimization studies must be conducted for each, and on-site operations would take at least 6 to 8 months to implement and complete remediation. Alternative 4 would require five workers on-site for the entire length of the project, whereas Alternative 5 would initially require up to five workers but once the system was in operation only three workers would be required. Alternative 4 would require more surface area (10 acres) and site improvements to prepare for initial field activities (e.g., construction of windrow pads and bins). Additionally, odor control is a major concern for Alternative 4, whereas for Alternative 5 odor control is not expected to be a concern beyond 50 feet from the unit.

If on-site treatment is preferred because of off-site liability and/or regulatory issues, Alternative 5 is recommended for implementation. If for any reason SABRE treatability studies turn out to be negative, Alternative 4 is also a very viable technology and could be implemented at close to the same cost and over approximately the same period of time.

TABLE ES-1

GENERAL COMPARISON OF ALTERNATIVES
MONITE EXPLOSIVE FACILITY, CARSON CITY DISTRICT, NEVADA

Alternative	Would Hazardous Wastes or Treated Wastes Remain Onsite?	Treatability Testing Required	Site Improvements to Implement Proposed Alternative	Number of Full Time Employees Needed to Implement Alternative	Total Time to Implement and Complete Remediation	Total Project Cost
1. No Action	Yes. Because the No Action alternative does not include any treatment, the hazardous wastes would remain inplace.	No	N/A	N/A	N/A	Minimal Cost
2. Off-Site Rotary Kiln Incineration/ Landfilling	No. Soils with constituent concentrations below the RCRA Universal Treatment Standards (UTS) would be sent offsite to either a RCRA Subtitle C or D landfill. Soils with constituent concentrations above the RCRA UTS would be sent offsite for incineration.	No	Improve site access road, utilities (electricity, phone, and water)	2	3 Months	$2,600,694
3. Off-Site Biotreatment	No. All soils >6.6 ppm (cleanup goal) will be excavated and shipped off-site for treatment.	Yes	Improve site access road, utilities (electricity, phone, and water)	2	3 Months	$1,196,476
4. Windrow Composting/ Landfilling	Yes. Soils with constituent concentrations below the RCRA UTS would be sent offsite to either a RCRA Subtitle C or D landfill. Soils with constituent concentrations above the RCRA UTS would be treated onsite by composting and the treatment residuals buried onsite.	Yes	Site grading & leveling for windrow construction on an asphalt pad, an access road to connect treatment area with existing roads, additional graded & graveled areas, utilities (water, electric, phone)	5	6 to 8 Months depending on landfill options or total on-site treatment, respectively.	$2,164,311 to $2,210,203 depending on landfill options or total on-site treatment, respectively.
5. Slurry-Phase Biotreatment (SABRE Technology)/ Landfilling	Yes. Contaminated soil which is not a hazardous waste but has constituent concentrations above the cleanup goal will be sent offsite to a RCRA Subtitle D landfill. Soil that is a RCRA hazardous waste will be treated onsite with the SABRE process and treatment residuals will be buried onsite.	Yes	Additional graded and graveled areas, an access road to connect treatment area with existing roads, utilities (water, phone, electric)	3 to 5 depending on activity	6 Months	$2,144,983

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TABLE ES-2

COMPARISON OF ALTERNATIVES AGAINST NCP CRITERIA
MONITE EXPLOSIVE FACILITY, CARSON CITY DISTRICT, NEVADA

Effectiveness						
Overall Protection	Compliance with ARARs	Long-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume	Short-Term Effectiveness	Implementability	Cost
Alternatives 2, 3, 4, and 5 provide overall protection of human health in accordance with the NCP by reducing the excess cancer risk to within the range 1×10^{-4} - 1×10^{-6}. Alternative 1 provides no protection for future users of the site, does not enhance protection of the environment, and is not addressed further in this table.	Alternative 2 complies with all ARARs. Alternatives 3, 4, and 5 will likely meet most or all of the ARARs depending on results of treatability studies.	Long-term effectiveness is achieved in Alternative 2 by the permanent destruction of >99.99 percent of contaminants. Alternatives 3 and 4 achieve long-term protection by degrading contaminants 97 to 99 percent. Alternative 5 is expected to achieve long-term protection by destroying 99.4 percent of contaminants.	Alternative 2 would provide the greatest reduction of toxicity by destroying virtually all toxic contaminants (>99.99 percent). Stack emissions expected to be of low toxicity due to the use of air pollution control devices. Treated soil is not expected to be hazardous. Alternatives 3 and 4 reduce soil toxicity as measured by bacterial mutagenicity (98 percent) and aquatic toxicity (88 percent). Resulting low levels of explosives and metabolites, bacterial mutagenicity, and leachable toxicity remain after composting, but would not present a health concern. Nutrient-rich compost is residual product. Alternative 5 reduces soil toxicity that requires no additional long-term controls. Treated soil would have low residual TNT and dinitrotoluene concentrations. Treatment would not leave intermediates, if conducted properly. If treatment is terminated prematurely, could result in intermediates. If not fully dried, soil volume would be increased.	Alternatives 2, 3, 4, and 5 pose little risk to the community, workers, or the environment during implementation. Alternatives 2, 3, 4, and 5 use special waste handling procedures (e.g., dust control), monitoring, and use of appropriate protective gear to protect the workers. Because Alternatives 2 and 3 involve no on-site treatment, odors would not be a concern. For Alternative 4 (on-site composting), odor control would be a great concern. For Alternative 5 (SABRE), odors are not expected to be noticeable 50 feet from the unit. Alternatives 2 and 3 would take the least amount of time to implement and complete remediation (3 months). Additionally, they would achieve short-term effectiveness in 2 months (i.e., the amount of time to excavate and remove the soil), the remaining 1 month is for backfilling and recontouring. Alternatives 4 and 5 would take approximately the same amount of time to implement and complete remediation (6 months).	Alternative 2 is a widely accepted and proven method of treatment and poses no unusual design or construction problems and the services are readily available. Alternatives 3, 4, and 5 have been effectively demonstrated in pilot-scale tests at sites with similar wastes and are considered a potentially viable innovative technology. They are commonly used in other applications. A treatability study would need to be conducted for Alternatives 3, 4, and 5. Alternative 3 would require a delay in implementing due to outstanding issues dealing with acceptance of waste by the U.S. Army, tort liability, and coordination with Hawthorne operations.	Alternative 2 is the most expensive with a cost of approximately $2.60 million. Alternative 3 is the least expensive with a cost of approximately $1.20 million. Alternative 4 is slightly higher than Alternative 5 with costs totaling $2.21 and $2.16 million, respectively.

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1.0 INTRODUCTION

1.1 PURPOSE AND BACKGROUND

Brown & Root Environmental has been tasked to prepare an Engineering Evaluation/Cost Analysis (EE/CA) for a possible Removal Action of nitroaromatic compounds at the Monite Explosive Facility (USEPA ID# NVD980637540), located just outside of Sparks in the Bureau of Land Management's (BLM) Carson City District, Nevada. This work is part of the BLM's Hazardous Materials Management Program and was performed by C.C. Johnson & Malhotra (CCJM) and Brown & Root Environmental under the BLM Site Evaluation Contract, Number 1422-N651-C4-3049, Task Order 95-001-BY, Modification 3. The BLM Hazardous Materials Program is designed to identify contamination of BLM lands and facilities resulting from past operations and to institute corrective measures, as needed. The BLM has determined that a non-time-critical removal action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 is necessary to prevent, minimize, or mitigate damage to public health or welfare. This EE/CA was prepared in accordance with the U.S. Environmental Agency (USEPA) *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (USEPA, 1993a) and is consistent with the EPA Region IX's Superfund Accelerated Cleanup Model process.

The specific justification for the removal action is the "actual or potential exposure to nearby human populations...from hazardous substances or pollutants or contaminants"; and "high levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may migrate," as specified in the National Contingency Plan (NCP) 40 CFR Section 300.415 (b)(2)(i and iv). This determination was based upon the results of the sampling conducted as part of the Preliminary Assessment (PA) for the Monite Explosive Facility (CCJM, 1995a). The sampling identified elevated levels of 2,4,6-trinitrotoluene (TNT), and 2,4- and 2,6-dinotrotoluene in the soil at the facility.

This EE/CA was prompted due to concerns that nitroaromatic-contaminated soils at the site could present a threat to nearby sensitive receptor populations and to persons recreating on-site. The scope of this EE/CA is limited to areas of surface soil contamination and geophysical anomalies within the fenced enclosures on-site so that an evaluation of available removal actions may be conducted. The

presence of contaminants that do not pose the potential for direct exposure to human populations under current conditions will be addressed by the BLM in subsequent studies.

The goal of this document is to present potential removal alternatives and describe the recommended option. The subsequent recommendation is based on an evaluation of the removal action objectives and the effectiveness, implementability, and cost of the alternatives.

Vendors of a variety of services and products were contacted during development of this document. Information was obtained as to the availability, effectiveness, and cost of their services/products. In cases where a number of vendors are available only a representative sample (generally the closest to the site) was contacted for pricing. Further, this document is not an offer/solicitation by Brown & Root Environmental or CCJM to conduct the work.

1.2 REPORT ORGANIZATION

This EE/CA consists of seven sections. Section 1.0 introduces the purpose of the report. Section 2.0 presents the site characterization, background information, and analytical data obtained from previous field sampling and laboratory analysis. Section 3.0 identifies the risk-based action levels, applicable or relevant and appropriate requirements (ARARs), and removal action objectives. Section 4.0 presents potentially applicable technologies and alternatives for the sites. Section 5.0 compares the feasible alternatives. Section 6.0 describes the recommended alternative. Section 7.0 lists references.

2.0 SITE CHARACTERIZATION

2.1 FACILITY DESCRIPTION

2.1.1 Facility Location and Description

The Monite Explosive Facility (MEF) is located in the Bureau of Land Management (BLM) Carson City District just outside of Sparks, Nevada. The legal description of the site is Section 28, Township 20 North, Range 20 East (BLM, 1994a; United States Geological Survey [USGS], 1984a; 1984b). The geographic coordinates corresponding to the center of the site are 37°33'58.5" north latitude and 119°44'22.3" west longitude (USGS, 1984a; 1984b; USEPA, 1994a). The site location is shown on Figure 2-1. Investigations of the site have been limited to approximately 7 acres of BLM-administered land, where previous manufacturing activities had occurred.

The site is rectangular in shape and trends northwest to southeast. The site is in a shallow depression (bowl), with small hills located nearby to the north, southeast, and east. The site area slopes toward the northwest (USGS, 1984a; 1984b). Site layout, topography, and two existing fenced enclosures are shown on Figure 2-2.

The MEF is inactive, and there is no indication of mining or grazing activity. No buildings are standing, but the remains of several foundations are evident in the southeastern section of the site. Other site features include two flush-mounted caissons (unknown use--not related to public utilities), an abandoned well, the walls and footings of a bunker, and two excavated trenches (on the eastern part of the site). Several trails or roads cross the facility which are currently used for recreational purposes. An abandoned narrow-gauge railroad grade runs along the eastern portion of the site. Historical features identified from aerial photographs and from a review of historical society records are shown on Figure 2-3.

Access to the site is unrestricted with the exception of a trench excavated along the southern boundary of the site, and two small fenced enclosures. The trench precludes vehicle access to the site from the south except by four-wheel drive; however, entrance to the site is relatively unrestricted from the north, and there is little impediment to casual foot access from any direction. The site is

unattended, and there is considerable evidence of recreational usage including walking, running, bike riding, motorcycling, and target shooting (CCJM, 1994a; 1994b; 1995a).

The fenced enclosures were constructed during September 1993 in the southwestern and southeastern portions of the site. BLM restricted access into these areas due to the discovery of a 320-pound drum of waste and visible soil staining (BLM, Undated). The fencing is about 6 feet high and is topped with barbed wire. A locking swing gate allows access into the enclosures. The larger fenced enclosure encompasses approximately 33,000 square feet, while the smaller occupies about 4,300 square feet (CCJM, 1995b).

A residential area is located adjacent to the southern boundary of the BLM parcel across Orr Ditch to the west. The nearest residence is approximately 100 feet west of the site boundary and about 200 feet from the smaller fenced enclosure (CCJM, 1995b).

Orr Ditch, owned and controlled by the Orr Ditch Company, borders the west side of the Monite Explosives Facility. Orr Ditch is an unlined man-made agricultural canal that flows intermittently and generally remains dry for extended periods (Orr Ditch Company, 1994). Vegetation found along Orr Ditch includes hydrophytes such as Fremont cottonwoods, willows (*Salix spp*), bulrush (*Scirpus spp*), and occasional pockets of cattail (*Typha latifolia*) (CCJM, 1994a; 1994b).

Native vegetation at the site has been impacted by past operations. However, the climate is semi-arid and vegetation is relatively sparse under natural conditions. Plant species noted at the site include sagebrush, bitterbrush, cheatgrass, needlegrass, siberian elms, and black locust trees (CCJM, 1994a; 1994b; 1995b; USDA, 1985). There is little if any vegetation covering waste sources (CCJM, 1994a; 1994b; 1995b).

Information obtained from the Nevada Natural Heritage Program (NNHP) identifies the altered andesite buckwheat (*Eriogonum robustum*), a federally designated sensitive plant species, and the spotted bat, a candidate for federal endangered status (C2 designation) within a 4-mile radius of the site. The NNHP documented the spotted bat (*Euderma maculatum*) in Township 19 North, Range 20 East, Section 7. In addition, there may be raptor populations in the vicinity; however, these species most likely migrate through the area and do not nest in areas contaminated by previous site operations (NNHP, 1995).

The prevailing wind direction is from the west-northwest, with gusts from the southwest, away from nearby houses (NOAA, 1990; USGS, 1984a; 1984b). However, the site is located near the base of

a hillslope where the local topography may affect the prevailing wind direction. The highest average wind speed of 8.2 miles per hour occurs during April; the mean annual wind speed is 6.6 miles per hour. The mean annual precipitation is 7.49 inches (NOAA, 1990).

2.1.2 Facility History

The Monite Explosive Facility started manufacturing explosives sometime in early 1930. Records indicate construction on the facility may have started in the late 1920s (Sparks Tribune, 1930). The facility changed names several times: originally Monite Explosives, Inc. managed by E.H. Hamlin, from 1927 to 1932; Rocky Mountain Explosives, Inc. from 1932 to 1935; and Explosives, Inc. from 1935 to 1938. There is no listing for the facility after 1938 until 1948 when the name again changed this time to the International Explosive Company (CCJM, 1995c; Dynamac Corporation, 1993).

Information concerning the explosive agent at Monite is not available but it is believed to have been nitroglycerine based. A 1930 newspaper article indicated that the Monite explosives differed materially from dynamite in order to make the product easier to handle (Sparks Tribune, 1930). Monite explosives may have been a mixture of nitroglycerine and 2,4-dinitrotoluene. 2,4-dinitrotoluene was used in some explosive mixtures in 1931 (U.S. Army, 1984). High levels of dinitrotoluene were found on the site in 1992.

The manufacturing process at the Monite Explosive Facility consisted of material assembly, dehydration, grinding, mixing dry material with oils, loading material in paper shells, a paraffin dip, and final packaging. The sizes of the explosives manufactured ranged from ⅞ to 1¼ inches in diameter and the standard 8 inches in length. Small conveyors on mine rails transported the packaged explosives from the plant to the warehouse, which was located on-site (Sparks Tribune, 1930).

BLM was able to obtain additional information on historical site operations through interviews with former employees. They indicated that during the mid-1950s the site received and dismantled military ordnance. The ordnance was reportedly from the Hawthorne Naval Munitions Plant and included depth charges and other naval ordnance. These were cut open and the explosives (most likely trinitrotoluene [TNT]) hammered out (Graig, 1995; Nenzel, 1995; Robinson, 1995). The explosive materials generated through the dismantling process were repackaged and shipped off-site (BLM, 1993a; 1994a; 1994b; 1994c).

According to the former caretaker at the facility, the site ceased operations around 1955 or 1956 (Bateson, 1993). During the mid-1970s the facility was dismantled during scavenging operations, but the exact date of dismantling is uncertain. Site structures have been reduced to several cement foundations and numerous debris piles scattered throughout the site (CCJM, 1994a; 1994b; 1995b; Dynamac Corporation, 1993). Continuing analysis of historical aerial photography indicates that the site activities may have continued beyond 1956.

Site activities may have resulted in the generation of wastewater which could have been released to soils at the site. Additional environmental concerns stemming from past operations include widespread surficial soil contamination and the possibility of explosives buried or discarded on-site (Dynamac Corporation, 1993).

2.1.3 Site Geology

The Monite Explosive Facility lies at the southern end of Washoe County. The southern two-thirds of Washoe County has a topography typical of the Basin and Range physiographic province. The Basin and Range Province is typically composed of elongated mountain ranges bounded by tensional faults and separated by alluvial/colluvial basins. Igneous, metamorphic, and sedimentary rocks cover the area, ranging in age from the Permian through Quaternary Periods. The oldest exposed rock is granodiorite probably of Mesozoic age. The granodiorite is overlain by pyroxene andesite flows of the Alta Formation, the principal exposed rock unit.

The facility is situated on a geologic unit consisting largely of consolidated rocks characterized by low water-yielding capacity (NBMG, 1969). Groundwater immediately underlying the site is associated with sedimentary, volcanic and altered volcanic rocks, and is typically encountered at depths of about 100 feet below ground surface (bgs). Permeability is low and, depth to water is considered deep for the Alta Formation. Approximately 0.1 mile south of the site is the surface contact between the Alta Formation and the Quaternary members of the alluvial fan deposits underlying the Pyramid Lake Highway (NBMG, 1992).

Water well yields from unconsolidated materials in the vicinity of MEF are sufficient for domestic use but are only marginally sufficient for agriculture or municipal use. Water well yields for consolidated rocks near the Spanish Springs Valley floor are marginally sufficient for domestic use and insufficient for agriculture or municipal use. These consolidated rock formations, the same as those underlying the

site, are impractical for use due to the depth to water and the relatively low permeability (NBMG, 1992).

Soils underlying the facility are classified by the United States Soil Conservation Service as members of the Risley-Rock outcrop complex. This unit consists of approximately 65 percent Risley very stony loam, 15 to 30 percent slopes, and about 25 percent rock outcrop. The Risley soil is located on side slopes of upland areas while rock outcrops occupy ridges and peaks. The Risley soil is moderately deep and well drained. Risley soils form in residuum consisting predominantly of altered, weathered andesite. Typically, 3 to 10 percent of the surface is covered with stones. The surface layer is a light gray, very stony loam about 3 inches thick. The subsoil is brown clay about 20 inches thick. Weathered, altered andesite occupies the subsurface at a depth of approximately 23 inches (USDA, 1985).

Permeability of the Risley soil is slow. Available water capacity is low. Effective rooting depth is 20 to 30 inches. Runoff is medium to rapid, and the hazard of water erosion is moderate to high. Rock outcrops consist of exposed andesite on small peaks and on ridges (USDA, 1985).

A single metal casing, possibly a well, is present on-site. However, it is filled with dirt and assorted debris. No records related to the property were found on file with the Nevada State Engineers Office, Division of Water Resources (CCJM, 1995b).

A well driller's report on file with the Nevada Department of Water Resources (NDWR) indicates that a domestic well (Log #26172) is located about 1,500 feet south of the site. This well (Evans well, 601 Queens Way) is the nearest documented drinking water well to the site. The lithology at this location consists of 25 feet of sand at the surface. The sand is underlain by alternating sequences of volcanic rock, clay, and sandstone strata to a total logged depth of 330 feet bgs. The well casing is perforated at 100 to 120 feet bgs and 300 to 320 feet bgs, and the corresponding formations at these intervals are described as white and yellow clay and gray sandstone. Upon well completion, the static water level was at 70 feet bgs and the yield was 10 gallons per minute (gpm) (NDWR, 1995).

The general direction of near-surface groundwater flow beneath the site is to the south, toward the Truckee River. Locally, the direction due to fracture flow may vary considerably. The lateral continuity, vertical hydraulic conductivity, and permeability of the alternating sequences of fractured volcanic rock, clay, and sandstone have not been established (CCJM, 1995b).

2.1.4 Site Hydrology

The surface water migration pathway is comprised of an overland segment and an in-stream segment. The overland segment begins at the site and continues downgradient to Orr Ditch (USGS, 1985).

Sensitive environments present along a 15-mile in-stream distance include areas mapped by the U.S. Fish and Wildlife Service (USFWS) as lacustrine wetlands adjacent to surface water impoundments associated with the Spanish Springs Valley, and areas mapped as riverine wetlands associated with the Truckee River. Orr Ditch is mapped as an intermittent, artificial, riverine wetland (USFWS, 1979; 1988a; 1988b).

A Preliminary Assessment (PA) conducted in late 1994 by CCJM confirmed the presence of pockets of hydrophytic vegetation along Orr Ditch. Whether the U.S. Army Corps of Engineers (COE) assumes jurisdiction over Orr Ditch under Section 404 of the Clean Water Act may depend on whether irrigation water is the ditch's only source of water. Orr Ditch is a man-made water conveyance crossing an upland landscape. The technical manual used by the COE to delineate wetlands indicates that areas of man-made origin supporting hydrophytic vegetation and extended periods of saturation or inundation, such as Orr Ditch, are wetlands that are regulated under Section 404. However, the manual goes on to state that if the hydrophytic vegetation is being maintained only because of man-induced wetland hydrology that would no longer exist if the activity (e.g., irrigation) were terminated, the area should not be considered a wetland (Environmental Laboratory, 1987).

2.2 PREVIOUS REMOVAL ACTIONS/INVESTIGATIONS

In 1992, children playing on the site discovered a drum containing approximately 320 pounds of what was determined to be dinitrotoluene. The materials were removed by personnel from the City of Sparks/Reno Bomb Squad, Washoe County Health Department, and the BLM State Office. Bomb squad personnel secured the drum and transported it approximately 25 miles north of town (BLM, Undated). An explosive charge was placed on the drum and subsequently detonated (Murray, 1995).

On August 11, 1993, 14 random soil samples were collected. The locations were selected based upon historic aerial photographs. BLM personnel collected samples from areas of visible contamination for laboratory analysis. Aero-Jet Analytical Laboratories used a Modified U.S. Environmental Protection Agency (USEPA) Method 8330 to positively identify and quantify the contaminants present. The analysis indicated the presence of TNT at levels up to about 50,000 mg/kg (5 percent by weight); 2,6-

dinitrotoluene at up to 3,600 mg/kg; and 2,4-dinitrotoluene at up to 5,100 mg/kg (BLM, 1993b). Based upon results of this sampling, the larger of the two current fenced enclosures was established (Figure 2-2).

On November 16-17, 1993, the BLM Service Center and Carson City District personnel, in conjunction with Washoe District Health Department officials, collected and analyzed 92 soil samples for the presence of TNT at the site. During this activity, sampling personnel collected 70 samples from a grid. Samples were collected from grid points spaced on 20- to 40-foot centers over a 1-acre parcel that formerly housed the manufacturing facilities (BLM, 1993b).

BLM analyzed the samples for the presence of TNT and related compounds using a field screening technique, Ensys Soil Test System (USEPA SW-846, Method 8510). The resulting values indicated maximum concentrations above 100 mg/kg for site soils. Several hot spots of TNT-related compounds were mapped as a result of this investigation, including localized zones outside the fenced areas. It was determined that the field screening method requires dilutions for concentrations greater than ~100 ppm.

Eleven additional soil samples were collected from points other than the grid locations. BLM personnel focused these sampling efforts in areas of stained soils within what is now the larger fenced enclosure. Sample depths for these locations ranged from 6 inches to 24 inches bgs. Information gathered as a result of this effort indicated the presence of TNT and related compounds at depths up to 24 inches below ground surface (bgs) (BLM, 1993b).

In the spring of 1994, children playing on-site found 3.5 pounds of a crystalline material which was believed to be 2,4-dinitrotoluene. The Reno/Sparks Bomb Squad responded. An explosive charge was placed on the crystalline material and detonated in place on April 4, 1994 (Murray, 1995). The BLM then fenced an additional (smaller) area where the chunk of crystalline material was discovered, and attempted to limit vehicular traffic to the site through the placement of large rocks along some of the site boundaries. Initially, signs within the fenced area were stolen, indicating that access had not been effectively restricted. The signs have not been disturbed recently. The fences are deterring access to the areas of highly contaminated soils; however, pedestrian, all-terrain vehicle (ATV), and bicycle traffic across the unfenced portions of the site continues unimpeded.

Unauthorized, indiscriminate dumping was evident throughout the site when it was first discovered, and typically consisted of municipal wastes such as boilers, scrap metal, whiteware (e.g, sinks), and

car bodies (CCJM, 1994a; 1994b). Most of the waste and construction debris was removed prior to a geophysical survey conducted in 1994 (Murray, 1995).

In October 1994, CCJM was tasked to conduct a PA at the Monite Explosive Facility. The PA included establishing a sampling grid which encompassed approximately 7 acres. Samples were collected at 25-foot intervals across the entire grid. The sampling grid is shown in Figure 2-4. A total of 894 soil samples were collected and analyzed using a TNT field screening method with dilutions (Jenkins, 1990); 15 were collected and analyzed for the full USEPA Contract Laboratory Program (CLP) Target Analyte List (TAL) inorganics and Target Compound List (TCL) organics, and 152 samples were analyzed for explosives using USEPA Method 8330. Concentrations of dinitrotoluene of up to 6 percent and TNT levels up to 5 percent were found in site soils. In addition, small yellowish crystals were analyzed and found to contain approximately 10 percent dinitrotoluene.

In October 1994, a surface geophysical investigation was conducted at the site by Microgeophysics Corporation. As part of the investigation, magnetics and electromagnetics (EM61) methods were conducted over a 900 by 775 foot area. A total of 108 anomalies were identified. Anomalies attributable to surface material or cultural features were classified as "SA" (surface anomaly). Anomalies of particular interest include two possible underground storage tanks and a possible pipeline or trench running through the larger fenced enclosure (MicroGeophysics Corporation, 1994). Geophysical anomalies are indicated in Figure 2-5 and an explanation of each is given in Appendix C.

In March 1995, contaminated soil (>5 ppm dinitrotoluene) from a small area on the east side of the larger fenced enclosure was excavated and contained in four drums which were then placed inside the larger fenced enclosure. The enclosure was also extended 40 feet to the southwest in order to restrict access to another area of contaminated soil. Both of these areas were delineated during sampling for the PA conducted by CCJM (BRE, 1995).

Additional samples were collected in April 1995 to delineate the vertical extent of contamination within the fenced enclosures. Twenty grab sample locations were sampled at depths of 1, 2, and 3 feet bgs. The samples were analyzed using the TNT/dinitrotoluene screening method previously described. In addition, nine samples were collected and analyzed for explosives using the USEPA Method 8330 and also for leachable 2,4-dinitrotoluene using the Toxicity Characteristic Leaching Procedure (TCLP).

On April 18, 1995, a partially collapsed underground tunnel system was discovered. The underground works were formerly used for storage of explosives. BLM had noted that the storage area was free

of explosives and filled the entrance with dirt in the late 1980s. Children had recently discovered the collapse and were seen entering the former storage area. On April 20, 1995, BLM collapsed approximately 30 feet of the tunnel length and backfilled with clean soil in order to prohibit entrance (BRE, 1995). The underground storage area was not sampled due to the risk of collapse.

The two chainlink fences on-site have not completely prohibited the entry of unauthorized individuals into the enclosed areas of surface soil contamination. Evidence of unauthorized entry has been documented by the removal of pin flags from sampling grid points within the enclosures (CCJM, 1994a; 1994b; 1995b).

On April 26, 1995, the Washoe County District Health Department issued an order to the BLM Carson District Office concerning the Monite Explosive Facility. The order stated that based on levels of soil contamination and recreational usage, the site poses an imminent threat to the human health of adjacent residents. BLM was ordered to restrict access over contaminated areas and to issue an advisory statement to residents of adjacent properties. In addition, BLM was to determine the extent of soil contamination, submit a plan for its remediation to the Washoe County District Health Department (Division of Environmental Health Services) for approval, and commence remediation activities no later than 90 days following approval (Rice, 1995).

2.3 SOURCE, NATURE, AND EXTENT OF CONTAMINATION

Sampling and analysis activities have documented the presence of dinitrotoluene and TNT in surficial soils (0-3 inches) at the facility. Field screening results indicate two general areas of surficial soil contamination: 1) a large area in the vicinity of the former manufacturing buildings now enclosed by a fence, and 2) a second smaller area to the northwest also enclosed by a fence. Screening concentrations of TNT/dinitrotoluene across the site range from $\leq$ 0.55 (below the detection limit) up to 26,500 mg/kg with maximum concentrations present in the large fenced enclosure. Concentrations of TNT/dinitrotoluene in the smaller fenced enclosure are significantly lower than those in the large fenced enclosure. Figure 2-6 shows the approximate lateral extent of TNT/dinitrotoluene surficial soil contamination based on an example case with the lower concentration limit set at 1 mg/kg. Only grid lines A through N were used for contaminant concentration contouring. As shown in Figure 2-6, several small areas of surficial soil contamination ($\geq$ 1 ppm) exist outside of the two current fenced enclosures.

Laboratory analysis of soil samples by USEPA Method 8330 indicates that 2,4-dinitrotoluene, and 2,6-dinitrotoluene compounds were detected more frequently than TNT, which implies that dinitrotoluene constitutes the majority of the field screening results. The extent of TNT/dinitrotoluene contamination appears to be primarily limited to surficial soils in the western portion of the large fenced enclosure. The total area of surficial soil contamination (based on the field screening results of > 1 ppm TNT/ dinitrotoluene) was determined to be approximately 28,200 square feet.

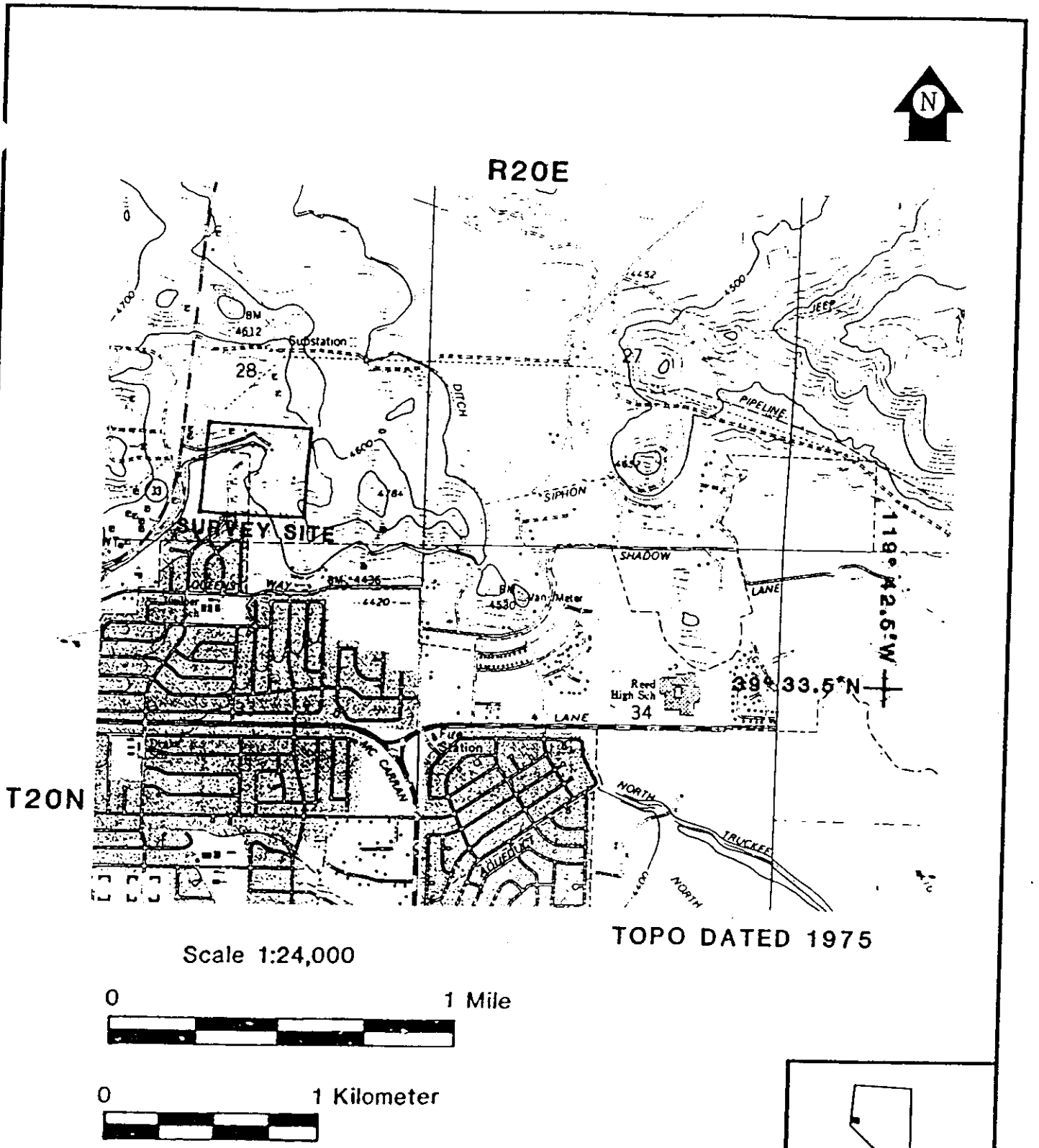
Vertical extent of soil contamination was determined on the basis of the April 1995 sampling and analysis of 26 (21-screening, 5-USEPA method 8330) locations ranging from 1-foot depths to 8 feet. Assumptions were made that surrounding surface non-detect locations are non-detect in the subsurface. Subsurface soil contamination at concentrations exceeding 1 mg/kg exists within the two fenced enclosures. The total area of soil at the 2-foot depth interval exceeding 1 mg/kg TNT/dinitrotoluene was estimated to be 14,972 square feet with a maximum concentration of 2,300 mg/kg. TNT/dinitrotoluene concentrations and total area of soil decrease significantly at the 3- and 4-foot depth intervals. TNT/dinitrotoluene was detected in only two soil samples collected at the 4-foot depth interval, with a maximum concentration of 12.8 mg/kg in the west-central portion of the larger fenced enclosure. The area of soil exceeding 1 mg/kg at the 4-foot depth interval was estimated to be 1,991 square feet.

Soil samples analyzed for full CLP TAL and TCL indicated that no volatile, semivolatile, pesticides, or polychlorinated biphenyls (PCBs) were detected other than toluene (2.5 ppm). Inorganic constituents detected in site soils greater than three times background include lead and mercury (CCJM, 1995). However, concentrations of these constituents are not persistent and are at low enough levels so they are not believed to have any effect on remediation alternatives.

2.4 DESCRIPTION OF CONTAMINATION

TNT and both isomers of dinitrotoluene were detected at significant concentrations in soil samples. With respect to the terrestrial fate of 2,4-dinitrotoluene, the estimated soil adsorption coefficient (K_{oc} = 282) indicates that it is slightly mobile in soil and has less tendency to adsorb to low organic sediment (Howard, 1989). Nitroaromatic compounds are not susceptible to hydrolysis, and photolysis should not be an important process in soil. Some biodegradation may occur in both aerobic and anaerobic zones of soil. Various studies indicate that 2,4-dinitrotoluene will not significantly bioconcentrate in aquatic organisms (Howard, 1989).

With respect to the terrestrial fate of 2,6-dinitrotoluene, the calculated soil adsorption coefficient (K_{oc} = 204) indicates that it is also slightly mobile in soil, and has only a slight tendency to sorb to sediments, suspended solids, or bioconcentrate in biota (Howard, 1989).

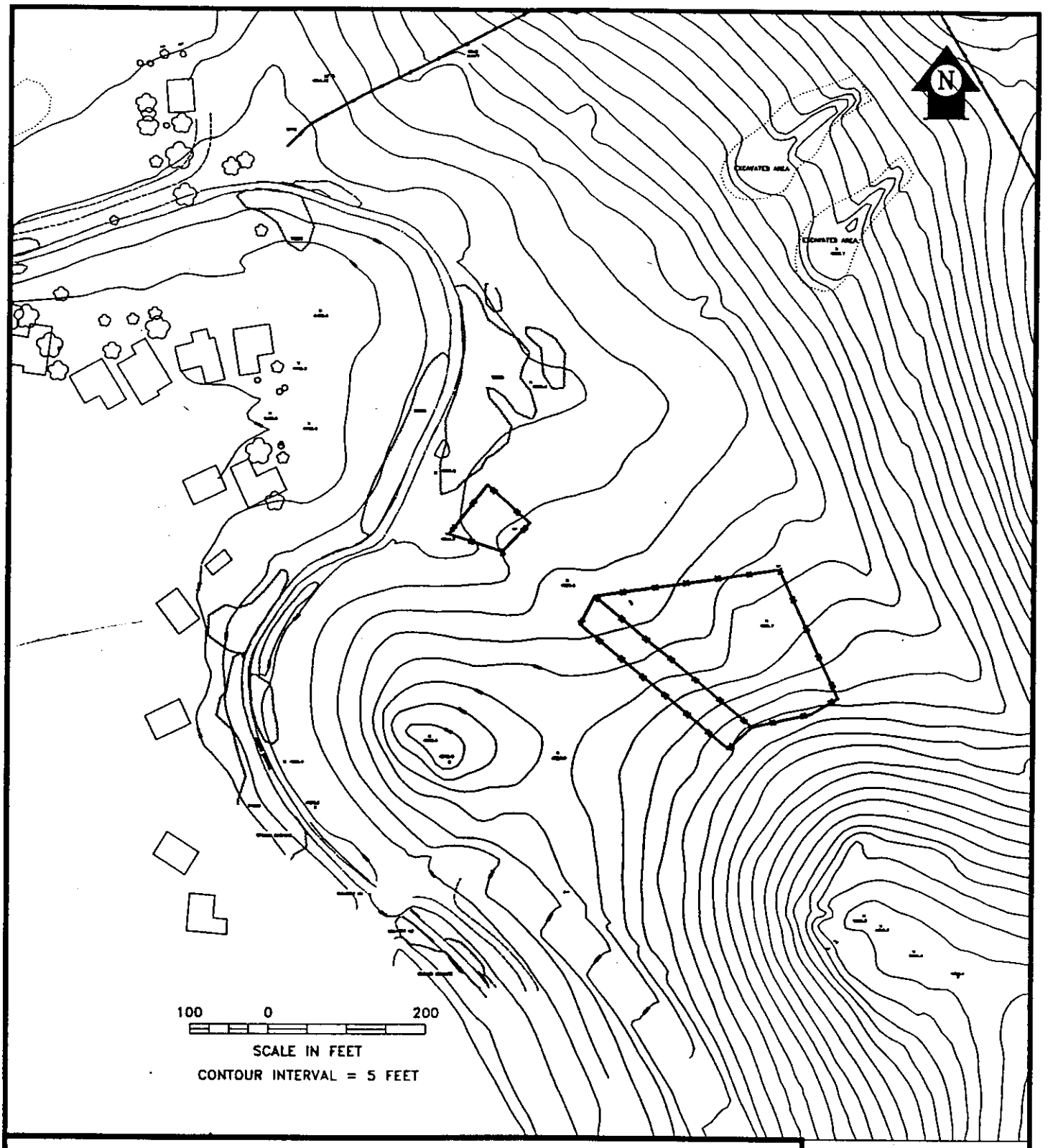


QUADRANGLE LOCATION

SOURCE: MICROGEOPHYSICS CORPORATION, 1994

SCALE: AS SHOWN	BUREAU OF LAND MANAGEMENT BLM - MONITE EXPLOSIVE FACILITY SPARKS, NEVADA LOCATION MAP	FIGURE 2-1
DATE: MAY 1995		DRAWN BY: RSG

BROWN AND ROOT ENVIRONMENTAL

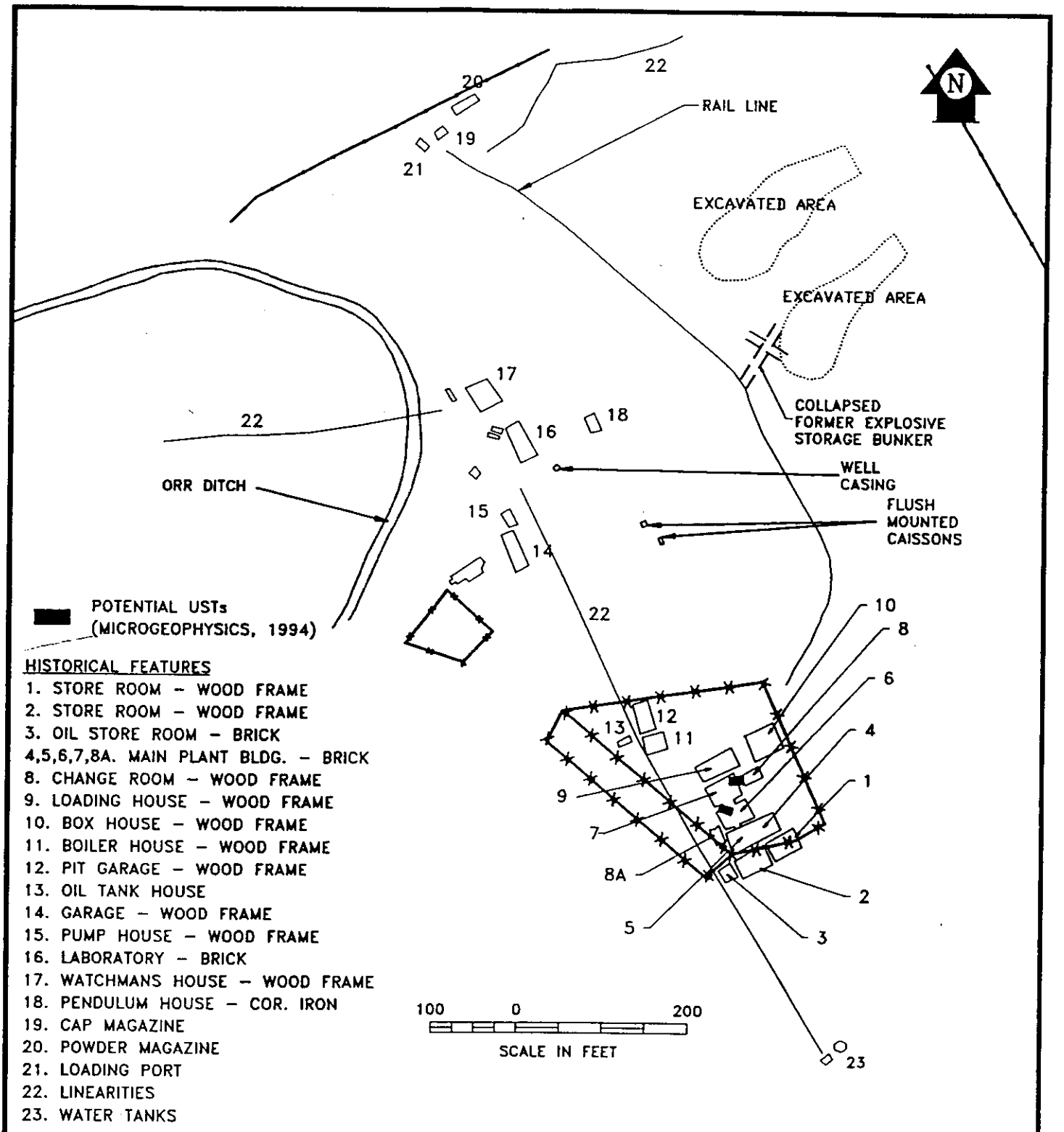


SOURCE: CCJM, 1995b

SCALE: AS SHOWN	BUREAU OF LAND MANAGEMENT BLM - MONITE EXPLOSIVE FACILITY SPARKS, NEVADA	FIGURE 2-2
DATE: JULY 1995	SITE LAYOUT MAP	DRAWN BY: RSG

FIGURE22... DATE 07-13-95 1200 ACADR13 RSG

BROWN AND ROOT ENVIRONMENTAL

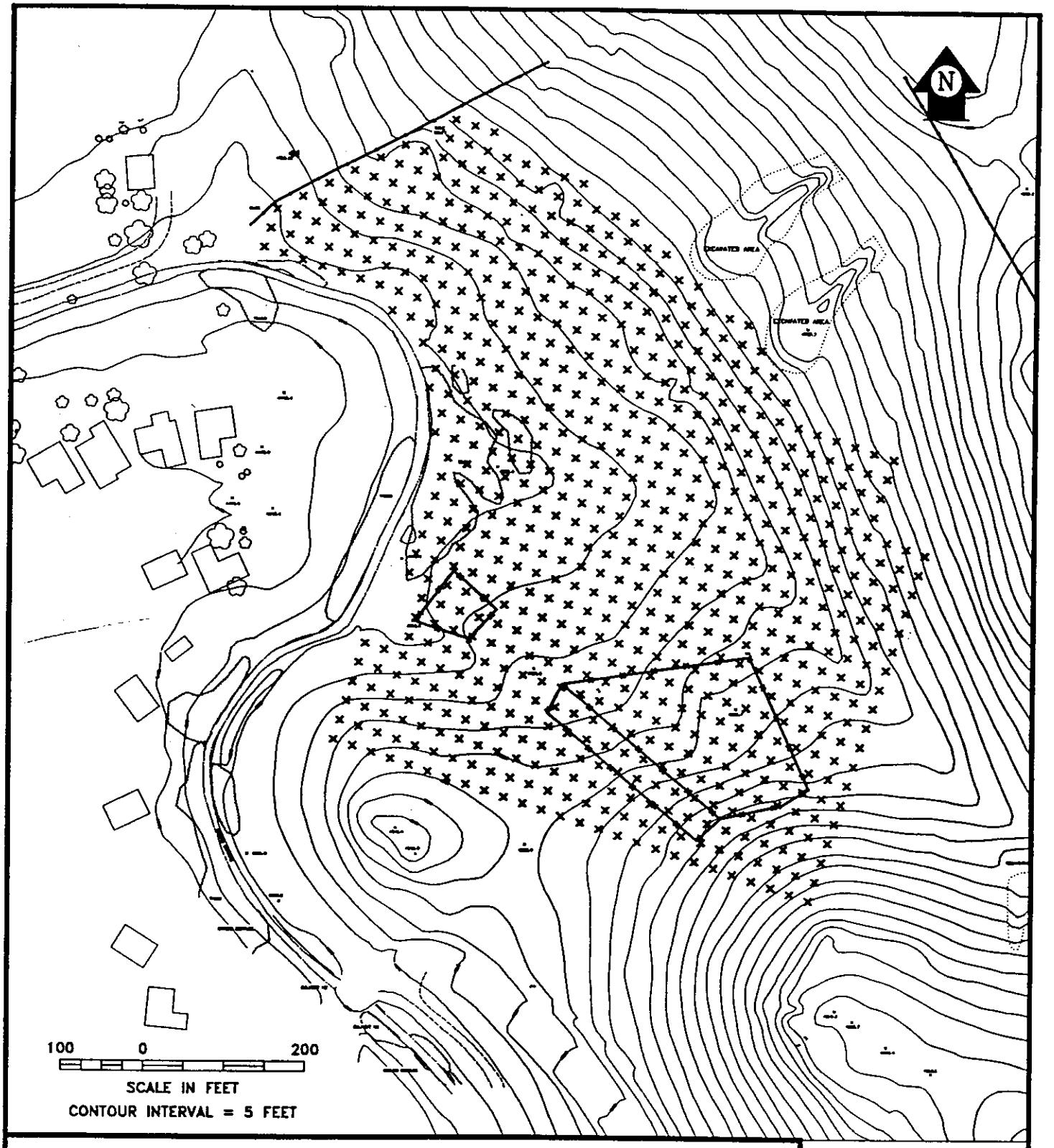


SOURCE: BLM REMOTE SENSING AND DISTRICT OFF, CARSON CITY, NEVADA

SCALE: AS SHOWN	BUREAU OF LAND MANAGEMENT BLM - MONITE EXPLOSIVE FACILITY SPARKS, NEVADA	FIGURE 2-3
DATE: JULY 1995	CULTURAL AND HISTORICAL FEATURES	DRAWN BY: RSG

FIGURE23. DATE 07-13-95 1200 ACADR13 RSG

BROWN AND ROOT ENVIRONMENTAL

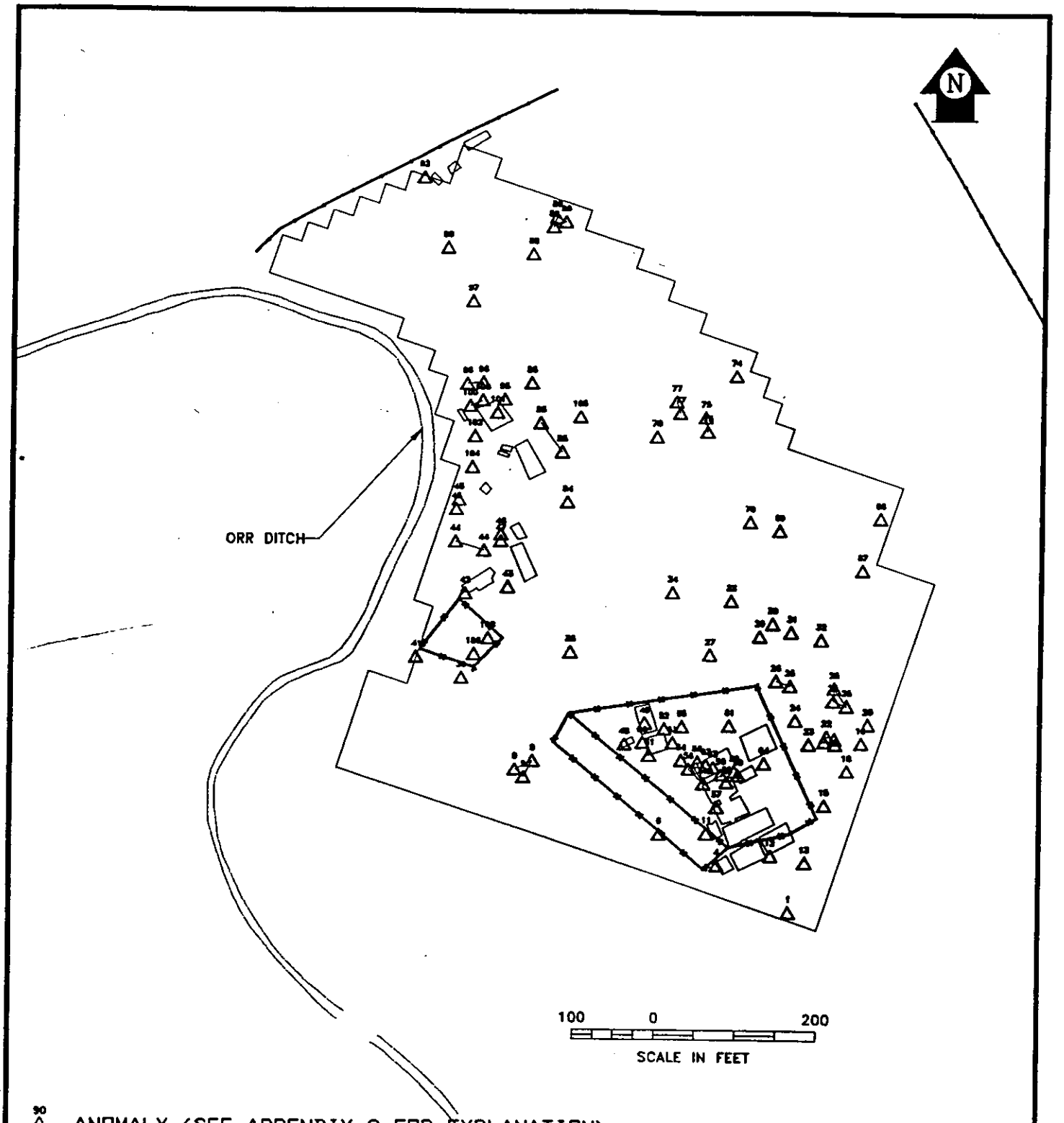


SOURCE: CCJM, 1995b

SCALE: AS SHOWN	BUREAU OF LAND MANAGEMENT BLM - MONITE EXPLOSIVE FACILITY SPARKS, NEVADA	FIGURE 2-4
DATE: JULY 1995	SAMPLING GRID	DRAWN BY: RSG

FIGURE24. DATE 07-13-95 1200 ACADR13 RSG

BROWN AND ROOT ENVIRONMENTAL



ANOMALY (SEE APPENDIX C FOR EXPLANATION)

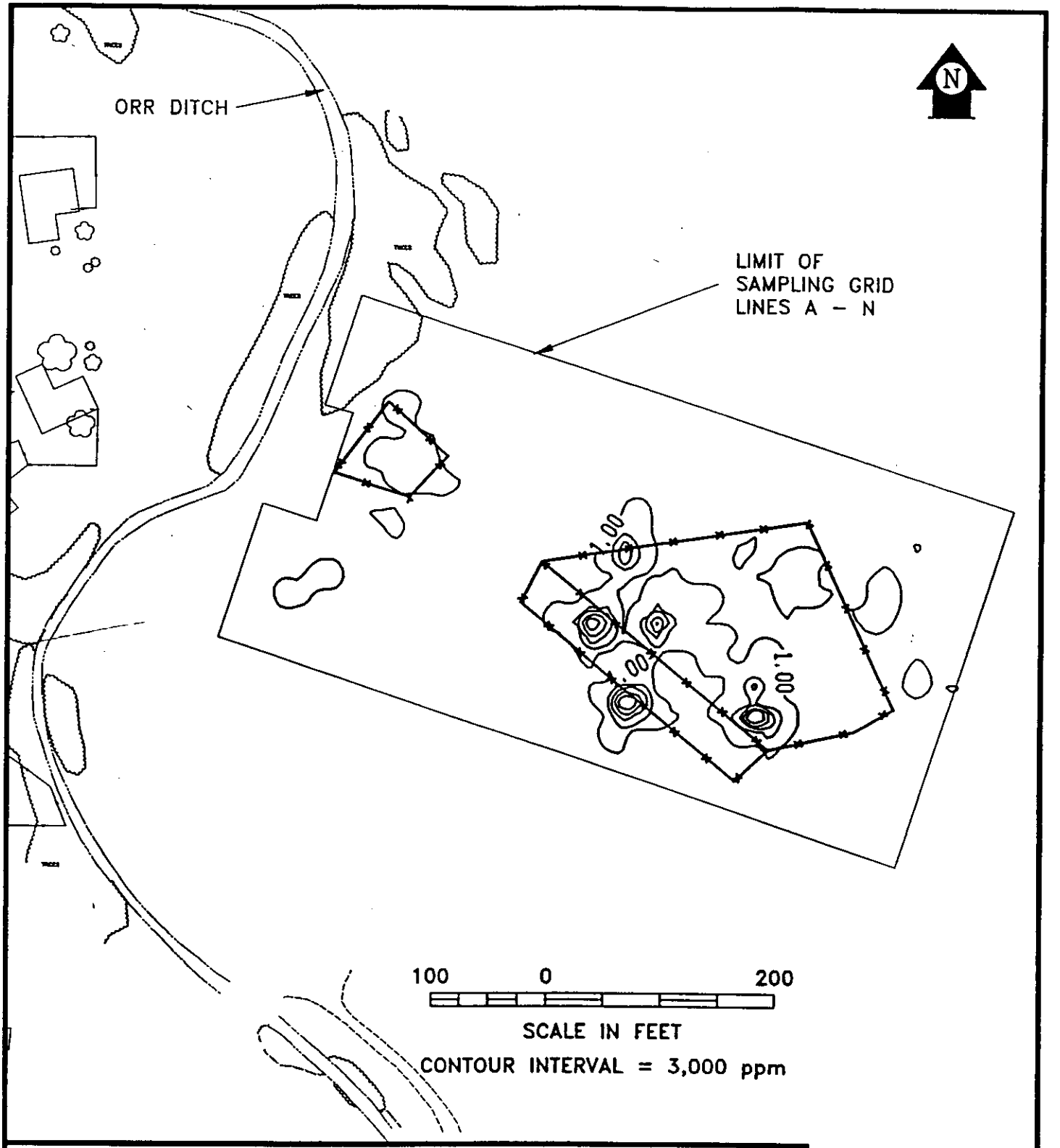
SOURCE: MICROGEOPHYSICS CORPORATION, 1994

SCALE: AS SHOWN	BUREAU OF LAND MANAGEMENT BLM - MONITE EXPLOSIVE FACILITY SPARKS, NEVADA	FIGURE 2-5
DATE: JULY 1995	GEOPHYSICAL ANOMALIES	DRAWN BY: RSG

DATE 07-13-95 1200 ACADR13 RSG

FIGURE25

BROWN AND ROOT ENVIRONMENTAL



SOURCE: BROWN AND ROOT ENVIRONMENTAL, 1995

SCALE: AS SHOWN	BUREAU OF LAND MANAGEMENT BLM - MONITE EXPLOSIVE FACILITY SPARKS, NEVADA	FIGURE 2-6
DATE: JULY 1995	AREAL EXTENT OF TNT/DNT CONTAMINATION (GREATER THAN 1 ppm)	DRAWN BY: RSG

FIGURE26... DATE 07-13-95 1200 ACADR13 RSG

BROWN AND ROOT ENVIRONMENTAL

3.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

3.1 PROJECT OBJECTIVES

The primary objectives of the removal action are to minimize the potential for human exposure to the contaminants and reduce migration of contaminants into the environment. The specific objectives are derived from the media under consideration, contaminants of concern, risk evaluation, and applicable or relevant and appropriate requirements (ARARs). The treatment technologies presented in later sections are analyzed for their ability to meet these objectives. The cost analysis provides information to compare the relative costs of remediation alternatives that are considered viable. The overall objective is to achieve all essential goals in a cost-effective manner.

