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618-4 Burial Ground Excavation Report

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Prepared for the U.S. Department of Energy
Office of Environmental Restoration

Bechtel Hanford, Inc.
Richland, Washington

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Author
J. A. Lerch

Date Published
August 1998

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EXECUTIVE SUMMARY

The 618-4 Burial Ground, located approximately 1.6 km (1 mi) north of the Richland City limits and 340 m (1,115 ft) west of the Columbia River, is part of remedial action activities at the Hanford Site, 300-FF-1 Operable Unit (OU). Because it is one of the initial burial ground projects at the Hanford Site to undergo an excavation and removal cleanup program, the 300-FF-1 OU decision makers agreed that a summary report would be prepared to assist with planning and implementation of similar cleanup projects at Hanford and throughout the U.S. Department of Energy (DOE) complex. Although excavation of the 618-4 Burial Ground is not finished, it was determined that enough information was gathered to prepare the report based on activities completed through the end of April 1998.

The 618-4 Burial Ground was a single disposal pit measuring approximately 32 m (105 ft) by 160 m (525 ft) and little information is available on the inventory and source of waste that was deposited there. It is believed that the 618-4 Burial Ground operated as an official burial ground from 1955 through 1961.

Previous investigations were performed at the 618-4 Burial Ground as part of remedial investigation activities for the 300-FF-1 OU. Investigations identified large amounts of ferrous waste materials based on geophysical surveys, detectable concentrations of volatile organic compounds in soil gas samples, and miscellaneous debris (e.g., contaminated pipe, scrap metal, salt-bath precipitate, rubber, pipe insulation, burnt wood, melted glass, asbestos, lead bricks) mixed with sand and gravel fill observed during excavation of test pits. Test pit sample results identified uranium as the primary contaminant, consistent with available 300 Area process

history. No evidence of liquid waste disposal was observed in the test pits. There is no groundwater contamination attributed to the 618-4 Burial Ground.

Pre-job planning activities for the 618-4 Burial Ground included preparation of the initial design plan, selection of a remedial action subcontractor (RAS), development of data quality objectives (DQOs), establishment of health and safety requirements, and performance of a readiness assessment. Excavation activities were scheduled to be complete over a period of approximately 4 months, between October 1997 and February 1998. The projected cost for remediation of the 618-4 Burial Ground based in the initial design plan was approximately $1.9 million including ERC labor and overheads, RAS labor and overheads, and waste disposal costs.

Remedial action activities to remove the cover (topsoil and overburden) material at the 618-4 Burial Ground were initiated in October 1997 under authorization of the 300-FF-1 and 300-FF-5 OU ROD (EPA et al. 1996) and in accordance with the *300-FF-1 Remedial Design Report/Remedial Action Work Plan* (RDR/RAWP) (DOE-RL 1997a). Site workers supporting excavation operations were outfitted in Level D personal protective equipment (PPE). The cover material was put into a clean soil stockpile outside of the Area of Contamination (AOC).

Prompted by unexpected excavation of anomalous liquid waste materials at Landfill 1D (another 300-FF-1 OU waste site undergoing concurrent excavation), all 300-FF-1 OU excavation activities, including the 618-4 Burial Ground, were suspended in mid-November 1997 until a safety evaluation could be performed. Based on the potential to excavate unknown chemical hazards, a subsequent decision was made that level B PPE would be used by all workers at the 300-FF-1 OU landfills and the 618-4 Burial Ground until adequate information was available to

permit a downgrade. Excavation and removal of the cover material at the 618-4 Burial Ground was postponed until cleanup of Landfill 1D was completed.

Excavation activities resumed at the 618-4 Burial Ground in early February 1998 with removal of the remaining cover material followed by excavation of contaminated material and debris. Workers at the site were outfitted in level B PPE during all excavation operations. In accordance with original plans, material from the 618-4 Burial Ground was to be passed through a large segregation grid (grizzly) before being dispositioned. Experience with use of the grizzly at Landfill 1D prior to excavation of waste material at the 618-4 Burial Ground led to proposed modifications in the waste excavation/sorting process to improve efficiency. An earlier field demonstration attended by representatives of the EPA and RL resulted in the approval of four additional techniques to sort/disposition waste material. As a result, the grizzly was not used at any time during excavation of the 618-4 Burial Ground.

Production was relatively efficient during the first weeks of waste excavation at the 618-4 Burial Ground. Excavated material consisted mostly of uranium-contaminated soil mixed with metallic debris. Contaminated material and debris was sent to the Environmental Restoration Disposal Facility (ERDF – a large permitted landfill located in the Hanford Site 200 West area) for disposal. Isolated anomalous waste items that required characterization before they could be sent to the ERDF were identified and set aside with minor impacts to excavation efficiency.

Production slowed during subsequent weeks as greater quantities of asbestos material and anomalous waste were unearthed. The anomalous waste unearthed included large quantities of lead contaminated soil, barium contaminated soil, and lead debris that were set aside in

individual stockpiles within the AOC. A large number of drums were also excavated from a central portion of the 618-4 Burial Ground AOC. Most of the drums were intact, approximately 35-gal in size, and had a stenciled D38 marking on the side. Approximately 338 drums had been excavated when interviews with retired Hanford Site employees and evidence from leaking drums identified that the drum contents were likely depleted uranium metal shavings and oil. It was further learned that uranium metal is pyrophoric under the right conditions and that oil was commonly used as a stabilizing agent to cover shavings from machining operations. Geophysical data and field observations of multiple drum layers suggest that as many as 1200 additional drums may remain buried within the 618-4 Burial Ground.

The information from the interview prompted the suspension of drummed waste excavation activities at the 618-4 Burial Ground on April 2, 1998. Because some of the drums were believed to have lost all or part of their oil contents, a stabilization operation was developed and implemented on April 11, 1998. Without incident, 149 drums were overpacked, stabilized with mineral oil, and staged within the AOC at the bottom of the excavation between April 11 and April 22, 1998. The remaining drums were considered stable in their existing state (based on the absence of visible oil leaks and relative fullness).

The presence of large quantities of anomalous waste materials led to a decision to postpone remediation of the 618-4 Burial Ground. Pending the disposition of anomalous waste at the 618-4 Burial Ground, equipment and personnel were demobilized from the site and the excavation operations were moved to a 300-FF-1 OU liquid waste disposal site in May 1998. As part of demobilization activities, the remaining excavated drums were dry-overpacked and staged

within the AOC and the exposed drums within the 618-4 Burial Ground soil were covered with soil and marked. A crusting agent was applied to all of the soil surfaces and stockpiles (i.e., lead contaminated soil, barium contaminated soil, and lead debris) within the 618-4 Burial Ground AOC to provide dust control during the period of inactivity. Demobilization was completed on May 5, 1998.

The material removed from the 618-4 Burial Ground through the end of April 1998 (including cover and soil/debris) represents approximately 42% of the work to be performed based on the quantity estimated in the design package. The total cost of the project through July 1998 was approximately $3.4 million. Development of DQOs and subsequent characterization of the drummed waste is scheduled to be complete by the end of fiscal year (FY) 1998. Based on the characterization results, plans for continued excavation of the drummed waste and selection of treatment/disposal methods is scheduled to be complete in mid-FY 1999. Remediation of the 618-4 Ground is scheduled to resume at the end of FY 1999.

Remediation of the 618-4 Burial Ground provided an opportunity to identify project successes, areas for improvement, and lessons learned. The ERC team, the RAS, DOE-RL, and EPA successfully worked together as a 300-FF-1 OU project team to adapt to changing and unexpected conditions that were presented daily during excavation operations. In doing so, the work at the 618-4 Burial Ground was performed safely without any lost-time injuries.

The cost of remediation activities at the 618-4 Burial Ground was significantly greater than the original projection. In comparison with the projected $1.9 million to complete the project, approximately $3.4 million was spent to excavate 42% of the material estimated in the initial design. The increase in cost was due to the quantity/type of anomalous waste materials that were encountered. The decision to upgrade the level of PPE because of the potential to excavate unknown materials resulted in a greater number of personnel supporting the project. The quantity of anomalous waste material unearthed also slowed the excavation process and decreased productivity. Based on FY1999 detailed work plan development, excavation of the 618-4 Burial Ground is scheduled to be complete in FY2000 and treatment/disposal of the drummed waste is scheduled to be complete in FY2001. The total cost of the project at completion is estimated to be $14.4 million including excavation of remaining soil and debris, verification sampling, backfill/recontouring, and treatment/disposal of anomalous waste materials.

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ACRONYMS

ACL	above cleanup level
AOC	area of contamination
BCL	below cleanup level
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COC	contaminant of concern
DCE	dichloroethene
DCG	derived concentration guide
DOE	U.S. Department of Energy
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
ERC	Environmental Restoration Contractor
ERDF	Environmental Restoration Disposal Facility
FRR	functional review requirement
FY	fiscal year
GPH	ground penetrating holography
GPR	ground penetrating radar
HASP	health and safety plan
HAZCAT	hazard category
IH	industrial hygiene
LCY	loose cubic yards
LDR	land disposal restriction
MTCA	Model Toxics Control Act
NPL	National Priorities List
OU	Operable Unit
PCB	polychlorinated biphenyl compound
PCE	tetrachloroethene
PPE	personal protective equipment
RAO	remedial action objective
RAS	remedial action subcontractor
RDR/RAWP	*300-FF-1 Remedial Design Report/Remedial Action Work Plan*
RESRAD	Residual Radioactivity
RI	Remedial Investigation
RL	U.S. Department of Energy, Richland Operations Office
ROD	record of decision
RWP	radiological work permit
SAP	Sampling and Analysis Plan
SSWMI	site-specific waste management instruction
TBD	to be determined
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
WAC	*Washington Administrative Code*
WIDS	Waste Information Data System
XRF	x-ray fluorescence

1.0 INTRODUCTION

The purpose of this report is to document the planning, processes, events, cost, and lessons learned associated with excavation of the 618-4 Burial Ground. The 618-4 Burial Ground is part of remedial action activities at the 300-FF-1 Operable Unit (OU) and is one of the initial projects of its kind at the Hanford Site to undergo an excavation and removal cleanup program. A number of other 300 Area and 100 Area burial grounds exist at the Hanford Site that will be evaluated for selection of cleanup alternatives. To assist with planning, selection of remedial alternatives, and implementation of remedial action operations for other projects at Hanford and throughout the U.S. Department of Energy (DOE) complex, the 300-FF-1 OU decision makers agreed that a 618-4 Burial Ground excavation report would be prepared. The following items are addressed in the report:

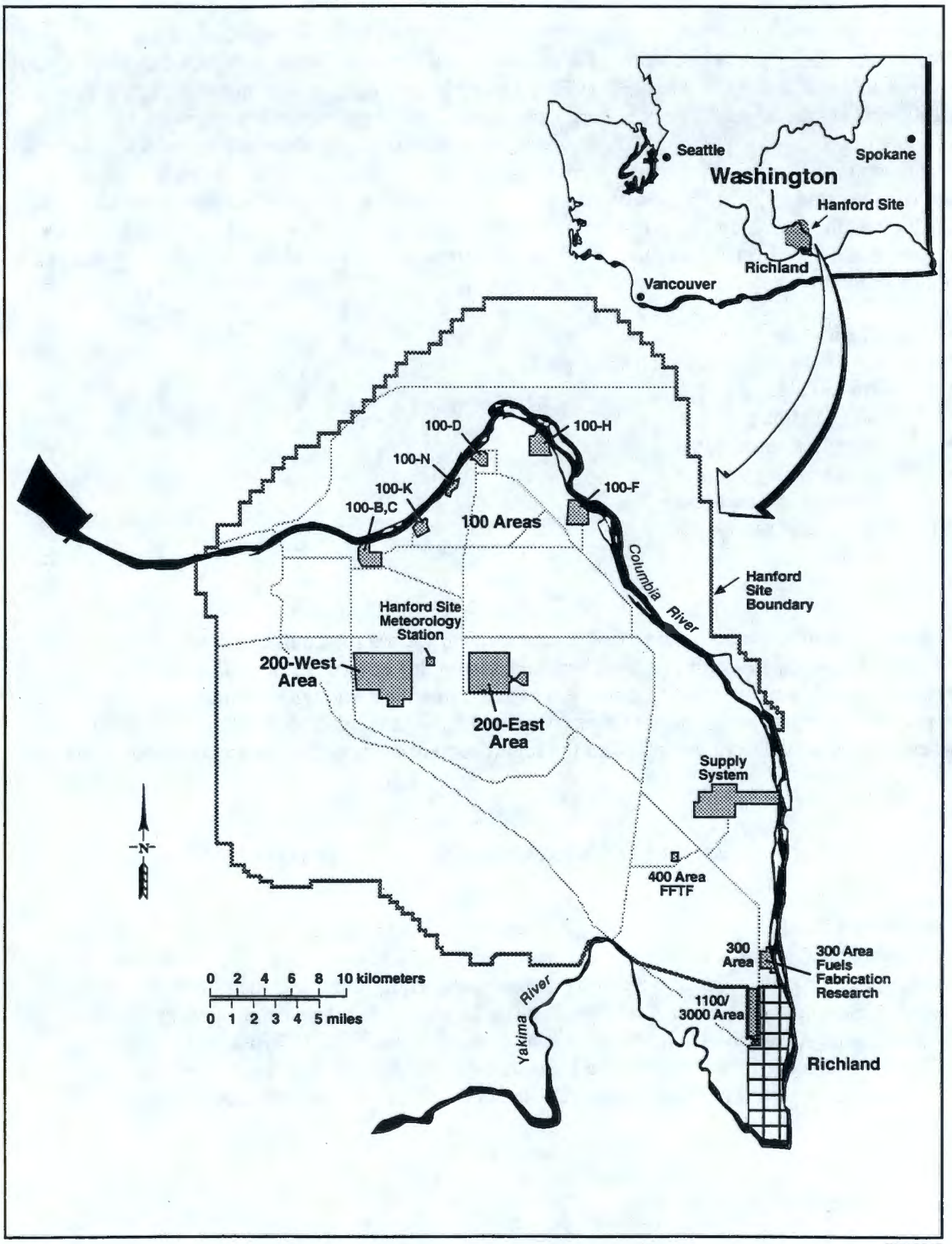
- Site history
- Remedial action objectives and goals
- Pre-job planning
- Remediation process
- Sampling and analysis
- Waste management,
- Radiological controls
- Health and safety
- Cost
- Lessons learned.

Remedial action activities at the 618-4 Burial Ground were initiated in October 1997 and were postponed in April 1998 for reasons discussed later in this report. Although excavation of the 618-4 Burial Ground was not finished, it was determined that enough information was gathered to prepare the report based on activities completed through the end of April 1998. Specific cases where this determination has impacted the report content are noted in the sections that follow.

2.0 SITE HISTORY AND DESCRIPTION

The Hanford Site is a 1,450-km^2 (560-mi^2) federal facility located in southeastern Washington State along the Columbia River and north of the city of Richland. From 1943 until 1990, the primary mission of the Hanford Site was defense production of nuclear materials. The Hanford Site was listed on the National Priorities List (NPL) pursuant to the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) in 1989. The NPL listing identified four areas of the Hanford Site (100 Area, 200 Area, 300 Area, and 1100 Area) as depicted in Figure 1 and resulted in initiation of environmental restoration activities.

Figure 1. Hanford Site.



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The 300 Area is located in the southeastern corner of the Hanford Site boundary and is divided into three OUs. The 300-FF-1 OU includes liquid waste disposal sites, landfills, burial grounds, surface radiation areas, and miscellaneous debris. The 618-4 Burial Ground is located in the northwest corner of the 300-FF-1 OU (Figure 2).

2.1 PHYSICAL DESCRIPTION

The 618-4 Burial Ground site is located approximately 1.6 km (1 mi) north of the Richland City limits and 340 m (1,115 ft) west of the Columbia River. It was a single disposal pit measuring approximately 32 m (105 ft) by 160 m (525 ft). Depth of the disposal pit was not documented in historical records. Based on previous investigations documented in Section 2.3, the main part of the disposal pit was estimated to be at least 6 m (19 ft) deep. Depth to groundwater in the 618-4 Burial Ground area is approximately 9.1 to 11 m (30 to 35 ft) below the surface, depending on the water level in the Columbia River and local surface topography.

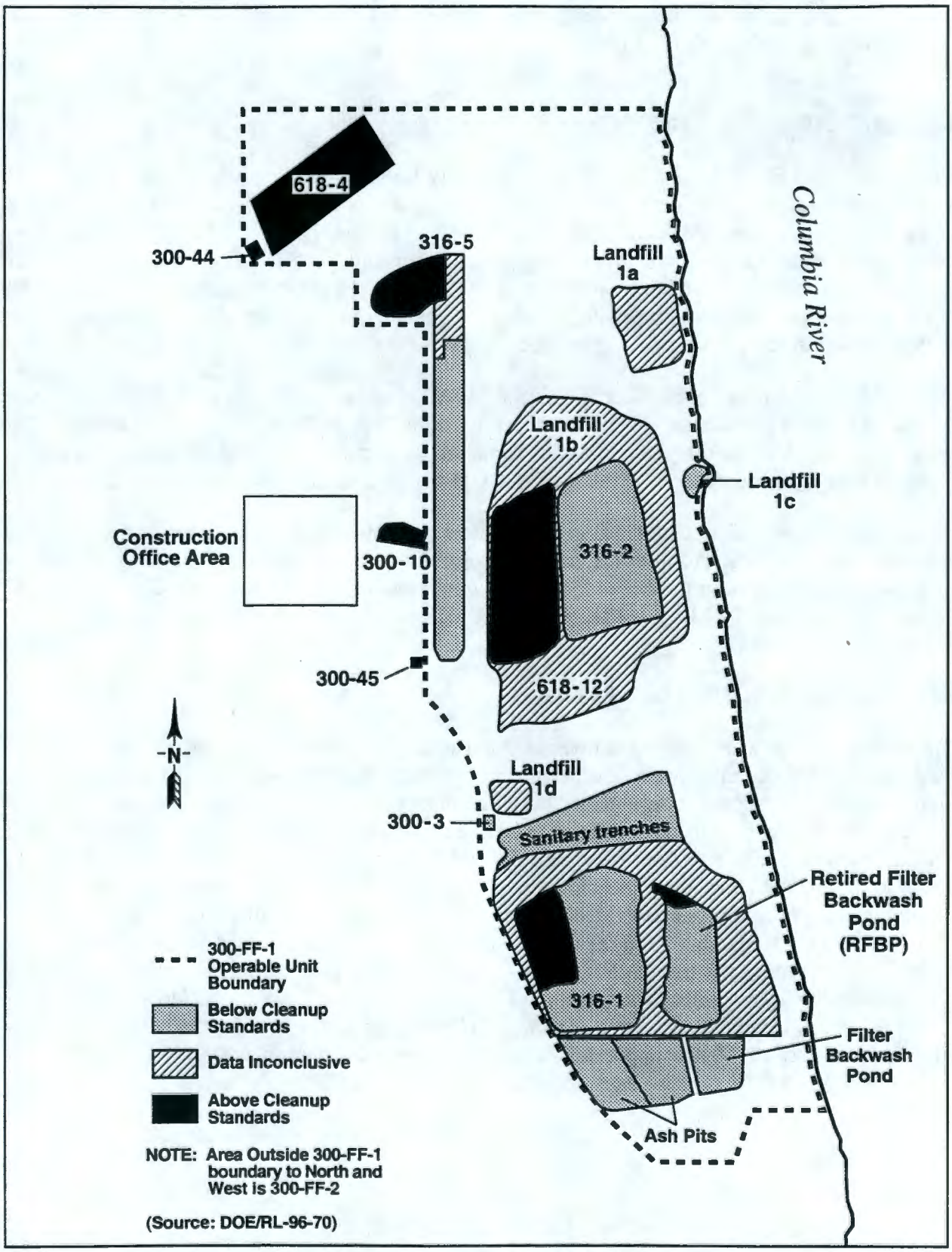
The 618-4 Burial Ground area of contamination (AOC) is approximately 70 m (230 ft) by 180 m (590 ft) as defined by an existing fence that surrounds the disposal pit. Use of the fence line to define the AOC was based on a review of historical records, the potential for random surface debris, and an agreement among the 300-FF-1 OU decision makers.

Local soil is typically characterized as predominately sand and gravel with a fines content that is generally less than 10%. Additional information on soil types and geological characteristics of the area are documented in the *Phase I Remedial Investigation Report for the 300-FF-1 Operable Unit* (Phase I RI Report) (DOE-RL 1993).

2.2 BURIAL GROUND OPERATION

Little information is available on the inventory and source of waste deposited in the 300 Area burial grounds. Some information has been pieced together based on available records of 300 Area operations during the time when the burial grounds were active. The time periods of operation are also subject to some debate. In accordance with the *Past Practices Technical Characterization Study-300 Area-Hanford Site* (WHC 1992) document, the 618-4 Burial Ground was used as regulated burning ground for uncontaminated and uranium-contaminated trash during the late 1940's through 1951. Sources cited in the Waste Information Data System (WIDS – the TPA resource for information and data associated with Hanford Site waste sites) (DOE-RL 1998) specify that the 618-4 Burial Ground operated as an official burial ground from 1955 through 1961. Aerial photographs found in the *Addendum to Data Compilation Task Report for the Source Investigation of the 300-FF-1 Operable Unit Phase I Remedial Investigations* (PNL 1991) support this information as being the most accurate.

Figure 2. 300-FF-1 Operable Unit.



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During the late 1940's and throughout the 1950's, numerous activities were conducted in the 300 Area to support fuel fabrication and process development. The 313, 314, and 3732 Buildings were used in various aspects of the fuel fabrication process for activities such as metal extrusion and canning process development. Neighboring buildings such as the 3730 and 306-fabrication shop were also used for metallurgical fabrication work such as the machining of graphite, and development of fuel fabrication processes. The 3706, 321 "semi-works", 325, 326, and 327 laboratories were all operational in parallel with the fuel fabrication facilities. Waste materials from any or all of these facilities may have been deposited in the 618-4 Burial Ground or the other 300 Area burial grounds that were operational during that time period.

References to the 618-4 Burial Ground as a "storage area for uranium-bearing aluminum-silicon and for bronze crucibles bearing radiation levels from fuel fabrication work" and a destination for "transfers of solid waste chips from the 327 building hot cells" (WHC 1992) seem to be indicative of the types of waste that were buried at the site. Besides information that the 618-4 Burial Ground contains miscellaneous materials contaminated with radioactive uranium, there is little historical information available on the inventory of materials that were deposited there. It was unknown if liquid waste materials were disposed of in the 618-4 Burial Ground.

In 1979, twenty improperly discarded depleted uranium elements were discovered near the 618-4 Burial Ground. The fuel elements and associated contaminated surface soil were subsequently removed from the site and disposed of on the Hanford Site in the 200 West Area.

Errors have been identified with some information from the cited references. A recent review of the references has shown that documented fires in the 618-4 Burial Ground actually occurred at the 300 North or 618-10 burial ground, which became operational at about the same time (1954) as the 618-4 Burial Ground. Due to the uncertainties associated with the available historical information, it was deemed necessary to conduct further characterization activities at the 618-4 Burial Ground during the 300-FF-1 OU Phase I Remedial Investigation.

2.3 PREVIOUS INVESTIGATIONS

The 618-4 Burial Ground was included with remedial investigation activities for the 300-FF-1 OU. Investigation techniques used for the 618-4 Burial Ground included geophysical surveys, soil gas surveys, and test pit excavations. Associated groundwater monitoring was performed under the 300-FF-5 OU workscope that includes the groundwater beneath the 300-FF-1 OU.

