LOW-LEVEL RADIATION BURIAL SITE ENGINEERING EVALUATION / COST ANALYSIS

BELTSVILLE AGRICULTURAL RESEARCH CENTER

Contract No. 53-3K15-5-9083

DRAFT

Prepared for:

U.S. Department of Agriculture
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Beltsville, Maryland

Prepared by:

ENTECH, Inc.
7926 Jones Branch Drive, Suite 620
McLean, Virginia

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ACRONYMS

1,1,1-TCA	1,1,1-trichloroethane
4,4'-DDD	4,4'-dichlorodiphenyl-dichloromethane
4,4'-DDE	4,4'-dichlorodiphenyl-dichloroethylene
4,4'-DDT	4,4'-dichlorodiphenyl-trichloromethane
AEC	Atomic Energy Commission
ARAR	Applicable or Relevant and Appropriate Requirement
ARS	Agricultural Research Service
BARC	Beltsville Agricultural Research Center
BRA	Baseline Risk Assessment
BTAG	Biological Technical Assistance Group
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COMAR	Code of Maryland Regulations
COPC	Contaminant of Potential Concern
CWA	Clean Water Act
CY	Cubic Yard
DCF	Dose Conversion Factor
DOE	Department of Energy
DOL	Department of Labor
DOT	Department of Transportation
DSR	Dose/Source Ratio
EE/CA	Engineering Evaluation/Cost Analysis
ENTECH	ENTECH, Incorporated
EPA	Environmental Protection Agency
EPIC	Environmental Photographic Interpretation Center
ETF	Environmental Transport Factor
FS	Feasibility Study
HEPA	High Efficiency Particulate Air
IDL	Instrument Detection Limit
IDW	Investigation-Derived Waste
INEEL	Idaho National Engineering and Environmental Laboratory
ISV	In-Situ Vitrification
LLRBS	Low-Level Radiation Burial Site
LLRW	Low-Level Radioactive Waste

ACRONYMS (continued)

LLW	Low-Level Waste
LTTD	Low Temperature Thermal Desorption
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MDE	Maryland Department of the Environment
MDL	Method Detection Limit
MDNR	Maryland Department of Natural Resources
MGD	Million Gallons per Day
mg/kg	milligrams per kilogram
µg/L	micrograms per liter
µm	micrometer
mrem/yr	millirem per year
MSL	Mean Sea Level
NA	Not Analyzed
NAAQS	National Ambient Air Quality Standards
NCP	National Contingency Plan
ND	Not Detected
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
NSPS	New Source Performance Standards
O&M	Operations and Maintenance
OSHA	Occupational Safety and Health Administration
PA	Preliminary Assessment
PCB	Polychlorinated Biphenyl
pCi/g	picoCuries/gram
pCi/L	picoCuries/Liter
ppb	parts-per-billion
PPE	Personal Protective Equipment
ppt	parts-per-trillion
PRSC	Post-Removal Site Control
QA	Quality Assurance
QC	Quality Control
RA	Removal Action
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act

ACRONYMS (continued)

RESRAD	Residual Radioactivity
RI	Remedial Investigation
ROD	Record of Decision
RPM	Regional Project Manager
RSS	Radiation Safety Staff
SDWA	Safe Drinking Water Act
SF	Source Factor
SI	Site Inspection
SOHES	Safety, Occupational Health, and Environmental Staff
SVE	Soil Vapor Extraction
SVOC	Semi-Volatile Organic Compound
TAT	Technical Assistance Team
TBC	To-be-considered
TIC	Tentatively Identified Compound
TOC	Total Organic Carbon
TOX	Total Organic Halogens
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFW	U.S. Fish and Wildlife Service
VOC	Volatile Organic Compound
WSSC	Washington Suburban Sanitary Commission

EXECUTIVE SUMMARY

This Engineering Evaluation/Cost Analysis (EE/CA) has been developed for the Low-Level Radiation Burial Site (LLRBS) at the Beltsville Agricultural Research Center (BARC), Beltsville, Maryland, to address the source of radiological contamination at the site. The LLRBS is an inactive burial area formerly used for the disposal of low-level radioactive waste (LLRW) from the late 1940s to the mid-1980s. No records exist which reveal the total volume of waste buried at the site, but an estimated 33,000 cubic feet of waste may have been buried at the site. Materials disposed at the LLRBS reportedly include radioactive isotopes, scintillation fluids, contaminated debris, contaminated animal carcasses, and animal wastes. Based on investigative studies to date, groundwater emanating from the LLRBS is contaminated with radionuclides and volatile organic compounds (VOCs). Based on the most recent groundwater data, contamination has not left BARC property. In addition, residual radioactivity (RESRAD) modeling indicates radiological contamination in the groundwater may pose a risk to human health.

The LLRBS is currently being investigated via the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation/Feasibility Study (RI/FS) process. A baseline risk assessment (BRA) is required under the RI/FS process; however, a BRA cannot be completed for the LLRBS without characterizing the source materials in the burial pits. The material in the pits cannot be adequately characterized through conventional means, therefore the contents of the pits must be excavated to characterize this material. During this process, the source materials and any generated wastes will be disposed offsite as necessary. In addition, there is a documented release of contaminants from this site to the groundwater. Removal of the source material will assist in preventing additional releases to groundwater. Finally, Nuclear Regulatory Commission (NRC) decommissioning policy calls for unrestricted future use of the site. Removal of the source of contamination will be a first step toward reaching that goal.

The scope of the removal action at the LLRBS is the removal of all low-level radioactive source material and other waste debris from the burial pits. This removal would minimize future contamination of subsurface soils beneath and groundwater below and downgradient of the site. This activity and subsequent disposal of all waste streams will comply with pertinent State and Federal applicable or relevant and appropriate requirements (ARARs) as warranted. Because the removal action is focusing on the radioactive contamination in the burial pits, cleanup goals established for this activity are based on potential external, inhalation, and ingestion exposures to workers during the excavation of the pits. Additional cleanup goals to address other contaminants, environmental media, and exposure routes will occur during the RI/FS process.

A variety of technologies were identified to address the contamination in the burial pits at the LLRBS including: subsurface barriers, capping the burial area, ground freezing, vitrification, bioremediation, solidification and stabilization, soil washing, acid extraction, soil vapor extraction, low temperature thermal desorption, incineration, and excavation. Of these technologies, only excavation of the waste is amenable to meeting NRC's requirement for unrestricted future use of the site. Therefore, 3 excavation alternatives were analyzed, in addition to the No Action alternative as required by CERCLA.

The 3 excavation alternatives consisted of Limited Excavation, Bulk Excavation, and an intermediate option falling within the range of the first 2 called Hybrid Excavation. All 3 alternatives result in excavation, characterization, and offsite disposal of the buried wastes. Of the 3 excavation scenarios, the Limited Excavation alternative was selected because this method generates the least amount of waste of the 3, and is the least expensive of the 3 excavation alternatives with an estimated cost of $3.4 million dollars. Approximately 20 weeks are required to perform this removal action in the field.

1. SITE CHARACTERIZATION AND REGULATORY STATUS

This Engineering Evaluation/Cost Analysis (EE/CA) has been developed for the Low-Level Radiation Burial Site (LLRBS, BARC 18) at the Beltsville Agricultural Research Center (BARC), Beltsville, Maryland, by ENTECH, Incorporated (ENTECH). ENTECH submits this EE/CA in partial fulfillment of the requirements of Contract No. 53-3K15-5-9083, Task Order No. 02, "Monitoring Well Installation, Sampling, and Investigation-Derived Waste Disposal, Low-Level Radiation Burial Site, Beltsville Agricultural Research Center," for the U.S. Department of Agriculture's (USDA's) Agricultural Research Service (ARS). This section presents a description of the LLRBS, its physical setting, and a brief site history including past use and present status of the site. A discussion of the regulatory status of this site in relation to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), National Contingency Plan (NCP), and Nuclear Regulatory Commission (NRC) regulations is also presented.

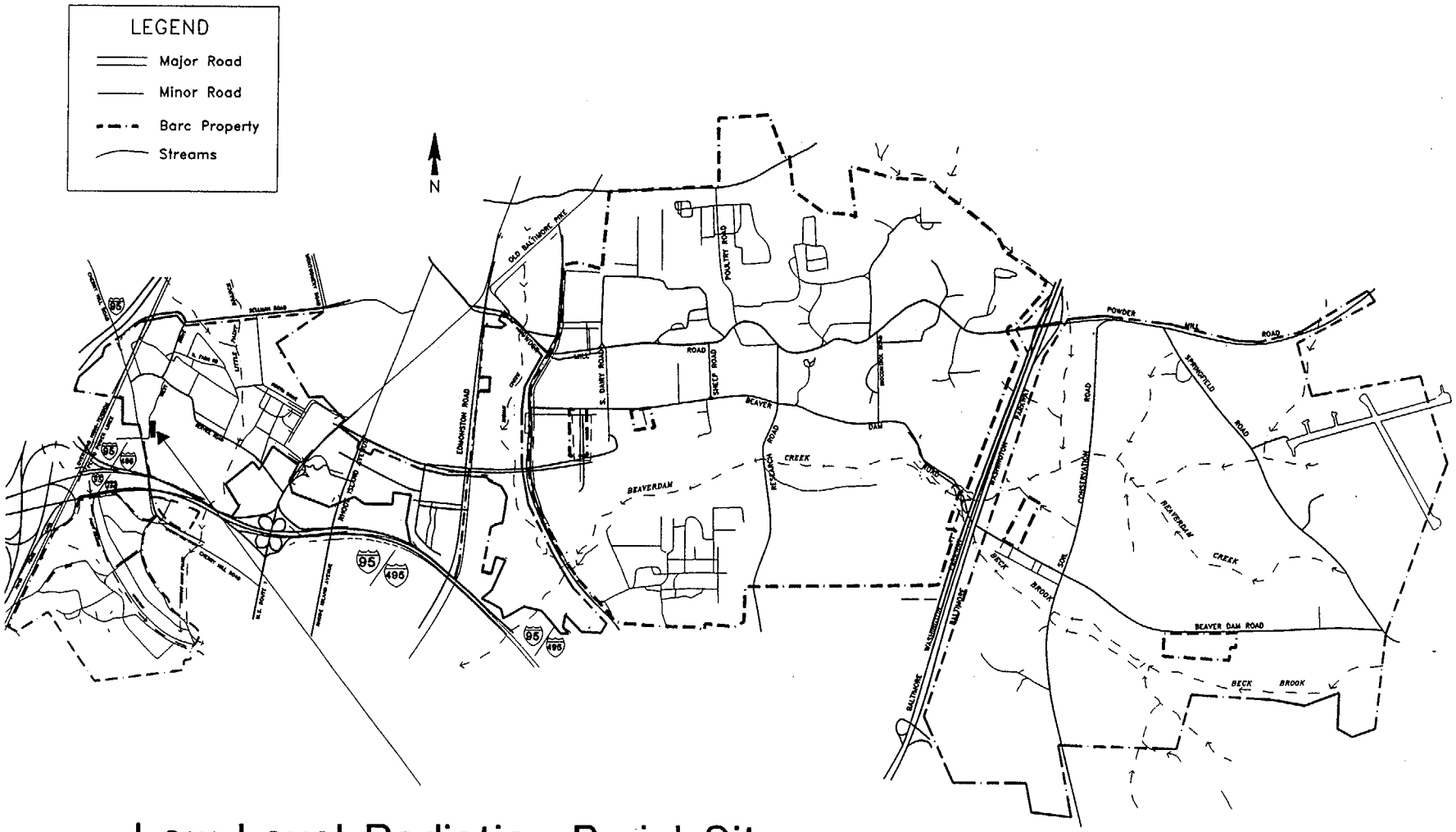
1.1 Low-Level Radiation Burial Site Description

The LLRBS is an inactive site formerly used for the disposal of low-level radioactive waste (LLRW) under a license from the NRC. The site is located within the boundaries of BARC and encompasses approximately 60,000 square feet of fenced land. Specifically, the site is located approximately 1/4 mile north of the Cherry Hill Road overpass of the Capital Beltway (I-95/495). The location of the site within BARC is presented in Figure 1.1; a detailed view of the site and vicinity is presented in Figure 1.2.

The LLRBS consists of two contiguous fields. Each field is approximately 200 feet by 150 feet and is surrounded by a 7-foot high chain link fence. The northern field reportedly was used continuously from the late 1940s to the mid-1980s and consists of many individual disposal pits within the fence line. The southern field was reportedly never used for disposal of any waste materials (Apex 1993). This information was later confirmed by ENTECH's aerial photographic interpretation (ENTECH 1997). The area immediately surrounding the site is undeveloped. Open fields border the site to the north, east and south. A wooded area is present to the west (Apex 1993).

Primary access to the site is gained along a gravel road that leads from Cherry Hill Road to a cluster of BARC maintenance buildings approximately 1/4 mile north of the site. The gravel road passes these buildings and runs adjacent to the western side of the site.

Figure 1.1 Location of Low-Level Radiation Burial Site within BARC



Low-Level Radiation Burial Site

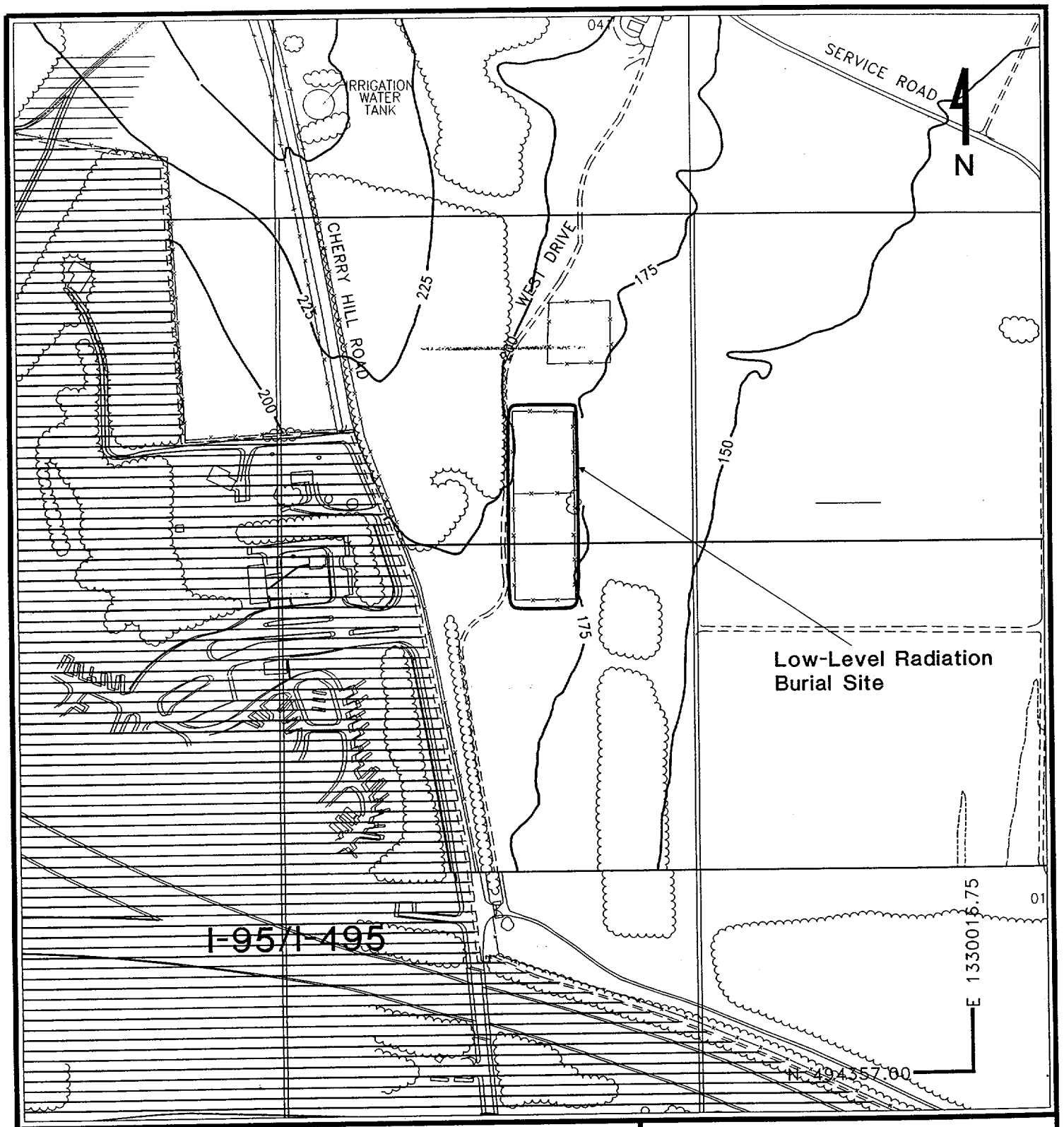


FIGURE: 1.2

Low Level Radiation Burial Site and Vicicnity

ENTECH INC

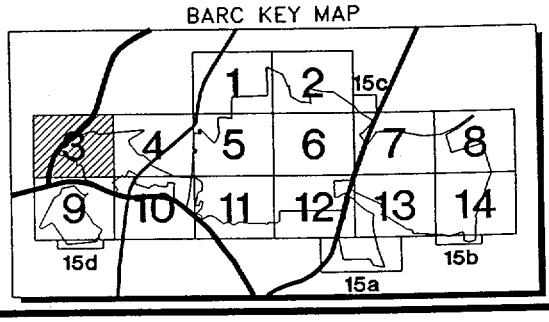
LEGEND

- BARC Boundary
- AOC Boundary
- 003 BARC Bldg & No.
- Treeline
- Single Trees
- Road
- Unpaved Road
- Fence
- Gate
- Sidewalk
- Streams

APPROX. SCALE: 1"=175'

DATE: MAY 99

BARC KEY MAP



1.2 Physical Setting

The LLRBS is located in an area of rolling terrain. Elevations are higher to the west with overall elevations decreasing to the east and southeast. The highest elevations are approximately 250 feet above mean sea level (MSL). Elevations within the site boundaries range from approximately 200 feet to 170 feet with a 10 to 15 percent slope to the east. Elevation due east of the site at Little Paint Branch is approximately 110 feet (Apex 1993).

The nearest perennial stream to the site is Little Paint Branch, located approximately 2,000 feet east of the site boundary, which flows in a southerly direction. Downstream, Little Paint Branch feeds into Paint Branch 1.4 miles to the south. Paint Branch continues to the south, eventually draining into the Anacostia River.

Runoff from the LLRBS follows the topography to the east and southeast. Runoff enters a tributary of Little Paint Branch located approximately 1,000 feet east of the site. Runoff from the site may be percolating to the groundwater, and then reaching this tributary or Little Paint Branch through groundwater discharge. Soils at the LLRBS consist of the Beltsville series of silty, loamy soils, which are moderately to well-drained. These soils typically occur on level to gently sloping uplands and are subject to erosion and gully development (Mack, 1966).