ARARs are presented below which set chemical-specific action levels or which restrict or limit site activities. Risk-based action levels, the scope of the removal action, and estimated quantities are also presented. The general schedule for this removal action project is discussed in Section 3.4.

3.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Actions at any hazardous waste site, including federal facilities must comply with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 and the Superfund Amendments and Reauthorization Act (SARA) of 1986, Sections 120 and 121. These sections mandate that the development and selection of remedial/removal action alternatives comply with requirements or standards under state or federal environmental laws that have ARARs for the substances or circumstances at the site. More stringent state laws take precedence over federal laws that are less stringent in those cases where standards are promulgated by both. Primary consideration is given to the degree of public health or environmental protection afforded by each remedy or remedies that attain or exceed ARARs.

Depending on the status of the federal facility (i.e., National Priorities List [NPL] site, non-NPL site, or Resource Conservation and Recovery Act [RCRA] facility), remedial action will be conducted under different authorities. Under Executive Order 12580 (i.e., Superfund implementation), U.S. Environmental Protection Agency (USEPA) was delegated authority to govern the extent of remedies at federal facilities on the NPL. For federal facilities not on the NPL, the Secretary of Interior was delegated the authority to select remedial actions. Program activities must be carried out consistently

with Section 120 of CERCLA, in consultation with the USEPA Administrator. State laws concerning removal and remedial actions are still applicable to non-NPL federal facilities by virtue of Section 120(a)(4) of CERCLA. To date, the Monite Explosive Facility has not been listed on the NPL.

Other regulations relevant to Monite Explosive Facility include the National Environmental Policy Act (NEPA) of 1969. NEPA requires that federal agencies include in their decision-making processes appropriate and careful consideration of all environmental effects of proposed actions, avoid or minimize adverse effects of the proposed actions, and restore and enhance environmental quality as much as possible.

ARARs must be identified on a site specific basis and involve a two-part analysis: (1) a determination whether a given requirement is applicable; and (2) if it is not applicable, a determination whether it is both relevant and appropriate. Determining whether a requirement is both relevant and appropriate is essentially a two-step process. First, to determine relevance a comparison is made between the action, location, or chemicals covered by the requirement and related conditions of the site, release, or potential remedy; a requirement is relevant if the requirement generally pertains to these conditions. Second, to determine whether the requirement is appropriate, the comparison is further refined by focusing on the nature of the substances, the characteristics of the site, the circumstances of the release, and the proposed remedial action; the requirement is appropriate if, based on such comparison, its use is well-suited to the particular site. Only those requirements that are determined to be both relevant and appropriate must be complied with. These definitions are discussed below.

- Applicable Requirements means those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that directly and fully address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

- Relevant and Appropriate Requirements means those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable," address problems or situations sufficiently similar (relevant) to those encountered at the CERCLA site, and their use is well suited (appropriate) to the particular site.

Other information that does not meet the definition of ARAR may be necessary to determine what is protective or may be useful in developing Superfund remedies. This other information is known as to be considered (TBC) criteria.

- TBC Criteria are nonpromulgated, non-enforceable guidelines or criteria that may be useful for developing remedial action, or necessary for determining what is protective to human health and/or the environment. Examples of TBC criteria include USEPA Drinking Water Health Advisories, Carcinogenic Potency Factors, and Reference Doses.

ARARs fall into three categories, based on the manner in which they are applied. The characterization of these categories is not perfect, as many requirements are combinations of the three types of ARARs. These categories are as follows:

- Chemical-Specific: Health-/risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants. Chemical-specific standards have been established under a number of statutes, including RCRA, the Safe Drinking Water Act (SDWA), the Clean Water Act (CWA), and the Clean Air Act (CAA). However, standards have been established for only a limited number of chemicals. In the absence of chemical-specific ARARs, it is often necessary to consider nonpromulgated chemical-specific advisories or guidance documents to identify cleanup remedies that are protective of human health and the environment. Chemical-specific ARARs govern the extent of site cleanup.

- Location-Specific: Restrictions on the concentration of hazardous substances or the conduct of activities in specific locations. These may restrict or preclude certain remedial actions or may apply only to certain portions of the site. Examples of location-specific ARARs include RCRA location requirements and floodplain management requirements. Location-specific ARARs pertain to special site features.

- Action-Specific: Technology- or activity-based controls or restrictions on activities related to management of hazardous substances. Action-specific ARARs pertain to implementing a given remedy.

Section 5.0 has a more detailed discussion of ARARs specific to the site and proposed activities. This section compares removal action alternatives.

3.2.1 Chemical-Specific ARARs and TBCs

This section presents a summary of federal and state chemical-specific ARARs and TBC criteria. All ARARs and TBC criteria provide some medium-specific guidance on "acceptable" or "permissible" concentrations of contaminants.

The chemicals of concern at the Monite Explosive Facility are 2,4-dinitrotoluene, 2,6-dinitrotoluene, and trinitrotoluene (TNT). Washoe County to date has not developed contaminant cleanup levels on a site-specific basis (Sack, 1995). The Nevada Division of Environmental Protection's (NDEP's) policy as outlined in the Contaminated Soil and Ground Water Remediation Policy (June 25, 1992) utilizes existing state and/or federal regulatory standards, if available.

Waste treatment standards that often include contaminant concentration criteria have been established under RCRA for certain hazardous wastes that are otherwise banned from land disposal (40 CFR Part 268). Since some of the alternatives could involve treatment of soil and subsequent land disposal, the RCRA requirements were reviewed to determine if they would be ARARs and result in chemical-specific treatment standards.

The contaminated soil was evaluated using the RCRA waste designation process outlined in 40 CFR Part 261. Four listed waste codes that may apply include K044 (wastewater treatment sludges from the manufacturing and processing of explosives), K047 (pink/red water from TNT operations), 2,4-dinitrotoluene "contained in" the soil (U105), and 2,6 dinitrotoluene (U106). Because the Monite Explosive Facility ceased operations in 1955 or 1956, there are no site records documenting the manufacturing process and the waste streams generated. Accordingly, it is not possible to determine conclusively whether the wastes meet the U- or K-listings. However, soils contaminated with 2,4-dinitrotoluene may demonstrate the characteristic of toxicity with a USEPA hazardous waste number of D030.

Reference Dose (RfD), as defined in the USEPA Integrated Risk Information System (IRIS), is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure (mg/kg body weight) to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. RfDs are developed for chronic and/or subchronic human exposure to hazardous chemicals and are based on the assumption that thresholds exist for certain toxic effects.

Cancer Slope Factors (CSFs) are used for estimating the lifetime probability (assumed 70-year lifespan) of human receptors contracting cancer as a result of exposure to known or suspected carcinogens. These factors are generally reported in units of kg body weight-day/mg and are derived through an assumed low dosage linear relationship and an extrapolation from high to low dose responses determined from human or animal studies.

3.2.2 Location-Specific ARARs and TBCs

Federal facilities must comply with location-specific ARARs which may result in restriction on remedial action activities, depending on the characteristics of a site or its immediate environs. Appendix C-1 summarizes the location-specific ARARs identified for the Monite Explosive Facility.

3.2.3 Action-Specific ARARs and TBCs

Action-specific ARARs provide a basis for screening remedial technologies, developing remedial alternatives, and assessing the feasibility and effectiveness of each remedial alternative retained for detailed evaluation. Action-specific ARARs, unlike location- and chemical-specific ARARs, are usually technology- or activity-based limitations that direct how remedial actions are conducted. Appendices C-2 and C-3 summarize the potential action-specific requirements associated with each of the remedial alternatives that may be considered at Monite Explosive Facility.

The Clean Air Act (42 USC 7401) consists of three programs or requirements that may be ARARs: National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), National Emissions Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR Part 61), and New Source Performance Standards (NSPS) (40 CFR Part 60).

NESHAPs are emission standards for source types (i.e., industrial categories) that emit hazardous air pollutants, and include significant sources of beryllium, vinyl chloride, benzene, asbestos, wet dust particulate, and other hazardous substances.

As discussed earlier, USEPA requires the attainment and maintenance of primary and secondary NAAQS to protect public health and public welfare, respectively. NAAQS are available for six criteria pollutants (carbon monoxide, lead, nitrogen oxide, ozone, sulfur dioxide and airborne particulates). These standards are not source specific but rather are national limitations on ambient air quality. The sources of the contaminant and the routes of exposure were considered. However, the standards do not consider costs for achievement or feasibility. States are responsible for assuring compliance with

the NAAQS. Requirements in an USEPA-approved State Implementation Plan (SIP) for the implementation, maintenance, and enforcement of NAAQS are potential ARARs.

NSPS are established for new sources of air emissions to ensure that the new stationary sources minimize emissions. These standards are for categories of stationary sources that cause or contribute to air pollution that may endanger public health or welfare. Standards are based upon the best demonstrated available technology (BDAT). NSPS are generally not applicable to CERCLA remedial actions but may be relevant and appropriate if the pollutant(s) emitted (e.g., from an air stripping tower) and the technology employed during the cleanup action are sufficiently similar to the pollutant and source category regulated by an NSPS and are well suited to the circumstances at the site. Also, OSWER Directive 9355.0-28, Air Emissions for Non-Attainment Areas, requires new major stationary sources of air emissions to determine whether the source is in an NAAQS attainment or non-attainment area. All Washoe County air enforcement requirements would be adhered to if more stringent than the federal and state requirements.

Enforcement of most sections of the Federal NESHAP and NSPS have been delegated to the State of Nevada and to the Washoe County District Health Department. The county enforces a 3-minute limitation on visibility and specific requirements for emissions of particulate matter and dust control. Ventilation of hazardous or toxic chemicals from waste treatment must be controlled using the lowest achievable emission rate (LAER) control technology.

The CWA sets USEPA Ambient Water Quality Criteria (AWQCs) that are non-enforceable guidelines developed for pollutants in surface waters pursuant to Section 304(a)(I) of the CWA. Although AWQCs are not legally enforceable, they have been used by many states to develop enforceable water quality standards; they should be considered as potential ARARs, as specified by CERCLA. AWQCs are available for the protection of human health from exposure to contaminants in drinking water as well as from ingestion of aquatic biota and for the protection of fresh water and salt water aquatic life. AWQCs may be considered for actions that involve discharge to nearby surface waters.

RCRA Subtitle C regulates the treatment, storage, and disposal of hazardous waste from its generation until its ultimate disposal. In general, RCRA Subtitle C requirements are applicable if:

- The waste is a listed or characteristic waste under RCRA.
- The waste is treated, stored, disposed of (as defined in 40 CFR 260.10) or actively managed after the effective date of the RCRA requirements under consideration.

- The activity at the CERCLA site constitutes current treatment, storage, disposal, or placement as defined by RCRA.

RCRA Subtitle C requirements may be relevant and appropriate when the waste is sufficiently similar to a hazardous waste and/or the on-site remedial action constitutes treatment, storage, or disposal, and the particular RCRA requirement is well suited to the circumstances of the contaminant release and site. RCRA Subtitle C requirements may also be relevant and appropriate when the remedial action constitutes generation of a hazardous waste. Section 121(e) of CERCLA exempts from federal, state, or local permitting requirements, response actions that are conducted entirely on-site. This exemption was codified in 40 CFR 300.400(e). 40 CFR 300.400(e) waives the requirement to obtain federal, state, or local permits for on-site response actions conducted in accordance with CERCLA 104, 106, 120, 121, and 122 (i.e., fund-financed response actions conducted by the government, response actions conducted by responsible parties, and federal facility response actions). 40 CFR 300.5 defines on-site as "the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action." This means that the actual permits do not have to be obtained for on-site response actions, but compliance is required with the administrative and substantive requirements that would otherwise be included in such a permit. For example, waste would still need to be properly stored, handled, packaged, and transported in accordance with all applicable regulations. Accordingly, this waiver is only an exemption from the administrative process which could delay implementation of a response action and is basically intended to speed the cleanup process. All RCRA Subtitle C requirements must also be met and/or when the hazardous waste moves off-site.

The following requirements included in the RCRA Subtitle C regulations may pertain to the Monite Explosive Facility:

- Standards for owners and operators of hazardous waste treatment, storage and disposal facilities (TSDFs) (40 CFR Part 264).
- Hazardous waste generator requirements (40 CFR Part 262).
- Hazardous waste transportation requirements (40 CFR Part 263).
- Land Disposal Restrictions (40 CFR Part 268).

A generator that treats, stores, or disposes of hazardous waste on-site must comply with RCRA.

Standards for Owners and Operators of Hazardous Waste TSDFs (40 CFR Part 264) are applicable to remedial actions and to off-site facilities receiving hazardous waste from the site for treatment and/or disposal. Standards for TSDFs include requirements for preparedness and prevention, releases from solid waste management units (i.e., corrective action requirements), closure and post-closure care, use and management of containers, and design and operating standards for tank systems, surface impoundments, waste piles, landfills, and incinerators.

Standards Applicable to Generators of Hazardous Waste (40 CFR Part 262) include hazardous waste tank and container accumulation standards, manifest requirements, pre-transport requirements (i.e., packaging, labeling, placarding), recordkeeping, and reporting hazardous waste.

Standards Applicable to Transporters of Hazardous Waste (40 CFR Part 263) are applicable to off-site transportation of hazardous waste. These regulations include requirements for compliance with the manifest and recordkeeping systems and requirements for immediate action and cleanup of hazardous waste discharges (spills) during transportation.

RCRA Land Disposal Restrictions (LDR) Requirements (40 CFR Part 268) restrict certain wastes from being placed or disposed of on land unless they meet specific BDAT treatment standards (expressed as concentrations, total or in the Toxicity Characteristic Leaching Procedure (TCLP) extract, or as specified technologies). Removal and treatment of a RCRA hazardous waste or movement of the waste outside of the Corrective Action Management Unit (CAMU), thereby constituting "placement," will trigger the LDR requirements.

Most characteristic wastes are regulated under the LDR program in the 1990 third-third rule. The basic premise of the LDR regulations is relatively straightforward. For each hazardous waste, USEPA establishes treatment standards that will be protective of human health and the environment if the wastes are land disposed. Wastes may not be land disposed unless they meet the treatment standards or are otherwise subject to a variance.

At the Monite Explosive Facility, several of the treatment alternatives being considered involve excavation and treatment of soil contaminated with 2,4-dinitrotoluene (D030). After treatment of D030 nonwastewater, in order to meet the LDR treatment standard, the DNT concentration in the treatment residue may not exceed 140 mg/kg. In addition, any underlying hazardous constituent in the residue may not exceed the Universal Treatment Standard (UTS) specified in 40 CFR 268.48. If, after treatment, the concentration(s) of hazardous constituent(s) do not exceed the levels specified in 40 CFR 261.24, the waste is no longer hazardous (assuming it is not a listed waste) (Elsevier, 1995);

that is, the hazardous characteristic has been removed and the waste may be managed in a RCRA Subtitle D facility.

Note that the treatment standard and the hazardous waste identification level for a constituent may not be the same. In some cases the treatment standard is higher, and therefore the waste must still be managed as hazardous even when it meets the treatment standard. In some cases the treatment standard is lower, and therefore a waste would still require LDR treatment even though it no longer exhibited a hazardous characteristic (USEPA, 1990).

According to 40 CFR 268.9(d), when characteristic wastes are treated to meet the treatment standards, and as a result of treatment they no longer exhibit a characteristic, the generator need only send USEPA a one-time notification and certification. According to the January 9, 1992 *Federal Register* preamble (57 FR 978), by requiring notifications and certifications to be prepared, USEPA is also ensuring that a record is kept that the characteristic waste has been treated to meet the standard and is not diluted. USEPA allows but does not restrict the disposal of these wastes at a RCRA Subtitle D landfill (municipal or industrial waste landfills).

General Pretreatment Regulations for Existing and New Sources of Pollutants (40 CFR Part 403) were promulgated under the CWA and include provisions for effluent discharge to publicly owned treatment works (POTW). Discharge of pollutants that pass through or interfere with the POTW, contaminate sludge, or endanger health/safety of POTW workers is prohibited. These regulations should be used in conjunction with local POTW pretreatment program requirements.

Department of Transportation Regulations for Hazardous Materials Transport (49 CFR Part 107 and Parts 171 through 179) regulate the transport of hazardous materials, including packaging, shipping equipment, and placarding. These rules are considered applicable to wastes shipped off site for laboratory analysis, treatment, or disposal.

The CERCLA Off-Site Policy (40 CFR 300.440) describes procedures that should be observed when a response action under CERCLA or Section 7003 of RCRA involves off-site storage, treatment, or disposal of CERCLA wastes. This regulation requires that hazardous substances, pollutants or contaminants transferred off-site for treatment, storage or disposal during a CERCLA response action be transferred to a facility operating in compliance with Sections 3004 and 3005 of RCRA and all other applicable federal laws and all applicable state requirements. The USEPA regional off-site contact needs to be contacted prior to sending wastes off-site to ensure the receiving facility is acceptable.

If concentrated explosive wastes are excavated, they may be taken to a facility with a RCRA open burning/open detonation (OB/OD) permit. Alternatively, the waste may be transported to another location where the waste may be treated by OB/OD under an emergency permit.

3.3 REMOVAL ACTION OBJECTIVES

Groundwater was not addressed as part of the engineering evaluation/cost analysis (EE/CA) due to the limited mobility and solubility of the contaminants, the depth to groundwater, and the lack of groundwater use in the immediate vicinity of the site. Sediments in Orr Ditch are considered negligible as part of the EE/CA due to the limited nature of the contamination (CCJM, 1995).

3.3.1 Media and Contaminants of Concern

This EE/CA Report addresses on-site contaminated soils and the investigation of geophysical anomalies within the fenced enclosures. If any sediments from Orr Ditch are found to exceed the removal action levels, the sediments will be removed and handled as soil. However, an April 1995 round of sediment sampling revealed nondetect in all samples (CCJM, 1995).

The contaminants of concern are 2,4-dinitrotoluene, 2,6-dinitrotoluene, and TNT. These three contaminants were found at high concentrations (up to 5 percent in soil) in and around the fenced enclosures. Table 3-1 provides some of the chemical and physical properties of the contaminants of concern. This section presents toxicity information and removal action levels for TNT/dinitrotoluene.

3.3.1.1 2,4- and 2,6-Dinitrotoluene

3.3.1.1.1 Pharmacokinetics

Dinitrotoluene isomers are rapidly absorbed and primarily excreted in the urine (USEPA, 1994b). Excretion of these compounds in the bile occurs to a lesser extent. The metabolism of dinitrotoluene isomers initially occurs through liver oxidation. Typical urinary metabolites of dinitrotoluene include glucuronide conjugates of 2,4-dinitrobenzyl alcohol and 2-amino-4-nitrobenzyl alcohol.

3.3.1.1.2 Non-cancer Toxicity

Toxicity studies are not available for 2,6-dinitrotoluene. However, since this chemical is usually found to some extent in the presence of 2,4-dinitrotoluene, and because it is structurally similar to 2,4-dinitrotoluene, the toxic effects for the two compounds are assumed to be comparable.

Similar adverse health effects have been noted for animals and humans exposed to 2,4-dinitrotoluene. Neurotoxicity, Heinz bodies changes, and biliary tract herplasia are the primary toxic effects. In human occupational studies, neurotoxicity has been characterized by vertigo, paresthesia, tremors, unconsciousness, and paralysis. Inhalation was assumed to be the principal exposure route, with minor exposures stemming from dermal absorption and ingestion. Available data are considered inadequate for the derivation of an RfD for inhalation. However, an oral RfD of 0.002 mg/kg/day was derived from a no observed adverse effects level (NOAEL) of 0.2 mg/kg/day for neurotoxicity, Heinz bodies, and biliary tract herplasia (USEPA, 1994b) with an uncertainty factor of 100 for 2,4-dinitrotoluene. The NOAEL was developed from a chronic toxicity study where beagle dogs were fed a supplement of 98 percent pure 2,4-dinitrotoluene for 2 years. The uncertainty factor accounts for interspecies and intraspecies variability. USEPA has proposed a subchronic RfD of 0.002 mg/kg/day (USEPA, 1994c).

Provisional chronic RfDs (0.001 mg/kg/day) and subchronic RfDs (0.01 mg/kg/day) RfDs were also developed for 2,6-dinitrotoluene by the USEPA (1994c). These values are based on a NOAEL in dogs fed 4 mg/kg/day and uncertainty factors of 3,000 and 300, respectively. Reportedly, the central nervous system, blood, and kidneys are affected by 2,6-dinitrotoluene.

3.3.1.1.3 Carcinogenicity

No data were available concerning the carcinogenicity of 2,4- or 2,6-dinitrotoluene in humans. In a 1-year carcinogenesis study, oral doses of 2,6-dinitrotoluene produced hepatocellular carcinomas in 85 to 100 percent of male rats. In two studies, technical mixtures of the dinitrotoluene isomers produced a positive hepatocarcinogenic response in rats (Faust, 1991). The USEPA has classified the dinitrotoluene mixture as a probable human carcinogen (Class B2 carcinogen). A 0.68 $(mg/kg/day)^{-1}$ cancer slope factor has been calculated for oral exposure to the dinitrotoluene mixture (USEPA, 1995a).

3.3.1.2 2,4,6-Trinitrotoluene

3.3.1.2.1 Pharmacokinetics

TNT, which is rapidly biotransformed following exposure, is mainly excreted in the urine and to a lesser extent distributed to the organs. More than 50 percent of administered doses were absorbed in several oral and dermal studies, indicating that the compound is well absorbed (ATSDR, 1993). Observed absorption in the gastrointestinal tract ranged from 1.7 percent in dogs to 22.7 percent in rabbits. All studies indicate that TNT is extensively metabolized.

3.3.1.2.2 Non-cancer Toxicity

The threshold limit value (TLV) for inhalation of TNT is 0.5 mg/m^3. Several adverse health effects including anemia, liver function abnormalities, respiratory complications, and cataracts have been noted in workers exposed to levels above the TLV (ATSDR, 1993). These effects may also be attributed to dermal exposure as well as inhalation occupational exposure, since these exposures occurred simultaneously in the cited studies. No studies are available regarding developmental or reproductive effects.

Based on a subchronic dog study, USEPA (1994b) derived an oral RfD of 0.0005 mg/kg/day for TNT from a lowest observed adverse affects level (LOAEL) of 0.5 mg/kg/day for liver effects and an uncertainty factor of 1,000. Dogs from all dose groups experienced varying degrees of hepatic swelling and hepatocyomegaly. The uncertainty factor used accounts for extrapolation of animal to human doses, LOAEL to NOAEL, and subchronic to chronic.

3.3.1.2.3 Carcinogenicity

TNT is classified as a cancer weight-of-evidence Group C carcinogen (possible human carcinogen). The U.S. Department of Defense (DOD) conducted a study to determine the carcinogenic effects of this chemical in rats. A drinking water unit risk of 0.0000009 per μg/L was identified in this study. Urinary bladder papillomas and carcinomas were observed in rats. It should be noted that the unit risk factor should not be used if the water concentration exceeds 0.0001 μg/L, as the slope factor (0.03 kg/mg/day) may vary at this level.

3.3.2 Risk-based Removal Action Levels

A risk evaluation was performed to establish health-based action levels commensurate with the stated objectives of this EE/CA. This analysis is intended to aid in the determination of preliminary remediation goals. The risk evaluation was used to provide an estimate of how and to what extent humans might be exposed to the chemicals of concern, and to develop risk-based soil concentrations which are protective of human health using USEPA-recommended methods (USEPA, 1991a; 1995a). A human exposure scenario was assumed consistent with the current status of the area as an undeveloped property used by neighbors for recreational purposes. It was also assumed, based upon the county Recreation & Public Purposes lease application (to obtain the property for use as a park) and the designation of the property as open space by the county (Murray, 1995), that use of the property will not change significantly in the foreseeable future.

Sampling data collected during the Preliminary Assessment (PA) were used to identify areas of contaminated soil and to select the chemicals of concern (2,4-dinitrotoluene, 2,6-dinitrotoluene, and trinitrotoluene). As part of the PA, 16 samples were analyzed for the full USEPA Contract Laboratory Program Target Compound List organics and Target Analyte List inorganics. A total of 152 samples were analyzed (USEPA Method 8330) for the presence of explosive-related compounds, and about 950 samples were screened for the presence of trinitrotoluene and related compounds.

Adults and children recreating at the Monite Explosive Facility may be exposed to contaminated soils while walking, riding bicycles, or playing in areas of contaminated soils. Most of the established paths on-site are in uncontaminated areas; however, those that are in contaminated areas are now fenced off, limiting access.

Potential exposure routes include incidental ingestion of soil and dermal absorption of contaminants. For the purpose of developing action levels, it is assumed that inhalation of volatiles was not considered relevant, since this pathway is only evaluated for chemicals with a Henry's Law Constant of greater than 1×10^{-5} atmosphere-cubic meter per mole (atm-m^3/mol) and a molecular weight of less than 200 grams per mole (g/mol). The compounds of concern do not meet these criteria (USEPA, 1991a). Therefore, volatilization is not considered a significant release mechanism, and inhalation is not considered a primary exposure route. The inhalation of contaminated particulates was not evaluated, because inhalation toxicity values have not been developed for the contaminants of concern and the route to route extrapolation of the values is inappropriate for any use other than screening.

Incidental ingestion and dermal contact with soil are considered to be the primary exposure routes in the development of risk-based cleanup levels for the Monite Explosive Facility. Contact with contaminated soils while recreating on-site could result in exposure by incidental ingestion of small quantities of soil or dermal absorption of contaminants. These routes of exposure were evaluated in accordance with USEPA methods, both regional and national, for developing site-specific removal action goals (USEPA, 1989a; 1991a; 1991b; 1995a). In accordance with USEPA guidance, cleanup goals were developed based upon a reasonable maximum exposure. The reasonable maximum exposure (RME) scenario utilizes assumptions to approximate high end, yet plausible, exposures.

Remediation goals for the Monite contaminants of concern were developed using methods described in the USEPA *Technical Background Document for Soil Screening Guidance* and the *Risk Assessment Guidance for Superfund (RAGS), Part B* as adapted by USEPA Region IX (USEPA, 1994d; 1995a). The National Contingency Plan (NCP) (40 CFR Section 300.430 (e)(2)(i)(A)(2)) has defined exposure levels resulting in an excess upper bound lifetime cancer risk to an individual of between 1×10^{-6} and 1×10^{-4} as being acceptable, with 1×10^{-6} being the point of departure for evaluating remedial goals. An excess cancer risk of 1×10^{-6} is generally used for residential areas and a 1×10^{-4} level is generally acceptable for industrial settings. The Monite Explosive Facility does not fall into either of these settings but has elements of both scenarios (i.e., open access but not for the extended lengths that one might expect in the yard of a home). Thus, a risk level of 1×10^{-5} was considered appropriate. For systemic toxicants, the accepted non-cancer-risk level is a hazard index of no greater than 1.0.

In evaluating site-related risks and developing preliminary remediation goals, USEPA Region IX has integrated the soil ingestion and dermal absorption equations as specified in USEPA *Risk Assessment Guidance for Superfund Part B*. As discussed previously, the inhalation route of exposure was not evaluated and hence was dropped from the equation used by the region. The acceptable levels of exposure to carcinogenic chemical contaminants by the soil ingestion and dermal exposure routes were estimated using the following equation (USEPA, 1995a):

$$C_{Soil}(mg/kg) = \frac{TR \times AT \times 365 days/yr}{EF\ [(\frac{IFS_{adj} \times CSF_o}{10^6 mg/kg}) + (\frac{SFS_{adj} \times ABS \times CSF_o}{10^6 mg/kg})]}$$

where: C_{Soil} = chemical concentration in soil (mg/kg)

TR = target cancer risk (unitless)

AT	=	averaging time (years)
EF	=	exposure frequency (days/year)
IFS_{adj}	=	ingestion factor, soils (mg-yr/kg-day)
CSF_o	=	cancer slope factor oral $(mg/kg\text{-}day)^{-1}$
SFS_{adj}	=	skin contact factor, soils (mg-yr/kg-day)
ABS	=	skin absorption (unitless)

The preliminary remediation goals for noncarcinogenic compounds were determined with the following equation (USEPA, 1995a):

$$C_{Soil}(mg/kg) = \frac{THQ \times BW_c \times ED_c \times 365 days/yr}{EF \times ED_c \left[\left(\frac{1}{RfD_o} \times \frac{IRS_c}{10^6 mg/kg}\right) + \left(\frac{1}{RfD_o} \times \frac{SA_c \times AF \times ABS}{10^6 mg/kg}\right)\right]}$$

where:

C_{Soil}	=	chemical concentration in soil (mg/kg)
THQ	=	target hazard quotient (unitless)
BW_o	=	body weight, child (kg)
ED_c	=	exposure duration, child (years)
EF	=	exposure frequency (days/year)
RfD_o	=	oral reference dose (mg/kg-day)
IRS_o	=	soil ingestion, child (mg/day)
SA_o	=	surface area, child (cm^2)
AF	=	adherence factor (mg/cm^2)
ABS	=	skin absorption (unitless)

For the purpose of developing preliminary removal action goals, a reasonable maximum exposure was used. Individuals are assumed to be exposed to contaminated soils at the site 350 days per year under the residential exposure scenario, and 100 days per year (or approximately 2.5 days per week during the spring, summer and fall) for the visitor scenario. The exposure frequency for the visitor scenario was developed based upon foot or bicycle access, with the contaminated areas assumed to be less than ¼ mile from residences. Access to the site involving contact with contaminated soil is expected to be less during winter months. The number of trips to the site is a conservative assumption based on the access to the site and the lack of facilities/improvements. The reasonable maximum exposure

parameters used reflect typical high-end exposures. Exposure parameters used in the calculations are presented in Table 3-2.

The oral cancer slope factors used for dinitrotoluene (mixture) and TNT were 0.68 and 0.03 $(mg/kg/day)^{-1}$, respectively (USEPA, 1994c). The oral reference doses used for 2,4-dinitrotoluene, 2,6-dinitrotoluene and TNT were 0.002, 0.001, and 0.0005, respectively (USEPA, 1994a). The preliminary cleanup goals are presented in Table 3-3.

A cleanup level of 6.6 mg/kg dinitrotoluene and 148 mg/kg TNT provides an appropriate level of protection for the likely future uses of the property.

3.3.3 Removal Action Scope

The removal action scope is designed to minimize the actual or potential threat to nearby human populations from the contaminants present in surface soils at the site and to minimize the potential for these contaminants to migrate. The removal action will address the disposition of soils with contaminant levels above the risk-based action levels. SURFER® for Windows was used to aid in interpreting the sampling results. Contour gridding of screening data (TNT/dinitrotoluene) concentrations from over 300 sample locations was performed using kriging algorithms. The contouring developed a theoretical limit of the areas at various depth intervals for material exceeding the various potential action levels (1, 2.3, 6.6, 10, and 140 mg/kg). Figures 3-1 through 3-5 show the surface areal extent for each respective action level. In general, the contaminated areas are adjacent to the former process buildings. The contaminant concentrations diminish rapidly with depth. The majority of the contamination appears to be contained in the upper 2 feet of soil. The areas that would require excavation to a depth of greater than 2 feet are expected to be small and are unlikely to have a significant impact on the total contaminated soil volume to be removed. Subsurface control with respect to concentrations of TNT/dinitrotoluene at depth are limited to areas of high surface soil contamination (see Figure 3-6). If the surface soils were nondetect, it was assumed that subsurface soils were nondetect at the same locations.

There are numerous geophysical anomalies located beneath the area of surfical soil contamination (MicroGeophysics Corporation, 1994). These anomalies are shown in Figure 2-5 and will be excavated and identified prior to dealing with the contaminated soils. This is due primarily to concerns about having to excavate near (and the likelihood of driving heavy equipment over) any potentially explosive devices.

3.3.4 Removal Quantity

The area of contaminated soil contains several concrete foundations and a variety of small demolition debris such as bricks and large gravel. Contamination is likely beneath one or more of the foundations, since screening sample E8 contained contaminants above the risk-based action level. All debris and foundations in the area (Figure 2-3) would require removal and sampling to determine if decontamination were necessary prior to disposal. If lead paint is associated with this debris, the debris may exhibit the toxicity characteristic for lead. If this is the case, the D008 waste debris could either be treated to meet the 5 mg/L numeric standard for lead in 40 CFR 268.40 or the treatment standards for debris in Section 268.45. If the debris standard is used, the residue is still subject to hazardous waste management standards (see Section 261.3(f)) and must be managed at a RCRA Subtitle C facility.

Removal quantities were determined based upon screening results which are not compound specific. In determining the quantity, it was assumed that the screening data represented only 2,4-dinitrotoluene which has the most conservative cleanup level (6.6 mg/kg). Linear regression (least squares) analysis of the relationship between total 2,4-dinitrotoluene concentrations (USEPA Method 8330 data) and the corresponding TCLP concentrations was performed for the Monite soils (Figure 3-7). This analysis indicated that soils with a total 2,4-dinitrotoluene concentration above 8 mg/kg would be classified as exhibiting the RCRA characteristic of toxicity (>0.13 ppm).

The amount of soil requiring removal was determined utilizing SURFER® for Windows contouring and volumetric package as well as professional judgment. The total amount of contaminated soil above the cleanup goal (6.6 ppm) is estimated to be 1,056 cubic yards (in situ). The soil contaminated above the cleanup level may be dealt with by utilizing a variety of techniques. Therefore, the volume of soil above certain benchmark concentrations are presented below.

Cleanup Goal	Estimated In-situ Volume and Weight* of Contaminated Soil
1.0 ppm	1,887 cubic yards (2,830 tons)
6.6 ppm	1,056 cubic yards (1,584 tons)
8.0 ppm	908 cubic yards (1,361 tons)
140 ppm	606 cubic yards (908 tons)

*For conversion purposes, it was assumed that the soil density is 1.5 tons per cubic yard in situ and 1.1 tons per cubic yard ex situ.

The volume of soil above the 8 mg/kg cutoff is estimated at 908 cubic yards. This would allow for disposal of a portion of the contaminated soils between 8 mg/kg and 6.6 mg/kg (~150 cubic yards or 225 tons) at a RCRA Subtitle C facility without treatment.

3.4 DETERMINATION OF REMOVAL ACTION SCHEDULE

BLM has determined that a non-time-critical removal action is appropriate for the Monite Explosive Facility. The removal could commence within 6 to 12 months following completion of this EE/CA. It is estimated that any removal action undertaken will require 2 to 12 months to complete.

3.5 COMMUNITY RELATIONS

An EE/CA for non-time-critical removal actions provides a vehicle for public involvement as well as for evaluating and recommending the appropriate response. Soliciting and responding to public comments on the administrative record, which must include the EE/CA, are required by 40 CFR Section 300.820(a) of the NCP.

Community relations requirements for Superfund site remedial responses are generally non-mandatory, though recommended, at the PA and SI stages (USEPA, 1992). However, *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (USEPA, 1993a), provides guidance applicable to the Monite site, as a non-time-critical removal action, and is the basis for the following.

Since removal actions generally move quickly, there is less time to plan or conduct public participation activities than during remedial responses. Sections 300.415(m) and 300.820 of the NCP specify two forms of public participation for all removal actions:

1. Community relations activities designed to integrate the information needs of the community into the communications approach or site Community Relations Plan.

2. Administrative record activities designed to chronicle the basis for the response selection and serve as a vehicle for public participation in the removal action.

Each is described below.

1. The following are community relations requirements for non-time-critical removal actions:

   - Designate a community relations spokesperson.
   - Conduct community interviews before completing the EE/CA.
   - Prepare a Community Relations Plan before the EE/CA is completed.
   - Establish an Information Repository not later than the signing of the EE/CA Approval Memorandum.
   - Provide Public Notice of Availability of the EE/CA for public comment (the EE/CA is part of the Administrative Record).

2. The administrative record, as provided in Section 300.820 of the NCP, may include site-specific data and comments, documents which were considered or relied on to select the removal action, guidance documents, technical references, and documents that reflect the views of the public concerning the selection of a removal action. For non-time-critical removal actions, the EE/CA Approval Memorandum, and the EE/CA are key components of the administrative record file. The required administrative record activities for non-time-critical removal actions are:

   - Establish the administrative record file no later than the completion of the EE/CA.
   - Publish a Notice of Availability of the administrative record file when the EE/CA is placed in the administrative record file and is available for comment.
   - Hold a 30-day public comment period on the EE/CA and any supporting documentation at the time the EE/CA is made available for public comment.
   - Develop written responses to significant comments (to be included in the administrative record file).

As of this time, public meetings have been held near the Monite site, and fact sheets have been prepared (Appendix E). The Bureau of Land Management (BLM) is in the process of preparing the Community Relations Plan and will be planning additional activities.

TABLE 3-1

CHEMICAL AND PHYSICAL PROPERTIES
MONITE EXPLOSIVE FACILITY, CARSON CITY DISTRICT, NEVADA

	2,4-Dinitrotoluene	2,6-Dinitrotoluene	Trinitrotoluene
CAS Registry Number	121-14-2	606-20-2	118-96-7
Empirical Formula	$C_7H_6N_2O_4$	$C_7H_6N_2O_4$	$C_7H_5N_3O_6$
Molecular Weight[a]	182.14	182.14	227.15
Density (g/cm^3)[a]	1.521 (15°C)	1.283 (111°C)	1.65[b]
Melting Point (°C)[a]	71	66	80.75[b]
Vapor Pressure (mm Hg, 25°C)[b]	2.17×10^{-4}	5.67×10^{-4}	5.51×10^{-6}
Aqueous Solubility (mg/L)[a]	270 (22°C)	180 (20°C)	150 (25°C)[b]
Henry's Constant ($atm.m^3/mole$)[a]	4.5×10^{-6}	7.9×10^{-6}	1.10×10^{-8} [b]
Log K_{ow}[a]	2.0	2.3	2.00[b]

[a]ATSDR, 1989.
[b]Dames & Moore, 1991.

TABLE 3-2

EXPOSURE INPUT PARAMETERS
MONITE EXPLOSIVE FACILITY, CARSON CITY DISTRICT, NEVADA

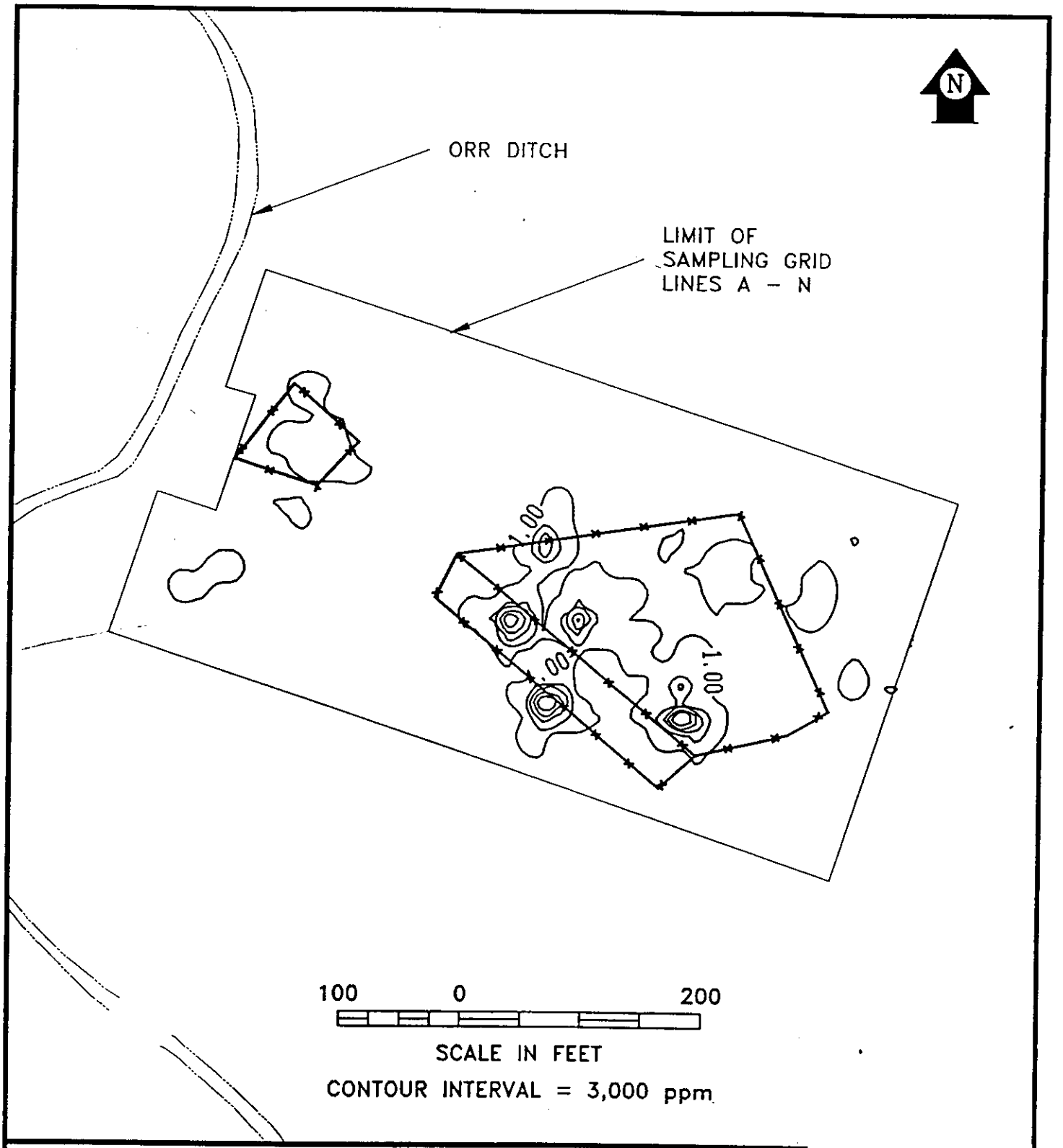
Input Parameter	Description	Value	Rationale
TR	Target Cancer Risk	10^{-6} to 10^{-4}	NCP (40 CFR 300.430)
AT	Averaging Time	70 years	USEPA, 1989a
EF	Exposure Frequency	Resident: 350 days/yr Visitor: 100 days/yr	USEPA, 1991b Professional judgement
IFS_{adj}	Ingestion Factor, Soils	114 mg-yr/kg-day	USEPA, 1991a
CSF_o	Cancer Slope Factor, Oral	Chemical-specific	
SFS_{adj}	Skin Contact Factor	503 mg-yr/kg-day	USEPA, 1995a by analogy to RAGS Part B (USEPA, 1991c)
ABS	Skin Absorption	0.1	USEPA, 1995a
THQ	Target Hazard Quotient	1.0	USEPA, 1995a
BW_c	Body Weight, child	15 kg	USEPA, 1991b
ED_c	Exposure Duration	6 years	USEPA, 1991b
RfD_o	Reference Dose, Oral	Chemical-Specific	
IRS_c	Soil Ingestion, Child	200 mg/day	USEPA, 1991b
SA_c	Surface Area, Child	2,000 cm^2	25 percent of surface (USEPA, 1992a; 1995a)
AF	Adherence Factor	0.2 mg/cm^2	USEPA, 1992a

TABLE 3-3

PRELIMINARY RISK-BASED REMOVAL ACTION GOALS
MONITE EXPLOSIVE FACILITY, CARSON CITY DISTRICT, NEVADA

Compound	Carcinogens, Soil Concentrations (mg/kg)			Noncarcinogens, Soil Concentrations (mg/kg)
	10^{-6} Target Cancer Risk	10^{-5} Target Cancer Risk	10^{-4} Target Cancer Risk	
Residential Scenario				
TNT	14.8	148	1,481	33
2,4-Dinitrotoluene	NA	NA	NA	130
2,6-Dinitrotoluene	NA	NA	NA	65
Dinitrotoluene, mixture	0.66	6.6	66	NA
Visitor Scenario				
TNT	51.8	518	5,184	114
2,4-Dinitrotoluene	NA	NA	NA	455
2,6-Dinitrotoluene	NA	NA	NA	228
Dinitrotoluene, mixture	2.32	23.2	232	NA

Note: Preliminary cleanup goals were developed based upon the soil ingestion and dermal absorption exposure routes.
NA - Not applicable.