2.3.1 Geophysical Surveys

Geophysical surveys of the 618-4 Burial Ground were performed to identify and/or confirm from existing maps the boundary of the disposal pit, estimate the depth of fill material, and locate waste materials or other significant features of the survey area. Surveys were initially planned for late 1989 but were postponed because required radiological surveys had not been completed. Surveys of the 618-4 Burial Ground were subsequently performed between June and August 1991 including use of ground penetrating radar (GPR), magnetometer, and metal detector instrumentation. In addition to the area within the fence perimeter, a small area outside of the fence was included in the survey. Grid spacing for the GPR surveys was 2 m by 2 m (6.6 ft by

6.6 ft). Line spacing was 2 m (6.6 ft) for the magnetometer and metal detector surveys that were performed in a north-south direction.

Results of the geophysical surveys suggested that a majority of the waste in the 618-4 Burial Ground was metallic in composition. Strong magnetic anomalies at the west end of the 618-4 Burial Ground indicated presence of a significant amount of ferrous waste materials. The GPR profiles showed that waste material and debris in the main part of the trench extended to a depth of at least 6 m (19 ft). The results also suggested that the waste materials were covered with a layer of relatively clean sand and gravel that varied in thickness between 1 m to 4 m (3.3 to 13 ft). Results of the geophysical investigations are depicted in Figures 3a and 3b.

In June and July 1997, a technology demonstration was conducted on part of the 618-4 Burial Ground using an enhanced GPR system referred to as ground penetrating holography (GPH). The objective of the demonstration was to create holographic images from GPR data that could be used to differentiate between types of buried objects (e.g., barrels, rods) and identify some of the physical attributes of the objects (e.g., dimension, orientation). When the demonstration was performed, the GPH equipment was not at a point of development to reliably identify specific features, and it provided approximately the same level of information as conventional GPR.

2.3.2 Soil Gas Surveys

Soil gas surveys were performed in August 1991 to determine the nature and extent of volatile organic compounds at the 618-4 Burial Ground. Samples were collected at 60 locations within the 618-4 Burial Ground from soil gas probes installed at depths of 0.6 m to 1.2 m (2 ft to 4 ft) and left in the ground for 12 hours to equilibrate. Detectable concentrations of volatile organic compounds including 1,2-dichloroethene (DCE), trichloroethene (TCE), and tetrachloroethene (PCE) were identified at 8 of the 60 sample locations. Concentrations of the detected compounds ranged from 0.1 to 15.6 ppm. The compounds were detected at five locations near the west end, one location at the approximate center, and two locations toward the northeast corner of the 618-4 Burial Ground (Figure 4).

2.3.3 Test Pit Excavation

In February 1992, two test pits were excavated in the 618-4 Burial Ground at locations selected based on evaluation of groundwater monitoring, geophysical survey, and soil gas survey results (Figure 5). During excavation of the pits, contaminated pipe, scrap metal, salt-bath precipitate, rubber, pipe insulation, burnt wood, melted glass, asbestos, lead bricks, a drum with missing bung, and other miscellaneous debris mixed with sand and gravel fill were encountered. No evidence of liquid waste disposal was observed in either of the test pits. Below the debris and fill, undisturbed native sandy gravel of the Hanford formation was identified. Based on observations during the excavation process, the depth of fill was estimated to be 5.8 m and 2.7 m (19 ft and 9 ft) at the location of test pits B4TP-1 and B4TP-2, respectively. A photographic log of the materials encountered during excavation of the test pits is found in the *618-4 and 618-5 Burial Ground Test Pit Photographs* memorandum (BHI 1997b).

Figure 3a. Results of Geophysical Investigation at the 618-4 Burial Ground: Magnetic Anomalies.

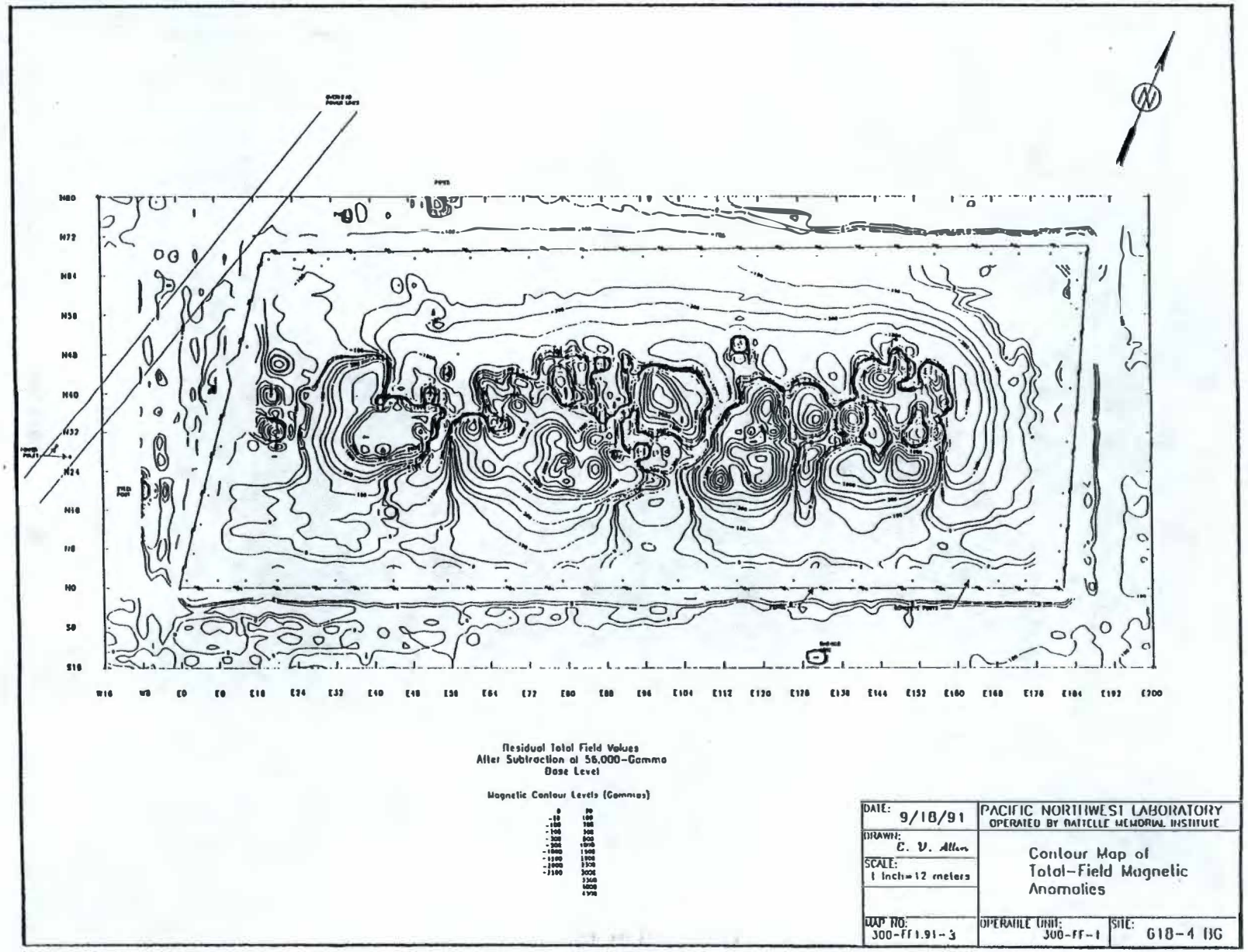


Figure 3b. Results of Geophysical Investigation at the 618-4 Burial Ground: Ground-Penetrating Radar.

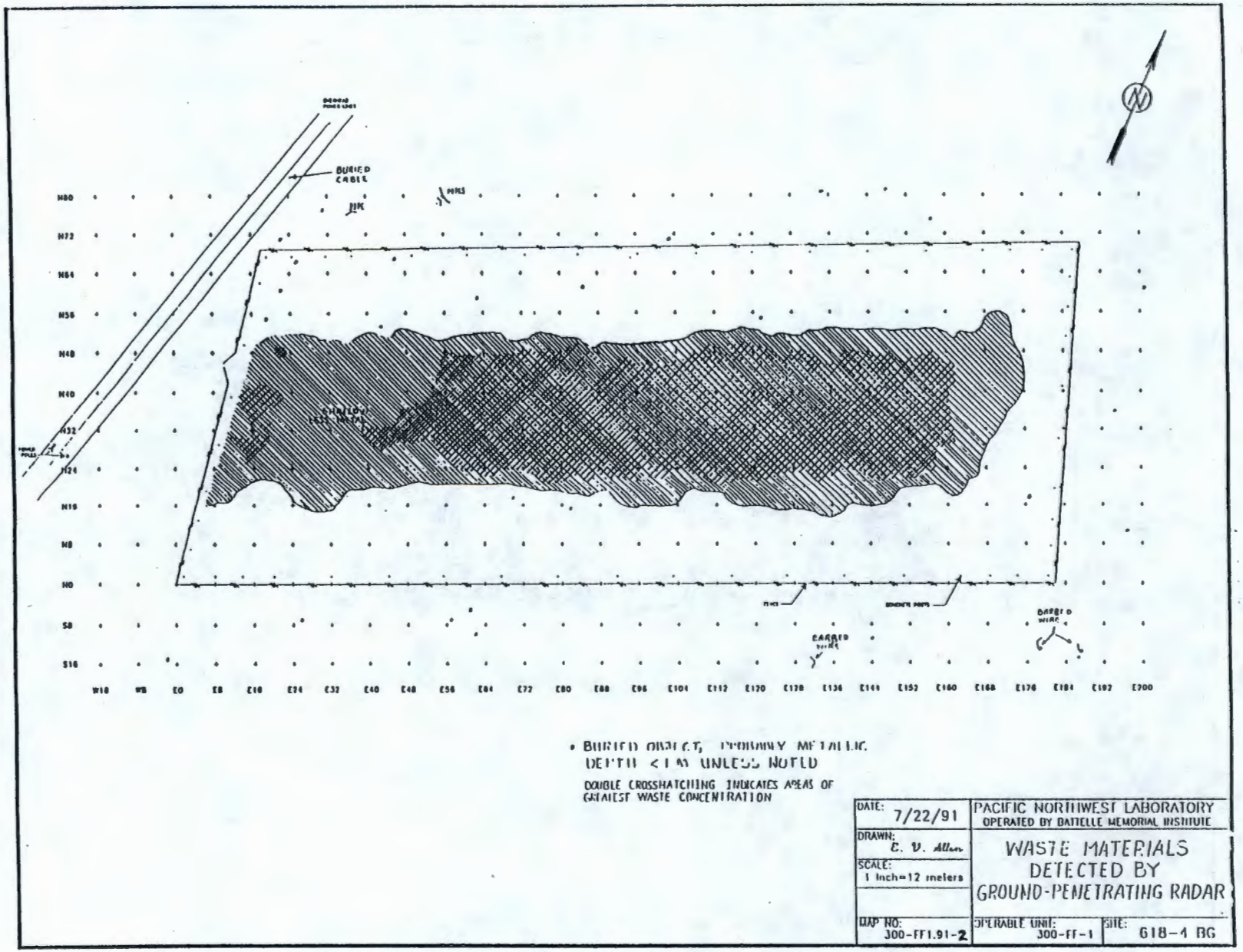
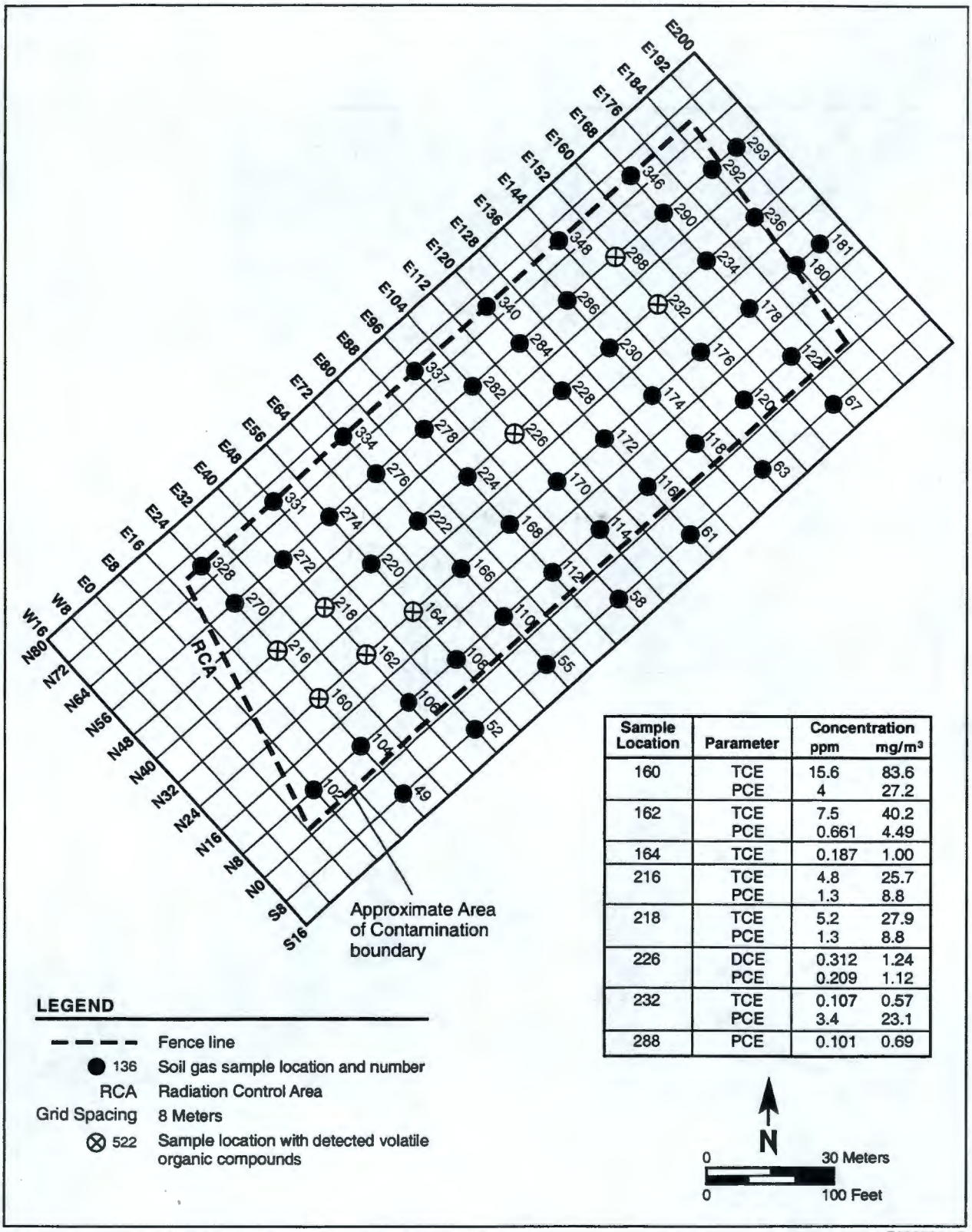


Figure 4. 618-4 Burial Ground Soil Probe Locations and Sample Results.



Sample Location	Parameter	Concentration ppm	Concentration mg/m³
160	TCE	15.6	83.6
	PCE	4	27.2
162	TCE	7.5	40.2
	PCE	0.661	4.49
164	TCE	0.187	1.00
216	TCE	4.8	25.7
	PCE	1.3	8.8
218	TCE	5.2	27.9
	PCE	1.3	8.8
226	DCE	0.312	1.24
	PCE	0.209	1.12
232	TCE	0.107	0.57
	PCE	3.4	23.1
288	PCE	0.101	0.69

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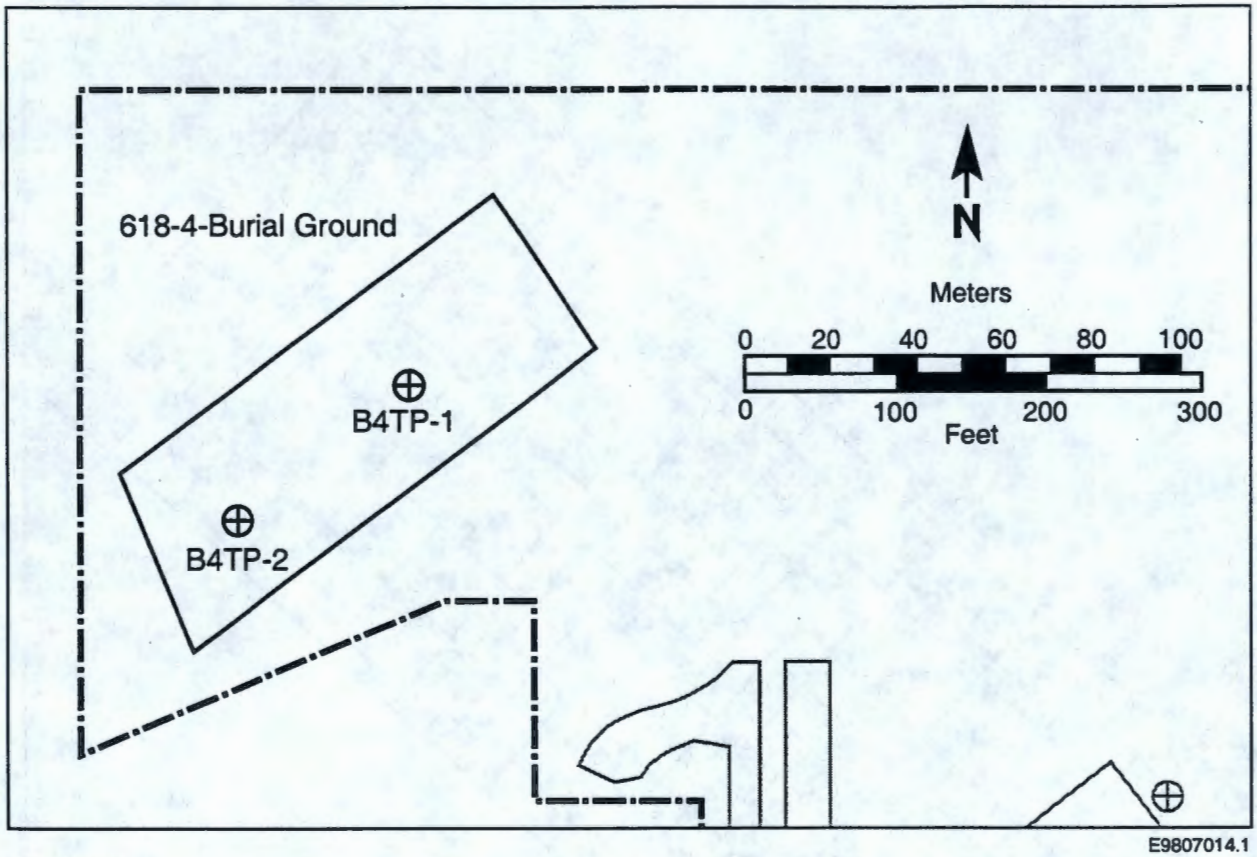
Figure 5. 618-4 Burial Ground Test Pit Locations.



LEGEND

⊕ Testpit location

Nine samples were collected from the two test pits at depths up to 7.3 m (24 ft). Results from the samples revealed discrete and highly variable concentrations of radioactive uranium throughout the depth profile, strongly suggesting that migration of the radionuclides, if any had occurred, was very slow. Maximum concentrations of uranium-234 and uranium-238 were each 2,100 pCi/g at a depth of 1 m (3.3 ft) in B4TP-1. Copper and chromium were detected with maximum respective concentrations of 230 and 960 mg/kg in the 1- to 2-m (3- to 6-ft) interval of B4TP-2. Polychlorinated biphenyl compounds (PCBs) were also detected in both test pits with a maximum concentration of 2.7 mg/kg at a depth of 0.6 m (2 ft) in B4TP-2. Detailed sample results are presented in the Phase I RI Report (DOE-RL 1993).

2.3.4 Groundwater Monitoring

Contamination of groundwater emanating from the 300 Area is addressed within the 300-FF-5 OU scope. Contributors to groundwater contamination include the source area OUs above the water table (300-FF-1 and 300-FF-2). The primary 300-FF-5 plume, which is the only plume that is derived from 300 Area operations, is centered beneath the 300-FF-1 OU in the vicinity of the process trenches and north and south process ponds. No groundwater contamination is attributed to the 618-4 Burial Ground.

Contaminants of concern for 300-FF-5 are uranium, DCE, and TCE. The chemical contaminants have localized distribution with concentrations that are decreasing over time. Uranium in groundwater is widely distributed across the 300 Area, and concentrations are also decreasing over time. Additional information is available in the *Operation and Maintenance Plan for the 300-FF-5 Operable Unit* (DOE-RL 1996).

3.0 REMEDIAL ACTION OBJECTIVES AND GOALS

The remediation authority, remediation objectives, and remediation goals for the 618-4 Burial Ground are described in the following sections.

3.1 REMEDIATION AUTHORITY

Remediation of the 300-FF-1 OU waste sites is authorized in the 300-FF-1 and 300-FF-5 OU ROD (EPA et al. 1996). Contaminants of concern (COCs) for the 300-FF-1 OU as identified in the *300-FF-1 Remedial Design Report/Remedial Action Work Plan* (RDR/RAWP) (DOE-RL 1997a) are uranium-234, uranium-235, uranium-238, cobalt-60, arsenic, thallium, benzo(a)pyrene, chrysene, and PCB compounds. The methods used to demonstrate achievement of remedial action objectives are documented in the RDR/RAWP (DOE-RL 1997a).

3.2 REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) for the 300-FF-1 OU as specified in the RDR/RAWP (DOE-RL 1997a) are listed as follows:

- Protect human and ecological receptors from exposure to contaminants in soil and debris by inhalation or ingestion of radionuclides, metals, and organics
- Protect human and ecological receptors from exposure to contaminants in the groundwater and control sources of groundwater contamination within the 300-FF-1 OU to minimize future impacts to groundwater resources
- Protect the Columbia River such that contaminants in the groundwater or remaining in the soil after remediation do not result in an impact to the river that could exceed the Washington State Surface Water Quality Standards.

3.3 REMEDIAL ACTION GOALS

Contaminant-specific cleanup criteria developed for the 300-FF-1 OU waste sites to ensure that the RAOs are achieved through implemented remedial actions are listed as follows:

- Remove debris and contaminated soil to achieve the *Washington Administrative Code* (WAC) 173-340-740, "Model Toxics Control Act-Cleanup" (MTCA) Method C cleanup standards for the chemical COCs (metals, semivolatile organics, and PCBs). Compliance with these cleanup standards is confirmed through results of verification samples collected after completion of removal activities. The cleanup standards include criteria specifying that the 95% upper confidence level (on the mean) cannot exceed the cleanup level, that no single sample result can exceed twice the cleanup level, and that less than 10% of all results can exceed the cleanup level.
- Remove debris and contaminated soil to achieve a 15 mrem/year dose industrial standard above background for the radiological COCs (uranium and cobalt-60). The uranium concentration determined to be equivalent to a dose of 15 mrem/year maximum above background is 350 pCi/g. This is demonstrated by comparison of the uranium results from the verification samples to uranium concentrations modeled under an industrial scenario using the Residual Radioactivity (RESRAD) computer code. The RESRAD model used only uranium in development of the radiation cleanup standard because cobalt-60 is of concern only in the 300-FF-1 South Process Pond and it also has a short half-life (5.26 years). No other radionuclides contribute significantly to the total dose.
- Remove debris and contaminated soil to achieve protection of groundwater and surface water. This is demonstrated by meeting the MTCA C and dose standard criteria, and by showing that RESRAD models of the uranium results from the verification samples are equal to or lower than the concentration and time plots from the original analysis. RESRAD parameters used for groundwater protection verification are included in Appendix B of the RDR/RAWP (DOE-RL 1997a).