The principal water-bearing units in northern Prince George's County are sands and gravels of the Patuxent and the Patapsco Formations. These formations are used to provide drinking water in Prince George's County as well as counties to the east. Only the Patuxent Formation is present beneath the LLRBS. Water is primarily obtained from the Patuxent aquifer under water table conditions, but in some areas (particularly east of BARC) the aquifer becomes confined by the increasing thickness of the overlying, impermeable Arundel clays, and wells are under artesian conditions (Mack, 1966).

Recharge to the Patuxent aquifer occurs by the percolation of precipitation from the ground surface where the Arundel clay is missing. Outcrop areas of the Patuxent Formation trend northeast-southwest, with the formation dipping to the southeast. Movement of water from the outcrop areas establishes a regional groundwater flow direction to the southeast, in the direction of the formation dip (Mack, 1966).

Geologic cross-sections of the LLRBS indicate it is underlain by terrace sand and gravel deposits. The terrace deposits are underlain by unconsolidated sands and gravels of the Patuxent Formation. These cross-sections support the conclusion that Arundel clays are not present beneath the site, and the general vicinity is a recharge zone for the Patuxent aquifer (Apex, 1993). A south-north trending cross-section based on data collected during installation of 5 additional monitoring wells in 1997 supports prior

documentation of the subsurface at the LLRBS (Figure 1.3). In the immediate vicinity of the LLRBS, terrace deposits are approximately 30 to 35 feet thick, and thin to approximately 15 feet (near MW-13) as the formation heads in a southerly direction. The unconsolidated sands and gravels of the Patuxent Formation are present below the terrace deposits. The formation is roughly 15 to 20 feet thick in the vicinity of the LLRBS. Low permeability saprolite is present below the water-bearing Patuxent Formation, which acts as an aquitard.

Groundwater beneath and downgradient of the LLRBS moves to the south-southeast. An average flow rate of 1.6 feet per day was recorded by ENTECH using GeoFlo® meters in the existing and newly installed monitoring wells.

Nine (9) BARC water supply wells (the nearest being greater than 2.5 miles to the east of the LLRBS) tap the Patuxent aquifer, and pump in excess of 0.6 million gallons per day (MGD). Total depths for the production wells range from 200 to 600 feet. Minimum screened depths are thought to be 120 to 150 feet below ground surface (telecon with Charles Cassell, BARC Water Treatment Plant foreman). Approximately 1,500 people use the BARC wells on a regular basis as a source of drinking water. In addition, the water is used for research purposes and to irrigate crops and water livestock. Private wells are in use around BARC, although most off-site properties are supplied by the Washington Suburban Sanitary Commission (WSSC). Ten (10) private wells are within 2 miles of the LLRBS, in addition to 3 known commercial/industrial use wells within 2 miles. The nearest of these 10 wells is approximately 1.5 miles east (ENTECH, 1999).

Surface water is not used for drinking water within 15 miles downstream of the LLRBS. Fishing or recreational uses of surface water within the boundaries of BARC are not permitted.

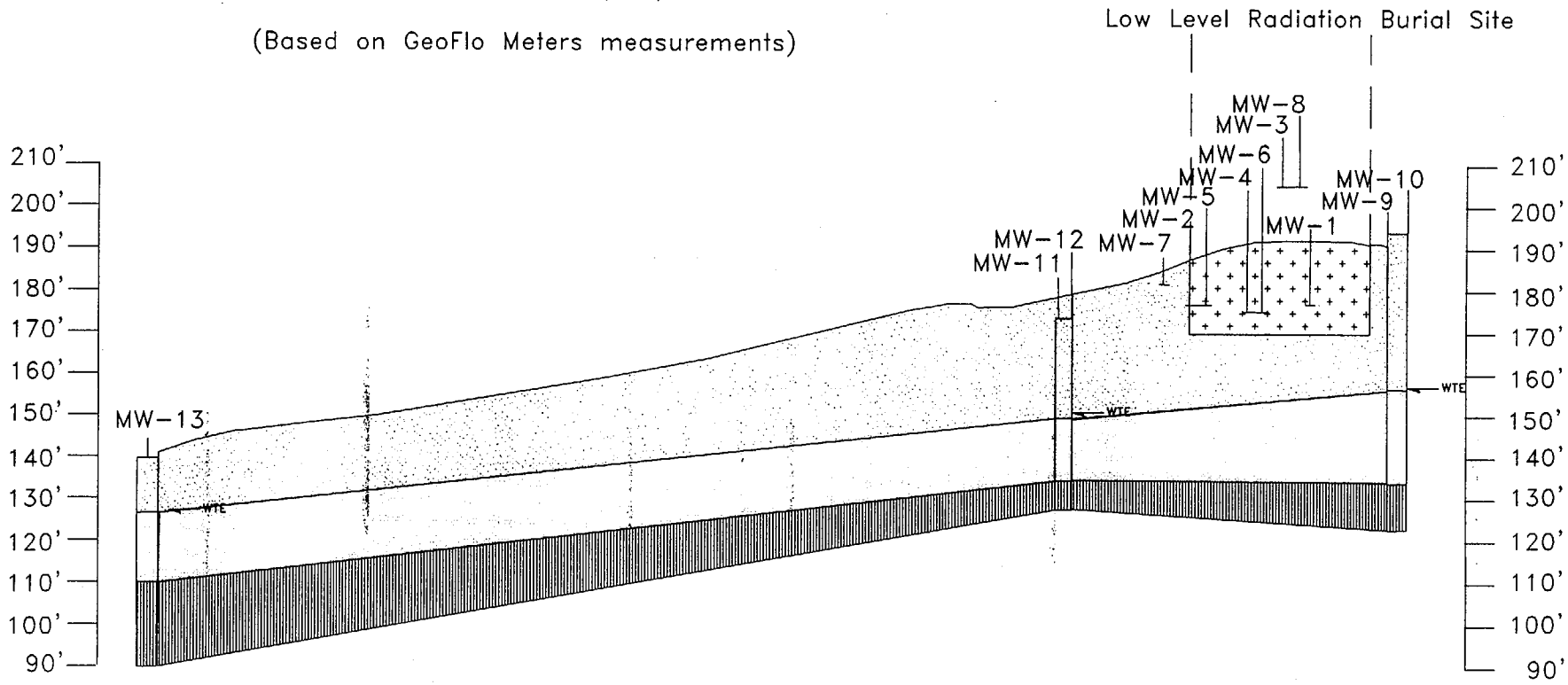
Recent information on sensitive environments was obtained by ENTECH. A November 1996 letter from the U.S. Fish and Wildlife Service (USFW), Chesapeake Bay Field Office, indicated that "no Federally listed or proposed endangered or threatened species are known to exist in the [BARC CERCLA] project impact area" (USFW, 1996). An October 1998 letter from the Maryland Department of Natural Resources (MDNR) indicated the presence of several rare, threatened, and endangered State-listed species and natural communities on the BARC facility (MDNR, 1998). State-listed plant and animal species are presented in Table 1.1.

Wetlands are present along Little Paint Branch and Paint Branch Creeks downgradient of the LLRBS. However, no other sensitive environments such as National or State parks, wildlife refuges, Federal- or State-designated Scenic Rivers, or State-designated wildlife management or natural areas are present on- or off-site BARC property in the general vicinity of the site.

GW Flow Direction: S-SE

Average Flow Rate: 1.6 ft/day

(Based on GeoFlo Meters measurements)



USDA ars Agricultural Research Service

Low Level Radiation Burial Site Remedial Investigation

Facility: Beltsville, Maryland

ENTECH INC

ENTECH, Inc.
7926 Jones Branch Dr.
Suite 620
McLean, VA 22102

FIGURE: 1.3 S-N Geologic Cross-section

Revised: 05/97	By: FFC	File: B18Xsection.dwg	Vertical Exaggeration: 5X

LEGEND

Top Soil = Beltsville-Leonardtown-Chillium association moderately deep, well drained to poorly drained, dominantly gently sloping soils that have a compact substratum.

Fill

TERRACE DEPOSITS; SW, loose, orange-brown, poorly sorted, medium-coarse grain SAND, dry

PATUXENT FORMATION; SP, loose, brown, well sorted, medium grain SAND, wet

SAPROLITE; ML, dense, white to red, micaceous SILT/CLAY

BARC KEY MAP

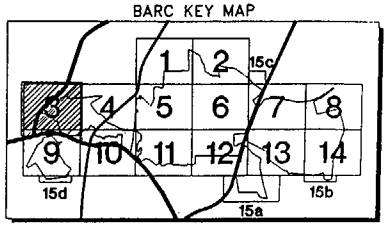


Table 1.1. State of Maryland Threatened and Endangered Species in the Vicinity of BARC

Scientific Name	Common Name	State Rank	State Status
Animals			
Chlorotettix	Cicadellid leafhopper	SU	-
Gomphus rogersi	Sable Clubtail	S1	E
Limotettix	Eastern sedge barrens planthopper	S1	-
Percina notogramma	Stripeback darter	S1	X
Plants			
Amelanchier obovalis	Coastal juneberry	S1	E
Aristida curtissii	Curtiss' three-awn	SU	-
Bideus discoidea	Swamp beggar-ticks	S2/S3	-
Carex emoryi	Emory's sedge	S1	-
Carex tonsa	Shaved sedge	S4	-
Lycopodiella caroliniana	Carolina clubmoss	SH	X
Passiflora incarnata	Purple passionflower	SU	-
Sanguisorba canadensis	Canada burnet	S2	T
Sphenopholis pensylvanica	Swamp-oats	S1/S2	T

S1 = highly State rare; S2 = State rare; S3 = State watch list; S4 = Apparently secure in State; SH = historically known, but not verified for an extended period; SU = Possibly rare.
E = endangered; T = threatened (could become endangered); X = endangered extirpated (no known natural population).

1.3 Site History

The LLRBS was established on June 23, 1949, and was used for the disposal of low-level radioactive waste until 1987. The site is permitted under a USDA-wide license originally issued by the Atomic Energy Commission (AEC), and later by the NRC. Records indicate the last liquid burial at the site was on September 17, 1984. All burials were dry solids packed in 55-gallon drums from September 24, 1985, until disposal ceased in 1987.

Information obtained from the USDA Radiation Safety Staff (RSS) and the BARC Safety Occupational Health and Environmental Staff (SOHES) indicates the NRC license which covers the LLRBS was renewed through September 30, 2005 (Powell, 1999; Flook, 1997). The conditions of the NRC license do not authorize additional burials of radioactive material, but require the continued maintenance and monitoring of the site.

No records exist which reveal the total volume of waste buried at the site. At the time disposal occurred, the NRC license required only the maintenance of radionuclide and activity records for wastes disposed. A summary of disposed isotopes and associated activities for materials disposed after 1960 is the most complete information available and is presented in Table 1.2. ARS records indicate a total of 50 pits were excavated between 1951 and 1987. The approximate dimensions of the pits were 10 feet wide by 12 feet long by 10 feet deep with 6 feet of separation between pits. Five feet of clean backfill was placed on top of the contents of each pit to ground level. Based on calculated, aggregate pit volume, ARS estimates as much as 33,000 cubic feet of waste may have been buried at the site (Apex, 1993).

In addition to radioactive isotopes, buried substances include scintillation fluids (isotopes and organic fluids); contaminated metal, glass, and plastic objects; contaminated animal carcasses; and animal wastes. ARS records do not reveal the types or volumes of organic fluids contained in the scintillation vials. Typically, organic solvents associated with scintillation fluids include toluene and xylenes. It is also likely ash from incinerated animal tissue is buried at the site (Apex, 1993).

Types of containers disposed, as documented in the files, are cardboard boxes of 1 to 4 cubic feet in volume, 1- to 5-gallon containers for liquids, plastic milk jugs, plastic carboys, solvent bottles, fiberboard drums, and 55-gallon drums. Liquid containers were placed in cardboard boxes, usually 4 to a box (Apex, 1993).

No known records exist listing the specific types of containers used for the early burials. Records from the 1980s reveal contaminated, non-burnable solids of glass and plastic (vials, pipettes, needles, scalpels, etc.) were buried in cardboard boxes. Animal carcasses, bedding, and excreta were sealed in polyethylene bags and placed in boxes. Liquid wastes were packed in plastic containers and placed in cardboard boxes. Animal tissue (generally contaminated with H^3 and C^{14}) was routinely incinerated (beginning in the early 1980s) in one of two incinerators located at BARC. It is possible that incinerator ash, which tested positive for radioactivity, could have been sent to the LLRBS; however no known records exist regarding ash disposal.

1.4 Previous Investigations and Contamination Summary

Previous investigations conducted at the LLRBS produced sampling data on the soils and groundwater outside of the boundaries of the northern portion of the site. Other non-intrusive investigations provide the current status of the site. The results of these investigations are summarized below.

Table 1.2. Radioactive Materials Disposed at the Low-Level Radiation Burial Site (1960-1987)

(activity decayed to 01/01/93, in millicuries)

Year	H^{3*}	C^{14}	Pb^{210*}	Sr^{90*}	Cl^{36}	Ni^{63}	Ra^{226}	Na^{22*}	Fe^{55*}	Cs^{137}
1960	0.12	3.22	-	0.44	-	-	?	-	-	-
1961	0.04	10.21	-	-	-	-	-	-	-	-
1962	0.48	1.51	-	-	-	-	-	-	-	-
1963	0.20	6.63	-	-	-	-	-	-	-	-
1964	2.06	54.22	-	-	0.002	-	0.15	-	-	-
1965	0.03	1.59	-	-	-	-	-	-	-	-
1966	0.38	18.43	-	-	0.10	0.15	-	-	-	-
1967	61.81	6.61	-	-	-	0.50	-	-	-	-
1968	5.45	41.68	-	-	-	0.50	-	-	-	-
1969	8.35	34.88	-	-	-	0.30	-	-	-	-
1970	2.26	10.32	-	-	-	0.20	-	-	-	-
1971	1.65	12.83	-	-	-	0.30	-	-	-	-
1972	0.32	27.28	-	-	-	0.10	-	-	-	-
1973	1.61	17.50	1.54	-	-	-	-	-	-	0.65
1974	46.14	37.70	-	-	-	2.0 24.5†	-	-	-	-
1975	4.95	4.84	-	-	0.001	-	-	-	-	-
Subtotal	135.85	289.45	1.54	0.44	0.103	4.05 24.5†	0.15	0.0	0.0	0.65

* - Decayed value: Na^{22} and Fe^{55} $T_{1/2}$ = 2.6 years; H^3 $T_{1/2}$ = 12.3 years; Pb^{210} $T_{1/2}$ = 20.4 years; and Sr^{90} $T_{1/2}$ = 27 years
† - Solid form - sealed source or electron capture detector
Source: Memorandum to Mr. Nicholas DiNardo, USEPA Region III, from W.G. Horner, USDA

Table 1.2 (Continued). Radioactive Materials Disposed at the Low-Level Radiation Burial Site (1960-1987) (activity decayed to 01/01/93, in millicuries)

Year	H^{3*}	C^{14}	Pb^{210*}	Sr^{90*}	Cl^{36}	Ni^{63}	Ra^{226}	Na^{22*}	Fe^{55*}	Cs^{137}
1976	26.97 157.11†	27.0	-	-	-	7.5	-	-	-	-
1977	51.13 103.89†	15.04	20.908	6.8	-	-	-	-	-	-
1978	129.59 549.54†	25.54	-	-	-	24.0	-	-	-	-
1979	857.65 1158.13†	82.04	2.143	-	-	88.0†	-	-	-	2.96
1980	111.33 250.0†	99.45	-	-	-	15.0†	-	-	-	-
1981	73.36 413.78†	152.04	-	-	-	10.0†	9.0†	-	0.442	-
1982	40.10 579.61†	26.62	-	-	-	-	-	0.010	-	-
1983	24.63	26.69	-	-	-	-	-	0.024	-	-
1984	38.14	18.76	-	-	-	-	-	-	-	-
1985**	11.45 829.84†	56.43	-	-	-	38.5†	-	-	0.288	-
1986**	24.35	12.60	-	-	-	-	-	0.141	-	-
1987**	7.96	0.03	-	-	-	-	-	-	0.012	-
Subtotal	1396.66 4041.9†	542.24	23.051	6.8	0.0	31.5 151.5†	0.0 9.0†	0.175	0.742	2.96
Total	1532.51 4041.9†	831.69	24.591	7.24	0.103	35.55 176.0†	0.15 9.0†	0.175	0.742	3.61

* - Decayed value: Na^{22} and Fe^{55} $T_{1/2}$ = 2.6 years; H^3 $T_{1/2}$ = 12.3 years; Pb^{210} $T_{1/2}$ = 20.4 years; and Sr^{90} $T_{1/2}$ = 27 years
** - Volume: 1985 = 398.5 ft^3; 1986 = 270 ft^3; 1987 = 37.5 ft^3
† - Solid form - sealed source or electron capture detector
Source: Memorandum to Mr. Nicholas DiNardo, USEPA Region III, from W.G. Horner, USDA

1.4.1 Preliminary Assessment/Site Inspection for the Beltsville Agricultural Research Center - Apex Environmental, May 1991

This Preliminary Assessment/Site Inspection (PA/SI) was conducted in response to deficiencies identified by Environmental Protection Agency (EPA) Region III in a PA completed early in the 1980s for BARC. This assessment/inspection was performed in 2 phases: a PA for potential inactive waste sites, followed by an SI for those sites identified in the PA which may present a significant threat to human health and the environment. The intent of the PA was to:

- Identify all sites and activities at BARC in which CERCLA hazardous substances and/or wastes have been or were currently being used, stored, or disposed.

- Identify sources where CERCLA hazardous substances had been or potentially could have been released to the environment, and evaluate the threat to human health and the environment.

- Eliminate from further consideration those sites with no record of disposal, or those which pose no threat to human health and the environment.

During the PA, 44 different sites were identified where disposal or releases of wastes were known to have occurred or were suspected. Of the 44 sites, 16 were identified where CERCLA hazardous substances may have been present. The LLRBS was among the 44 sites identified in the PA, but not among the 16 recommended for further investigation in the SI. The remaining 28 sites were eliminated from further consideration, as they were determined by Apex to be ineligible under CERCLA authority or EPA policy at that time. Because the LLRBS was not inspected under the SI, no analytical data are available from these activities.

1.4.2 EPA Site Analysis, Beltsville Agricultural Research Center - EPIC, February 1993

This report contains an analysis of historical aerial photography of BARC and presents the conclusions reached from reviewing aerial photography from the years 1937 to 1992. In addition to examining photography concerning the 44 previously identified areas at BARC, this analysis identified an additional 48 sites of potential concern.