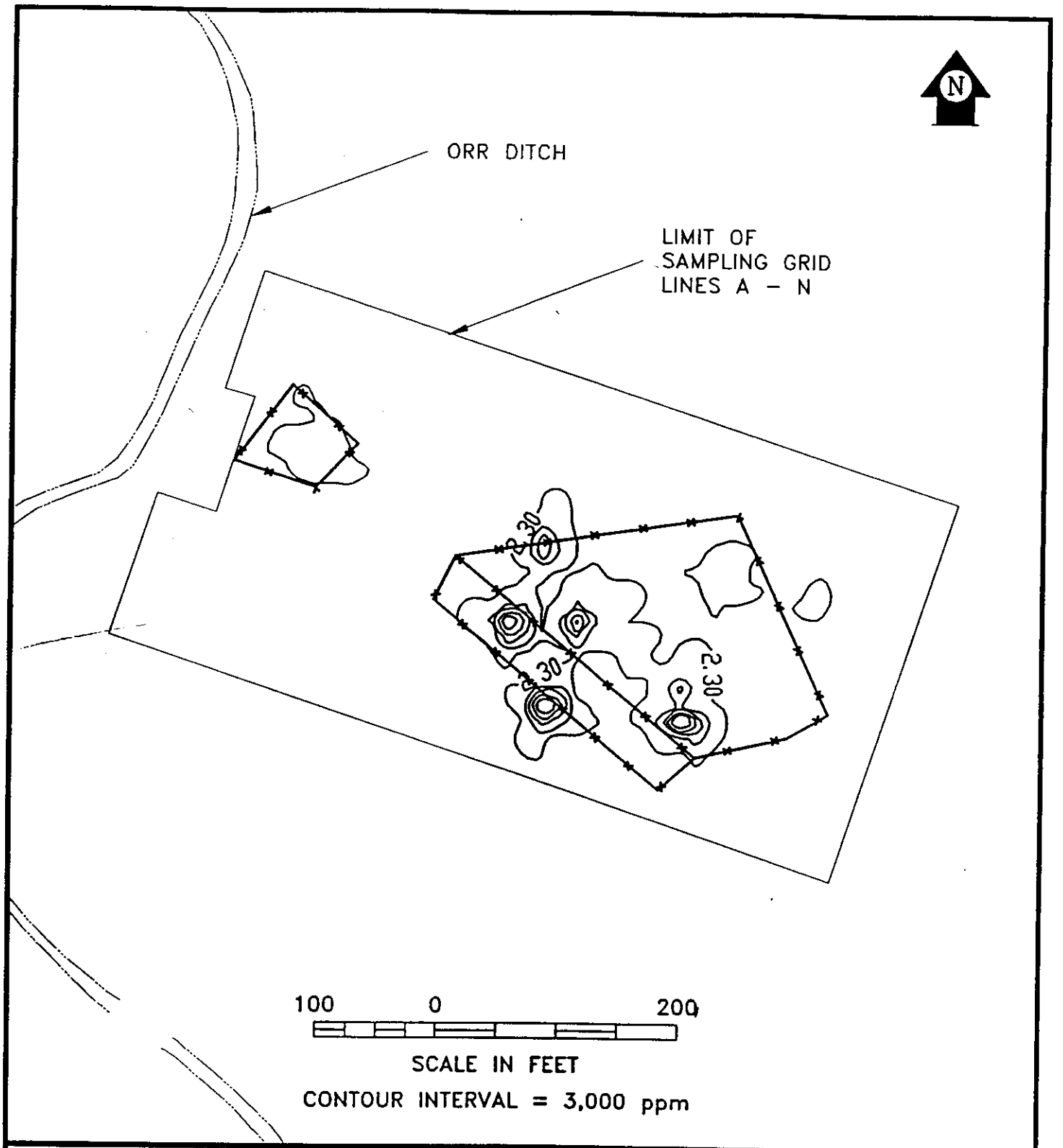


SOURCE: BROWN AND ROOT ENVIRONMENTAL, 1995

SCALE: AS SHOWN	BUREAU OF LAND MANAGEMENT BLM - MONITE EXPLOSIVE FACILITY SPARKS, NEVADA	FIGURE 3-1
DATE: JULY 1995	AREAL EXTENT OF TNT/DNT CONTAMINATION (GREATER THAN 1 ppm)	DRAWN BY: RSG

FIGURE31. DATE 07-13-95 1200 ACADR13 RSG

BROWN AND ROOT ENVIRONMENTAL

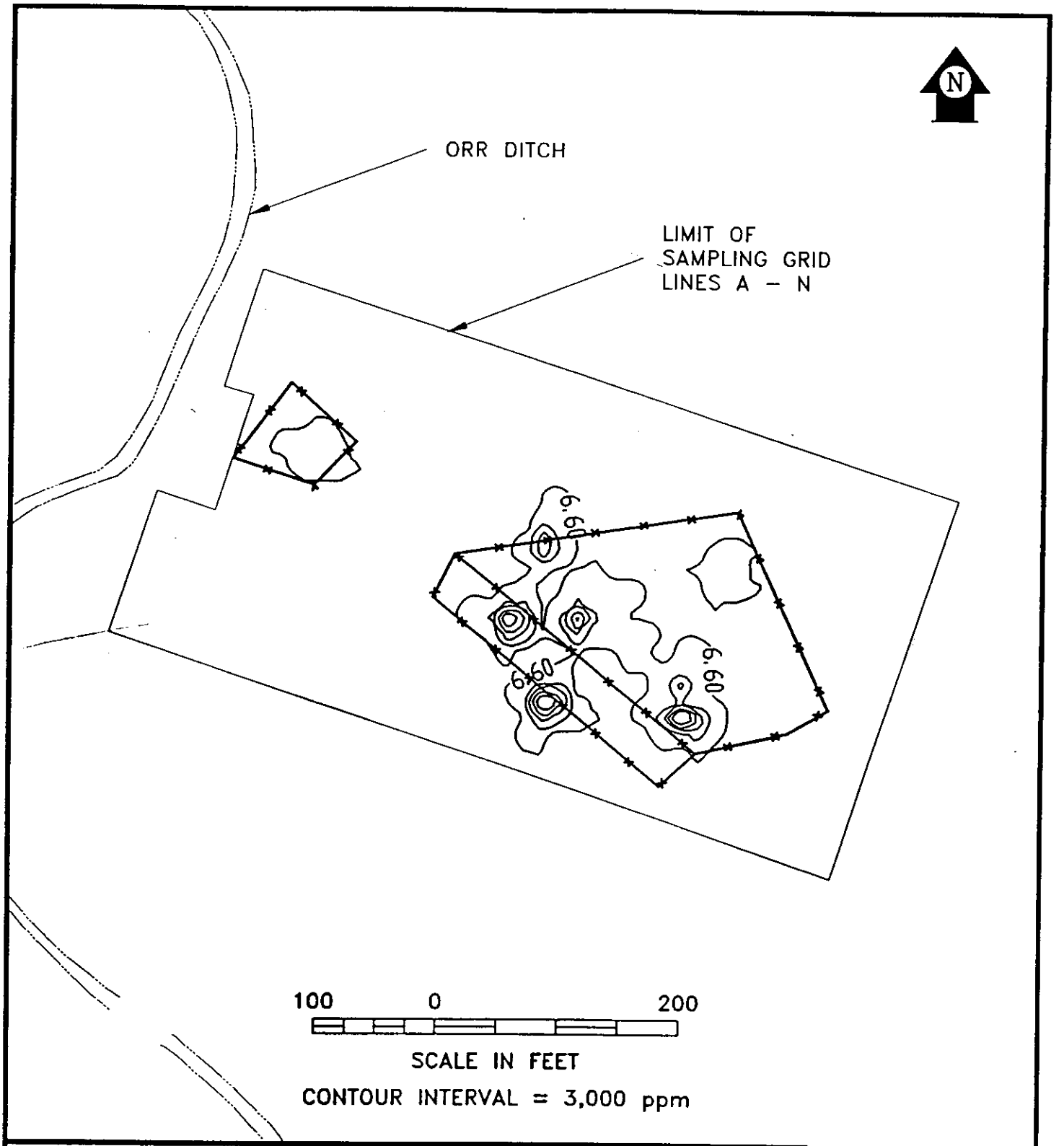


SOURCE: BROWN AND ROOT ENVIRONMENTAL, 1995

SCALE: AS SHOWN	BUREAU OF LAND MANAGEMENT BLM - MONITE EXPLOSIVE FACILITY SPARKS, NEVADA	FIGURE 3-2
DATE: JULY 1995	AREAL EXTENT OF TNT/DNT CONTAMINATION (GREATER THAN 2.3 ppm)	DRAWN BY: RSG

FIGURE32... DATE 07-13-95 1200 ACADR13 RSG

BROWN AND ROOT ENVIRONMENTAL

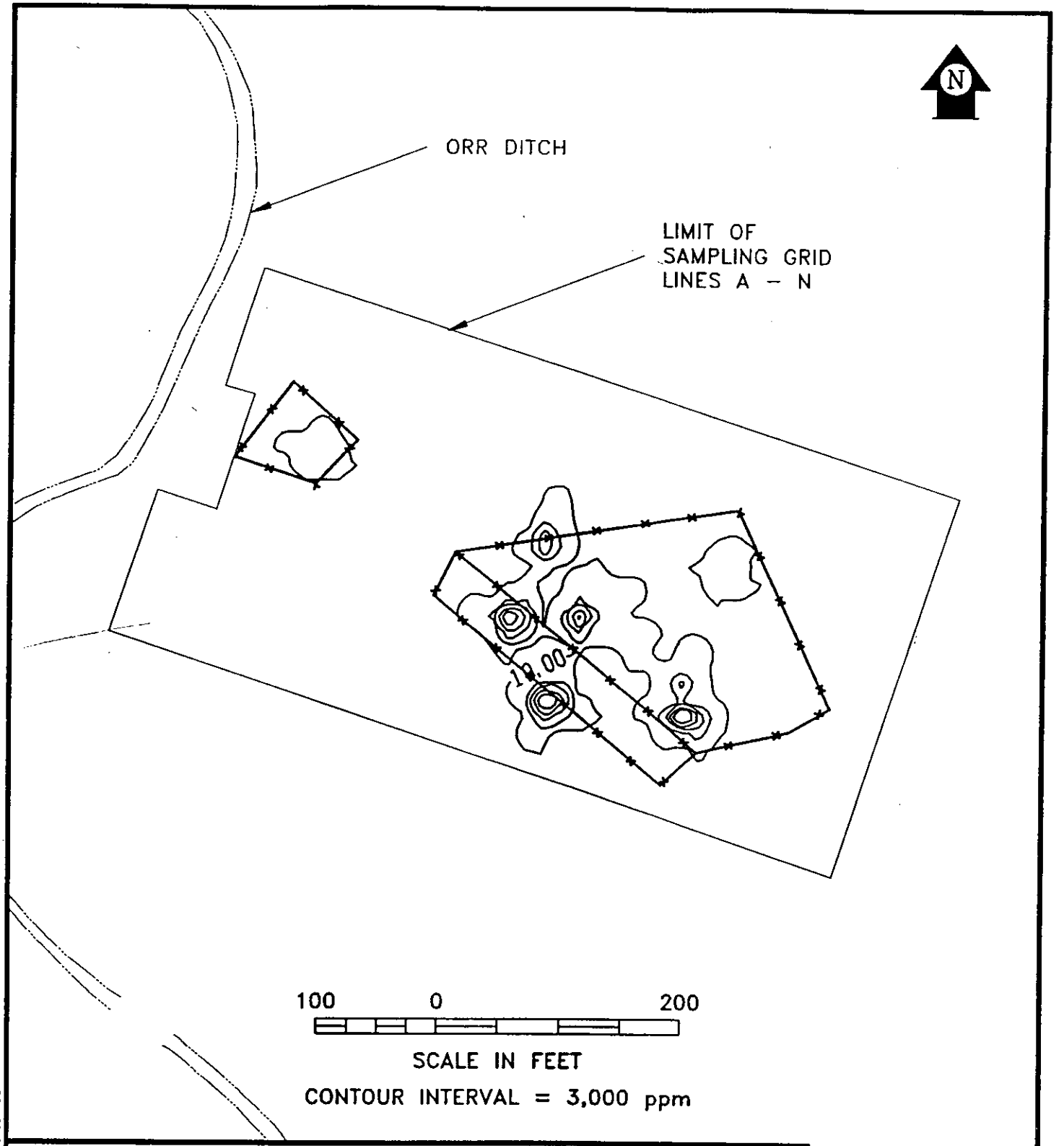


SOURCE: BROWN AND ROOT ENVIRONMENTAL, 1995

SCALE: AS SHOWN	BUREAU OF LAND MANAGEMENT BLM – MONITE EXPLOSIVE FACILITY SPARKS, NEVADA	FIGURE 3-3
DATE: JULY 1995	AREAL EXTENT OF TNT/DNT CONTAMINATION (GREATER THAN 6.6 ppm)	DRAWN BY: RSG

FIGURE33. DATE 07-13-95 1200 ACADR13 RSG

BROWN AND ROOT ENVIRONMENTAL

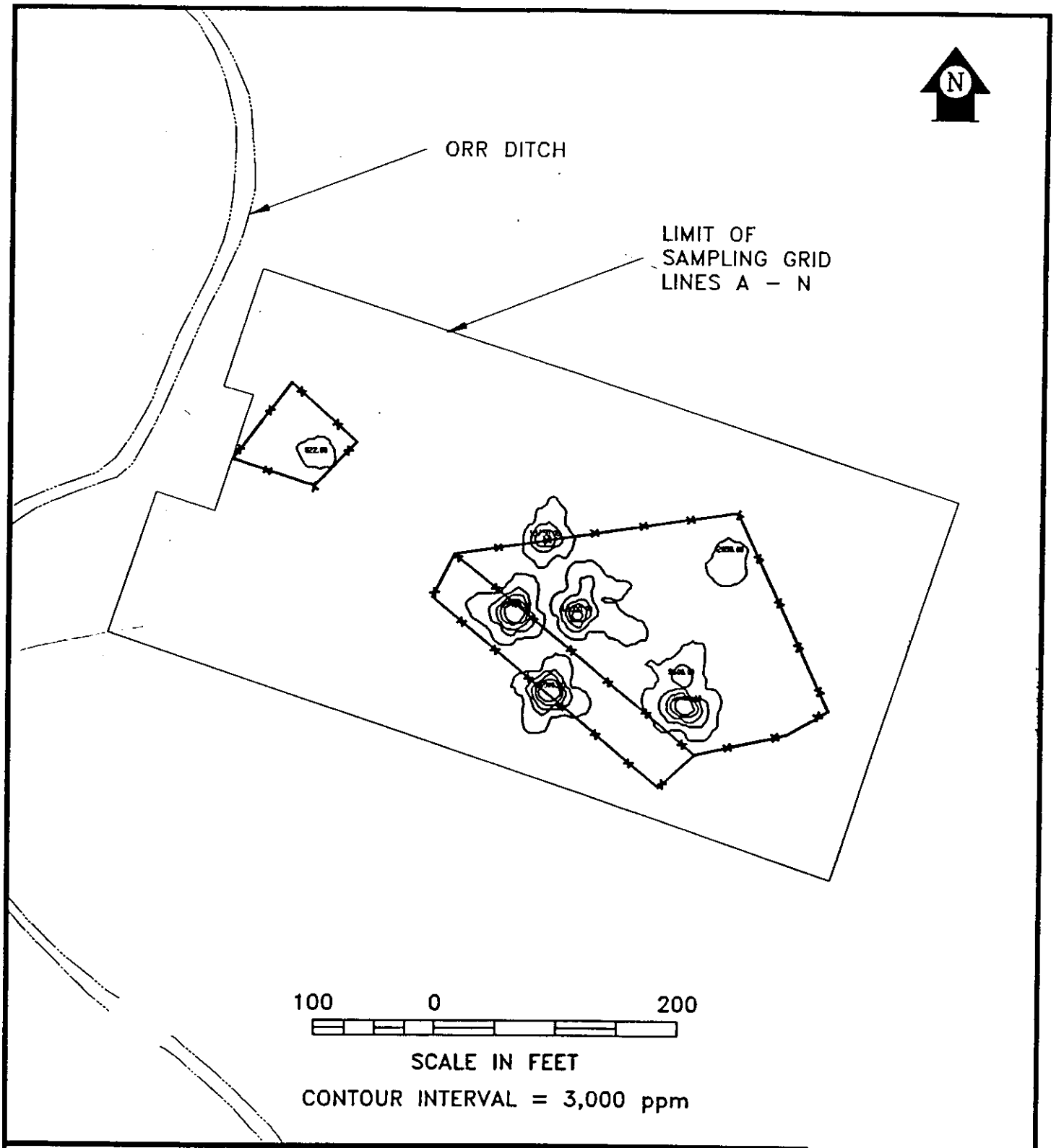


SOURCE: BROWN AND ROOT ENVIRONMENTAL, 1995

SCALE: AS SHOWN	BUREAU OF LAND MANAGEMENT BLM - MONITE EXPLOSIVE FACILITY SPARKS, NEVADA	FIGURE 3-4
DATE: JULY 1995	AREAL EXTENT OF TNT/DNT CONTAMINATION (GREATER THAN 10 ppm)	DRAWN BY: RSG

FIGURE34 DATE 07-13-95 1200 ACADR13 RSG

BROWN AND ROOT ENVIRONMENTAL

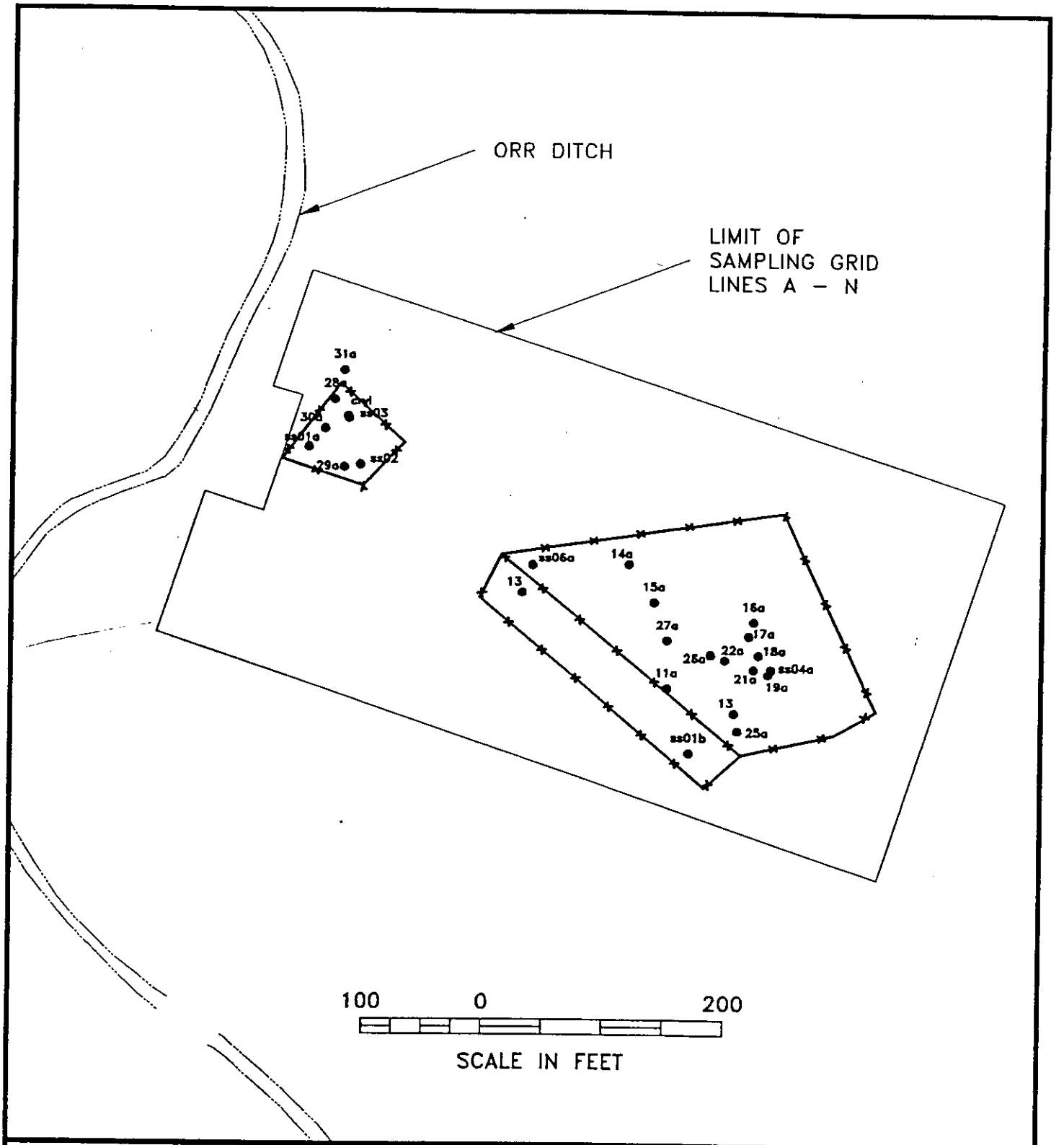


SOURCE: BROWN AND ROOT ENVIRONMENTAL, 1995

SCALE: AS SHOWN	BUREAU OF LAND MANAGEMENT BLM - MONITE EXPLOSIVE FACILITY SPARKS, NEVADA	FIGURE 3-5
DATE: JULY 1995	AREAL EXTENT OF TNT/DNT CONTAMINATION (GREATER THAN 140 ppm)	DRAWN BY: RSG

FIGURE3... DATE 07-13-95 1200 ACADR13 RSG

BROWN AND ROOT ENVIRONMENTAL



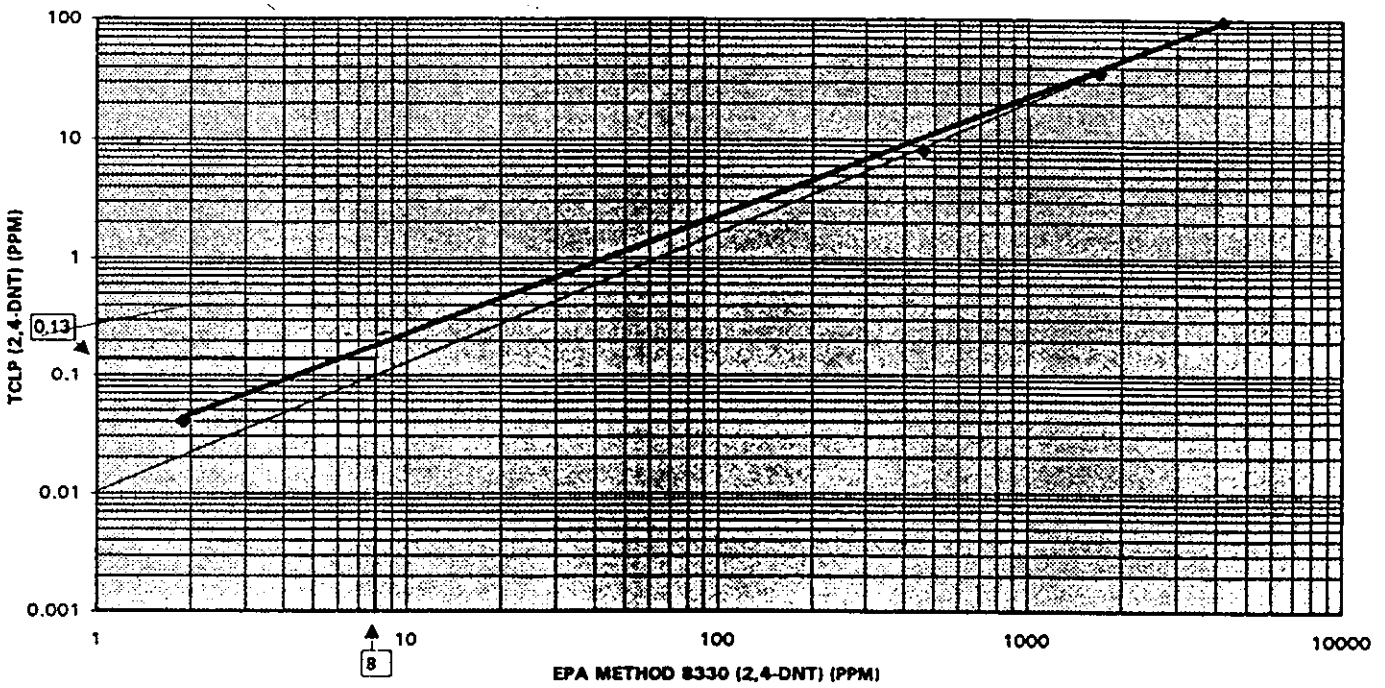
SOURCE: BROWN AND ROOT ENVIRONMENTAL, 1995

SCALE: AS SHOWN	BUREAU OF LAND MANAGEMENT BLM - MONITE EXPLOSIVE FACILITY SPARKS, NEVADA	FIGURE 3-6
DATE: JULY 1995	SUBSURFACE CONTROL POINTS FOR VERTICAL EXTENT OF CONTAMINATION	DRAWN BY: RSG

FIGURE3: DATE 07-13-95 1200 ACADR13 RSG

BROWN AND ROOT ENVIRONMENTAL

Sample #	X (8330)	Y (TCLP)
MN83SI48B	4200	97
MN83SI49B	1.9	0.04
MN83SI50B	460	8.2
MN83SI52B	1700	36



Computer calculated linear regression analysis of all data points shown

Visual best fit of all upper-end data (mid-level to high concentration)

SCALE: N/A	LINEAR REGRESSION ANALYSIS 8330 vs. TCLP (2,4-DNT)	FIGURE 3-7
DATE: MAY 1995		Brown & Root Environmental

4.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

General response actions (e.g., treatment) are broad categories of remedial measures that could be used to achieve the removal action objectives. A particular general response involves one of several technologies (e.g., physical or chemical treatment). A single technology may, in turn, have several process options (e.g., soil washing, solvent extraction). The process options within each technology have been initially screened based upon effectiveness, technical implementability, and cost. The process options found to be viable have been incorporated into specific removal action alternatives for the site.

4.1 ANTICIPATED WASTE STREAMS

There may be two separate waste streams from the Monite Explosive Facility (MEF). The first consists of soil contaminated with 2,4- and 2,6-dinitrotoluene and trinitrotoluene (TNT). In addition, several geophysical anomalies have been detected. Since a drum containing approximately 320 pounds of material believed to be dinitrotoluene was previously excavated at the site, it is possible that one of the anomalies identified may contain an explosive/reactive waste or product. Therefore, the second waste stream is assumed to consist of debris with concentrated dinitrotoluene (associated with the anomalies). As discussed in Section 3.0, possible waste codes for these wastes are K044, K047, U105, and U106.

4.1.1 Geophysical Anomalies

Excavation of the geophysical anomalies will precede any action on the contaminated soil. Thus, some alternatives related to the anomalies are discussed in this section. One of the anomalies appears to be a former pipeline, and one or more of the others may be containers or drums. It is considered possible though unlikely that a torpedo carcass, depth charges, or chunks of TNT could be found during the planned excavation of the anomalies. As discussed in Section 3.3.4, any lead paint (in this case, used on torpedoes and depth charges) could also cause the second waste stream to exhibit the toxicity characteristic for lead (D008). The excavation of the geophysical anomalies will be coordinated with an on-site Unexploded Ordnance (UXO) Specialist who will provide technical assistance and direction. Should explosives or military ordnance be found, the bomb squad or Department of Defense Explosive Ordnance Disposal (EOD) personnel would handle its disposal, most

likely by detonation in a remote location or removal to a unit permitted for open burning/open detonation.

Two of the geophysical anomalies within the fenced enclosures have been tentatively identified as either underground storage tanks or septic tanks. If they are underground storage tanks, it is likely that they formerly contained fuel oil. If they are septic tanks, they most likely contain sanitary waste residue. However, if the septic tanks are connected to a demilitarization operation that uses water to remove explosive material from their casings, the tanks may contain TNT and dinitrotoluene.

Since vendors providing treatment and disposal of petroleum products and petroleum-contaminated soil are widely available, the petroleum waste stream will not be discussed in detail in this engineering evaluation/cost proposal (EE/CA). Liquid petroleum products require sampling and analysis to confirm that they have not been contaminated with other hazardous materials. Uncontaminated liquid could then be collected and recycled. Petroleum sludges could be sent to a local landfarming facility.

One or both of the anomalies could be a septic tank. The contents would require sampling and analysis to determine if hazardous compounds are present. If so, the most likely tank contents are nitroaromatic contaminated soil/sludge. To assign hazardous waste code(s) to this potential waste stream, documentation must exist to determine if the waste is a listed waste. Analysis results and process knowledge could be used to determine if the waste stream is a characteristic waste. Process knowledge would be used to rule out the reactivity characteristic (waste code D003). Results of the analysis would be used to determine if the waste exhibits a toxicity characteristic (e.g., for DNT, waste code D030).

If it is determined that the waste stream is not a hazardous waste, it may be handled as a solid waste in a nonhazardous waste management facility. If the waste stream is determined to be D030, then the waste could be handled in the same manner as either the concentrated waste stream or the contaminated soil. This includes treatment to meet the treatment standards for D030 nonwastewaters. If the waste stream is determined to meet another characteristic, it will be treated differently.

4.2 GENERAL RESPONSE ACTIONS

Based upon the media, contaminants, and volume to be addressed, the following general response actions are considered capable of achieving the removal action objectives when appropriate technologies are implemented:

- No Action or natural attenuation/assimilation
- Institutional controls
- Containment
- Removal
- Disposal
- Immobilization
- Treatment

The National Contingency Plan (NCP) requires that "No Action" be included among the general response actions considered. No action involves no response to the contamination; actions previously initiated are terminated, and no further active human intervention occurs. Natural attenuation/assimilation of the contamination might occur under this response. Other response actions are compared to the baseline provided by the No Action alternative.

Institutional controls include land use restrictions, site access restrictions, and relocation of potential receptors. Although this general response would minimize the possibility of exposure, it would not affect the toxicity, mobility, or volume of contamination. Natural attenuation/assimilation of the contamination might occur under this response also.

Containment technologies are intended to reduce or eliminate the release of contaminants to the surrounding environment. They may also be used to reduce the possibility of direct contact with the contaminated media. Containment actions typically involve the construction of a physical barrier to prevent contamination migration.

Removal technologies entail excavation and subsequent transport of contaminated material from its location at the site to another location either on-site or off-site for treatment, storage, or disposal. Removal alone may eliminate the possibility of exposure to contaminants at the site but it has no effect upon the toxicity or volume of contaminated material. Increased exposure may temporarily result due

to mobilization of the contaminants from removal activities (e.g., fugitive dust emissions from excavation activities). Removal is commonly specified in combination with treatment and disposal.

Disposal involves the excavation of contaminated soil from its present location, consolidation, and deposition either on- or off-site. Disposal sites are sited and engineered to reduce the possibility of contaminant contact with the environment. Disposal is generally used in combination with one of the other remedial options.

Immobilization incorporates actions that limit the solubility or mobility of contaminants. This could involve a change in the physical or chemical characteristics of the waste material. In order to be considered a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) based treatment, solidification must be accompanied by stabilization.

Treatment involves actions which permanently and significantly reduce the toxicity, mobility, or volume of wastes. Treatment may involve changing the properties of a waste so that it can undergo further treatment. Even after treatment, many technologies produce residuals or by-products that may require further treatment prior to disposal.

In the following section, several technologies and process options are briefly discussed for the general response actions presented. The selection of alternatives is consistent with NCP Section 300.430(e)(3), which requires evaluation of a range of alternatives and specifies evaluation criteria. This discussion involves an initial screening. The options are discussed in detail in Section 5.0.

4.3 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Technologies and options were initially screened by evaluating the technical and regulatory constraints. For remedial actions, CERCLA mandates that the remedy selected "utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent possible." Remedial actions which treatment "permanently and significantly reduces the volume, toxicity, or mobility of hazardous substances, pollutants, and contaminants as a principal element" are preferred.

Section 300.415 of the NCP requires removal actions to "contribute to the efficient performance of any anticipated long-term remedial action" to the maximum extent practical. The three broad categories for the evaluation of short- and long-term aspects of the alternatives are effectiveness, implementability, and cost.

Effectiveness considers the degree to which an alternative reduces toxicity, mobility, or volume of the contaminants; minimizes residual risks and affords long-term protection; complies with State and Federal regulations; minimizes short-term impacts and quickly achieves protection. Alternatives that are not sufficiently protective of human health and the environment are eliminated from consideration.

Implementability is the technical feasibility and availability of the technology, and the administrative feasibility of implementing the alternative. Three subcriteria are evaluated: technical feasibility, general availability, and administrative feasibility. Technical feasibility includes consideration of construction and operational issues, demonstrated performance, and adaptability to site conditions. General availability involves the evaluation of whether sufficient equipment, personnel, services and disposal capacity exist to implement the alternative. Administrative feasibility considers the ability to obtain necessary permits or easements, and adherence to non-environmental laws and concerns of regulatory agencies. The evaluation focuses on the institutional aspects of implementability, such as ability to obtain permits, availability of services, and availability of equipment and resources. Alternatives that are infeasible in a reasonable time due to technical or administrative constraints are eliminated from consideration.

Costs considered in the evaluation include direct and indirect capital costs, and long-term operations and maintenance. Cost plays a limited role in the initial selection of alternatives. Nevertheless, alternatives that are excessively costly compared with other similarly effective and implementable alternatives are eliminated. The cost analysis is based on engineering judgment, and each process is evaluated as to whether the costs are low, medium, or high relative to the other options. Cost is more fully developed for limited number of options in the comparative analysis of alternatives.

The following sections provide a preliminary evaluation of technologies and discuss some of the process options for technologies that will be carried forward to the comparative analysis of alternatives.

4.3.1 No Action

The No Action alternative involves no technology, requires no implementation, does not reduce the potential for human exposure, does not reduce the toxicity, mobility, or volume of contaminated materials, and incurs no direct costs. Although some natural attenuation/assimilation might occur, the presence of high concentrations of contaminants at the site almost 40 years since the facility ceased operations demonstrates that the rate of attenuation/assimilation has been quite slow. The NCP

requires that this alternative be carried through subsequent screening and analysis of the removal alternatives as a baseline reference for comparison with the other technologies. Due to the likelihood of human exposure to the contaminants at the site, the No Action alternative is considered unacceptable to both the Bureau of Land Management (BLM) and the regulatory community.

4.3.2 Institutional Controls

Institutional controls include access restrictions, withdrawal from public entry, and monitoring. Institutional controls are mainly administrative. Access restrictions, withdrawal of the lands, and similar controls to limit use of the site are inconsistent with the BLM mission to promote multiple uses of the public lands. Institutional controls also include monitoring.

Monitoring by itself, however, is not a suitable technology, because it does not prevent exposure to contaminants nor does it reduce toxicity, mobility or volume. Monitoring is considered only as a means to determine the effectiveness of other technologies.

4.3.2.1 Fencing

The most highly contaminated portions of the Monite Explosive Facility have been enclosed within 6-foot chain link fences topped with barbed wire. The fencing and associated warning signs were intended to discourage access to the contaminated areas and thereby prevent direct contact with the contaminants.

Effectiveness. Fencing the areas of contamination has been practical only for keeping casual users from having direct contact with the majority of the contaminated soil. However, theft of warning signs from within fenced enclosures indicates that some visitors to the property have gained access to the areas within the fences. In addition, sampling results indicate that some small, isolated areas of contamination are outside of the enclosures. In addition, fencing does not prevent contaminated materials from migrating out of the enclosures due to air entrainment or surface water erosion. Since fencing is not completely restricting access to the site and does not reduce toxicity, mobility, or volume, it is not considered effective.

Implementability. Fencing is in place, and thus implementability is not an issue. Expansion of the fenced enclosures to enclose the additional areas of contaminated is easily done. However, restricting access is contradictory to the mission of BLM, which is to promote multiple uses of public lands. In

addition, the county has filed a lease application expressing an interest in using the site as a park. Public and regulatory acceptance of fencing alone is unlikely.

Cost. The costs of expanding and maintaining the fences are low.

Conclusion. Fencing alone is not effective, nor is it likely to be implementable as a long-term solution. However, the use of fencing in combination with another technology such as containment may be appropriate.

4.3.2.2 Withdrawal from Public Entry

Use restrictions are an institutional control recorded on the BLM Land Use Plan. Closure of the property to administratively prohibit public entry into the contaminated areas was completed with the publication of a notice in the *Federal Register*.

Effectiveness. The withdrawal has been effected, and no additional risks to human health or the environment have resulted directly from its imposition. Withdrawal will ensure that future use of the site will be restricted. Withdrawal of the land is a purely administrative function which may prevent changes in the use of the land, but it is not effective in preventing contact with or migration of the contaminants. Withdrawal of the land does not affect the toxicity, mobility, or volume of contaminated soil. Withdrawal is not in and of itself an effective removal action.

Implementability. Withdrawal from public entry has been effected by the publication of a public notice in the *Federal Register*. It was implemented with the concurrence of BLM management and without protest from the regulators. Withdrawal is an administrative action and therefore, the likelihood of regulatory or public acceptance of it as a stand-alone long-term solution is low.

Cost. Because no additional actions would be taken at the site, no capital costs would be involved. Some minor operations and maintenance costs might be incurred in monitoring the site to ensure that no unauthorized use had occurred.

Conclusion. Because withdrawal from public entry is not entirely effective this option is not considered further as a stand-alone removal alternative. However, withdrawal from public entry in combination with a treatment or disposal may be appropriate.

4.3.2.3 Evacuation

Evacuation involves the removal of persons from a threatened area. Evacuation of nearby residences may be necessary for short periods of time during the excavation and identification of the geophysical anomalies. Evacuation is considered appropriate only during excavation of the geophysical anomalies, since it is only during this operation that encountering explosive concentrations is considered plausible.

Effectiveness. Evacuation does not reduce the toxicity, mobility, or volume of contaminants and thus is not appropriate as a stand-alone remedy. However, the intent is to utilize evacuation to minimize short-term risks associated with the possible detonation of explosives. Evacuation thus removes the human population potentially at risk from the threatened area. The U.S. Army has developed methods for determining minimum distances for partial or full evacuation and other protective actions (U.S. Army, 1981). Excerpts from the Army manual are presented in Appendix A. Evacuation is effective in protecting human health from the short-term risks associated with the possibility of explosion.

Implementability. Evacuation of nearby residences is both technically and administratively feasible. Advance coordination with the affected residents would be necessary to minimize the difficulty with public acceptance. In addition, the cooperation of local police and emergency services would be necessary to ensure that a secure perimeter is maintained. It is anticipated that evacuation of only a few nearby residences would be necessary and that any excavation of the anomalies would be conducted during normal working hours to minimize the hardship on the affected parties. It is anticipated that all of the anomalies could be excavated and identified in fewer than 10 working days.

Costs. The costs associated with evacuation would be low.

Conclusion. Evacuation of nearby residences during excavation of the geophysical anomalies is effective for protecting nearby population from short-term risks and is implementable. This option is retained for consideration when used in conjunction with a treatment or disposal option.

4.3.3 Containment

Waste containment technologies are generally intended to minimize direct contact with contaminated soil and to reduce the mobility of the contaminants by imposition of a barrier. Containment does not affect either the toxicity or the volume of contaminated materials. Containment could be accomplished by capping the site with clean soil or covering the site with an engineered cover. Containment can be

used effectively either as a stand-alone technology or in conjunction with another technology. Capping in particular is generally used when subsurface contamination precludes excavation and removal or treatment of wastes because of potential hazards or unrealistic costs.

4.3.3.1 Engineered Cap

There are a variety of options for covering the contaminated areas with an engineered cover. There are a number of construction materials which could be used such as clay, geomembranes, asphalt, asphaltic concrete, portland cement, concrete, and combinations of these materials. Consolidation or regrading of isolated areas of contaminated soil prior may be required.

Effectiveness. An engineered cap properly implemented is effective in reducing mobility of the contaminants by limiting infiltration, which decreases leaching of the contaminants, and by limiting fugitive dust emissions and erosion of contaminated soil via surface water. Capping also creates a barrier which minimizes the potential for dermal contact and ingestion and isolates the contaminants, limiting the potential for inhalation of contaminated particulates. Implementation of an engineered cap can effectively reduce the mobility, but it will not affect the toxicity or volume of the contaminants.

Implementability. Installing an engineered cap is technically feasible. The construction techniques are widely used and the materials are readily available. However, it is not known whether the regulatory community would accept this as a stand-alone remedy, unless they agreed that removal and/or treatment of the contaminated soil was not feasible. Future uses of the site would have to be carefully reviewed, due to the need to protect cap integrity. Because capping would leave the contaminants in place, public acceptance of the measure near a residential area would be problematic. Removal followed by treatment would be preferred.

Cost. An engineered cap would be moderately costly to implement and maintain.

Conclusion. Use of a stand-alone engineered cap is eliminated from further consideration. Although capping is effective in controlling direct exposure to and mobility of the contaminants, it would not reduce toxicity or volume, and future uses of the site would be limited. As a stand-alone removal action, it may not meet BLM, public, or regulatory preferences. As a secondary measure, it could be used in combination with removal and/or treatment, but the expense is unlikely to be justified by the benefit when compared to other containment options.

4.3.3.2 Soil Cover

Covering the contaminated areas with a layer of clean soil is an alternative containment option. Soil could be obtained either from an uncontaminated portion of the Monite site or from an off-site location.

Effectiveness. A soil cover is less effective than an engineered cap at preventing infiltration. However, since potential evapotranspiration rates in the region (about 35 inches per year) exceed precipitation rates (7.49 inches per year) (Murray, 1995; NOAA, 1990), a cover of clean soil would reduce the amount of precipitation reaching the underlying contaminated soil. A clean soil cover would also reduce fugitive dust emissions, erosion of contaminated soil via surface water, and root contact with contaminated soil. Soil cover also minimizes the potential for dermal contact and ingestion, and also isolates the contaminants, limiting the potential for inhalation of contaminated particulates. However, soil cover alone would not reduce the toxicity or volume of contaminated soil and would only provide a limited reduction in mobility.

A soil cover is more susceptible than an engineered cap to wind and surface water erosion. Proper grading and placement of vegetation would reduce this deterioration.

Implementability. Covering the contaminated areas with soil is relatively simple. Clean soil could be obtained either on-site or from nearby areas. However, it is unlikely that the regulatory community would accept this as a stand-alone remedy, unless they agreed that removal and/or treatment of the contaminated soil was not feasible. Future uses of the site would have to be carefully controlled, due to the need to protect the integrity of the soil cover. As with an engineered cap, regulatory and public acceptance of the measure near a residential area without other remediation would be problematic. Removal followed by treatment would be a preferred option.

Cost. A soil cover would entail a relatively low cost. Some operation and maintenance costs would also be incurred.

Conclusion. Soil cover is retained for further evaluation but only as a secondary removal measure. It could be used in the event that low-level residual contamination remained after removal/treatment.

4.3.3.3 Dust Control

In order to control dust emissions prior to the start of removal activities, BLM is developing an interim dust control plan. The plan as currently proposed involves spraying of biodegradable binder on the soil within the fenced areas. The binder remains effective only as long as the soil surface is undisturbed.

Dust control using a temporary building, water spray, or plastic covers is a short-term alternative which would be used during any construction activities that could result in fugitive dust emissions. These dust control measures for construction activities are discussed below.

Effectiveness. Dust control is a necessary and useful interim technology to minimize fugitive dust emissions. It is not a viable long-term technology since it does not reduce toxicity or volume and requires intensive long-term maintenance. Use of a water spray to reduce dust could increase the leaching of contaminants. Surface controls are an effective short-term technology.

Implementability. Municipal water supply lines and Orr Ditch are located near the facility, and thus implementation of a water spray dust suppression system is feasible. Plastic sheeting for an interim cover is widely available; spreading and securing the sheeting are easily done. While inexpensive and easily implemented as a short-term measure, water spraying or use of a plastic cover would require excessive maintenance over a long period.

Costs. Costs for use as a short-term measure would be low.

Conclusion. Dust control will be retained for use in conjunction with other removal measures.

4.3.4 Removal

Removal of contaminated soil would minimize the potential for individuals using the site to be exposed to contaminants. The U.S. Army has evaluated various methods for soil-handling associated with treatment nearby. These include using front-end loaders and trucks; slurry pipeline/pump; and conveyor system solid feed (TVA, 1990).

Effectiveness. Removal alone does not reduce toxicity, mobility, or volume. Although removal is an inappropriate stand-alone technology, it can be effectively used in concert with ex situ treatment and disposal alternatives. The ex situ option requires the removal of contaminated soil, and excavation of

contaminated soil using conventional construction equipment and methods is effective. Due to the possible presence of bulk explosives, excavation of the geophysical anomalies would require the use of nonsparking handtools, an "armored cab" excavator for larger excavations, and construction of protective works for earth shock and blast. Excerpts from *Explosive Ordnance Reconnaissance* (U.S. Army, 1981) which provides discussion of the identification and implementation of appropriate protective measures (i.e., evacuation and construction of protective works), and *Handbook: Approaches for the Remediation of Federal Facility Sites Contaminated With Explosive or Radioactive Wastes* (USEPA, 1993b), which discusses detection and retrieval of military ordnance, are provided in Appendix A. The methods presented in these documents are effective for the excavation and identification of potentially explosive items or for protection from detonation during excavation and retrieval.

Implementability. Selection of an appropriate excavation technology depends on the volume, depth location, and materials to be excavated. The contaminated soils at MEF consist primarily of a thin veneer of clay and dry sand intermixed with gravel overlying shallow bedrock. The area is sloping, with grades ranging from about 6 to 25 percent. There are no overhead obstructions and the geophysical anomalies will be excavated and identified prior to large-scale earth-moving activities. Excavation to bedrock could be accomplished with side slopes sufficient to minimize any need for shoring. Conventional construction equipment such as scrapers, front-end loaders, backhoes and draglines could be used.

Some crystalline explosives (about 10 percent DNT) were found in a thin (about 1 inch thick) layer just beneath the surface in a small portion of the northwest part of the site. All other explosive concentrations were less than 6 percent. Soils at the site are therefore not believed to be susceptible to the initiation or propagation of an explosion. However, appropriate safety measures would be implemented to further reduce the potential for detonation.

Cost. Excavation using conventional methods is inexpensive on a per-yard basis. The U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) determined that use of a front-end loader and truck is slightly less expensive than use of a slurry pipeline for transport of about 3,000 feet, and both are significantly less expensive than use of a conveyor system (TVA, 1990).

Conclusion. Excavation using conventional methods is retained for consideration in combination with other removal technologies.

4.3.5 Disposal

Disposal of the contaminated soil will be required if it is removed from its current location. Disposal could be performed either with or without treatment, and either on- or off-site.

Effectiveness. Disposal at a properly designed site would decrease mobility of the contaminants. In addition, proper disposal of the contaminants would reduce the threat to human health and the environment. The toxicity and volume of waste would be unaffected, however, and therefore disposal is an inappropriate stand-alone technology, but it could be effective if used in concert with removal and treatment alternatives.

Implementability. On-site disposal would be appropriate only if the soil was first treated to meet the removal action objectives. BLM has expressed a preference for on-site remediation, reflecting the U.S. Environmental Protection Agency's (USEPA's) policy to pursue response actions that involve treatment versus land disposal; off-site disposal increases the short-term risks of a transportation accident and subsequent public exposure to the contaminated soil. There are several off-site landfills that would be willing to accept explosive-contaminated soil. However, Resource Conservation and Recovery Act (RCRA) Land Disposal Restrictions mandate treatment in order to reduce the leachability of the dinitrotoluene, and it must be demonstrated that the soil does not exhibit one of the other RCRA waste characteristics. The RCRA Universal Treatment Standards would apply to waste taken off-site for disposal. A portion of the contaminated soil could be disposed of without treatment in either a RCRA Subtitle C landfill (if the waste meets the universal treatment standards but exhibits a hazardous characteristic), or Subtitle D landfill (if the waste does not exhibit a characteristic). The disposal site would have to be approved by USEPA to accept CERCLA off-site wastes.

Cost. The cost of on-site disposal is low. The cost of off-site disposal ranges from moderate to low depending upon the type of facility (RCRA Subtitle C or D) to which the waste is sent. An estimate for disposal and taxes in the U.S. Ecology (Beatty, Nevada) RCRA Subtitle C facility was $125 per ton ($188/cy), assuming a disposal volume of approximately 1,000 tons (Calvo, 1995). The landfill is approximately 340 miles from the MEF site. The cost of disposal at a Subtitle D facility just outside of Reno is $2 per ton ($3/cy) (Frenchi, 1995). Transportation costs are estimated at 20 to 40 cents per ton per mile.

Conclusion. Disposal is retained for consideration in combination with other removal technologies.

4.3.6 Immobilization

Immobilization is intended to reduce the solubility or mobility (leachable toxicity may also be reduced) of contaminants either with or without changing the physical characteristics of the matrix. Physical immobilization involves blending the contaminated soil with stabilizing materials, while chemical immobilization uses a chemical reaction to bind the contaminants into a material that reduces mobility. Immobilization technologies include stabilization, solidification/stabilization, and sorbent solidification. Solidification alone is generally the conversion of the matrix into a solid monolith primarily for the purpose of structural integrity. Stabilization is generally the physical or chemical bonding of the contaminants within the matrix.

Effectiveness. Solidification/stabilization could be accomplished by mixing the contaminated soil with materials such as cement, pozzolans, silicates, etc. to form a solid mass that incorporates the contaminants. Immobilization can be performed either in situ or ex situ. The contaminants may or may not chemically bind with the matrix. This alternative would require a site-specific treatability study to determine the chemistry and effective reduction in contaminant mobility. Solidification/stabilization would not reduce either toxicity or volume of the waste. USEPA has indicated that immobilization of semivolatile organics, such as the explosives at the Monite Site, requires a site-specific treatability study or study data for a site that is very similar (e.g., contaminants, concentrations, and matrix). Immobilization must demonstrate a significant reduction (over 90 percent) in the leachable concentration of the contaminants of concern. This technology has not been demonstrated for this wastestream.

Implementability. Technically, solidification/stabilization would be implementable. Immobilization process options are widely used for other wastes. In order to gain regulatory approval, treatability studies demonstrating effectiveness would be required. Effectiveness is difficult to demonstrate, because testing to predict permanence is a formidable task.

Cost. The costs associated with immobilization vary greatly with the process option selected. The costs can range from low to high. The required treatability studies would add significantly to the costs.

Conclusion. Because this technology has not been demonstrated for these wastes and treatability studies have not been conducted for the site contaminants and soils, immobilization was not deemed appropriate for further consideration.

4.3.7 Treatment

4.3.7.1 Thermal Treatment

Thermal treatment is the thermodynamic oxidation at elevated temperatures of combustible organic compounds. High-temperature combustion usually involves the application of direct heat, while low-temperature decomposition involves indirect heat. These techniques convert combustible pollutants to carbon dioxide and water. Other elemental constituents (e.g., sulfur, nitrogen, halogens, and phosphorus) are typically converted to acidic vapors. Wastes containing significant concentrations of metals are not suitable for incineration. Thermal treatment could be conducted either on-site using a mobile incinerator or off-site.

The U.S. Army considers incineration of materials containing less than 10 percent secondary explosives by weight to be a nonexplosive operation (DOD Environmental Technology Transfer Committee, 1994). Although dinitrotoluene crystals above 10 percent have been found in isolated areas of the Monite site, screening and blending of soil prior to incineration should dilute the contamination and produce a homogenous mixture below the 10 percent limit.

Effectiveness. Incineration is widely used as an effective means of remediating organic-contaminated soil. Explosive destruction efficiencies of greater than 99.99 percent were achieved during a pilot-scale demonstration of a rotary kiln incinerator at the Savanna Army Depot Activity, Savanna, Illinois (USEPA, 1989b). Treatment either on-site or off-site with a rotary kiln incinerator would be effective.

Fluidized bed incineration and infrared conveyor furnace are also potentially applicable, as they both use temperatures similar to rotary kiln incinerators. Both of these technologies have proven effective on a variety of organic contaminants. However, neither technology has been demonstrated on explosive-contaminated soils. Additional studies would be required to determine if these technologies are effective for the contaminants of concern.

Low-temperature thermal desorption was assessed for explosive-contaminated soil, but treatability studies found that it does not adequately remove explosives from the soil (IT, 1987). In addition, toxic intermediaries are created in the process (Craig, 1995). Therefore, low-temperature thermal desorption is not evaluated further, due to questions about its effectiveness.

Implementability. The implementability of on-site rotary kiln incineration has been demonstrated at various Army Ammunition Plants. Concentrations of explosives at the Monite site do not appear to be a constraint based upon preliminary discussions with incineration service providers, but further discussions would be necessary to confirm that the soils can be fed directly to the primary combustion chamber of an incinerator without exceeding acceptable safety limitations.

Based upon the volume of contaminated soil to be remediated, if on-site incineration were to be selected, a mobile rotary kiln unit would be more feasible than a transportable unit. For example, VESTA Technology, Ltd., has suitable units with feed rates ranging from ½ ton per hour to 4 tons per hour (Papadelis, 1995). The number of commercial mobile units is somewhat limited. Sufficient land area is available at the site for erection of a mobile unit.

Commercial infrared systems are available but on a more limited scale than rotary kilns; thus a competitive bidding climate might not exist. Transportable infrared furnace units are available from Shirco, Continental Resource Recovery, and O.H. Materials. The Shirco design, known for use with polychlorinated biphenyl (PCB) and petroleum-contaminated soils, is the most widely used infrared unit commercially available, and numerous pilot and commercial systems have operated successfully or are presently operating. Implementation would probably be possible.

Implementability of fluidized bed combustion technology is relatively uncertain. The Ogden circulating bed combustor was the only commercially available unit located during the screening. This single, 5-ton-per-hour, transportable circulating bed combustor, available from Ogden Environmental Services, has been used to treat soils containing petroleum and PCBs.

Public and regulatory acceptance of on-site incineration has proven difficult in the past. Permitting of the incinerator is not ensured and requires a significant level of effort.

Several off-site incineration facilities have indicated a willingness to accept the explosive-contaminated soils in bulk, provided the contaminants are not present in the soils at explosive levels. Soils with a flash point below 140°F could not be accepted in bulk. The nearest potential candidate is the rotary kiln incinerator owned and operated by Aptus/Westinghouse at Aragonite, Utah (about 460 miles from the site). This facility has sufficient capacity and is approved to accept CERCLA waste (Westinghouse, 1995). The incinerators owned and operated by Chemical Waste Management in Sauget, Illinois and Port Arthur, Texas, and the Aptus/Westinghouse incinerator in Coffeyville, Kansas, can also accept the soils (Ragland, 1995; Westinghouse, 1995). The incinerators in Texas and Kansas are approved to

accept CERCLA waste, and the facility in Illinois is awaiting approval, which is expected in 3 to 6 months.

Cost. The unit cost of mobile rotary kiln incineration is highly dependent on the total mass of soil; because of the fixed costs of site preparation, mobilization, and trial burns, the cost per ton increases as the total mass decreases. In a survey conducted by McCoy and Associates, Inc., unit operating costs estimated by two vendors of mobile rotary kiln incinerations ranged from $250 to $750 per ton (USEPA, 1991c). The costs did not include excavation, site preparation, or solids handling. McGowan and Ross (1991) estimated total incineration costs for Superfund sites, including excavation, permitting, and ancillary equipment, in the $200 to $650 per ton range. Explosive-contaminated soils were incinerated at two Army facilities for $260 per ton (40,000 tons total) and $330 per ton (102,000 tons total).