Site-specific cleanup standards for the 300-FF-1 OU COCs are listed in Table 1.

Table 1. 618-4 Burial Ground Cleanup Standards.

Constituent	MTCA C	Surface and Groundwater	Dose Exposure
Arsenic	219 mg/kg	a	N/A
Benzo(a)pyrene	18 mg/kg	a	N/A
Chrysene	18 mg/kg	a	N/A
PCBs	17 mg/kg	a	N/A
Thallium	245 mg/kg	a	N/A
Radionuclides	N/A	b	15 mrem/yr[c]

MTCA = Model Toxics Control Act
N/A = Not Applicable
PCBs = polychlorinated biphenyl compounds
[a] No additional evaluation of metal and semivolatile organic constituents is required. A qualitative evaluation of the physicochemical properties of 300-FF-1 soils and contaminants show future migration potential of contaminants to be extremely slow and at low concentrations as documented in the *300-FF-1 Remedial Design Report/Remedial Action Work Plan*(DOE-RL 1997a). Toxicity characteristic leachate procedure results provide supporting evidence of slow leaching potential.
[b] Demonstrated by comparison of the uranium results from the verification samples to uranium concentrations modeled under an industrial scenario using the RESRAD computer code.
[c] 15 mrem/yr equates to 350 pCi/g for uranium in the 300-FF-1 industrial scenario.

4.0 PRE-JOB PLANNING

Pre-job planning activities for the 618-4 Burial Ground included preparation of the initial design plan, selection of a remedial action subcontractor (RAS), development of data quality objectives (DQOs), establishment of health and safety requirements, and performance of a readiness assessment. Excavation activities were scheduled to be complete over a period of approximately 4 months, between October 1997 and February 1998. The projected cost for remediation of the 618-4 Burial Ground, based on the initial design plan, was approximately $1.9 million including ERC labor and overheads, RAS labor and overheads, and waste disposal costs. Additional cost information is provided in Appendix B.

4.1 INITIAL DESIGN PLAN

The initial design plan for the 618-4 Burial Ground was prepared based on the available historical information, results from previous investigations (e.g., remedial investigation data and geophysical, soil gas, and radiological surveys), design drawings, and the cleanup standards established in the ROD (EPA et al. 1996). The information was used to estimate excavation volumes as summarized in Table 2.

Table 2. 618-4 Burial Ground Excavation Quantity Estimates.

Item	Disposition	Volume (m^3)[a]	Quantity (m tons)[a]
Soil cover (BCL)	Stockpile at 300-FF-1	16,200	35,000
ACL	Disposal at ERDF	7,870	17,000
BCL (sorted from waste)	Stockpile at 300-FF-1	7,870	17,000

ACL = above contamination level
BCL = below contamination level
ERDF = Environmental Restoration Disposal Facility
[a]Volumes and quantities based on measured area of 7,193 m^2 and average removal depth of 4.5 m.

The excavation scope was divided into removal of cover material, waste material and debris, and subgrade material.

4.1.1 Cover Removal

Prior to removal of cover material, 20 to 25 individual specimens of large, uncontaminated antelope bitterbrush were to be transplanted from the 618-4 Burial Ground to a pre-determined location east of the site. Contaminated vegetation was to be loaded into containers and transported to the Environmental Restoration Disposal Facility (ERDF – a large permitted landfill located in the Hanford Site 200 West area) for disposal. The upper 15 cm (6 in.) of topsoil was then to be removed and stockpiled within the 300-FF-1 OU. Thickness of the remaining soil cover (overburden) was estimated to range from 1 to 4 m (3.3 to 13 ft) based on previous investigations. The overburden material was to be identified by field surveys, removed from the 618-4 Burial Ground, and stockpiled within the 300-FF-1 OU.

4.1.2 Waste and Debris Removal

Waste was to be removed from the 618-4 Burial Ground in horizontal or sloping-face lifts of 0.3 m (1 ft). Prior to being dispositioned, the excavated material was to be passed through a large sieve type apparatus (grizzly) with 15-cm (6-in.) openings, screened, and directed in one of the following ways based on the results:

- Waste above cleanup levels (ACL) and within the ERDF waste acceptance criteria was to be loaded into containers for shipment to ERDF.
- ACL waste that was not within the ERDF waste acceptance criteria or undetermined was to be set aside within the AOC for further characterization and final disposition.
- Material that was below cleanup levels (BCL) was to be stockpiled within the 300-FF-1 OU for use as backfill material.
- All debris was to be removed.

The process was to be repeated until excavation of the 618-4 Burial Ground was complete as indicated by the absence of debris in the excavated subgrade. As specified in Table 2, it was estimated that half of the material excavated from the 618-4 Burial Ground during the process of waste and debris removal would meet the criteria for BCL material and would be stockpiled at 300-FF-1 for later use as backfill.

4.1.3 Subgrade Removal

The 618-4 Burial Ground subgrade was to be excavated in accordance with the "confirm as clean" process documented in the RDR/RAWP (DOE-RL 1997). The confirm as clean process consists of ACL soil removal in 0.3-m-(1-ft) thick layers followed by field surveys and screening to determine if further soil removal is required. The process is then repeated as needed until all ACL soil has been removed or until the groundwater table has been reached.

4.2 SUBCONTRACT STRATEGY AND SELECTION

A technical specification was prepared to support competitive-bid procurement of a subcontractor to perform the remedial action activities for all of the 300-FF-1 OU waste sites. The specification included the initial design plan elements and schedule requirements for the 618-4 Burial Ground as documented in Section 4.1. One subcontract was to be awarded to the technically qualified bidder with the lowest evaluated price.

The solicitation permitted bidders to select the crew size and heavy equipment to perform the scope and schedule requirements. Bidders were requested to submit proposals demonstrating technical qualification and to provide unit pricing for several pay items based on the amount of material excavated in metric tons. The scope of work included unit price pay items to perform the following primary activities:

- Excavate and stockpile soil cover (overburden)
- Excavate, load, and haul ACL material
- Excavate and stockpile BCL material.

The unit price mechanism was used because of uncertainties with the actual amount of material to be excavated. Bidders were also requested to submit time and materials pricing to excavate and store ACL material that could not be transported to the ERDF. Lump sum was the preferred pricing mechanism for scope that could be better quantified up-front and was used in the solicitation for the other 300-FF-1 OU waste sites whenever possible.

The ERC team received proposals from seven bidders. It was determined that each bidder met the minimum technical qualifications based on the information submitted in the respective proposals. The remedial action subcontract was awarded based on having the lowest evaluated price for the 300-FF-1 OU scope of work.

4.3 DATA QUALITY OBJECTIVES

A DQO process based on U.S. Environmental Protection Agency (EPA) guidance (EPA 1994) and implemented by BHI-EE-01, *Environmental Investigation Procedures*, Procedure 1.2, "Data Quality Objectives," was used for the 300-FF-1 OU to accomplish the following objectives:

- Identify the criteria for shipment of contaminated soil and debris to the ERDF
- Identify the criteria for demonstration that cleanup standards established by the ROD (EPA et al. 1996) were met following completion of remediation activities
- Provide the information necessary to develop a sampling and analysis plan (SAP) strategy for evaluation of soil and debris against the criteria

The process included participation from the Environmental Restoration Contractor (ERC) team, U.S. Department of Energy, Richland Operations Office (RL), EPA, Washington State Department of Ecology, and Department of Health representatives. Through the DQO process, it was concluded that six verification samples were required from the excavated 618-4 Burial Ground and six verification samples were required from the BCL stockpile to demonstrate achievement of the cleanup standards and acceptability of the overburden stockpile for use as backfill material. Complete results of the DQO process including decision error tolerances and evaluation criteria for verification sample results are documented in the *300-FF-1 Remedial Action Sampling and Analysis Plan DQO Process Summary Report* (BHI 1997a). Based on inputs from the DQO process, the SAP was developed and issued as an appendix to the RDR/RAWP (DOE-RL 1997a).

As planning for implementation of remediation activities at the 618-4 Burial Ground continued, it became evident that additional information was necessary to guide the excavation process due to the anticipated diversity of materials that could be unearthed. This led to performance of a supplemental DQO process to support the following objectives specific to the 618-4 Burial Ground:

- Define "anomalous waste" and establish the process for identification, handling, characterization, and disposition of items/material identified as anomalous.
- Establish processes for collection of information during the remediation activities that could be used to assist with planning and implementation of remediation activities at other Hanford Site burial grounds, including excavation versus leave-in-place determinations.

Representatives from the ERC team, RL, and the EPA participated in the supplemental DQO process and results are documented in the *Data Quality Objectives Summary Report for the 618-4 Burial Ground* (618-4 DQO report)(BHI 1997c).

Anomalous waste was defined as material identified during the excavation process that was not profiled for disposal at ERDF in accordance with applicable procedures from BHI-EE-10, *Waste Management Plan*. Evaluation of material and identification of anomalous waste was to be made on the vertical dig face, on material retained by a segregation grid (grizzly), and on material passing through the grizzly. A series of logic diagrams and associated contingencies were developed and documented in the 618-4 DQO report (BHI 1997c) to guide activities for further characterization of material identified as anomalous to determine its disposition.

4.4 HEALTH AND SAFETY

The *Health and Safety Plan for the 300-FF-1 Operable Unit* (HASP) (BHI 1997d) was prepared as a project document to establish the bounding requirements for the RAS and provide a basis for preparation of site-specific health and safety plans by the subcontractor. Based on available information, a hazards categorization was completed for the 300-FF-1 OU waste sites. The sites were determined to be non-nuclear or industrial facilities classified as "low hazard" or "low to moderate hazard." Because of limited information for the 618-4 Burial Ground, the hazard classification was unknown but was anticipated to be "low to moderate hazard" depending on what was found during the excavation. Definitions of "low" and "moderate" hazards are provided as follows:

- **Low.** Hazards that present minor onsite and negligible offsite impacts to human health and the environment.
- **Moderate.** Hazards that potentially present considerable onsite impacts to human health and the environment, but minor offsite impacts.

Personal protective equipment (PPE) was to be established by the RAS for each task and documented in the site-specific health and safety plan. In accordance with the HASP (BHI 1997d), level D PPE (work clothes, no respiratory protection) was anticipated for worker protection of both radiological and chemical hazards. Industrial hygiene (IH) support and associated monitoring were to be provided by the RAS as needed during excavation activities.

4.5 READINESS ASSESSMENT

A readiness assessment for the 300-FF-1 OU remedial action task was performed prior to initial startup in accordance with BHI-MA-02, *ERC Project Procedures*, Procedure 8.2, "Readiness Assessments." The 618-4 Burial Ground was included in the scope of the assessment. Results of the assessment were documented in the *Remedial Action and Waste Disposal Project - 300-FF-1 Remedial Action Readiness Assessment Report* (BHI 1997e). Approval to begin remediation of the 300-FF-1 OU liquid waste disposal sites was received in July 1997. The report required separate approval for initiation of remedial action activities at the 618-4 Burial Ground and 300-FF-1 OU landfills pending completion of contingency planning to satisfy Functional Review Requirement (FRR) number 22 and a meeting with RL and ERC team project managers to present the results.

A team of individuals with expertise in areas including industrial and radiological safety, sampling and analysis, waste management, project design, and 300 Area operations was organized to perform the contingency planning. The effort included a brainstorming session and subsequent meetings to identify the events/conditions that would require some level of contingency planning and their associated attributes. The product consisted of a collection of planning worksheets that were used to document each individual contingency event/condition. The planning worksheets fell into one of the three categories to document events/conditions that:

- Were addressed by current or planned revisions to existing project and/or ERC documents
- Required development of a new contingency plan before startup
- Would require development of a new contingency plan when or if the event/condition occurred during remediation (e.g., deemed unlikely to occur, resulted in low impacts to the project, and/or had an adequate response time available).

A project-controlled desk instruction was issued to address events/conditions that required new plans prior to startup. A list of contingency planning events/conditions that were identified by the team, and a summary of their attributes is provided in Appendix A.

Completion of the contingency planning effort was documented on the FRR worksheet, and a meeting was held with the appropriate project managers to present the results and discuss the strategy for initial excavation activities at the 618-4 Burial Ground. Authorization to proceed with excavation of contaminated material from the 618-4 Burial Ground and 300-FF-1 OU landfills was received from RL in October 1997 (DOE-RL 1997b).

5.0 REMEDIATION PROCESS

The remediation process for the 618-4 Burial Ground was implemented in accordance with the RDR/RAWP (DOE-RL 1997a). Activities were performed intermittently between October 1997 and April 1998. The material removed from the 618-4 Burial Ground through the end of April 1998 (including cover and soil/debris) represents approximately 42% of the work to be performed based on the volume/tons estimated in the design package. The total cost of the project through July 1998 was approximately $3.4 million, with the increase in projected cost due to the excavation and handling of large quantities of anomalous waste. Additional cost information is provided in Appendix B. Information related to excavation operations, demobilization, equipment, and personnel is presented in the subsections that follow.

5.1 EXCAVATION OPERATION

The excavation operation for the 618-4 Burial Ground included the removal of cover material, excavation of soil and debris, and subgrade removal. Concurrent with the initiation of activities at the 618-4 Burial Ground, remediation was being performed at the 628-4 Landfill 1D (Landfill

1D), a small 300-FF-1 OU waste site documented to be a burn pit between 1962 and 1974 for miscellaneous nonradioactive operations debris. The concurrent excavation operations were the result of ERC team acceptance of a RAS proposal to recover some earlier schedule variances. Excavation activities at both waste sites were anticipated to continue through completion of the remediation process at Landfill 1D.

Remedial action activities at the 618-4 Burial Ground were initiated in October 1997 and performed intermittently until a decision was made to postpone excavation operations in April 1998. A chronology of major events that occurred at the 618-4 Burial Ground and other relevant 300-FF-1 OU waste sites during that time period is provided in Table 3.

Table 3. Chronology of Major Events at the 618-4 Burial Ground. (2 sheets)

Date(s)	Event Summary
Oct 29, 1997	Topsoil removed. Concurrent remediation of Landfill 1D (1D) being performed.
Oct 30 – Nov 11	Overburden removal; debris encountered in some areas 1-2 ft below original grade.
Nov 12	Work suspended at 618-4 and 1D until safety evaluation could be performed; prompted by unexpected excavation of drummed liquid waste at 1D. Decision made on Nov 13 to use level B PPE at landfills and 618-4 Burial Ground until adequate information exists to downgrade.
Dec 5	Excavation resumed at 1D under level B PPE. Excavation at 618-4 postponed until 1D completed.
Jan 12, 1998	NPL agreement form signed documenting approval to implement waste identification techniques other than use of a grizzly at the 300-FF-1 landfills and 618-4 Burial Ground.
Jan 27	Demobilization from 1D initiated; unable to dispose of large volume of excavated and stockpiled lead contaminated soil. Remobilization to 618-4 initiated.
Feb 3	Removal of overburden resumed at 618-4 under level B PPE.
Feb 6 – Feb 17	Waste excavation performed under level B PPE; mostly non-asbestos, non-hazardous rad contaminated soil. Miscellaneous anomalous waste items unearthed including isolated drums w/liquid material. Work reasonably efficient.
Feb 17 – Mar 12	Continued waste excavation. Areas of lead- and barium-contaminated soil identified. Widespread asbestos intermixed w/soil and debris identified in several areas; perimeter marked with asbestos tape and excavation equipment was shifted to other areas within the AOC as encountered. Letter of Intent (LOI) submitted to Benton County Clean Air Authority for asbestos work. Productivity slowed. Area of drummed waste identified Mar 12 in central part of AOC.
Mar 13 – Mar 23	Excavation of drummed waste exclusive activity. Many drums intact w/evidence of containing oil material and stenciled with "D38" marking. Drums appeared to have been previously stacked on wooden pallets and banded together in groups of four. Evidence of second layer identified.
Mar 18	Toothless (straight-edged) bucket installed on track-hoe excavator to replace toothed bucket. Purpose of toothless bucket was to reduce chance to tear/puncture anomalous waste items/drums during excavation.
Mar 24 – Mar 30	Excavation of drummed waste put on hold to focus on soil removal. Excavation of material in asbestos areas performed under Asbestos Action Plan; material handled and packaged as asbestos for shipment to ERDF.

Table 3. Chronology of Major Events at the 618-4 Burial Ground. (2 sheets)

Date(s)	Event Summary
Mar 26	Decision made to stockpile suspect lead contaminated soil; criteria developed to test and release stockpile material prior to being loaded into ERDF containers to prevent the potential for loaded containers to be removed from service based on results from routine process monitoring samples.
Mar 31	Exclusive excavation of drummed waste resumed; evidence of second and possibly third layer present. As many as 1,500 total drums estimated based on area of geophysical survey anomaly and assumption of three layers.
Apr 2	Excavation of drummed waste suspended based on new information from retired Hanford 300 area employee that "D38" marking used to indicate depleted uranium; pyrophoric material commonly stabilized with oil. XRF results confirm presence of uranium metal in grab samples from two drums with access to contents. Total of 338 drums excavated from central area of burial ground since Mar 12. Notification of pyrophoric uranium metal made in accordance with CERCLA Section 103 (c).
Apr 3 – Apr 9	Excavation of bulk soil and debris performed while planning for stabilization and management of drummed waste.
Apr 6 – Apr 17	Fire watch maintained during nonbusiness hours. Nonintrusive temperature monitoring of excavated drums performed w/infrared thermometer.
Apr 11 – Apr 17	146 drums stabilized w/mineral oil and overpacked in accordance with *Field Instruction: 618-4 Burial Ground Drummed Waste Stabilization*.
Apr 22	Decision made to move remedial action operations from 618-4 Burial Ground to a liquid waste disposal site (North Process Pond) to permit planning for continued excavation, characterization, and disposition of drummed waste at burial ground. Mineral oil added to three additional overpacks for a total of 149 stabilized drums.
Apr 23 – May 5	Demobilization from 618-4 Burial Ground performed. Remainder of excavated drums considered stable and dry overpacked for interim storage within AOC. Other anomalous wate materials overpacked for interim storage within the AOC. Crusting agent applied to soil surfaces and stockpiles.
May 5	Nonintrusive monitoring of drummed waste at 618-4 Burial Ground initiated twice per month. Excavation initiated at North Process Pond.

AOC = area of contamination
ERDF = Environmental Restoration Disposal Facility
NPL = National Priorities List
PPE = personal protective equipment

The quantity of materials excavated and dispositioned during the active period of remedial action activities at the 618-4 Burial Ground is summarized with production rate estimates in Table 4.

Table 4. 618-4 Burial Ground Excavation Summary.[a]

Item	Disposition	Quantity (metric tons)	Productivity (LCY/h)
Bitterbrush	Transplanted Southeast of AOC	24 plants	N/A
Cover (topsoil/overburden)[b]	Stockpiled North of AOC	11,042	143
Soil/debris (level B PPE)			
- BCL	- Stockpiled North of AOC	0	N/A
- ACL	- ERDF	18,082	32/21[c]

ACL = above contamination level
AOC = area of contamination
BCL = below contamination level
LCY = loose cubic yards
N/A = not applicable
PPE = personal protective equipment
[a] Includes activities completed through decision to postpone remediation at the 618-4 Burial Ground in April 1998.
[b] Cover was removed in two phases. Phase 1 consisted of 7150 m tons removed under level D PPE. Phase 2 consisted of 3982 m tons removed under level B PPE.
[c] Production rate estimated to be 32 LCY/h during periods when isolated anomalies were excavated. Estimated rate reduced to 21 LCY/h during periods of when large quantities of anomalous waste including suspect LDR material and drummed waste were excavated.

Copies of selected photographs from the 618-4 Burial Ground excavation activities are presented in Appendix E. Specific information related to the various tasks is provided in the following subsections.

5.1.1 Cover Removal

Prior to removal of the soil cover, 24 bitterbrush plants that were immediately adjacent to the 618-4 Burial Ground AOC were transplanted to a designated area southeast of the 618-4 Burial Ground on October 8 and 9, 1997. The plants were not removed from within the AOC in accordance with the design plan because they could not be radiologically released. As a result, a backhoe excavator was used to remove the bitterbrush plants from an area that would later be disturbed when the site is backfilled/recontoured. The backhoe excavator was also used to dig the transplant holes. A natural resources representative from the ERC team was present to observe and guide the transplant activities. Radiological field surveys were performed to confirm that each plant was not above background levels prior to being removed from the ground. Few of the bitterbrush plants survived after being transplanted.

Removal of the soil cover was initiated on October 29, 1997. The PPE worn by site workers during removal of the soil cover was level D as specified in Section 9.0 of this report. A shallow layer of topsoil approximately 15 cm (6 in.) in depth was scraped from the surface and put into a clean soil stockpile on the south side of the 618-4 Burial Ground within the AOC. Following removal of topsoil, a radiological field survey was performed. Material that was identified as BCL based on the survey and visual absence of debris was excavated in a 0.3-m (1-ft) horizontal lift as overburden and was put into a clean soil stockpile for BCL material north of the 618-4

Burial Ground AOC. The survey and removal process was repeated in 0.3-m (1-ft) horizontal lifts. As the overburden material was excavated, some areas of debris and/or ACL materials were encountered approximately 0.3 to 0.6 m (1 to 2 ft) below the original surface. This material was left in place and excavation equipment was moved to other areas to continue the removal of overburden.

Prompted by unexpected excavation of anomalous liquid waste materials at Landfill ID, all 300-FF-1 OU excavation activities, including the 618-4 Burial Ground, were suspended in mid-November 1998 until a safety evaluation could be performed. Based on the potential to excavate unknown chemical hazards, a subsequent decision was made that level B PPE would be used by all workers at the 300-FF-1 landfills and the 618-4 Burial Ground until adequate information was available to permit a downgrade. A total of 7,150 metric tons of overburden material had been excavated from the 618-4 Burial Ground and stockpiled under level D PPE through the decision to suspend work. The estimated productivity rate for the cover removal operation during this period was 143 loose cubic yards (LCY)/hour using the equipment and personnel identified in Sections 5.3 and 5.4, respectively.

Excavation resumed at Landfill 1D in early December 1998 following mobilization of Level B equipment and completion of respirator use training by all site workers. Operations at the 618-4 Burial Ground were postponed until completion of remediation at Landfill 1D.

Excavation of overburden material at the 618-4 Burial Ground resumed in early February 1998 under level B PPE. The same survey and excavate process that was previously employed was used to remove the remaining overburden material. Approximately 3,892 metric tons (4,390 U.S. tons) of overburden material was excavated and stockpiled during the level B operations, bringing the total amount of overburden material removed from the 618-4 Burial Ground to approximately 11,042 metric tons (12,174 U.S. tons). The total was less than one-third of the 35,000 metric ton (38,588 U.S. ton) estimate that was specified in the design plan as documented in Section 4.1. The depth of overburden material was found to range from 0 to 2.4 m (0 to 8 ft) in comparison with estimates of 1 m to 4 m (3.3 to 13 ft) that were determined from the previous investigations discussed in Section 2.3.

5.1.2 Soil and Debris Excavation

In accordance with the original plans specified in Section 4.1 of this report, excavated material from the 618-4 Burial Ground was to be passed through a 15-cm (6-in.) grizzly before being dispositioned. Experience with use of the grizzly at Landfill 1D prior to excavation of waste material at the 618-4 Burial Ground led to proposed modifications in the waste excavation/identification process to improve efficiency. A field demonstration was conducted in January 1998 to show representatives of the EPA and RL four additional techniques to sort/disposition waste material as described below:

- **0.3-m (1-ft) Horizontal Lifts.** The exposed surface of each lift was visually observed, radiologically screened, sorted as necessary, then excavated by the trackhoe and stockpiled. Material was also observed as it was being stockpiled for any additional sorting that was appropriate.