Analysis of photography in the vicinity of the LLRBS indicates it was first visible in 1952. At that time, the site contained an area of disturbed ground and a possible pit. An adjacent field (southern portion) was seen added by 1963. The site remained active through 1984, based on the photography, and contained pits, disturbed ground, and mounded materials. By 1992 the site had completely revegetated, indicating

cessation of site activities. Because this report consisted solely of the analysis of aerial photography, no related analytical data are available.

1.4.3 Hydrogeologic Characterization and Monitoring of the BARC Radiation Burial Site - Apex Environmental, September 1993

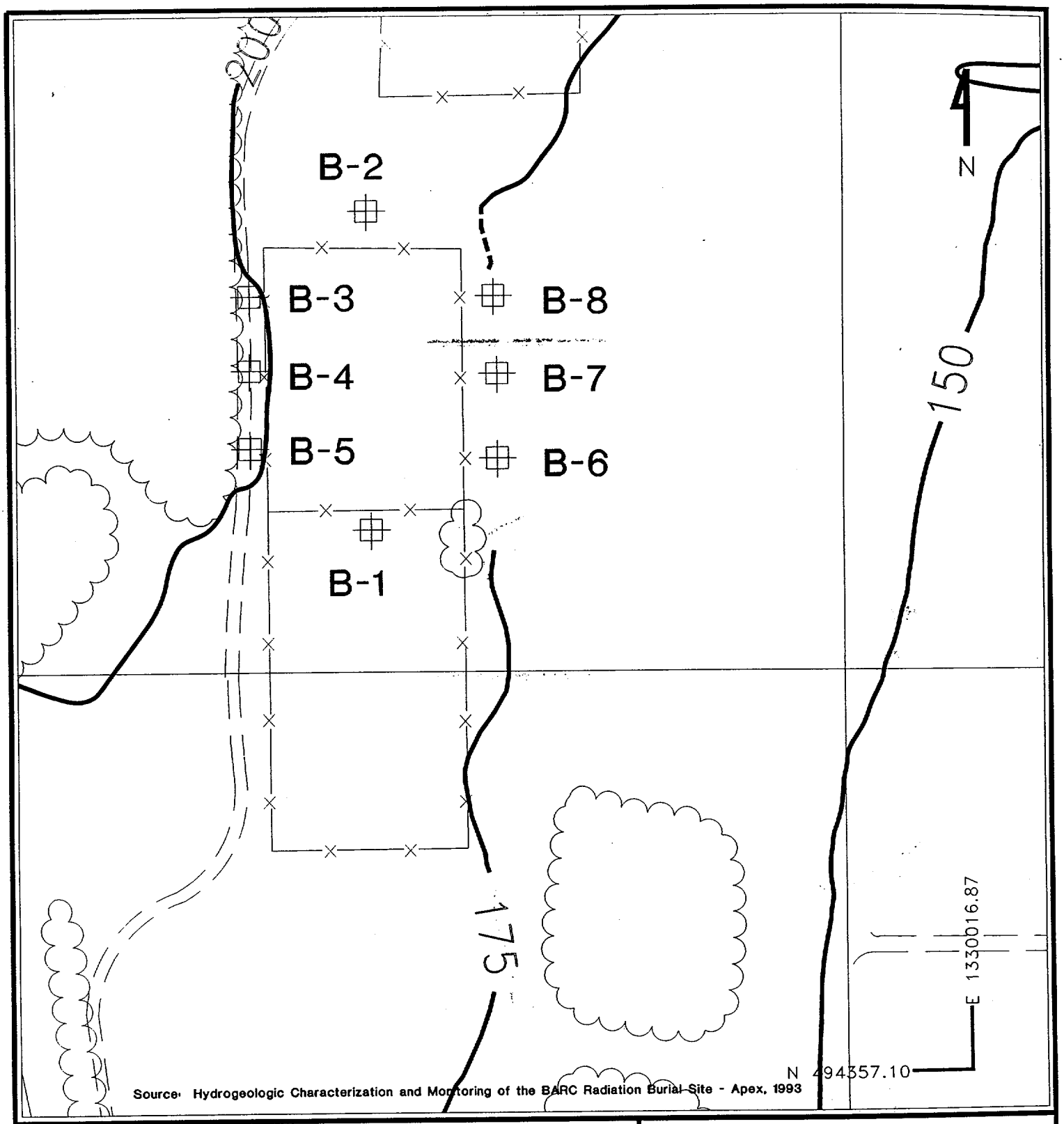
This investigation included the installation of 8 soil borings to bedrock, collecting split spoon soil samples on 5-foot centers for lithologic description, field monitoring of soil samples for the presence of radiological and organic contaminants, collecting an average of 2 soil samples from each boring for geotechnical and chemical analyses, and performing downhole geophysics in each borehole. The locations of the soil borings are presented in Figure 1.4. In addition, 3 piezometers/groundwater monitoring wells were installed to provide potentiometric groundwater data for the site. Initial field work was completed over a 4-week period between October 1 and October 28, 1992. The piezometers/monitoring wells were installed between April 13 and April 15, 1993.

Soil samples collected during the initial phase were analyzed for volatile organic compounds (VOCs), total organic carbon (TOC), total organic halogens (TOX), gross α, gross β, gross γ, and pH. These analytical results are presented in Tables 1.3, 1.4, and 1.5 respectively. The samples were collected and analyzed to evaluate whether any gross contamination existed at the site which might have indicated a need for immediate interim corrective actions, or required special precautions for site workers during subsequent site activities. In addition to the chemical and radiological analyses, a total of 20 undisturbed soil cores were collected for analysis of the following geotechnical properties: moisture content, bulk density, porosity, texture, horizontal hydraulic conductivity, and vertical hydraulic conductivity. Laboratory analysis of these properties was performed to provide information pertinent to the determination of contaminant fate and transport.

This investigation was intended to be consistent with requirements of CERCLA under protocols for remedial investigations/feasibility studies (RI/FSs). The results of this investigation represent the first 2 phases of work in a 5-phase investigative process initiated by Apex Environmental. The conclusions from this investigation were:

- The stratigraphy beneath the site consists of surficial terrace deposits of silty sand and gravel overlying well-sorted sand and gravel of the Patuxent Formation, which in turn overlies a clay/silt/saprolite unit representing the Wissahickon Formation (bedrock).

- Borehole geophysics utilizing natural γ radiation provided additional data confirming the interpretation of the stratigraphy beneath the site based on the soil boring classification.



Source: Hydrogeologic Characterization and Monitoring of the BARC Radiation Burial Site - Apex, 1993

FIGURE 1.4
Apex Soil Boring Locations

Low-Level Radiation Burial Site

ENTECH INC

LEGEND

- BARC Boundary
- AOC Boundary
- 003 BARC Bldg & No.
- Treeline
- Single Trees
- Soil Borings
- Road
- Unpaved Road
- Fence
- Gate
- Sidewalk
- Streams

APPROX. SCALE: 1" = 175'

BARC KEY MAP

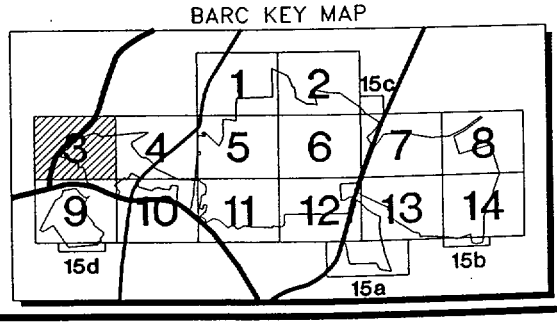


Table 1.3. Apex Soil Boring VOC Analytical Results (Detections Only)

Boring No.	Sample Depth (feet)	Analyte	Concentration (ppb)
1	40 - 42.5	2-Butanone	72
2	37 - 40	Acetone	14
3	46 - 49	Acetone	10
4	45 - 50	Xylene	4
	55 - 61	Acetone	9
5	47.5 - 50	1,1,1-Trichloroethane	9
8	47.5 - 50	Acetone	14

Table 1.4. Apex Soil Boring TOC and TOX Analytical Results (Detections Only)

Boring No.	Sample Depth (feet)	TOC (mg/kg)	TOX (mg/kg)
6	25 - 32	190	<0.1
8	27.5 - 30	580	<0.1

- The hydrology of the site consists of a single, unconfined aquifer which occurs within the Patuxent Formation, varying in thickness from 20 to 30 feet.

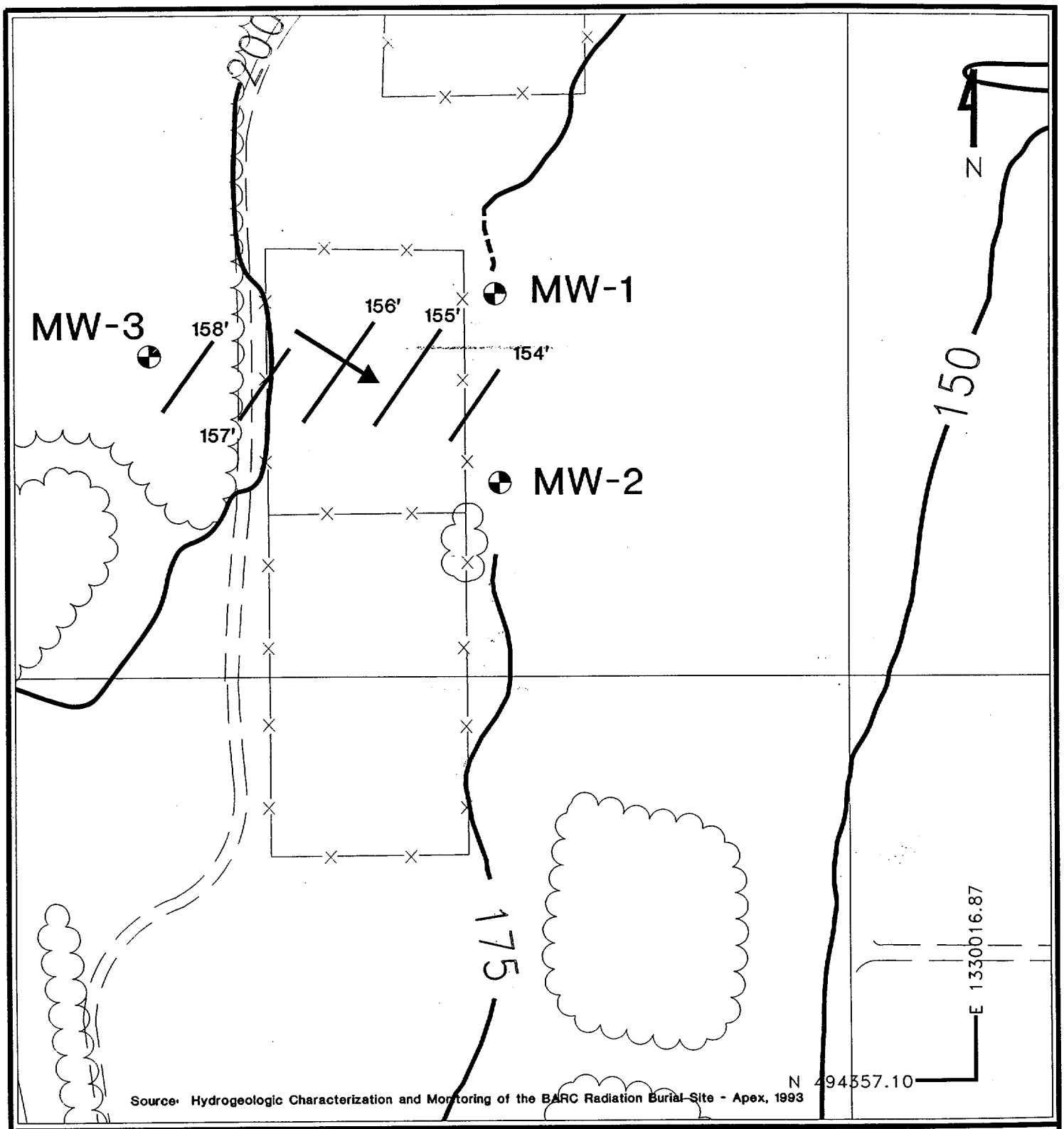
- Based on water level measurements from site wells, the groundwater flow direction was determined to be to the southeast, as seen in Figure 1.5.

- Monitoring of the soils for radiological and chemical constituents did not yield any results above background.

- Laboratory analyses revealed single detections of 2-butanone, xylene, and 1,1,1-trichloroethane; and 4 detections of acetone (a common laboratory solvent/contaminant) in soil samples.

- Laboratory analyses revealed no detections of TOX in any soil samples, and slightly acidic pH values, between 5 and 6. TOC levels above the method detection limit (MDL) were encountered in samples collected from downgradient borings (Nos. 6 and 8) at the water table.

- Laboratory analyses suggested naturally occurring α, β, and γ radiation was detected in the soils surrounding the site.



Source: Hydrogeologic Characterization and Monitoring of the BARC Radiation Burial Site - Apex, 1993

FIGURE 1.5
Groundwater Flow Direction

Low-Level Radiation Burial Site

ENTECH INC

LEGEND

- BARC Boundary
- AOC Boundary
- 003 BARC Bldg & No.
- Treeline
- Single Trees
- Shallow Well
- Road
- Unpaved Road
- Fence
- Gate
- Sidewalk
- Streams

APPROX. SCALE: 1" = 175'

BARC KEY MAP

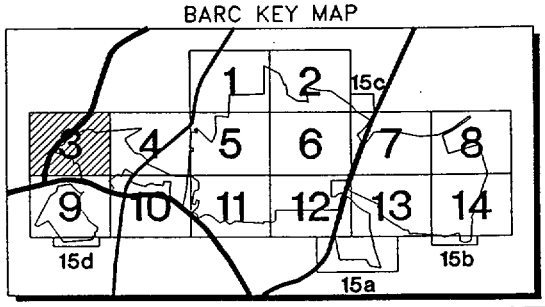


Table 1.5. Apex Gross α, Gross β, and Gross γ Soil Analytical Results

Boring No.	Sample Depth (feet)	α (pCi/g)	β (pCi/g)	γ (pCi/g)
1	40 - 42.5	1.64	<1.0	4.10
	50 - 52.5	1.10	1.06	7.08
	57.5 - 60	8.15	7.42	30.76
2	37 - 40	1.27	<1.0	2.85
	55 - 57.5	4.26	2.36	23.90
3	46 - 49	1.10	<1.0	3.37
	62.5 - 65	2.55	1.00	14.35
4	45 - 50	1.97	1.53	4.79
	55 - 61	1.47	<1.0	8.63
5	47.5 - 50	<0.5	<1.0	1.84
	60.5 - 65	2.78	1.65	13.34
6	25 - 32	<0.5	<1.0	3.89
	47.5 - 50	5.44	3.25	26.61
7	25 - 30	0.81	<1.0	6.26
	34 - 40	<0.5	<1.0	3.06
8	27.5 - 30	0.68	<1.0	7.77
	47.5 - 50	2.28	1.13	15.89

In an attempt to confirm that disposal did not occur in the southern portion of the site, Apex reviewed aerial photographs from 1957, 1966, 1977, 1987, and 1991. Analysis confirmed disposal activities were confined to the northern portion of the site.

1.4.4 Environmental Monitoring Summary Report of the BARC Radiation Burial Site (Draft) - Apex Environmental, March 1994

This investigation consisted of follow-on work to the prior Apex hydrogeologic activities. The overall objective of this study was to determine if buried waste at the site has released its constituents to the surrounding environment. Additionally, the NRC requires monitoring of the site to provide early warning of radionuclide migration. The data presented in the previous Apex report was used to design and install a groundwater monitoring network at the site. Based on the results of the previous study, 5 additional monitoring wells were installed around the disposal area to compliment the 3 previously installed wells and, at the time, to complete the saturated zone monitoring well network. This network established 3 well

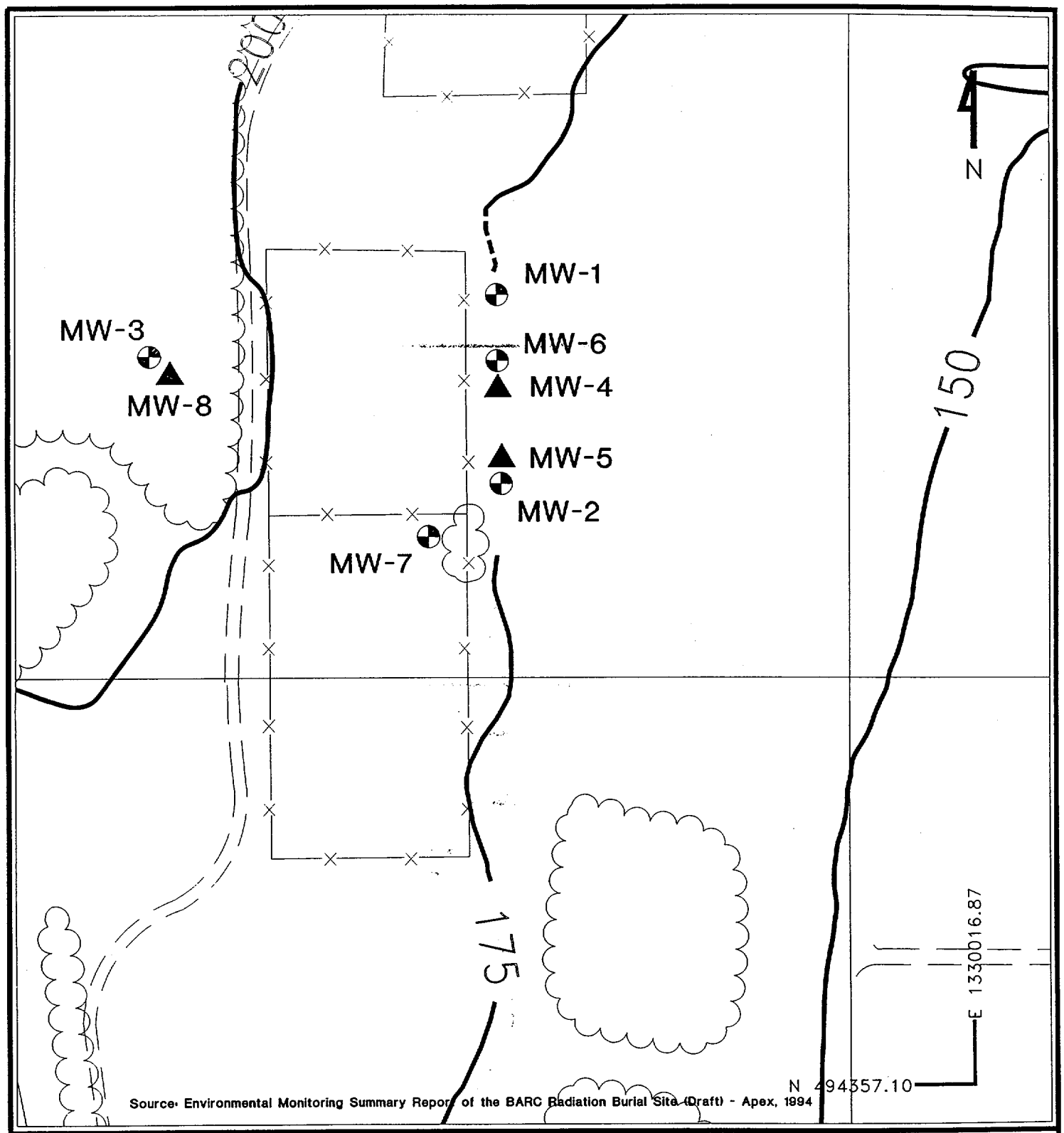
clusters within the Patuxent Formation; 1 upgradient and 2 downgradient of the site. Each cluster consists of a shallow water table monitoring well and a deep well screened at the bottom of the Patuxent aquifer above bedrock. The remaining 2, non-nested wells are screened at the water table and are located downgradient of the site. The locations of the 8 wells are presented in Figure 1.6.