A cost estimate for on-site infrared incineration was $1 to 1.2 million for mobilization/demobilization of a 7 to 8 ton per hour unit, plus a processing fee of about $250 per ton (Hay, 1995). These costs excluded permitting, excavation, and ancillary equipment. The cost to incinerate 900 tons would be about $1.3 million, excluding all costs except incinerator mobilization/demobilization and fees. The vendor indicated that the transportable unit is not generally cost competitive for less than 5,000 tons (Hay, 1995).

The estimated incineration cost for the Odgen circulating bed combustor is $150 to $200 per ton, excluding permitting, excavation, and ancillary equipment. No information was provided as to premiums for low soil masses. These costs are comparable to the low to mid-range costs for a rotary kiln incinerator.

The costs for the VESTA Technology, Ltd. mobile rotary kiln incinerator are about $280,000 for mobilization/demobilization to and from Nevada, $250,000 for set-up and shakedown, a monthly fee of $140,000 (1 month would be required to process 900 tons), and a processing fee of $300 per ton (Papadelis, 1995). The cost to incinerate 900 tons would be about $940,000, excluding all costs except incinerator mobilization/demobilization and fees.

Estimated off-site incineration costs obtained from Westinghouse and Chemical Waste Management for handling the soil from the Monite Explosive Facility were $1,000 to $1,300 per ton. The facilities indicated that they could accept essentially pure dinitrotoluene for incineration for between $2,200 and $10,000 per ton; TNT would not be accepted at explosive levels. Estimates for transportation to

the incinerators ranged from 20 to 40 cents per ton per mile, assuming the soil was carried in bulk containers (Ragland, 1995; Westinghouse, 1995). While the on-site incineration option is effective, it is not cost-effective due to the low soil mass. A low soil mass is more cost-effectively incinerated off-site.

Conclusion. On-site rotary kiln incineration is rejected because, although it would probably be effective, it might be difficult to implement and it has a high cost. Off-site rotary kiln incineration is selected for further detailed evaluation because its effectiveness and implementability have been demonstrated in similar applications. Infrared and fluidized bed incineration, although expected to be effective, were not selected for detailed evaluation because of the lack of demonstrated effectiveness for explosive-contaminated soil and potential constraints on availability.

4.3.7.2 Biological Treatment

Biological treatment, or bioremediation, uses microbes to degrade organic contaminants to less hazardous compounds. Biological treatment can be conducted either in situ or ex situ. Biological treatment is most effective on dilute solutions of explosives. TNT and potentially other compounds in a crystalline form may be difficult to bioremediate.

TNT degrades under aerobic conditions to monoamine-, diamino-, hydroxylamine-dinitrotoluene, and tetranitro-azoxynitrotoluenes. Researchers have not identified any specific organisms that are particularly effective for degrading explosive waste; an indigenous consortium of organisms usually affects the degradation.

DOD considers the most promising biological treatments for explosive-contaminated soils to be slurry-phase biotreatment, composting, land farming, and white rot fungus treatment. The later three treatments are solid-phase treatments.

4.3.7.2.1 Slurry-phase Biotreatment

Slurry-phase biotreatment involves mixing the contaminated soil with water and feeding the resulting slurry into a system containing bacteria. Some processes prewash the soil to concentrate the contaminants. Clean sands can then be discharged, and the contaminated fines and wash water are retained for treatment. This is a promising technology and will be retained for further evaluation.

Effectiveness. Slurry-phase treatment allows good process control, can be configured in a number of treatment trains to handle a variety of explosives, and have the potential to remediate to very low contaminant concentrations. However, unlike composting which binds contaminants to humic materials, bioreactors may accumulate the products of biotransformation.

The J.R. Simplot Company has developed and patented the Simplot Anaerobic Biological Remediation Ex-situ (SABRE™) process. The process is an anaerobic slurry phase biological treatment and has been demonstrated on a pilot scale at two sites with explosive-contaminated soil. The projects treated 20 and 40 cubic yards of contaminated soil. A March 1994 Superfund Innovative Technology Evaluation (SITE) Program Fact Sheet indicates that toxicity testing was being conducted on the pre- and post-treatment soils to verify the Simplot claim of a reduction of 95 percent of the nitroaromatic compounds without the formation of toxic intermediates (USEPA, 1994e). More recent studies on TNT demonstrate a 99.4 percent reduction efficiency (USEPA, 1995).

The Simplot process involves the construction of either in-ground or above-ground treatment units. The in-ground unit is a double-lined impoundment into which a 2-foot layer of soil is placed. An above-ground unit could be constructed as a modular tank in which the soil is placed. The soil is then covered with about a 2-foot layer of water. Carbon supplements and pH buffers are added and the material is mixed. This alternative would require a site-specific treatability study to determine the chemistry and effective reduction in contaminant concentrations and determine whether toxic intermediates or by-products remain.

Implementability. The technology has been used for treating sewage sludge for many years. However, keeping the moisture and pH in balance have proven difficult at times. The SABRE process has not been demonstrated at full-scale. A full-scale conceptual design is now being developed for this technology; however, the mechanical equipment for full-scale application is only now being constructed (Yergovich, 1995). In order to implement this alternative, regulators would require that the technology be proven for the site-specific conditions through a treatability test.

In order to prevent the use of the treatment units by migratory birds, access to open water would need to be prevented.

Cost. Slurry-phase biotreatment has only recently been demonstrated in pilot-scale tests. Estimates are $147 per cubic yard for a 5,000 cubic yard project. Additional charges from the vendor for use of the technology may be about $100 per cubic yard for a 5,000 cubic yard project (USEPA, 1995b).

Conclusion. Although this technology has not been proven at full-scale, pilot-scale projects have demonstrated that it may be effective, and implementable. An independent evaluation report on costs and effectiveness will be available in the near future. This technology is retained for further evaluation.

4.3.7.2.2 Composting

Composting has been evaluated as a method for treating explosive-contaminated soil since 1982. Composting involves one of three methods: static-pile composting, mechanically agitated in-vessel composting, and windrow composting. Composting has been shown to degrade TNT, hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), dinitrotoluene, teryl, and nitrocellulose in soils and sludges. After composting has achieved the desired cleanup goals, the material can be returned to the site and unlike, incinerated soils, the compost is an enriched material which can sustain vegetation. In addition, composting is effective for a variety of wastes. The presence of indigenous organisms which can degrade the contaminants and the local availability of amendment mixtures influence the economic feasibility of composting. Some wastestreams require long treatment periods. Another drawback is that composting requires a substantial amount of space for implementation.

Effectiveness. Previous studies for composting at other sites have demonstrated the susceptibility of explosives and propellants to microbial degradation (Williams et al., 1988 and Woodward-Clyde Consultants et al., 1990; Weston, 1993a; 1993b). Nitroaromatics have not been shown to be mineralized to carbon dioxide, but they are biotransformed to organic end products. The organic end products are bound to the compost matrix in a nonextractable/nonleachable form (Pennington et al., 1994; 1995). The composted product shows a substantial reduction in toxicity (Griest et al., 1995; Weston, 1993a; 1993b). However, it is unknown what the exact end products are bound to the compost matrix. Windrow composting has shown greater reductions in TNT, RDX, and HMX than the other composting technologies, and has significantly less process control requirements (Weston, 1993a; 1993b).

Both TNT and RDX have demonstrated significant degradation (97 to 99 percent) when composting parameters are optimized. The effectiveness of degradation was significantly enhanced by using an amendment containing horse or cow manure and by limiting soil loading to no more than 30 percent of the total compost volume. It should be noted that addition of a microbe consortia selected for explosive degradation did not improve composting performance, even after 90 days. A pilot study using windrow technology has shown a 99.7 percent reduction in TNT concentrations over a 30-day

treatment period (Weston, 1993a; 1993b). Recent studies indicate that optimized compost piles may achieve cleanup goals in 15 to 20 days (Craig, 1995). A treatability study would be required to determine if composting of the soils and contaminants at the Monite site could achieve the removal action goals.

Implementability. Composting would be relatively easy to implement from both a technical and administrative standpoint and would require a low level of technology. The necessary amendments are readily available locally and could be trucked in with conventional hauling equipment. BLM has a surplus of horse manure at its Palamino Valley wild horse facility that potentially could be used as an amendment. The soil and amendments could be combined using a front-end loader, and conventional equipment (a windrow turner) could be used for mixing. Control of the critical parameters (temperature, moisture, air) would be the most difficult aspect of implementation and would require careful evaluation during the remedial design. Administrative acceptance has been demonstrated at the federal level as composting has been selected as the Record of Decision treatment for 14,800 tons of soil contaminated with TNT, RDX, and HMX at the Umatilla Depot Activity and for 2,200 tons of TNT-contaminated soil at the U.S. Navy Submarine Base in Bangor, Washington (USEPA, 1994f).

Community acceptance may be difficult, since organic amendments would be required for composting. The organic amendments which include manure could create odor problems especially during turning of the compost piles. Odor suppression techniques could be used to reduce the production of the chemicals responsible for offensive odors.

Cost. The U.S. Army estimated windrow composting costs at $206 to $766 per ton ($309/cy to $1149/cy) including excavation for remediating 20,000 tons of soil over a 5-year period (USEPA, 1994f). An economic evaluation of windrow composting identified potential savings of $25 per ton. Additionally, the Army has concluded that windrow composting is less costly than the other composting options or incineration for treating a soil volume of 20,000 tons (Weston, 1993b).

Several vendors indicated that a composting treatability study could be conducted in a 30-day period for $20,000 or less (Wiser, 1995; Ryan, 1995; Brinton, 1995).

Conclusion. Windrow composting is retained for detailed analysis on the basis of its feasibility as demonstrated by pilot testing, its acceptance by federal regulators, and its potentially lower cost as compared to incineration.

4.3.7.2.3 Landfarming

Landfarming is used extensively to treat petroleum, pentachlorophenol, and polycyclic aromatic hydrocarbon contaminated soils; it could be used to treat soils contaminated with low to medium levels of explosive contamination. Landfarming involves the excavation of soils to treatment plots where they are tilled to mix in nutrients, moisture, and bacteria.

Effectiveness. A pilot study conducted in Hercules, California did not achieve the cleanup goals of 30 parts per million (ppm) TNT, 5 ppm dinitrotoluene, and 5 ppm dinitrobenzene. Contaminant degradation levels of 30 to 40 percent were achieved in the study. Since landfarming was unable to achieve cleanup goals that are similar to the Monite goals, the technology is not an effective remedy for the site.

Implementability. Since performance of this technology has not been demonstrated, this alternative is not considered technically or administratively feasible.

Cost. The costs associated with landfarming are low.

Conclusion. Since landfarming has not yet been shown to be able to achieve the cleanup goals established for the site, it is not considered for further evaluation.

4.3.7.2.4 White Rot Fungus

White rot fungus, *Phanerochaete chrysosporium*, has been more extensively evaluated for its capability to remediate explosive-contaminated soils than any other fungal species.

Effectiveness. White rot fungus has been reported to degrade explosive contaminants in a laboratory setting using pure cultures (DOD Environmental Technology Transfer Committee, 1994). However, several factors make full-scale application problematic. These factors include competition from indigenous bacterial populations, toxicity inhibition, chemical sorption, and the inability to achieve risk-based cleanup goals. This alternative has not yet been demonstrated effective in full-scale tests.

Implementability. Since performance of this technology has not been demonstrated, this alternative is not considered technically or administratively feasible.

Cost. Although this alternative has high operation and maintenance costs, the overall cost of white rot fungus treatment is moderate.

Conclusion. Due to the difficulties associated with implementing white rot fungus treatment and the lack of pilot or field studies, this option is not carried further.

4.3.7.2.5 In Situ Biotreatment

In situ biological treatment uses either indigenous or exogenous microorganisms to degrade contaminants. Treatment can be either aerobic or anaerobic with the contaminants converted to carbon dioxide, water, biomass, methane, and/or trace amounts of hydrogen. In situ treatment can be less expensive than other technologies and results in low contaminant concentrations. However, some contaminants or conditions can result in the production of intermediates that are either equally or more hazardous than the original contaminants.

Effectiveness. In application, in situ biotreatment has been relatively unsuccessful in vadose zone applications due to the difficulty in maintaining a uniform and constant distribution of nutrients, moisture, and oxygen (for aerobic processes). Available data also indicate that in situ treatment might create more mobile intermediates during biodegradation. In addition, the effective biodegradation of explosives requires that large amounts of organic matter be available in the soil. At the Monite site, this could be achieved only by mixing large volumes of organic amendments into the soil, which would require extensive soil handling and site disturbance. This and the difficulty in verifying the effectiveness of the treatment eliminate much of the potential benefits of in situ treatment. The difficulties in maintaining a uniform and constant environment for in situ biotreatment have not yet been overcome by available technologies, and so this alternative is not considered effective.

Implementability. Since the effectiveness of this technology is difficult to verify, this alternative is not considered technically or administratively feasible.

Cost. This alternative has high operation and maintenance costs. The overall cost of in situ biotreatment is moderate.

Conclusion. Due to the need to add large quantities of soil amendments requiring extensive soil handling, the difficulty in maintaining uniform and constant conditions, and the problems with verifying performance, this treatment option is not considered further.

4.3.7.3 Physical Treatment

These technologies involve the transfer of contaminants from one medium to another, with or without concentration, for the purposes of facilitating final treatment or disposal.

4.3.7.3.1 Solvent Extraction

Solvent extraction involves mixing the contaminated soil with an appropriate solvent, either in situ or ex situ, to liberate contaminants. Studies using an acetone-water mixture have indicated that greater than 99.5 percent of the explosives may be removed from contaminated soils (USEPA, 1989b). The transfer of the contaminants from the soil into the solvent is not a stand-alone remediation, but it could be used in combination with other technologies.

Ex situ solvent extraction systems remove contaminants from the excavated soil by transfer of the contaminant to a solvent phase. Typically, the contaminated solvent is then subjected to a fractionation process such as distillation to remove the contaminant. The fraction containing the contaminant must be treated, either to stabilize the contaminant or to destroy it using a method such as incineration or oxidation. Alternately, the entire volume of solvent could be treated.

Effectiveness. Solvent extraction has been demonstrated on a laboratory scale to be an effective means of removing explosive contaminants from soil. A study conducted by USATHAMA (USEPA, 1986b) used acetone as the solvent, since all of the explosives of interest were either somewhat or easily dispersible in acetone at room temperature. Initial concentrations of explosives in the soil ranged from 1,200 mg/kg to 420,000 mg/kg. Final concentrations were 6 to 17 mg/kg, for an extraction efficiency of greater than 99.5 percent.

The limitations of solvent extraction arise upon consideration of the fate of the extract. In the USATHAMA study, the acetone was recovered by boiling the mixture, leaving a small amount of acetone with the explosives to maintain them in a wet state and reduce the potential for detonation. While this reduces the volume of contaminated media, it is not final treatment. The study concluded by indicating that the acetone/explosive mixture, particularly when entrained in a flammable solvent, is generally unacceptable because of the stringent requirements imposed on facilities that process detonatable concentrations. In addition, it is unlikely that a commercial incinerator would be willing to accept a potentially explosive mixture.

Implementability. The process would not be easily implemented from either a technical or an administrative perspective. Considerable equipment would be needed to perform the multiphase treatment processes needed for complete remediation. In addition, the design of a fractionation system would have to incorporate potentially costly explosion safety controls, because fractionation of the contaminants would normally result in their concentrating to potentially reactive levels. Officials from both USEPA and the U.S. Army Environmental Center indicated that solvent extraction was not being pursued due to the difficulties associated with the resulting explosive-contaminated solvent (Craig, 1995; Dette, 1995).

Administratively, the process is unproven for explosives. Treatability studies would be required to demonstrate that the solvent and resulting concentrated explosive contaminants were adequately managed.

Cost. Cost would be expected to be high because of the additional treatability testing required, the design and mobilization of expensive equipment, and the need to have process equipment for each of the several phases leading to complete remediation of the soil. A pilot-scale study determined that solvent extraction would not be economically feasible unless the number of washes required could be reduced, and the acetone would have to be recovered and reused.

Conclusion. Ex situ solvent extraction is rejected on the basis that it is undemonstrated for this site and these contaminants, would require extensive treatability testing to demonstrate viability, and would potentially require costly design elements to mitigate safety concerns. The methods available for recovery of the solvent create serious safety concerns.

4.3.7.3.2 Soil Washing

Soil washing uses water as the extraction medium for removal of contaminants from the soil. The contaminated water would then need to be treated prior to discharge.

Effectiveness. The contaminants of concern at the Monite facility have low aqueous solubilities, which limits the viability of both in situ and ex situ aqueous soil washing. In order to gain regulatory approval, treatability studies demonstrating effective removal from the soil would be required. Soil washing without treatment could be used to reduce the volume of contaminated soil; however, the liquid extract would require treatment. The toxicity of the waste would be unaffected, but mobility

could be increased. Therefore, soil washing is an inappropriate stand-alone technology; however, it could be effective if used in concert with treatment.

Implementability. This alternative would require the conduct of a site-specific treatability study to determine if the cleanup goals could be achieved. If goals could be achieved, and if a proper treatment train is established, this alternative should be implementable. Officials from the USEPA and the U.S. Army Environmental Center indicated that soil washing was not being pursued, however, due to the large volumes of contaminated water being generated and the need to treat the fines in which the explosives are concentrated (Craig, 1995; Dette, 1995).

Cost. The costs associated with soil washing are moderate. However, the liberated contaminants would require treatment which would add to the cost of the removal. The required treatability studies would add significantly to the costs.

Conclusion. Because treatability studies have not been conducted for the site contaminants and soils, and an effective treatment train has not been developed, soil washing was not deemed appropriate for further consideration.

4.3.7.4 Chemical Treatment

Chemical treatment involves the application of oxidizing and/or reducing agents to selectively convert organic compounds to less hazardous forms. Neither oxidation nor reduction has been successful in studies conducted thus far (IT, 1987). Many explosives are extremely resistant to oxidative degradation, and chemical reduction often results in compounds that are hazardous. USATHAMA has evaluated six chemical treatment processes: caustic hydrolysis/peroxide oxidation, shock plasma, microwave/hydrolysis/oxidation, microwave/sonic/oxidation, nitric acid/heat, and supercritical fluids (TVA, 1990).

Effectiveness. Studies conducted thus far have found that neither oxidation nor reduction is successful (IT, 1987). Many explosives are extremely resistant to oxidative degradation, and chemical reduction often results in compounds that are hazardous. USATHAMA determined that microwave/sonic/hydrolysis/oxidation and nitric acid/heat are technically infeasible. Shock plasma has not been fully developed, and high order detonation is a concern. The caustic hydrolysis/peroxide oxidation process is considered technically feasible, but it has not been demonstrated in the field (TVA, 1990). Chemical treatment technology has not proven effective for explosive-contaminated soils.

Implementability. Since the effective performance of this technology has not been demonstrated and is difficult to verify, this alternative is not considered technically or administratively feasible.

Cost. Cost for chemical treatment can range from low to high depending upon the technology selected. Estimates developed for caustic hydrolysis/oxidation not including excavation, site preparation, or solids handling were about $98 per ton ($147/cy), with capital costs of approximately $2,800,000 (TVA, 1990).

Conclusion. Due to the lack of demonstrated effectiveness for explosive-contaminated soil, this option was eliminated from further consideration.

4.4 SELECTION OF SPECIFIC ALTERNATIVES FOR DETAILED EVALUATION

In Section 4.3, many response actions, technologies, and associated process options were screened for use on this site using the general criteria of implementability, effectiveness, and cost. The options selected for further evaluation are shown in Table 4-1.

These remedial actions will be combined to form the following five specific alternatives. With the exception of the No Action alternative, all alternatives include dust control, geophysical anomalies, and excavation. In addition, three of the alternatives include disposal to help reduce treatment costs.

- Alternative 1: No Action.

- Alternative 2: Off-site Incineration/Landfilling. This alternative includes excavation of the contaminated soil with conventional excavation equipment, testing of the soil below the excavation to verify removal of contaminants to an acceptable level or excavation to bedrock, transportation, off-site incineration, testing of the incinerated soil to confirm effectiveness, and landfilling of the incinerated soil. The disturbed area would be filled, covered with clean soil, and revegetated. Dust control and air monitoring would be used as necessary for the protection of both public and worker safety during remediation.

- Alternative 3: Off-site Biotreatment. This alternative includes excavation of the contaminated soil with conventional excavation equipment, testing of the soil below the excavation to verify removal of contaminants to an acceptable level or excavation

to bedrock, off-site transportation to Hawthorne Army Depot, and probably batch treatment by windrow composting. This alternative assumes a full-scale operation on-going at Hawthorne and agreements in place to accept MEF's contaminated soil. The disturbed area would be filled, covered with clean soil, and revegetated. Dust control and air monitoring would be used as necessary for the protection of both public and worker safety during remediation.

- Alternative 4: Windrow Composting. This alternative includes excavation of the contaminated soil with conventional excavation equipment, testing of the soil below the excavation to verify removal of contaminants to an acceptable level or excavation to rock, on-site composting, testing of the composted soil to confirm effectiveness, and replacement of the composted soil in the excavation. The disturbed area would then be covered with clean soil and revegetated. Dust control and air monitoring would be used as necessary for the protection of both public and worker safety during remediation.

- Alternative 5: Slurry-phase Biotreatment. This alternative includes excavation of the contaminated soil with conventional excavation equipment, testing of the soil below the excavation to verify removal of contaminants to an acceptable level or excavation to rock, on-site treatment, dewatering of the slurry or allowing water to evaporate, testing of the treated soil to confirm effectiveness, and covering of the treatment unit. The disturbed area would then be covered with clean soil and revegetated. Dust control and air monitoring would be used as necessary for the protection of both public and worker safety during remediation.

These alternatives will be analyzed in detail in Section 5.0.

TABLE 4-1

REMEDIAL OPTIONS SELECTED FOR FURTHER EVALUATION
MONITE EXPLOSIVE FACILITY, CARSON CITY DISTRICT, NEVADA

General Response Actions	Technologies	Process Options
No Action	None	None
Institutional Control	Monitoring Access Control	Soil Air Fencing Withdrawal from Public Entry Evacuation
Containment	Cover Dust Control	Soil Cover Water Spraying Plastic Cover
Removal	Excavation	Geophysical Anomalies Conventional Equipment
Disposal	Landfilling	Municipal Landfill (Subtitle D) RCRA Hazardous Waste Landfill (Subtitle C)
Treatment	Thermal Biological	Incineration Composting Slurry-phase Biotreatment

5.0 DETAILED EVALUATION OF ALTERNATIVES

5.1 ELEMENTS COMMON TO REMOVAL ALTERNATIVES

Components that are common to three or four of the alternatives are discussed here as a group in order to limit redundancy.

5.1.1 Estimated Volumes of Contaminated Soil Requiring Remediation

Based on the trinitrotoluene (TNT)/dinitrotoluene screening results, an estimated 1,056 cubic yards (1,584 tons) of soil are contaminated above the cleanup goal of 6.6 milligrams per kilogram (mg/kg). The screening results are not compound specific, but it was assumed that the concentration represents only 2,4-dinitrotoluene. The 2,4-dinitrotoluene is the compound which drives the cleanup.

A linear regression analysis of the Toxicity Characteristic Leaching Procedure (TCLP) and U.S. Environmental Protection Agency (USEPA) Method 8330 analysis for 2,4-dinitrotoluene indicates that soil containing 8 mg/kg will exhibit the Resource Conservation and Recovery Act (RCRA) characteristic of toxicity. The quantity of soil between the 6.6 mg/kg cleanup level and 8 mg/kg is about 150 cubic yards (225 tons). Soil in this range is not a hazardous waste and could be disposed of in a RCRA Subtitle D facility (sanitary landfill).

Soils containing between 8 mg/kg and 140 mg/kg are assumed to exhibit the RCRA characteristic of toxicity but are below the RCRA Universal Treatment Standards and are therefore not subject to Land Disposal Restrictions (assuming that 2,6-dinitrotoluene is not present above 28 mg/kg). Soil in this range are considered a hazardous waste and could be disposed of in a RCRA Subtitle C facility (hazardous waste landfill). Approximately 300 cubic yards (450 tons) of soil fall into this range of concentrations.

Soils containing over 140 mg/kg would exhibit the RCRA characteristic of toxicity and would need to be treated to a concentration of less than 140 mg/kg before they could be landfilled off-site. There are approximately 606 cubic yards (909 tons) of soil with TNT/dinitrotoluene screening levels over 140 mg/kg.

It was assumed that each of the alternatives other than the No Action Alternative would include the collection of 400 additional screening samples. These samples would be used to clearly define the depth of contamination and differentiate between soils requiring treatment and those that could be landfilled directly.

5.1.2 Excavation and Feed Preparation

Composting, off-site incineration, slurry-phase biotreatment, and off-site biotreatment would involve excavation of the contaminated soil and backfill of the excavated area. Costs for excavation and backfill were based on the following assumptions:

- Geophysical anomalies would be investigated independently and exhumed as the first phase of excavation. All of the following assumptions for excavation would apply, in addition to the basic case of requiring two unexploded ordnance (UXO) specialists with the necessary detection equipment on-site for a period of 6 weeks. It is assumed that these UXO operations would be addressed in a detailed Standard Operating Procedure (SOP) specific to the site and the potential hazards. Any special needs (e.g., armored/remote equipment and protective works) are not addressed in the cost estimate. Disposal of exhumed materials is dependent on analysis of what is found, as discussed in Section 4.1.1.

- Excavation, hauling, and backfill could be done using conventional equipment and technology (e.g., backhoes, front-end loaders, dump trucks, scrapers).

- The soil would be hauled to a predetermined location near the treatment area. In the on-site treatment alternatives, following treatment the soil would be returned to the excavation or would be left in the treatment unit. The distance between the excavation and the treatment area is assumed to be 200 feet. (Costs to prepare a temporary stockpile pad at the treatment area are included in the site preparation costs for individual alternatives.)

- Excavation and backfill would be preformed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site health and safety requirements implemented under the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120). It is assumed that no respiratory

protection would be required but that the contractor would use appropriate dust control methods and would monitor for airborne particulates.

- The backfill material would consist primarily of treated soil for the composting and slurry-phase biotreatment alternatives; it would be compacted only to the degree required to prevent significant additional settling. Clean backfill would be required for the off-site incineration and off-site biotreatment alternatives.

- The treated soil would be covered by a minimum of 1 foot of clean soil, obtained from on-site or from nearby Bureau of Land Management (BLM) property. The clean soil would be collected using a conventional scraper or similar equipment. The distance from the area of clean soil to the site is assumed to be under ½ mile.

Based on experience with similar site conditions, excavation and hauling costs charged by a contractor for an unshored, uncontaminated excavation are typically $10 per cubic yard of soil. These costs generally escalate because of the general requirements associated with CERCLA site health and safety, and the loss of productivity incurred because of monitoring, use of personal protective gear, and decontamination procedures. The U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) estimated the cost of explosive-contaminated soil handling to be $10.61 per ton ($15.92/cy) (TVA, 1990). This value was not used for cost estimating purposes. The cost estimate for this engineering evaluation/cost analysis (EE/CA) assumed that a contractor would bill for the personnel and equipment on-site rather than at a unit rate.

5.1.3 Treatment Residuals

Incineration, composting, and slurry-phase biotreatment would result in residual treated soil, including any rocks and debris removed and washed during feed preparation. Residual ash from incineration would be landfilled at a RCRA Subtitle C facility. The treated soil from composting and slurry-phase biotreatment would be analyzed to verify the effectiveness of the treatment in achieving the cleanup goals and treatment standards. Residual soils from composting on-site would then be used to backfill the excavation. Soils from slurry-phase biotreatment would be left in the treatment unit, which would be filled with clean soil and covered with a geomembrane. The disturbed area from composting or slurry-phase biotreatment would then be covered with a minimum of 1 foot of clean soil. Additional clean fill would be added as necessary to return the area to its natural contours. Finally, the area would be revegetated with native plants.

Composting might also result in a small amount of washwater if screening for rock/debris was required. The anticipated volume of the washwater is low enough that it probably could be used to maintain moisture levels in the compost windrows.

Water remaining in the slurry-phase biotreatment unit would be allowed to evaporate once treatment was completed. Thus, no treatment residuals other than the treated soil and washed rocks and debris would be produced.

5.1.4 Monitoring and Review

High surface soil concentrations of contaminants would remain under the No Action alternative, and low concentrations of contaminants would remain in soils in all other alternatives. CERCLA requires that if the remedial action selected results in contamination remaining at the site, a review of the action must be conducted no less often than every 5 years to ensure that human health and the environment are being protected [CERCLA Section 121(c)]. For purposes of this EE/CA, it has been assumed that a 5-year review would be conducted for any alternative selected.

5.1.5 Land Use Restrictions

A basic premise guiding remediation at the Monite Explosive Facility (MEF) is that the site will be used in the future as a public park or an open space, not for residential development. Therefore, the alternatives include deed restrictions and other administrative limitations on future land use.

5.2 ALTERNATIVE 1: NO ACTION

5.2.1 Process Review

According to the USEPA's National Contingency Plan (NCP), the level of treatment achieved must be compared to the required expenditures of time and materials as an integral portion of the remedy selection process. The No Action alternative serves as a common reference point for subsequent analysis and comparison with the other alternatives selected for detailed evaluation.

No Action does not mean that the MEF would be abandoned. The existing fences that limit public access would remain for the foreseeable future.

Some natural recovery of the soil would be expected as a result of natural degradation/transport processes. Photolysis of the contaminants could occur in exposed surface soils, but this would have little overall impact on recovery. In-situ biodegradation might occur, but its success and rate would be severely limited by the lack of sufficient organic material, moisture, and aeration in the soil present at the site. The low precipitation rate versus high evapotranspiration rate in Sparks, Nevada makes natural in-situ soil washing an unfavorable mechanism for removing contaminants from the soil. Much of the contamination is believed to have been deposited over 40 years ago. The high concentrations of contamination in the soil after this extended period indicates that natural processes are not effective in reducing contaminant concentrations. Therefore, it is expected that natural recovery of the soil would not occur within a reasonable time frame.

5.2.2 NCP Criteria Analysis

The degree to which the No Action alternative satisfies the criteria of the NCP is summarized in Table 5-1 and discussed below.

Overall Protection of Human Health. This alternative does nothing to enhance protection of adjacent communities, the environment, or future land users. The risks posed by the soil would remain at the current level.

The No Action alternative would continue to present a risk of exposure to persons recreating on-site. The site is in an area of active use, and direct contact with soils will be expected. If the fencing continues to limit vehicular traffic, exposure via the air pathway would be minimal. This is because the explosives have a low volatility, the contaminated surface soils at the site are relatively stable with respect to wind erosion, and no excavation projects (other than those associated with removal) are planned for the site. This alternative would not require any further construction or operation activities.

Compliance With ARARs. This alternative would not comply with either state or federal applicable or relevant and appropriate requirements (ARARs) regarding soil remediation. The cancer risk posed by direct contact with the contaminated surface soils exceeds the acceptable range of 1×10^{-4} to 1×10^{-6} stated in the NCP (40 CFR 300.430 [e][2][i][A][2]). The No Action alterative does not demonstrate a remedial effort that results in protection of human health or the environment.

Long-Term Effectiveness and Permanence. This alternative provides no long-term protection of human health and the environment, and the potential for direct exposure to site users remains. This

alternative does not provide a permanent solution to the contamination at the site. As no action is taken, there is no appreciable reduction in toxicity, mobility, volume, or access to the contaminants.

Reduction of Toxicity, Mobility, and Volume. The No Action alternative achieves little if any reduction in the toxicity, mobility, or volume of the contaminants present.

As discussed above, some natural degradation of the explosives might occur in situ, thus reducing toxicity. Conditions for degradation are unfavorable, however, and the rate of recovery would be expected to be very slow. This assumption is based on the observation that in 1995, 40 years after the facility discontinued operations, contaminant concentrations remain unacceptable.

Short-Term Effectiveness. Since no remedial activities are conducted, there would be no short-term impacts to workers, the public, or the environment.

Implementability. There is no technical reason that the No Action alternative could not be implemented.

There are two administrative considerations in implementing the No Action alternative. First, it is highly unlikely to be acceptable to the regulatory agencies or to generate favorable response from the local communities. Second, existing levels of contamination place restrictions on future land use. This is a situation that would be contrary to the mission of the BLM, which is to promote multiple use of the public lands.

Cost. The immediate cost of implementing the No Action alternative would be minimal. However, because the site poses unacceptable risks to nearby residents and recreational users, BLM might be required to retain ownership of the site and provide long-term monitoring and management. These costs, while potentially substantial, have not been estimated because of their indefinite nature.

5.3 ALTERNATIVE 2: OFF-SITE INCINERATION/LANDFILLING

This option encompasses three different general response actions. The first response action is sending the soils and debris that are above the cleanup goals but are not a RCRA hazardous waste to a municipal landfill. Soils and debris that are considered "hazardous" will be sent either to a RCRA interim status/permitted landfill or to an incinerator (depending upon contaminant concentrations). Several viable thermal treatment options were discussed in Section 4.2.7.1. Each of the incinerator

designs has proven effective in treatment of contaminated soils. However, the rotary kiln design is the one that has been used most extensively for the contaminants found at the MEF. Several off-site incinerators are capable of handling the contaminants and soil volumes found at the site.

5.3.1 Process Review

Excavation/Backfilling and Materials Handling. The contaminated soils would be excavated as described in Section 5.1.2. Large rocks and debris would need to be removed from the soils to be sent to the incinerator. The extent of screening would depend on the facility to which the material is sent. For the purposes of the EE/CA, it is assumed that the entire volume of material is processed through an appropriate size vibrating screen. The rocks and debris would be washed to remove contaminants from the surface. The washwater generated would be captured and allowed to evaporate with the residual soil sent to either an incinerator or a landfill, depending upon contaminant concentrations. The rocks/debris would then be sampled to determine if any contamination remained. The excavation would proceed from the area of lowest concentration to the area of highest concentration.

Backfilling would involve moving uncontaminated soil from an area on-site or from nearby BLM property, followed by deposition and compaction in the excavation. The slope would be returned to original contours.

Landfilling. The contaminated soil that is not a RCRA hazardous waste but is above the cleanup goal would be sent to a local RCRA Subtitle D facility (sanitary landfill) once approval was gained from the regional USEPA off-site coordinator. Any soils which qualify as a hazardous waste due to TCLP results but have contaminant concentrations below the RCRA Universal Treatment Standards would be sent to a RCRA Subtitle C facility (hazardous waste landfill) approved to accept CERCLA off-site wastes. The remaining soil (i.e., soils which are hazardous waste and have contaminant concentrations above the RCRA Universal Treatment Standards) would be incinerated. The incinerator ash must be disposed of in a RCRA Subtitle C facility.

Incineration. Because of the relatively low volume of soils to be treated, it is assumed that an off-site incinerator would be used. Rotary kilns are capable of handling a wide variety of solid and liquid wastes. Solid wastes must have a flashpoint greater than 140 degrees Fahrenheit. Metal and rock chunks must be less than 6 inches in any dimension and no rebar is permitted. Metal plate must be less than ⅛-inch thick. No intact containers are allowed. All metal, plastic, and glass must be either

broken or shredded. It is assumed that in order to meet the above requirements, all soil would be passed through an appropriately sized vibrating screen as described previously.

Waste is combusted in an inclined cylindrical, refractory-lined shell. The incinerator is generally heated to temperatures ranging from 1,800 to 2,200 degrees Fahrenheit by the burning of fossil fuels. Most of the heating of the waste is due to heat transfer from the combustion product gases and walls of the kiln. Wastes are introduced into the kiln at the higher end and are passed through the combustion zone as the kiln rotates. The rotation creates turbulence and improves combustion. Residence time and temperature depend upon the combustion characteristics of the waste. Residence times range from a few seconds to an hour or more for bulk solids.

Air Pollution Control (APC). Exhaust gasses pass through both an afterburner (to ensure complete combustion) and air pollution control equipment. The gases move from the afterburner chamber to a Quench Tower-Spray Dryer at approximately 2,200 degrees Fahrenheit; here they are cooled to approximately 450 degrees Fahrenheit by water evaporation. Some particulates are removed during this stage. The gases then move through a series of woven glass bags called the "Baghouse," which removes the remaining particulates from the gases. From the Baghouse, the gases enter a saturator where it is sprayed with a water solution to lower its temperature to about 170 degrees Fahrenheit. The saturated gas then passes through a two stage wet scrubber where acids are removed and neutralized. The final stage of gas cleansing is the Wet Electrostatic Precipitation (WESP) area. The WESP removes aerosols and very fine particulates from the gas. The gas is then driven by an induction fan out a stack. The exhaust is primarily carbon dioxide and water vapor.

Incineration Waste Control. The primary residuals generated are the combusted soils (disposal of the ash is included in the incineration cost) from the 1) incinerator and 2) the air pollution control equipment; air emissions are also produced. Water from the pollution control scrubber is generally recycled.

Incinerator Requirements. All waste streams entering an incinerator must meet certain characteristics in order to be incinerated. These characteristics are set by the state and the individual facility. A sample of the waste must be sent to the incineration facility for analysis prior to shipping of the waste.

5.3.2 Operating Parameters

Site Suitability. Off-site incineration/landfilling offers the advantage of requiring only limited space at the MEF. Space would be required for the excavation, stockpiling, and support operations only. The site access road would require improvement in order to be adequate for the excavation equipment and haul trucks.

Topographic Constraints. Existing topography would not inhibit the use of conventional excavation and earth-moving techniques.

Site Area Requirements. An area approximately 300 feet by 500 feet would be required to set up the equipment necessary to accomplish the excavation and sorting of the debris. This area would include a contaminated soil stockpile, a decontamination area, and the contaminated excavation area.

Utilities. The utilities required for this activity would be for water lines and equipment for dust suppression.

Personnel. Two personnel would be required for the excavation phase. These would include one equipment operator/sampler to handle a front-end loader, and a field engineer. The operations would typically consist of 8-hour shifts, 5 days per week. The field team would be supported by an office staff that would provide project management support. The office staff would consist of a number of people who are not dedicated full time to the cleanup.

Personnel exposed to contaminated soil are subjected to the OSHA requirements for hazardous waste site operations (29 CFR 1910.120), including requirements for personal protective equipment (as dictated by the specific site conditions and contaminants), physical examinations, and hazardous waste site training.

Implementation Time. The time required to implement the landfilling/incineration alternative is dependent mainly on the time required to excavate the contaminated soil. However, prior to acceptance at either an incinerator or landfill, waste profiles and samples would need to be provided. A Subtitle D facility would require prior approval by the USEPA regional CERCLA off-site coordinator. Several Subtitle C facilities in USEPA Region IX are already approved to accept CERCLA waste. The time required to flag the areas and excavate the entire volume of soil to be remediated would be approximately 3 months, including backfilling and recontouring of disturbed areas.

5.3.3 NCP Criteria Analysis

The degree to which the incineration/landfilling alternative satisfies the criteria of the NCP is summarized in Table 5-2 and is discussed below.

Overall Protection of Human Health and the Environment. This alternative would provide for overall protection of human health and meet the cleanup goals set by destroying the highly contaminated soils and moving the less contaminated materials to an appropriately designed disposal facility. The concentrations of explosives in the incinerated soil would be reduced approximately 99.99 percent. Resulting concentrations would be below detection limits. Explosives concentrations would be below levels at which plant effects are noted.

Near-term protection of the public health and the environment during remediation would be achieved directly by using specific design and operating controls to minimize dust emissions during excavation. Operation of the incinerator and the disposal facilities is governed by RCRA and is closely monitored by USEPA and/or local authorities. Occupational risks to on-site workers are expected to be minimized through the use of specific operating controls and procedures and appropriate training. Occupational risks would be addressed in the project Health and Safety Plan.

Compliance with ARARs. Incineration/landfilling would be expected to meet all ARARs, as described below.

Chemical-Specific ARARs. Incineration would be expected to successfully reduce explosive concentrations in the incinerated soil to below detection levels. Soils with dinitrotoluene concentrations below the RCRA Universal Treatment Standards would be appropriate for landfilling at a Subtitle D facility (sanitary landfill) if the soils did not exhibit the RCRA characteristic of toxicity; or at a Subtitle C facility if soils continued to exhibit the characteristic of toxicity.

The Washoe County Department of Health would require approval before the disposal of any of the wastes from the site at the local Subtitle D facility.

Location-Specific ARARs. Off-site incineration/landfilling would have no effect on any local protected species or off-site designated wetlands.

Action-Specific ARARs. ARARs that must be addressed in evaluating the landfilling/incineration alternative were discussed in Section 3.2. All of these would be met by the alternative as proposed. Of particular note is the CERCLA off-site rule, which requires that USEPA approve of the disposal site prior to its accepting CERCLA waste.

Long-Term Effectiveness and Permanence. Landfilling will provide long-term protection of the nearby residents by removing the contaminants from the site to a facility where infiltration and leaching are controlled, hence limiting mobility of the contaminants. Incineration provides for the permanent and irreversible destruction of contaminants, and thus the incineration systems evaluated here are expected to provide long-term protection of human health. The removal of the contaminants from the Monite Site would reduce the excess cancer risks at the site to within the acceptable range.

Final explosives concentrations in the incinerated soil would be expected to be below detection limits (less than 1 μg/g). These concentrations are associated with an excess cancer risk of less than 1×10^{-6} and are well below levels observed in laboratory studies to cause adverse impacts on vegetation (PNL, 1989; 1990). There would be no permanent disturbance of land areas as part of the remedial project, as the area would be restored to surrounding conditions following remediation.

Reduction of Toxicity, Mobility, or Volume. Rotary kiln incineration achieves permanent and irreversible reductions in the concentrations of and, thus, toxicity of the contaminants of concern. The incineration of explosive-contaminated soil in a rotary kiln would destroy virtually all (>99.99 percent) of the toxic contaminants present (USATHAMA, 1985). Significant volumes of stack gas would be exhausted to the atmosphere, but these emissions are expected to have virtually no adverse impacts because of the use of scrubbing and control systems.

Disposal of soil/ash at a properly designed and operated facility would decrease the mobility of the contaminants. The reduction in mobility is achieved by limiting the infiltration of precipitation, hence reducing the production of leachate, and by preventing erosion of the contaminated soil by wind or surface water.

Short-Term Effectiveness. If selected as the removal action, landfilling/incineration could be implemented as soon as funding is in place, bids can be solicited and the contract can be awarded. Following that, the desired cleanup levels could be achieved in 3 months.

This alternative would pose little risk to the community, workers, or the environment during its implementation. There would also be minimal risk to the workers involved in this operation. Workers would be protected from exposure to contaminants through special waste-handling procedures (e.g., dust control), monitoring, and use of appropriate protective gear. The use of dust control techniques would also afford protection of the local community from fugitive dust emissions.

No adverse affects to protected species or sensitive land areas would be expected during remediation. Land areas disturbed during the excavation operations would be restored following project completion.

Implementability. The general technical feasibility of landfilling/incineration of soils containing organic explosives has been demonstrated at numerous sites. Landfilling/incineration has been employed for a wide variety of contaminants and the technology is well proven. The excavation and separation of the areas of differing levels of contamination for incineration or disposal do not pose unusual design or construction problems, nor are unusual skills or knowledge required.

Administratively, landfilling/incineration of explosive-contaminated soil has been approved by USEPA at numerous sites. It is expected to require little administrative effort to implement.

Cost. Costs are presented in Appendix D; the elements of the individual cost categories are discussed below. The costs associated with this alternative are as follows:

Transportation to Sanitary Landfill	40 cents/ton/mile	= (.4) (1.5) (20) = $12/cy
RCRA Subtitle D Landfill Disposal	$2/ton	= $3/cy
Transportation (Hazardous Waste)	40 cents/ton/mile	= (.4) (1.5) (340) = $204/cy
RCRA Subtitle C Landfill Disposal	$125/ton	= $188/cy
Transportation to Incinerator	40 cents/ton/mile	= (.4) (1.5) (460) = $276/cy
Incineration	$1,200/ton	= $1800/cy

Costs were developed based on the process description for incineration/landfilling presented earlier. They are considered order-of-magnitude estimates and have an expected accuracy within +50 percent and -30 percent as defined by the American Association of Cost Engineers. This range of accuracy is also consistent with current USEPA guidance (USEPA, 1988).

Planning, engineering, and design costs were based on complexity of engineering required for this option. The site facility design should be relatively straightforward. A contingency of 10 percent was added to all estimated site preparation costs and capital equipment costs.

Excavation/Backfill. Excavation and backfill costs were presented in Section 5.1.2. The cost is included as part of the overall project. The cost for excavation/backfilling consists of lease of excavation and hauling equipment, operations and maintenance, labor for the equipment operator. It was assumed that clean soil would be obtained from a readily accessible area nearby.

Site Preparation and Capital Equipment Costs. Site preparation includes advance planning and management; detailed site design and development (e.g., access roads, clearing, surface construction); utilities connections; and site support staff.

Area and surface requirements were described in Section 5.3.2. The required area would be cleared of existing vegetation, surveyed, graded, and compacted. An asphalt pad would be prepared to provide a stockpile area for contaminated soil. Graded and graveled areas would be constructed for auxiliary equipment (e.g., vehicle storage, personnel trailers). The gravel road from Pyramid Highway to the site would be improved and widened to accommodate construction equipment.

Electrical cable and appropriate auxiliary equipment would be installed to tie in to the existing public power supply. Temporary piping would be installed to provide water service to the site from Orr Ditch or the municipal water system.

Operations/Maintenance. Operations and maintenance costs include all costs for labor, equipment maintenance, supplies, and utilities associated with operation of the facility.

Equipment operations and maintenance costs would include the cost of fuel, electricity, and maintenance for the excavation equipment. Equipment operations and maintenance costs were assumed to be 15 percent of the equipment lease or purchase cost.

Two full-time employees would be the minimum required during excavation of the soils for incineration/landfilling. These would include one equipment operator/sampler to handle a front-end loader and a field engineer. Weekly labor costs would be about $3,830, including fringe benefits and the OSHA hazardous waste site training and medical evaluations required under 29 CFR 1910.120.

Additional project office staff costs (project management, maintenance and support staff) are estimated to be $3,000 per week.

It was assumed that the incinerator used was 460 miles from the site, the hazardous waste landfill was 340 miles from the site, and the nonhazardous waste landfill was 20 miles from the site.

Composite samples for laboratory analysis (USEPA Method 8330) would be collected weekly for the first month and monthly thereafter to monitor progress. Verification samples would be collected to assure that the removal action goals have been achieved. A detailed sampling plan would be developed as part of the remedial design, but it is assumed that a local laboratory would perform the necessary analysis. It was assumed that 100 screening samples would be collected and analyzed at a cost of $40 per sample. An additional ten samples will be collected and analyzed by USEPA Method 8330 to monitor the remediation progress and confirm cleanup. Estimated costs for these analyses are $220 each.

5.3.4 Summary

A summary of the NCP criteria evaluation for this option is provided in Table 5-2. Landfilling/ incineration would be one cost-effective method for reducing explosives concentrations and toxicity in the contaminated soil to acceptable levels. Concentrations of TNT and dinitrotoluene would be decreased to acceptable levels at the site, and a large portion of the contamination would be destroyed. Soils contaminated with low levels of contaminants would be placed in a facility designed to prevent the infiltration of precipitation which would reduce the mobility of the contaminants. The total excess cancer risk to an individual exposed to soils at the site would be reduced. An acceptable level of protection could be achieved for a total estimated expenditure of $2.61 million.

5.4 ALTERNATIVE 3: OFF-SITE BIOTREATMENT (COMPOSTING)

This option consists of two general response actions. The first response action is removing all contaminated soils and debris that are above the cleanup goals (6.6 ppm 2,4-dinitrotoluene). The second is to haul contaminated soil to an off-site facility for biotreatment. Several viable biotreatment options were discussed in Section 4.3.7.2. Based on several recent and ongoing pilot-scale studies at various formerly used defense sites (FUDS), composting has been selected as the full-scale remedial action treatment at two NPL sites (Umatilla and U.S. Naval Submarine Base) for cleanup of soils containing munitions residues (Craig et al., 1995). One off-site facility (Hawthorne Army Ammunition

Plant) has been identified by the BLM as potentially capable and willing to handle the contaminants and soil volumes found at the MEF site (Murray, 1995b).

5.4.1 Process Review

Excavation/Backfilling and Materials Handling. The contaminated soils would be excavated as described in Section 5.1.2. Large rocks and debris would need to be removed from the soils to be sent to the incinerator. The extent of screening would depend on the facility to which the material is sent. For the purposes of the EE/CA, it is assumed that the entire volume of material is processed through an appropriate size vibrating screen. The rocks and debris would be washed to remove contaminants from the surface. The washwater generated would be captured and allowed to evaporate with the residual soil sent to either an incinerator or a landfill, depending upon contaminant concentrations. The rocks/debris would then be sampled to determine if any contamination remained. The excavation would proceed from the area of lowest concentration to the area of highest concentration.

Backfilling would involve moving uncontaminated soil from an area on-site or from nearby BLM property, followed by deposition and compaction in the excavation. The slope would be returned to original contours.

The conceptual process for the complete remediation off-site (Hawthorne) using biotreatment is unknown at this time. However, the system components and operations may be similar to those of windrow composting described in Alternative 4 of this EE/CA. See subsections under Section 5.5.1 in this document.

5.4.2 Operating Parameters

Site Suitability. Off-site biotreatment, as in Alternative 2, offers the advantage of requiring only limited space at the MEF. Space would be required for the excavation, stockpiling, and support operations only. The site access road would require improvement in order to be adequate for the excavation equipment and haul trucks.

Topographic Constraints. Existing topography would not inhibit the use of conventional excavation and earth-moving techniques.

Site Area Requirements. An area approximately 300 feet by 500 feet would be required to set up the equipment necessary to accomplish the excavation and sorting of the debris. This area would include a contaminated soil stockpile, a decontamination area, and the contaminated excavation area.

Utilities. The utilities required for this activity would be for water lines and equipment for dust suppression.

Personnel. Two personnel would be required for the excavation phase. These would include one equipment operator/sampler to handle a front-end loader and a field engineer. The operations would typically consist of 8-hour shifts, 5 days per week. The field team would be supported by an office staff that would provide project management support. The office staff would consist of a number of people who are not dedicated full time to the cleanup.

Personnel exposed to contaminated soil are subjected to the OSHA requirements for hazardous waste site operations (29 CFR 1910.120), including requirements for personal protective equipment (as dictated by the specific site conditions and contaminants), physical examinations, and hazardous waste site training.

Implementation Time. The time required to implement the off-site biotreatment alternative is dependent mainly on the time required to excavate the contaminated soil. However, prior agreements for acceptance at an off-site facility would need to be acquired. This could account for a long (unknown) period of time depending on what stage the facility (Hawthorne) is at in establishing a full-scale operation. The time required to flag the areas and excavate the entire volume of soil to be remediated would be approximately 3 months including backfilling and recontouring of disturbed areas.

5.4.3 NCP Criteria Analysis

The degree to which the off-site biotreatment alternative satisfies the criteria of the NCP is summarized in Table 5-3 and is discussed below.

Overall Protection of Human Health and the Environment. This alternative would provide for overall protection of human health and meet the cleanup goals set by greatly reducing TNT/dinitrotoluene concentrations in the finished compost. The plant stress associated with very high explosive concentrations would be greatly reduced. Laboratory studies indicate there might still be some stunting of plant height at concentrations of 30 mg/kg (PNL, 1989; 1990).

Near-term protection of the public health and the environment during remediation would be achieved directly by using specific design and operating controls to minimize dust emissions during excavation. Occupational risks to on-site workers are expected to be minimized through the use of specific operating controls and procedures and appropriate training. Occupational risks would be addressed in the project Health and Safety Plan.

Compliance with ARARs. It appears that off-site biotreatment (composting) would meet all ARARs.

Chemical-Specific ARARs. Composting would not be expected to reduce explosive concentrations in the excavated soil to background (below detection) levels. However, it would be expected to reduce explosives concentrations to levels that are within the acceptable range of 1×10^{-4} to 1×10^{-6} for excess cancer risk.

Location-Specific ARARs. Off-site composting would have no effect on any local protected species or off-site designated wetlands.

Action-Specific ARARs. ARARs that must be addressed in evaluating a composting alternative were discussed in Section 3.2. All of these would have to be met by Hawthorne's facility design and operation.

The proposed composting facility layout would need to include all of the state-mandated design features. Fugitive dust and odor emissions would have to be controlled through the application of water while the windrows were being turned, and geotextiles would be used to cover the piles.