- **0.3-m (1-ft) Diagonal (Sloping) Lifts.** The exposed surface of each lift was visually observed as it was raked down the face of the excavation slope by the trackhoe from top to bottom. Material was radiologically surveyed at the bottom of the slope, sorted as necessary, and stockpiled. Material was also observed as it was being stockpiled for any additional sorting that was appropriate.

- **Bulk Excavate and Spread.** Material was bulk excavated with the trackhoe, then spread onto the ground in approximately 0.3-m (1-ft) layers. The spread material was then radiologically screened and sorted.

- **0.2-m (0.6-ft) Loader Lifts.** The surface of each lift was visually observed, radiologically screened, sorted as necessary, then excavated using the front-end loader (best suited for areas of little visible debris).

A 300 NPL Agreement/Change Control Form (BHI 1998a) was used to document approval of each of the proposed excavation techniques. The agreement permitted the 300-FF-1 OU project team to select and use the most effective sorting technique based on the conditions at the dig site (the grizzly was included as an approved technique for a total of five options).

Excavation of contaminated material and debris was initiated at the 618-4 Burial Ground on February 6, 1998. Workers at the site were outfitted in level B PPE during all excavation operations. The objective was to excavate and remove all ACL material and debris until native soil was reached. To the extent possible, material that could be identified as BCL during the excavation process was to be separated from the debris/ACL material and stockpiled outside of the 618-4 Burial Ground AOC. Material was typically excavated in 0.3-m (1-ft) horizontal lifts as described earlier in this section. Other techniques including diagonal lifts and bulk excavation/spread were used depending on the size and amount of debris present in a given area. The grizzly was not used at any time during excavation of the 618-4 Burial Ground.

Production was relatively efficient during the first weeks of waste excavation at the 618-4 Burial Ground. Excavated material consisted mostly of uranium-contaminated soil mixed with metallic debris. Debris that was too large to meet the ERDF waste acceptance criteria was set aside within the AOC but outside of the excavation perimeter for subsequent sizing. Isolated anomalous waste items were identified and set aside for characterization with minor impacts to excavation efficiency. A much higher ratio of debris/ACL material to BCL material was found during the excavation process than had been anticipated. The estimated productivity rate for the soil/debris removal operation during this period was 32 LCY/hour using the equipment and personnel identified in Sections 5.3 and 5.4, respectively.

ACL material and debris that was not identified as anomalous waste was initially loaded directly into haul containers that were subsequently staged in the 300-FF-1 queue until they were picked up by the ERDF trucking operation. During the process of filling containers at the 618-4 Burial Ground, radiological screens were performed and routine process monitoring samples were collected for each 115 m^3 (150 yd^3) of material loaded. The surveys were performed and samples were analyzed in accordance with Section 6.0 of this report. Results were usually available within 24 hours. Each night, ERDF haul trucks would pick up the containers that were filled that day and transport them to the ERDF.

Production slowed to an estimated rate of 21 LCY/hour during the subsequent weeks of operation. Much greater quantities of asbestos material and anomalous waste, including drummed liquid materials that were not anticipated to be in the 618-4 Burial Ground, were encountered. In some cases, chemical anomalous waste materials (e.g., potential land disposal restriction [LDR] lead concentrations) that had not been previously identified during the excavation process were found based on the routine monitoring results. While the initial process timing was adequate to prevent anomalous waste from inappropriate disposal at the ERDF, it occasionally resulted in specific containers or groups of containers being held in the 300-FF-1 queue or at the ERDF until a final LDR determination could be made. If additional analytical results were required to make the determination, the subject containers were out of service for an extended period of time that was unacceptable to the project.

The process was later modified to prevent loaded containers from being held/taken out of service during characterization. Material that was identified as anomalous based on the sorting technique was set aside for characterization as before. Material not initially identified as anomalous waste was excavated and put into a small stockpile within the AOC. Samples were collected from the completed stockpile based on its estimated size (e.g., minimum of one sample per stockpile or for each 115 m^3 [150 yd^3], whichever was greater). Prior to being loaded into ERDF containers, a final determination was made on each stockpile based on the following criteria approved by the EPA and RL:

- The stockpile was released for loadout into ERDF containers if all associated screening results were within the ERDF acceptance criteria.
- The stockpile was put on hold if results for one or more of the associated samples potentially exceeded the acceptance criteria. In such cases, a split of the sample with the highest concentration was sent to the contract laboratory for additional characterization.
- The stockpile was released for loadout into ERDF containers if the laboratory results were within the acceptance criteria. If the laboratory results exceeded the acceptance criteria, the material remained on hold and was added to a master stockpile within the AOC.

The presence of large quantities of anomalous waste materials (specifically drummed waste that appeared to contain oil and uranium metal) led to a decision to suspend and eventually postpone excavation activities at the 618-4 Burial Ground in April 1998. Pending the disposition of drummed waste at the 618-4 Burial Ground, equipment and personnel were demobilized from the site and the excavation operations were moved to a 300-FF-1 OU liquid waste disposal site in May 1998. Additional information related to anomalous waste and asbestos material at the 618-4 Burial Ground including their associated impacts to the excavation operation is presented in the subsections that follow.

5.1.2.1 Anomalous Waste. The primary responsibility for the identification of anomalous waste material was assigned to ERC team waste management personnel who were present at the dig site during all operations to observe the material as it was being excavated. Any of the other workers (ERC team or RAS) at the 618-4 Burial Ground site during operations were able to assist the waste management personnel with the anomalous waste identification process.

Material identified as anomalous or potentially anomalous waste was handled in accordance with the process established in the 618-4 DQO report (BHI 1997c) and summarized in Figure 6. The primary objective for handling anomalous waste material was to make an initial "safe to move/handle" determination and then to move the material into a staging location within the AOC away from the active excavation area. If the anomalous material was intermixed with the soil (versus a discrete item), it was separated to the extent practical and stockpiled away from the active excavation area. This process was established to permit the excavation equipment to remain productive while characterization and a final determination was made on the anomalous material. In cases where it was not possible to move the material to a staging location, excavation equipment was moved to another area of the 618-4 Burial Ground to continue the excavation operation. Anomalous waste material were characterized using the available analytical resources as described in Section 6.0.

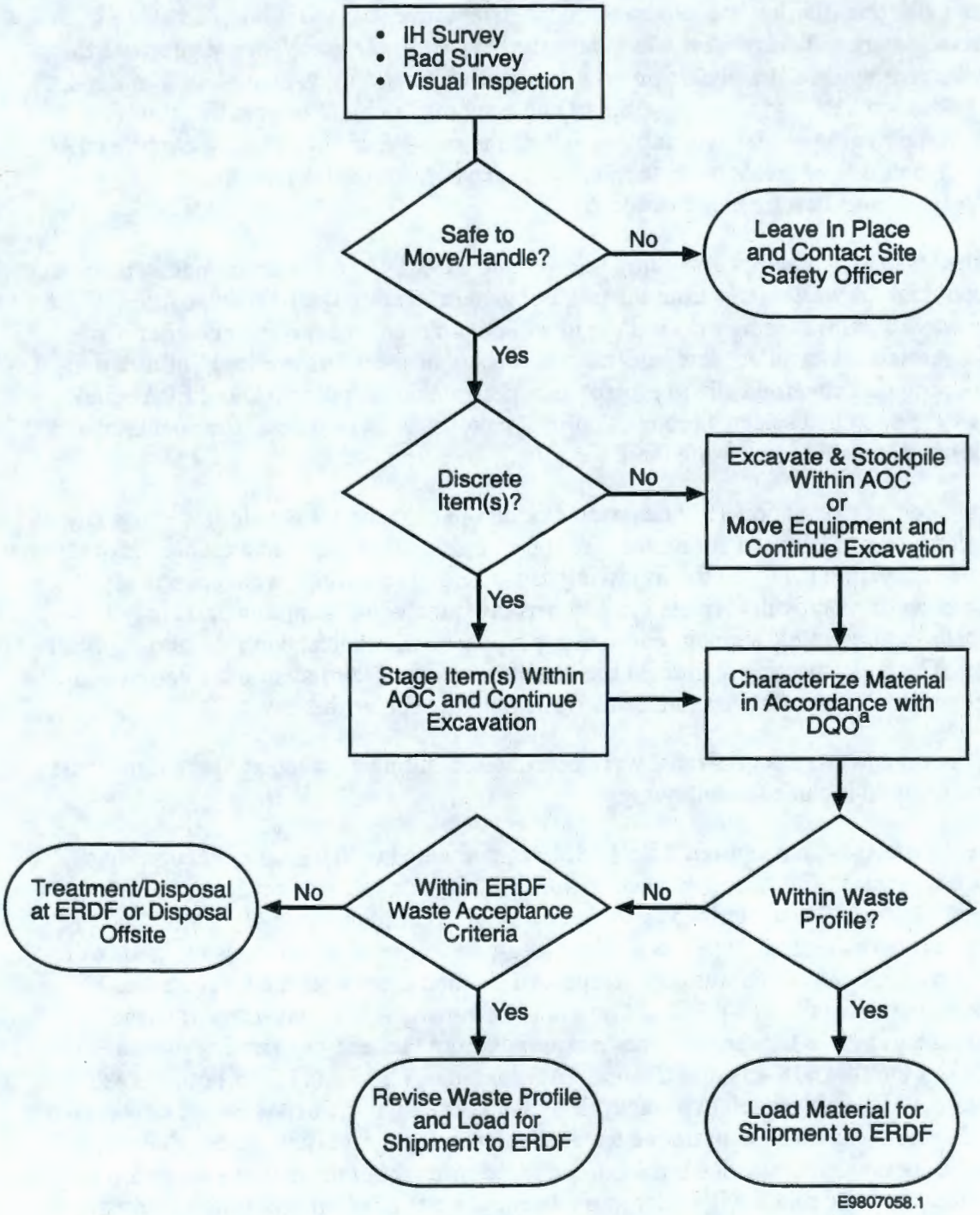
A spreadsheet was developed as a working tool for 300-FF-1 OU project team members to track and status anomalous waste items from the point of generation through final disposition. Each anomalous waste item was assigned a unique identification number for reference after it was excavated. As needed to reflect new information, the spreadsheet was updated, information copies were provided electronically to project team personnel (including RL and EPA), and hardcopies were posted at selected project facility locations. An example of the anomalous waste tracking spreadsheet is provided in Figure 7.

At the conclusion of excavation activities each day, an open meeting was held to discuss any new anomalous items identified during the day and any issues that required attention prior to the beginning of excavation activities the following day. The daily meetings were open to all personnel, but were specifically targeted to key personnel including sampling and analytical support, waste shippers, field support, engineering support, radiological controls, and subcontract supervision. The daily meeting facilitated the communication of consistent information and was used to gather information for the anomalous waste tracking spreadsheet.

Specific anomalous waste materials that were encountered during excavation operations at the 618-4 Burial Ground include the following:

- **Lead/Asbestos-Contaminated Soil.** Soil contaminated with lead at concentrations exceeding the LDR limits published in 40 CFR 268 was found throughout the 618-4 Burial Ground. The material was identified by discoloration (typically white) and/or routine process monitoring. Much of the lead-contaminated soil was also mixed with asbestos. Although lead was used in fuels fabrication processes, the source of lead contamination in the 618-4 Burial Ground is unknown. It is possible that the lead contamination was the result of waste materials from the lead-dip canning process that were put into the 618-4 Burial Ground. Approximately 88 m^3 (115 yd^3) of lead/asbestos contaminated soil was left in a stockpile at the west-end of the 618-4 Burial Ground when the decision was made to postpone excavation operations. It is anticipated that lead-contaminated soil will continue to be found throughout the material that remains to be excavated and that it will undergo treatment to meet LDR criteria followed by disposal at the ERDF.

Figure 6. Summary of Anomalous Waste Handling Process.



[a] Data Quality Objectives Summary Report for the 618-4 Burial Ground (BHI 1997c)

Figure 7. Anomalous Waste Tracking Spreadsheet Example.

Field Use Only

300-FF-1 ANOMALOUS WASTE TRACKING - 618-4 Burial Ground

ITEM #	DATE	SITE LOCATION			H&S SCREEN		DESCRIPTION	STAGING INFO		SAMPLE INFO									DISPOSITION			
		North	East	Depth	VOC<5	Rad		Date	Description (incl container IDs)	Date	Field ID	Tests	RCF ID	Tests	Lab ID	Tests	Comments		Description	Facility	Shipped Date	
yymddyy-BG-nn	mm/dd/yy	m	m	ft	ppm	pCi/g		mm/dd/yy		mm/dd/yy										ERDF, etc	y/n	mm/dd/yy
022498-BG-01	2/24/98				Y	N	fine white/salt like material layered between 022498-BG-02 and -03; 3500 cpm; *item # assigned subsequent to excavation*	2/24/98	material put on plastic in SW corner of excavation and excavation to other area; tracked as stockpile 040698-02	2/24/98	B0N269	XRF	B0N280	tot activity	B0N279	TCLP	XRF results 4600 ppm Ba, 304 ppm Pb; RCF/Lab samples collected on 2/24; TCLP Ba>limit (122ppm)	hazardous for Ba (D005)	tbd	N	
022498-BG-01a	2/24/98						milk can type container ~40 gal in size with ~10 gal liquid material inside	4/30/98	container and contents put into 85 gal poly overpack (300A-98-0027)													
022498-BG-02	2/24/98				Y	N	rust colored layer w/clumps of fine deposits above 022498-BG-01 and -03; 17K cpm; *item # assigned subsequent to excavation*	2/24/98	material put on plastic in SW corner of excavation and excavation to other area	2/24/98	B0N268	XRF	B0N278	tot activity	B0N277	TCLP	XRF results 4300 ppm Ba, ~250 ppm Cr, 180 ppm Pb; RCF/Lab samples collected on 2/25; TCLP <limit	within profile; separate from 022498-BG-01 and -03 as practival and load into containers as encountered; monitor w/150 yd3 profile samples	ERDF	Y	n/a
022498-BG-03	2/24/98				Y	N	seafoam green layer of material beneath 022498-BG-01 and -02; 28K cpm; *item # assigned subsequent to excavation*	2/24/98	material put on plastic in SW corner of excavation and excavation to other area; tracked as stockpile 040698-02	2/24/98	B0N268	XRF	B0N276	tot activity	B0N275	TCLP	XRF results >45K ppm Ba; RCF/Lab samples collected on 2/26; TCLP Ba>limit (1170ppm)	hazardous for Ba (D005)	tbd	N	
022498-BG-04	2/24/98				Y	N	gray, lightweight, compressed cardboard type material; suspect asbestos; 400 cpm; *item # assigned subsequent to excavation*	2/24/98	left in place; stabilized, roped-off area and moved excavation to other area	2/24/98	na		na		B0N273	asbestos	70-80% chrysotile asbestos	bag as asbestos and load into containers as encountered	ERDF	Y	n/a
022598-BG-01	2/25/98	30	40	12	Y	N	off-white, clay type material when wet, w/long thin fibers; *item # assigned subsequent to excavation*	2/25/98	left in place; stabilized, roped-off area and moved excavation to other area	2/25/98	na		na		B0N283	asbestos	20-30% amosite asbestos	bag as asbestos and load into containers as encountered	ERDF	Y	n/a
022798-BG-01	2/27/98				Y	Y	10-15 gal of thin flushing oil like material from 55 gal drum	2/27/98	drum and oil put into 85 gal overpack (300A-97-0031); dirt and kitty litter used as absorbent put into 55 gal drum (300A-97-0024)	3/11/98	na		B0N2K0	tot activity	B0N2J9	VOA, SemiVOA, PCBs, TCLP	TCLP<limit; methylene chloride 2.8J, TCE 26, toluene 3.4J; semiVOA<detect; PCB<detect; 5.8 pCi/g TA		tbd	N	
030298-BG-01	3/2/98				N	Y	10-15 gal green liquid from 55 gal drum, resembles thick antifreeze; 125 ppm OVA inside drum, 4-15 ppm breathing zone	3/2/98	drum and liquid put into 85 gal overpack (300A-97-0027)	3/4/98	na		B0N2C6	tot activity	B0N2C5	VOA, SemiVOA, PCBs, TCLP	TCLP<limit; toluene 54J, ethylbenzene 72, xylenes 380; napthalene 1700, 2-methylnapthalene 2300; pest/PCBs<detect; 1 pCi/g TA		tbd	N	
030298-BG-02	3/2/98				Y	N	white powder material; 1500 pCi/g	3/2/98	material put into 55 gal drum (300A-98-0022)	3/2/98	B0N298	XRF, VOC					XRF 690 ppm Pb		tbd	N	
030398-BG-01	3/3/98	33	130	8	Y	N	~10 gal oil type liquid from damaged 55 gal drum	3/3/98	put into 85 gal overpack (300A-97-0022) with soil from surrounding area	3/5/98	na		B0N2F0	tot activity	B0N2D9	VOA, SemiVOA, PCBs, TCLP	TCLP<limit; TCE 0.74, toluene 0.81, xylenes 0.7; phenanthrene 14; PCB<detect; 1 pCi/g TA		tbd	N	
030498-BG-01	3/4/98	40	160	10	N	N	crushed drum w/small amt of liquid; 7000 ppm inside drum w/OVM	3/4/98	absorbant used to secure free liquid; drum bagged	3/4/98	na		B0N2C0	tot activity	B0N2B9	VOA, SemiVOA, PCBs, TCLP	TCLP<limit; TCE 150, PCE 4100; phenanthrene 230, dibenzofuran 30; heptachlor 0.67, aldrin 0.43; 23 pCi/g TA		tbd	N	
030498-BG-02	3/4/98				N	N	30-40 gal of oil type liquid and 2-3" water (two phase) in intact 55 gal drum; 22 ppm inside drum w/OVM	3/4/98	drum and liquid put into 85 gal overpack (300A-97-0029)	3/4/98	na		B0N2C2	tot activity	B0N2C1	VOA, SemiVOA, PCBs, TCLP	clear amber water phase; TCLP<limit; TCE 0.14, PCE 0.69, toluene 0.36; semiVOA and PCBs <detect; 1 pCi/g TA		tbd	N	

- **Lead Debris**. Miscellaneous pieces of debris containing elemental lead were found throughout the 618-4 Burial Ground. This material included 12 lead batteries that were attached to a forklift and large quantities of lead-contaminated aluminum/silicon slag and ingot pieces from 300 Area processing operations. To the extent possible, the individual pieces of lead debris were separated from the soil matrix during the excavation process and set aside within the AOC for future handling and disposition. When the decision was made to postpone excavation operations, approximately 38 m^3 (50 yd^3) of lead debris material was left in a stockpile at the west end of the 618-4 Burial Ground. It is anticipated that lead debris intermixed with soil will continue to be found and stockpiled when excavation resumes at the 618-4 Burial Ground. The material will likely be macro-encapsulated to meet the 40 CFR 268 treatment standard and disposed of in the ERDF when excavation activities at the 618-4 Burial Ground are completed. Lead debris from other ERC projects have already been disposed of in the ERDF after treatment.

- **Barium Contaminated Soil**. An area of contaminated material that exceeded the LDR limits published in 40 CFR 268 for barium was identified at the west end of the 618-4 Burial Ground by observation of soil discoloration, elevated readings of field survey results, and subsequent field screening and laboratory test results. Barium salts were used as a flux material for metal baths during 300 Area operations. The salts were likely scraped off the top of the baths and eventually disposed of at the 618-4 Burial Ground. The contaminated material was found in two layers: a fine white salt-like layer and green layer. Approximately 38 m^3 (50 yd^3) of barium-contaminated soil was left in a stockpile at the west end of the 618-4 Burial Ground. It is unknown if additional barium contaminated soil will be encountered when excavation operations resume at the 618-4 Burial Ground. It is anticipated that the barium contaminated soil will undergo treatment to meet LDR criteria followed by disposal at the ERDF.

- **Drummed Waste**. Approximately 338 drums were excavated from a central area of the 618-4 Burial Ground between March 12 and April 2, 1998. Most of the drums were intact, approximately 35 gal in size and had a stenciled D38 marking on the side. Some 55 gal drums that are suspected to be overpacks for the smaller drums were also unearthed. There was evidence that many of the drums contained an oil material based on observation of small leaks and/or residue on the side of the drums. Intact drums were not opened and were set aside within the AOC as they were excavated from the ground. Initial results of oil samples collected from four of the drums with accessible contents suggest that regulated levels of PCBs, lead, and volatile organic compounds may be present in the oil. Through an interview with a Hanford Site retiree, it was learned that the D38 marking was commonly used to indicate depleted uranium. It was further learned that oil was used to stabilize uranium metal chips from milling operations due to their pyrophoric characteristic. The information from the interview prompted the suspension of drummed waste excavation activities at the 618-4 Burial Ground on April 2, 1998.

The information from the interview also prompted development and implementation of a stabilization operation for drums that were suspected to be at risk due to estimated oil levels. Between April 11 and April 22, 149 drums were subsequently overpacked, stabilized with mineral oil, and staged within the AOC at the bottom of the excavation. The remaining drums were considered stable in their existing state (based on the absence of visible oil leaks and relative fullness), were dry-overpacked, and were staged within the AOC in the northeast corner. Based on field observations and geophysical information, there is evidence that up to 1,200 additional drums remain to be excavated from the central area of the 618-4 Burial Ground.

Pending disposition of the drummed waste, a decision was made postpone remediation of the 618-4 Burial Ground and mobilize to a 300-FF-1 liquid waste disposal site on April 22, 1998. Development of DQOs and subsequent characterization of the drummed waste is scheduled to be complete by the end of fiscal year (FY) 1998. Based on the characterization results, plans for continued excavation of the drummed waste and selection of treatment/disposal methods is scheduled to be complete in mid-FY 1999. Remediation of the 618-4 Ground is scheduled to resume at the end of FY 1999. Supplemental information associated with the drummed waste is provided in Appendix C.

5.1.2.2 Asbestos. Like anomalous waste, asbestos material was found in the 618-4 Burial Ground in greater quantities than was expected. The asbestos material found included pieces of transite siding, compressed cardboard-type material, and coatings from kilns. In some areas, pieces of asbestos material were intermixed with the soil and debris (including lead-contaminated soil). When this type of material was encountered, the area was roped off and excavation equipment was moved to a different area of the 618-4 Burial Ground to continue the excavation operation.

As the excavation process continued, enough areas of intermixed soil/debris and asbestos material were identified such that some sections of the 618-4 Burial Ground were designated as asbestos work areas. Because of the determination, a notice of intent to the Benton County Clean Air Authority with a 10-day waiting period was required. In addition, discussions were required with ERDF personnel to determine how the material would be handled at the disposal facility.

Additional requirements for training, PPE, and personnel monitoring were implemented for the asbestos work as discussed in Section 9.0. As shipping containers were loaded with material from designated asbestos areas within the 618-4 Burial Ground, a crusting agent was immediately applied to prevent the material from becoming airborne during transportation to the 300-FF-1 frisking station. After radiological surveys were completed at the frisking station, the material was sealed in double liners for protection during transportation to and offloading at the ERDF. It is anticipated that areas of asbestos material intermixed with soil and debris will continue to be encountered in the 618-4 Burial Ground when excavation operations resume.