The 5 new wells were installed between October 25 and 27, 1993. All 8 wells were sampled on November 3 and 4, 1993, and analyzed for the following parameters: VOCs, gross α, gross β, gross γ, and pH. Results of the sampling indicated three shallow wells contained α radiation above the EPA maximum contaminant level (MCL) of 15 picoCuries/Liter (pCi/L) for α radiation in drinking water. Two of the shallow wells (MW-2 and MW-6) are located downgradient of the site; however, the third (MW-3) is located upgradient. Beta radiation was detected at levels comparable to α readings. No man-made γ emitters were detected in the groundwater. Four shallow wells (MW-2, MW-3, MW-6, and MW-7) contained chloroform. The concentration of chloroform in MW-7 was 120 µg/L; above the MCL of 100 µg/L for total trihalomethanes (trihalomethanes include bromodichloromethane, dibromochloromethane, bromoform, and chloroform). No other VOCs were detected in the groundwater samples collected. Groundwater sampling results for gross α and gross β, and VOCs, are presented in Tables 1.6 and 1.7, respectively.

In order to assess the α radiation detected, the 3 samples from the 3 shallow wells above the MCL for α radiation were reanalyzed to identify specific isotopes. The samples were reanalyzed for Ra^{226} (decay product of Th^{232}), Ra^{228} (decay product of U^{238}), tritium, and uranium. The results, presented in Table 1.8, suggested the α radiation was primarily the result of Ra^{226}/Ra^{228} and uranium isotopes present in the groundwater, and was attributed to natural sources. Beta radiation was attributed primarily to tritium in the groundwater. The tritium concentration of the groundwater from MW-2 downgradient of the site was 1,924 pCi/L; however, the shallow, upgradient monitoring well MW-3 contained 710 pCi/L. No site-specific natural tritium levels are available for the Beltsville Area; however, current background levels of tritium in groundwater in the U.S. are roughly 15 to 30 pCi/L, although geographic variability is to be expected. The tritium concentrations in MW-2 and MW-3 were above normally expected tritium levels but are below the EPA drinking water standard of 20,000 pCi/L.

This investigation was intended to be consistent with the requirements of CERCLA under protocols for RI/FSs. The conclusions drawn from this investigation and the prior Apex work were:

- Chloroform is present in the shallow groundwater downgradient of the site above the MCL of 100 µg/L for total trihalomethanes.



Source: Environmental Monitoring Summary Report of the BARC Radiation Burial Site (Draft) - Apex, 1994

FIGURE 1.6

Apex Monitoring Well Locations

Low-Level Radiation Burial Site

ENTECH INC

LEGEND

- BARC Boundary
- AOC Boundary
- 003 BARC Bldg & No.
- Treeline
- Single Trees
- Shallow Well
- Road
- Unpaved Road
- Fence
- Gate
- Sidewalk
- Streams
- Deep Well

APPROX. SCALE: 1" = 175'

BARC KEY MAP

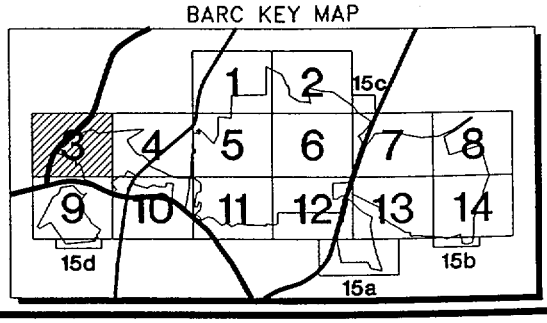


Table 1.6. Apex Groundwater Gross α and Gross β Results

Monitoring Well	α (pCi/L)	β (pCi/L)
MW-1 (shallow)	5.95 ± 1.36	14.02 ± 1.23
MW-2 (shallow)	16.25 ± 2.48	18.43 ± 1.54
MW-3 (shallow)	53.73 ± 4.09	40.00 ± 1.95
MW-4 (deep)	2.82 ± 1.55	11.79 ± 1.93
MW-5 (deep)	6.04 ± 1.44	12.10 ± 1.28
MW-5 (duplicate)	7.05 ± 2.87	13.58 ± 2.51
MW-6 (shallow)	17.19 ± 2.39	25.17 ± 1.84
MW-7 (shallow)	13.20 ± 2.09	14.07 ± 1.31
MW-8 (deep)	3.83 ± 1.31	4.67 ± 0.87

Table 1.7. Apex Groundwater VOC Analytical Results (Detections Only)

Monitoring Well	Analyte	Concentration (µg/L)
MW-2 (shallow)	Chloroform	25
MW-3 (shallow)	Chloroform	0.6
MW-6 (shallow)	Chloroform	3
MW-7 (shallow)	Chloroform	120

Table 1.8. Apex Isotopic Results of Groundwater Samples from MW-2, MW-3, and MW-6 (pCi/L)

Monitoring Well	Ra^{226}	Ra^{228}	Tritium	U^{234}	U^{235}	U^{238}
MW-2 (shallow)	2.08	3.27	1,924.211	<0.5	<0.5	<0.5
MW-3 (shallow)	17.24	12.31	710.57	6.11	<0.5	5.96
MW-6 (shallow)	4.25	4.35	<500.00	1.27	<0.5	1.13

- Alpha radiation is present in groundwater upgradient and downgradient of the site above the MCL of 15 pCi/L.

- Gross β radiation is present in groundwater upgradient and downgradient of the site and attributed to elevated tritium concentrations.

The investigation further concluded the elevated levels of chloroform and tritium may have been the result of a release from the site; however, the occurrence of tritium in the upgradient monitoring well suggested a possible upgradient source.

1.4.5 EPA Region III Technical Assistance Team Sampling - Weston, February 1996

On February 28 and 29, 1996, EPA Region III's Technical Assistance Team (TAT) performed sampling of the 8 monitoring wells at the LLRBS at the request of the EPA Regional Project Manager for BARC (Weston, 1996). The groundwater samples were analyzed for VOCs; semi-volatile organic compounds (SVOCs); total metals; dissolved metals; gross α, β, and γ; and the radioisotopes tritium, Ra^{226}, Ra^{228}, Sr^{89}, Sr^{90}, U^{234}, U^{235}, and U^{238}.

Analysis of the groundwater samples for VOCs and SVOCs detected a total of 8 contaminants: acetone; bis(2-ethylhexyl)phthalate; 4,4'-dichlorodiphenyl-dichloromethane (4,4'-DDD); 4,4'-dichlorodiphenyl-dichloroethylene (4,4'-DDE); 4,4'-dichlorodiphenyl-trichloromethane (4,4'-DDT); methylene chloride; methoxychlor, and chloroform. Bis(2-ethylhexyl)phthalate was detected in the low parts-per-billion (ppb) range in 7 of 8 wells, and the Field Blank for the TAT sampling. Bis(2-ethylhexyl)phthalate is a common laboratory contaminant, was detected at the same order of magnitude in the Field Blank as the well samples, and therefore is not likely attributable to the site. Acetone, detected in the ppb range in groundwater, also was detected in the ppb range in 4 of the 8 soil borings taken by Apex in 1993. Acetone is also a common laboratory contaminant, and was detected in both the Field Blank and the Trip Blank for the TAT samples. 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT were detected in the parts-per-trillion (ppt) range, and are likely common, low-concentration contaminants throughout BARC. The final 3 contaminants; methylene chloride, chloroform, and methoxychlor; were detected in the ppb, ppb, and ppt ranges respectively. Methylene chloride is a common laboratory contaminant, and was also detected in both the Field Blank and the Trip Blank for the TAT samples. Only chloroform (100+ ppb concentration) was detected above the MCL of 100 ppb for total trihalomethanes. Chloroform was the only VOC previously detected during the Apex sampling. Based on a review of the VOC and SVOC data, a plume of chloroform may be migrating southeastward from the LLRBS, primarily in the upper portion of the formation. VOC and SVOC analytical results for those constituents detected in the groundwater are presented in Table 1.9.

Unfiltered groundwater samples produced concentrations of arsenic (86.8 µg/L), chromium (145 µg/L), and thallium (4.2 µg/L) above their respective MCLs (50 µg/L, 100 µg/L, and 2 µg/L). Filtered groundwater samples produced concentrations of antimony (24.9 µg/L), mercury (3.1 µg/L), and thallium (4.3 µg/L) above their respective MCLs (6.0 µg/L, 2.0 µg/L, and 2.0 µg/L). Although thallium was detected above its MCL in both unfiltered and filtered samples, the detections were found in different monitoring wells.

Table 1.9. Summary of Organic Data for EPA Region III TAT Groundwater Samples

Monitoring Well	Analyte	Concentration (µg/L)
MW-1 (shallow)	Methylene chloride	1
	bis(2-Ethylhexyl)phthalate	2
	4,4'-DDD	0.013
MW-2 (shallow)	Methylene chloride	1
	Chloroform	100+
	bis(2-Ethylhexyl)phthalate	6
	4,4'-DDE	0.009
	Methoxychlor	0.12
MW-3 (shallow)	bis(2-Ethylhexyl)phthalate	3
MW-4 (deep)	Methylene chloride	1
	Acetone	4
	bis(2-Ethylhexyl)phthalate	8
	4,4'-DDT	0.019
MW-5 (deep)	Acetone	17
	bis(2-Ethylhexyl)phthalate	2
	4,4'-DDE	0.009
	4,4'-DDT	0.012
	Methoxychlor	0.074
MW-6 (shallow)	Chloroform	20
MW-7 (shallow)	Acetone	5
	Chloroform	68+
	bis(2-Ethylhexyl)phthalate	2
MW-8 (deep)	Acetone	3
	bis(2-Ethylhexyl)phthalate	2

Concentrations of unfiltered constituents in MW-6 (shallow, downgradient) and MW-8 (shallow, upgradient) are significantly lower than the other wells sampled. At this time, there is no obvious explanation for these readings. The significant decrease in metals concentrations between unfiltered and filtered samples and the lack of consistently elevated levels of metals above their respective MCLs seems to indicate the constituents are naturally occurring in the subsurface soils, and are not a result of a release from the site. Unfiltered and filtered inorganic results are presented in Tables 1.10 and 1.11 respectively.

Radiological results for the gross α, gross β, gross γ, and isotope-specific analyses did not produce any values above MCLs (15 pCi/L for gross α; 20,000 pCi/L for tritium); however, tritium levels in 3 shallow downgradient wells (MW-2: 1,580 pCi/L; MW-6: 1,920 pCi/L; and MW-7: 7,220 pCi/L) are somewhat elevated compared to the upgradient, background wells (MW-3: 59.0 pCi/L; and MW-8: 26.4 pCi/L). This more recent round of sampling by EPA's TAT indicates tritium is not present at elevated levels in the shallow background well, as previously indicated by 1994 Apex data. The elevated level in the 1994 data (710.57 pCi/L) was likely the result of cross-contamination during well installation or sampling.

Therefore, an upgradient source of tritium contamination is likely not present in the vicinity of the site. Other isotopes analyzed for (Ra^{226}, Sr^{89}, Sr^{90}, U^{234}, U^{235}, U^{238}) did not indicate a trend of elevated levels in downgradient wells compared to upgradient values. Radiological results are presented in Tables 1.12 and 1.13.

Based on the initial review of the EPA Region III TAT sampling data, the following conclusions are developed:

- A plume of chloroform appears to be migrating to the southeast from the LLRBS, primarily in the upper portion of the Patuxent Aquifer.

- Inorganic analytes detected in the existing monitoring wells appear to be naturally occurring in the soils in the general vicinity of the LLRBS, based on comparisons of the filtered and unfiltered data.

- A tritium source is not likely present upgradient of the LLRBS, based on comparison of EPA Region III TAT sampling data to previous Apex sample results.

- Tritium concentrations in 3 shallow downgradient wells (MW-2, MW-6, and MW-7) are elevated relative to background well concentrations (MW-3 and MW-8). This may be indicative of a plume of tritium migrating in a southeasterly direction from the LLRBS.

Table 1.10. Summary of Unfiltered Inorganic Data for EPA Region III TAT Groundwater Samples (µg/L)

Analyte	MCL	IDL	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8
Aluminum	-	14.3	43100	66000	56100	12800	30500	4530	55600	3060
Arsenic	50	2.7	63	39.5	37.2	22.9	37.1	2.8	86.8	3.2
Barium	2000	1.0	157	275	177	186	257	77.4	229	80.5
Beryllium	4	0.30	1	1.3	0.88	0.55	1.2	0.38	0.94	0.39
Cadmium	5	1.3	ND	1.4	ND	ND	ND	ND	ND	ND
Calcium	-	122	4430	11800	7440	10400	13100	4370	27100	6520
Chromium	100	2.1	143	105	105	61.4	93.4	10.9	145	8.4
Cobalt	-	2.3	9	12.5	11.8	13.3	12.5	3.2	12.2	4.7
Copper	-	6.6	137	150	207	86	79.8	17.2	169	18.4
Iron	-	10.6	112000	97200	93000	42300	75900	9840	138000	6380
Lead	50	1.7	30	41.3	27	20.6	30.8	6.1	36.9	5.3
Magnesium	-	23.7	5660	7240	7400	7190	6870	4160	8220	5560
Manganese	-	0.70	148	213	122	106	132	72	293	38.8
Mercury	2	0.10	0	1.4	1.3	0.4	0.28	0.12	1.4	0.54
Nickel	100	4.3	13	22.6	18	ND	10.4	ND	17.4	ND
Potassium	-	133	8560	5960	5090	8630	7450	4320	5110	4460
Selenium	50	3.9	10	7.4	5.3	4.8	6.9	ND	17.2	ND
Sodium	-	36.1	6910	12700	20500	12800	17000	7150	11000	19100
Thallium	2	3.7	ND	ND	ND	ND	ND	ND	4.2	ND
Vanadium	-	1.9	337	302	286	148	191	27	488	22.4
Zinc	-	5.8	51	77.1	58.4	35.9	53.8	16.6	62	13.4

MCL - Maximum Contaminant Level
IDL - Instrument Detection Limit
ND - Analyte Not Detected above Reporting Limit

Table 1.12. Summary of Gross α, Gross β, and Gross γ Data for EPA Region III TAT Groundwater Samples (pCi/L)

Monitoring Well	α	β	γ
MCL	15	-	-
MW-1 (shallow)	3.83 ± 3.44	11.1 ± 6.88	7.26 ± 6.63
MW-2 (shallow)	3.00 ± 4.23	6.21 ± 5.92	74.81 ± 60.1
MW-3 (shallow)	7.07 ± 4.39	2.96 ± 5.89	4.37 ± 6.92
MW-4 (deep)	6.30 ± 5.27	9.17 ± 6.28	ND
MW-5 (deep)	0.613 ± 4.30	5.84 ± 5.51	33.48 ± 82.3
MW-6 (shallow)	<0.5	5.49 ± 6.13	21.8 ± 41.8
MW-7 (shallow)	6.59 ± 4.90	6.20 ± 6.60	94.88 ± 71.2
MW-8 (deep)	1.74 ± 3.01	5.57 ± 6.02	ND

Table 1.13. Summary of Radioisotope Data for EPA Region III TAT Groundwater Samples (pCi/L)

Monitoring Well	Tritium	Ra^{226}	Sr^{89}	Sr^{90}	U^{234}	U^{235}	U^{238}
MW-1	97.9	0.258	1.08	<0.1	0.0769	0.0207	0.0695
MW-2	1,580	1.02	1.1	<0.1	0.0737	0.0120	0.0478
MW-3	59.0	1.69	0.445	<0.1	0.269	0.0218	0.174
MW-4	74.5	2.17	<0.1	0.182	0.143	0.0256	0.0794
MW-5	55.4	1.37	0.882	<0.1	0.0442	0.0169	0.0211
MW-6	1,920	0.728	0.914	0.602	0.0250	<0.01	0.0300
MW-7	7,220	0.775	0.989	0.141	0.483	0.0421	0.511
MW-8	26.4	1.28	<0.1	0.424	0.0809	0.0116	0.0198

1.4.6 Aerial Photographic Site Analysis: Beltsville Agricultural Research Center (Final) - ENTECH, January 1997

This investigation focused on historical waste management and disposal practices conducted at BARC. Eleven individual years of coverage spanning 7 decades, from 1937 to 1993, were analyzed. Based on the analysis, the northern field of the LLRBS was found to be actively involved in waste burial operations from at least 1952 to 1987; however, no direct evidence of waste materials or containment vessels were detected in the photography. All disposal activity appeared to have ceased prior to 1993. Additionally, the grid pattern for delineating the individual burial plots which was in place for several decades was removed by 1993. This analysis confirmed the southern portion of the site had not been used for disposal

1.4.8 Low-Level Radiation Burial Site Remedial Investigation - ENTECH, July 1997 - Present

The purpose of this investigation is to characterize the nature and extent of potential groundwater and surface water/sediment contamination associated with past disposal practices at the LLRBS. The primary investigative activities conducted to date consist of field screening groundwater in the vicinity of the LLRBS to assess the general extent of contaminant migration; installing additional downgradient and upgradient monitoring wells; sampling and analysis of groundwater, surface water, and sediment; and other activities associated with characterizing groundwater flow conditions in the general vicinity of the site.

1.4.8.1 Specific Objectives

The specific objectives of this project are designed to build upon previously gathered data from the studies summarized above. Based on a review of these studies, the field program was developed to meet the following objectives:

- Determine the general extent of contamination in the groundwater downgradient of the site. This was accomplished by conducting a Geoprobe® screening survey, and by installing a pair of nested monitoring wells at the downgradient extent of the contamination plume, and a well further downgradient for groundwater characterization and future monitoring. In addition, another pair of nested monitoring wells were installed upgradient of the site for background groundwater characterization and future monitoring.

- Determine the groundwater flow pattern based on the existing 8 and 5 newly installed wells.

- Determine the rate of contaminant migration in the groundwater.

- Determine potential contaminant release to surface water and sediment as a result of either surface runoff, or groundwater discharge to surface water. Four (4) co-located surface water and sediment samples were collected.