Of particular note, the CERCLA off-site rule requires that the USEPA approve of any facility prior to its accepting CERCLA waste.

Long-Term Effectiveness and Permanence. Off-site composting is expected to reduce explosive concentrations in excavated soil to levels that protect human health and that require no additional long-term controls. The degree of explosives degradation provided by composting is expected to result in low residual TNT and dinitrotoluene concentrations. The removal of the contaminants from the Monite Site would reduce the excess cancer risks at MEF to within the acceptable range.

Past composting studies have not specifically evaluated 2,4-dinitrotoluene, although laboratory studies indicate that it would be susceptible to biodegradation under composting condition (Dames & Moore,

1991). It has been reported that dinitrotoluenes are more rapidly and completely degraded than TNT (ABB Environmental Services, Inc., 1994).

There would be no permanent disturbance of land areas at the MEF as part of the remedial project, and the area would be restored to surrounding conditions following remediation.

Reduction of Toxicity, Mobility, or Volume. As discussed in Section 4.3.7.2.2, extractable concentrations of the explosives decrease by greater than 90 percent after composting. In addition, toxicological studies conducted by Oak Ridge National Laboratory (ORNL) indicate that, given appropriate composting conditions, the aquatic toxicity of the soil can be reduced by 88 percent and bacterial mutagenicity by 98 percent (ORNL, 1991).

The toxicological studies were conducted using samples of the finished compost produced during a composting optimization study. Study elements included: an analysis for contaminants and TNT metabolites (amine degradation products), Ames bacterial mutagenicity tests (using acetonitrile extracts of the compost), acute and chronic toxicity tests using the aquatic crustacean *Ceridaphnia dubia* (using leachate derived from the compost), and a rat oral toxicity screen, using a single 1-gram dose of compost and a 14-day observation period.

Results vary depending on soil loading and amendment composition. Given soil loadings of less than 30 percent, bacterial mutagenicity consistently decreases by greater than 90 percent regardless of amendment composition. A soil loading of 25 percent in composition with a cow manure-based amendment reduced aquatic toxicity by 88 percent.

Based on these studies, ORNL concluded that composting can effectively reduce the explosive concentrations and bacterial mutagenicity in explosive-contaminated soil and can reduce the aquatic toxicity. Leachate toxicity to humans was evaluated by comparing leachate concentrations of TNT, RDX, and HMX with 100 times their USEPA Drinking Water Equivalent levels. The factor of 100 is a conservative estimate of the soil-groundwater system dilution factor (ORNL, 1991). The concentrations in the leachate from finished compost were below this criterion, indicating that toxicity to humans would not be expected.

ORNL noted in their summary that low levels of explosives and metabolites, bacterial mutagenicity, and leachable toxicity remain after composting, but these did not appear to present a serious health concern. In fact, no mortality or toxic effects from finished compost were observed in a rat oral

toxicity screen. In a similar study conducted in 1993, aerated and non-aerated windrow composts of explosives contaminated sediments, had similar results. This study showed that the non-aerated windrow method of composting was slightly more efficient in reducing toxicity of the soils (TNT 99.9 percent; RDX >99.7 percent; HMX, 98.5 percent) than the aerated windrow compost method (Griest et al., 1994). Extractable mutagenicity declined 97.9 and 99.7 percent in the non-aerated compost. Leachable toxicity decreased by 92 percent in the non-aerated compost and 87 percent in the aerated compost. This demonstrates the windrow composting method is as effective as static-pile and mechanically stirred composting methods.

Short-Term Effectiveness. Assuming a full-scale biotreatment up and running at Hawthorne and an explicit agreement by all parties to accept the contaminated soils from MEF, the remediation could be initiated. Following that, the desired cleanup levels at the MEF could be achieved in 3 months.

This alternative would pose little risk to the community, workers, or the environment during its implementation. There would also be minimal risk to the workers involved in this operation. Workers would be protected from exposure to contaminants through special waste-handling procedures (e.g. dust control), monitoring, and use of appropriate protective gear. The use of dust control techniques would also afford protection of the local community from fugitive dust emissions.

No adverse affects to protected species or sensitive land areas would be expected during remediation. Land areas disturbed during the excavation operations would be restored following project completion.

Implementability. Off-site composting could be implemented following an optimization study which would require approximately 1.5 months to complete. Any pilot-scale test at the facility (Hawthorne) is highly dependent on coordinated scheduling, and start of full-scale operation is currently unknown and could be significantly delayed.

Construction of the windrow composting operations does not pose unusual design or construction problems, nor are unusual skills or knowledge required. A large body of knowledge exists on the methods and techniques that are effective in controlling the composting matrix environment. However, an optimization study would be required in order to ensure that amendments were properly applied.

Administratively, composting of explosives-contaminated soil is supported by USEPA as a potentially viable innovative technology. If agreements with Hawthorne can be put in place effectively, little administrative effort will be necessary to implement this alternative.

Cost. Costs are presented in Appendix D; the elements of the individual cost categories are discussed below. Assumed costs associated with this alternative include:

Treatability/Optimization Study	$20,000
Transportation to Hawthorne	40 cents/ton/mile = (.4)(1.5)(127) = $76/cy
Off-Site Biotreatment	$200/ton = $300/cy

Costs were developed based on the process description for off-site composting presented earlier. They are considered order-of-magnitude estimates and have an expected accuracy within +50 percent and -30 percent as defined by the American Association of Cost Engineers. This range of accuracy is also consistent with current USEPA guidance (USEPA, 1988).

Planning, engineering, and design costs were based on complexity of engineering required for this option. The site facility design should be relatively straightforward. A contingency of 10 percent was added to all estimated site preparation costs and capital equipment costs.

Treatability/Optimization Study. An optimization study using amendments available to Hawthorne and uncontaminated MEF site soil is necessary to ensure that the parameters necessary for proper composting are achieved. Following the laboratory study, the pilot-scale study would start. The costs associated with the pilot study are assumed to be included in the fee for off-site treatment.

Excavation/Backfill. Excavation and backfill costs were presented in Section 5.1.2. The cost is included as part of the overall project. The cost for excavation/backfilling consists of lease of excavation and hauling equipment, operations and maintenance, labor for the equipment operator. It was assumed that clean soil would be obtained from a readily accessible BLM site nearby.

Site Preparation and Capital Equipment Costs. Site preparation includes advance planning and management; detailed site design and development (e.g., access roads, clearing, surface construction); utilities connections; facility construction (e.g., construction of the windrow pad); and site support staff.

Area and surface requirements were described in Section 5.4.2. The required area would be cleared of existing vegetation, surveyed, graded, and compacted. An asphalt pad would be prepared to provide stockpile and mixing areas for contaminated soil, amendment, and finished compost. Graded and graveled areas would be constructed for auxiliary equipment (e.g., vehicle storage). The gravel

road from Pyramid Highway to the site would be improved and widened to accommodate construction equipment.

Electrical cable and appropriate auxiliary equipment would be installed to tie in to the existing public power supply. Temporary piping would be installed to provide water service from Orr Ditch and the municipal water system.

Operations/Maintenance. Operations and maintenance costs include all costs for labor, equipment maintenance, supplies, and utilities associated with operation of the facility.

Equipment operations and maintenance costs would include the cost of fuel, electricity, and maintenance for the excavation equipment. Equipment operations and maintenance costs were assumed to be 15 percent of the equipment lease or purchase cost.

Two full-time employees would be the minimum required during excavation of the soils for incineration/landfilling. These would include one equipment operator/sampler to handle a front-end loader and a field engineer. Weekly labor costs would be about $3,830, including fringe benefits and the OSHA hazardous waste site training and medical evaluations required under 29 CFR 1910.120. Additional project office staff costs (project management, maintenance and support staff) are estimated to be $3,000 per week.

It was determined that the distance to Hawthorne from the site is 127 miles.

Composite samples for laboratory analysis (USEPA Method 8330) would be collected weekly for the first month and monthly thereafter to monitor progress. Verification samples would be collected to assure that the removal action goals had been achieved. A detailed sampling plan would be developed as part of the remedial design, but is assumed that a local laboratory would perform the necessary analysis. It was assumed that 100 screening samples would be collected and analyzed at a cost of $40 per sample. An additional ten samples will be collected and analyzed by USEPA Method 8330 to monitor the remediation progress and confirm cleanup. Estimated costs for these analyses are $220 each.

5.4.4 Summary

A summary of the NCP criteria evaluation is provided in Table 5.3. Off-site composting would be one cost-effective method for reducing explosives concentrations and toxicity in the contaminated soil to acceptable levels. Concentrations of TNT and dinitrotoluene would be decreased to acceptable levels at the site, and a large portion of the contamination would be destroyed. The total excess cancer risk to an individual exposed to soils at the site would be reduced. An acceptable level protection could be achieved for a total estimated expenditure of $1.2 million.

5.5 ALTERNATIVE 4: WINDROW COMPOSTING/LANDFILLING

Three potential composting methods have been evaluated: static pile, windrow, and mechanically agitated in-vessel (MAIV). Treatability studies indicate that windrow composting is more effective than either static pile or MAIV (Weston, 1993a; 1993b).

5.5.1 Process Review

The conceptual process descriptions which follow address the system components and operations required to complete remediation using composting. Figure 5-1 presents a schematic flow of operations for composting. The details included in the process description might be refined during design.

Excavation, Materials Handling, and Compost Preparation. The contaminated soil would be excavated as described in Section 5.1.2. Large rocks and debris might need to be removed from the soil prior to composting if such artifacts would cause undue stress or damage to the windrow turner. The need for and the extent of screening would depend on the specific equipment to be used for remediation. For purposes of this EE/CA, it is assumed that the entire volume of soil is passed through an appropriately sized vibrating screen. Since contaminated particulates might adhere to the surface of the rocks, they would then be washed. The washwater generated could be used to help maintain the compost moisture content, and therefore treatment of the water would not be required. The screened soil would then be placed in the mixing area.

The mixing area would consist of four open-top, three-sided concrete bins. Three of these bins would be used to mix soil and amendment. The fourth would be used to receive and temporarily store the organic amendment that would be delivered.

The amendment composition, developed on the basis of materials available in the region around the Monite Site, incorporates horse manure, alfalfa, and sawdust, which appears to be effective at reducing explosive concentrations (Weston, 1991a; 1993a; 1993b).

The most effective soil loading volume is 30 percent of the total compost volume (Weston, 1993b). Greater volume loadings might reduce the degradation potential of the explosives due to self-heating. For the development of costs and operating parameters, a soil loading of 30 percent is assumed. The soil loading has the single largest effect on the economics of the composting system. Because the soil is a minority fraction, changes in loading greatly influence the volume of amendment required, the size of the facility necessary to process the compost mixture, and the remediation period.

A volume of screened soil would be placed into one of the mixing bins, 2.3 volumes of amendment would be added, and the materials would be combined using a front-end loader. Multiple mixing bins would allow for a completed batch to be removed from one bin while mixing was being done in a second bin and screened soil was being added to a third. The mixed batches would be loaded into a dump-truck and delivered to the windrow pad area. At the windrow pad area, a front-end loader would be used to form the mixture into a windrow on the pad.

For purposes of the EE/CA, it is assumed that soil excavation and compost preparation would be performed 5 days per week.

Landfilling. The contaminated soil which is not a RCRA hazardous waste but is above the cleanup goal will be sent to a local RCRA Subtitle D facility (sanitary landfill) once approval is gained from the regional USEPA off-site coordinator. Any soils which qualify as a hazardous waste due to TCLP results but have contaminant concentrations below the RCRA Universal Treatment Standards, will be sent to a RCRA Subtitle C facility (hazardous waste landfill) approved to accept CERCLA off-site wastes if this is more cost effective than composting. The remaining soil (i.e., soils which are hazardous waste and have contaminant concentrations above the RCRA Universal Treatment Standards) will be composted. This composting/landfilling alternative will include a cost comparison with the option for composting all of the contaminated soils removed (Appendix D).

Windrows. The following conceptual description of windrow composting was based on various USATHAMA reports (USATHAMA, 1991; Weston, 1993a; 1993b). The size and operating parameters of an actual facility might be modified based on the desired remediation time.

The primary design parameter is the assumption that a composting period of 30 days would be required to degrade explosives to acceptable levels using windrows. This period was based on USATHAMA windrow studies (Weston, 1993a; 1993b). The composting period required from November through March would increase slightly because of low ambient air temperatures.

For purposes of costing this alternative, it was assumed that the windrows would be constructed on an asphalt pad with room available to maneuver a mechanical windrow machine. The windrows would be covered with a geotextile (such as Goretex®) which allows air exchange. The primary benefits to covering the windrows are:

- reduced dispersion of material due to wind erosion
- minimal leachate because of the elimination of direct precipitation and stormwater run-on
- better control of temperature, moisture, and odors by reducing air exchange with the external atmosphere.

Every other working day, a new batch of compost mixture would be either used to start a new windrow or added as a new segment to an existing windrow. The windrow machine would then pass over the new compost to fluff it, aerate it, and establish the windrow. Once established, a windrow would need to be turned periodically by the windrow-turning machine. The optimum turning period in terms of balancing temperature control and aeration is about every 2 to 3 days. At the start of the third or fourth week, the volume of the windrow would be reduced by microbial activity so the windrow could be consolidated using a front-end loader. After a given windrow segment had composted for 30 days, it would be sampled to verify that remedial performance standards were met. If so, the compost would be loaded into a dump truck and returned for replacement in the excavation.

Aeration for the compost matrix is provided by the windrow-turning machine. This is assumed to be a self-propelled machine using a rotating drum with multiple short blades. As the machine moves along the windrow, it lifts the fabric cover, the drum cuts into the windrow, macerating and fluffing the compost pile, which allows air to be introduced into the compost matrix and then lays the fabric back down. This process increases the volume of the windrow by approximately 20 percent, admitting an excess amount of oxygen to maintain microbial activity but releasing heat and water vapor.

The loss of heat and water can adversely affect the activity of the microbial populations. Covering the windrows with a fabric like Goretex® would help reduce heat lost by maintaining a more uniform air temperature in the immediate vicinity of the material and would also control odors. To combat moisture loss, water is assumed to be added to the windrows as needed.

Compost Disposition. The compost periods assumed for the windrow system was developed based on the remedial goals for the project (i.e., reducing contaminant concentrations to levels that are protective of human health). It is anticipated that a compost period of up to 30 days would be required to meet these goals. As described in Section 5.1.3, the compost could be replaced in the excavation when the remedial goals had been achieved.

Many of the materials in the compost amendment, such as the manure, would be expected to decompose within the 30-day period. However, some of the components in the amendment, particularly vegetable matter such as straw, are more difficult to decompose and would continue to do so beyond the initial 30 days.

This phase of composting, referred to as "curing," results in the production of stabilized compost. Once stabilized, the compost has no additional nutrient demands and the need for oxygen is low. Curing would be enhanced by active management of the compost. However, curing would continue to proceed at a slower pace even if the compost was not managed and the treated soil was replaced in the excavation.

Nevada state solid waste regulations generally specify the acceptable quality of composted materials if made available to the public immediately. Regulatory acceptance normally requires curing. However, the goals of the Monite Explosive Facility composting are not comparable to those for a typical composting facility. BLM would restrict access to the area where the compost has been backfilled until it has fully cured in order to limit public exposure. Therefore, it is assumed that a 30-day compost period followed by replacement of the treated soil into the excavation would be acceptable.

5.5.2 Operating Parameters

Site Suitability. The selection of the material processing and compost treatment site is based upon the following criteria:

- The site ideally needs to contain sufficient land area to provide a ring of unoccupied space as a buffer zone between active storage, treatment, and disposal (TSD) areas and nearby human population.
- Access roads must be available and capable of supporting heavy earthmoving equipment and the windrow turner.
- Accessibility to the waste feed material must be direct and unencumbered, with adequate feed preparation areas.

The site appears to meet the site suitability requirements for development of a composting facility.

Topographic Constraints. The main topographic constraints are susceptibility to erosion and off-site drainage runoff. The site must be graded and leveled for equipment placement and the windrow pad. Attention should be given to the overall site slope, which should be compatible with the area's natural topographical slope for drainage.

Site Area Requirements. The site would require approximately 10 acres in order to provide adequate room for vehicle access and maneuvering; storage areas for contaminated soil, amendment, and treated soil; a mixing area, and the windrow pad. In addition, an access road would be required to connect the treatment area with the existing roads.

The windrows are assumed to be assembled on an asphalt pad which is 65 feet by 250 feet. This allows for room to maneuver the mechanical windrow turner between the piles and around the perimeter.

The contaminated soil stockpile, preparation, and staging area are assumed to require a curbed asphalt-paved area of 2,500 square feet, allowing for a 3-day stockpile of amendment (210 cubic yards), a 1-week stockpile of excavated soil (150 cubic yards), and four 3-sided mixing/storage bins. The

1-week stockpile capacity for excavated soil would prevent feed availability from limiting the preparation of compost in the event of excavation delays.

The treated compost stockpile area is also assumed to be on a curbed asphalt pad. A 2-week storage capacity would be provided to allow for flexibility in materials handling and to accommodate the analytical turnaround for performance verification sampling. The area required would be about 3,000 square feet, assuming that the volume for the final compost is approximately twice the volume of the initial soil added (the amendment compacts during composting.)

Additional graded and graveled areas are needed for vehicle access, administrative and personnel facilities, and maintenance areas. In addition to these areas, access roads would be required to connect the treatment area with existing roads.

Utilities. Utilities requirements for the windrow system include:

- A continuous water supply would be required to provide moisture for the compost mixture. For much of the year water could be obtained from Orr Ditch; if supplies from the ditch are insufficient or water is not available, municipal water is available on adjacent streets and could be brought on-site. Water for the compost system is not required to be potable. Total demand for process water is less than 1 gallon per cubic yard of compost. In addition, sufficient water pressure must be available to support the fire protection system typically required for composting facilities.

- Electrical service of 220/440-volts sufficient for a normal equipment maintenance facility is required. This should be sufficient to provide 200-ampere, 120-volt, 1-phase service for the administrative and personnel facilities.

Personnel. Five operating personnel would be required for windrow composting. This would include three equipment operators to handle the windrow machine, front-end loader, and dump truck, a field engineer, and an administrative assistance/clerk. The operations schedule would typically consist of 8-hour shifts, 5 days per week. The field team would be supported by an office staff that would provide project management support. The office staff would consist of a number of people not dedicated full time to the cleanup.

Personnel exposed to contaminated soil are subjected to the OSHA requirements for hazardous waste site operations (29 CFR 1910.120), including requirements for personal protective equipment (as dictated by the specific site conditions and contaminants), physical examinations, and hazardous waste site training.

Laboratory Analysis of Waste Feed. Laboratory analyses, prior to composting, for the following key physical and chemical properties of the contaminated soil and the compost matrix are desirable:

- Density - to determine amendment mixing ratio, compost processing time, and handling requirements
- Moisture content - to determine additional moisture requirements
- Explosive species and concentrations - to determine personnel protection needs and to provide a baseline for evaluating the effectiveness of treatment.

Following composting, the compost matrix would again be analyzed for explosive species and concentrations to verify that the remediation criteria were met.

Treatability Testing. Treatability testing and optimization for composting should be conducted to ensure maximum efficiency. Several pilot-scale studies have been conducted at various sites to evaluate composting for treatment of explosive-contaminated soils (Weston, 1993a; 1993b). Field demonstrations of composting of explosive-contaminated (TNT, HMX, and RDX) and propellent-contaminated (nitrocellulose) soils have been conducted at Louisiana Army Ammunition Plant and Umatilla Army Depot Activity which successfully reduced the explosive concentrations through biotransformation. An initial TNT concentration of as high as 17,872 mg/kg was reduced by greater than 99 percent (Williams et al., 1988). Of the four explosives present in these experiments, TNT is the most rapidly transformed. Although these studies did not specifically target the composting of dinitrotoluene, data from the field studies indicate that composting of dinitrotoluene contaminated soil should be successful. Considerable literature is available on the degradation pathways for nitroaromatic compounds and the relative biodegradability of TNT and dinitrotoluene. Dinitrotoluenes appear to be more rapidly and completely degraded than TNT. Degradation intermediaries and their toxicities are known, as are the kinetics for various microorganisms (Suen and Spain, 1993). While TNT degradation involves some potentially toxic and refractory intermediates, dinitrotoluene biodegradation apparently proceeds to completion with little difficulty. The U.S. Army Environmental

Center (USAEC) has developed a model that assists in the remedial design during bench-scale testing in selecting composting parameters including amendments, soil-amendment ratios, and the composting period (ABB Environmental Services, 1994). Good correlations of the model results to actual full-scale demonstration were obtained at Umatilla.

The toxicity of the composted material must be evaluated. An optimal compost amendment mixture must be developed based upon locally available materials. Failure to conduct optimization studies has resulted in failure to achieve the desired cleanup goals. Finally, the ability to control odors associated with composting must be verified.

Implementation Time. The time required to implement composting on-site would depend on the treatability testing and time required for construction. For purposes of this EE/CA, a period of 3 months is assumed necessary to complete treatability testing and to prepare the site for composting. Following that, full operation would commence. The operational time required to complete composting would depend on the soil mass. Allowing for the residence time for the last batch charged, the total period of composting operations on two pads would be between 6 and 8 months, based on whether all of the contaminated soil is treated on-site.

5.5.3 NCP Criteria Analysis

The degree to which the composting/landfilling alternative satisfies the criteria of the NCP is summarized in Table 5-3 and is discussed below.

Overall Protection of Human Health and the Environment. This alternative would provide for the overall protection of human health by reducing TNT and dinitrotoluene concentrations in the finished compost to the cleanup levels. The plant stress associated with very high explosive concentrations would be greatly reduced. Laboratory studies indicate there might still be some stunting of plant height at concentrations of 30 mg/kg (PNL, 1989; 1990).

Near-term protection of the public health and the environment during remediation would be achieved directly by using specific design and operating controls.

Occupational risks to on-site workers are expected to be minimal and would be addressed in the project Health and Safety Plan.

Compliance with ARARs. It appears that composting would meet all ARARs.

Chemical-Specific ARARs. Composting would not be expected to reduce explosive concentrations in the excavated soil to background (below detection) levels. However, it would be expected to reduce explosives concentrations to levels that are within the acceptable range of 1×10^{-4} to 1×10^{-6} for excess cancer risk.

Location-Specific ARARs. Composting would not be expected to affect protected species in the vicinity, nor is it expected to affect off-site designated wetlands.

Action-Specific ARARs. ARARs that must be addressed in evaluating a composting alternative were discussed in Section 3.2. All of these would be met by the proposed facility design and operation.

The proposed composting facility layout includes all of the state-mandated design features. Fugitive dust and odor emissions would be controlled through the application of water while the windrows were being turned and the use of geotextiles to cover the piles.

Composting optimization studies have indicated that explosive concentrations in composted soils are reduced to levels that meet the site clean up goals and the compost residue could be replaced in the excavation in accordance with all regulatory guidelines (Weston, 1993a, 1993b).

Long-Term Effectiveness and Permanence. Composting is expected to reduce explosive concentrations in excavated soil to levels that protect human health and that require no additional long-term controls. The degree of explosives degradation provided by composting is expected to result in low residual TNT and dinitrotoluene concentrations.

Past composting studies have not specifically evaluated 2,4-dinitrotoluene, although laboratory studies indicate that it would be susceptible to biodegradation under composting condition (Dames & Moore, 1991). It has been reported that dinitrotoluenes are more rapidly and completely degraded than TNT (ABB Environmental Services, Inc., 1994).

The implications for the long-term fate of degradation/transformation products of TNT after composting are unclear. The degradation products of TNT include cellulose, humic acid, fulvic acid, humin, 4-amino-2,6-dinitrotoluene (4ADNT), and 2-amino-4,6-dinitrotoluene (2ADNT). One study showed that more than 50 percent of the carbon from the TNT molecules was found in the cellulose and humin

portion of the soils. The remainder was contained in fulvic acid (17.54 percent), humic acid (8.84 percent), acetonitrile extractable (5.26 percent), and ether extractable (9.84 percent) portions. The concentrations of the extractable 4ADNT, and 2ADNT rose from approximately 0.75 mg/kg and 0.25 mg/kg, respectively, to 2 mg/kg and 1 mg/kg. This shows that the cellulose and humin portions of the degradation material are the most significant products of the TNT composting process. The long-term stability and environmental safety of explosive/cellulose and explosive/humin products have not been determined (Pennington et al., 1994). Although humus itself will eventually degrade, the mechanisms are such that the TNT metabolites would be expected to remain incorporated in fragments of humus and absorbed and degraded by the microbial population. Studies of RDX and 2,4-dinitrotoluene variously indicated that they also undergo a process of incorporation into humus, or that they are completely degraded depending upon the bacterial population and nutrient augmentation (Dames & Moore, 1991). Even though the biodegradation process is not entirely understood, studies indicate that the observed reductions in contaminant concentrations would be permanent.

In soil, compost, and water, TNT appears to biotransform rapidly into amine metabolites (Dames & Moore, 1991). A similar transformation process appears to occur following the absorption of TNT through the root systems of plants (PNL, 1989). When sufficient organic material is present (as in compost), the metabolites then appear to become covalently bonded to the insoluble macromolecule in the humus and biomass (Dames & Moore, 1991).

Because the reduction in explosives concentrations is expected to be permanent and the compost itself contains only native microorganisms, the treated soil would not require long-term management. Recent studies indicate that the final compost is quite stable (Brinton, 1995). However, due to the unknown long-term stability of the explosive/humin and explosive/cellulose fractions of the composted material, prudence dictates that some monitoring of the degradation of cellulose be conducted (Pennington et al., 1994).

There would be no permanent disturbance of land areas as part of the remedial project, and the area would be restored to natural contours following remediation.

Reduction of Toxicity, Mobility, or Volume. As discussed in Section 4.3.7.2.2, extractable concentrations of the explosives decrease by greater than 90 percent after composting. In addition, toxicological studies conducted by Oak Ridge National Laboratory indicate that, given appropriate composting conditions, the aquatic toxicity of the soil can be reduced by 88 percent and bacterial mutagenicity by 98 percent (ORNL, 1991).

The toxicological studies were conducted using samples of the finished compost produced during a composting optimization study. Study elements included: an analysis for contaminants and TNT metabolites (amine degradation products), Ames bacterial mutagenicity tests (using acetonitrile extracts of the compost), acute and chronic toxicity tests using the aquatic crustacean *Ceridaphnia dubia* (using leachate derived from the compost), and a rat oral toxicity screen, using a single 1-gram dose of compost and a 14-day observation period.

Results vary depending on soil loading and amendment composition. Given soil loadings of less than 30 percent, bacterial mutagenicity consistently decreases by greater than 90 percent regardless of amendment composition. A soil loading of 25 percent in composition with a cow manure-based amendment reduced aquatic toxicity by 88 percent.

Based on these studies, ORNL concluded that composting can effectively reduce the explosive concentrations and bacterial mutagenicity in explosive-contaminated soil and can reduce the aquatic toxicity. Leachate toxicity to humans was evaluated by comparing leachate concentrations of TNT, RDX, and HMX with 100 times their USEPA Drinking Water Equivalent levels. The factor of 100 is a conservative estimate of the soil-groundwater system dilution factor (ORNL, 1991). The concentrations in the leachate from finished compost were below this criterion, indicating that toxicity to humans would not be expected.

ORNL noted in their summary that low levels of explosives and metabolites, bacterial mutagenicity, and leachable toxicity remain after composting, but these did not appear to present a serious health concern. In fact, no mortality or toxic effects from finished compost were observed in a rat oral toxicity screen. In a similar study conducted in 1993, aerated and non-aerated windrow composts of explosives contaminated sediments, had similar results. This study showed that the non-aerated windrow method of composting was slightly more efficient in reducing toxicity of the soils (TNT 99.9 percent; RDX >99.7 percent; HMX, 98.5 percent) than the aerated windrow compost method (Griest et al., 1994). Extractable mutagenicity declined 97.9 and 99.7 percent in the non-aerated compost. Leachable toxicity decreased by 92 percent in the non-aerated compost and 87 percent in the aerated compost. This demonstrates the windrow composting method is as effective as static-pile and mechanically stirred composting methods.

Short-Term Effectiveness. If selected as the remedial action, composting could be implemented following an optimization study which would require approximately 1.5 months to complete and a pilot-scale test at the facility which would require about an additional month to complete once all the

facilities were in place on-site. The desired cleanup levels could be achieved in a total of about 6 to 8 months, depending on whether the partial landfilling or total treatment option was used.

This alternative poses little risk to the community, workers, or the environment during its implementation. However, unauthorized public access to the site and odors would be a concern. The microorganisms used for composting are native and are not expected to present health risks to the public.

There is also minimal risk to the workers involved in this operation. Workers would be protected from exposure to contaminants through special waste handling procedures (e.g., dust control), monitoring, and use of appropriate protective gear.

No protected species or sensitive land areas are expected to be affected during remediation. Land areas disturbed to accommodate composting operations would be restored following project completion or left for public use. Composting is not a water-intensive treatment method, so the impact on regional water supplies would be minimal.

Implementability. The general technical feasibility of composing soils containing organic explosives has been demonstrated on a pilot scale at Umatilla Army Depot Activity and Bangor Submarine Base. The process to be employed involves the composting of agricultural waste (manure, vegetable wastes, and bulking agents) and co-degradation of the explosives by the microbial populations. Composting of agricultural wastes is a well-developed technology used throughout the country. Construction of the windrow composting operations do not pose unusual design or construction problems, nor are unusual skills or knowledge required. A large body of knowledge exists on the methods and techniques that are effective in controlling the composting matrix environment. However, an optimization study would be required in order to ensure that locally obtained amendments were properly applied.

Administratively, composting of explosives-contaminated soil is supported by USEPA as a potentially viable innovative technology. It is expected to require little administrative effort to implement.

Cost. Costs are presented in Appendix D; the elements of the individual cost categories are discussed below. The costs associated with this alternative are as follows:

Transportation to Sanitary Landfill	40 cents/ton/mile	= (.4) (1.5) (20) = $12/cy
RCRA Subtitle D Landfill Disposal	$2/ton	= $3/cy

Transportation (Hazardous Waste)	40 cents/ton/mile	= (.4) (1.5) (340) = $204/cy
RCRA Subtitle C Landfill Disposal	$125/ton	= $188/cy

All site and facility preparation costs, including procurement of equipment items, are considered capital costs. It is assumed that excavation and backfill would be performed by an outside contractor who would provide all associated equipment, so this cost element is assumed to be entirely O&M. All costs to operate and maintain the compost facility once operations are initiated are assumed to be O&M.

Costs were developed based on the process description for windrow composting presented earlier. They are considered order-of-magnitude estimates and have an expected accuracy within +50 percent and -30 percent as defined by the American Association of Cost Engineers. This range of accuracy is also consistent with current USEPA guidance (USEPA, 1988). Costs are presented in Appendix D; the elements of the individual cost categories are discussed below.

Treatability/Optimization Study. An optimization study utilizing locally available amendments and uncontaminated site soil is necessary to assure that the parameters necessary for proper composting are achieved. Advanced Biological Solutions and Woods End Research Laboratory both indicated that the cost of the study would be approximately $20,000 (Wiser, 1995; Brinton, 1995). Woods End typically works closely with the design team in engineering the facility which adds several thousand additional dollars to the cost (Brinton, 1995). Following the laboratory study, the pilot scale study would start. The costs associated with the pilot test are included with operations and maintenance.

Excavation/Backfill. Excavation and backfill costs were presented in Section 5.1.2. The cost is included as part of the overall project. The cost for excavation/backfilling consists of lease of excavation and hauling equipment, operations and maintenance, labor for the equipment operators. It was assumed that clean soil would be obtained from a readily accessible area nearby.

Site Preparation and Capital Equipment Costs. Site preparation includes advance planning and management; detailed site design and development (e.g., access roads, clearing, surface construction); utilities connections; facility construction (e.g., construction of the windrow pad); and site support staff.

Area and surface requirements were described in Section 5.5.2. The required area would be cleared of existing vegetation, surveyed, graded, and compacted. An asphalt pad would be prepared to provide stockpile and mixing areas for contaminated soil, amendment, and finished compost. Graded

and graveled areas would be constructed for auxiliary equipment (e.g., vehicle storage, personnel trailers). The gravel road from Pyramid Highway to the site would be improved and widened to accommodate construction equipment.

Electrical cable and appropriate auxiliary equipment would be installed to tie in to the existing public power supply. Temporary piping would be installed to provide water service from Orr Ditch and the municipal water system. A fire control system, including pipes and a pump, would be installed for the active compost areas.

The only major equipment purchased for the windrow composting facility would be a windrow turner capable of lifting and replacing the geotextile as the pile was turned. A windrow turner costs about $50,000 (Brinton, 1995).

The equipment costs were adjusted in the overall site preparation costs to reflect a salvage value based on an estimated economic life of 5 years using straight-line depreciation. Consideration could also be given to leasing rather than purchasing the equipment. However, the equipment manufacturer does not offer the option of leasing.

Planning, engineering, and design costs were based on the complexity of engineering required for this option. The site facility design should be relatively straightforward, with the process water and fire control systems requiring the most effort. A contingency of 10 percent was added to all estimated site preparation costs and capital equipment costs.

Operations/Maintenance. O&M costs include all costs for labor, equipment maintenance, supplies, and utilities associated with feed preparation and operation of the composting facility.

Equipment O&M costs for the composting system would include the cost of fuel, electricity, and maintenance for the rolling stock. Equipment operations and maintenance costs were assumed to be 15 percent of the equipment lease or purchase cost.

Five full-time employees would be the minimum required to operate the windrow composting facility. These include operators for the windrow machine, front-end loader, and haul truck; a field engineer; and a staff assistant/clerk. Weekly labor costs would be about $7,500, including fringe benefits and the OSHA hazardous waste site training and medical evaluations required under 29 CFR 1910.120.

Additional project office staff costs (project management, maintenance and support staff) are estimated to be $3,000 per week.

The purchase of organic amendment, assumed to be a mixture of horse manure and vegetable waste, would be added to these costs. Green horse manure can be obtained from the Palimino Valley Corral, located about 20 miles from the site, at no cost. It is assumed that the corral would load the trucks. Wood chips and sawdust are available in sufficient quantity from the local landfill at a cost of $5.50 per cubic yard delivered (Frenchi, 1995). Alfalfa is available locally at a cost of $120 per ton, but moldy alfalfa could be obtained for about $72 per ton. Assuming an amendment density of about 900 pounds per cubic yard and a volume ratio of 2.3 parts amendment to 1 part soil, the cost of purchasing amendment would be $22 per cubic yard of amendment or $50.00 of amendments per cubic yard of soil to be treated.

Samples would be required from both the excavated soil prior to mixing and the finished compost. Samples would be analyzed for explosives using the Jenkins method (Jenkins, 1990) to verify that the removal action goals have been achieved. A detailed sampling plan would be developed as part of the remedial design, but is assumed that a local laboratory would perform the necessary analysis.

5.5.4 Summary

A summary of the NCP criteria evaluation is provided in Table 5-4. Composting using a windrow system would be a cost-effective method of reducing explosives concentrations and toxicity in the contaminated soil to acceptable levels. Concentrations of TNT and dinitrotoluene would be significantly decreased from their present levels. The total excess cancer risk to an individual exposed to the composted soil would be reduced. An acceptable level of protection could be achieved for a total estimated expenditure ranging from $2.16 million for partial landfilling to $2.21 million for total treatment on-site.

The windrow facility concept developed for this analysis was based on efficiently using the minimum equipment required to complete the job.

5.6 ALTERNATIVE 5: SLURRY-PHASE BIOTREATMENT

Several different slurry-phase biotreatment processes are available. The process which has been used for TNT is the Simplot Anaerobic Biological Remediation Ex-situ (SABRE). This method has been used

for demonstration purposes on TNT-contaminated soils at a Department of Defense facility in Weldon Spring, Missouri. Other slurry-phase biotreatment techniques are not as well documented for the remediation of TNT-contaminated soils.

5.6.1 Process Review

The conceptual process descriptions which follow address the system components and operations required to complete remediation of contaminants using the SABRE process. Figure 5-2 presents a schematic of the operations for slurry-phase biotreatment. The details included in the process description might be refined during design.

Excavation, Materials Handling, and Slurry Preparation. The contaminated soil would be excavated as described in Section 5.1.2. Rocks and other debris over ¾-inch in diameter would be removed from the excavated soil using a vibrating screen. For purposes of this EE/CA, it is assumed that the oversized materials are washed with water. The rinse solution would then be combined with makeup water and placed in the treatment unit. The rocks/debris could then be used to backfill the excavation or could be sent off-site for disposal (the EE/CA assumes that the material will be disposed of on-site). As an alternative to washing, the rocks and debris could be crushed and added to the slurry phase treatment unit. The screened soil would then be placed in a mixing area where a J.R. Simplot potato-processing starch by-product is homogenized with the soil. The soil/starch mixture would then be added to a double lined impoundment at a ratio of 1-kg soil/starch to 1-L water. A phosphate buffer would be added to the water during this process to maintain the pH at 7.

The potato starch is used to create the highly reducing (low redox potential) conditions required for the microorganisms to thrive. Batches of soil and potato starch (2 percent by weight) are mixed together and added to the bioreactor until all of the treatment soil is in the bioreactor. Aerobic bacteria in the water and soil consume the carbon source, which depletes the remaining oxygen and lowers the redox potential of the system.

Soils to be treated should not have an average contaminant concentration above 2,000 mg/kg. Higher levels may prove toxic to the microbial consortia or may greatly increase the required treatment time. Monite soils with contaminant concentrations over 8 mg/kg would average between 1,500 and 2,000 mg/kg.

For purposes of the EE/CA, it is assumed that all of the soil requiring treatment would be placed in a single treatment unit. The contaminated soil would be processed as a single batch.

Soils excavated during construction of the impoundment would be used to return the contaminated area to natural contours. It is anticipated that some additional backfill would be required; this would be obtained either on-site (perhaps from between the two open excavations on the east side of the site) or from a BLM parcel within ½-mile of the site. Obtaining the soil from on-site would have the added benefit of eliminating several of the site features which are used for indiscriminate dumping of refuse.

Landfilling. The contaminated soil which is not a RCRA hazardous waste but is above the cleanup goal will be sent to a local RCRA Subtitle D facility (sanitary landfill) once approval is gained from the regional USEPA off-site coordinator. The remaining soil (i.e., soils which are hazardous waste) will be treated on-site.

Treatment. The following conceptual description of the SABRE process was developed based upon communications with the vendor and a draft USEPA Superfund Innovative Technology Evaluation (SITE) Technology Capsule (Doeksen, 1995a, 1995b; Kaake, 1995; USEPA, 1995). The size and operating parameters of an actual facility might be modified based on the desired remediation time.

The primary design parameters are the assumptions that the treatment unit will consist of a single double-lined impoundment, and a treatment period of 4 months would be required to degrade explosives to acceptable levels. The vendor indicated that treatment time might vary between 60 and 150 days, depending upon site-specific conditions and ambient temperatures (Doeksen, 1995a; 1995b). During the SITE demonstration, Simplot claimed that a 95 percent reduction efficiency was achieved in approximately 5 months; USEPA data found a 99.4 percent reduction efficiency after a 9-month treatment period (USEPA, 1995). The vendor indicated that 4 months should be sufficient for remediation of the contaminated soil, provided the slurry was maintained in the optimum temperature range (Yergovich, 1995).

For purposes of costing this alternative, it was assumed that the impoundment would be 75 feet by 200 feet and excavated to a depth of 5 feet with a 1-foot berm. A 10-foot-wide gravel area would surround the impoundment. Approximately 2.2 feet of soil would be placed in the impoundment and covered with about 2 feet of water. The water used need not be potable and thus could be obtained from Orr Ditch depending upon the season. Water requirements at the USEPA demonstration project

were about 213 gallons per cubic yard of soil treated; however, the vendor indicated that 350 gallons per cubic yard should be available (USEPA, 1995; Doeksen, 1995d). A phosphate buffer would then be added to the system to control the pH and minimize oxygen diffusion into the soil (USEPA, 1994e). The nitroaromatic-degrading microbial consortium would then be added to the bioreactor.

A gantry-mounted hydromixer used to mix the slurry would straddle the impoundment and ride on iron rails mounted on a simple concrete foundation. The foundation would be installed in the key trench for the impoundment liner. The gantry is sectional and is available in sizes which will mix an impoundment up to 100 feet wide. A solar cover would have the added benefit of insulating the impoundment and keeping waterfowl out.

For the purposes of the EE/CA it is assumed that the impoundment is mixed an average of 3 days per week. The mixing requires 2 persons for 4 hours each.

The slurry should ideally be kept between 35° and 37°C for the treatment of TNT. Loss of heat adversely affects the activity of the microbial populations. In the SITE demonstration, electrical immersion heaters and a solar blanket were used to control the temperatures during winter months.

Additionally, the treatment unit is equipped with instrumentation to monitor pH, temperature, and redox potential. A pH below 8 is maintained (ideally between 6 and 7 for TNT degradation) through use of a phosphate buffer. The specially selected consortium of anaerobic microorganisms only becomes active when the redox potential is sufficiently low (approximately -200 mV) (Simplot, 1995). The measurement of pH, redox potential and temperature would be recorded continuously. It would be possible to check the measurements via a phone line. This would minimize the personnel required by determining remotely if any adjustments to the system were necessary.

Slurry Disposition. Following the treatment period, it is assumed that the water in the impoundment would be allowed to evaporate. The impoundment would then be filled with clean soil and covered with a geomembrane. A 1-foot layer of soil would then be placed on top of the geomembrane. The membrane and soil cover would need to be protected from erosion. The cover would not be compatible with use of the area for all-terrain vehicle or mountain bike use. An asphalt parking lot over the impoundment could provide added protection for the cover.

5.6.2 Operating Parameters

Site Suitability. Slurry-phase biotreatment would require minimal area at the Monite Explosive Facility. The selection of the material processing and treatment site is based upon the following criteria:

- The site ideally needs to contain sufficient land area to provide a ring of unoccupied space as a buffer zone between the treatment and disposal areas and the nearby human population.
- Sufficient area must be available for construction of the impoundment.
- Access roads must be available and capable of supporting heavy earth-moving equipment.
- Accessibility to the waste feed material must be direct and unencumbered, with adequate feed preparation areas.

The site appears to meet the site suitability requirements for development of a slurry-phase biotreatment facility.

Topographic Constraints. The main topographic constraints are susceptibility to erosion, and off-site drainage runoff. The site must be graded and leveled to allow for construction of the impoundment. The area immediately adjacent to the impoundment must be level to allow passage of the mixing gantry.

Site Area Requirements. The site would require approximately 3.5 acres to provide adequate room for vehicle access and maneuvering, a mixing area, and the treatment impoundment. Additional graded and graveled areas are needed for vehicle access, administrative and personnel facilities, and maintenance areas. In additional to these areas, access roads would be required to connect the treatment area with existing roads.

Utilities. Utility requirements for the slurry-phase biotreatment system include:

- A continuous water supply is required to provide makeup water for the impoundment. For much of the year water could be obtained from Orr Ditch; if supplies from the ditch

are insufficient or water is not available, municipal water is available on adjacent streets and could be brought on-site. Water for the system is not required to be potable. Total demand for process water is about 350 gallons per cubic yard of soil treated.

- Electrical service of 220/440-volts sufficient for a normal equipment maintenance facility. This should be sufficient to provide 200-ampere, 120-volt, 1-phase service for the administrative and personnel spaces.

Personnel. Three personnel (a field engineer and two equipment operators) would be required once the system is in operation. One person would be required to monitor the system on a regular basis unless telemetry was set up to allow monitoring from a remote location. Initially, an extra equipment operator and laborer would be required to help mix the amendments, load the soil into the treatment unit, balance the system pH, and ensure proper operation of the gantry.

It is assumed that the impoundment would be mixed an average of three times per week during the treatment. The mixing operation would require about 4 hours and would require an equipment operator and a laborer. It was assumed that when they were not busy mixing, the two workers would backfill and recontour the site under the supervision of a field engineer.

Personnel exposed to contaminated soil are subject to the OSHA requirements for hazardous waste site operations (29 CFR 1910.120), including requirements for personal protective equipment (as dictated by the specific site conditions and contaminants), physical examinations, and hazardous waste site training.

Treatability Testing. Treatability testing must be conducted to ensure maximum efficiency and to verify effectiveness for the contaminants at the site. Several pilot-scale studies have been conducted to evaluate the slurry phase for treatment of explosive contaminated soils (USEPA, 1994e; 1995). The study at Weldon Springs Ordnance Works of TNT-contaminated soils successfully demonstrated the reduction of explosive concentrations through biotransformation. Initial TNT concentrations of as high as 1,500 mg/kg were reduced 99.4 percent to a concentration of 8.7 mg/kg (USEPA, 1995).

Although previous studies have not specifically targeted dinitrotoluenes, considerable literature is available on the degradation pathways for nitroaromatic compounds and the relative biodegradability of TNT and dinitrotoluene. Dinitrotoluenes appear to be more rapidly degraded and completely than

TNT. Degradation intermediaries and their toxicities are known as are the kinetics for various microorganisms (Suen and Spain, 1993). While TNT degradation involves some potentially toxic and refractory intermediates, dinitrotoluene biodegradation apparently proceeds to completion with little difficulty.

The ability of the SABRE process to degrade the contaminants must be verified through the conduct of a treatability study. In addition, the toxicity of the treated soil must be evaluated. An optimal mixture of treatment amendments must be developed based upon site soils and contaminants. The treatability testing will provide an indication as to whether the SABRE process can effectively treat the contaminants within 45 days. However, a 3- to 4-month study would be required in order to verify the treatment time and amendment mixture necessary to achieve the cleanup levels.

Performance Testing. Regular monitoring of the system's pH, redox potential and temperature would be required in order to ensure maximum performance from the system. Composite samples for laboratory analysis (USEPA Method 8330) would be collected weekly for the first month, and monthly thereafter.

Implementation Time. Prior to the start of remediation, a treatability study would be required to confirm the effectiveness of the process on the contaminants at the site. The treatability test would require approximately 4 months to complete. After about 45 days, however, a determination could be made as to the effectiveness of the treatment. If the treatment was determined to be effective at the end of 45 days, construction of the impoundment could begin. It would require approximately 2 months to construct the treatment unit.

Major equipment is limited to bioreactor and agitation/suspension devices. Support equipment includes earthmoving equipment (for excavation, screening, and loading of bioreactor) and monitoring equipment (for tracking of pH, redox potential, and temperature). The modular bioreactor requires approximately 4 days. After excavation, bioreactor loading activities (soil and water) are a function of the treatment volume. If allowed by regulators, treated soil can be placed in the excavated area and used as fill material. For erected bioreactors, the integrity of the liner can be intentionally breached when treatment is complete.

5.6.3 NCP Criteria Analysis

The degree to which the incineration/landfilling alternative satisfies the criteria of the NCP is summarized in Table 5-4 and is discussed below.

Overall Protection of Human Health and the Environment. Slurry-phase biotreatment would achieve protection of human health by reducing TNT and dinitrotoluene concentrations to the cleanup levels. Previous projects have reduction efficiencies of 99.4 percent for TNT (USEPA, 1995). A treatability study would be necessary to verify the effectiveness of the treatment process for dinitrotoluene.

Near-term protection of the public health and the environment during remediation would be achieved directly by using specific design and operating controls to minimize emissions and discharges. Occupational risks to on-site workers are expected to be minimized through the use of specific design, operating controls and procedures, and appropriate training. Occupational risks would be addressed in the project Health and Safety Plan.

Compliance with ARARs. Slurry-phase biotreatment is expected to meet all ARARs as described below.

Chemical-Specific ARARs. Slurry-phase biotreatment would not be expected to reduce explosive concentrations in the excavated soil to background (below detection) levels. However, it would be expected to reduce explosive concentrations to level that are within the acceptable range of 1×10^{-4} to 1×10^{-6} for excess cancer risk.

Location-Specific ARARs. The SABRE process is not expected to affect protected species in the vicinity, nor is it expected to affect off-site designated wetlands. A net or fabric would be used to cover the impoundment in order to prevent migratory birds from utilizing it.

Action-Specific ARARs. ARARs that must be addressed in evaluating the slurry-phase alternative were discussed in Section 3.2. All of these would be met by the proposed facility design and operation.

Long-Term Effectiveness and Permanence. Slurry-phase biotreatment provides for the permanent and irreversible destruction of contaminants, and thus the systems evaluated here are expected to provide long-term protection of human health. Final explosive concentrations in the treated soil would be expected to be below regulatory limits. These concentrations are associated with an excess cancer

risk of 1 x 10^{-6} or less, and are well below levels observed in laboratory studies to cause adverse impacts on vegetation (PNL, 1989; 1990). There would be no permanent disturbance of land areas as part of the remedial project, and the area would be restored to surrounding conditions following remediation.

Reduction of Toxicity, Mobility, or Volume. Slurry-phase biotreatment is expected to reduce explosive concentrations in excavated soil to levels that protect human health and that require no additional long-term controls. The degree of explosives degradation provided by this alternative is expected to result in low residual TNT and dinitrotoluene concentrations.

Toxicity testing has been performed on TNT-contaminated soils treated by the SABRE process. The pre-treatment soil had a zero percent survival of earthworms even when diluted 100 percent. Soil from an intermediate phase of the treatment had essentially a 100 percent survival of the worms in all dilutions. In addition, a root elongation study showed a consistent relationship of more growth of alfalfa, red clover, cucumber, lettuce and wheat roots in the intermediate-treatment soil as compared to the pre-treatment soils (USEPA, 1995). Past SABRE process studies have not specifically evaluated 2,4-dinitrotoluene.

Short-Term Effectiveness. If selected as the remedial action, the SABRE process could be implemented following a treatability study which would require approximately 2 months to complete. Following that, the desired cleanup levels could be achieved in about 4 months. This assumes that construction of the treatment facility begins prior to completion of the treatability test.

This alternative poses little risk to the community, workers, or the environment during its implementation. However, unauthorized public access to the site would be a concern. The microorganisms used in the process are not native but are not expected to present health risks to the public. If properly implemented, no emissions are expected from this procedure. Odors associated with this process are not generally noticeable 50 feet from the treatment unit.

There is also minimal risk to the workers involved in this operation. Workers would be protected from exposure to contaminants through special waste-handling procedures (e.g., dust control), monitoring, and use of appropriate protective gear.

No adverse effects on protected species or sensitive land areas are expected during remediation. Land areas disturbed to accommodate operations would be restored following project completion, or left for public use.

Implementability. The general technical feasibility of slurry-phase biotreatment of soils containing organic explosives has been demonstrated on a pilot scale at Weldon Springs Ordnance Works. The technology has also been demonstrated on a nitroaromatic fertilizer (dinoseb), which exhibited some similar characteristics at a pilot scale. The process to be employed involves the treatment of explosive-contaminated soil through use of a selected consortia of anaerobic microbes. Slurry-phase treatment of sewage sludges, a similar process, is a well-developed technology used throughout the country. Construction of the treatment units do not pose unusual design or construction problems nor are unusual skills or knowledge required. A large body of knowledge exists on the methods and techniques that are effective in controlling the slurry environment.

Past studies have not specifically evaluated 2,4-dinitrotoluene; however, it has been reported that dinitrotoluenes are more rapidly and completely degraded than TNT (ABB Environmental Services, Inc., 1994). A treatability study would be necessary to demonstrate the effectiveness of the SABRE process in degrading the contaminants of concern.

Administratively, slurry-phase biotreatment of explosive-contaminated soil is supported by USEPA as a potentially viable innovative technology. It is expected to require little administrative effort to implement if the treatability study shows favorable results.

Cost. The costs associated with the SABRE process have been subdivided as follows:

- Excavation/backfilling
- Site and facility preparation
- Oversight of application of technology, licensing, mixer use
- Facility operations and maintenance.

All site and facility preparation costs, are considered capital costs. It is assumed that excavation and backfill would be performed by the gantry operator and his assistant when they were not involved in mixing of the impoundment. This cost element is assumed to be entirely operations and maintenance. All costs to operate and maintain the facility once operations are initiated are assumed to be O&M.

Costs were developed based on the process description for slurry-phase biotreatment presented earlier. They are considered order-of-magnitude estimates and have an expected accuracy within +50 percent and -30 percent as defined by the American Association of Cost Engineers. This range of accuracy is also consistent with current USEPA guidance (USEPA, 1988). Costs are presented in Appendix B; the elements of the individual cost categories are discussed below.