5.1.3 Subgrade Removal

It is believed that the subgrade was reached on the sloping surface at the far west end of the 618-4 Burial Ground as evidenced from visual observation of native soil/cobble and the absence of debris. Subgrade material at the bottom of the disposal pit was not reached in any areas of the 618-4 Burial Ground before excavation operations were postponed in April 1998. When excavation operations resume at the 618-4 Burial Ground and the subgrade is reached, it will be subjected to the "confirm as clean" process documented in the RDR/RAWP (DOE-RL 1997a) and summarized in Section 4.1. Following any necessary removal actions associated with the subgrade material, verification samples will be collected as prescribed in Section 6.3 to confirm that cleanup objectives are met.

5.2 DEMOBILIZATION

Demobilization from the 618-4 Burial Ground was initiated on April 23, 1998. The following items were completed as part of demobilization activities:

- All drums that had been excavated and previously determined to be stable were dry-overpacked in 85-gal poly containers and put on the excavation shelf within the AOC on the north side of the 618-4 Burial Ground toward the east end.
- A clean soil cover 1 m (3.3 ft) in depth was placed over the drummed waste face that had been previously exposed but was not yet excavated. The location was marked for future reference when excavation resumes.
- General regrading was performed to prevent surface ponding in the event of precipitation.
- Equipment and support facilities were removed.
- A crusting agent was applied to all of the soil surfaces and stockpiles within the 618-4 Burial Ground AOC to provide dust control during the period of inactivity.

Demobilization was completed on May 5, 1998. A general inventory of items remaining at the 618-4 Burial Ground is summarized in Table 5 and depicted in Figure 8.

Figure 8. General Inventory of Materials at the 618-4 Burial Ground.

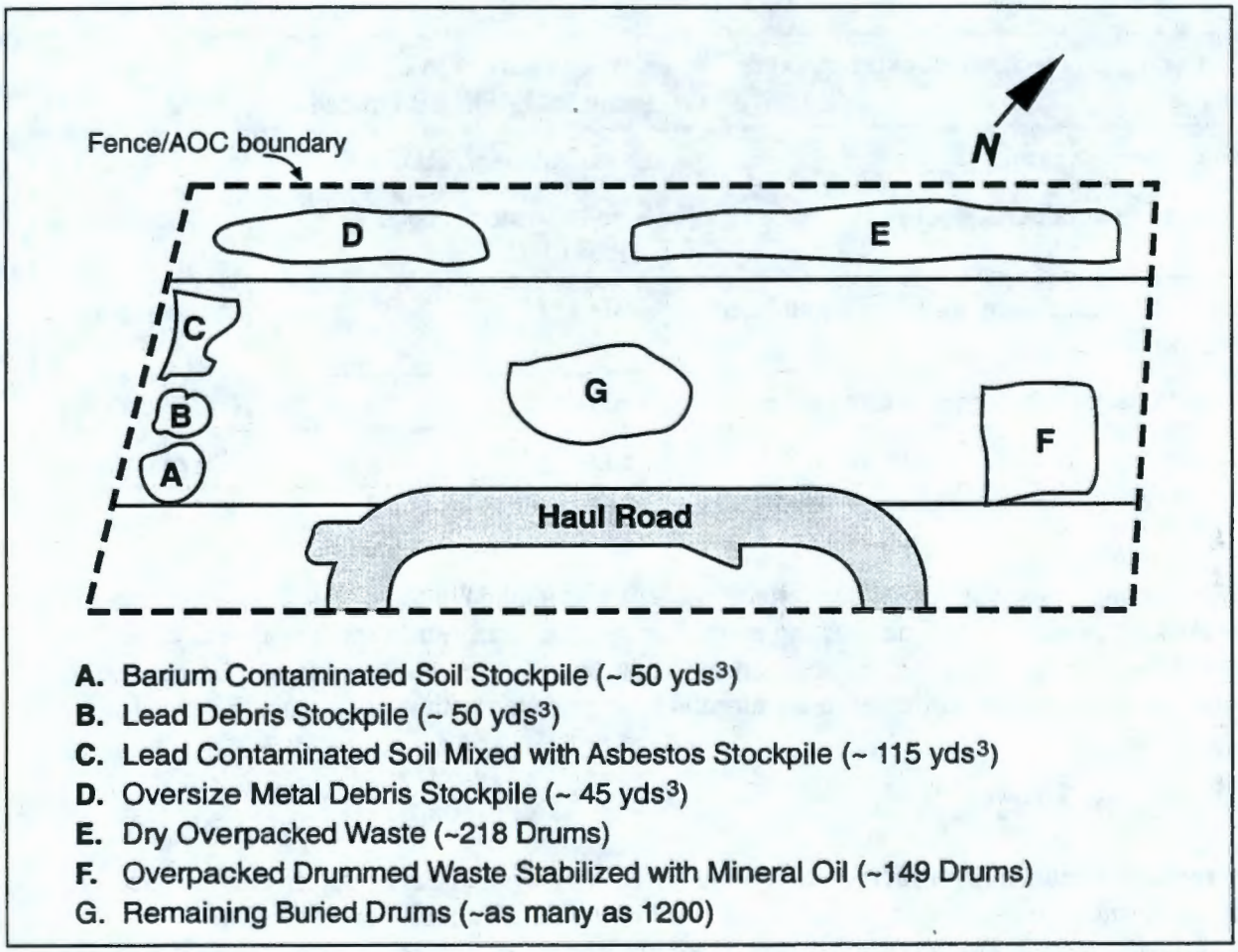


Table 5. General Inventory at the 618-4 Burial Ground After Demobilization.

Item	Disposition	Quantity
Barium contaminated soil stockpile	TBD, treatment to LDR standard/ERDF anticipated	50 yd^3
Lead-contaminated soil stockpile mixed w/asbestos	TBD, treatment to LDR standard/ERDF anticipated	115 yd^3
Lead debris stockpile	Encapsulation/ERDF	50 yd^3
Oversize metal debris stockpile	Size to waste acceptance criteria/ERDF	45 yd^3
Drummed waste overpacked and stabilized with mineral oil	TBD	149 drums
Dry-overpacked drummed waste	TBD	189 drums
Other overpacked anomalous waste	TBD	29 overpacks

ERDF = Environmental Restoration Disposal Facility
TBD = to be determined

Twice per month, the surfaces where crusting agent was applied at the 618-4 Burial Ground are inspected for degradation. The crusting agent is reapplied to any surfaces that appear to be compromised. Regardless of the condition of the surface, new crusting agent will be applied to the soil surfaces and stockpiles each six months in accordance with manufacturer instructions.

5.3 EQUIPMENT

The remedial action subcontract permitted the RAS to select the heavy equipment to be used for excavation of the 618-4 Burial Ground based on the material estimates and schedule requirements specified in the design plan. The equipment that was used by the RAS during operations and the associated excavation capacities are summarized in Table 6.

Table 6. 618-4 Burial Ground Excavation Equipment and Capacities.

Make	Model	Type	Capacity (m^3/yd^3)
John Deere	644	Front-end loader	3.1/4
John Deere	792	Trackhoe excavator w/thumb	1.1/1.5
John Deere	744	Front-end loader	3.8/5
John Deere	892	Trackhoe excavator w/thumb	1.6/2.3

The RAS began the 618-4 Burial Ground operation using the 644 loader and the 792 excavator. The excavator was equipped with a thumb to facilitate the handling of debris and anomalous waste materials. This equipment was used throughout the overburden removal process until work was suspended in mid-November 1997.

The original heavy equipment was replaced with the larger capacity 744 loader and 892 excavator (with thumb attachment) when work resumed at the 618-4 Burial Ground under level B PPE in early February 1998. The larger capacity equipment was used to compensate for some of the productivity lost when the PPE was upgraded from level D to level B for excavation operations. The larger capacity equipment was used with one modification until work at the 618-4 Burial Ground was postponed in April 1998. In mid-March 1998, the toothed bucket on the 892 excavator was replace with a toothless, straight-edged bucket of the same size. The modification reduced the potential for tears or punctures to anomalous waste items (specifically drummed or containerized liquid waste) during the excavation process.

During level B operations, the loader and the excavator buckets were each fitted with onboard monitors to record ambient air conditions. The air monitors were used during all hours of operation. Each Friday, samples were collected from the monitors and analyzed for gross alpha/beta. Any results that were greater than background required additional analyses. No results from the onboard monitors exceeded background levels.

5.4 EXCAVATION AND SUPPORT PERSONNEL

The RAS was permitted to determine the size of the crew used to support excavation of the 618-4 Burial Ground based on the material estimates and schedule requirements specified in the design plan. The RAS was responsible to provide the operators, laborers, teamsters, supervisors, and IH support (for RAS workers) necessary to excavate material, load and haul containers, maintain roads, and control dust. The ERC team was responsible to provide the RCT coverage, IH support (for ERC team workers), waste management support, and sampling and screening support as necessary to maintain RAS productivity. The typical crew size for the RAS and the ERC team to directly support the excavation, load, and haul operations under level B PPE was 18 and 10, respectively, as summarized in Table 7.

Table 7. Typical Crew Size for Level B Operations at the 618-4 Burial Ground.

Employer	Work Area	#[a]	Function
RAS	Inside AOC	5	Operate equipment, dust control, IH monitoring, miscellaneous help
	AOC Perimeter	5	Level B supervisor, emergency response, backup support, air supply, miscellaneous help
	Frisking Tent/Queue	4	Seal and line waste containers
	Other	4	Haul trucks (2-3), water truck
ERC Team	Inside AOC	4	Radiological surveys, industrial hygiene monitoring, anomalous waste identification and handling, sampling
	AOC Perimeter	2	Exit surveys and miscellaneous radiation control support, air supply
	Frisking Tent/Queue	2	Waste container radiological surveys
	Other	2	Shipment authorization, routine and anomalous waste testing

AOC = area of contamination

[a] Information presented in the table is based on the following assumptions/conditions: (1) use of Level B personal protective equipment; (2) operation of one excavator, one loader, and 2 to 3 haul trucks: (3) availability of up to 45 waste containers per day; and (4) independent industrial hygiene monitoring/supplied air systems for the RAS and the ERC team.

The information presented in Table 7 does not include project management or administrative personnel for the ERC team or RAS. As specified in the footnote, a decision was made to use independent supplied air systems and IH monitoring to minimize potential liabilities associated with crossing company lines between workers and supplied air system administration and/or IH monitoring responsibility. When work was performed in an asbestos area, there was an additional requirement for the RAS to provide a trained asbestos supervisor inside the AOC. The ERC team also provided an extra RCT in the frisking station when asbestos material shipments were made. Personnel monitoring for asbestos fibers was performed on selected individuals when excavation and haul operations were being performed in designated asbestos areas. There were no asbestos monitoring results that exceeded action levels.

All waste excavation activities at the 618-4 Burial Ground were performed under level B PPE. Supplemental information on personnel resources and the impacts of different work scenarios including an estimate of the resources to perform the same work scope under level D PPE is provided in Appendix D.

6.0 SAMPLING AND ANALYSIS

Sampling and analysis activities supporting remediation of the 618-4 Burial Ground were performed in accordance with the RDR/RAWP (DOE-RL 1997a) and the 618-4 DQO report (BHI 1997c). A variety of resources were used to provide analytical support including onsite screening capabilities, Hanford Site laboratories, and contract laboratories as summarized in Table 8.

Table 8. 618-4 Burial Ground Analytical Resources.

Resource	Location	Capabilities	Turnaround
300-FF-1 project Radiological Control Technicians	Onsite[a]	Radiological screening; optimized for uranium detection	Immediate
300-FF-1 project Industrial Hygiene personnel	Onsite[a]	Organic vapor/combustible gas detection	Immediate
300-FF-1 project Analytical Field Services	Onsite[a]	Chemical screening for soil/solid; metals (XRF), hazard class (HAZCAT), volatile organic compounds (field gas chromatography); PCBs (immunoassay)	< 24 hours
WSCF laboratory	Hanford Site (200 West Area)	Asbestos	1-2 days
Radiological Control Facility	Hanford Site (100 N)	Radiological screening; total activity, gamma energy analysis	1-4 days
Contract Lab (Quanterra)	Richland, WA; St. Louis, MO	SW-846 methods, radiochemistry	3-45 days[b]

PCBs = polychlorinated biphenyl compounds
WSCF = Waste Sampling and Characterization Facility
XRF = x-ray fluorescence
[a] Associated resource is located onsite at the 300-FF-1 OU through personnel and equipment assigned directly to the project from ERC team functional groups.
[b] Various turnaround times are available through the contract depending on requested analyses. Shorter turnaround times include an upward price adjustment.

Chemical screening capabilities were established in onsite mobile laboratory/test trailer units that were parked full-time at the 300-FF-1 OU and hooked up to site electrical power drops. The capabilities provided onsite were selected based on project need, availability of instrumentation and ease of use in the field, required sample preparation, and ability to produce quick results. For the most part, onsite chemical screening capabilities were limited to soil/solid samples.

Sampling and analysis activities associated with in-process monitoring, anomalous waste, and verification activities are discussed in the following subsections.

6.1 IN-PROCESS MONITORING

In-process monitoring for the remedial action operations at the 618-4 Burial Ground consisted of radiological field surveys and chemical screening in accordance with the RDR/RAWP (DOE-RL 1997a). The radiological survey and chemical screening results were used to confirm that excavated material was within the established waste profile and acceptable for shipment to the ERDF as documented in Section 7.0. Material that was determined to be outside of the waste profile was considered to be anomalous and subject to additional characterization in accordance with Section 6.2 or a waste profile revision.

6.1.1 Radiological Surveys

The *Survey Method for Radiological Surveys of the 300-FF-1 Operable Unit Soil and Materials* (BHI 1997f) was developed to optimize survey equipment for the 300-FF-1 radiological COCs (e.g., uranium) and implement the requirements of the RDR/RAWP (DOE-RL 1997a). Radiological field surveys were performed such that a minimum of 10% of the excavated material was surveyed. This was accomplished by conducting surveys of the material prior to the excavation of each lift, as it was stockpiled, and/or after it was spread into a layer following excavation.

6.1.2 Chemical Screening

A minimum of one surface soil sample was collected for each 115 m^3 (150 yd^3) of material excavated in accordance with the 618-4 report (BHI 1997c). Depending on the operation, collection frequencies were implemented in the field by one of the following methods:

- When material was being loaded into ERDF containers, it was estimated that each container represented 7.7 m^3 (10 yd^3) of material, and approximately one random grab sample was collected for each 15 containers.
- When material was being stockpiled and cleared for disposal at the ERDF prior to being loaded into containers, the volume of the stockpile was estimated and a minimum of one random grab sample was collected from each stockpile or for each 115 m^3 (150 yd^3), whichever was most frequent.

Grab samples were analyzed at the 300-FF-1 mobile lab/onsite test unit for metals by x-ray fluorescence (XRF) and volatile organics in accordance with procedures found in BHI-EE-05, *Field Screening Procedures*.

6.2 ANOMALOUS WASTE

Material identified as anomalous waste was initially inspected for presence of visible crystals (if containerized), surveyed for radiological contamination, and checked for organic/combustible vapors by RCT and IH personnel. Once a determination was made that the anomalous material was safe to handle/move, samples were collected and characterized in accordance with the field logic test diagrams prescribed by the 618-4 DQO report (BHI 1997c). To the extent possible, soil/solid anomalous waste material was characterized using the available onsite screening resources at the 300-FF-1 OU (e.g., XRF, GC, immunoassay). If additional characterization was required, aliquots (e.g., splits) of the soil/solid sample material were sent to the contract laboratory to complete the characterization process. Samples of liquid anomalous waste material were also sent to the contract laboratory for characterization.

6.3 VERIFICATION

Excavation of the 618-4 Burial Ground was not completed prior to the preparation of this report. When the sub-grade excavation is complete as determined by the absence of debris and results of in-process monitoring, verification samples will be collected in accordance with the RDR/RAWP (DOE-RL 1997a) and sent to a contract laboratory for analysis. Six verification samples are required from the 618-4 Burial Ground. Each sample will be analyzed for the 300-FF-1 COCs.

The 618-4 Burial Ground is one of three 300-FF-1 waste sites selected to undergo a data validation process associated with verification activities. Verification sample results will be reviewed by a validation contractor in accordance with BHI-EE-01 procedures that include criteria for analytical holding times, blank results, spike recoveries (accuracy), and duplicate results (precision).

The validated verification sample results will be evaluated against the established cleanup standards documented in Section 3.0. If the verification sample results demonstrate that remedial action goals have been met, then the 618-4 Burial Ground will be considered remediated and the request for approval to backfill and recontour the waste site will be submitted to the EPA.

7.0 WASTE MANAGEMENT

A site-specific waste management instruction (SSWMI) and a waste profile system were implemented to manage the handling and movement of 618-4 Burial Ground waste to the ERDF in accordance with applicable BHI-EE-10 requirements. Based on the information available from the previous investigations documented in Section 2.3, waste profile WP-6184001 was prepared and issued to establish the anticipated waste forms, volume, packaging, and radionuclide and chemical concentration expectations for shipment of waste to the ERDF. The initial revision of the waste profile permitted the immediate shipment of waste up to six times greater than the profile concentration values with the intent to issue a future revision. Concentrations greater than six times the applicable value required a revision to the profile prior

to waste shipment. A need for multiple revisions to the waste profile was anticipated throughout the excavation process as greater levels of radiological contamination were identified.

Waste from the 618-4 Burial Ground was routinely shipped to the ERDF based on a percentage of the profile concentration value. The percent profile determination was used to track estimated ERDF inventories and was not reflective of the percentage of the acceptance limits specified in the *Environmental Restoration Disposal Facility Waste Acceptance Criteria* (BHI 1998b). An average of the in-process monitoring results obtained for each 115 m^3 (150 yd^3) was used to verify that waste concentrations were within the profile limits and to determine the percent profile for waste shipments. The percent profile was adjusted on the shipping documentation as necessary to reflect day-to-day changes in the concentration of the waste material based on radiological survey information. Adjustment of the percent profile values usually trailed shipment of the corresponding containers by approximately one day.

During the course of remediation operations, the waste profile was revised five times to increase the radiological concentration limits and/or to add new chemicals that were previously unidentified. In some cases, the loadout of waste into shipping containers was delayed during the processing of the profile revision.

8.0 RADIOLOGICAL CONTROLS

Radiological controls at the 618-4 Burial Ground were implemented through a job-specific radiological work permit (RWP) FF-1/2-006 (BHI 1998c). The RWP was written to cover excavation, screening, sampling, sizing, loading, packaging, and associated support work to transport contaminated soil and materials from the 618-4 Burial Ground to the ERDF for disposal.

A physical limiting condition of the RWP was a requirement for no visible dust within posted boundaries. Requirements for dust control at the 300-FF-1 OU were implemented by a project controlled desk instruction and the RAS earthwork plan. Dust suppression during work operations was typically accomplished through the application of water to excavation areas via the use of overland piping and a water truck. Efforts were made to use the minimum amount of water necessary to maintain dust control and prevent the formation of puddles on applied surfaces. A crusting agent was applied to contaminated material in excavation areas to control dust during non-business hours based on the following criteria:

- Prediction (in afternoon weather reports checked daily by 300-FF-1 project team personnel) of sustained overnight winds in excess of 20 mi/h
- Presence of contamination levels greater than 7,500 pCi/g
- Periods of inactivity greater than 24 hours.

On one occasion, excavation operations were suspended due to high winds and the inability to control dust.

All radiological surveys were performed in accordance with the *Survey Method for Radiological Surveys of the 300-FF-1 Operable Unit Soil and Materials* (BHI 1997f) as identified in Section 6.1.1.

9.0 HEALTH AND SAFETY

As documented in Section 4.4, the HASP (BHI 1997d) was prepared as a project document to establish the bounding requirements for the RAS and provide a basis for preparation of site-specific health and safety plans by the RAS. In accordance with contractual requirements, the RAS prepared and issued a site-specific health and safety plan (site-specific HASP) as a sub-tier document to the HASP. All work at the 618-4 Burial Ground was performed safely without any lost-time injuries.

9.1 PLAN OF THE DAY MEETINGS

A pre-job health and safety briefing was held with all site workers prior to the start of remediation activities to review the 618-4 Burial Ground work scope, present available historical information, and discuss the planned excavation approach. At the beginning of each day of subsequent operations, a plan-of-the-day safety briefing was held with all site workers and support personnel. The following items were discussed at each plan-of-the-day briefing:

- Planned activities for the day
- Personnel and equipment needs
- Predicted weather conditions
- RWP requirements
- Potential hazards and precautions
- Emergency response procedures
- Any safety concerns held by site workers and/or support personnel.

9.2 LEVEL B OPERATIONS

Remediation of the 618-4 Burial Ground was initiated under level D PPE as prescribed by the site-specific HASP. However, as documented in Section 4.0, operations at the 618-4 Burial Ground were suspended and then postponed before removal of the cover material was completed. When work resumed, the level of protection was upgraded to level B due to the potential to excavate unknown chemical hazards. The upgrade to level B PPE was implemented through an addendum to the site-specific HASP.

The level of IH support was upgraded to full-time by the ERC team and the RAS concurrent with the implementation of level B operations at the 618-4 Burial Ground. Due to potential liabilities between contractor and subcontractor, the ERC team and the RAS provided IH support to their respective workers independently. ERC team IH personnel administered the supplied breathing air distribution system used by ERC workers and provided monitoring of the breathing zone.

The RAS workers used a bottled supplied air system operated by RAS personnel. The duplication of effort was very inefficient.

When the change was made to implement level B PPE, personnel directly supporting level B excavation operations were provided with two-way radios and a dedicated channel to transmit/receive information. This permitted workers to communicate without interruption from outside use. Workers and personnel not directly supporting level B excavation operations at the 618-4 Burial Ground were provided with two-way radios at the frequency used during day to day operations for communication. The RAS level B supervisor carried both radios at all times during operations. Selected individuals carried both radios periodically for specific tasks.