- Identify potential downgradient groundwater and surface water receptors.

- Assess potential risks to human health and the environment from potential groundwater and surface water/sediment contamination.

- Determine the need for remedial action.

As this investigation is ongoing, only a portion of the activities required to meet the above objectives have been performed. The remaining activities will be coordinated with field work associated with the removal action at the LLRBS, in order to eliminate duplication or unnecessary effort.

The 5 newly installed wells, in conjunction with the 8 existing wells, are used in a biannual monitoring program in order to track the extent of groundwater contamination and types of contaminants that are emanating from the site.

1.4.8.2 Results of the Geoprobe® Screening Survey

This screening investigation focused on determining the extent of VOC and radiological contamination present in the groundwater through the use of grab samples taken from the saturated zone via a Geoprobe®, and quick turnaround (24-hour) and fixed laboratory confirmatory analyses. A total of 57 groundwater samples were collected and analyzed from June 30 to July 16, 1997. The Geoprobe® groundwater sampling locations are presented in Figure 1.7. The majority of the data points were located to the southeast of the LLRBS, all outside of the northern fenced area. Several points were located upgradient of the site to provide background data for comparison to downgradient values. VOC target compounds of interest included methylene chloride, chloroform, 1,1,1-trichloroethane (1,1,1-TCA), trichloroethene, acetone, toluene, and total (m-, p-, and o-) xylenes. Radiological parameters included gross α, gross β, gross γ, tritium, C^{14}, Ra^{226}, Cl^{36}, Ni^{63}, and Sr^{90}.

VOC samples were available within 24 hours from the nearby laboratory subcontractor. Timely receipt of VOC sample results was used to facilitate a thorough characterization of groundwater plume geometry for the target VOCs. One-quarter (25%) of the screening samples were sent to a fixed laboratory for confirmation of the analytical results. Quick turnaround laboratory analytical results above the quantitation limit for the target VOCs are presented in Table 1.14.

Enough sample volume was collected at each Geoprobe® sampling point for fixed laboratory analysis of target radiological parameters. Fixed laboratory analytical results above the quantitation limit for radiological parameters are presented in Table A.1, which for brevity is contained in Appendix A.

VOC screening results indicate a potential groundwater plume directed towards the south-southeast emanating from the LLRBS. Of the VOCs detected in the screening samples, chloroform was found consistently in the groundwater southeast of the LLRBS, and is considered indicative of the contaminant

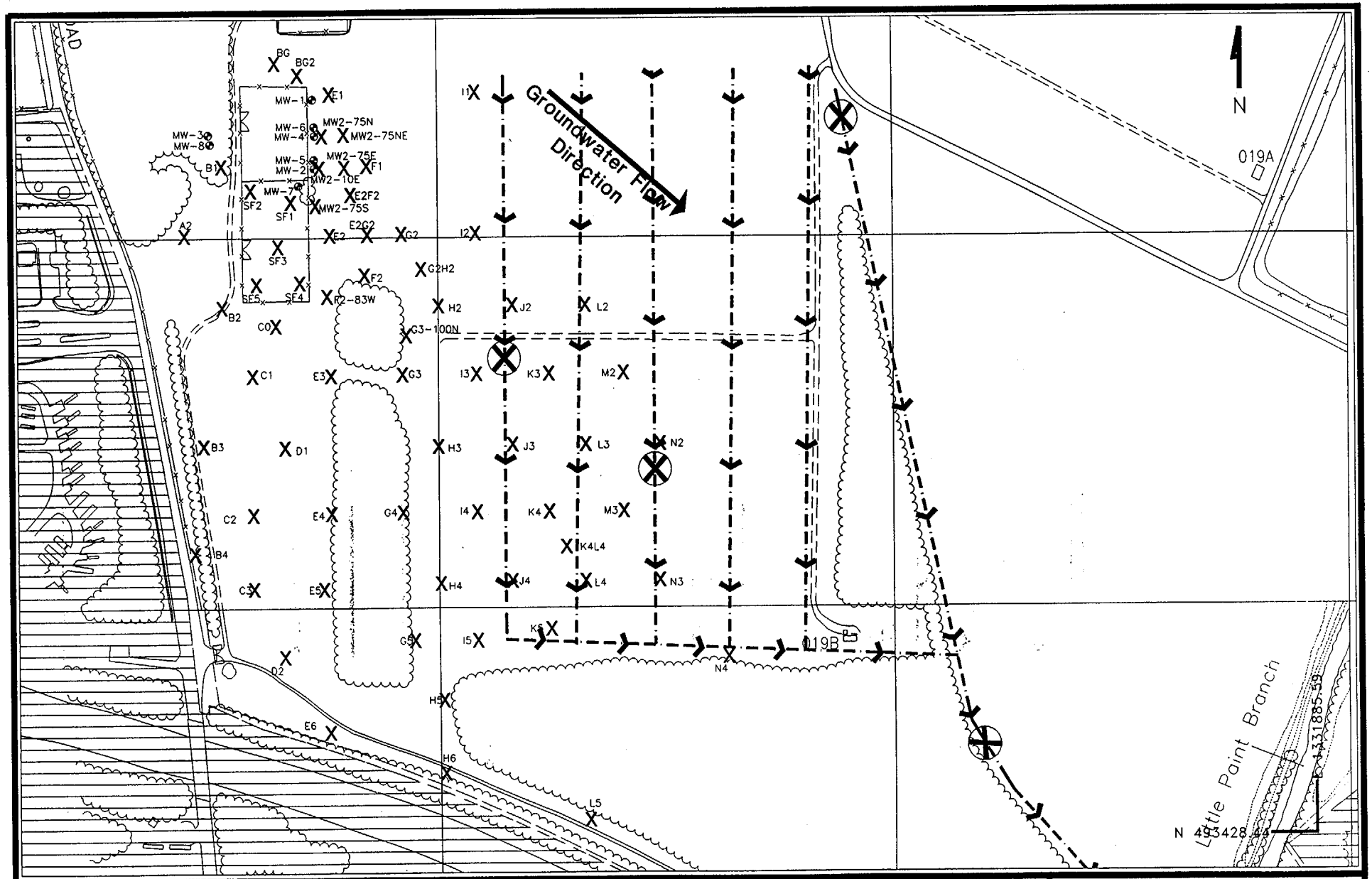


FIGURE: 1.7

ENTECH INC

Low-Level Radiation Burial Site
Groundwater Screening Locations and
Surface Water/Sediment Sampling Locations

LEGEND

- Soil Boring
- BARC Boundary
- BARC Building and Number (003)
- Treeline
- Single Trees
- Road
- Unpaved Road
- Fence
- Gate
- Sidewalk
- Groundwater Sampling Pt.
- Surface Water/Sediment Sampling Pt.
- Drainage Ditch

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BARC KEY MAP

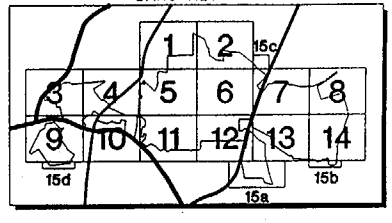

Table 1.14. ENTECH Geoprobe® Groundwater Quick-Turnaround VOC Results (Detections Only - µg/L)

Sample ID	Methylene Chloride	Chloroform	Acetone	Toluene	Total Xylenes
E2-GW	4.8	1.0	<1.0	<1.0	<1.0
F2-GW	2.4	1.6	1.5	<1.0	<1.0
H2-GW	<1.0	<1.0	1.6	<1.0	<1.0
G3-GW	<1.0	1.6	<1.0	<1.0	<1.0
H3-GW	<1.0	3.1	<1.0	<1.0	<1.0
E3-GW	<1.0	5.9	1.0	<1.0	<1.0
MW2GP-75E	<1.0	5.6	<1.0	<1.0	<1.0
MW22GP-10E	15.0	6.0	<1.0	<1.0	<1.0
MW2GP-75S	<1.0	25.0	1.2	<1.0	<1.0
MW2GP-75N	8.8	2.9	<1.0	<1.0	<1.0
E2G2-GW	2.6	2.1	<1.0	<1.0	<1.0
G4-GW	5.0	4.6	<1.0	<1.0	<1.0
E4-GW	<1.0	1.1	<1.0	<1.0	<1.0
C0-GW	<1.0	1.0	<1.0	<1.0	<1.0
D1-GW	<1.0	1.4	<1.0	<1.0	<1.0
F2-83W	<1.0	4.6	<1.0	<1.0	<1.0
I3-GW	<1.0	1.9	<1.0	<1.0	<1.0
I3-GW Dup.	<1.0	1.5	<1.0	<1.0	<1.0
J3-GW	<1.0	3.0	<1.0	<1.0	<1.0
H4-GW	<1.0	5.0	<1.0	<1.0	<1.0
C2-GW	<1.0	1.0	<1.0	<1.0	<1.0
J2-GW	<1.0	2.6	<1.0	<1.0	<1.0
K4-GW	<1.0	3.9	<1.0	<1.0	<1.0
G2H2-GW	<1.0	1.3	<1.0	<1.0	<1.0
MW275NE	5.4	<1.0	<1.0	<1.0	<1.0
I5-GW	<1.0	5.6	<1.0	<1.0	<1.0
K3-GW	<1.0	1.6	<1.0	<1.0	<1.0
C3-GW	<1.0	1.2	<1.0	<1.0	<1.0
G5-GW	<1.0	8.1	<1.0	<1.0	<1.0
H5-GW	<1.0	11.0	<1.0	<1.0	<1.0

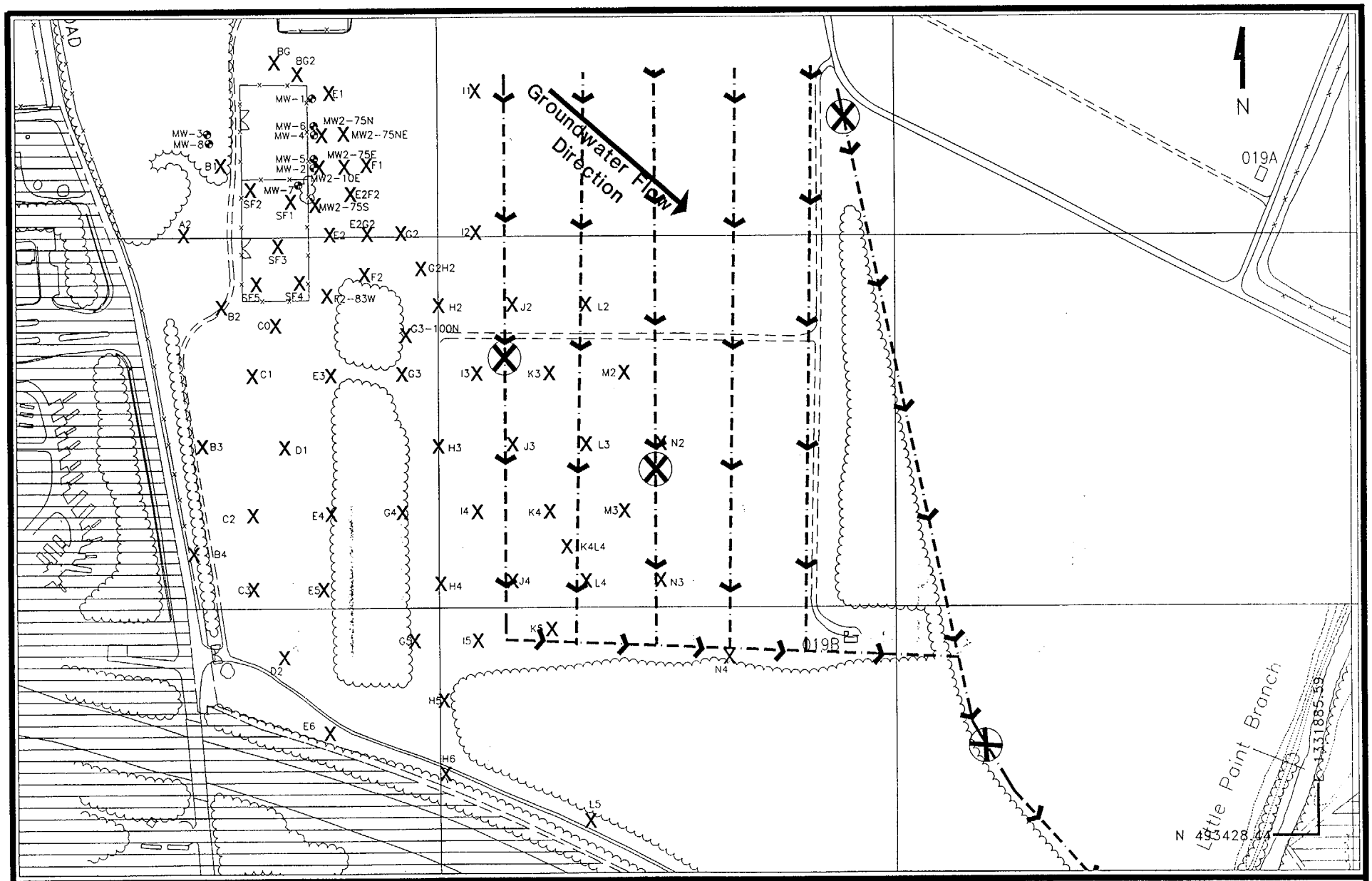

FIGURE: 1.7

ENTECH INC

Low-Level Radiation Burial Site
Groundwater Screening Locations and
Surface Water/Sediment Sampling Locations

LEGEND

- Soil Boring
- BARC Boundary
- BARC Building and Number (003)
- Treeline
- Single Trees
- Road
- Unpaved Road
- Fence
- Gate
- Sidewalk
- Groundwater Sampling Pt.
- Surface Water/Sediment Sampling Pt.
- Drainage Ditch

APPROX. SCALE: 1" = '

BARC KEY MAP

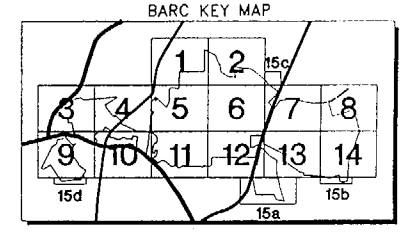

Table 1.14 (continued). ENTECH Geoprobe® Groundwater Quick-Turnaround

Sample ID	Methylene Chloride	VOC Results (Detections Only - µg/L) Chloroform	Acetone	Toluene	Total Xylenes
K5-GW	<1.0	1.8	<1.0	<1.0	<1.0
B3-GW	<1.0	<1.0	6.3	<1.0	2.8
SF3-GW	<1.0	<1.0	2.7	<1.0	<1.0
SF1-GW	<1.0	1.1	3.8	<1.0	<1.0
E6-GW	<1.0	1.2	2.6	<1.0	<1.0
H6-GW	<1.0	1.5	4.1	<1.0	<1.0
I1-GW	<1.0	1.0	2.4	<1.0	<1.0
N2-GW	<1.0	1.4	<1.0	<1.0	<1.0
SF5-GW	<1.0	1.2	<1.0	<1.0	<1.0
SF4-GW	<1.0	1.2	<1.0	<1.0	<1.0
B4-GW	<1.0	1.6	<1.0	<1.0	<1.0

plume as depicted in Figure 1.8. Isoconcentration contours for chloroform near monitoring well MW-7 indicate a potential "hot spot" of contamination in the vicinity. Contours further downgradient from the LLRBS are somewhat unclear in relation to plume geometry and flow path, likely due to decreasing chloroform concentrations in the groundwater. Chloroform was identified as a contaminant in prior groundwater investigations at the LLRBS.

Radiological results for the screening samples also confirm a south-southeasterly plume. Tritium (H^3) concentrations in the groundwater are also elevated in the vicinity of monitoring well MW-7, with a distinct decrease in concentrations as one moves further away from the LLRBS. The analytical result from a data point situated approximately 150 feet south of the southern fence line (Figure 1.9) indicates a potential "hot spot" of tritium in the vicinity. Alternatively, this data point could be an anomalous reading.

Radiological results for gross α and gross β indicate slightly elevated concentrations of radionuclides in groundwater near the eastern fence line, although a clear source for these contaminants is not evident from the data (Figures 1.10 and 1.11). Elevated α and β readings were detected at the same sample point located approximately 200 feet southeast of the LLRBS. The elevated readings may be anomalies or may indicate "hot spots" within the plume. Overall, data for gross α and gross β do not clearly depict a plume of radiological contamination relative to the tritium data.

1.4.8.3 Monitoring Well Installation and Groundwater Sampling Results

Based on the results of the Geoprobe® screening survey, 5 additional monitoring wells were installed to supplement the 8 existing wells at the LLRBS. One pair of wells was installed approximately 20 feet north of the northern fenceline; one screened at the water table, the other screened at the bottom of the saturated zone where saprolite was encountered. A second pair of wells was installed approximately 120 feet southeast of monitoring well MW-7. One well of this pair was again installed at the water table, with the second well installed at the bottom of the saturated zone at the saprolite interface. The fifth well was installed approximately 1300 feet south-southeast of the northern half of the LLRBS. This well is situated 100 feet north of the southern boundary of BARC, and is intended to monitor groundwater for contamination which is moving off BARC property. One of the objectives of potential future remedial action at the LLRBS may be to contain groundwater contamination within the confines of BARC property.

The construction of the 5 monitoring wells was consistent with the 8 previously installed monitoring wells, as well as consistent NRC-approved monitoring networks in unconfined, homogeneous aquifers beneath low-level radioactive waste sites. In addition, all 5 wells were constructed in accordance with State of Maryland requirements. The 5 new wells were developed, and all 13 wells at the LLRBS were purged prior to sampling. Groundwater samples were analyzed for SW-846 Method VOCs, SVOCs, pesticides/polychlorinated biphenyls (PCBs) and metals; tentatively identified compounds (TICs); gross α, gross β, gross γ; and specific radioisotopes (tritium, C^{14}, Ra^{226}, Cl^{36}, Ni^{63}, and Sr^{90}).

All 13 wells were sampled using the low-flow sampling protocol. Under this procedure, withdrawal rates are ideally kept to less than 0.5 L/min in order to minimize the amount of drawdown in the well. This also allows for water to be drawn from the formation, through the screen, and into the pump, with minimal disturbance of the stagnant water column in the well. Investigation-derived waste (IDW) disposal costs are also minimized as the volume of purge water is considerably less than traditional methods.

Three (3) rounds of sampling at the LLRBS wells have been conducted as of April, 1999. Round 1 was conducted in October, 1997; Round 2 in May, 1998; and Round 3 in December, 1998. During the initial round of sampling in October, 1997, a GeoFlow® meter was used in 4 of the 5 newly installed wells to determine groundwater flow rate and direction. Based on data obtained with the GeoFlow® meter, groundwater is moving in a south-southeasterly direction at an estimated 1.6 feet per day.