Treatability Study. A treatability study utilizing site soils is necessary to ensure that the parameters necessary for proper treatment are achieved. J.R. Simplot Company indicated that a streamlined treatability study would cost approximately $40,000 (Doeksen, 1995c).

Excavation/Backfill. Excavation and backfill costs were presented in Section 5.1.2. The cost is included as part of the overall project. The cost for excavation/backfilling consists of lease of excavation and hauling equipment, operations and maintenance, labor for the equipment operators. It was assumed that clean soil would be obtained from a readily accessible area nearby.

Site Preparation and Capital Equipment Costs. Site preparation includes advance planning and management; detailed site design and development (e.g., access roads, clearing, surface construction); utilities connections; facility construction (e.g., construction of the impoundment); and site support staff.

Area and surface requirements were described in Section 5.5.2. The required area would be cleared of existing vegetation, surveyed, graded, and compacted. An asphalt pad would be prepared to provide stockpile and mixing areas for the contaminated soil and amendment. Graded and graveled areas would be constructed for auxiliary equipment (e.g., vehicle storage, personnel trailers). The gravel road from Pyramid Highway to the site would be improved and widened to accommodate construction equipment.

Electrical cable and appropriate auxiliary equipment would be installed to tie in to the existing public power supply. Electrical heaters would be purchased in order to maintain the impoundment temperature. Temporary piping would be installed to provide water service from Orr Ditch and the municipal water system.

Planning, engineering, and design costs are based on the complexity of engineering required for this option. The site facility design should be relatively straightforward, with the process water requiring

the most effort. A contingency was added to all estimated site preparation costs and capital equipment costs.

Operations/Maintenance. O&M costs include all costs for labor, equipment maintenance, supplies, and utilities associated with operation of the facility.

Equipment O&M costs for the SABRE system would include the cost of fuel, electricity, and maintenance for the gantry and hydromixer. Equipment operations and maintenance costs were assumed to be 15 percent of the equipment lease or purchase cost.

Three full-time employees would be the minimum required to operate the treatment facility and backfill the site. This includes a field engineer and two equipment operators. It is assumed that the equipment operators will backfill the excavation when not mixing the impoundment. Weekly labor costs include fringe benefits and the OSHA hazardous waste site training and medical evaluations required under 29 CFR 1910.120. Additional project office staff costs (project management, maintenance and support staff) are estimated to be $3,000 per week.

Simplot provides oversight of the application of the SABRE technology and reviews reports for a fixed fee, which also includes the licensing fee and use of the hydromixer. The fee for a 1,000-cubic-yard cleanup is between $150 and $200 per cubic yard of soil treated. Mobilization/demobilization of the hydromixer would cost $20,000. The per yard fee would increase as the amount of soil to be treated decreased. In addition, the pH buffer and amendments cost $40 per cubic yard of soil treated (Yergovich, 1995).

Composite samples for laboratory analysis (USEPA Method 8330) would be collected weekly for the first month and monthly thereafter to monitor progress. Verification samples would be collected to ensure that the removal action goals have been achieved. A detailed sampling plan would be developed as part of the remedial design, but it is assumed that a local laboratory would perform the necessary analysis. It was assumed that 100 screening samples would be collected and analyzed at a cost of $40 per sample. An additional ten samples would be collected and analyzed by USEPA Method 8330 to monitor the remediation progress and confirm cleanup. Estimated costs for these analyses are $220 each.

Decommissioning. Once the treatment was completed, water in the impoundment would be allowed to evaporate. The impoundment would then be backfilled with clean soil from on-site or from a nearby

BLM property. A geomembrane would be used to cover the filled impoundment, and then an additional foot of clean soil would be placed on top. It is assumed that the equipment and operators on-site would complete this work.

5.6.4 Summary

A summary of the NCP criteria evaluation is provided in Table 5-5. Slurry-phase biotreatment using the SABRE process would be a cost-effective method for reducing explosive concentrations and toxicity in the contaminated soil to acceptable levels. Concentrations of TNT and dinitrotoluene would be significantly decreased from their present levels. The total excess cancer risk to an individual exposed to the treated soil would be reduced. An acceptable level of protection could be achieved for a total estimated expenditure of $2.14 million.

TABLE 5-1

SUMMARY OF NCP CRITERIA EVALUATION FOR NO ACTION ALTERNATIVE
MONITE EXPLOSIVE FACILITY, CARSON CITY DISTRICT, NEVADA

Effectiveness						
Overall Protection	Compliance with ARARs	Long-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume	Short-Term Effectiveness	Implementability	Cost
Does not enhance protection of human health and environment. Current and future risks related to soil exposure remain essentially unchanged.	Does not comply with remedial requirements of the NCP.	Long-term effectiveness not achieved since future human exposure potential and environmental impacts and are not reduced.	No reduction in mobility or volume. Minimal natural reduction in toxicity.	No near-term activities planned at the site, so little exposure to workers. Current access restrictions do not effectively protect public. Continued absence of vegetation.	Requires no active implementation. Difficult to justify to regulatory agencies and community.	Essentially zero in near-term. Probable long-term management and monitoring costs.

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TABLE 5-2

SUMMARY OF NCP CRITERIA EVALUATION FOR OFF-SITE ROTARY KILN INCINERATION/LANDFILLING ALTERNATIVE
MONITE EXPLOSIVE FACILITY, CARSON CITY DISTRICT, NEVADA

Effectiveness						
Overall Protection	Compliance with ARARs	Long-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume	Short-Term Effectiveness	Implementability	Cost
Protection of human health achieved by reduction of excess cancer risk to 1×10^{-6} (residential use scenario), and by treatment and monitoring of incineration stack gas emissions. Environmental protected by reducing explosives concentrations. Requires measures to protect workers and perhaps nearby communities during excavation handling, and treatment.	Incineration accomplishes >99.99 percent DRE of explosives. Subtitle D landfilling of soils with less than 8 ppm 2,4-DNT, and Subtitle C landfilling of soils with between 8 and 140 ppm will comply with the RCRA Land Disposal Restrictions.	Effectiveness is permanent and long term, since contaminants are destroyed with a >99.99 percent efficiency. No long-term management required. This alternative will provide a permanent solution for the contaminants on-site.	Destruction of contaminants reduces toxicity associated with explosives to essentially zero. Stack emissions expected to be of very low toxicity. Treated soil not expected to be hazardous.	Worker, environment, and community protected during operations by using proper safety procedures and process monitoring. Time to implement and complete remediation is approximately 3 months.	Incineration is a method commonly used for treatment of contaminated soils. This is a proven technology and incineration services are readily available.	The cost for incineration alone is $,1,200 per ton of soil. The cost for disposal in a RCRA Subtitle C landfill is $125 per ton and the cost for disposal in a RCRA Subtitle D landfill is $2 per ton. Other costs would include site preparation, excavation, backfilling, and verification sampling. The total project cost is estimated at $2.61 million.

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TABLE 5-3

SUMMARY OF NCP CRITERIA EVALUATION FOR OFF-SITE BIOTREATMENT (COMPOSTING) ALTERNATIVE
MONITE EXPLOSIVE FACILITY, CARSON CITY DISTRICT, NEVADA

Effectiveness						
Overall Protection	Compliance with ARARs	Long-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume	Short-Term Effectiveness	Implementability	Cost
Protection of human health achieved through degradation of explosives to protective levels. Protection of environment achieved by reducing plant stress associated with high explosives concentrations. Requires measures to protect workers and perhaps nearby communities during excavation handling, and treatment.	Accomplished by reduction of contaminants to protective levels using cost-effective methods. Some of the contaminated soil would be disposed of off-site and would need to comply with the RCRA Land Disposal Restrictions.	Effectiveness is expected to be long-term since degradation products either mineralize or bind covalently into macromolecules. Contaminant concentrations reduced 97 to 99 percent. This alternative will provide a permanent solution for the contaminants on-site.	Composting reduces soil toxicity as measured by bacterial mutagenicity and aquatic toxicity by 88 to 98 percent. Residual material is nutrient-rich compost. No other waste streams are produced.	Protection of workers, environment, and community during operations is accomplished with proper safety procedures and process monitoring. Time to implement and complete remediation is about 3 months from commencement of excavation activities.	Implementation could be significantly delayed until a pilot or full-scale treatment facility at Hawthorne is up and running and agreements are in place for acceptance of MEF soils. Issues of "Non-Defense Waste" and tort liability still need to be resolved.	The U.S. Army estimates costs to be between $206 and $766 per ton for a 20,000 cubic yard cleanup. This alternative assumes a unit treatment cost of $200/ton at Hawthorne. The total project cost for this alternative is $1.2 million.

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TABLE 5-4

SUMMARY OF NCP CRITERIA EVALUATION FOR WINDROW COMPOSTING ALTERNATIVE
MONITE EXPLOSIVE FACILITY, CARSON CITY DISTRICT, NEVADA

Effectiveness						
Overall Protection	Compliance with ARARs	Long-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume	Short-Term Effectiveness	Implementability	Cost
Protection of human health achieved through degradation of explosives to protective levels. Protection of environment achieved by reducing plant stress associated with high explosives concentrations. Requires measures to protect workers and perhaps nearby communities during excavation handling, and treatment.	Accomplished by reduction of contaminants to protective levels using cost-effective methods. Some of the contaminated soil would be disposed of off-site and would need to comply with the RCRA Land Disposal Restrictions.	Effectiveness is expected to be long-term since degradation products either mineralize or bind covalently into macromolecules. Contaminant concentrations reduced 97 to 99 percent.	Composting reduces soil toxicity as measured by bacterial mutagenicity and aquatic toxicity by 88 to 98 percent. Residual material is nutrient-rich compost. No other waste streams are produced.	Protection of workers, environment, and community during operations is accomplished with proper safety procedures and process monitoring. Time to implement and complete remediation is about 6 to 8 months.	Composting is commonly used in other applications. Materials of construction and compost amendments readily available in area. A treatability/ optimization study would be required.	The U.S. Army estimates costs to be between $206 and $766 per ton for a 20,000 cubic yard cleanup. Cost for smaller cleanups would be higher. A portion of the untreated soil could be landfilled without treatment which would result in little cost savings. The total project cost is estimated at $2.16 million for the landfill option to $2.2 million for total treatment on-site.

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TABLE 5-5

SUMMARY OF NCP CRITERIA EVALUATION FOR THE J.R. SIMPLOT SABRE TECHNOLOGY MONITE EXPLOSIVE FACILITY, CARSON CITY DISTRICT, NEVADA

Effectiveness						
Overall Protection	Compliance with ARARs	Long-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume	Short-Term Effectiveness	Implementability	Cost
Provides both short- and long- term protection by destroying contaminants in soil. Requires measures to protect workers and perhaps nearby communities during excavation handling, and treatment.	Requires compliance with RCRA treatment, storage, and land disposal regulations (for a hazardous waste). Excavation, construction, and operation of on-site treatment unit may require compliance with location-specific ARARs. Wastewater discharges to POTW or surface bodies requires compliance with Clean Water Act regulations.	Permanently destroys contamination and intermediates. Provides reduction in contamination levels; duration of treatment determines final contaminant levels. Overall toxicity reduced between pre- and post-treatment.	Eliminates toxicity of soil contaminants through treatment. Does not leave intermediates if conducted properly. Could result in intermediates if terminated prematurely. If not fully dried, increases volume of treatment material by addition of water to create slurry.	Presents potential short-term risks to workers and nearby community, including exposure to noise and contaminants released to air during excavation and handling. These can be minimized with correct handling procedures and borders. Time to implement and complete remediation is approximately 8 months.	Construction of the treatment units does not pose unusual design or construction problems, nor are unusual skills or knowledge required. A large body of knowledge exists on the methods and techniques that are effective in controlling the slurry environment. Administratively, slurry-phase biotreatment of explosive-contaminated soil is supported by USEPA as a potentially viable innovative technology. It is expected to require little administrative effort to implement if a treatability study shows favorable results.	$112/cy for remediation of 5,000 cy of soil in four lined pits, with a treatment period of 6 months. This is based on the contamination and remediation levels observed during the SITE Demonstration. Actual cost of a remediation technology is dependent upon the volume of soil, soil characteristics, contaminants present, and the initial and target cleanup levels. The total project cost is estimated at $2.14 million.

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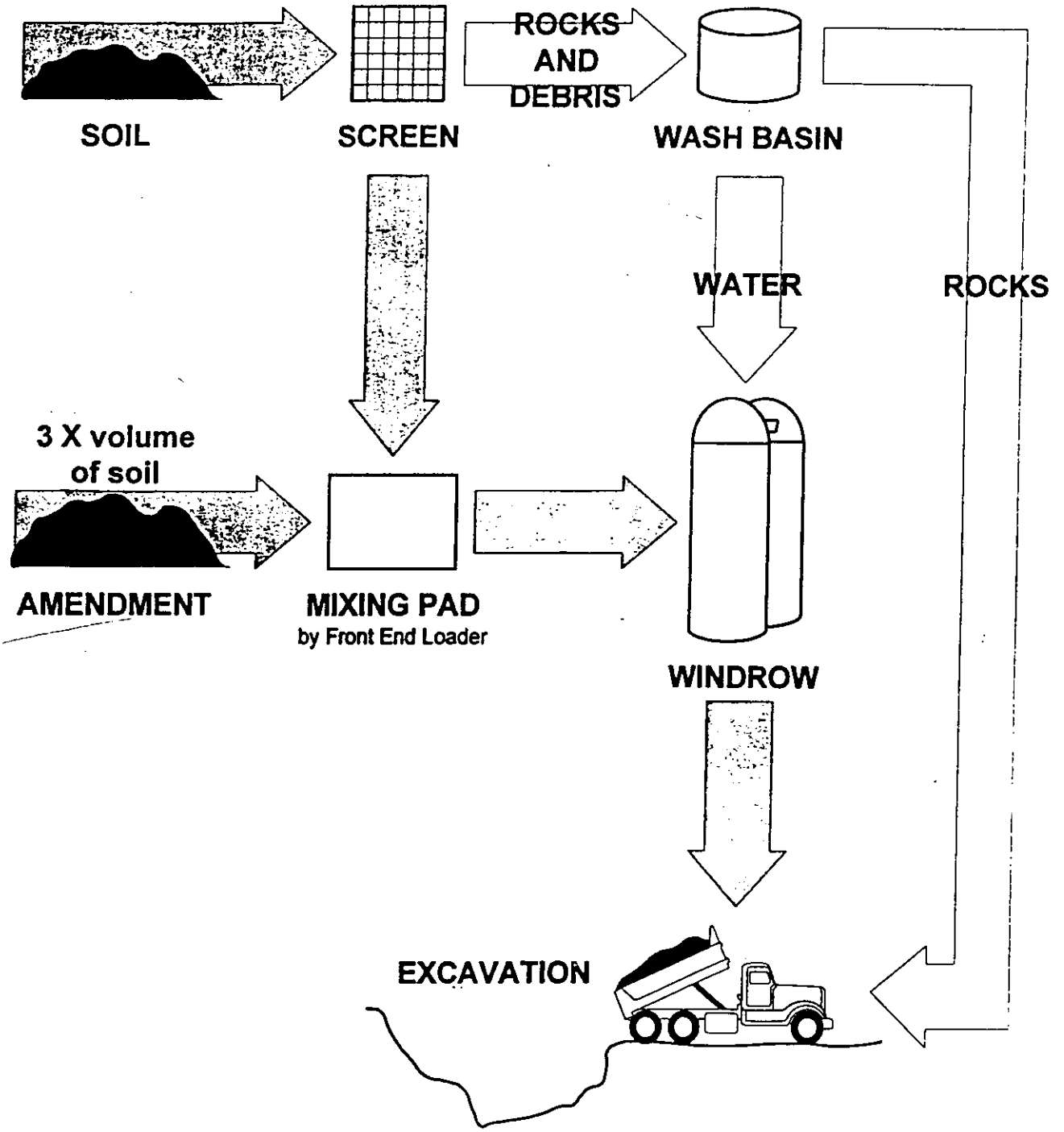
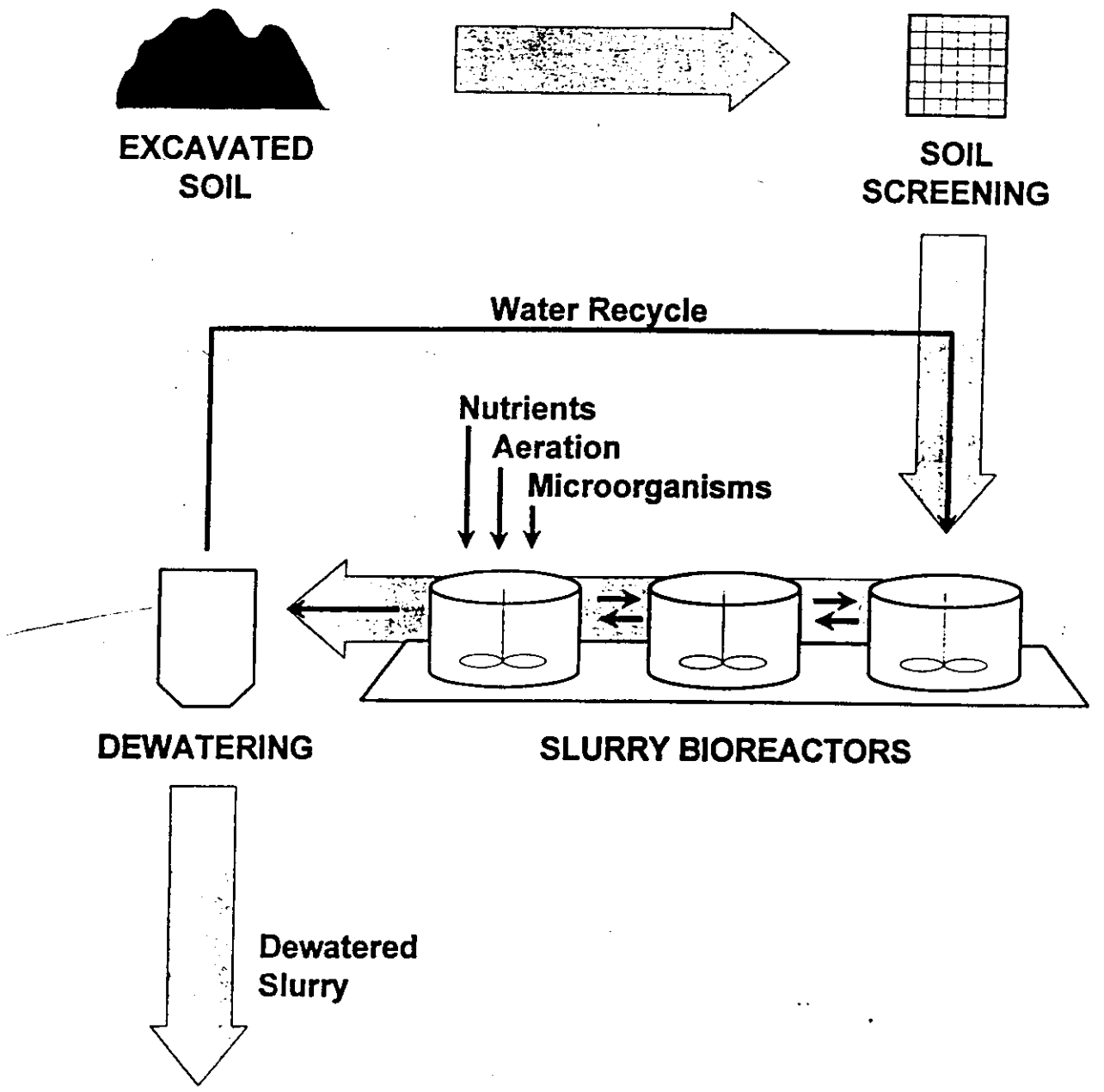


SCALE: N/A	SCHEMATIC DIAGRAM FOR COMPOSTING TREATMENT	FIGURE 5-1
DATE: MAY 1995		Brown & Root Environmental



SCALE: N/A	SCHEMATIC DIAGRAM OF SLURRY PHASE BIOTREATMENT	FIGURE 5-2
DATE: MAY 1995		Brown & Root Environmental

6.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

Table 6-1 presents a general comparison of the alternatives and Table 6-2 presents an evaluation of the detailed alternatives against the National Contingency Plan (NCP) criteria. Because Alternative 1 (No Action) provides virtually no protection of human health, it has been eliminated from consideration as a viable remedial alternative.

Alternative 2 (Off-site Incineration/Landfilling) provides the greatest reduction of risk, with a destruction and removal efficiency (DRE) of greater than 99.99 percent of hazardous contaminants. Alternative 2 is also the most expensive alternative to implement, with a cost of approximately $2.6 million; however, this is only approximately $500,000 more than both Alternatives 4 and 5, which require on-site treatment along with some disposal options. Alternative 3 (Off-site Biotreatment) would also be protective of human health, would result in residual contaminant concentrations within acceptable risk ranges, and would likely meet ARARs (depending on results of treatability studies) at a significantly lower cost ($1.2 million).

Alternatives 2 and 3 require that all soils be taken off-site for treatment and/or disposal. This involves the greatest risk of accidents during transportation (the closest incineration facility identified capable of treating the Monite soil is about 460 miles from the site, and Hawthorne is located approximately 127 miles away). Still, if negotiations with the U.S. Army remain positive in the current and future course of action, Alternative 3 (Off-site Biotreatment) offers the best option for the BLM in terms of cost and final disposition of soils subject to the removal action. If agreements with the U.S. Army do not appear possible, Alternative 2 (Off-site Incineration/Landfilling) should be reconsidered. If funding is available, this option (given the relatively small amount of contaminated soil) would appear to be the next best recommendation, with a total estimated cost less than 20 percent above the on-site treatment options.

Alternative 4 (Windrow Composting) and Alternative 5 (Slurry-Phase Biotreatment) are both likely to meet ARARs and would reduce contaminant concentrations to an acceptable risk (between 1×10^{-4} and 1×10^{-6}). Both Alternatives 4 and 5 are very close in price; the cost of Alternative 4 is approximately $20,000 higher than Alternative 5. Treatability/optimization studies must be conducted for each, and on-site operations would take at least 6 to 8 months to implement and complete remediation. Alternative 4 would require five workers on-site for the entire length of the project,

whereas Alternative 5 would initially require up to five workers but once the system was in operation only three workers would be required. Alternative 4 would require more surface area (10 acres) and site improvements to prepare for initial field activities (e.g., construction of windrow pads and bins). Additionally, odor control is a major concern for Alternative 4, whereas for Alternative 5 odor control is not expected to be a concern beyond 50 feet from the unit.

If on-site treatment is preferred because of off-site liability and/or regulatory issues, Alternative 5 is recommended for implementation. If for any reason SABRE treatability studies turn out to be negative, Alternative 4 is also a very viable technology and could be implemented at close to the same cost and over approximately the same period of time.

TABLE 6-1

GENERAL COMPARISON OF ALTERNATIVES
MONITE EXPLOSIVE FACILITY, CARSON CITY DISTRICT, NEVADA

Alternative	Would Hazardous Wastes or Treated Wastes Remain Onsite?	Treatability Testing Required	Site Improvements to Implement Proposed Alternative	Number of Full Time Employees Needed to Implement Alternative	Total Time to Implement and Complete Remediation	Total Project Cost
1. No Action	Yes. Because the No Action alternative does not include any treatment, the hazardous wastes would remain inplace.	No	N/A	N/A	N/A	Minimal Cost
2. Off-Site Rotary Kiln Incineration/ Landfilling	No. Soils with constituent concentrations below the RCRA Universal Treatment Standards (UTS) would be sent offsite to either a RCRA Subtitle C or D landfill. Soils with constituent concentrations above the RCRA UTS would be sent offsite for incineration.	No	Improve site access road, utilities (electricity, phone, and water)	2	3 Months	$2,600,694
3. Off-Site Biotreatment	No. All soils >6.6 ppm (cleanup goal) will be excavated and shipped off-site for treatment.	Yes	Improve site access road, utilities (electricity, phone, and water)	2	3 Months	$1,196,476
4. Windrow Composting/ Landfilling	Yes. Soils with constituent concentrations below the RCRA UTS would be sent offsite to either a RCRA Subtitle C or D landfill. Soils with constituent concentrations above the RCRA UTS would be treated onsite by composting and the treatment residuals buried onsite.	Yes	Site grading & leveling for windrow construction on an asphalt pad, an access road to connect treatment area with existing roads, additional graded & graveled areas, utilities (water, electric, phone)	5	6 to 8 Months depending on landfill options or total on-site treatment, respectively.	$2,164,311 to $2,210,203 depending on landfill options or total on-site treatment, respectively.
5. Slurry-Phase Biotreatment (SABRE Technology)/ Landfilling	Yes. Contaminated soil which is not a hazardous waste but has constituent concentrations above the cleanup goal will be sent offsite to a RCRA Subtitle D landfill. Soil that is a RCRA hazardous waste will be treated onsite with the SABRE process and treatment residuals will be buried onsite.	Yes	Additional graded and graveled areas, an access road to connect treatment area with existing roads, utilities (water, phone, electric)	3 to 5 depending on activity	6 Months	$2,144,983

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TABLE 6-2

COMPARISON OF ALTERNATIVES AGAINST NCP CRITERIA
MONITE EXPLOSIVE FACILITY, CARSON CITY DISTRICT, NEVADA

Effectiveness						
Overall Protection	Compliance with ARARs	Long-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume	Short-Term Effectiveness	Implementability	Cost
Alternatives 2, 3, 4, and 5 provide overall protection of human health in accordance with the NCP by reducing the excess cancer risk to within the range 1×10^{-4} - 1×10^{-6}. Alternative 1 provides no protection for future users of the site, does not enhance protection of the environment, and is not addressed further in this table.	Alternative 2 complies with all ARARs. Alternatives 3, 4, and 5 will likely meet most or all of the ARARs depending on results of treatability studies.	Long-term effectiveness is achieved in Alternative 2 by the permanent destruction of >99.99 percent of contaminants. Alternatives 3 and 4 achieve long-term protection by degrading contaminants 97 to 99 percent. Alternative 5 is expected to achieve long-term protection by destroying 99.4 percent of contaminants.	Alternative 2 would provide the greatest reduction of toxicity by destroying virtually all toxic contaminants (>99.99 percent). Stack emissions expected to be of low toxicity due to the use of air pollution control devices. Treated soil is not expected to be hazardous. Alternatives 3 and 4 reduce soil toxicity as measured by bacterial mutagenicity (98 percent) and aquatic toxicity (88 percent). Resulting low levels of explosives and metabolites, bacterial mutagenicity, and leachable toxicity remain after composting, but would not present a health concern. Nutrient-rich compost is residual product. Alternative 5 reduces soil toxicity that requires no additional long-term controls. Treated soil would have low residual TNT and dinitrotoluene concentrations. Treatment would not leave intermediates, if conducted properly. If treatment is terminated prematurely, could result in intermediates. If not fully dried, soil volume would be increased.	Alternatives 2, 3, 4, and 5 pose little risk to the community, workers, or the environment during implementation. Alternatives 2, 3, 4, and 5 use special waste handling procedures (e.g., dust control), monitoring, and use of appropriate protective gear to protect the workers. Because Alternatives 2 and 3 involve no on-site treatment, odors would not be a concern. For Alternative 4 (on-site composting), odor control would be a great concern. For Alternative 5 (SABRE), odors are not expected to be noticeable 50 feet from the unit. Alternatives 2 and 3 would take the least amount of time to implement and complete remediation (3 months). Additionally, they would achieve short-term effectiveness in 2 months (i.e., the amount of time to excavate and remove the soil), the remaining 1 month is for backfilling and recontouring. Alternatives 4 and 5 would take approximately the same amount of time to implement and complete remediation (6 months).	Alternative 2 is a widely accepted and proven method of treatment and poses no unusual design or construction problems and the services are readily available. Alternatives 3, 4, and 5 have been effectively demonstrated in pilot-scale tests at sites with similar wastes and are considered a potentially viable innovative technology. They are commonly used in other applications. A treatability study would need to be conducted for Alternatives 3, 4, and 5. Alternative 3 would require a delay in implementing due to outstanding issues dealing with acceptance of waste by the U.S. Army, tort liability, and coordination with Hawthorne operations.	Alternative 2 is the most expensive with a cost of approximately $2.60 million. Alternative 3 is the least expensive with a cost of approximately $1.20 million. Alternative 4 is slightly higher than Alternative 5 with costs totaling $2.21 and $2.16 million, respectively.

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SECTION 5.0 UXO IDENTIFICATION AND FIELD SCREENING

5.1 UXO Identification Techniques and Procedures

CEHNC-ED-CS-G (1mm) 22 October 1996

MEMORANDUM FOR Director, Ordnance and Explosives (OE) Team

SUBJECT: Hand-Held Geophysical Instruments for OE Quality Assurance (QA)

1. The purpose of this memorandum is to provide the list of acceptable hand-held UXO detectors for use in OE field QA. I request wide dissemination of this document.

2. Over the last several months CEHNC-ED and CEHNC-OE personnel, along with several contractors, have evaluated different geophysical detectors at the UXO calibration plot on McKinley Range at Redstone Arsenal. We have determined that there are significant differences between instruments; some are clearly better than others for detecting buried UXO. Please read "Evaluation and Comparison of UXO Detectors" (enclosure) prepared by ED-SY, 17 Oct 96, if you wish a detailed discussion of methodology and results.

3. The best hand-held, analog output, geophysical instruments we have tested for their ability to detect buried ferrous UXO are as follows:

- Schonstedt 52-CX
- Magnatrak 102
- Foerster Mk 26.

These three instruments had a significantly better combination of high detection rates and low false alarm rates than other hand-held instruments tested. Use of other instruments will result in buried UXO being passed over that should have been detected during a QA check.

4. Therefore, <u>only</u> these three detectors should be considered as acceptable field QA geophysical instruments for Corps of Engineers OE projects. Corps employees should not use any other hand-held analog instruments when performing QA for buried ferrous UXO.

5. Feel free to contact Mr. Roger Young if you have comments or questions.

Encl

RONALD R. LEIN, P.E.
Director of Engineering

SC&A S. COHEN & ASSOCIATES
AN EMPLOYEE-OWNED COMPANY

JUL 29 1996

July 23, 1996

Bruce Culp
Scientech, Inc.
Assistant Manager
1585 N. Skyline Drive
Idaho Falls, ID 83402

Dear Bruce,

We are pleased to announce that SC&A has been awarded a multi-year, multi-million dollar contract by the US Army Corps of Engineers, Engineering and Support Center, Huntsville, Alabama, to develop and deploy the next generation of Knowledge Base technologies.

The Ordnance and Explosive Knowledge Base (OE-KB) is a collection of geophysical data analysis technologies, integrated with the Intergraph GIS, used to detect, locate, and classify buried ordnance. SC&A conceived these technologies and performed initial development under Huntsville Center sponsorship. Highly successful at over a dozen live UXO sites, the OE-KB technologies are becoming widely accepted throughout the UXO community. Using OE-KB, SC&A placed first at Jefferson Proving Ground (Phase II) in 1995 (85% detection), and this has furthered the acceptance of SC&A's technology.

This major contract award validates our visionary approach to this difficult problem and will enable SC&A to continue its focus on providing the best UXO detection and characterization technology in the world. I look forward to continuing our relationship with Scientech, and to our future mutual success.

Sincerely,

John Foley

John E. Foley, Ph.D.
Director, GeoScience Division

1355 BEVERLY ROAD • SUITE 250 • MCLEAN, VIRGINIA • 22101 • 703.893.6600 • FAX 703.821.8236

U.S. Army Corps of Engineers
Engineering and Support Center, Huntsville

Ordnance and Explosive GIS and Knowledge Base

INTRODUCTION

The U.S. Army Engineering and Support Center in Huntsville, Alabama has adapted Geographic Information System (GIS) technologies for ordnance and explosive waste (OE) applications. This has resulted in a comprehensive set of software tools, referred to as the OE-GIS, used to facilitate many aspects of the OE remediation process. Part of OE-GIS is a suite of software analysis techniques for OE detection, location, and classification. This subset of the OE-GIS is called the OE Knowledgebase (OE-KB).

STANDARDIZATION IS NEEDED

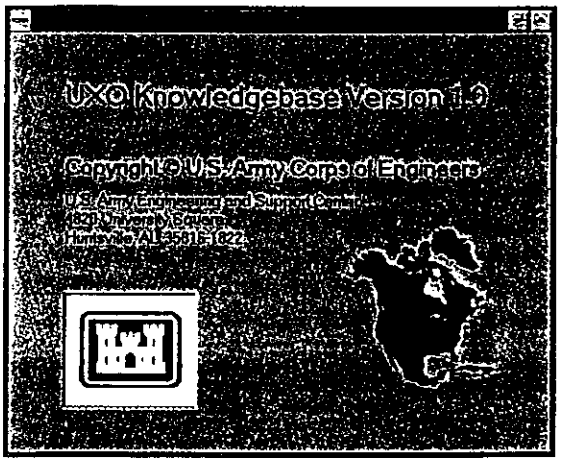
The Support Center in Huntsville developed the OE-GIS and the OE-KB to provide a standardized suite of state-of-the-art OE detection and analysis tools for the OE community. These tools, which are presently under development, will:

- Provide a standard methodology for OE applications
- Define a central repository for OE site information
- Assist in the management of the OE program and individual projects
- Assemble data from site investigations to determine if further investigation is required
- Discriminate ordnance from background anomalies such as scrap metal
- Administer the removal of ordnance items
- Digitally store the data for the administrative record

OFF THE SHELF TECHNOLOGIES

Using off-the-shelf GIS software and readily available personal computers, the OE-GIS collects, integrates, archives, and analyzes data from OE site investigations.

The GIS is based on the Windows NT operating system,Microstation CADD engine, Intergraph Modular GIS Environment (MGE) 6.0 software, and Oracle relational data base. The OE-KB software being developed by the Huntsville Center operates on the same platform as the OE-GIS.



OE-GIS APPLICATIONS / EXAMPLES

OE-GIS and OE-KB technologies have been utilized at sites including:

- Fort Monroe, VA
- Camp Simms, DC
- Camp Croft, SC
- Duck Island, NC
- Motlow, TN
- Nebraska Ordnance Plant
- Redstone Arsenal, AL
- Pueblo Army Depot, CO

Information included in the analyses comes from historical records, survey and mapping data, remote sensing devices, and non-intrusive subsurface geophysical instrumentation.

Typical Project Work Flow

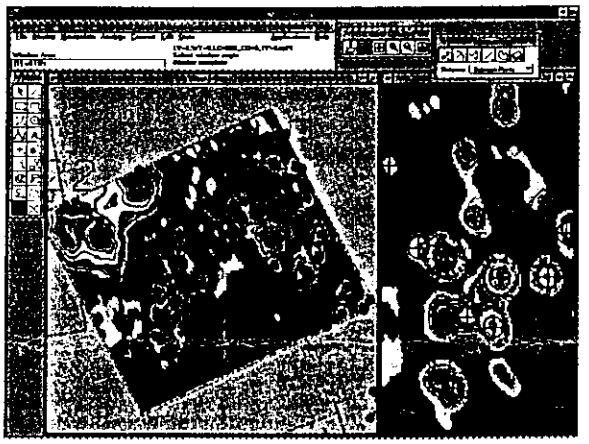
- Data Collection: Planimetric, historic, topographic and geophysical surveys, and photogrametric data are captured, integrated, and registered to produce a digital record.

- Data Storage: Data are stored in three different forms in a GIS relational database (Digital, Graphical, and Tabular). Data are then linked to and associated with common features to provide various informational needs.

- Data Analysis and Manipulation: Analysis is carried out on multiple types of geophysical data; currently including data from the Geonics EM-61 conductivity meter and the TM-4 magnetometer.

Various data analysis functions, such as arithmetic manipulation, statistical analysis, and analytical modeling, are implemented through Intergraph's built-in software as well as through the integration of external programs.

Through the OE-KB module, anomaly characteristics are compared to known OE signatures, processed numerical signatures, and interpreted image signatures to further streamline the OE investigation and establish a profile for specific ordnance items.



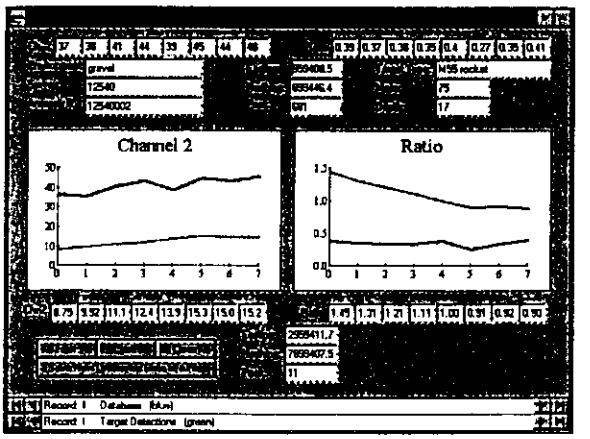
OE - Knowledge Base

An important part of OE-GIS analysis is performed by the OE Knowledge Base module. OE-KB is an ever-growing database of ordnance information used to detect and classify OE at on-going operations. Data in the OE-KB comes from non-intrusive instruments, such as metal detectors and conductivity meters.

The OE-KB discriminates ordnance anomalies from background noise, estimates ordnance size, determines areas potentially containing ordnance contamination, and develops a database of ordnance characteristics used to "fingerprint" an ordnance item. The analysis method used by the OE-KB is an artificial-intelligence neural network, which is designed to learn the patterns in the database which identify ordnance items.

OE-KB Tools

OE-KB tools are used to process and analyze historical and present-day field data. The tools are fully integrated with the Intergraph GIS system and can be employed to detect, locate, and classify ordnance. Being integrated with Microstation, the OE-KB also provides the full strength of a comprehensive GIS. The OE-KB takes advantage of this fact and utilizes the relational database function of the GIS.



OE-KB Neural Network

An important component of the OE-KB analysis toolbox is a signature classification module which utilizes a neural network classification technique. This program was developed to determine the size and depth of detected ordnance items. "Neural network" is a term describing a broad category of classification and analysis tools based on the way the human brain receives, processes, stores, and communicates knowledge. In the OE application this knowledge is the stored data recorded as part of previous and on-going site investigations. The OE-KB uses this knowledge to train a neural network to identify and classify ordnance items based on the results of previous studies.

For additional information contact Scott Millhouse at the Huntsville Center, 205-895-1607 or Jack Foley of SC&A, 508-458-8059.

GEOPROFILES

A Publication of **GEOMETRICS, Inc.** May, 1996

UXO Detection Demonstration Project at Jefferson Proving Ground

In July of 1995, Geometrics was selected to participate in a funded demonstration to locate and characterize unexploded ordnance at the Jefferson Proving Ground (JPG) in Madison, Indiana, USA. Approximately 15 other leading companies specializing in geophysical instrumentation and ordnance detection services also participated in the project. The purpose of the JPG program is to identify the best equipment and procedures for the location and characterization of UXO in order to set standards for the clean-up of military bases.

New Mag Provides Excellent Results

The Geometrics team used three Geometrics G-858 dual-sensor cesium magnetometers for the magnetic detection. Specialized processing of the magnetic data, to identify and position ordnance, was provided by AETC. Geometrics also worked closely with GDE, Inc. who provided a ground-penetrating radar for additional target characterization after detection, and with Wyle Labs who provided a senior UXO specialist as a field operations consultant.

The G-858 was used in the "Mapped Survey" mode, which allows the operator to easily pre-program the MagMapper software with the dimensions and internal reference markers of the area before the survey; thus, accurate positioning on the data to the 40-acre grid was easily done by marking the survey grid with intermediate reference points and having the operator simply walk the survey lines and enter the "MARK" (fiducial) points into the G-858 as he crossed each point or the end of a line. In addition to this internally mapped survey positioning technique, the G-858 was integrated with a differential GPS. The operator carried a backpack on which were mounted a GPS receiver, data radio, and 12VDC battery to power the equipment. The differential GPS base station was located at a known reference site within the grid.

Les Clark of Wyle Labs — "Ready to Go"

83% Detection Rate with Fewest False Positives

Geometrics, in conjunction with AETC, produced remarkably high-resolution magnetic contour maps of the JPG 40-acre site. Unfortunately, since this is an ongoing project, the government contractor will not allow us to publish the maps showing the distribution of detected targets. We have, however, received preliminary information showing that the Geometrics team did extremely well in detecting the buried ordnance. In fact, the G-858 had a detection rate of 83%, by far the best detection score of any magnetometer team. The only other instrument that had a similar detection ratio was a time domain EM device with a detection score of 85%. But the EM device indicated 23% more false targets than the G-858. This means that the G-858 had the best combination of more true target "hits" and fewer false alarms than any other JPG participant. Perhaps more importantly, the G-858 allowed the Geometrics field crew to produce these outstanding results at a rate of over eight acres per day in very difficult terrain. No other instrument gave as high a detection rate combined with low false positive "hits" and high production rates. For more details about the instruments, processing, or results of the JPG Unexploded Ordnance Detection Demonstration, please contact Geometrics.

WHAT'S INSIDE

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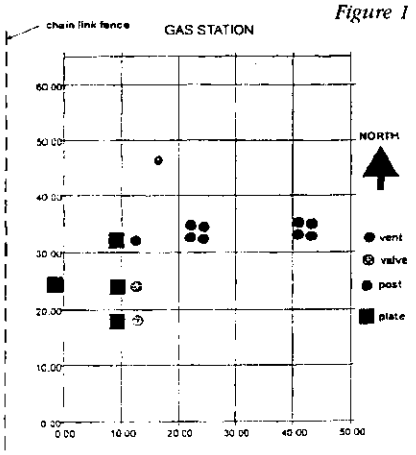
Case History Using the G-858 MagMapper with MagAID

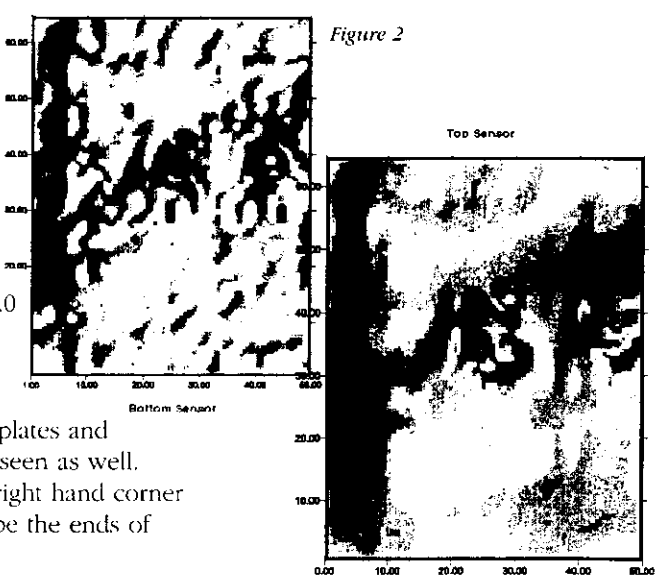
Survey data from an abandoned gas station was collected with a G-858G and processed using MagAID, the anomaly-characterization software developed with AETC. The purpose of the survey was to see if there were any remaining UST's (Underground Storage Tanks) on the property. The first map is a plan view of the gas station, a 65 by 50 foot area. Notice the chain link fence on the left, the three "plates and valves" which were the three fuel pumps in the island and the two "post" areas which were stanchions used for store protection from the driveway. The area is covered by concrete and is believed to have rebar in it.

Figure 1



The second figure shows a shaded relief map of the magnetics data: bottom and top sensor. The posts are clearly the largest anomalies, but the shaded relief maps (Surfer 6.0 by Golden Software) produce an excellent dynamic range presentation, so the plates and valves can easily be seen as well. Notice in the lower right hand corner what we believe to be the ends of rebar sections.

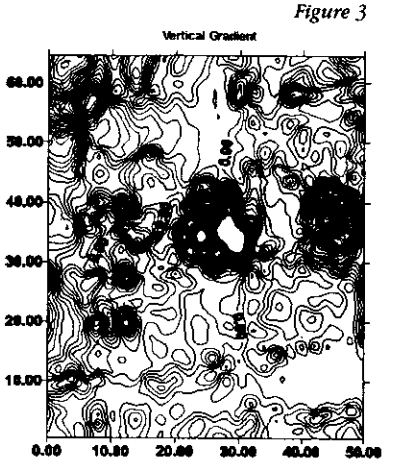
Figure 2



Automated Software Improves Target Recognition

Although the shaded relief does a great job of showing large and small features simultaneously, it is hard to determine relative amplitudes and sign of the anomalies. A surface contour plot shows that almost all of the anomalies are negative. While it is not the norm to see multiple negative anomalies, it is possible of course, if the steel objects are bucking the earth's induced field. Why that may occur is not clear to us, but it is the case in this instance and others we have examined.

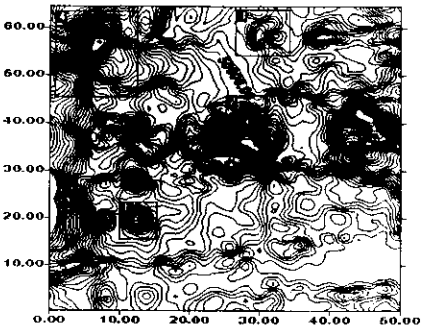
Figure 3



In addition to the large negative anomalies associated with the stanchions, there is another large negative anomaly in the upper left hand corner. From the shaded relief maps, it is apparent that there is a linear anomaly superimposed on the slope of the fence, extending down the left side of the property. One could even make a case that there is pipeline running down the left side, possibly connecting to the dispensing island valves.

The purpose of the survey was to locate any potential tanks, so we used the newly developed MagAID software to analyze the anomalies. The MagAID program is based on magnetic pattern matching algorithms, using a maximum-likelihood estimator approach. The program is very easy to use. Surfer for Windows is used to grid the data and make a planar map. MagAID imports the map and grid file and prompts the user to draw a box (with the mouse) about the suspected anomaly; MagAID then uses its pattern matching algorithm to

Figure 4



compute the x-y position, depth and size of the body. Most importantly, the software has a built-in quality indicator which measures the "goodness-of-fit", or how well the user's data fits the estimated object.

As shown in Figure 4, we have drawn boxes about the lowest valve and obtained a depth of 2 feet and an effective sphere radius of 1.5 feet, reasonable numbers for a pipe junction. Next we tried the central post

continued on next page

Continued from previous page

and got 4.2 feet depth and a radius of 3 feet, also a reasonable solution for a vertical steel rod. There is a small target at x=28, y=59 that is buried a couple of feet, but the goodness-of-fit is less than 80%, so the interpretation is less sure than the others.

Finally we used the program to analyze the anomaly in the upper left corner, which gave a solution of 7.35 feet depth and an effective spherical radius of 5 feet, well within the bounds of what one would expect from a UST. We have asked the DOT to excavate the site to see if our projections are correct. While it is possible that the anomaly is caused by the end of a long steel pipe, we believe the tank interpretation is more likely because of the quality

Figure 5 — MagAID results showing location and quality.

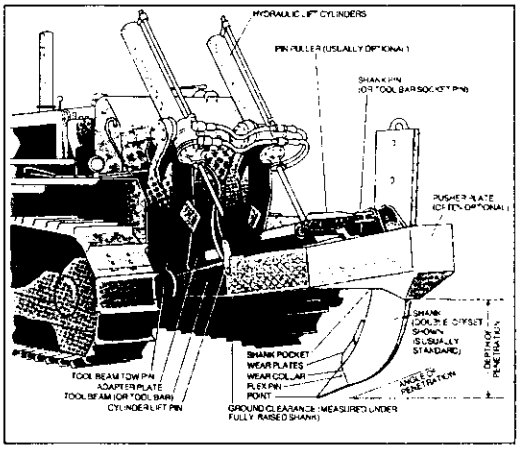
Obj No	X	Y	Depth	Size	Fit Quality
1	11.25	20.21	2.15	1.47	0.96
2	26.43	39.29	4.23	3.10	0.83
3	28.33	58.93	2.47	1.33	0.68
4	3.58	53.72	7.35	5.07	0.86

indicator and the excellent results with the program on data acquired at the Stanford Environmental Test Site, where ground truth is known. It will be very satisfying to show — for the first time, we believe — that tank-size objects can be positively identified through a layer of rebar.

We are in the process of trying the program on many other sites and anomalies to try to develop a sense for its power and limitations. We will have more information shortly. The MagAID software, which costs about $2,500, offers excellent value in identifying ferromagnetic objects, especially in high noise and high interference areas where targets are not easily detected or analyzed by any other means. The same algorithm was used very successfully to analyze the data from the JPG UXO detection demo described in the accompanying article.

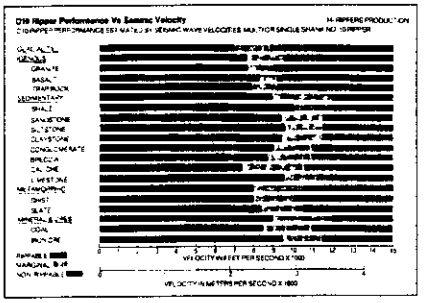
Refraction Surveys Help Streamline Quarry Operations

When United Tractors, a dealer for earth movers and excavators, helps customers decide on the right choice for earth moving equipment, it now comes armed with a new tool — seismic refraction surveying. United Tractors, based in Jakarta, Indonesia, has been heavily involved in the building boom that has followed the expansion of many S.E. Asian economies. And most building projects ultimately rely on an affordable source of aggregates from local quarries.



Large ripper 'shanks' tear rock and are often less costly than drill and blast operations (reprinted from Coal Age)

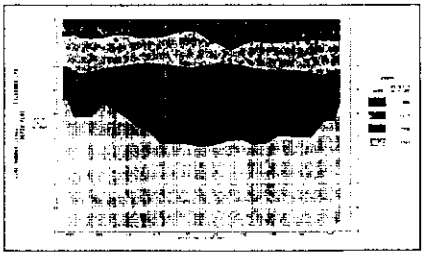
Choosing the right equipment for mining a quarry is not easy. One must consider the overburden depth, the volume of the deposit and the hardness of the rock to decide the best and most economical method to mine the deposit. Drilling is effective, but costly and only gives a very local measurement. And in areas of severe topography, drilling is often not practical.



Rock velocities correlate directly with hardness and rippability. Excavation of an aggregate deposit can be planned by comparing the results of a seismic refraction survey with the above chart (reprinted from Coal Age).

Engineering manager Andi Sjahrandi says refraction surveying gives his company an edge in determining what equipment and options to provide with heavy equipment. A comprehensive refraction survey provides a map of overburden thickness and rock rippability to determine how to deploy resources. A key issue for Mr. Sjahrandi was that the SmartSeis 24 channel seismograph can provide preliminary results directly in the field. Even though a more comprehensive analysis is done at United Tractors headquarters, the ability to convince their clients that it is a viable technique while in the field adds a great deal to their credibility. Some deposits can be ripped with a long 'tooth' attached to the back of a tractor, supplementing or even replacing expensive and hard to permit drill and blast operations.

The figure below shows a geological interpretation from a hammer refraction line printed on the SmartSeis printer. In field first break picking and layer assignment provides an excellent quality control measure to ensure optimum data quality.



Results from the SmartSeis seismograph, printed on the built-in printer. Iterative ray tracing software from Rimrock Geophysics is used to convert travel times to earth velocities and depths.

Downhole Seismic Surveying — Quality Control for Geophysics

Geophysical surveying for engineering and groundwater studies is an effective tool to reduce the number of costly boreholes. Seismic surveying in the boreholes themselves can provide critical quality control data for a surface seismic survey — and adds information that can not be obtained any other way.

Required Equipment

Downhole seismic surveys (also called borehole velocity surveys) are simple and relatively easy to undertake. They require a downhole sensor, a suitable length of cable to lower the sensor down the borehole, and a seismograph capable of sample rates faster than 0.25 ms. The most common procedure is to measure the travel times of signals from an impulsive source of energy at the surface to progressively greater depths in the hole. A sledge hammer is a suitable energy source for surveys to depths of 100 meters — greater depths may require stacking.