9.3 ASBESTOS WORK AREAS

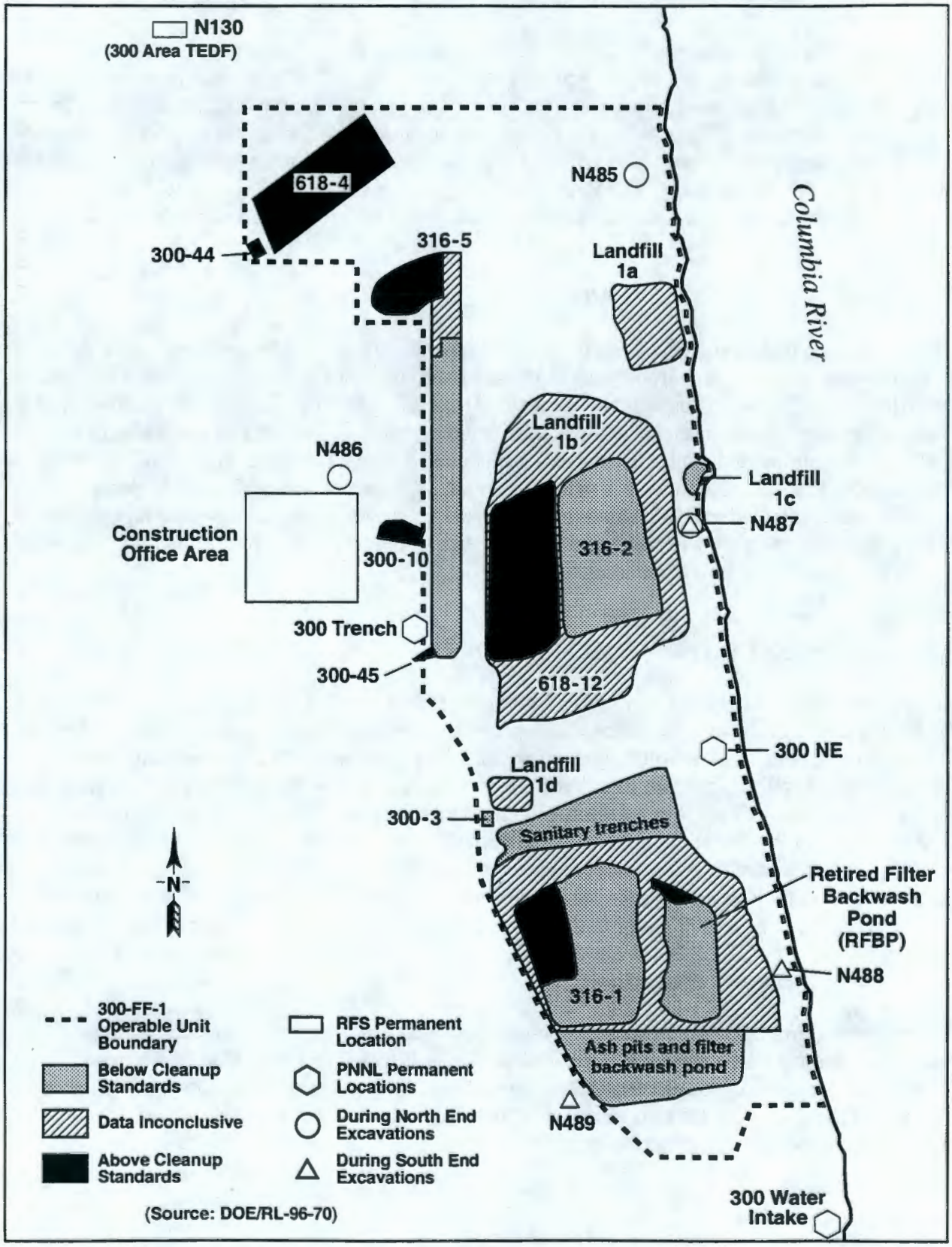
When selected areas of the 618-4 Burial Ground were designated as asbestos work areas, an asbestos work plan was prepared by the RAS, approved by the ERC team, and added to the site-specific HASP. The asbestos work plan specified the PPE, personnel monitoring, training, and engineering control requirements associated with the performance of work in designated areas. The level B clothing and equipment already being used by the workers covered all of the PPE requirements associated with work in asbestos areas. When work was performed in designated asbestos areas, selected individuals were monitored for asbestos fibers at 618-4 Burial Ground excavation site and in the frisking tent that was used to support the haul operation. No personnel monitoring results exceeded action levels.

9.4 EMISSION CONTROL/AIR MONITORING

Control of emissions during excavation of the 618-4 Burial Ground was accomplished through the suppression of dust in accordance with a project controlled desk instruction as summarized in Section 8.0. A near-field monitoring network consisting of six stations at upwind and downwind locations based on three predominant wind directions identified by the 300 Area meteorological station wind rose was used to monitor the air emissions during all 300-FF-1 remediation activities (Figure 9). Based on data collected through mid-April 1998, it was concluded that the 300-FF-1 remedial action activities have had no air releases that impacted human health or the environment. A majority of gross beta values were less than 10% of the derived concentration guide (DCG) value of 0.02 pCi/m^3. All of the gross alpha values were less than 1% of the DCG value of 9.0 pCi/m^3. The DCG values are used and reported in the annual *Hanford Site Environmental Reports* and are based on DOE Order 5400.5.

During the drummed waste stabilization process performed in April 1998, an additional air monitoring station was activated northeast of the 618-4 Burial Ground AOC at the request of the DOH. The information collected from the station was consistent with the results from the near field monitoring network stations discussed above. The station was removed from service after the stabilization effort was completed.

Figure 9. 300-FF-1 Air Sampler Locations.



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10.0 DISCUSSION/LESSONS LEARNED

Remediation of the 618-4 Burial Ground provided an opportunity to identify project successes, areas for improvement, and lessons learned. The ERC team, the RAS, DOE-RL, and EPA successfully worked together as a 300-FF-1 OU project team to adapt to changing and unexpected conditions that were presented daily during excavation operations. In doing so, the work at the 618-4 Burial Ground was performed safely without any lost-time injuries.

The cost of remediation activities at the 618-4 Burial Ground was significantly greater than the original projection. In comparison with the $1.9 million estimated to complete the project, approximately $3.4 million was spent to excavate 42% of the material projected in the initial design. The increase in cost was directly related to the quantity/type of anomalous waste materials that were encountered. The decision to upgrade the level of PPE because of the potential to excavate unknown materials resulted in a greater number of ERC team and RAS personnel supporting the project. The quantity of anomalous waste material unearthed also slowed the excavation process and decreased productivity. Based on FY1999 detailed work plan development, excavation of the 618-4 Burial Ground is scheduled to be complete in FY2000 and treatment and disposal of the drummed waste is scheduled to be complete in FY2001. The total cost of the project at completion is estimated to be $14.4 million including excavation of remaining soil and debris, verification sampling, backfill/recontouring, and treatment/disposal of anomalous waste materials. Additional cost information is provided in Appendix B.

The primary lesson learned was that the 300-FF-1 OU project team had not anticipated the quantity and/or type of anomalous waste materials that were unearthed from the 618-4 Burial Ground. Given the type and quantity of anomalous waste material that was encountered during excavation operations, process modifications were implemented by the 300-FF-1 OU project team to improve safety and efficiency. These improvements and others that are identified through review of the operations completed prior to the decision to postpone excavation activities will be utilized when excavation of the 618-4 Burial Ground resumes in FY 1999. Specific lessons learned and discussion items are presented as follows.

- **Contracting Strategy.** Separation of work scope between burial grounds/landfills and liquid waste disposal sites should be considered in future contracting strategy. Significant differences exist between the two waste site types with respect to the heavy equipment requirements, the mix of personnel skills needed, excavation approach, safety precautions/PPE, and process monitoring. The separation of work scope could likely be accomplished within a single subcontract or through two discrete subcontracts depending the specific requirements of the project.

- **Area of Contamination Size.** A clear understanding of the AOC boundary based on the site history, characterization data, and environmental regulations is very important. To operate efficiently, sufficient space is needed to stockpile contaminated materials and oversize debris, stage anomalous waste items during the characterization process, and treat LDR waste. Excavation, load, and haul equipment must have room to operate within the AOC during the waste/material monitoring, characterization, and handling processes to avoid equipment idle time and delays. If the AOC is too small, the

excavation operation can be suffocated by anomalous waste items and/or contaminated materials as was experienced at Landfill 1D. The size of the 618-4 Burial Ground AOC was tight at times, but was adequate for the required operation activities.

- **Waste Sorting**. Use of the grizzly apparatus designed for the 300-FF-1 project (non-mechanized, 6 in. grid spacing, with flip top) was an inefficient method for sorting waste material during the excavation process. Based on experience from Landfill 1D, routine use of the grizzly was discontinued prior to the start of waste removal from the 618-4 Burial Ground. A selection of alternate sorting methods were shown to be effective and efficient in a field demonstration and were subsequently approved for use by DOE and EPA as discussed in Section 5.1.2. The use of a mechanized grizzly was investigated by 300-FF-1 project personnel, but required a significant capital investment with no guarantee of improved efficiency with respect to the nonmechanized grizzly. It is suggested that subcontract language provide the flexibility to permit the use of several sorting methods to best fit the needs of a specific project or waste site.

- **Anomalous/Land Disposal Restricted Waste.** The 300-FF-1 RI data suggested the potential for LDR waste at the 618-4 Burial Ground. A much greater quantity of LDR waste was excavated than what was expected. The project could have benefited from identification of the potential for LDR waste in the subcontract language and an associated requirement for prospective subcontractors to address the handling and management of LDR waste in their bid proposals. When the potential for LDR waste is known to exist based on available historical information and characterization data, the contractor could also investigate treatment/disposal options prior to the start of work. This is also true of anomalous waste in general. Greater quantities were found at the 618-4 Burial Ground than anticipated. Provisions for handling, staging, and disposal of waste materials that cannot be readily accepted at the ERDF should be in place or well thought out prior to the start of remedial action activities at burial grounds and landfills.

- **Asbestos.** Like LDR waste, the potential for asbestos was known and was found in greater quantities than was expected such that some sections of the 618-4 Burial Ground were designated as asbestos work areas. Because of the determination, a notice of intent to the Benton County Clean Air Authority with a 10-day waiting period was required. In addition, discussions were required with ERDF personnel to determine how the material would be handled at the disposal facility. Special requirements for the handling and disposal of asbestos should be included in the subcontract language with an associated requirement for the subcontractor to prepare an asbestos handling plan prior to the start of work.

- **Container Loading/Process Monitoring.** The initial process of loading material and debris that was not identified as anomalous waste directly into haul containers resulted in the potential for containers to be placed on hold or removed from service during the characterization process. This potential was determined to be unacceptable to the 300-FF-1 OU project team. The process modification that was implemented to stockpile and release material within the AOC prior to being loaded into ERDF containers successfully resolved the issue and was shown to be reasonably efficient. It is anticipated that the process will be used at the other 300-FF-1 OU burial ground/landfill waste sites.

- **Personal Protective Equipment.** Level B PPE was worn by all personnel working inside the AOC during excavation operations at the 618-4 Burial Ground. A complete review of the level B operations and exclusion zone size is planned for FY 1999 to determine if a graded approach can be implemented based on the specific tasks performed by an individual. It is suggested that the number of personnel outfitted in level B PPE be kept to a minimum as necessary to safely perform the work.

- **Industrial Hygiene.** A clear definition of IH responsibilities between the contractor and subcontractor is very important. Interpretation of the responsibilities and reluctance to provide IH support across company (contractor/subcontractor) lines due to concerns with liability resulted in independent and duplicative IH support using different equipment. The duplication of effort resulted in higher cost to the project, confusion among project team members at times, and an increase in the number of personnel in the excavation area/exclusion zone, which is not consistent with Hanford Site ALARA principles.

- **Heavy Equipment.** Beginning in February 1998, a larger excavator/bucket combination was utilized in the 618-4 Burial Ground such that material could generally be excavated at a rate that exceeded the front-end loader capacity to fill haul containers. This enabled the creation and screening of stockpiles ahead of the load operation and permitted a release/hold determination on each stockpile without affecting productivity (provided that screening results supported release of a majority of the stockpiles). The ability to create this reserve capacity of stockpiled material proved to be worth any additional cost associated with the larger equipment. The use of a toothless (straight-edged) excavation bucket worked well to reduce the chance of tearing or puncturing anomalous waste items and containers.

- **Remedial Investigation Data.** It is important to scrutinize available historical information and characterization data during the remedial design phase. Test pit data collected from the 618-4 Burial Ground RI suggested an overburden thickness that was not realized during the actual removal operation. Contaminated material and some debris were identified on or near the surface during a thorough site walkdown and radiological survey just prior to initiating remedial action activities at the 618-4 Burial Ground. The walk down indicated that the overburden layer was thinner than estimated in some parts of the waste site. This had an effect of increasing the contaminated material volume estimate. A thorough walkdown and radiological survey of the waste site surfaces is recommended to facilitate the design phase. The RI data also suggested the possibility of LDR waste.

- **ACL/BCL Material Estimate.** The projection that clean soil was packed around the contaminated debris has not been supported for the 618-4 Burial Ground to date. Instead, much of the soil surrounding the debris was clearly contaminated when it was originally put into the 618-4 Burial Ground. The percentage of ACL material to BCL material beneath the cover and overburden was originally projected at 25/75 based on results from the two test pits excavated during the RI. Through the decision to postpone remediation activities in April 1998, less than 5% of the excavated material beneath the overburden layer was designated as BCL. (Note: A small amount of material that was designated as BCL was taken from a stockpile within the AOC during demobilization activities and

used as soil cover for the exposed excavation faces of drummed waste. This resulted in the value of 0 tons presented in Table 4).

- **BCL Stockpiles.** The original 300-FF-1 remedial action design specified centrally located BCL stockpiles that were not immediately adjacent to the waste site. Project personnel were able to authorize the creation of a BCL stockpile immediately adjacent to the 618-4 Burial Ground. This agreement resulted in cost savings to the RAS by eliminating additional transport of BCL material from the 618-4 Burial Ground to a central stockpile and then back to the waste site for backfill/regrade operations after excavation is complete and the cleanup standards have been met.

- **Dust Control.** Combinations of overland piping and a water truck were used to distribute water to the project for dust suppression. Use of the two local truck fill stations to supply water to the 618-4 Burial Ground via the overland piping guaranteed the availability of water at the site when needed and enabled the project to use one water truck instead of two.

- **Communication.** In addition to the morning plan-of-the-day meetings attended by all project personnel, the post-excavation daily meetings were a valuable communication tool for participating personnel. The daily meetings were open to all personnel and were specifically targeted to key personnel including sampling and analytical support, waste shippers, field and engineering support, radiological controls, and subcontract supervision. The purpose of the meetings was to recap the activities of the day, discuss new anomalies that were unearthed and status existing ones, and review plans for the next working day. The meetings facilitated the ability to provide clear direction to the subcontractor at the plan of the day and minimize idle time for heavy equipment operations. The meetings were also used to support preparation of the anomalous waste tracking spreadsheet.

- **Analytical Needs.** The ability to provide screening for metals (XRF) and volatile organic compounds (field gas chromatography) onsite at the 300-FF-1 OU was essential to maintaining productivity of the excavation, load, and haul operations. With the onsite capabilities, results were typically available the same day or by the beginning of business the following work day. Without it, the productivity would have suffered while the project waited for results. Other onsite capabilities identified in Table 8 such as the Hazcat kit were less effective as a daily screening tool. The onsite capabilities established at the 300-FF-1 OU were effective for soil/solid material. The capabilities were not set up and could not be easily adapted to handle liquids. A need exists for quick-turnaround toxicity characteristic leaching procedure (TCLP) analysis from a local laboratory. The LDR regulations for heavy metals are based on the results from TCLP analysis intended to simulate landfill conditions. It is anticipated that the presence of heavy metals will be an issue common to many burial ground/landfill remedial action operations. Quanterra has initiated efforts to obtain the capability in their Richland laboratory.

- **Work Hours.** Midway through excavation of the 618-4 Burial Ground, the ERC team changed to an alternate schedule that consisted of 9-hour work days Monday through Thursday and an 8-hour workday on Friday. The RAS and ERC personnel directly supporting the RAS (e.g., RCTs, IH technicians) remained on an 8-hour workday schedule. A common start time was used for both the ERC team and subcontract personnel. On most days, the schedule modification provided the ERC team personnel with an extra work-hour after excavation activities were completed for the day. The extra time at the end of the day was beneficial to wrap-up the day's activities and prepare for the next day, including participation in post-excavation daily meetings and completion of daily logs, anomalous waste tracking reports, and screening results.

- **Waste Profile System.** The waste profile system should be reviewed to permit more flexibility with respect to the quantity/concentration of waste that can be shipped to the ERDF within the waste acceptance criteria. The concentrations listed on the initial 618-4 Burial Ground waste profile were based on the RI data, although it was anticipated that higher concentrations would be encountered during excavation operations. Five revisions to the initial waste profile were required during the excavation process. The revisions were time consuming and resulted in shipping delays that could have been avoided if the initial profile values had been set higher.

- **Transplanting.** The bitterbrush transplant operation had a poor success rate. Potential considerations to improve the chance for success include the use of equipment specifically designed for transplant operations instead of a backhoe and presoaking the soil around individual plants prior to removal. The consideration of areas outside of the AOC that would eventually be disturbed (through construction of haul roads, backfill/recontouring, etc.) was important and increased the number of candidates for the transplant operation.

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APPENDIX A

SUMMARY OF 618-4 BURIAL GROUND CONTINGENCY EVENTS/CONDITIONS

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SUMMARY OF 618-4 BURIAL GROUND CONTINGENCY EVENTS/CONDITIONS

One of the functional readiness requirements (FRRs) for the 618-4 Burial Ground was to address uncertainties that could occur during remediation activities. A team of individuals with expertise in areas including industrial and radiological safety, sampling and analysis, waste management, project design, and 300 Area operations was organized to perform the contingency evaluation. A total of 47 events/conditions were identified and documented on contingency planning worksheets. The probability of occurrence, method of coverage, and other aspects were considered for each event/condition as summarized in Table A-1.

Probability. The probability of occurrence at some point during remediation of the 618-4 Burial Ground expressed in the following terms:

L Low Probability
M Medium Probability
H High Probability

Coverage. The method used to address an event/condition expressed with the following keys:

1 The event/condition was covered in existing procedures and plans such as the 300- FF-1 Health and Safety Plan (HASP), Radiation Work Permit (RWP), Site-Specific Waste Management Instruction (SSWMI), and/or BHI-EE-02, *Environmental Requirements*.

2 The event/condition was addressed through preparation and issuance of a new project-specific controlled desk instruction for contingency plans.

3 Because the event/condition was deemed unlikely to occur, determined to cause minimal impacts to the project, and/or an adequate response time was available. A contingency plan will be developed and issued when or if the event/condition occurs.

Table A-1. 618-4 Burial Ground Contingency Planning Summary. (2 sheets)

#	Contingency Planning Event/Condition	Probability	Coverage
1	300-FF-1 emergency	M	1
2	300 Area emergency	L	1
3	exothermic reaction (fire/explosion)	L	3
4	grass fire in vicinity	M	1
5	inadvertent intruder	L	1
6	injured worker needs evacuation	L	1
7	heavy precipitation within short time period	M	1
8	inhalation hazards encountered	M	1
9	severe heat or cold working conditions	H	1
10	snakes, wasps, scorpions encountered	M	1

Table A-1. 618-4 Burial Ground Contingency Planning Summary. (2 sheets)

#	Contingency Planning Event/Condition	Probability	Coverage
11	strong winds encountered	H	1
12	cave-in occurs at excavation face	M	1
13	sinkhole develops	M	1
14	equipment failure (e.g., hydraulic line rupture)	H	1
15	groundwater encountered in excavation	L	3
16	Hanford historical artifacts encountered	M	1
17	large quantities of anomalous waste	H	3
18	Native American artifacts encountered	L	1
19	prolonged shutdown of operations	L	3
20	plume chasing required	M	3
21	waste routinely jams grizzly	H	1
22	alpha contamination encountered	H	1
23	large quantities of asbestos encountered	H	1
24	bio-hazardous waste encountered	L	3
25	buried equipment w/oil encountered	H	2
26	classified materials encountered	L	3
27	intact, unmarked containers encountered	H	2
28	elevated metals concentrations encountered	H	2
29	waste cannot be excavated for physical and/or chemical reasons	H	1
30	non-irradiated fuel elements encountered	M/H	2
31	irradiated fuel elements encountered	L	3
32	gas cylinders encountered	L	3
33	heat/shock sensitive chemicals encountered	L	3
34	herbicides encountered	M	2
35	high dose-rate material encountered	M	3
36	liquid waste encountered	H	2
37	waste that does not meet waste acceptance criteria is shipped to ERDF	L	3
38	ordnance encountered	L	3
39	oversize object encountered	H	3
40	pesticides encountered	M	2
41	plutonium metal encountered	L	3
42	pyrophoric waste encountered	L	3
43	LDR waste encountered	H	2
44	TCE and/or elevated organics encountered	H	2
45	unexpected contaminants encountered	H	2
46	unexpected soil discoloration encountered	H	2
47	unknown/unidentified waste type encountered	H	2

APPENDIX B

618-4 BURIAL GROUND EXCAVATION COST SUMMARY

APPENDIX B

618-4 BURIAL GROUND EXCAVATION COST SUMMARY

Remediation of the 618-4 Burial Ground was initiated in October 1997 and excavation operations were performed intermittently until April 1998 as documented in Section 5.0. a cost and scope summary for remediation at the 618-4 Burial Ground is presented in Table b-1 based on initial design, actual (through July 1998), and projected at completion values.

Table B-1. 618-4 Burial Ground Excavation Scope Summary

Element	Initial Design	Actual to Date[a]	Projected at Completion
COST ($ million)	1.9	3.4	14.4
SCOPE			
Bitterbrush Transplant (specimens)	20-25 (FY1997)	24	24
Excavation Duration (months)	4 (FY1998)	4 (42%)[b]	12 (FY2000)
Excavation Quantity (metric tons)			
cover	35,000	11,042	11,042
ACL	17,000	18,082	36,000[c]
BCL	17,000	0	9700
Personal Protective Equipment	Level D	Level D/B[d]	Level B
Anomalous Materials			
drummed waste (drums)	--	338	1500 (FY2000)[e]
lead contaminated soil (yds^3)	--	115	TBD (FY2000)
lead debris (yds^3)	--	50	TBD (FY2000)
barium contaminated soil (yds^3)	--	50	TBD (FY2000)
Drummed Waste DQO Process	--	--	(FY1998)
Drummed Waste Characterization	--	--	(FY1998)
Drummed Waste Excavation Plan	--	--	(FY1999)
Drummed Waste Treatment Plan	--	--	(FY1999)
Lead Contaminated Soil/Debris Treatment/Disposal	--	--	(FY2000)
Barium Contaminated Soil Treatment/Disposal	--	--	(FY2000)
Drummed Waste Treatement/Disposal	--	--	(FY2001)
Verification Sampling and Analysis	(FY1998)	0	(FY2000)
Backfill, Regrading, Revegetation	(FY1998)	0	(FY2000)

[a] Actual completed through July 1998.
[b] Percentage calculated based on total design quantities for cover, ACL, and BCL materials.
[c] Total based on revised design estimate.
[d] One month of excavation was performed using level D PPE before excavation operations were suspended in mid-November 1997. Three months of excavation operations were performed using level B PPE beginning in February 1998.
[e] Number of drums estimated based on field observations and remedial investigation geophysical survey results.
-- = not specified
TBD = to be determined

Supplemental information on the cost elements, included scope, and assumptions that are associated with each cost basis is provided in the subsections that follow.

B.1 INITIAL DESIGN ESTIMATE

The estimated total cost for remediation of the 618-4 Burial Ground based on the initial design was $1.9 million including costs associated with ERC labor and overheads, RAS labor and overheads, ERDF disposal, contract laboratory services, and contract validation services. The initial cost estimate consisted of the following scope items and assumptions:

- Pre-planning including a DQO process, readiness assessment, and contingency planning.
- Bitterbrush transplant (20 – 25 specimens)
- Excavation and removal of approximately 69,000 metric tons of material from the disposal pit over a period of 4 months including cover (topsoil/overburden), BCL, and ACL material. Use of level D personal protective equipment was anticipated for site workers supporting the excavation operation.
- Collection and analysis of routine process monitoring samples for each 150 cubic yards of soil excavated.
- Management of anomalous waste materials including sampling and analysis.
- Disposal of 17,000 metric tons of ACL material at the ERDF.
- Collection and analysis of verification samples after completion of excavation operations.
- Validation of verification sample results.
- Backfill, regrading, and revegetation.
- Project management and infrastructure.

B.2 ACTUAL COST TO DATE

The actual cost for remediation of the 618-4 Burial Ground through July 1998 is $3.4 million including costs associated with ERC labor and overheads, RAS labor and overheads, ERDF disposal, contract laboratory services, and contract validation services. The actual cost consists of the following scope items and assumptions:

- Pre-planning including a DQO process, readiness assessment, and contingency planning.
- Bitterbrush transplant (24 specimens).

- Excavation and removal of approximately 29,000 metric tons of material (42% of the initial design value) including cover, BCL, and ACL material. Use of level D personal protective equipment was used during excavation operations for removal of the first 7000 metric tons of cover material. Level B PPE was used for the remaining cover and ACL material. Excavation operations were performed intermittently during a four month period.