Analytical data (positive results only) are presented in Appendix A in Tables A.2, A.3, and A.4 for Rounds 1, 2, and 3 respectively. Although formal data validation findings are available only for the first 2 rounds of data, the list of detected groundwater contaminants has remained fairly limited and consistent through all prior monitoring events. Only chloroform, toluene, and the radionuclides tritium, C^{14}, and $Ra^{226/228}$ have

Figure 1.8. Low-Level Radiation Burial Site Chloroform Concentrations (ppb) June/July 1997 - ENTECH Geoprobe Samples

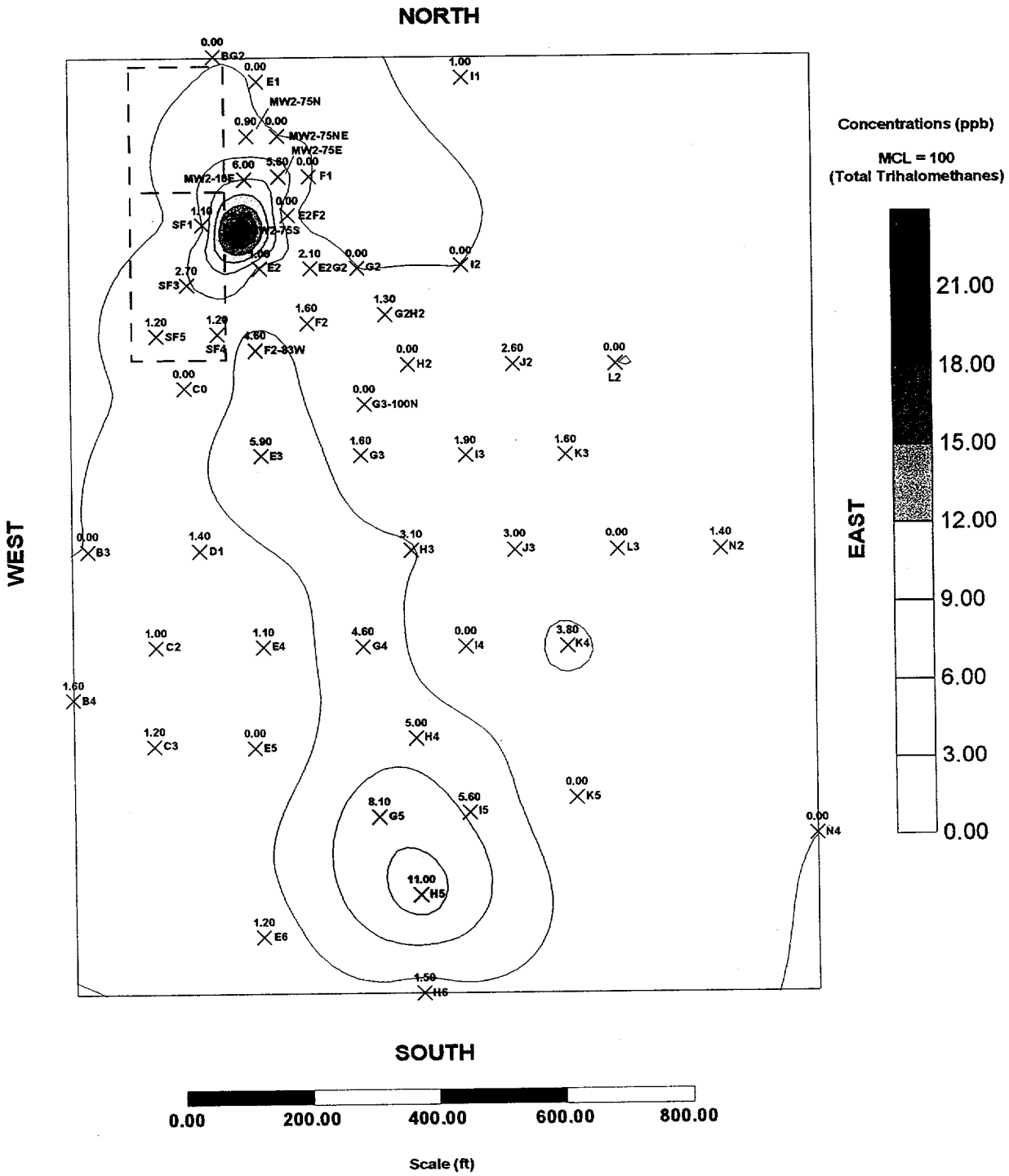

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Figure 1.9. Low-Level Radiation Burial Site Tritium Concentrations (pCi/L) June/July 1997 - ENTECH Geoprobe Samples

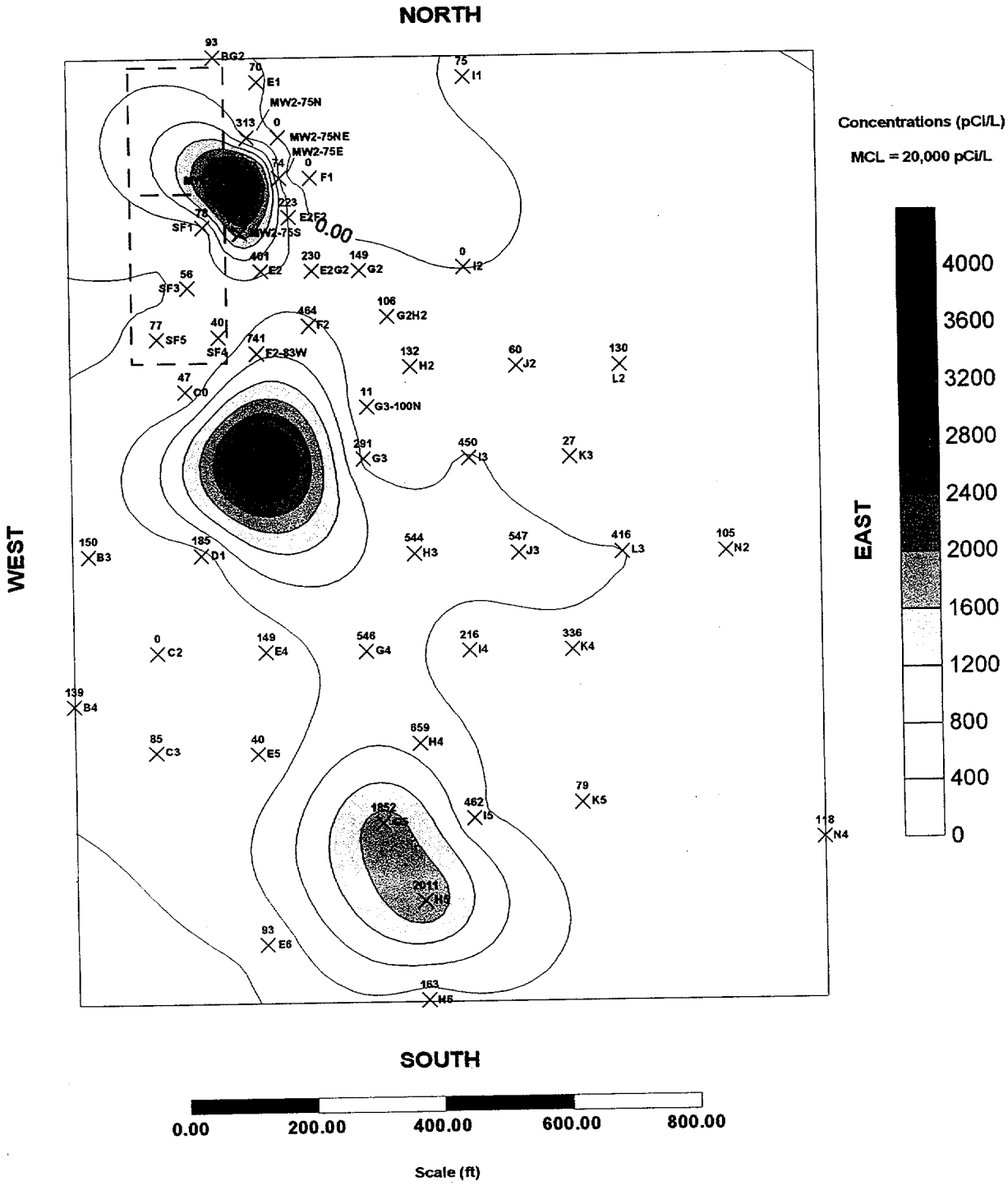

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Figure 1.10. Low-Level Radiation Burial Site Gross Alpha Concentrations (pCi/L) June/July 1997 - ENTECH Geoprobe Samples

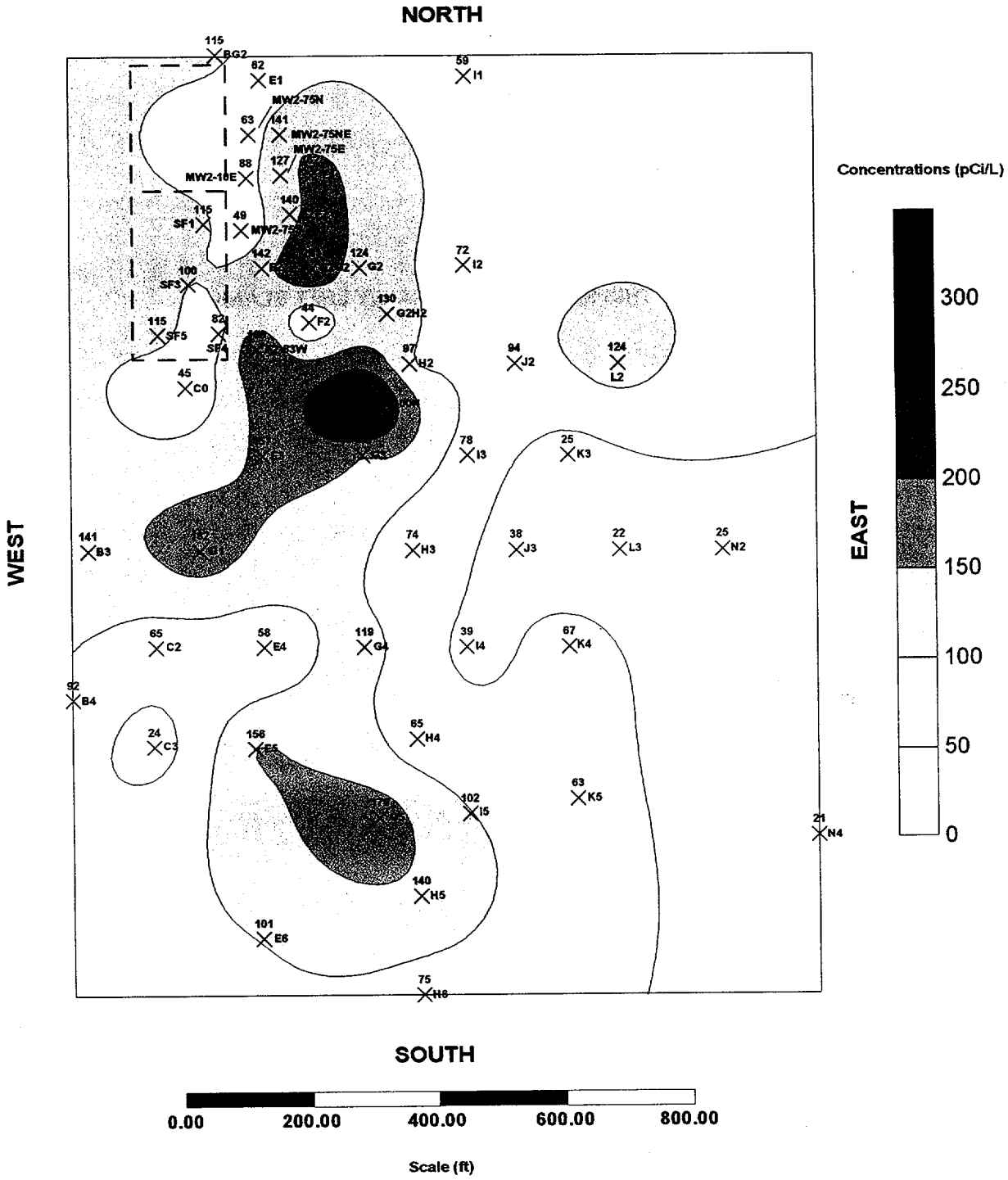

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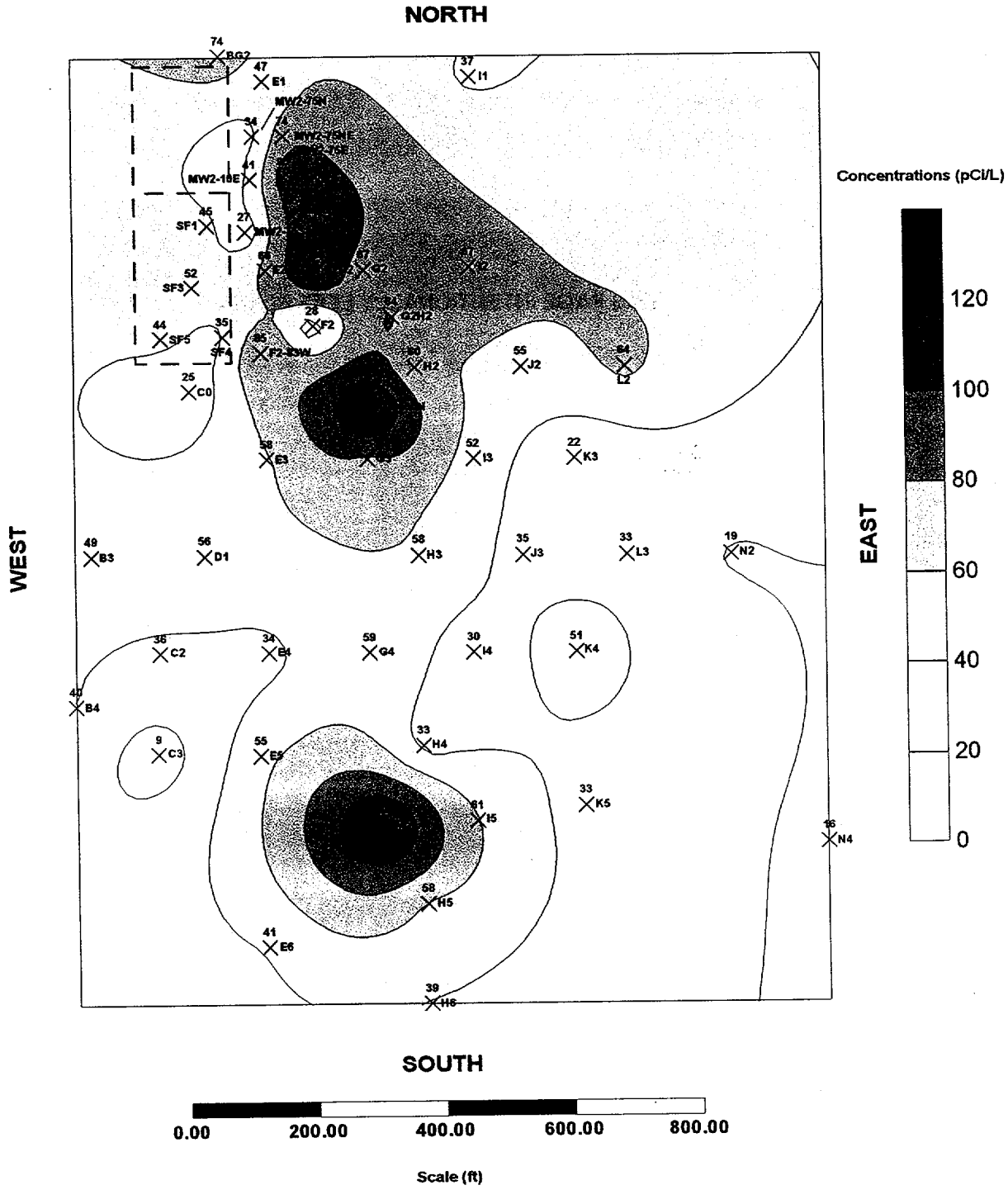
Figure 1.11. Low-Level Radiation Burial Site Gross Beta Concentrations (pCi/L) June/July 1997 - ENTECH Geoprobe Samples



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ever been detected in monitoring well samples at levels significantly above background. Groundwater results from these 2 sampling rounds indicate the presence of a contaminant plume emanating from the LLRBS and heading in a south-southeasterly direction. Figure 1.12 presents positive analytical results from Round 2.

1.4.8.4 Surface Water and Sediment Sampling Results

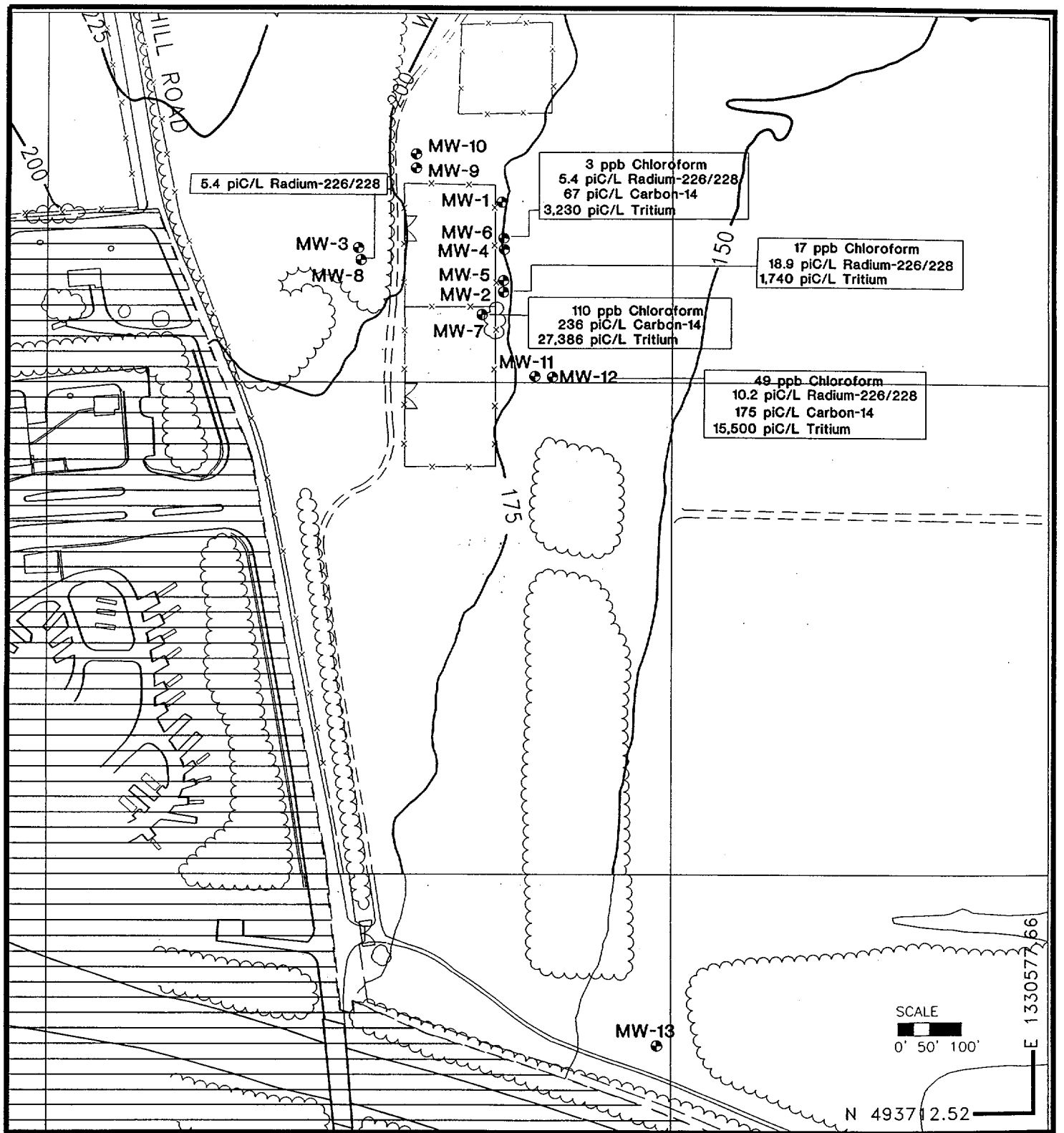
Although it is unlikely, based on distance, that surface water in the vicinity of the LLRBS has been impacted by site-related contamination, 4 co-located surface water and sediment samples were taken downgradient of the site (Figure 1.13). Two (2) of the sample locations were in spray irrigation runoff ditches located in research fields southeast of the LLRBS. These surface water conveyances are not believed to be in connection with shallow groundwater; the objective of the sampling was to determine if contamination had migrated from the LLRBS via runoff/overland flow. The other 2 sample locations were in an unnamed tributary to Little Paint Branch further downgradient of the site in the general direction of groundwater flow. The objective of these samples was to assess the potential for contaminated groundwater discharge to surface water. Surface water and sediment samples were analyzed for SW-846 Method VOCs, SVOCs, pesticides/PCBs and metals; TICs; gross α, gross β, gross γ; and specific radioisotopes (tritium, C^{14}, Ra^{226}, Cl^{36}, Ni^{63}, and Sr^{90}).