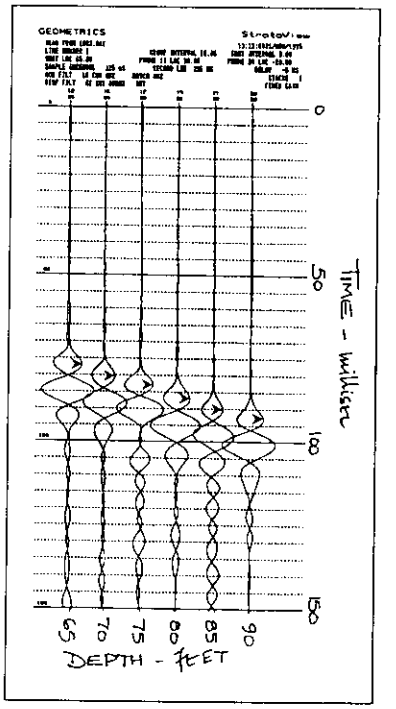
Professor Scott Ashford observing downhole shear-wave velocity survey on campus of Asian Institute of Technology near Bangkok, Thailand

Downhole sensors are typically geophones or hydrophones. Downhole geophones are more versatile and usually have three sensors that measure motion in the vertical and two orthogonal horizontal directions, so are useful for measuring both compressional and shear motion. A clamping mechanism holds the geophone tightly against the borehole wall for each measurement so the geophones can couple with the acoustic signals being transmitted in the earth. Some borehole geophones have an air filled bladder or balloon that can be inflated to lock the geophone tool in place. An array of hydrophones can be used in certain conditions for downhole compression-wave surveys, although they must be immersed in water and cannot detect shear waves. Hydrophones are best suited for surveys of materials with relatively high velocities, say greater than 2000 meters per second.

Survey Technique

Performing a downhole velocity survey is straightforward. Usually the sensor is lowered into the hole just below the surface, clamped to the borehole wall, and the measurement taken by striking the hammer against a plate on the surface. The tool is then lowered by a suitable increment for the resolution required (usually 0.5 m to begin with, then larger intervals at deeper depths) and the measurement repeated.

If shear-wave velocity is to be measured, a shear-wave source must be used. The most effective method is to place a wooden plank horizontally beside the borehole and weight it by driving a vehicle onto it. Each end of the plank is struck the with sledge hammer and the two separate reverse polarity records are recorded on the seismograph to help identify the shear 'S' waves. The ground is struck vertically, usually on a metal plate, if compressional 'P' waves are to be measured.



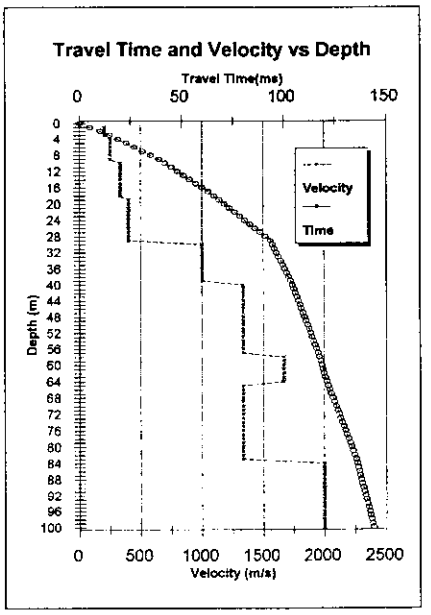
Downhole seismic record showing shear wave from opposing hammer blows. Markers show first arrival of energy used to calculate shear velocities of layers.

Data Processing

Much like a seismic refraction survey, only the first arrival of energy, or the first breaks, are of interest. The corresponding plot of travel time vs depth is then converted to velocity vs depth by computing the least-squares slopes of the major straight-line segments of the plotted data, after compensating for any horizontal offset between the source and well. Like refraction surveys, it is best to try and pick first arrivals while the survey is being undertaken to ensure that your data are good before leaving the field.

Critical Information from a Downhole Survey

Downhole surveys can be important supplements to surface seismic surveys and can identify unusual conditions that surface surveys cannot detect. They provide more localized measurement of earth materials at depth, where as surface seismic surveys provide an average measurement. Downhole surveys can be used to calculate important engineering parameters at low strain: shear moduli, soil compressibility and Poisson's ratio — all important parameters in calculating the bearing capacity of soil and in designing foundations for structures to be built there.



Travel time curve (o) and calculated interval velocities (x) from downhole velocity survey.

The accuracy of surface refraction surveys occasionally suffers when either of two geologic conditions exist: 1) If a low velocity layer underlies a higher velocity material, refracted energy along the low-speed layer is not generally observable; this undetected layer might be an important aquifer or might be structurally incompetent. 2) Similarly, if a low velocity layer overlies a much higher velocity stratum with a thin intermediate layer between them, this thin layer is also undetectable by surface refraction. Downhole surveys can detect both these conditions and the refraction surveys can be compensated with downhole data.

Shear waves measured downhole can be used to determine critical parameters for evaluating earthquake site response — the amount of amplification that local soils produce when earthquakes shake underlying bedrock. The shear wave velocity profile is also important to determine earth resonances. If earthquakes contain specific frequencies with suitable duration, the ground and the buildings that the ground supports can be driven at resonance, a condition that spells destruction for improperly designed structures. For example, local resonances and geologic conditions were responsible for the destruction of certain mid-sized buildings in the last Mexico City earthquake; larger and smaller buildings survived intact.

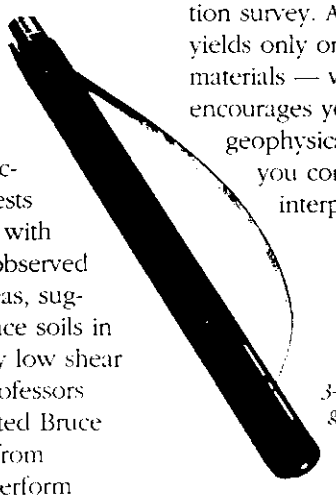
Downhole Surveys in Use — A Case History from Thailand

In order to assess the earthquake vulnerability of buildings in the Bangkok region, Dr. Scott Ashford of the Asian Institute of Technology and Dr. Panitan Lukkunaprasit of Chulalongkorn University in Bangkok have been studying the dynamic properties of Bangkok's soils. Correlations of soil characteristics (obtained from tests of local drilling samples) with dynamic soil properties observed in other geographical areas, suggested that the near-surface soils in Bangkok could have very low shear moduli. In April 1996, Professors Ashford and Panitan invited Bruce Redpath, a geophysicist from Murphys, California, to perform downhole shear wave velocity surveys in the Bangkok area in order to confirm or refute their laboratory predictions of extremely low velocities.

The borehole measurements did indeed confirm the work of Drs. Ashford and Panitan. The shear-wave velocities of some of the near-surface clays were as low as 60 meter/second, lower than anything Mr. Redpath had measured before. With their dynamic analysis of Bangkok soils supported by in-situ measurements, Drs. Ashford and Panitan can now proceed with confidence to model the earthquake response characteristics of soils beneath Bangkok.

Computer models of ground motion, amplification, resonance and damping can help engineers understand the types of motion that buildings will be subjected to and design them accordingly. These parameters can be used to modify city building codes to make structures more sound and cities safer for everyone.

It should be noted that surface seismic surveys and downhole surveys should work together to be most effective. Surface surveys provide a 'bulk' measurement of earth velocities over a large volume, whereas downhole surveys provide 'point' measurements of materials close to the borehole. Because geologic conditions can vary widely over the study area, a more complete analysis often includes a surface refraction or reflection survey. Also, seismic surveying yields only one measure of earth materials — velocity. Geometrics encourages you to consider other geophysical measurements to help you confirm your geological interpretation.



3-component downhole geophone manufactured by Geostuff

Stratagem Case Histories Now Available

Geometrics newest product, the Stratagem EH4 conductivity imaging system, is poised to become a standard instrument for EM investigations in mining, groundwater exploration, engineering, and basic research. In addition to the standard Stratagem EH4 configuration, which measures EM fields from 10 Hz to 100,000 Hz, the instrument is now available with optional low-frequency sensors and electrodes. This allows sensitivity to an additional two decades of low-frequency signals — to as low as 0.1 Hz — and considerably greater depth of investigation.

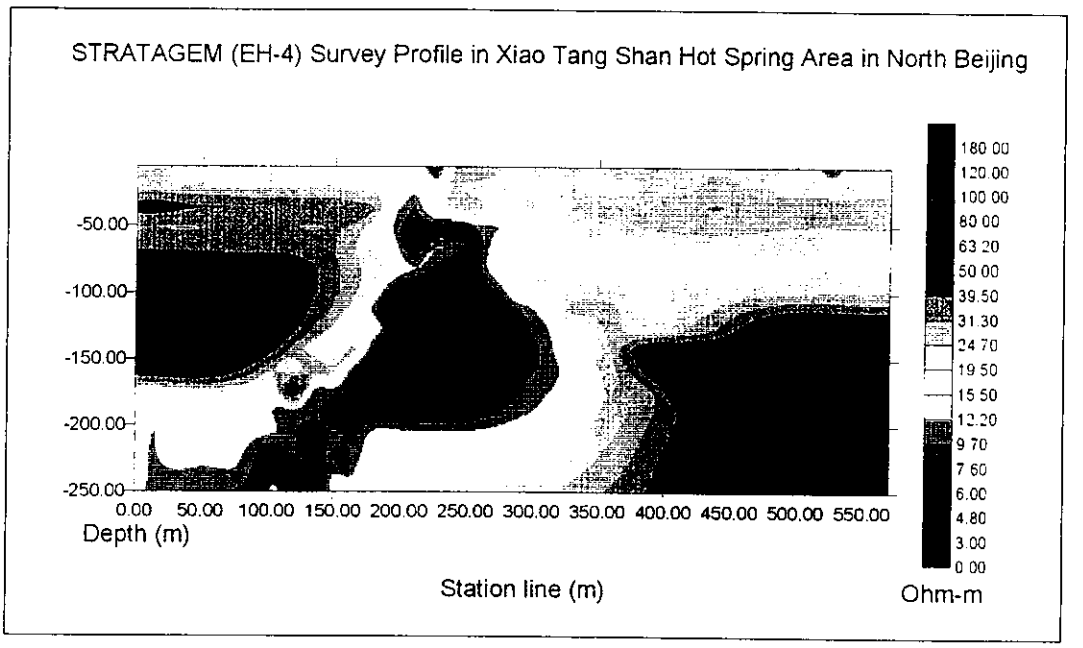


Figure 1

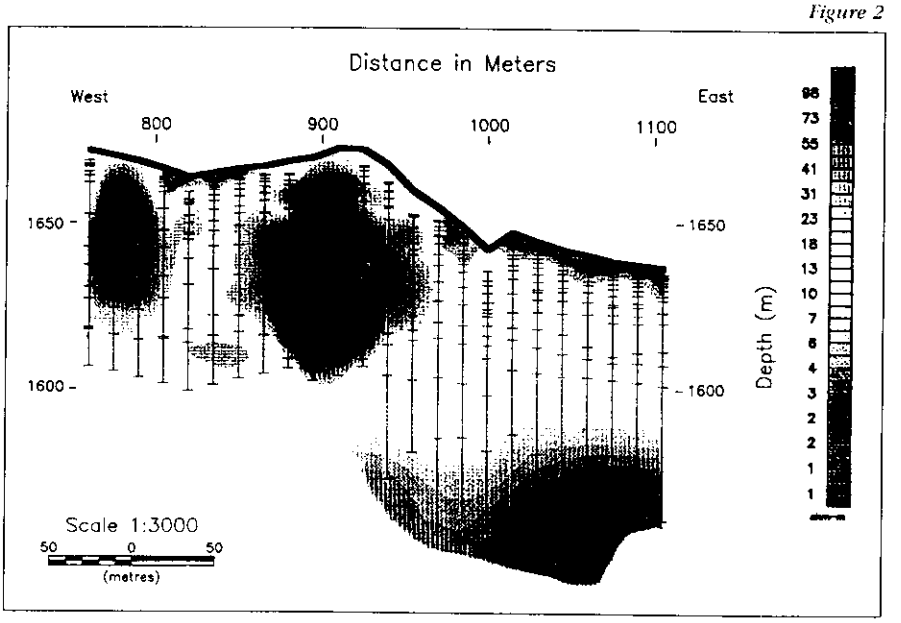
Since Geometrics shipped the first Stratagem unit in March of 1995, Stratagems have been successfully used in mining, ground water, and engineering investigations. A number of case studies have been made available by Stratagem operators.

Figure 1 shows the results of a Stratagem EH4 survey of a geothermal area, conducted by Laurel Industries, at the Xiao Tang Shan Hot Springs Area of North Beijing. The survey consisted of forty (40) stations using 15 meter dipole spacings, for a total survey line length of 600 meters. The data were then processed using Stratagem's 1D and 2D inversion software. Further contouring was done using WinSurf™ from Golden Software.

The large red zone in Figure 1 is interpreted as a conductive fault zone. The increased conductivity is probably the result of weathering in the fault as well as ionic solutes associated with the geothermal activity. Structure of the fault is clearly seen down to 250 meters (825 ft.) The offset in the more resistive blue/green area indicates a vertical displacement along the fault line.

Figure 2 shows the results of a Stratagem EH4 survey of a gold field, carried out by ENW Services of Denver, CO. The conductivity cross section consists of 24 individual stations using 15 meter dipole spacings. The output of the Stratagem 2D processing was contoured using Geosoft™ mapping software. The geology of this area has been well characterized by over 200 boreholes. The resistive (blue) areas on the map correspond very well to known silicified gold bearing zones in the more conductive alluvial sediments.

Figure 2



Research Contracts for New Geophysical Instruments

Early in 1995 Geometrics teamed with Conductus (a Sunnyvale based company which manufactures high-temperature superconducting materials) to obtain a Phase II SBIR (Small Business Innovative Research) contract with the US Department of Energy (DOE) to develop, "A Superconducting Magnetometer/Gradiometer for Advanced Geophysical Imaging." A new type of magnetic sensing system was proposed for the advanced geophysical imaging system and is to be integrated into a geophysical borehole tool (initially for a 4" diameter borehole). The new magnetic sensing system will be able to measure three magnetic field components plus five independent magnetic gradients which will allow measurement of the magnetic tensor. The magnetic detection array will be fabricated using high-temperature (liquid nitrogen or 77 Kelvin) superconducting (HTS) SQUID sensors that can be reliably operated in a shallow borehole (less than 500 meters depth). A SQUID is a Superconducting Quantum Interference Device which is one of the most sensitive and compact (<1 cm^2 in area) vector magnetometers available today. The SQUID is capable of measuring magnetic field changes from DC to well over 100 kHz. The system currently under development will be used with an active electromagnetic (EM) source (10 Hz to 100 kHz) which can be placed at the surface near the borehole for surface-to-borehole studies or in an adjacent borehole for cross-hole studies.

While the system under development is for borehole work, it is being developed with the goal of being able to use the system as a portable controlled-source EM system for surface work, initially a frequency domain system but with the long term objective of being able to use the system in either the frequency or time domain. The tensor EM sensor array is unique and is not available in any commercial system or non-commercial system for that matter. It will offer a new dimension to portable controlled source EM systems (surface or borehole) which should open new markets for this type of system such as for Non-Destructive Evaluation (NDE), high resolution/near surface environmental studies, etc. As part of this SBIR contract Geometrics is acting as a subcontractor to Conductus to design, build and test the data acquisition, control and processing system for the new device and Conductus is building the SQUID sensors. Geometrics has an agreement to market and sell the final commercial system that will be developed under this SBIR as well as other geophysical products to be developed with HTS SQUID sensors.

In February of this year, the Office of Naval Research (ONR) awarded Geometrics a $1.6 million contract for development of a UXO (Unexploded Ordnance) Standoff Detection and Classification System using HTS (high temperature) SQUID Sensors. For this contract Conductus is a subcontractor to Geometrics to develop the high temperature SQUID sensors and AETC, a San Diego-based company, is a subcontractor to develop specialized processing and analysis software. AETC also worked as a subcontractor to Geometric to process and analyze the magnetic data from JPG, as described on page 1.

The ONR contract and the DOE Conductus contract have similar objectives and should, therefore, allow the opportunity to use the combined effort to accelerate development of a commercial version of the unique portable controlled source EM system.

Geometrics is on the Internet

Geometrics has a Web Home Page. Our full address is http://www.geometrics.com. Right now we have on-line some basic information on the Company, plus some data sheets for our most popular products. Soon we should have applications notes, lists of available parts and accessories, hints for troubleshooting, repair and maintenance, trade show information, etc.; perhaps even some complete product manuals (like the new ones for the G-858 and the StrataView) and Sheldon Breiner's Applications Manual for Portable Seismographs. If you want more information, just push our button on the Home Page and we'll get back to you. If you would like to e-mail us directly, use the address rob@mail.geometrics.com for general sales and seismograph queries (for mag use ross@, for E-M use doug@, for rentals use ron@, for contracts use dick@, and for cheers or jeers please CC to steve@).

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Blackhawk Geosciences Merges with Geometrics

Geometrics, Inc. has acquired Blackhawk Geosciences, a former subsidiary of Coleman Research Corporation. Blackhawk, established in 1985, is a leader in geophysical contracting and consulting services, specializing in time-domain electromagnetics and multi-component seismics. Blackhawk conducts environmental and geotechnical investigations, locates and characterizes resources such as ground water, minerals and geothermal energy, and analyzes selected problems in oil and gas exploration.

In announcing the merger, Steve Duckett, president of Geometrics, and Pieter Hoekstra, president of Blackhawk, emphasized the complementary capabilities of the two companies. Both organizations are working on different aspects of state-of-the-art contracts — including a $3 million contract with the Office of Naval Research — and both participated in UXO detection projects such as JPG. Blackhawk expects to leverage Geometrics' international marketing organization and the new instruments like the G-858 MagMapper and the 24-bit StrataView seismographs; Geometrics, in its turn, will use Blackhawk's standards for fieldwork and analysis to improve the design of a new generation of geohysical instruments.

BLACKHAWK GEOMETRICS

After the merger, Geometrics, Inc. will be composed of two major divisions, Blackhawk Geometrics and Geometrics Instruments, plus a foreign investment corporation. Geometrics, Inc. is an employee-owned business established in 1969.

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The Legacy of Unexploded Ordnance

(from Spring/Summer **IDA Research Summaries**)

It is inevitable that in the use of ordnance, some does not explode as intended. This unexploded ordnance (UXO) remains as the legacy of past testing, training, and wartime activities. Millions of acres of government-owned or previously government-owned land in the United States and in foreign countries are contaminated with unexploded ordnance.

Unexploded ordnance is a worldwide humanitarian concern. For example, about 900 tons of bombs per year are recovered in France alone, 30 tons of which contain toxic chemical warfare agents. French deminers make 11,000 stops annually at citizens' homes to recover UXO; in 1991, 36 French farmers were killed by UXO encountered while tilling their soil. In addition to the deaths in France, 14,000 Polish citizens have been killed by UXO in the 36 years after World War II, 120 Angolans are killed per month from land mines, and there is one casualty per day in Khe Sanh where US forces alone delivered millions of tons of ordnance in the Battle of Khe Sanh.

While UXO contamination in foreign lands is largely the result of war, contamination in the US is the result of preparing for war. More than 11 million acres of US government land is suspected to be contaminated with UXO. Contamination may be found on active ranges, on bases slated for realignment and closure, at formerly used defense sites, and on other government lands.

Using current techniques, which are labor-intensive and hazardous, the estimated cost of clearing UXO from US lands is in the hundreds of billions of dollars. The Congress mandated funds for a UXO technology demonstration to be conducted at the Jefferson Proving Ground in Indiana. The objective was to identify and evaluate innovative and cost-effective systems for the detection, identification, and remediation of sites contaminated with unexploded ordnance. IDA conducted a series of detailed technical evaluations for this program. These efforts highlighted issues related to system performance, assessed the applicability of the results to other contaminated sites, determined the implications for past and future cleanup efforts, and evaluated the technical requirements of future research and development activities. Our general conclusion was that operationally, the demonstrated level of performance at Jefferson Proving Ground was not adequate to deal effectively with lands contaminated with UXO. The Department of Defense has responded by expanding efforts to address this problem and continues to turn to IDA for technical expertise.

Welcome

The Institute for Defense Analyses invites you to read about the research, staff and organization that support the Department of Defense, the Joint Staff, the unified commands and defense agencies in their study and analyses program. IDA-Studies & Analyses is a federally funded research and development center established by the Department of Defense 40 years ago to provide objective, external advice on many of today's important national security issues.

Enjoy your visit with us.

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Overview

IDA is a nonprofit corporation whose purpose is to promote national security and the public interest and whose primary mission is to assist the Office of the Secretary of Defense, the Joint Staff, the unified commands and defense agencies in addressing important national security issues, particularly those requiring scientific and technical expertise. To avoid institutional pressures in support of Service positions, IDA does not work directly for the Military Departments. To ensure freedom from commercial or other potential conflicts of interests, IDA does not work for private industry or foreign governments.

IDA research requires in-depth knowledge of defense systems, technologies, operations, strategies, and resources. Our work addresses issues of both long-term and immediate concern. IDA's research program includes multi-year efforts, and quick response analyses in areas of established expertise. The work often requires privileged access to information, including sensitive government information and industry proprietary data not normally available to non-government organizations.

History

IDA traces its roots to 1947, when Secretary of Defense Forrestal established the Weapons Systems Evaluation Group (WSEG) to provide technical analyses of weapons systems and programs. In the mid-1950s, the Secretary of Defense and the Chairman of the Joint Chiefs of Staff asked the Massachusetts Institute of Technology to form a civilian, nonprofit research institute. The Institute would operate under the auspices of a university consortium to attract highly qualified scientists to assist WSEG in addressing the nation's most challenging security problems.

Over the years, IDA has modified the structure of its Studies and Analyses FFRDC to remain responsive to sponsor needs. In 1958, at the request of the Secretary of Defense, IDA established a division to support the newly created Advanced Research Projects Agency. Shortly thereafter, the mandate of this division was broadened to include scientific and technical studies for all offices of the Director of Defense Research and Engineering. Subsequent divisions were established to provide cost analyses, computer software and engineering, strategy and force assessments, and operational test and evaluation. Most recently, a Simulation Center was created to focus on advanced distributed simulation.

Throughout its history, IDA also has assisted other federal agencies. Recent work includes research in civil space, expert systems for criminal investigation, and energy and environmental issues.

5.3 Field Sampling for Ordnance Explosives

United States
Environmental Protection
Agency

National Exposure
Research Laboratory
Las Vegas NV 89193-3478

Research and Development

EPA/540/S-97/501 Dec. 1996

EPA

Project Summary

Field Sampling and Selecting On-Site Analytical Methods for Explosives in Soil

Alan B. Crockett, Harry D. Craig, Thomas F. Jenkins, and Wayne E. Sisk

A large number of defense-related sites are contaminated with elevated levels of secondary explosives. Levels of contamination range from barely detectable to levels above 10% that need special handling because of the detonation potential. Characterization of explosives-contaminated sites is particularly difficult because of the very heterogeneous distribution of contamination in the environment and within samples. To improve site characterization, several options exist including collecting more samples, providing on-site analytical data to help direct the investigation, compositing samples, improving homogenization of samples, and extracting larger samples. On-site analytical methods are essential for more economical and improved characterization, and what they may lack in accuracy relative to laboratory methods, is more than offset by the increased number of samples that may be run. While verification using a standard analytical procedure should be part of any quality assurance program, reducing the number of samples analyzed by the more expensive methods may result in significantly reduced costs. Often 70 to 90% of the soil samples analyzed during an explosives site investigation do not contain detectable levels of contamination. Two basic types of on-site analytical methods are in wide use for explosives in soil: colorimetric and immunoassay. Colorimetric methods generally detect broad classes of compounds such as nitroaromatics or nitramines, while immunoassay methods are more compound specific. Because TNT or RDX is usually present in explosives-contaminated soils, the use of on-site methods designed to detect only these or similar compounds may be very effective. Selection of an on-site analytical method involves evaluation of many factors including the specific objectives of the study, compounds of interest and other explosives present at the site, the number of samples to be run, the sample analysis rate, interferences/cross-reactivity of the method, the skill required, analytical costs per sample, and the need for and availability of support facilities and services. Other factors to be considered are the precision and bias of the on-site analytical method, but it should be remembered that 1) the analytical error is generally small compared to field error and 2) the precision and bias of a method are dependent on the site (compounds present and relative concentration) and the specific objectives. Modifications to on-site methods may improve method performance including extracting a larger soil sample to improve the representativeness of the analytical sample, ensuring that the shaking/extraction phase of all methods lasts at least 3 minutes, and evaluating the rate of extraction for heavy soils by conducting a simple kinetic study. With appropriate use, on-site analytical methods are valuable tools for characterization of soils containing explosive residues and monitoring remediation operations.

It is imperative that any persons working on sites believed to be contaminated with explosive residues thoroughly familiarize themselves with the physical and toxic properties of the materials potentially present and to take all measures as may be prudent and/or prescribed by law to protect life, health, and property. This publication is not intended to include discussions of the safety issues associated with sites contaminated with explosive residues. Examples of safety issues to be considered include but are not limited to: explosion hazards, toxicity of secondary explosives, and/or personal protective equipment. Information pertaining to these concerns can be found in Roberts and Hartley (1992) and Yinon (1990). Specifically, this paper is not intended to serve as a guide for sampling and analysis of unexploded ordnance, bulk high explosives, or where secondary explosives concentrations in soil exceed 100,000 mg/kg (10%). **These conditions present a potential detonation hazard, and as such, safety procedures and safety precautions should be identified before initiating site characterization activities in these environments.** Finally, this paper does not address primary explosives or initiating compounds, such as lead azide, lead styphnate, or mercury fulminate, which are extremely unstable and present a substantial safety risk at any concentration.

Introduction

Historical disposal practices from manufacturing, spills, ordnance demilitarization, lagoon disposal of explosives-contaminated wastewater, and open burn/open detonation (OB/OD) of explosive sludges, waste explosives, excess propellants, and unexploded ordnance often result in soils contamination. Facilities that may be contaminated with explosives include, for example, active and former manufacturing plants, ordnance works, Army ammunition plants, Naval ordnance plants, Army depots, Naval ammunition depots, Army and Naval proving grounds, burning grounds, artillery impact ranges, explosive ordnance disposal sites, bombing ranges, firing ranges, and ordnance test and evaluation facilities. A number of these facilities have high levels of soil and groundwater contamination, although waste disposal was discontinued 20 to 50 years ago. Because of such extensive contamination, the Environmental Protection Agency's Federal Facilities Forum determined that remedial project managers need guidance about field sampling and on-site analytical methods for detecting and quantifying secondary explosive compounds (Table 1) in soils.

Under ambient environmental conditions, explosives are highly persistent in soils and groundwater, exhibiting a resistance to naturally occurring volatilization, biodegradation, and hydrolysis. Site investigations indicate that TNT is the least mobile of the explosives and most frequently occurring soil contamination problem. RDX and HMX are the most mobile explosives and present the largest groundwater contamination problem. TNB, DNTs, and tetryl are of intermediate mobility and frequently occur as co-contaminants in soil and groundwater.

The frequency of occurrence of specific explosives in soils was assessed by Walsh et al. (1993), who compiled data on soils collected from 44 Army ammunition plants, arsenals, and depots and two explosive ordnance disposal sites. Of the 1,155 samples, a total of 319 samples (28%) contained detectable levels of explosives. The frequency of occurrence and the maximum concentrations detected are shown in Table 2. TNT was detected in 66% of the samples and 80% of the samples if the two explosive ordnance disposal sites are excluded. Overall, either TNT or RDX or both were detected in 72% of the samples containing explosive residues, and 94% if the ordnance sites are excluded. Thus, by screening for TNT and RDX at these facilities, 94% of the contaminated areas could be identified (80% if only TNT was determined). This demonstrates the feasibility of screening for one or two compounds to identify the extent of contamination at munitions sites.

Table 1. Analytical Methods for Commonly Occurring Explosives, Propellants, and Impurities/Degradation Products.

Acronym	Compound Name	Field Method	Developer/ Test kit	Laboratory Method
Nitroaromatics		Cs	CRREL, EnSys RIS[S]	N
TNT	2,4,6-trinitrotoluene	Cp	CRREL, EnSys RIS[S]	N
		Cp	USACE	
		Ip	D TECH	
		Ip	Idetek Quantix	
		Ip	Ohmicron RaPID Assay	
		Ip	EnviroGard	
TNB	1,3,5-trinitrobenzene	Cs	CRREL, EnSys RIS[S]	N
		Is	Ohmicron RaPID Assay	
DNB	1,3-dinitrobenzene	Cs	CRREL, EnSys RIS[S]	N
2,4-DNT	2,4-dinitrotoluene	Cp, Cs	CRREL	N
2,6-DNT	2,6-dinitrotoluene	Cs, Is	CRREL, EnviroGard	N
Tetryl	Methyl-2,4,6-trinitro-phenylnitramine	Cs	CRREL	N
2AmDNT	2-amino-4,6-dinitrotoluene			N
4AmDNT	4-amino-2,6-dinitrotoluene	Is	EnviroGard	N
NT	Nitrotoluene (3 isomers)			N
NB	Nitrobenzene			N
Nitramines		Cs	CRREL, EnSys RIS[S]	N
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine	Cp	CRREL, EnSys RIS[S]	N
		Ip	D TECH	
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	Cs	CRREL, EnSys RIS[S]	N
NQ	Nitroguanidine	Cs	CRREL	G
Nitrate Esters		Cs	CRREL	
NC	Nitrocellulose	Cs	CRREL	*L
NG	Nitroglycerin	Cs	CRREL	*P
PETN	Pentaerythritol tetranitrate	Cs	CRREL	*P
Ammonium Picrate/Picric Acid			CRREL	
AP/PA	Ammonium 2,4,6-trinitrophenoxide/	Cp	CRREL	A
	2,4,6-trinitrophenol	Is	D TECH	

A = Ammonium Picrate/Picric Acid (Thorne and Jenkins 1995).
Cp = Colorimetric field method, primary target analyte(s).
Cs = Colorimetric field method, secondary target analyte(s).
G = Nitroguanidine (Walsh 1989).
Ip = Immunoassay field method, primary target analyte(s).
Is = Immunoassay field method, secondary target analyte(s).
L = Nitrocellulose (Walsh unpublished CRREL method).
N = EPA SW-846, Nitroaromatics and Nitramines by HPLC, Method 8330.
P = PETN and NG (Walsh unpublished CRREL method).
* The performance of a number of field methods have not been assessed utilizing "approved" laboratory methods.

Table 2. Occurrence of Analytes Detected in Soil Contaminated with Explosives.

Nitroaromatics	% Samples with Analyte Present	Maximum Level (μg/g)
TNT	66	102,000
TNB	34	1790
DNB	17	61
2,4-DNT	45	318
2,6-DNT	7	4.5
2-AmDNT	17	373
4-AmDNT	7	11
Tetryl	9	1260
Nitramines		
RDX	27	13,900
HMX	12	5700
TNT and/or RDX	72	

Derived from Walsh et al. (1993).

Overview of Sampling and Analysis for Explosives in Soil

The environmental characteristics of munitions compounds in soil indicate that they are extremely heterogenous in spatial distribution. Concentrations range from nondetectable levels (< 0.5 ppm) to percent levels (> 10,000 ppm) for samples collected within several feet of each other. In addition, the waste disposal practices at these sites, such as OB/OD, exacerbate the problem and may result in conditions ranging from no soil contamination up to solid "chunks" of bulk secondary explosives, such as TNT or RDX. Secondary explosives concentrations above 10% (> 100,000 ppm) in soil are of concern from a potential reactivity standpoint and may affect sampling and materials handling processes during remediation.

Reliance on laboratory analyses only for site investigations may result in a large percentage of the samples with nondetectable levels (up to 80%) at a high analytical cost ($250 to 350 per sample). Because of the extremely heterogeneous distribution of explosives in soils, on-site analytical methods are a valuable, cost-effective tool to assess the nature and extent of contamination. Because on-site method costs per sample are lower, more samples may be analyzed and the availability of near-real-time results permit redesign of the sampling scheme while in the field. The use of on-site methods also facilitates more effective use of off-site laboratories.

Data Quality Objectives

The Environmental Protection Agency (EPA) Data Quality Objectives process is designed to facilitate the planning of environmental data collection activities by specifying the intended use of the data (what decision is to be made), the decision criteria (action level), and the tolerable error rates. Integrated use of on-site and laboratory methods for explosives in soil facilitate achieving such objectives as determining the horizontal and vertical extent of contamination, obtaining data to conduct a risk assessment (EPA 1992), identifying candidate waste for treatability studies, identifying the volume of soil to be remediated, determining whether the soil presents a potential detonation hazard (reactive according to Resource Conservation and Recovery Act regulations), and determining whether remediation activities have met the cleanup criteria (typically 10 to 100 ppm).

Unique Sampling Design Considerations for Explosives

Heterogeneity Problems and Solutions - Jenkins et al. (1996) recently collected and analyzed seven soil cores within a radius of 2 ft from nine locations. Results showed extreme variation in concentration in five of the nine locations, and in all cases only a small fraction of the total error was because of analytical error; field sampling error dominated total error. To improve site characterization and reduce sampling error, the major effort should be to increase sampling densities and composite samples. There are several practical approaches to reducing overall error during characterization of soils contaminated with explosives, including increasing the number of samples or sampling density, collecting composite samples, using a stratified sampling design, and reducing within-sample heterogeneity.

One simple way to improve spatial resolution is by collecting more samples on a finer sampling grid such as a 5-m instead of a 10-m spacing. This approach has been rejected in the past because of the higher costs but when inexpensive on-site analytical methods are used, this approach becomes feasible.

Samples are always taken to apply inferences from the samples to a larger volume of material, and a set of composite samples provides a more precise estimate of the mean than a comparable number of discrete samples. This occurs because compositing is a "physical process of averaging." Decisions based on a set of composite samples provides greater statistical confidence than a comparable set of individual samples (Gagner and Crockett 1996). In Jenkins' study, composite samples were much more representative of each plot than the individual samples that made up the composites. Using a composite sampling, it is possible to reduce costs and the total number of samples collected while improving characterization.

Stratified sampling also may be effective in reducing field and subsampling errors. Using historical data and site knowledge or results from an exploratory study, it may be possible to identify areas in which contaminant concentrations are expected to be moderately heterogeneous (pond bottom) or extremely heterogeneous (open detonation sites). Different compositing and sampling strategies may be used to characterize different areas that may result in a more efficient characterization. Another means of stratification is based on particle size. Because explosive residues often exist in a wide range of particle sizes (crystals to chunks), it is possible to sieve samples into various size fractions, which may reduce heterogeneity.

Within-sample heterogeneity is frequently observed with on-site analyses when duplicate subsamples are analyzed and the results differ by an order of magnitude. To reduce within-sample heterogeneity and obtain a representative analytical sample, two methods may be employed: either homogenization and extraction or analysis of a larger sample. The smaller the volume of the subsample removed for extraction and analysis, the more homogeneous the entire sample should be before subsampling. This may require sample drying, grinding, and riffle splitting (Gagner and Crockett 1996).

While sample-mixing procedures such as sieving to disaggregate particles, mixing in plastic bags, etc., should be used to prepare a sample. Extracting a larger sample is perhaps the easiest method of improving representativeness. Jenkins recommends extraction of 20 g of soil, and the same approach may be used easily to improve the results with most on-site analytical methods.

Sample Holding Times and Preservation Procedures - Based on spiking clean soils with explosives in acetonitrile, Maskarinec et al. (1991) recommended the following holding times and conditions: TNT—immediate freezing and 233 days at -20°C; DNT—107 days at 4°C; RDX—107 days at 4°C; and HMX—52 days at 4°C. Grant et al. (1993, 1995) spiked soils with explosives dissolved in water to eliminate any acetonitrile effects and also used a field-contaminated soil. The results on spiked soils showed that RDX and HMX are stable for at least 8 weeks when refrigerated (2°C) or frozen (-15°C). Soils spiked with nitroaromatics should be frozen as soon as possible because some results showed significant TNT and TNB degradation within 2 hours. However, both compounds and 2,4-DNT may be adequately preserved for 8 weeks or longer by freezing. The results for field-contaminated soils did not show the rapid degradation of TNT, and TNB observed in the spiked soils and refrigeration appeared satisfactory. Presumably, the explosives still present in the field soil after many years of exposure are less biologically available than in the spiked soils. Explosives in air-dried soils

are stable at room temperature if kept in the dark. Acetonitrile extracts of soil samples are expected to be stable for at least 6 months under refrigeration. Acetone extracts are also thought to be stable if stored in the dark under refrigeration.

Explosion Hazards and Shipping Limitations - EPA regions and the U.S. Army Environmental Center consider soils containing more than 10% secondary explosives (i.e., TNT, RDX, HMX, DNT, TNB, and DNB) by weight to be susceptible to initiation and propagation (EPA 1993). If on-site analyses indicate that soil samples contain less than 10% total secondary explosives by weight, they may be shipped to off-site laboratories as environmental samples. Samples with more than 10% explosives must be shipped to a explosives-capable laboratory for analysis, and they must be packaged and shipped in accordance with applicable Department of Transportation and EPA regulations for reactive hazardous waste and Class A explosives (AEC 1994). For sampling at sites with unknown or greater than 10% by weight of secondary explosives contamination, special sampling procedures must be followed (AEC 1994).

Summary of On-site Analytical Methods For Explosives in Soil

Ideally, on-site methods provide high-quality data on a near-real-time basis at low cost and of sufficient quality to meet all intended uses including risk assessments and final site clearances without the need for more rigorous procedures. While the currently available on-site methods may not be ideal (not capable of providing compound specific concentrations of multiple compounds simultaneously), they have proven very valuable during the characterization and remediation of numerous sites. Currently available on-site analytical methods that have been evaluated against standard analytical methods and demonstrated in the field include colorimetric and immunoassay methods (Table 1). Each method has relative advantages and disadvantages; therefore, one method may not be optimal for all applications. To assist in the selection of one or more on-site methods for various users needs, Table 3 was developed comparing the available colorimetric and immunoassay on-site analytical methods for detecting explosives in soil. The selection criteria presented include method type, analytes determined, detection limit and range, sample preparation and extraction procedure, analytical production rate, interferences and cross-reactivities, recommended quality assurance/quality control, suggested storage conditions and shelf life, skill required, availability of training, cost per sample, and, among others, additional method selection considerations. The comparable table in the complete issue paper also includes references to comparisons with Method 8330 and other references.

Interferences/Cross-Reactivity - A major difference among the field methods is with interferences for colorimetric methods and cross-reactivity for immunoassay methods. The colorimetric methods for TNT and RDX are broadly class sensitive, that is, they respond to many other similar compounds (nitroaromatics and nitramines/nitrate esters, respectively). Immunoassay methods are relatively specific for the primary target analytes. The cross-reactive secondary target analytes for TNT are mainly other nitroaromatics, but this varies considerably among the four TNT immunoassay test kits. Depending upon the sampling objectives, broad sensitivity or specificity may be an advantage or a disadvantage. If the objective is to determine whether any explosive residues are present in soil, broad sensitivity is an advantage. For the Cold Regions Research and Engineering Laboratory (CRREL) and EnSys RIS^E colorimetric methods, the color development of the extracts may give the operator an indication of what types of compounds are present in soil. An advantage of some colorimetric methods is they may be used to detect compounds other than the primary target analyte. For example, the colorimetric RDX methods may be used to screen for HMX when RDX levels are relatively low, and for NQ, NC, NG, and PETN in the absence of RDX and HMX.

For colorimetric methods, interference is defined as the positive response of the method to secondary target analytes or co-contaminants similar to the primary target analyte. For TNT methods, the primary target analyte is TNT, and the secondary target analytes are other polynitroaromatics TNB, DNB, 2,4-DNT, 2,6-DNT, and tetryl. For RDX methods, the primary target analyte is RDX, and the secondary target analytes are nitramines (HMX and NQ), and nitrate esters (NC, NG, and PETN). If the primary target analyte is the only compound present in soil, the colorimetric methods measure the concentration of that compound. If multiple analytes are present in soil, field methods measure the primary target analyte plus the secondary target analytes, nitroaromatics for the TNT test kit, and nitramines plus nitrate esters for the RDX test kits. In addition, the response of colorimetric methods to the secondary target analytes is similar to that of the primary target analyte, and remain constant throughout the concentration range of the methods.

For immunoassay methods, cross-reactivity is defined as the positive response of a method to secondary target analytes or co-contaminants similar to the primary target analyte. For TNT methods, the primary target analyte is TNT, and the secondary target analytes are nitroaromatics TNB, DNTs, Am-DNTs, and tetryl. For RDX methods, the primary target analyte is RDX, and cross-reactivity is slight, 3% with HMX. If the primary target analyte is the only compound present in soil, the immunoassay methods measure the concentration of that compound. If multiple analytes are present in soil, the immunoassay methods measure the primary target analyte plus some percentage of the cross-reactive secondary target.

Both colorimetric and immunoassay methods may be subject to positive matrix interference from humic substances in soils. For colorimetric methods, this typically occurs below 10 ppm, and is indicated by yellow extracts. These interferences may be reduced by careful visual analysis prior to colorimetric analysis. Nitrate and nitrite, common plant nutrients in soil, are potential interferents with the CRREL and EnSys RIS^E colorimetric procedures for RDX. An extra processing step may be used to remove these interferents in soils that are rich in organic matter or that may have been fertilized recently.

Comparisons to Laboratory Method, SW-846 Method 8330 - Precision and bias of the on-site methods are most appropriately assessed by comparison to established laboratory methods such as EPA Method 8330. Methods of comparison that have been used include relative percent difference (RPD), linear regression, correlation, percent false positive and false negative results, and analysis of variance and paired t-tests. It also should be remembered that analytical accuracy is generally quite small compared to total error (field error is the major contributor).

Table 3. Comparative Data for Selecting On-Site Analytical Methods for Explosives in Soil[a].

Method/ Kit	Criteria						
	Method Type Analytes and EPA Method No.	Detection Range and Range Factor	Type of Results	Samples per Batch	Soil Sample Size	Sample Preparation & Extraction	Analysis Time - Production Rate (one person)
CRREL	Colorimetric TNT, RDX, 2,4-DNT, Ammonium Picrate /Picric Acid	TNT: 1 to 22 mg/kg (22 X) RDX: 1 to 20 mg/kg (20 X) 2,4-DNT: 2 to 20 mg/kg (10X) AP/PA: 1.3 to 69 mg/kg (53 X)	TNT, RDX: Quantitative 2,4-DNT: Semiquantitative AP/PA: Quantitative	TNT: Batch or single RDX: 6 to 7/batch or single 2,4-DNT & AP/PA: Single or batched	20 g	3 min shaking in 100 mL acetone; settling; filtration.	20 minute extract 6/samples; TNT: 5 minutes/sample; RDX: 30 minutes/6 RDX samples; 25 samples/day for TNT + RDX DNT: 30 minutes/6 samples AP/PA: 15 minutes/sample
EnSys RIS®	Colorimetric TNT: Method 8515 draft RDX: Method 8510 proposed	TNT: 1 to 30 mg/kg (30 X) RDX: 1 to 30 mg/kg (30 X)	Quantitative	Single	10 g	Dry < 10% moisture (optional); 3 min shaking in 50 mL acetone; 5 min settling; filtration.	TNT: 30 to 35 minutes/10 samples in lab; estimated 40 to 45 minutes in field. RDX: 60 minutes/6 samples. Optional drying time not included.
USACE	Colorimetric TNT	6 to 100 mg/kg (17 X)	Quantitative	Single or batched	6 g	1 min shaking in 35 mL methanol; settling; filtration as needed.	10 to 20 samples/day depending on soil characteristics
D TECH™	Immunoassay - ELISA TNT: Method 4050 draft RDX: Method 4051 draft	TNT: 0.5 to 5.0 mg/kg (10 X) RDX: 0.5 to 6.0 mg/kg (12 X)	Semiquantitative (concentration range)	4 (single or batch)	3 mL (~4.5 g)	3 min shaking in 6.5 mL acetone; settle 1 to 10 min.	30 minutes for 1 to 4 samples for TNT or RDX.
Idetek Quanix™	Immunoassay - ELISA Antigen-Antibody TNT	TNT: 0.25 to 100 mg/kg (400 X)	Quantitative	20 to 40 (batch only)	~4.2 g	3 min shaking in 21 mL acetone; settle several minutes.	2.5 to 3.5 hours for 20 to 40 samples. Idetek estimates - 2 hours for up to 40 TNT samples.
EnviroGard™	Immunoassay - ELISA TNT: Plate kit TNT: Soil (tube) kit	Plate kit: 1 to 100 mg/kg (100 X) Tube kit: 0.2 to 15 mg/kg (75 X)	Plate: Quantitative Tube: Semiquantitative (concentration range)	Plate: batch of 8 Tube: batch of 14	2 g	Air dry soil, 2 min shaking in 8 mL acetone; filter.	Plate: 90 minutes for 8 samples Tube: 30 minutes for 14 samples Drying time not included.
Ohmicron RaPID Assay®	Immunoassay - ELISA Magnetic particle/tube kit TNT: Method 4050 proposed	TNT: 0.07 to 5 mg/kg (71 X)	Quantitative	5 to 51 (batch only)	10 g	1 min shaking in 20 mL methanol; settle 5 min; filter	1 hour for 20 extractions; 45 minutes for analysis (51 samples)

[a]Expanded and modified from EPA 1995b

Table 3. Comparative Data for Selecting On-Site Analytical Methods for Explosives in Soil[a] (continued)

Method/ Kit	Criteria			
	Interferences and Cross-reactivities > 1% based on IC50 (see text)	Recommended QA/QC	Storage Conditions and Shelf Life of Kit or Reagents	Skill Level
CRREL	TNT = TNT + TNB + DNB + DNTs + tetryl; - detection limits (ppm); TNB 0.5, DNB < 0.5; 2,4-DNT 0.5; 2,6-DNT 2.1; tetryl 0.9 RDX = RDX + HMX + PETN + NQ + NC + NG - detection limits (ppm); HMX 2.4; PETN 1; NQ 10; NC 42, NG 9 Soil moisture > 10%, and humics interfere with TNT and RDX; nitrate and nitrite interfere with RDX. 2,4-DNT = 2,4-DNT + 2,6-DNT + TNT + TNB + tetryl; high copper, moisture and humics interfere. AP/PA = relatively free of humic and nitroaromatic interferences.	Blank and calibration standards analyzed daily before and after sample analyses. Blank and spiked soil run daily.	Store at room temperature.	Medium
EnSys RIS®	TNT = TNT + TNB + DNB + DNTs + tetryl; - detection limits (ppm); TNB 0.5; DNB < 0.5; 2,4-DNT 0.5; 2,6-DNT 2.1; tetryl 0.9 RDX = RDX + HMX + PETN + NQ + NC + NG - detection limits (ppm); HMX 2.4; PETN 1; NQ 10; NC 42; NG 9 Soil moisture > 10%, and humics interfere with TNT and RDX; nitrate and nitrite interfere with RDX.	Method and soil blanks and a control sample daily, one duplicate/20 samples. Some positive field results (1:10) should be confirmed.	Store at room temperature Shelf life: TNT = 2 to 24 months at 27°C RDX = 2 to 12 months at 27°C	TNT: Low RDX: Medium
USACE	TNB interferes by raising minimum detection limit.	Blank soil sample, and calibration standard prepared from clean site soil.	Store at room temperature	Medium
D TECH™	Cross reactivity: TNT: tetryl = 35%; TNB = 23%. 2AmDNT = 11%; 2,4-DNT = 4%; AP/PA unknown but ~100% at lower limit of detection RDX: HMX = 3%	Samples testing positive should be confirmed using standard methods.	Store at room temperature or refrigerate; do not freeze or exceed 37°C for prolonged period. Shelf life 9 months at room temperature	Low
Idetek Quantix™	Cross reactivity: TNB = 47%; tetryl = 6.5%; 2,4-DNT = 2%; 4AmDNT = 2%	Duplicate extractions 1 in 10 replicate 2 sample wells/extract	Refrigerate 2 to 8°C, do not freeze or exceed 37°C. Shelf life 9 to 12 months. Avoid direct light.	Medium-high, initial training recommended
EnviroGard™	Cross reactivity: Plate: 4-AmDNT = 41%; 2,6-DNT = 41%; TNB = 7%; 2,4-DNT = 2% Tube: 2,6-DNT = 20%; 4AmDNT = 17%; TNB = 3%; 2,4-DNT = 1%	Plate: Samples run in duplicate.	Store 4 to 8°C; do not freeze or exceed 37°C. Do not expose substrate to direct sunlight. Shelf life: Plate 3 to 14 months. Tube 3 to 6 months.	Plate: Medium-high Tube: Medium
Ohmicron RaPID Assay®	Cross reactivity: TNB = 65%; 2,4-Dinitroaniline = 6%; tetryl = 5%; 2,4-DNT = 4%; 2AmDNT = 3%; DNB = 2%	Duplicate standard curves; positive control sample supplied. Positive results requiring action may need confirmation by another method.	Refrigerate reagents 2 to 8°C. Do not freeze. Shelf life 3 to 12 months.	Medium-high, initial training recommended

[a] Expanded and modified from EPA 1993b

Table 3. Comparative Data for Selecting On-Site Analytical Methods for Explosives in Soil* (continued).

Method/ Kit	Criteria					
	Training Availability	Costs (not including labor)	Comparisons to Method 8330 References	Other References	Developer Information	Additional Considerations
CRREL	Free video for TNT and RDX, see text for address. None available for 2,4-DNT, AP/PA.	$15/sample plus $1,500 for Hach spectrometer.	Brouillard et al. 1993; EPA 1993, 1995a (Method 8515), 1995b; Jenkins 1990; Jenkins and Walsh 1992; Markos et al. 1995; Lang et al. 1990; Walsh and Jenkins 1991; Jenkins et al. 1996a; Jenkins and Walsh 1991, 1992; Thorne and Jenkins 1995a	Jenkins et al. 1995; Thorne and Jenkins 1995b	Dr. Thomas F. Jenkins CRREL 72 Lyme Road Hanover, NH 03755-1290 (603) 646-4285	Large work area (2 large desks); requires the most setup time, possible TNB interference, no electricity or refrigeration required; deionized water required; must assemble materials; glassware must be rinsed between analyses; larger volume of acetone waste, color indicative of compounds.
EnSys RIS®®	Training available. Applicable video on CRREL method available, address in text.	$21/sample for TNT, $25/sample for RDX plus $160/day or $430/wk for lab station. Lab station cost = $1,950	EPA 1995a (Method 8515); EPA 1995b; IT 1995; Jenkins et al. 1996a, 1996b; Markos et al. 1995; Myers et al. 1994.		Strategic Diagnostics, Inc. 375 Pheasant Run Newtown, PA 18940 (800) 544-8881	Large work area (desk size) power supply required to charge Hach spectrometer; possible TNB interference; color indication of other compounds; requires acetone and deionized water; cuvettes must be rinsed between analyses. Nitrate and nitrite interferences with RDX kit can be corrected using alumina-cartridges from EnSys.
USACB	None available.	$4/sample or $5/sample if filtered plus $1,500 for Hach spectrometer	IT 1995; Medary 1992		Dr. Richard Medary U.S. Army Corps of Eng. 601 E. 12th Street Kansas City, MO 64106 (816) 426-7882	Large work area (2 large desks); requires the most setup time; possible TNB interference; no electricity or refrigeration required; must assemble materials; glassware must be rinsed between analyses.
D TECH™	2 to 4 hours free on-site training.	$30/sample for TNT or RDX plus $300 for DTECHTOR (optional)	EPA 1995a (Methods 4050 and 4051); EPA 1995b; Haas and Simmons 1995; Markos et al. 1995; Myers et al. 1994; Tearney and Hudak 1994	Tearney et al. 1993. Calif. EPA 1996a and 1996b	Strategic Diagnostics, Inc. 375 Pheasant Run Newtown, PA 18940 (800) 544-8881	Small working area; few setup requirements; no electricity or refrigeration required; temperature dependent development time (effect can be reduced by changing DTECHTOR setting); significant amount of packing, relatively narrow range; no check on test; easy to transport or carry; kits can be customized. Out-of range reruns require use of another kit.
Idetek Quantix™	1 day free on-site training.	$21/sample for TNT plus $5,880 for lab station or $500/month rental.	EPA 1995b; Haas and Simmons 1995; Markos et al. 1995		Idetek, Inc. 1245 Reamwood Ave. Sunnyvale, CA 94089 (800) 433-8351	Large work area (desk); requires setup time, electricity, refrigeration and deionized water; requires careful washing of microwells; replicate run for each sample, average of the two is the result; less temperature dependent. Out of range reruns require use of another kit.
Enviro-Gard™	Free training available.	Plate: $17/sample plus $4129 for equip. & small supplies. Tube: $20/sample plus $2409 for equip. & small supplies.	Haas and Simmons 1995	Calif. EPA 1996c	Strategic Diagnostics, Inc. 375 Pheasant Run Newtown, PA 18940 (800) 544-8881	Large work area (desk size); requires setup time, refrigeration and power; acetone not supplied. Out-of-range reruns require use of another kit.
Ohmicron RaPID Assay®	4 hours free on-site training.	$13 to $20/sample plus $5,500 for equip. (purchase) or $800 for first month, $400 each additional month (rental).	EPA 1995b; Haas and Simmons 1995; Markos et al. 1995; Rubio et al. 1996	Calif. EPA 1996d	Strategic Diagnostics, Inc. 375 Pheasant Run Newtown, PA 18940 (800) 544-8881	Large work area (desk); requires setup time, electricity and refrigeration; less temperature dependent; low detection limit; all reagents supplied; reagents and kit need refrigeration. Out-of-range reruns require use of another kit.