- Preparation for level B excavation operations.

- Collection and analysis of routine process monitoring samples for each 150 cubic yards of soil excavated.

- Management of anomalous waste materials including sampling and analysis. Anomalous waste included excavation and removal of 338 drums from central area of the disposal pit.

- Stabilization of 149 drums with mineral oil.

- Disposal of approximately 18,000 metric tons of ACL material at the ERDF.

- Project management and infrastructure.

B.3 PROJECTED COST AT COMPLETION

The projected cost for remediation of the 618-4 Burial Ground at completion is estimated to be $14.4 million including ERC labor and overheads, RAS labor and overheads, waste treatment subcontract labor/overheads, ERDF disposal, contract laboratory services, and contract validation services. In addition to the actual costs identified in Section B.2, the estimated cost at completion consists of the following scope items and assumptions subdivided by fiscal year (FY) and based on information prepared during development of the FY1999 detailed work plan.

FY 1998 Estimate at Completion (EAC)

- Development of DQOs for characterization of excavated drummed waste.

- Characterization of excavated drummed waste.

FY1999

- Development of drummed waste treatment plan.

- Development of drummed waste excavation plan.

- Initiation of drummed waste excavation (estimated total of 1200 drums between FY1999 and FY 2000) and removal of approximately 3,000 metric tons of ACL material from the disposal pit and over a period of one month under level B excavation operations.

- Collection and analysis of routine process monitoring samples for each 150 cubic yards of soil excavated.

- Management of anomalous waste materials including sampling and analysis.

- Disposal of profiled ACL material at the ERDF.

FY2000

- Completion of drummed waste excavation (balance from FY1999 of 1200 drum estimate) and removal approximately 15,000 metric tons of ACL material (remainder of 36,000 metric ton revised ACL estimate) under level B operations over a period of 7 months.

- Collection and analysis of routine process monitoring samples for each 150 cubic yards of soil excavated.

- Management of anomalous waste materials including sampling and analysis.

- Disposal of profiled ACL material at the ERDF.

- Collection and analysis of verification samples after completion of excavation operations.

- Validation of verification sample results.

- Backfill, regrading, and revegetation.

- Treatment of lead contaminated soil and barium contaminated soil to meet LDR criteria followed by disposal at the ERDF.

- Initiation of treatment and disposal for drummed waste during a 3 month period.

- Project management and infrastructure.

FY2001

- Completion of drummed waste treatment and disposal over a two month period.

APPENDIX C

DRUMMED WASTE SUPPLEMENTAL INFORMATION

APPENDIX C

DRUMMED WASTE SUPPLEMENTAL INFORMATION

C.1 BACKGROUND

An area of drummed waste was discovered in the 618-4 Burial Ground on March 12, 1998. As the drums were excavated from the ground in the days that followed, there was evidence that the drums had at one time been banded together in groups of four and placed on wooden pallets in the 618-4 Burial Ground. Most of the drums were intact, approximately 35 gallons in size, and had a D38 marking on the side. There were also 55-gallon drums that were suspected to be secondary containers for inner drums. Based on observation of the contents from damaged drums, there was evidence that layers of fine sediments and/or metal cuttings were present in the bottom of the drums. A thin oil material was also observed in drums that contained the fine sediments/metal cuttings. Intact drums were not opened and were set aside within the area of contamination (AOC) as they were excavated from the ground. Initial sample results of oil samples from four of the drums with accessible contents suggest that regulated levels of PCBs, lead, and volatile organic compounds may be present in the oil.

Later in the excavation process, evidence of a second and possibly a third layer of drums was observed. Based on the elevation of the first layer of drums and the estimated depth of the 618-4 Burial Ground from previous investigations, the presence of three layers was further supported. Review of the information from the geophysical surveys performed suggested a large rectangular metallic anomaly at the approximate location where the drums were being excavated (Figure 3a). The area of the metallic anomaly, the physical size of the drums, and an assumption that the drums were buried in three uniform layers was used to estimate that up to 1,500 drums may have been buried at that location.

In parallel with the excavation process and the development of an estimate for the total 618-4 Burial Ground inventory, investigations were conducted to determine the meaning of the D38 markings and locate information that documented disposal of the drummed waste. Through an interview with a Hanford Site retiree, it was learned that the D38 marking was commonly used to indicate depleted uranium. It was further learned that oil was used to stabilize uranium chips from milling operations due to its pyrophoric characteristic. The information from the interview prompted the suspension of drummed waste excavation activities at the 618-4 Burial Ground on April 2, 1998.

An extensive search of historical records has yielded no information on the original source of the buried drums. Although many uranium processes occurred at the Hanford Site between 1955 and 1961, most would have generated enriched uranium scrap. Processes such as those conducted in the 306-W Hot Machine Shop would have generated depleted uranium fines similar to those believed to be in the 618-4 Burial Ground drums but at much smaller quantities than the estimated drummed waste inventory. It is possible that the drummed waste was produced offsite and shipped to the Hanford Site for disposal as no onsite depleted uranium machining work of this magnitude could be identified. The lack of available historical records does not preclude the possibility that classified historical documents exist that have not yet been declassified.

Approximately 338 drums had been excavated between March 12 and April 2, 1998. Due to damage, degradation, and/or compromised integrity, approximately 10% to 15% of the drums were overpacked in 85-gal poly containers immediately following excavation and staged within the AOC. The other drums were mostly intact and were also staged within the AOC.

C.2 URANIUM METAL CHARACTERISITICS

Uranium metal is combustible and can self-ignite under the right conditions (e.g., small pieces, dryness, and exposure to moist air). The potential for self-ignition is inversely proportional to the size of the metal chips/pieces. Agitation of the uranium metal or mechanical movement of the material increases the potential for self-ignition. Once ignited, uranium burns very slowly with no visible flame, and the oxide smoke tends to deposit in the immediate area of the burning material in the absence of strong drafts or other debris. Burning uranium reacts violently with 1,1,1-trichloroethane and carbon tetrachloride. One method of stabilizing uranium metal from machining operations is to coat/immerse it in oil.

The preferred method for extinguishing burning uranium metal is the use of carbon micro-spheres or Met-L-X dry suppressant chemicals. Water can also be used to provide control by immersing the uranium metal. Water is not appropriate for use on material if there is any degree of uncertainty with the state of the uranium because a criticality could result from the addition of water to enriched uranium. Burying the burning uranium metal in soil is another method that can be used for control. Although the metal can continue to burn underground, and may ignite other nearby items, the soil provides effective control of emissions.

C.3 DRUMMED WASTE STABILIZATION

Enough information was gathered to suggest that there was a potential for self-ignition of uranium metal in excavated drums that appeared to be empty/nearly empty of liquid contents. To significantly minimize the risk of self-ignition, a decision was made to implement the following actions for each drum considered to be at risk:

- Overpack the drum into a new secondary container
- Add a sufficient volume of mineral oil to immerse the solid contents of the drum.

The methodology that was used to safely and efficiently accomplish the stabilization task was documented in the *Field Instruction: 618-4 Burial Ground Drummed Waste Stabilization* (BHI 1998d). The purpose of this field instruction was to provide the task-specific requirements for stabilization of selected drums that had been excavated from the 618-4 Burial Ground. The instruction was developed to supplement the existing site documents that governed the stabilization task and all other work in the 618-4 Burial Ground as identified below:

- *300-FF-1 Remedial Design Report/Remedial Action Work Plan* (RDR/RAWP) (DOE-RL 1997)

- *Health and Safety Plan for the 300-FF-1 Operable Unit* (HASP) (BHI 1997)
- Radiation Work Permit (RWP) FF-1/2-006 (BHI 1998c).

Health and safety precautions and contingency plans for the task were integrated with the stabilization methodology to provide a guidance tool for the pre-job safety briefing and a field reference for personnel performing and supporting the work.

The stabilization field work was initiated on April 11, 1998. A total of 149 drums were overpacked and stabilized with mineral oil without incident. All drums staged within the 618-4 Burial Ground AOC (including drums that had not been overpacked because they were intact and were thought to contain an adequate level of oil) were considered stable on April 22, 1998.

C.4 DEMOBILIZATION

As part of demobilization activities, a decision was made to dry-overpack all drums at the 618-4 Burial Ground that had not been previously overpacked to prepare them for an extended period of storage within the AOC. The remaining drums were dry-overpacked into 85-gal poly containers between April 22 and April 28, 1998. The containers were fitted with screw-type lids that were not fully tightened to prevent potential pressurization. A bimonthly inspection program was established to monitor the overpacked drums for signs of internal leakage or pressurization during storage within the 618-4 Burial Ground AOC.

When activities were suspended at the 618-4 Burial Ground, an excavation face of drummed waste was left partially exposed. The decision was made to cover the exposed drums with soil as part of the demobilization activities. The exposed drums were inspected for signs of lost integrity and were subsequently covered with a layer of below contaminated level soil 1 m (3.3 ft) in depth. The drummed waste area was marked with posts for reference when excavation activities resume.

C.5 CHARACTERIZATION AND DISPOSAL PLANS

Characterization of the drummed waste that has been excavated from the 618-4 Burial Ground is scheduled to be complete by the end of FY 1998. To accomplish this task, implementation of the data quality objectives (DQO) process is planned. Results of the DQO process will be used to develop the sampling design and prepare a sampling and analysis plan to guide the characterization effort. In FY 1999, the characterization results will be used to develop a plan for continued excavation of the drummed waste and selection of a disposal method.

In addition to the efforts at the Hanford Site, cleanup projects involving uranium metal are being managed at three other DOE sites including, Rocky Flats, Los Alamos, and Oak Ridge. Personnel from the 300-FF-1 project team have established contacts at each of the sites to share information, benchmark activities between sites, and assist with the planning process as necessary.

C.6 REFERENCES

BHI 1998a, *Field Instruction: 618-4 Burial Ground Drummed Waste Stabilization*, CCN 052944, Bechtel Hanford, Inc., Richland, Washington.

BHI, 1998b, *Radiological Work Permit*, number FF 1/2-006, technical work document number 0300F-SC-G0004.

BHI 1997, *Health and Safety Plan for the 300-FF-1 Operable Unit*, BHI-00795, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

DOE-RL, 1997, *300-FF-1 Remedial Design Report/Remedial Action Work Plan*, DOE/RL-96-70, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

APPENDIX D

IMPACTS OF LEVEL B OPERATIONS

APPENDIX D

IMPACTS OF LEVEL B OPERATIONS

All waste excavation activities at the 618-4 Burial Ground were performed under level B PPE. Comparisons with estimates of the resources that would have been required to perform remediation of the 618-4 Burial Ground and a 300-FF-1 OU liquid waste disposal site under level D PPE is presented in Table D-1.

Table D-1. Comparison of Personnel Resources Required Based on Level of PPE and Waste Site Type.

Location	Employer	Discipline	Function	Burial Ground (level B)	Burial Ground (level D)	Liquid Disposal Site (level D)
Inside AOC	RAS	operator	loader	1	1	1
		operator	trackhoe	1	1	1
		laborer	water hose/dust control	1	1	1
		laborer	misc. help	1	1	
		IH	vapor monitoring	1	.5	
	ERC team	RCT	rad surveys	1	1	1
		IH	vapor monitoring	1		
		waste mgmt	anomalous waste id	1	1	
		sampler	sample collection, anomalous waste id and handling	1	1	
Outside AOC	RAS	operator	backup	1		
		laborer	supplied air, emergency	2		
		laborer	misc. help	1	1	
		supervisor	level B ops	1		
	ERC team	RCT	exit surveys, misc.	1		
		IH	supplied air (ERC)	1		
Frisking tent/que	RAS	laborer	seal waste containers	2	2	2
		laborer	line waste containers	2	2	2
	ERC team	RCT	waste container rad surveys	2	2	3
other	RAS	teamster	drivers for haul route	4	4	4
	ERC team	waste mgmt	shipment authorization	1	1	1
	ERC team	field screen	sample screening	1	1	
				28	20.5	16

AOC = area of contamination
ERC = Environmental Restoration Contractor
IH = industrial hygiene
RAS = Remedial Action Subcontractor
RCT = Radiological Control Technician

In addition to the increase in the number of personnel used to support a level B operation, the number of productive work hours per day is reduced. Additional time is spent dressing in and out of the equipment a minimum of four times/day per person (morning entry, lunch exit, afternoon entry, afternoon exit). The potential for heat stress is also increased. Depending on the weather conditions and physical fitness of the workers, breaks may be required at routine frequencies.

The number of personnel required to support a liquid waste disposal site is decreased mainly due to the assumption that there are no anomalous materials. As a result, the operation may be performed under level D PPE. Full time IH support is not required for this type of waste site. In addition, there are no routine monitoring sample requirements for screening of chemical compounds. Only the lift surveys performed by the RCTs are routinely performed. An extra RCT is required in the frisking tent during excavation of a liquid waste disposal site due to higher production rates in terms of tonnage shipped per day.

APPENDIX E

SELECTED PICTURES OF 618-4 BURIAL GROUND OPERATIONS

E98080052.1

Figure 1. 11/97/91, looking East. Removal of overburden with the excavator and tramming to the clean soil stockpile with the loader.

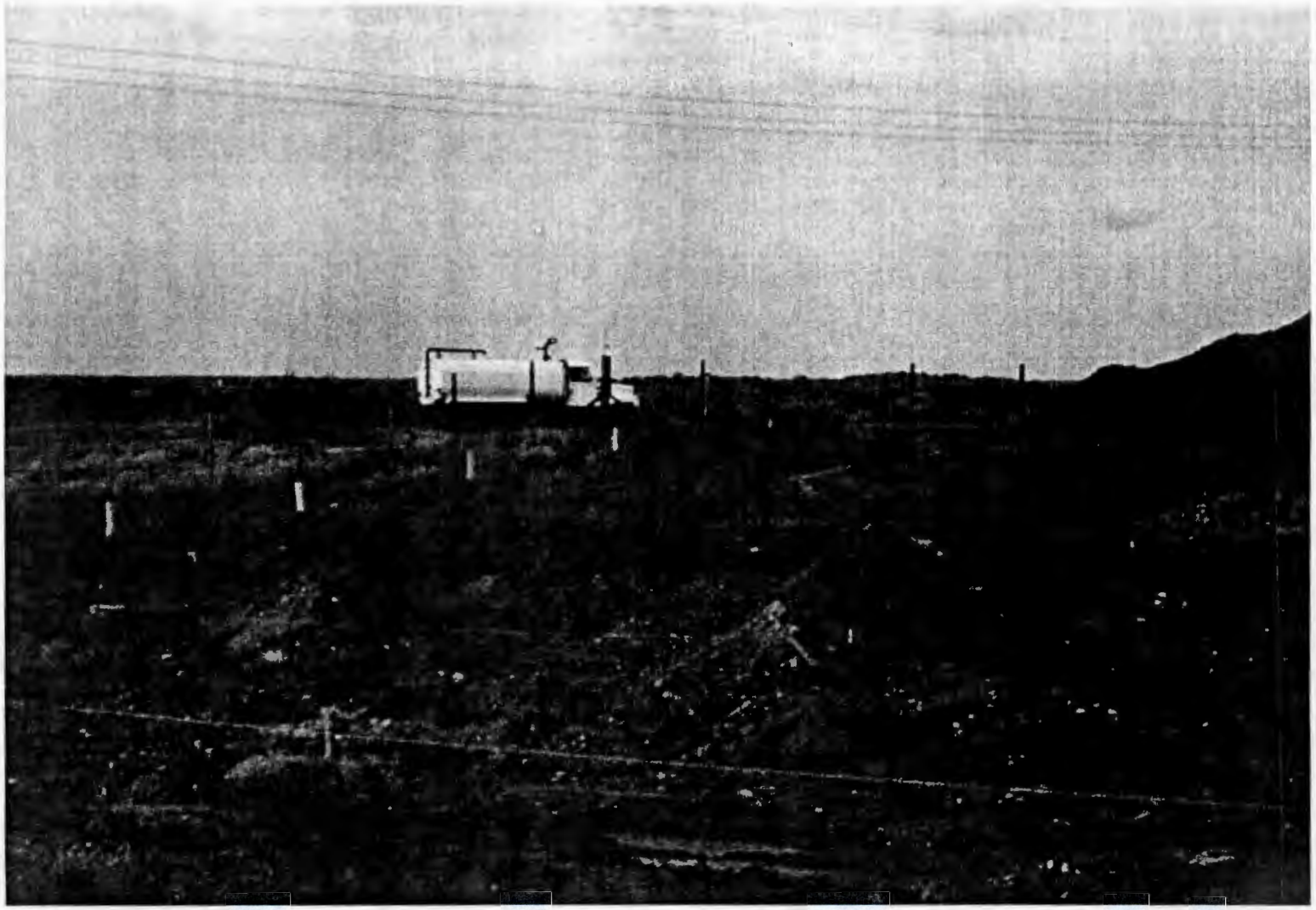

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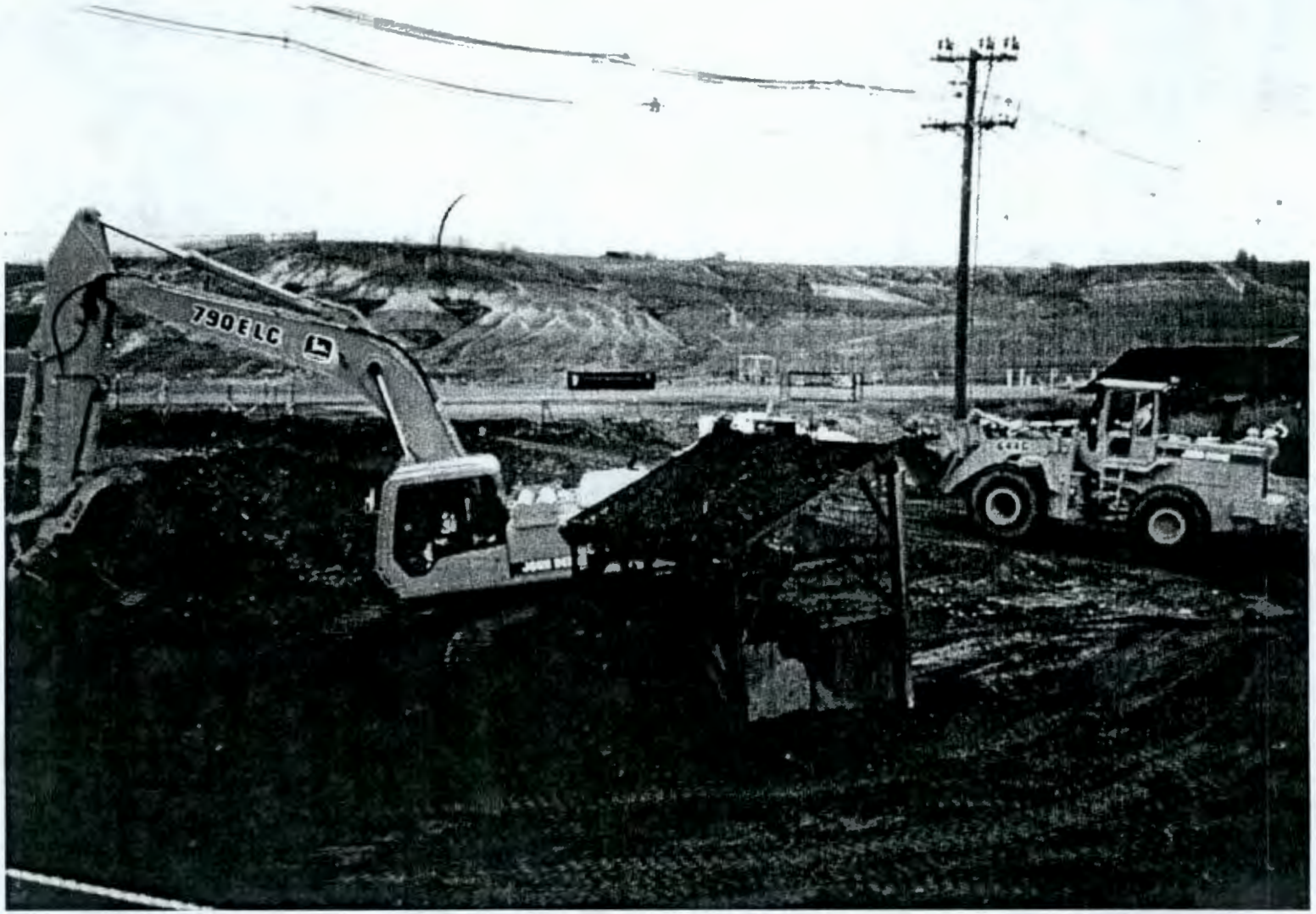
Figure 2. 11/6/97, looking Northwest. View of West end of AOC during removal of overburden. Section in middle of picture is roped-off due to contamination and debris found near the surface.



E9808052.3

1/6/98. Grizzly sorting apparatus in use at Landfill 1D.

E9808052.4

Figure 4. 2/6/98, looking North. Front-end loader backdragging ramp to clean soil stockpile area outside of AOC. Note large metallic debris unearthed near surface.

E9808052.5

Figure 5. 2/6/98, looking Southeast. Excavator casting clean soil into pile. Loader picking up clean soil for transfer to the clean soil stockpile.

E9808052.6

Figure 6. 2/9/98, looking North. Excavation of contaminated soil and debris. Clean soil stockpile in background.

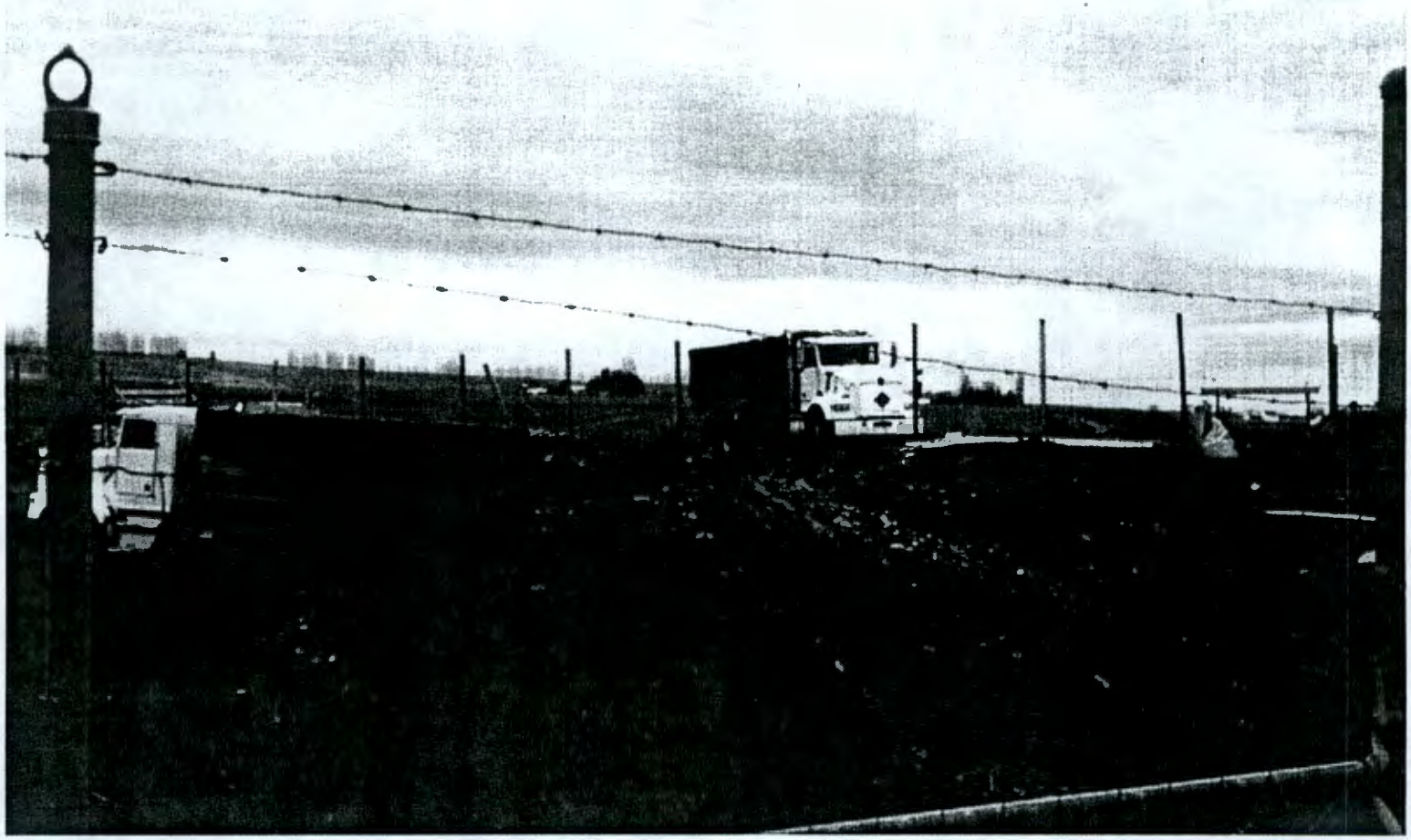


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Figure 7. 2/10/98, looking South. Haul trucks entering through South fence on way to load-out area.