Tables A.5 and A.6 in Appendix A present the surface water and sediment sampling results, respectively. Based on analysis of the surface water and sediment data, no contamination from the LLRBS has migrated overland or through the groundwater to these sample locations.

1.5 Streamlined Risk Evaluation

The streamlined risk evaluation is intended to be intermediate in scope between the limited risk evaluation performed for emergency removal actions and the conventional baseline risk assessment normally conducted for remedial actions. The streamlined risk evaluation assists in justifying a removal action and identifies what current or potential exposures should be prevented. The streamlined evaluation uses sampling data from the site to identify chemicals of concern, provides an assessment of the health effects associated with these chemicals, and projects the potential risk of health problems occurring if no cleanup action is taken at a site.

The streamlined risk evaluation for the LLRBS, residual radioactivity (RESRAD) modeling, is intended to focus on the specific problem the removal action is intended to address: removal of the low-level radioactive source material from the burial site.



USDA ARS Agricultural Research Service

BARC 18 RI/FS
Facility: Beltsville, Maryland

FIGURE 1.12
Low Level Radiation Burial Site Monitoring Well Locations and Results from Round 2

Revised: 05/99	By: BB	File: FIG2.9.dwg

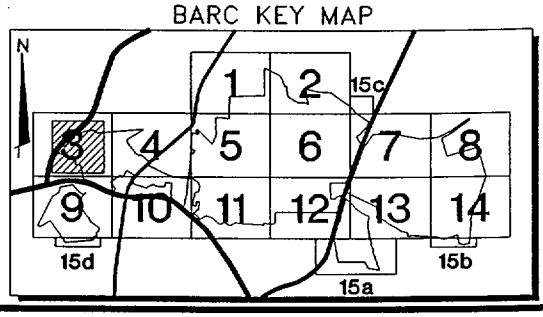
ENTECH, Inc.
7926 Jones Branch Dr.
Suite 620
McLean, VA 22102

LEGEND

piC/L = picocuries per liter
ppb = parts per billion

- Streams
- 003 Building and No.
- Treeline
- BARC Boundary
- Road
- Unpaved Road
- Fence
- Sidewalk
- Gate
- Shallow Monitoring Well

BARC KEY MAP



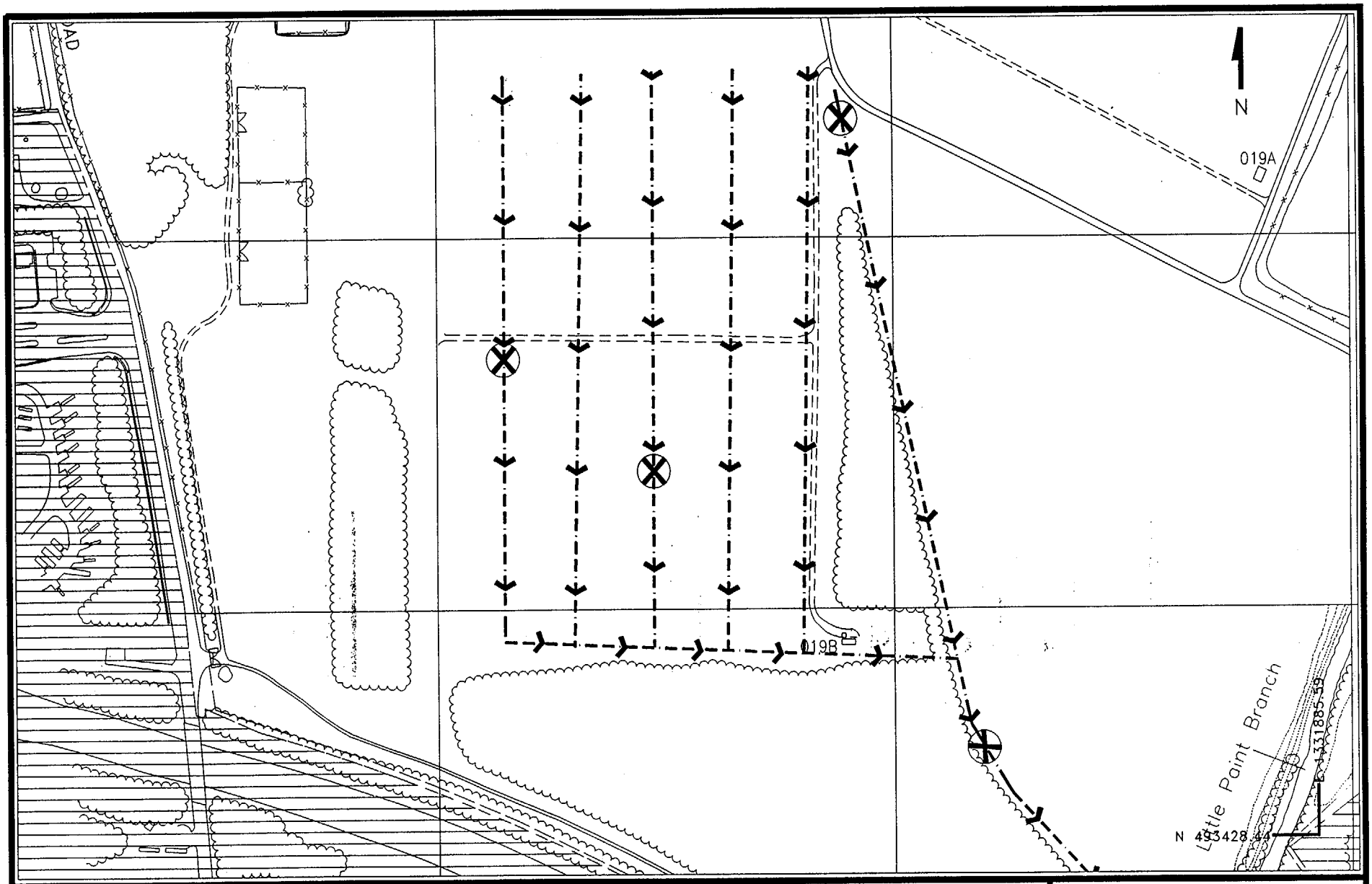


FIGURE: 1.13

ENTECH INC

Low-Level Radiation Burial Site

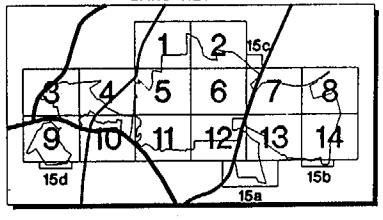
Surface Water/Sediment Sampling Locations

LEGEND

- Soil Boring
- BARC Boundary
- BARC Building and Number (003)
- Treeline
- Single Trees
- Road
- Unpaved Road
- Fence
- Gate
- Sidewalk
- Surface Water/Sediment Sampling Pt. Drainage Ditch

APPROX. SCALE: 1" = 320'

BARC KEY MAP



1.5.1 Residual Radioactivity Modeling Results

RESRAD modeling was originally performed to supplement RI activities at the LLRBS (ENTECH, 1998). The primary purpose of RESRAD is to provide guidance in estimating individual dose resulting from possible reuse of property containing residual radioactive material. The basic criterion for releasing a site without radiological restriction is the dose limit. The dose limit is converted to soil guidelines (specified as radionuclide concentrations by means of dose/source ratios - DSRs) that are expressed in terms of dose conversion factors (DCFs), environmental transport factors (ETFs), and source factors (SFs). RESRAD generates site-specific guidelines for deriving allowable residual concentrations of radionuclides in soil. RESRAD model results can be used to consider and evaluate viable remedial measures that reduce doses/exposures to a few millirem per year (mrem/yr) or less. Several assumptions were made in development of input parameters for the model, and are listed below:

- All exposure pathways were modeled, with the exception of plant, meat, milk, and aquatic food consumption. Groundwater drinking water ingestion is the dominant pathway, with direct soil contact during future construction/excavation secondary.

- Modeling runs only make use of recorded disposal activity at the LLRBS for 1960 through 1987, and do not take into account unrecorded disposals prior to 1960.

- Disposal records were decayed forward through 1993; therefore, this date was used as the "disposal" date and start time for modeling further decay, transport, and dose.

- Where groundwater data were used, the conservative maximum monitoring well concentrations were modeled.

- Contaminants were assumed to be evenly distributed throughout the volume of the pit materials in order to calculate an average soil concentration for model input.

Six (6) separate scenarios were modeled using available soil and groundwater LLRBS data:

1) Estimated soil concentrations with no actual groundwater contamination.

2) Estimated soil concentrations with actual maximum groundwater contamination.

3) One (1) one-thousandth estimated soil concentrations with actual maximum groundwater contamination.

4) One (1) one-thousandth estimated soil concentrations with actual maximum groundwater contamination (also assuming a 20-year burial timeframe).

5) No cover (direct contact/construction scenario) with estimated soil concentrations.

6) No cover (direct contact/construction scenario) with 1/100th estimated soil concentrations.

Table 1.15 presents a summary of model output for the first 4 scenarios above. Scenarios 5 and 6 above address risks associated with disturbing the site, and resulted in much less dramatic exposures compared to the groundwater ingestion scenarios. The results presented in Table 1.15 indicate that dose and risk are dominated almost entirely by the drinking water ingestion pathway. While no individuals are currently drinking groundwater in the general vicinity (e.g., within 1 mile) of the site, the LLRBS is located in the homogenous sand recharge zone of the Patuxent Aquifer, a source of drinking water in Prince Georges County, Maryland. Each of the 4 scenarios resulted in dose calculations well above the EPA and NRC remediation standards of 15 mrem/yr and 25 mrem/yr, respectively, and cancer risks in excess of EPA's target range of 10^{-4} to 10^{-6}.

Actual soil concentration from within or beneath the buried waste and soil core leachability data would improve the "reality" of model results. Site-specific data for both of these parameters, however, would require sampling the waste pits, and USDA-ARS does not wish to disturb the disposal area at this time. The model runs summarized in Table 1.15 include all available site-specific data. Input soil concentrations, however, are based on a professional estimate. A variety of input parameters are required for the RESRAD model, and are listed in Appendix B. Parameters which are shaded may utilize site-specific data if available. Default values are provided for practically all input values except for concentrations in the environmental medium of interest. A summary of site-specific parameters and default values used in the 6 scenarios described above are included in Appendix C.

Based on the results of the RESRAD modeling presented above, removal of the source material at the LLRBS is warranted.

1.5.2 Human Health and Ecological Risk Assessments

A human health and ecological risk assessment will be performed in conjunction with RI activities at the LLRBS. This baseline risk assessment (BRA) will be conducted using data gathered during the removal action and subsequent field investigation. The RESRAD modeling presented in Section 1.5.1 above is meant to address removal of low-level radioactive source material. The BRA conducted as part of the

Table 1.15. RESRAD Modeling Results

Scenario	(1)	(2)	(3)	(4)
Max. Total Dose (mrem/yr) @ t years	4.95×10^3 @ 12.7 yrs.	5.27×10^5 @ 10.2 yrs.	5.30×10^2 @ 10.2 yrs.	6.74×10^3 @ 0 yrs.
Dominant Pathway	Groundwater Ingestion	Groundwater Ingestion	Groundwater Ingestion	Groundwater Ingestion
Estimated Soil Concentration (pCi/g) C-14 H-3 Ra-226	 7.12×10^3 4.77×10^4 7.83×10^1	 7.12×10^3 4.77×10^4 7.83×10^1	 7.12×10^3 4.77×10^4 7.83×10^1	 7.12×10^3 4.77×10^4 7.83×10^1
Soil Guideline[1] (pCi/g) C-14 H-3 Ra-226	 2.35×10^1 1.37×10^3 8.04	 1.65 5.63×10^1 2.59×10^{-3}	 1.64 5.64×10^1 2.58×10^{-3}	 5.06 1.06×10^{-1} 7.75×10^{-3}
Time (yrs) of Max. Individual Dose C-14 H-3 Ra-226	 15 9 3,000	 11 4 11	 11 4 11	 34 0 34
Total Excess Cancer Risk	1.36×10^{-2}	4.1×10^{-1}	4.1×10^{-4}	1.2×10^{-3}

1 - Acceptable residual soil concentration based on a basic radiation dose limit of 15 mrem/yr (EPA standard).

ongoing RI will address residual soil contamination with radionuclides, organic, and inorganic constituents, as well as groundwater contamination from the LLRBS.

1.6 Regulatory Requirements

1.6.1 CERCLA Requirements

CERCLA provides the federal government with broad authority to respond to disposal sites involving uncontrolled releases of hazardous substances, to develop long-term solutions for sites containing hazardous substances, and to arrange for the restoration of damaged natural resources. As part of USDA-ARS's CERCLA program at BARC, an RI/FS was initially called for at the LLRBS to address contaminants which are emanating from the burial site. The NCP requires that a detailed RI/FS be conducted for sites listed on the National Priorities List (NPL) and targeted for remedial response under §104. Although BARC is listed for another former disposal area, all waste sites at the facility are subject to these provisions.

Based on historical investigative data an RI/FS was initiated in 1997. Under CERCLA, the RI/FS (including a BRA) is conducted, a remedy for the site is selected, a Record of Decision (ROD) is agreed

upon by regulatory authorities and other stakeholders, a remedial design is developed, and the remedy subsequently implemented. The RI/FS process is the methodology that CERCLA has established for characterizing the nature and extent of risks posed by uncontrolled hazardous waste sites and for evaluating potential remedial options.

Although the RI/FS process is typically presented in a fashion that makes the steps appear sequential and distinct, in practice the process is highly interactive and the RI and FS portions can be conducted concurrently. Where the RI emphasizes data collection and site characterization, the FS focuses on data analysis and evaluation of remedial action alternatives. Data collected during the RI influence the development of remedial alternatives in the FS, which affects the data needs and scope of field investigations. In addition, new site characterization information may be compiled as the RI progresses, which may require reassessment of the types of response actions identified. In turn, this may require expanding the RI to obtain the data necessary to evaluate the new alternatives.

1.6.2 National Contingency Plan Requirements

CERCLA requires all actions taken in response to releases of hazardous substances shall, to the greatest extent possible, be in accordance with the provisions of the NCP, which is codified in Title 40 of the Code of Federal Regulations (CFR) part 300. The NCP outlines the steps that must be followed when responding to situations in which hazardous substances are released or are likely to be released into the environment. The NCP implements the response authorities and responsibilities created by CERCLA and the Clean Water Act (CWA). The NCP has the following basic components:

- Methods for discovering sites at which hazardous substances have been disposed.
- Methods for evaluating releases to determine potential impact to public health and the environment.
- Methods and criteria for determining the appropriate response and extent of cleanup.
- Means of assuring that remedial action measures are cost-effective.

The process established by the NCP for addressing hazardous substances is triggered by the identification of potential hazardous waste sites under CERCLA's §103 notification program. The process begins with a preliminary determination of whether there is an emergency requiring immediate action at a particular site. If there is, the next step is to act as quickly as possible to remove or stabilize the threat. Even after the necessary action has been taken to control the immediate threat, contamination may remain at the site. A more detailed analysis of the contamination may be needed to determine if further decontamination is required. If long-term action is deemed necessary, a decision is made regarding the relative priority of responding to the threat at that site. If it is warranted, the site will enter the remedial action process.

1.6.3 Response Actions

Two categories of response actions are identified by the NCP: removal and remedial actions. A removal action involves cleanup or other actions that are taken in response to emergency conditions (e.g., spills) on a short-term or temporary basis. The following factors are considered in determining the appropriateness of a removal action at a particular site [40 CFR 300.415(b)(2)]:

- Actual or potential exposure of nearby populations, animals, or the food chain to hazardous substances or pollutants or contaminants.
- Actual or potential contamination of drinking-water supplies or sensitive ecosystems.
- Hazardous substances or pollutants or contaminants in drums, barrels, tanks, or other bulk storage containers that may pose a threat of release.
- High levels of hazardous substances or pollutants or contaminants in soils, largely at or near the surface, that may migrate.
- Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released.
- Threat of fire or explosion.
- The availability of other appropriate federal or state response mechanisms to respond to the release.
- Other situations or factors that may pose threats to public health or welfare or the environment.

The evaluation of the appropriateness of a removal action is done by a removal site evaluation (40 CFR 300.410). If a removal action is deemed appropriate under CERCLA, there are 3 categories of removal actions; however, it should be noted that CERCLA requires all removal actions to be conducted so as to contribute to the efficient performance of long-term remedial measures that EPA deems practicable. The response action categories are as follows:

- *Emergency,* which generally refers to a release that requires removal activities begin on-site within hours of the lead agency's determination that a removal action is appropriate.
- *Time-critical,* where the lead agency determines that a removal action is appropriate and there is a period of less than 6 months available before removal activities must begin on the site.