*Expanded and modified from EPA 1995b

Three studies have evaluated multiple methods under slightly different field conditions. Readers should consult the original studies for more details; however, some summary conclusions from the three cited studies follow. An EPA study (EPA 1995) compared the CRREL, EnSys RIS^{c} (colorimetric), D TECH, Idetek Quantix, and Ohmicron RaPID Assay methods for TNT. The study concluded that overall "no single method significantly out-performed other methods" and accuracies for all the on-site methods were comparable. However, CRREL, EnSys RIS^{c}, and Ohmicron RaPID Assay were more accurate in the greater-than-30-mg/Kg TNT ranges, and D TECH was more accurate in the less-than-30-mg/Kg range. The same study compared CRREL, EnSys RIS^{c}, and D TECH methods for RDX in soil and concluded that they were slightly less accurate than the corresponding TNT methods.

Haas and Simmons (1995) evaluated immunoassay kits for TNT (D TECH, EnviroGard Tube and Plate, Idetek Quantix, and Ohmicron RaPID Assay). They concluded that for semiquantitative screening, all kits have the potential to accurately screen soil samples for contamination at risk-based levels. For quantitative analyses, several of the assays had "significant positive bias" compared with high performance liquid chromatography (HPLC) results below 1 ppm; measurements near the detection limit "are often problematic"; and above 1 ppm, the correlation between the immunoassay kits and HPLC was "generally good."

Myers et al. (1994) evaluated and compared the EnSys RIS^{c} and D TECH methods for TNT in soil versus EPA Method 8330. "EnSys demonstrated a good one-to-one linear correlation with RP [reverse phase]-HPLC that may be attributed to the procedure for extraction, i.e., a large sample size of dried homogenized soil." For the D TECH kit, comparison was more difficult because of the concentration range type data (as opposed to single value) and because "one-to-one linear correlation with RP-HPLC was poorer." The study concluded that the EnSys RIS^{c} kit was well suited for analyses requiring good quantitative agreement with the standard laboratory method and that the D TECH kit was "better suited for quick, on-site screening in situations in which all samples above a certain range will be sent forward to a laboratory for confirmation by the standard method."

Emerging Methods and Other Literature Reviewed - Other on-site procedures are being used but limited information is available on them. Emerging procedures include an antibody-based continuous-flow immunosensor for TNT and RDX and a fiber optic biosensor for TNT that are being evaluated by the Navy for use in soil. the U.S. Army is developing a cone penetrometer for *in situ* detection of explosives, ion mobility spectrometry is being evaluated by several organizations, a modified Method 8330 has been used in a mobile trailer, thermal desorption followed by gas chromatography/mass spectrometry analysis has been reported, and work is under way within CRREL to investigate the use of a simple thin-layer chromatographic method for use as a confirmation test following colorimetric-based procedures.

Summary

The heterogeneity of explosives in soils poses significant problems for site characterization. Several options exist including collecting more samples, providing on-site analytical data to help direct the investigation, compositing samples, improving homogenization of samples, and extracting larger samples. On-site analytical methods are essential for more economical and improved characterization. What the on-site methods lack in terms of precision and accuracy in simultaneously identifying specific multiple compounds, they more than make up for in the increased number of samples that can be run.

Modifications to on-site methods may be able to improve method performance. In most cases, a larger soil sample may be extracted to improve the representativeness of the analytical sample. Also, with heavy soils or soils with high organic matter content, it may be useful to conduct a short-term kinetic study to determine whether a 3-minute extraction period is adequate. It is recommended that the shaking/extraction phase of all methods last at least 3 minutes. In all cases, it is recommended that a portion of the on-site analytical results is confirmed using a standard laboratory method.

Notice

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SECTION 6.0 CHARACTERIZATION AND REMEDIATION COSTS COMPARISON

Ordnance • Explosives environment

News From the Mandatory Center of Expertise and Design Center

These pages contain selected articles from *Ordnance and Explosives Environment,* the newsletter which provides information about Department of Defense ordnance response actions, issues, policy, and technology. The newsletter is published quarterly by the Ordnance and Explosives Center of Expertise (CX) and Design Center, U. S. Army Engineering and Support Center, Huntsville.

Newsletter editor is Ms. Betty Neff, telephone 205-895-~~1691~~ 1778, e-mail address: neffe@smtp.hnd.usace.army.mil.

Volume 3, No. 1, April-June 1996

- Getting Our Money's Worth: Removal Actions
- Blast Containment Structure Passes Proof Test
- DOD Seeks Public's Input on Range Rule

Volume 3, No. 2, July-September 1996

- DOIT Advises Government on Munitions Issues
- Ruling Forces: Munitions Rule Versus Range Rule
- Navy Tech Division Expands UXO Risk Assessment Model
- OECert Gets a Handle on Risk of Public Exposure fo UXO
- UXO Risk Assessment Methodology Developed for Fort Meade Base Realignment and Closure Parcel
- UXO Forum "96: Ordnance Issues Elevated, New Technologies Emphasized

Volume 3, No. 3, October-December 1996

- Ordnance Decentralization Begins
- Archives Search Report: A Safe Bet for BRAC
- DOIT Committee Makes Final Recommendations
- Response Tackles Hazards of Chemical Ordnance

Volume 4, No. 1, January-March 1997

- Corps Selects Regional Ordnance and Explosives Design and Execution Districts
- Draft Guidance Promotes Safe Geotechnical Surveys and Site Visits
- OE Knowledge Base: Creating Software That Learns
- Dredging Contaminated Sediments at an Active Impact Range: An Ordnance Avoidance Success
- Corps Awards Removal Contracts
- Partnering for Success at Salton Sea Test Base

Getting Our Money's Worth: Removal Actions

by

Betty Neff, Huntsville Center Engineering Directorate

Probably the hardest thing to accept about the Defense Environmental Restoration Program (DERP) is that it is impossible to find and remove *all* of our Nations ordnance. Technology, funding, and regulations set limits on what can be done.

Nonetheless, the Army Corps of Engineers has scoured thousands of acres of land and carted off thousands of tons of ordnance and ordnance scrap since the first removal actions in 1988. DERP may not be able to remove everything; yet, through removal actions, the program is not only salvaging land, it is protecting the public and raising awareness.

Of the more than 1,900 formerly used defense sites (FUDS) with potential ordnance contamination, about 500 will require removal actions, which is where most DERP dollars go. Based on the data from nine projects, the cost per acre for a removal action ranged from $94 to $36,642, depending on the type of work required. The average cost per acre for all nine was $4,006. "In FY96, we could spend as much as $12.5 million on FUDS removal actions alone,"says Bob Britton, a Huntsville Center program manager. "And those funds don't include work for base closures, installation restorations, or others."

Regardless of site or program or cost, the goal of a removal action is to reduce the risk to the public - a goal that may be sought in more than one way.

"First, it's important to understand the nature of removal actions," says Rob Wilcox of Huntsville's Ordnance and Explosives (OE) Team. "Because removal actions encompass various responses, they should not necessarily be equated with clearance. Only one type of removal action alternative actually removes something," Wilcox explains. "When you erect a fence or post a sign, for instance, you actually leave something."

Huntsville OE team member Bob Nore adds, "Typically, we either remove the ordnance or deter access to the area. But education programs, too, can be an important part of a removal action."

Ordnance is often removed from sites with public access and a history of ordnance. For example, visitors repeatedly found ordnance at a city park located on old Camp Grant land. During the resulting time-critical removal action, ordnance workers found and removed 140 mortar rounds from the ground's surface.

Another site, Tierrasanta, located on a former Marine base in California, became a candidate for ordnance removal primarily because of a history of ordnance in a heavily populated suburb. Now ready for closeout, Tierrasanta yielded nearly 5,000 ordnance items over a three-year clearance effort.

Sometimes barriers are used, although "fencing is usually considered a temporary means," says Nore. Fences may be used to deter access during a removal project or until one begins. For example, the Corps erected a chain link fence around a ten-acre area of the former Raritan Arsenal in New Jersey to protect the public during a lengthy removal. "One of the problems with fencing,"says Charles Heaton of Huntsville, "is that you usually have to own the property to restrict access." Fences, therefore, are better suited to public lands. For instance, FUDS land forming the easement along a California state highway near Tierrasanta has been fenced off to limit access. Similarly, a fence encloses Fort Ord land that has been converted to a wildlife refuge. Also, fences have been erected at former Fort Segarra, which is Department of the Interior land.

Besides clearance and barriers, institutional controls, such as public education and warning signs, also fall under removal actions. In the Fort Ord area, education campaigns focus on groups that might try to gain access to the wildlife refuge, such as local college students. At Tierrasanta, where two boys were killed in 1983 by a projectile, the education program targets children through a video showing them what to do if they find

ordnance. Warning signs have also been posted throughout Tierrasanta's neighborhoods.

Clearance, barriers, institutional controls - all are removal actions, all have advantages, all have drawbacks and deficiencies. Together, however, the various removal action methods are helping to reclaim land use and protect the public.

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Developing a Center of Expertise

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Introduction. In April 1990 Huntsville was designated by Headquarters, U.S. Army Corps of Engineers (USACE) as the Mandatory Center of Expertise (MCX) and Design Center for all USACE activities involving ordnance and explosives (OE). This assignment resulted from our experience on several precedent setting ordnance projects. We had recently completed a surface clearance of a demolition area at Hawthorne Army Ammunition Plant in Nevada, coordinated the cleanup of a beach at Martha's Vineyard in Massachusetts using Army and Navy Explosive Ordnance Disposal (EOD) units, conducted a site investigation of an OE site on Kodiak Island in Alaska, and completed surface and subsurface OE clearance at Tidewater Community College in Virginia. We had also completed a Feasibility Study at the Tierrasanta community in San Diego, California, and had just awarded a contract for the surface and subsurface clearance of 1900 acres there. These removal actions attracted high-level attention and demonstrated Huntsville's unique qualifications and expertise in the OE arena.

MCX Responsibilities. The designation as an MCX included the responsibility of developing an overall framework for response for the OE program, along with many other policies and procedures that just did not exist at the time. There was almost no written guidance on how to properly execute OE projects, on how to assess risk, on personnel qualifications needed to ensure safe and efficient execution, on how to contract for the work, or on environmental regulations as they apply to OE work.

Training was needed to ensure that Huntsville personnel were informed on the emerging policies, procedures and guidelines. Personnel from other USACE districts, divisions, and headquarters needed similar training in order to better understand the OE program, to safely avoid OE problems as they went about their hazardous waste and construction projects, and to know where to go for help if OE was encountered.

Roles and responsibilities of various agencies connected with OE activities were in some instances not defined, causing confusion and exasperation among the parties. Agreements were needed with agencies such as Army EOD, Army Environmental Center, and the Program Manager for Non-Stockpile Chemical Materiel.

Design Center Responsibilities. The designation as Design Center included responsibility for all Corps of Engineers OE investigations and removal actions at Formerly Used Defense Sites (FUDS), active sites under the Installation Restoration Program, and Base Realignment and Closure (BRAC) sites. These programs were at first expected to be very limited in scope, as the FUDS inventory at that time had only a few hundred potential OE sites. There are now over 1800 potential OE sites on the FUDS inventory. The total OE budget grew from the original $2 million for five projects in FY 1990 to $60 million for over 50 projects by FY 1996. Manpower for the MCX and Design Center grew from two man-years in FY 1990 to 100 man-years by FY 1996.

Early Development. The original Huntsville Division organization for the OE program was basically a three-person project management group with matrixed support from occupational safety and health, engineering

and contracting disciplines. One project manager (PM) addressed MCX issues and the other two PMs managed Design Center projects. Still there was no formal OE organization and no clear distinction between the MCX and Design Center.

The original organization relied on active EOD units for ordnance expertise and support. The rapid growth of OE projects outstripped the ability of these units to provide EOD support. Therefore, we at Huntsville began recruiting former EOD personnel to develop our own capability. From only one former EOD person in FY 1990, we expanded to the current count of 20 former EOD personnel. These personnel were instrumental in defining safe procedures for working with OE and establishing minimum qualifications for a new class of contractor personnel, the unexploded ordnance (UXO) specialist.

One of the main concerns with the UXO specialist was how to most efficiently use this resource for quality oversight on active projects. Our policy required that Huntsville UXO safety specialists be present on any site whenever UXO contractors were performing ordnance operations. Although we would have preferred to assign one individual to a site full time, we wanted to ensure that these individuals rotated into the office both to help with the paper workload and to spend time with their families. We settled on an in-house rotation policy of two weeks in the field and one week at the office. Scheduling of field time was a major effort. Although we tried very hard to maintain the two week/one week ratio, often the UXO personnel were required to stay in the field for four and even six weeks without relief. Much to the credit of the profession, the typical UXO specialist bore this inconvenience without complaint.

As Design Center responsibilities expanded exponentially, the ability to fulfill MCX responsibilities diminished. Personnel were not available to address MCX issues because they were always committed to executing projects already underway. The MCX and Design Center were generally still viewed as one unit with one function: to execute projects. Therefore, early MCX procedures and policies were usually developed only after issues became too serious to ignore, and were limited to bare necessities. Early coordination with other agencies such as EOD units and the U.S. Army Technical Escort Unit was inconsistent, and led to confusion between USACE and the EOD command structure. Training was limited to safety issues such as ordnance recognition. New technology was used on actual projects if it showed promise, but resources weren't available to validate new systems before fielding them.

Reorganization. After several attempts at reorganization, we finally found a satisfactory organizational structure, identifying dedicated MCX personnel and separating them from Design Center personnel. At that point the new MCX was able to focus on satisfying the documentation, training, technology and coordination needs of the ordnance program.

Under the new organizational structure we began to make great strides in planning our approach to formalization of the OE Program. We were able to finalize the family of documents supporting our Management Plan. This family of documents consisted of systems safety, quality management, training, and innovative technology program plans. Numerous interim policies and procedures documents were also completed to standardize processes and products. These documents defined our response process, anomaly review boards, restoration advisory boards, administrative records, public involvement, and many other processes affecting OE work. In the Spring of 1995 we began the conversion of this interim guidance into more formal policies and procedures for

approval at Headquarters level. Interim guidance is now being converted to Engineering Regulations, Engineering Pamphlets, and Engineering Technical Letters. Appendix A lists the formal documentation developed by Huntsville for HQUSACE review, most of them in the first six months after reorganization.

A concentrated training program was devised to get the word out to the entire Corps of Engineers, which often didn't seem to know that Huntsville existed or that we had an ordnance mission. Over a two-year period, more than a dozen workshops were conducted to educate USACE personnel on the goals of the OE program, policies and procedures, how an OE project is executed, OE recognition and safety, community relations, how to get assistance from Huntsville and EOD when ordnance is discovered, and many other topics. This effort has been instrumental in convincing the various USACE districts that they benefit from coordination with Huntsville. This spring we presented the first of many workshops focused on recovered chemical warfare materiel.

Besides the workshops, OE overviews are provided for several of the Corps of Engineers PROSPECT training courses. Our current priority for training focuses on development of a refresher training school for UXO specialists, both government and contractor. Our goal is to establish certification procedures that ensure a reliable, safety-conscious work force.

Our reorganization also established a distinct MCX working group responsible for innovative technology. The goal of this group is to apply and integrate existing technology across all phases of the OE program. Among the more noteworthy products of the technology program are: computer software (OECert) for risk-based management and decision making; software (GridStats and SiteStats) to enable statistical sampling for OE; blast-effects modeling for design of barriers and containers for blast and fragmentation suppression and containment; integration of Geographic Information System (GIS) and a UXO Discrimination Knowledgebase for site characterization and removal management; and an Internet Homepage for sharing MCX and Design Center products and information. These initiatives and others contribute greatly to reaching our goals of maximizing efficiency, reducing costs and maintaining our high degree of safety.

Our quality management program provides for three levels of quality assurance. The lowest, or individual project level, has been in place since the beginning. It requires contractors to establish a quality control plan which they must follow and which we monitor with our quality assurance measures. The middle level, which is not yet fully in place, requires government personnel to develop programmatic quality assurance plans to ensure that we are prepared to monitor the quality of all products and processes of the ordnance program. The highest level is ISO 9000, which we are just now beginning to implement.

Another of our initiatives has been to market the expertise and capabilities of the MCX and Design Center. Personnel are being encouraged to prepare and present papers at conferences related to the ordnance program. We have representation on various steering committees and associations that have a stake in this now highly-visible program. Partnerships were developed with USADACS, PMCD, FORSCOM EOD, and USAEC that helped to raise issues to higher levels for resolution, and also to clearly define respective roles in the OE program. A storyboard was developed to document and explain to decision makers the various issues affecting successful execution of an OE program. Wherever possible, we injected our organization into the rule-making process in order that the decision-makers have the best possible perspective of the effect their policies have on the actual field work.

Contracting methods have evolved rather quickly over the few years we've been in existence. From the original firm fixed-price (FFP) construction contract for ordnance removal we learned a lot, mainly that FFP contracts are not well suited to projects where you can't predict with any degree of certainty the amount of work that is involved. Our next iteration in ordnance removal contracts was to establish two Indefinite Delivery Order Time and Materiel (T&M) contracts of $5 million capacity each. Program growth quickly outstripped contract capacity, and the next year we began soliciting for several IDO Time & Materiel contracts in the $29 million range. We found T&M to be an ideal format for ordnance removals although they require intensive monitoring. We also found that a lot of companies are not adept at tracking real-time expenditures in order to prevent overspending. Not only was there a learning curve for government personnel for this type of contract, but we also had to guide many contractors through the unfamiliar territory of T&M contracts. Our current thrust is to award a $100 million small business set-aside, indefinite delivery contract to handle ordnance removal services for the entire United States. This contract will allow us to task work out under fixed price, time and materials, or cost plus fixed fee task orders.

For ordnance investigations we found the conventional Architect-Engineer (A-E) fixed-price service contracts to be clumsy for our work, because again we could seldom estimate the effort it would take to characterize an ordnance site. We switched to cost plus fixed-fee A-E contracts which required the A-E firms with design/investigation experience to team with ordnance firms to ensure safe investigations. The current A-E contracts are $30 million to $50 million capacity and divide the country into three regions. Our contract evaluation process considers past performance and allows for oral interviews and presentations.

Lessons Learned. The many successes of the CX have resulted from a combination of foresight, lessons learned and sometimes sheer determination. Foresight led to development of management plans to ensure safe operations, quality products and services, a trained workforce, and application of the best available technology. A few of the more notable lessons learned are as follows:

a. Early projects concentrated on getting an OE removal action started as soon as possible, with the intent of clearing the property completely. The unknown extent of OE anomalies almost always drove costs far beyond government estimates and left us scrambling for funds and greater contract capacity. We learned that it is usually more prudent to study the site, analyze various approaches to cleanup, and then select the best alternative. A major premise of this lesson is that there is not enough money to completely eliminate the ordnance risk, but rather we must learn to manage risk.

b. Some DOD installations and USACE districts are very resistant to the idea of holding public meetings when ordnance projects are planned. We have learned that the earlier we inform the public about our actions, the better we fare. The headlines are usually more damaging when the public finds out that the installation or USACE district withheld information. For that reason we are strong supporters of the concepts of public meetings and media days for each of our projects. In addition, we support involvement of all the stakeholders in our decision-making process by setting up restoration advisory boards for large or controversial projects.

c. Architect-Engineer firms lost the option of conducting archives searches because they appeared unable to recommend no further action where it was merited. They always recommended further investigation and gave the appearance of lobbying for more work. We gave the work to St. Louis and Rock Island Districts in order to get more objective recommendations.

d. Finding a balanced application for both A-E firms and OE specialty firms was difficult at first. Architect-Engineer firms proved appropriate for engineering studies of ordnance sites mainly because of their skills in writing environmental reports, but proved weak in ability to effectively manage OE removal actions. OE specialty firms are now required to be prime contractors for removal actions. A-E firms are prime contractors for investigations, and are often teamed with OE subcontractors who execute the fieldwork.

e. We have to educate others as to our policies and procedures and be constantly vigilant in enforcing those policies and procedures. For example, various USACE geographic districts which are familiar with hazardous waste processes have a hard time understanding our insistence on no permits for on-site treatment of OE. Also, project managers are tempted to label an action as time-critical simply because a property owner is yelling at his congressman, forgetting that time-critical is intended for sites where there is immediate danger of injury.

Conclusion. The CX is still in evolution. Huntsville is moving towards a self-directed team environment, and this initiative can detract at times from the OE mission. We are discussing decentralization with Headquarters, whether or not the program is large enough to establish other design centers or execution districts within the Corps of Engineers. Such a decision will require us to refocus our efforts towards getting policies formalized, evaluating USACE district capabilities, and training the districts.

Whatever the difficulties we have faced in the past, personal commitment to the program has resulted in success. Most of the OE personnel weather the storms because they believe in the OE program, that they are performing a worthwhile service for their country.

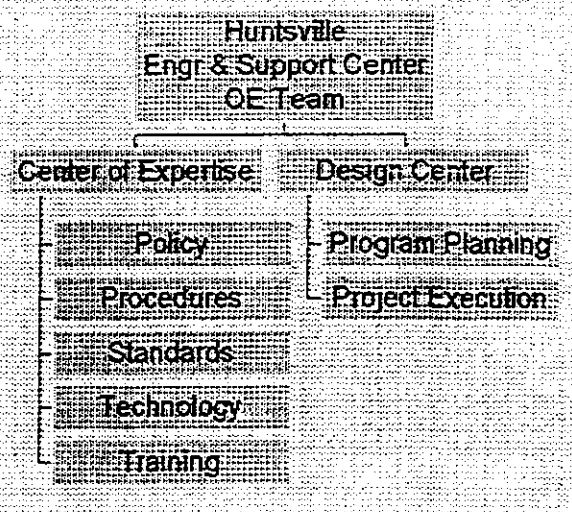
Our challenge as the Center of Expertise for OE is to ensure a dynamic, effective OE program through technology, training, and quality oversight in a global teaming environment.

Appendix A
Guidance Documents
Development Plan

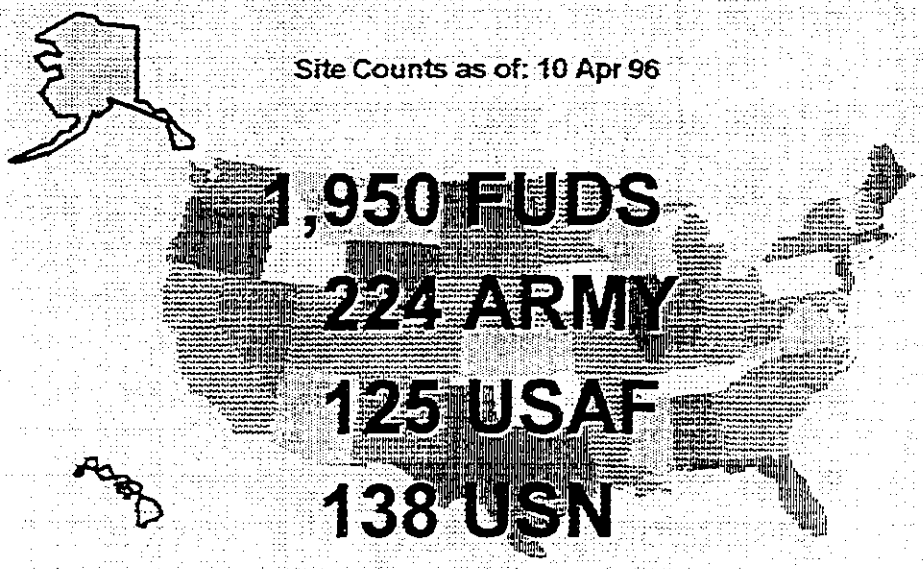
DOCUMENT	TYPE	DATE TO HQ
Ordnance Response	ER 1110-1-8153	30 Apr 96 Draft
Ordnance Response	EP 1110-1-18	30 Apr 96 Draft
CWM Safety Submission	EP 385-1-59	24 Jul 95
Emergency Response SSHP	EP 385-1-60	FY 96
Conv. Ordnance SSHP	EP 385-1-61	FY 96
Field Operations Handbook	EP 385-1-62	24 Jul 95
Safety Concepts	ETL 385-1-1	27 Mar 95
Ordnance Avoidance SOW	ETL 385-1-2	30 Mar 95
Ordnance Removal SOW	ETL 385-1-3	16 Jun 95
Ord Investigation SOW	ETL 385-1-4	FY 96
Preliminary Assessments	ETL 1110-1-165	7 Apr 95
Archives Searches	ETL 1110-1-166	1 Jun 95
Generic Ordnance IPMP	ETL 1110-1-167	FY 96
Administrative Record	ETL 1110-1-168	18 Sep 95
Restoration Adv. Board	ETL 1110-1-169	25 Sep 95
Public Involvement Plan	ETL 1110-1-170	5 Sep 95

OE CX

CX and Design Center Functions



Potential OE Sites



Site Counts as of: 10 Apr 96

1,950 FUDS

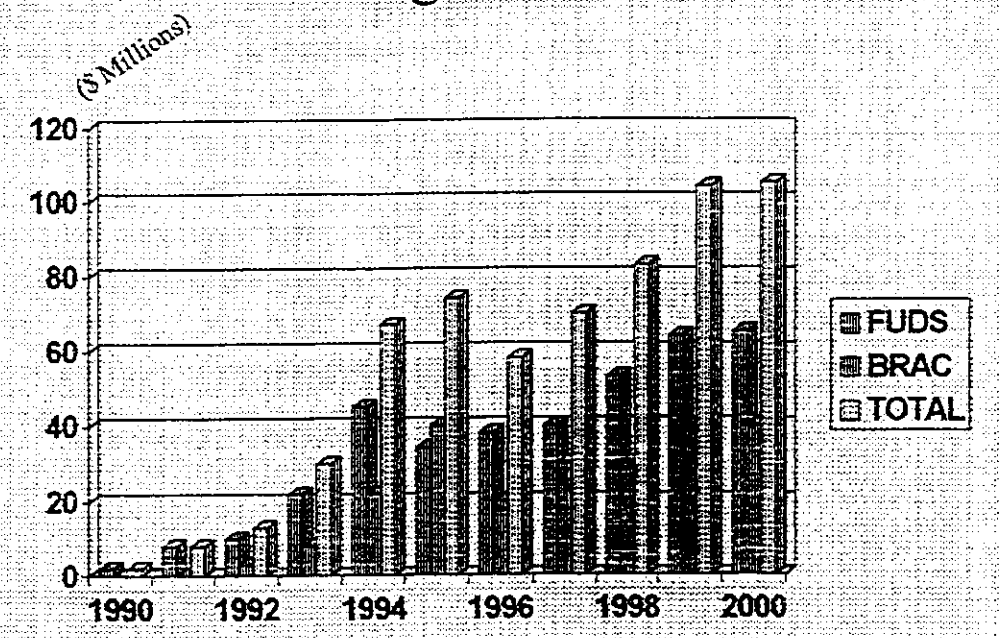
224 ARMY

125 USAF

138 USN

(224 est. CWM)

OE Program Growth



Guidance Development

- Management Plan
  - Responsibility Matrix
- Systems Safety Program Plan
- Quality Management Plan
- Training Plan
- Innovative Technology Implementation Plan
- Coordination with EOD

Guidance Development

- Environmental Compliance
- Permit Policy
- Removal Response Planning
- SOP for Site Safety & Health Plans
- Work Standards for UXO Personnel
- Landowner Notification
- Safety Submissions
- Policy on Preparation of Scopes Of Work
- SOP for OE Contracts

Guidance Documents Development Plan

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Restoration Adv. Board	ETL 1110-1-169	25 Sep 95
Public Involvement Plan	ETL 1110-1-170	5 Sep 95

Administrative Initiatives

- Newsletter
- Annual Report
- Brochures/Fact Sheets
- OE Training
  - Workshops
    - » FY 95 - Mar, Jun & Jul (CWM)
    - » FY 96 - Dec, Jan (CWM), & May
    - » As Requested
  - PROSPECT Training Courses

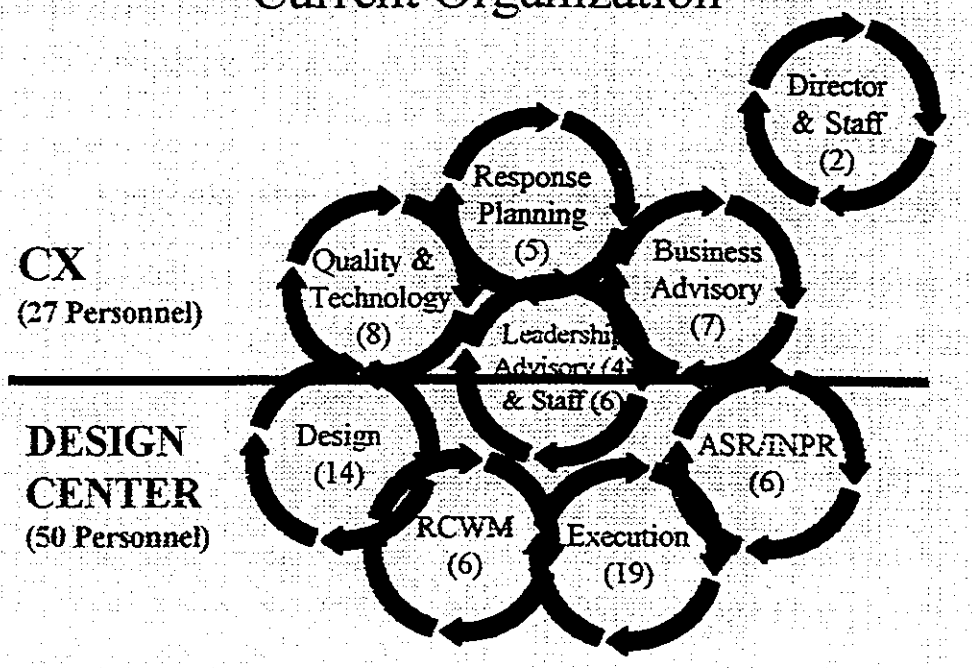
Technology Innovative Applications

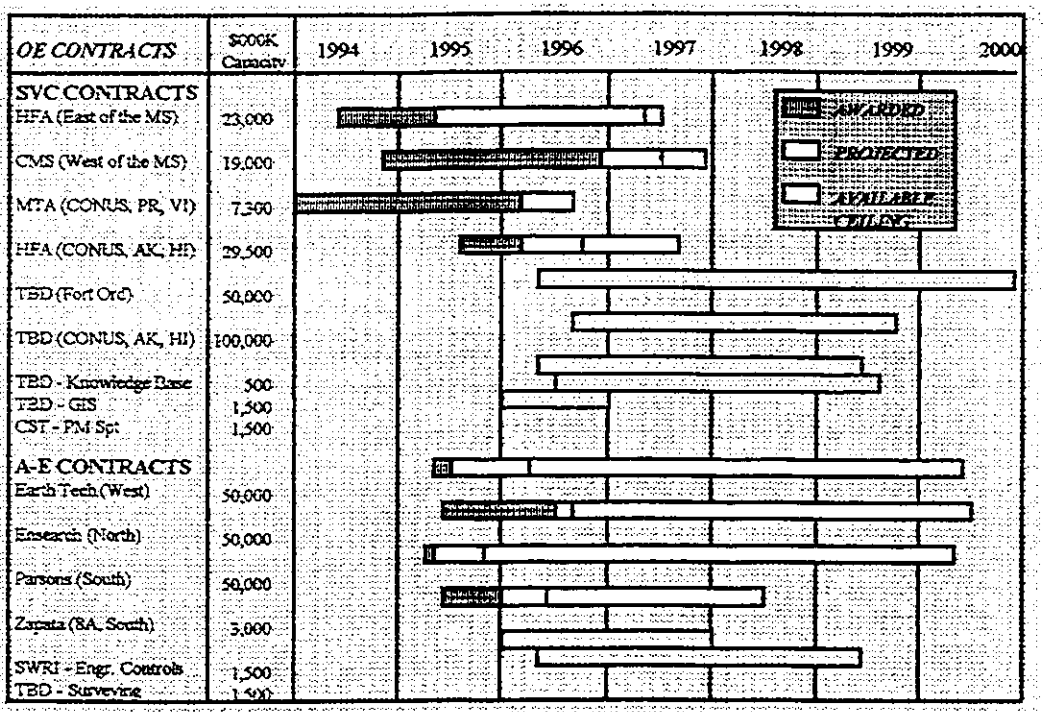
- Internet Homepage - Project and Guidance Documents
- Risk-Based Management Tools (OECert)
- Statistical Sampling Tools (GridStats and SiteStats) for cost effective characterization
- Analytical Geographic Info. System (GIS) & UXO Discrimination Knowledgebase
- Blast Effects Modeling for Barrier and Container Design

Policy Initiatives

- DA Explosives Safety Policy on Real Property containing OE
- DOD Instructions on Framework for OE response
- EPA Munitions Rule
- DA Range Rule
- Panels:
  - Western Governers Assn.
  - OE Task Force
  - CWM Technical Steering Committee for EIS

OE Team Current Organization





Lessons Learned

- We can't **eliminate** risk, so we must learn to **manage** risk.
- Involve the stakeholders early in the process.
- Give us objective recommendations, or we won't hire you anymore.
- A-E Firms for studies, UXO firms for clearances.
- Educate others about the OE program.

ORDNANCE AND EXPLOSIVES COST-EFFECTIVENESS RISK TOOL (OECert)

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ABSTRACT

A mathematical/engineering risk model has been developed by the U.S. Army Corps of Engineers and QuantiTech, Inc. for use in the defining of Ordnance and Explosives (OE) risk at Formerly Used Defense Sites (FUDS). The model uses several factors at a site (density of ordnance, type of ordnance, terrain features, population density, and many others) to determine the risk to public safety at the site. The model uses many of these same factors, as well as other factors to develop rough order of magnitude life cycle costs for the site. The model will allow the Government to develop a prioritized work list for the FUD sites, as well as to perform prioritized work between different sub-sites of a site. The model will also assist the decision maker in performing cost/benefit tradeoffs. The prioritization list will be used to ensure that the work that will reduce public risk the most for each dollar spent will be performed first. The model can also be used to determine the inherent risk at a site and can be used to determine when a site has been remediated to some previously specified level.

1.0 INTRODUCTION

The cost-effective remediation of sites which have been contaminated by Ordnance and Explosives is an elusive goal. The U.S. Army Engineering and Support Center, Huntsville, in its role as OE Mandatory Center of Expertise and Design Center, has taken on the difficult task of formulating a quantitative risk tool to calculate the amount of risk reduction that can be achieved per dollar spent on OE site remediation. This tool, developed by QuantiTech, Inc. is the OE Cost Effectiveness Risk Tool (OECert). The model facilitates cost planning and aids in the formulation of remediation standards for all OE contaminated sites. The following sections provide a general overview of each of the modules, addressing background, methodology, data requirements, and model output products.

The OECert methodology is built around the exposure of the public to risk and the life cycle cost of the contaminated site through the phases of pre-remediation, remediation and post-remediation. Site assessment must precede any meaningful assessment of cost-effectiveness. The factors which drive cost-effectiveness are summarized in Figure 1. An important characteristic of OECert is the explicit integration of demographics with the characteristics which define the degree of contamination.

OECert prioritizes sites based on risk, cost, or cost-effectiveness ration. Effectiveness is measured by the risk reduction that can be obtained through remediation of a site. As shown in Figure 1, cost and risk reduction are dependent on a large number of variables. Cost for prioritization purposes, is measured in constant year dollars and includes the direct and indirect cost of remediation. The following summary explains how risk and cost are estimated, as well as how the cost-effectiveness ratio is calculated.

2.0 RISK ESTIMATION

A widely accepted definition of risk states that risk is equal to the product of the probability of an event occurring and the consequences of that event. This parallels the estimation

approach used in OECert. An event is defined as the exposure by one member of the public to at least one ordnance item. The consequence of this event is defined as the relative hazard associated with the OE located on the site. Hazard subjectively combines both the sensitivity of the ordnance and the consequences of the explosion.

The expected number of exposures to ordnance at a site is a function of the number of people entering the site, the activities they are performing, and the amount, type and visibility of ordnance contamination at the site.

For each activity occurring at a site, the expected number of exposures for a single individual performing that activity is determined based on the area covered by the individual, the OE contamination density, and the surface/subsurface distribution of the OE. Next, the expected number of participants in that activity for the particular site is calculated using the local demographics, activity participation rates and percentages, and the presence/absence of "competing" sites to perform the activity. These values are calculated and summed for all activities occurring in the site, yielding a total expected number of exposures. Risk then is calculated as the product of the expected exposures and the hazard factor for the OE contamination at the site. The fundamental risk equation for dispersed areas and their associated activities is summarized in Figure 2.

The amount of unexploded ordnance (UXO) contamination at a site may be described in terms of density or area and visibility of contamination. If the ordnance is spread over a relative large geographic area (i.e. dispersed sites), density (expressed as the number of UXO items per unit area) is used to describe the extent of ordnance contamination. Intuitively, the higher the density, the higher the risk of exposure. If the ordnance is confined to a relatively well defined area (i.e. localized sites), the two dimensional area containing the ordnance or line of sight surrounding the contaminated area is the measure that describes the extent of contamination. It is assumed that the larger the area the hazard occupies, or the more visible the hazard is, the higher the risk of public exposure.

The type of ordnance contamination at a site may be classified as one of eleven categories. These categories were identified by UXO professionals experienced in the handling and disposal of UXO and are as follows: dispersed UXO; dispersed UXO with special fuzing mechanisms; dispersed UXO with a charge of white phosphorus; dispersed controlled chemical biological or radiological weapons; localized armed UXO; localized unarmed UXO; explosives and materiel; propellants and pyrotechnics; non-controlled chemicals; bulk white phosphorus; localized controlled chemical, biological, and radiological weapons. Each of these ordnance categories has two relative hazard factors associated with it. These relative values describe the consequence of an ordnance item detonating and the sensitivity to detonation of the ordnance in each hazard classification.

3.0 COST ESTIMATION

A site's life-cycle is made up of three parts: pre-remediation, remediation and post-remediation. Cost estimates for these phases and the sum of these estimates provides a total site life cycle cost estimate.

Pre-remediation is the time period beginning when the site is identified and placed on the list of sites to be prioritized, and ending when remediation begins. Costs associated with this phase include any personnel, equipment, and material costs incurred during activities, such as feasibility studies, engineering evaluations, and site planning that take place to facilitate the site being prioritized and/or remediated.

Remediation is the time period when the physical site clean-up occurs. Cost associated with this phase include all personnel, equipment and material costs directly or indirectly related to the actual clean-up of ordnance contamination at the site. Remediation is expected to be the most cost intensive phase of the site life-cycle.

Post-remediation is the time period beginning when the site remediation effort ends and ending at the end of the analysis period. The total site life-cycle is assumed to be 30 years. Post-remediation under this assumption would be 30 years minus the number of years required

for pre-remediation and remediation. Costs associated with this phase include any personnel, equipment, and material costs relating to activities required to limit public entry to the site (i.e. fence maintenance, guards, etc.). If the site is completely turned over for public use after remediation, there will be no post remediation cost associated with the site.

The cost module uses a combination of all four widely accepted cost-estimating methods depending on the data available. This combination of methods takes place within a framework of a "bottoms-up" work breakdown structure. The four methods are parametrics, engineering (bottoms-up), analogies, and expert opinion. Parametric estimates are those that apply quantitative methods to arrive at estimating relationships between cost elements. The expected evolution of OECert cost methodology is from parametric, through analogous, to bottoms-up. For example, by gathering actual contract data and applying regression analysis, a percentage can be applied to remediation clearance time to arrive at quality assurance time. The engineering, or bottoms-up approach, estimates at a piece part level and requires a great deal of experience in the activities being estimated. Analogies are costs that are estimated using actual costs from programs based on similarities that characterize the programs. Often, with analogies, complexity factors are used to adjust the cost upward or downward to account for the differences between technical considerations. Expert opinion estimates are judgments expressed by those with education and experience in the particular area being estimated.

Currently, the cost module's estimates are built on actual data collected at Mission Trails/Tierrasanta and Raritan sites and data from the OE-CWM Generic Cost Estimate. For prioritization and cost planning purposes, a database is being developed to supplement and enhance the previously gathered data. This database will provide consistency for studies, analyses, and budget and planning exercises and result in the reduction of cost analysis subjectivity.

Cost data is available to build the database. The data requirements include actual contract cost data, interviewing remediation participants and experts, analysis of data, and making provisions for cost feedback over time.

The model output for the cost module consists of a series of reports and briefing charts that summarize life-cycle cost. These reports are arranged by pre-remediation, remediation, post-remediation, and cost of no remediation. Reports are available to meet the various needs of the budgeting exercises, trade studies, and various other analyses. Within three life cycle elements, the work breakdown structure is employed to show costs at the lower levels. The cost module also shows costs either held constant or adjusted for inflation (escalated) and calculates both present and future values for the purpose of economic analyses dealing with the time value of money and alternate investment strategies.

4.0 COST-EFFECTIVENESS MEASURE

The prioritization of sites is based on a calculated cost-effectiveness ratio for each site. The cost-effectiveness measure compares delta risk to delta cost for each site. Delta risk is the difference between the estimated level of risk associated with the site before remediation occurs and the risk level established as the remediation standard. Delta cost is the difference between the life-cycle cost including remediation and the life cycle cost with no remediation phase included. The ratio resulting from these calculations gives the amount of expected risk reduction per dollar spent at the site under analysis.

5.0 DATA REQUIREMENTS

The data required to execute OECert can be placed into four broad categories: demographic data, parametric data, expert opinion data, and site assessment data. Data categories and sources gathered thus far are presented in tabular form. Data values that currently are nominal have potential data sources listed.

Demographic data includes, population totals, activity participation rates, gross and new construction building permit totals, average construction site sizes, surveying activity totals, and state and national park totals. These data values, with the exception of construction site size, are

used in the calculation of the potential number of entrants to a contaminated site. Construction site size is used in the calculation of subsurface risk area.

Population totals are collected by count or city and are broken down into nine age categories. Activity participation rate data is broken down into the same nine age categories and is based on national participation statistics. Building permits are collected at the city and county level. Surveying activity is a nominal value based on local information and uses the number of "new" building permits issued. "New" construction is assumed to be all building not related to renovation, alteration, or addition. The number of state and national parks is collected on a state by state basis, but is implemented at the regional level. Table 1 summarizes the demographic data sources.

The parametric data set consists of the parameters needed to describe an individual's participation in identified activities. These parameters are: subsurface area covered by an individual, path width of an individual, an individual's activity participation time, an individual's velocity while performing an activity, and velocity degradation resulting rom the terrain conditions. Not all parameters are applicable to all activities. The values are used in the calculation of the area an individual covers while at a site. Table 2 presents the current parametric data requirements, sources for "hard" numbers, and proposed sources for nominal values.

Expert opinion data requirements consist of hazard factors elicited from UXO/EOD professionals through application of the Analytic Hierarchy Process (AHP) developed by T.L. Saaty of the University of Pittsburgh. THE AHP is an analytic technique that requires subject matter experts to compare the importance, in this case, sensitivity and consequence, of one ordnance item to another on a 1 to 9 scale of absolute numbers, 1 indicating equal importance and 9 indicating absolute superiority of one item to the other. A team of UXO safety professionals from the Corps of Engineers, Huntsville Division, participated in an AHP session and their input became the basis for the hazard classification. The hazard factor is the product of the sensitivity factor times the consequence factor. These factors have been adjusted to a scale from 1 to 100

for ease of application and presentation purposes. Table 3 lists the eleven hazard classifications along with their respective hazard factor values.

Table 1. Demographic Data Sources

Data Required	Source
Population Totals	United States Census Bureau 1990 CD ROM
Activity Participation	American Sports Data Rates Inc. American Sports Analysis 1992 Summary Report
Building Permits	United States Census Bureau Construction Statistics 1988-1992
Surveying Activities	Local data based on number of new building permits issued
Average Construction Size	Nominal value based on estimates of local Realtor
State and National Park Totals	The Outdoor Atlas and Recreation Guide 1992

Table 2. Parametric Data Sources

Data Required	Proposed Source
Subsurface Area	Outdoor Recreational guides
Path Width	Ergonomic studies
Participation time	Marketing Surveys
Velocity	Army Field Manual 21-18
Velocity Degradation	Army Field Manual 21-18

Table 3. UXO Hazard Factors

UXO Type Dispersed	Sensitivity Factor	Consequences Factor		Product Hazard Factor
UXO	126	80	10,080	29
UXO Light Motion	327	80	26,160	76
UXO White Phos	126	36	4,536	13
Controlled Chem, Biological or Rad	126	273	34,398	100

UXO Type Localized	Sensitivity Factor	Consequences Factor		Product Hazard Factor
UXO Armed	126	80	10,080	29
UXO Unarmed	16	80	1,280	4
Explosives and Material	24	36	864	3
Propellants and Pyrotechnics	43	18	774	3
Non-Controlled Ch	22	15	330	1
White Phosporus	44	20	880	3
Controlled Chem, Biological or Rad	22	281	6,182	18

6.0 MODEL EXECUTION

To run OECert, several key pieces of information must be obtained. The information needed for a dispersed site include the following items: hazard type; degree of slope; vegetation type; presence of slippery ground cover; percentage of UXO on the surface; sector UXO and total item density; weighted average of UXO weights; soil type; sector acreage; presence of bees,

snakes, and poisonous foliage; presence of archaeological activity; presence of environmentally sensitive plants and wildlife; fencing required; number of guards needed and knowledge of which activities occur at the site.

For a localized site the following information is needed: hazard type, degree of slope, vegetation type, presence of slippery ground cover, area of hazard, maximum line of sight distance surrounding the hazard, excavation volume, area to be reconstituted, environmental factors, sifter requirement, fencing required, number of guards needed, knowledge of which activities occur at the site, OE removal volume, area to be prepared for clearance, and area of original site.

The model outputs from OECert will consist of a list sites prioritized by risk, cost, or cost-effectiveness ratio. The prioritized list may consist of any subset of the sites present in the database at the time of analysis. Additionally, detail risk estimates are provided at a "per activity" level, as well as life cycle cost estimates.

7.0 FUTURE USAGE

In the future, OECert will be expanded to handle many of the challenging issues pertaining to ordnance remediation. In addition to site prioritization based on cost-effectiveness, the following applications will be available.

7.1 Defacto Risk Standard Density

Defacto risk standards are being developed to determine when a site has been cleaned to an acceptable level. To develop these standards, the post-remediation risk is being measured at sites that have been cleaned to an acceptable level for their current land usage. These defacto standards will be based on the following definitions of risk: (1) the probability of exposure to ordnance for one person during a single site visit, and (2) the expected number of exposures to the surrounding population annually. In the future, OECert will accept a risk standard as input

and compute the corresponding post-remediation ordnance density that must be achieved in order to meet the defacto risk standard.

7.2 Remediation Planning Tool

A remediation planning tool is being developed so that the project managers of formerly used defense sites may assess site remediation alternatives. These alternatives are base on : (1) a specified level of work performed, (2) a specified cost of remediation or (3) a specified residual risk. The tool is intended to assist im making level of remediation versus cost of remediation decisions.

A specified level of work is defined to be the clearance of UXO to a specified depth assuming some achieved sweep efficiency. Sweep efficiency is the portion of anomalies detected and removed in the clearance action. A specified cost is defined to be the remediation cost associated with clearance of UXO to some combination of level of work (clearance depth) and sweep efficiency which will result in the specified dollars. A specified risk is defined to be the probability of exposure (for an individual at a FUDS) associated with clearance of UXO to some combination of level of work (clearance depth) and sweep efficiency which will result in the specified residual risk.

7.3 Summary

The quantification of OE contamination is a necessary and prudent part of the management of sites which have been used by our armed forces. The quantification is necessary to communicate with the public and to plan remediation activities. A continued evolution of the OECert methodology will serve as a foundation for difficult future decisions concerning the allocation of scarce resources to very sensitive issues of great public concern.

OE RISK ASSESSMENT MODEL

OECERT

DEVELOPED BY U S ARMY ENGINEERING AND SUPPORT CENTER, HUNTSVILLE

OE RISK ASSESSMENT METHODS

- RISK ASSESSMENT CODE (RAC)
  - SUBJECTIVE
  - RELATIVELY FAST TO DETERMINE
  - USED TO SEPARATE SITES INTO CLASSES
- ORDNANCE AND EXPLOSIVES COST-EFFECTIVENESS TOOL (OECert)
  - OBJECTIVE
  - RELATIVELY SLOW
  - USED TO DETERMINE PUBLIC RISK INHERENT AT A SITE
  - USED TO DIFFERENTIATE BETWEEN SITES OF THE SAME CLASS

OECERT RISK TECHNICAL DETAILS

- QUEING MODEL - UXO ACTS AS SERVER
- POISSON MATHEMATICAL MODEL
  - DISCRETE DISTRIBUTION
  - PROBABILITY OF EXPOSURE BASED ON NUMBER OF UXO TIMES SIZE OF POPULATION
  - HAZARD FACTORS - SUBJECTIVE EVALUATION OF RELATIVE CONSEQUENCES OF DIFFERENT TYPES OF ORDNANCE
- EXTENSIVE PEER REVIEW OF MODEL

OECERT COST TECHNICAL DETAILS

- USES BOTTOMS UP METHODOLOGY WHEN DATA IS AVAILABLE
- HAS PARAMETRIC ESTIMATORS THAT CAN PROVIDE ESTIMATES
- USES REGRESSION MODELS TO DEVELOP COST ESTIMATING RELATIONSHIPS
- HAS A FEEDBACK MECHANISM THAT IMPROVES THE ACCURACY OF THE COST PREDICTOR AS MORE DATA BECOMES AVAILABLE

OECERT INPUTS AND OUTPUTS

- INPUTS
  - TYPES OF ORDNANCE
  - AMOUNTS OF ORDNANCE
  - SITE ACTIVITIES (PAST AND FUTURE)
  - SITE DEMOGRAPHICS
  - SITE PHYSICAL CONDITIONS
- OUTPUTS
  - INHERENT PUBLIC RISK AT SITE
  - INDIVIDUAL RISK AT SITE (PER EACH VISIT)
  - LISTING OF SITES BY RISK (LISTING OF SUBSITES BY RISK)

OECERT FUNDAMENTALS

- BASICS
  - DETERMINE THE RISK FOR COMMON ACTIVITIES AT A SITE
  - DETERMINE THE NUMBER OF INDIVIDUALS THAT WILL PERFORM THAT ACTIVITY
  - DETERMINE THE FREQUENCY THE ACTIVITY WILL BE PERFORMED
  - INDIVIDUAL RISK = THE PROBABILITY OF AN INDIVIDUAL BEING EXPOSED TO ORDNANCE FOR A GIVEN ACTIVITY
  - PUBLIC RISK = THE SUMMATION OF ALL INDIVIDUAL RISKS

USES OF OECERT

- DEVELOP BASELINE RISK ESTIMATE
- DETERMINE DELTA RISK FOR EACH ALTERNATIVE UNDER CONSIDERATION
- DEVELOP ROM COST FOR EACH ALTERNATIVE
- ALLOWS THE DECISION MAKER TO DETERMINE WHICH ALTERNATIVE BEST FITS BUDGETARY CONSTRAINTS
- DEVELOPS A NUMERICAL VALUE OF RISK REDUCTION FOR THE RECORD OF DECISION
- ALLOWS THE GOVERNMENT TO PRIORITIZE ALTERNATIVES AT A SITE
- ALLOWS THE GOVERNMENT TO PRIORITIZE ALL SITES
- COMMON METHODOLOGY FOR ALL SITES

APPENDIX A

EPA Guidance for Remediation of Federal Facility Sites Contaminated with Explosive or Radioactive Wastes