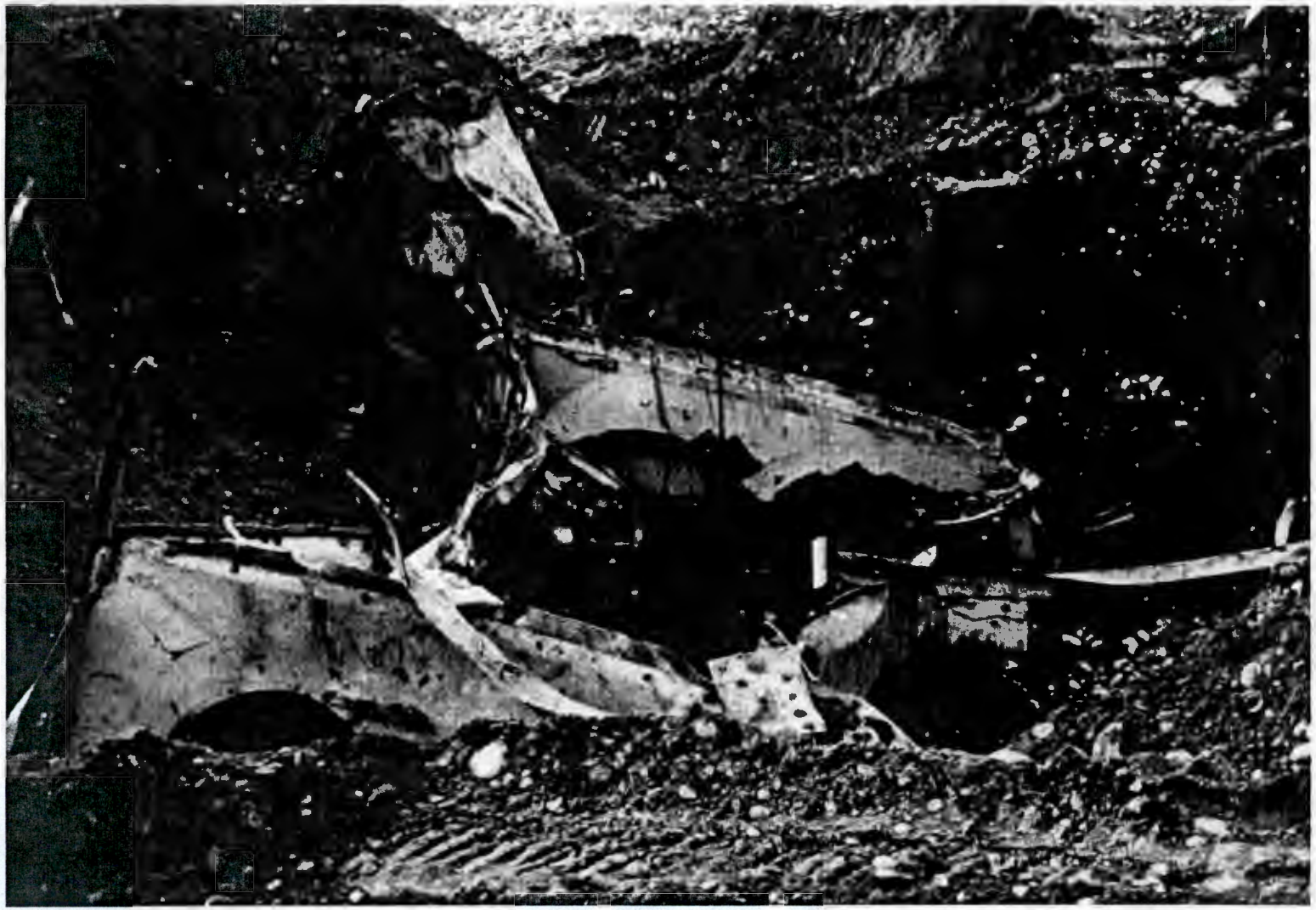

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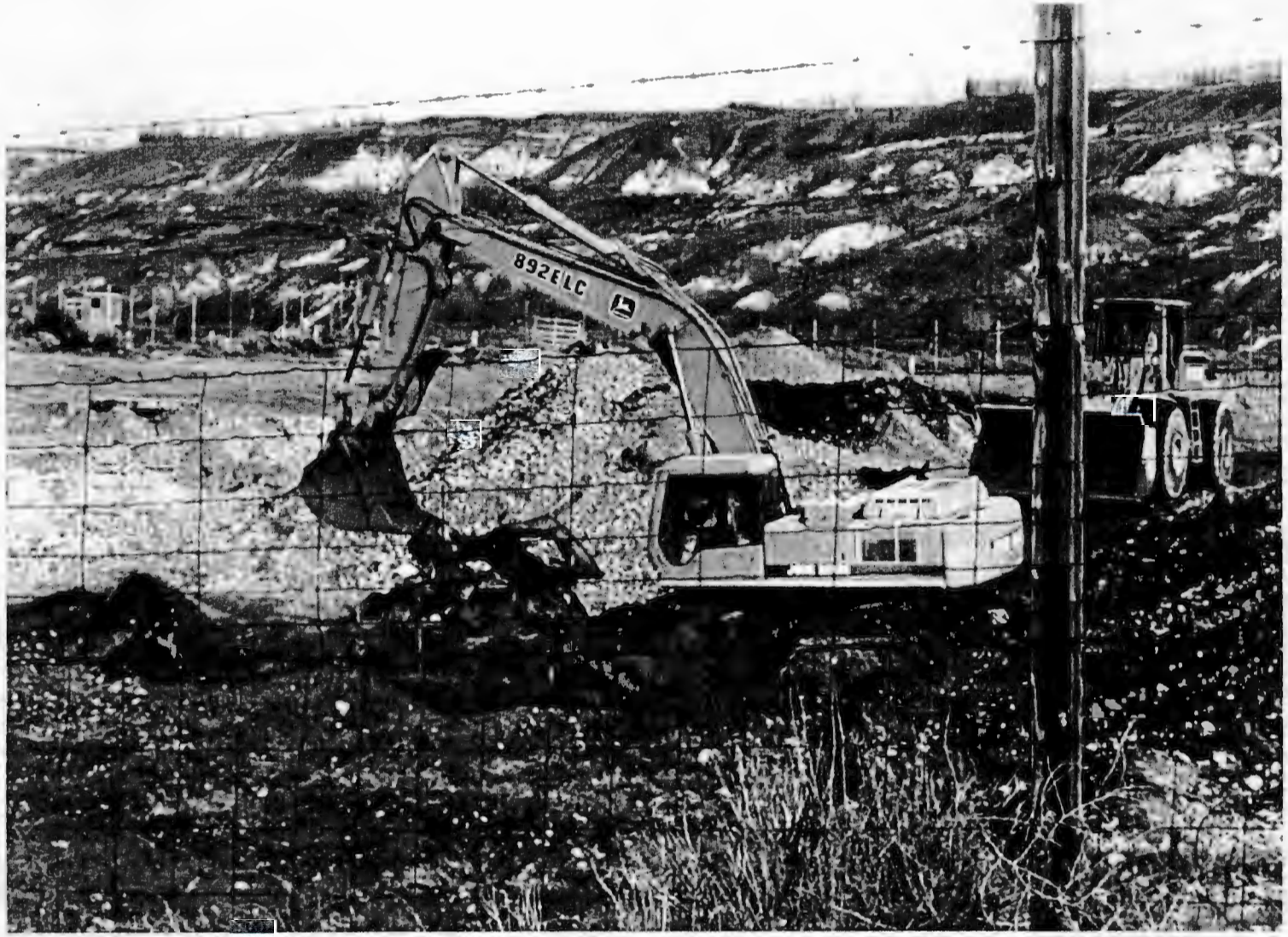
Figure 8. 2/10/98, looking North. Contaminated soil and debris near West end.



E98080052.9

Figure 9. 2/17/98, looking Est. Debris unearthed near west end.

Figure 10. 2/19/98. Piece of discolored material contaminated with uranium.

E98008052.11

Figure 11. 2/20/98, looking Northeast. Excavator placing metallic debris on North side of AOC that requires sizing to meet waste acceptance criteria.

E9808052.12

Figure 12. 2/26/98, looking Northeast. Area of suspect asbesots contamination in center of AOC that has been barricaded to keep personnel out. Oversize material staged within AOC to the left of picture and clean soil stockpile outside of AOC in background.

E98008052.1

Figure 13. 3/2/98, looking Northwest. Large kiln and metallic debris including empty drums unearthed near East end.

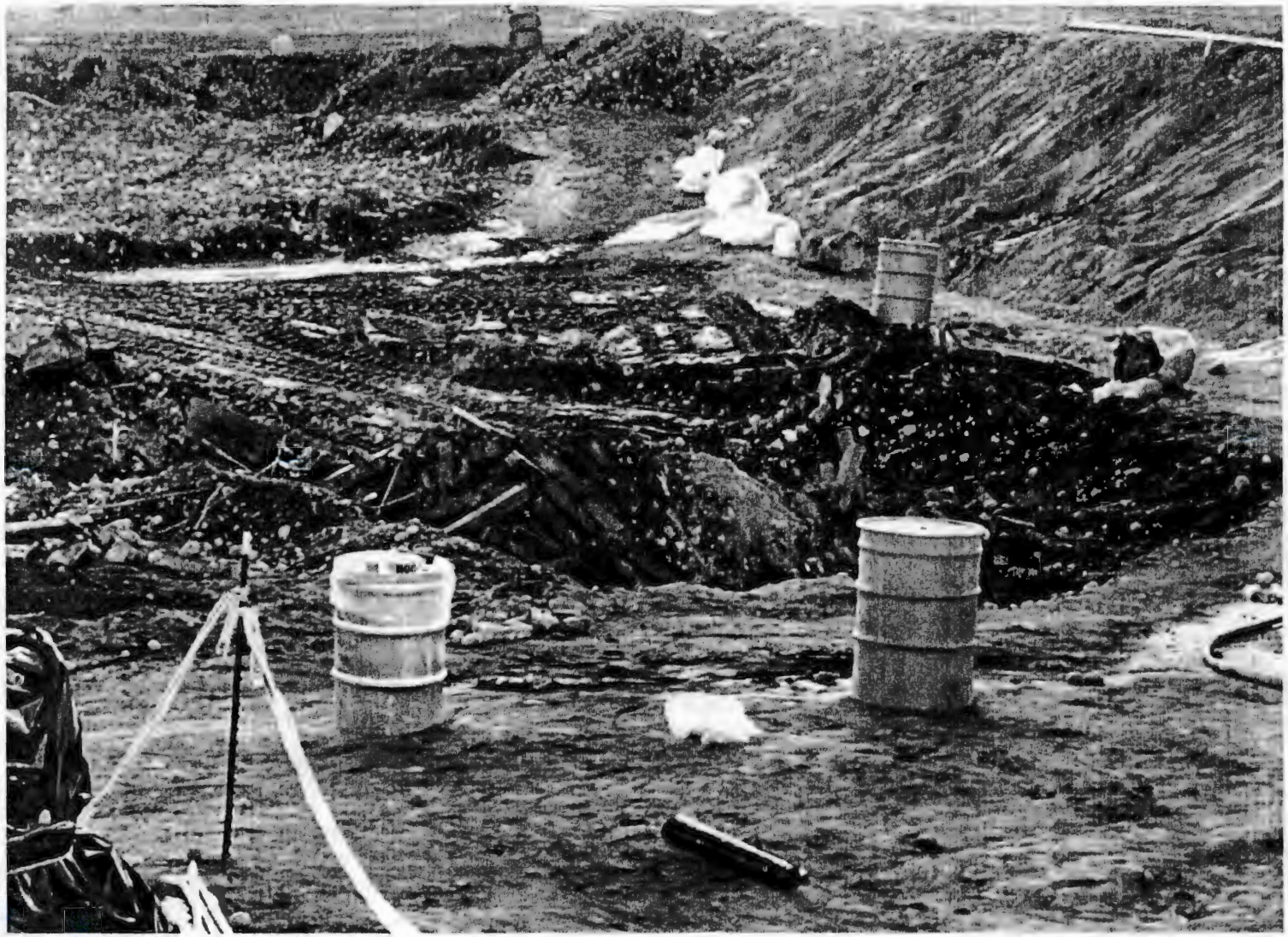


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Figure 14. 3/4/98, looking West. Metallic debris including battery powered forklift and kiln unearthed near East end. Galvenized 55-gal drums to left of picture are empty and available to containerize anomalous waste materials as needed.

E9808052.15

Figure 15. 3/4/98, looking West. Suspect graphite blocks unearthed near East end.

E9808052.16

Figure 16. 3/5/98, looking West. Excavatin operatin near East end with debris staged for later handling in foreground. Water is used for dust suppression. The breathing air bottle cart can be seen in the upper right hand side of the picture.

E98080052.17

Figure 17. 3/5/98, looking East. Water truck applying soil stabilizing/crusting gent at east end due to high wind forecast.

E98808052.18

Figure 18. 3/11/98, looking West. Excavation operation in central part of AOC. Asbestos contamination areas near East and Weat ends on AOC are marked with tape.

E9808052.19

Figure 19. 3/20/98, looking West. Removal of intact drummed waste from central portion of AOC. Leaking drums are over packed as they are unearthed.

E9808052.20

Figure 20. 3/20/98, looking West. Drums in anomalous waste staging location in Northeast portion of AOC. Orange numbers applied by project as drums are excavated for anomalous waste tracking purposes.

E98008052.21

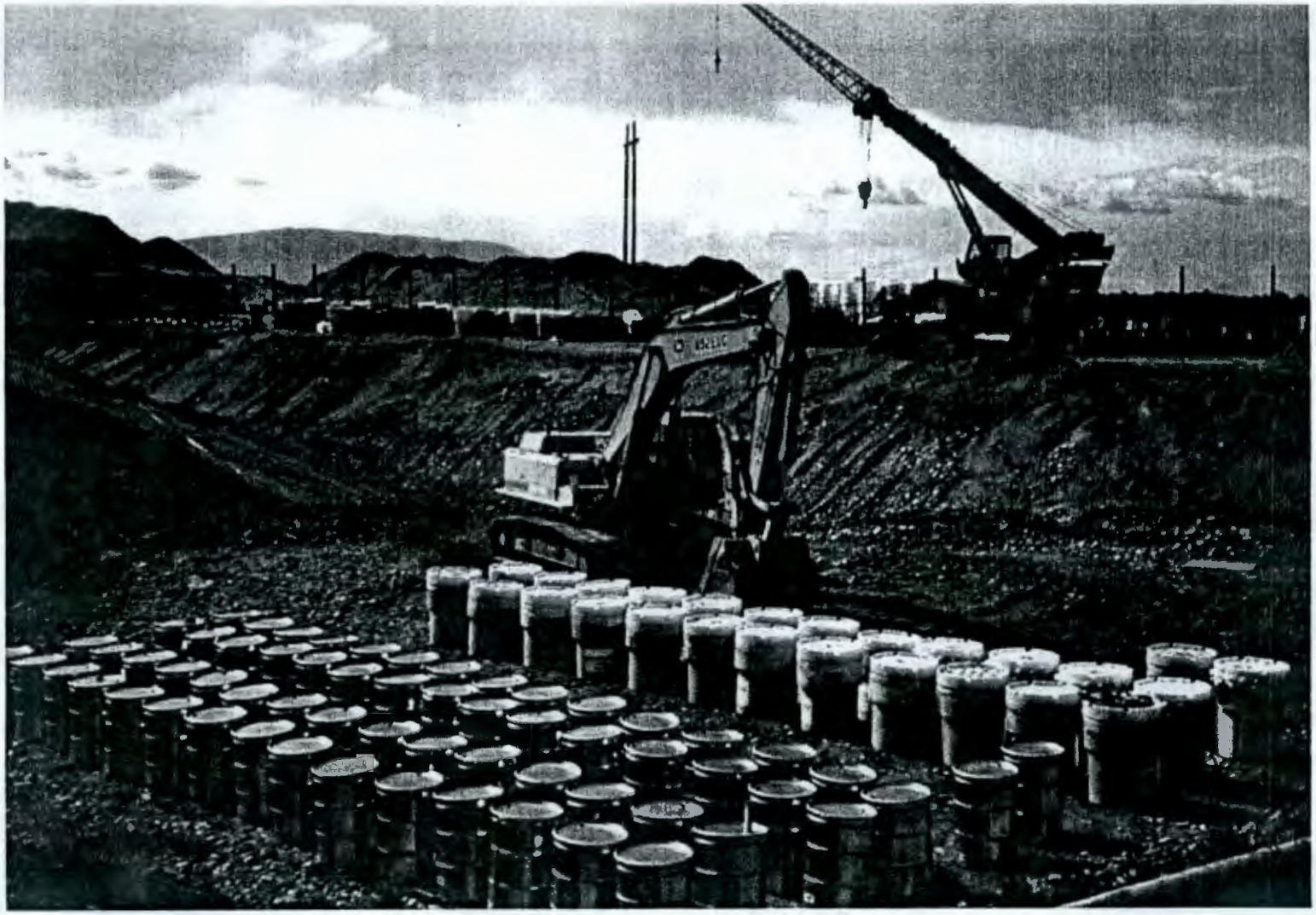
Figure 21. 3/20/98. Close-up of drums in anomalous waste staging area within AOC. Note "D38" stencil and gross, tare, and net weight markings.

E9808052.22

Figure 21a. 4/12/98, looking South. Close-up of drummed waste in central portion of AOC. Two layers are exposed.

E98808052.23

Figure 22. 4/12/98, looking West. Drummed waste stabilization operation. Laborer filling "D38" drum with mineral oil after being put into galvinized 55-gal overpack.



E9808052.24

Figure 23. 4/14/98, looking West. Stabilized drummed waste in galvanized 55-gal and poly 85-gal overpacks staged near East end of AOC. Drums and overpacks have been filled with mineral oil and over packs are vented to prohibit pressurization.

E9808052.Z4

Figure 24. 4/28/98, looking West. Dry-overpacked drums and miscellaneous anomalous waste materials staged in the Northeast portion of the AOC near the completion of demobilization activities.

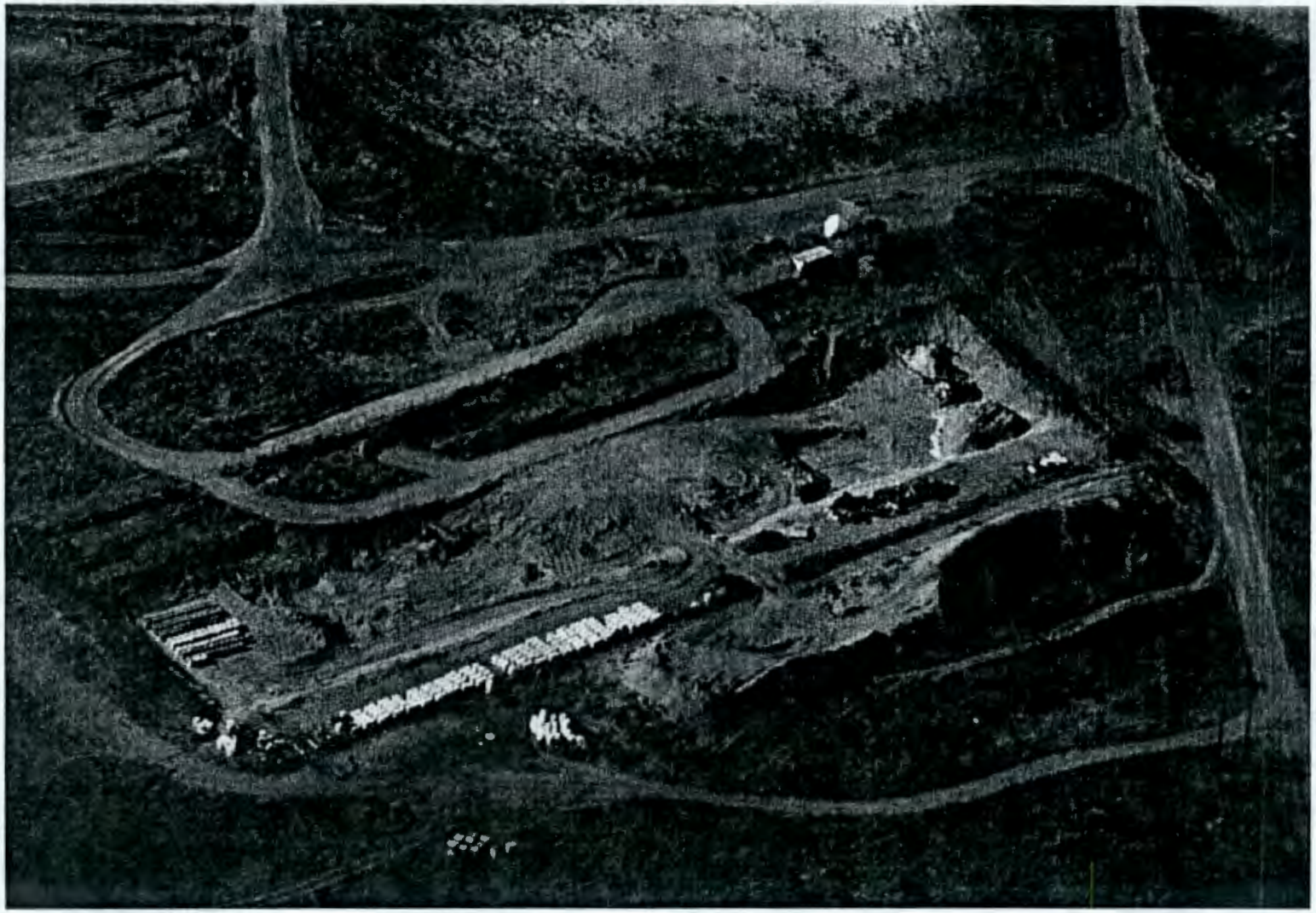


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Figure 25. 6/30/98. Overview of 618-4 Burial Ground after completion of demobilization activities. See Figure 8 and Table 5 for additional information on features.

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