- *Non-time-critical,* where the lead agency determines that a removal action is appropriate and there is a planning period of more than 6 months before on-site removal activities must begin.

The removal action deemed appropriate at the LLRBS is non-time-critical. Under section 300.415(b)(4)(i) of the NCP, an EE/CA is required for all non-time-critical removal actions. The EE/CA document identifies removal action alternatives, analyzes removal action alternatives, and analyzes the feasibility and cost of each alternative. Removal action goals for the LLRBS include preventing or abating actual or potential contamination of drinking water supplies; and treating or eliminating "significant" levels of hazardous and radioactive substances, pollutants and contaminants in soil near the ground surface that may migrate.

Each alternative developed for the EE/CA is evaluated against the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost.

Effectiveness: Does the alternative meet the objectives of the removal action and achieve the level of cleanup desired? Does it achieve overall protection of human health and the environment? Is it protective of site workers during implementation? Does it provide long-term effectiveness and permanence? Does it achieve a reduction in waste toxicity, mobility, and volume through treatment and/or disposal? Does it comply with Applicable or Relevant and Appropriate Requirements (ARARs)?

Implementability: Is the alternative technically and administratively feasible, and are the various services (transportation and disposal firms) and materials (structures, equipment) required readily available? Can the alternative be conducted within the time frames in the removal schedule? Is the alternative technology reliable (e.g., "mature")? Has the alternative proven successful under similar conditions for similar wastes? Are there any perceived operational difficulties (e.g., special waste handling)? Does the alternative contribute to the efficient performance of any potential future remedial activities (e.g., groundwater treatment)? Will special permits be required for either onsite or offsite activities? Is it certain that offsite treatment, storage, and/or disposal capacity is available? Will adequate laboratory testing capacity and/or turnaround times be available? Other than EPA Region III and NRC, will the Maryland Department of the Environment (MDE) have any technical or administrative concerns? Is there any perceived difficulty in community acceptance?

Cost: Each removal action alternative will be evaluated to determine its projected costs. The evaluation compares each alternative's direct and indirect capital and post-removal site control (PRSC) costs. Direct capital costs include: construction, labor, equipment, material, transport, disposal, and analytical costs. Indirect capital costs include: engineering and design expenses,

permit costs, and start-up and shakedown costs. Annual PRSC costs include: operating and maintenance (O&M) costs, support, and monitoring costs.

An EE/CA Approval Memorandum must be prepared by EPA's Regional Project Manager (RPM). This memorandum discusses the current or potential threat to human health and the environment; documents that the situation meets the NCP criteria for initiating a removal action, and that the required action is non-time-critical; provides a finding of actual or threatened releases from the LLRBS; and authorizes EPA management approval for regulatory oversight of the EE/CA and USDA removal action. This document becomes part of the administrative record for the LLRBS. In carrying out a non-time-critical removal action, the EPA RPM also reviews the work of other federal agencies and contractors to ensure compliance with CERCLA and the NCP; and reviews all decision documents.

1.6.4 Public Participation

Because of BARC's listing on the NPL, CERCLA required USDA-ARS to develop a comprehensive public participation program. The NCP mandates community involvement at specific points during the response process. Pertaining to public participation, response actions include all removal, remedial, and enforcement actions. Public participation requirements include the establishment of an administrative record, development of a community relations plan, and opportunities for the general public and other interested parties to participate in response action decision-making.

1.6.4.1 Administrative Record

An administrative record file for BARC has been established. All information and documentation used in the selection of a response action must be contained in this file [40 CFR 300.800(a)]. The administrative record file must be available for public review, and a copy is maintained at BARC for this purpose. In addition, a duplicate record must be maintained in a central location, such as a state office or the lead agency's office. For removal response actions, supporting data in the administrative record file must be made available to the public when the removal begins. For non-time-critical removal response actions, supporting data in the administrative record file must be established when the EE/CA is made publicly available. The administrative record file must contain all relevant and appropriate documentation, public comments, site-specific data, decision documents, enforcement orders, guidance documents, and technical documents and references used by EPA Region III in considering decisions involving the response action (40 CFR 300.810). In addition, an inventory of all the file's contents must be included in the file.

1.6.4.2 Community Relations Plan

A community relations plan has been developed for BARC [40 CFR 300.415(m)(3)(1) and 300.430(c)(2)(ii)]. The content and scope of the plan were developed by interviewing residents, local officials, and community groups to ascertain the community's primary concerns and the extent of the community's desire to participate in the response action decision-making process. The plan outlines in detail the activities that will be conducted to ensure that members of the community can present their opinions and concerns about the site as well as be kept informed throughout the response process. Typically, one of the first steps in the community relations program is to establish an information file at a local public building known as an information repository, which is separate from the administrative record file. The information repository contains site-related material such as news releases, technical reports, and fact sheets related to site activities. The BARC Information Repository is housed in Building 003, Room 017, and is available for public access from 8:30 am to 4:30 pm, Monday through Friday.

1.6.4.3 Public Participation and Non-Time-Critical Removal Actions

Because the two types of response actions (removal and remedial) are different, public participation requirements differ between the two. For longer-term, non-time-critical removal actions, the public must be notified; the public, local officials, and affected parties must be interviewed to determine the extent of their concern; the administrative record file must be updated with appropriate site-specific materials; the community relations plan must be implemented; and the public must be provided an opportunity to comment on the response action [40 CFR 300.415(m)(3)]. The public must also have an opportunity to specifically comment on the EE/CA. A public notice describing the EE/CA and announcing a public comment period must be published in a major local newspaper. The public notice may be combined with a notice of availability of the administrative record file and work plans.

Relative to a removal action, a remedial action can take years to develop and implement and can include a number of steps. Because of the significance of its potential impact, more detailed public participation and community relations programs are required for a remedial action. In addition, the community relations plan has to include provisions for the additional opportunities and degree of involvement necessitated by the remedial response process.

The specific requirements of public participation include the following:

- Before the adoption of any removal action plan, the public must have access to a published notice and a brief analysis of the proposed action, as well as an opportunity for a public meeting.

- The final removal action plan must be made available to the public before the commencement of any removal action. If there are any significant changes to the proposed plan, a discussion of the reasons for these changes must be included.

- Responses to all significant public comments submitted in written comments or during oral presentations must be made available in a "responsiveness summary."

- After the adoption of a final removal action plan, if there is remedial action, enforcement action, or settlements that differ in any significant aspects from the final plan, an explanation of the reasons for such changes must be published in a major local newspaper.

1.6.5 Nuclear Regulatory Commission Requirements

On August 19, 1996, the NRC published Information Notice 96-47 which requires that radioactive waste burial sites established under former NRC regulations be decommissioned in accordance with the NRC Timeliness Rule (established in 1993). This rule indicates that licensees who have unused outside areas (e.g., burial areas that have not been in use for a period of 24 months) containing elevated levels of licensed radioactive materials, are required to notify NRC that they are in possession of these areas and must begin following a schedule for decommissioning these areas. By October 15, 1996 USDA-ARS was to provide NRC with a list of all low-level radioactive waste burial sites and confirm that they would, within 12 months (by October 15, 1997), submit a decommissioning plan for all sites. According to NRC's revised enforcement policy (NUREG-1600), failure by USDA-ARS to meet requirements in the "Timeliness Rule" can be classified as a Severity Level III violation subject to a civil penalty.

The NRC published (October 25, 1996 Draft Branch Technical Position) a "Screening Methodology for Assessing Prior Land Burials of Radioactive Waste Authorized Under Former 10 CFR 20.304 and 20.302," which USDA-ARS could use to determine if the LLRBS requires remediation (i.e., removal of the radioactive waste). The screening tool is based on the total activity disposed of in the burial ground and the potential for that activity to produce a significant dose to the public. Screening is intended to be used for sites in which the former burial is expected to be the only source of residual contamination at the time of decommissioning. Screening is based solely on the radiological risks associated with the burial. If the burial areas require characterization and/or remediation, or contain hazardous and/or mixed wastes, other applicable local, state, or Federal radiological and non-radiological regulations should be considered.

This methodology is intended to be used by USDA-ARS as a screening tool to determine which burial sites are acceptable for release for unrestricted use, recognizing that exceptions may be identified by NRC or USDA-ARS. As stated above, the screening methodology is based on the total activity disposed of in

the burial site and the potential for that activity to produce a significant dose to the public. Although this methodology estimates doses, the estimates are very conservative and actual doses produces by a site would be a fraction of the doses estimated using this screening methodology.

The screening methodology consists of 3 steps. Step 1 involves collecting information on the materials which were buried at the site. The other 2 steps involve conservative dose assessments using the historical information gathered in Step 1 to determine the possible consequences from human exposure to the buried material. If a site passes the screening based on calculations performed in Step 2, there is no need to collect additional information which may be required in Step 3 since Step 2 dose assessments are more conservative. If a site does not pass the screening based on calculations performed in Step 2, then Step 3 calculations are performed. Failure of the third step requires more detailed analysis to determine if the site poses an unacceptable risk to the public.

Step 2 addresses the groundwater pathway, and assumes that the total activity for each isotope is leached into the minimum quantity of water needed to meet a family of four's average use in 1 year. Once a concentration is calculated for each isotope based on this assumption, the concentrations are compared to effluent release criteria for water. A dose is determined for each isotope, and the doses totaled. If the total dose is less than the 100 mrem/yr screening level, the site passes Step 2 and requires no further evaluation.

Step 3 addresses the exhumation concentration of the radionuclides, and assumes that the total inventory of the site is evenly distributed throughout the burial trenches. This step then assumes a member of the public builds a house directly on the burial site. A dose for each radionuclide is calculated based on exposure to the estimated burial concentrations, and the doses totaled. If the total dose is less than the 100 mrem/yr screening level, the site passes the screening.

Based on the reported activity disposed in the burial pits at the LLRBS, the site did not pass the NRC screening methodology, and USDA-ARS is required to submit a decommissioning plan. In addition, ENTECH performed RESRAD modeling (Section 1.5.1) at the LLRBS. The primary purpose of RESRAD is to provide guidance in estimating individual dose resulting from possible reuse of property containing radionuclides. The LLRBS RESRAD results indicate elevated risk of cancer from radioactive contaminants present at the site, and therefore indicates a need for further action at the site. This EE/CA is submitted in partial fulfillment of decommissioning requirements at the LLRBS.

1.6.6 Summary Regulatory Status of the Low-Level Radiation Burial Site

Based on historical activity and reported contents of the burial pits at the LLRBS, the site is subject to both CERCLA/NCP requirements as enforced by EPA, and NRC requirements for decommissioning of inactive radioactive disposal sites. A CERCLA RI/FS, including a BRA, is currently underway at the site. The proposed LLRBS removal is an interim action; contaminated groundwater may require a future response action after completion of the RI and BRA. Only the disposal area and vadose zone soils will be addressed as part of the removal action. The source of groundwater contamination will be removed; however, the contaminant plume itself will be addressed further during subsequent RI/FS and BRA activities.

1.7 Need for, and Purpose of, the Removal Action

A BRA is conducted as part of the RI under the CERCLA site investigation process. A BRA cannot be completed for the LLRBS without characterizing the source materials currently in the burial pits. The material in the pits cannot be adequately characterized by conventional media sampling via hand augers, soil boring equipment, or split-spoon samplers. This conclusion leads to a requirement to excavate the trenches in order to characterize the source materials present, effectively removing the source material and disposing this waste offsite in the process, which results in a removal action.

There is a documented release of hazardous substances and radionuclides to the groundwater beneath the LLRBS. A plume of contamination is emanating from the site, and is heading in a south-southeasterly direction, which may result in migration of contaminants off BARC property. In addition, the LLRBS is located in a recharge zone of a drinking water aquifer; therefore, a removal action is warranted to prevent further releases of contaminants to the groundwater and to mitigate further migration of contaminants.

NRC decommissioning policy call for unrestricted future use of the site. Screening results to date indicate that the LLRBS in its current condition will not meet that requirement. Removing the source will be a significant action towards meeting the unrestricted future use requirement, although it is recognized that source removal alone will not achieve this goal. Residual groundwater contamination will continue to be addressed through the CERCLA RI/FS process leading to a ROD for the site.

2. IDENTIFICATION OF REMOVAL ACTION SCOPE, GOALS, AND OBJECTIVES

This section identifies the scope, goals, and objectives of the removal action. These items are determined taking into consideration pertinent ARARs and the overall objectives of the ongoing RI/FS process at the LLRBS.

2.1 Determination of Removal Scope

The scope of the removal action at the LLRBS is the removal of all low-level radioactive source material and other waste debris (including containerized organic and inorganic wastes) from the burial trenches. Removal of source material, debris, and nearby adjacent soils will be conducted to the cleanup goals presented in Section 2.2.3. The removal action is not meant to completely remediate the site for future use. Remediation of subsurface soils determined to be beyond the scope of this removal action, and mitigation of existing groundwater contamination at the LLRBS will be addressed as part of the ongoing RI/FS process.

The scope of the removal action (RA) as it pertains to specific environmental media is presented in the following subsections. The scope of this RA is based on available data from prior investigations, and present media-specific estimates of areas and volumes to which a response action may be applied. Assumptions utilized in determining these media-specific estimates are provided. These assumptions, in conjunction with the site-specific characterization data and process knowledge, form the basis of design for implementing the selected alternative.

2.1.1 Groundwater

Remediation of contaminated groundwater is not within the scope of this RA. Remediation of contaminated groundwater will be addressed separately for the LLRBS as part of the ongoing RI/FS. Removal of the buried waste within the north burial area as part of this RA will eliminate the source of present and potentially future groundwater contamination.

2.1.2 Surface Water

Remediation of potentially contaminated surface water and sediments is not within the scope of this RA since available data indicate the LLRBS contamination has not affected these media to date. However, surface water controls will be required in conjunction with removal alternatives or other construction activities in order to prevent overland transport of contaminants to surface water. Further evaluation of

potential effects of contaminants in surface water and sediments will be addressed as part of the ongoing LLRBS RI/FS.

2.1.3 Air

Air is not a medium requiring remediation at the LLRBS; however, air pollution preventive measures (e.g., dust suppression) will be employed as necessary during removal activities.

2.1.4 Buried Waste and Soil

Buried waste and nearby surrounding soil are the primary media to be addressed at the LLRBS during the RA. Potential response actions to be evaluated in Sections 3 and 4 of this EE/CA could include institutional controls, excavation, and disposal technologies. Estimates of areas and volumes for each of these technology types are presented in the following sections.

2.1.4.1 Estimate of Area for Institutional Controls

As shown in Figure 1.2, the LLRBS is located in the western end of the North Farm section of BARC. The burial area consists of two contiguous fields with waste disposal activities limited to the north area only. The north field is 200 ft by 150 ft for a total surface area of 30,000 ft^2. The perimeter of the north field is 700 ft long.

Current institutional controls include restriction of the general public to the area, posted radiological control warning signs, limits on activities according to BARC procedures, and vehicle and equipment entry limitations. Additional institutional controls also are currently in place which limit access and intrusion into the waste pits. These controls would remain in effect throughout any removal activities.

2.1.4.2 Estimate of Volume for Excavation Technologies

Excavation of 5 feet of soil cover above each waste pit will produce approximately 30,000 ft^3 of uncontaminated backfill. This soil would be available to be used as backfill if clean, and if the contents of the waste pits are excavated. Based on historical records, approximately 33,000 ft^3 of waste is disposed of within the waste cells. When in-situ waste is excavated and left in an unstressed condition, an expansion factor of 25% is appropriate to apply to the final volume produced. Using this assumption approximately 41,250 ft^3 of waste will be generated from excavation of the pits.

In addition to the data presented in the historical disposal records, additional characterization of the disposal pits utilizing radiological surveying equipment may be utilized to refine or limit the volume of material removed during excavation.

2.1.4.3 Estimate of Volume for Treatment Technologies

Treatment technologies may be applied to the waste and excavated contaminated soil. The volume of buried waste that may require treatment is approximately 41,250 ft^3 as noted in Section 2.1.4.2.

2.1.4.4 Estimate of Volume for Disposal Technologies

Disposal of waste may be considered as part of an engineered alternative. The estimated disposal volume of low-level waste is approximately 41,250 ft^3. This assumes that the 5 feet of cover over each waste pit can be used as backfill, and that clean fill will be used as a final cover.

2.2 Removal Action Goals and Objectives

Identifying the goals and objectives is a critical step in the EE/CA and in the conduct of non-time-critical removal actions. These goals and objectives can be achieved by meeting cleanup levels while working within the statutory limits and attaining ARARs to the extent practicable.

2.2.1 Removal Action Objectives

RA objectives are site-specific goals that define the cleanup required for a CERCLA response action. The RA objectives address the site risks, exposure pathways and media of concern for current and future land use, clean up options, and ARARs.

The RA objective for this unit is to allow unrestricted future use of the burial area. The land use scenario includes protection of a future resident that may live onsite. Given the long-lived nature of the buried radiological waste and the risk of future exposure if the waste is left in place, unrestricted future use of the area requires that the contents of the waste pits be removed. Removal of the buried waste will also eliminate further migration of contamination to the groundwater. Specific removal action objectives for the LLRBS are as follows:

- Remove the contents of all 50 waste pits in order to eliminate the source of subsurface soil and groundwater contamination.

- Remove the contents of the waste pits to minimize future contamination of soil and groundwater beneath the LLRBS.

- Comply with ARARs presented in Section 2.2.2, to the extent practicable.

- Remove soil immediately beneath and adjacent to the waste pits to meet the cleanup goals proposed in Section 2.2.3.

- Dispose of wastes removed and generated during the removal action.

2.2.2 Compliance with Applicable or Relevant and Appropriate Requirements

A requirement under other environmental laws may be either applicable or relevant and appropriate to activities conducted under CERCLA authority. Identification of ARARs is typically performed on a site-specific basis and involves a two-part process. First, a determination whether a given requirement is applicable; then, if it is not applicable, a determination whether it is relevant and appropriate.

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, removal action, location, or other circumstance at a CERCLA site. Relevant and appropriate requirements, while not applicable to a hazardous substance, pollutant, contaminant, removal action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the activity conducted.

The determination that a requirement is relevant and appropriate involves a comparison of a number of site-specific factors, including the characteristics of the removal action, the hazardous substances present at the site, or the physical circumstances of the site. In some cases, a requirement may be relevant, but not appropriate; therefore, such a requirement would not be an ARAR for the site.

To-be-Considered (TBC) materials are non-promulgated advisories or guidance issued by Federal or State government that are not legally binding and do not have the status of potential ARARs. However, in many circumstances TBCs are considered along with ARARs as part of the site assessment and may be used in determining the necessary level of cleanup for protection of human health or the environment. There are different types of requirements with which removal actions may have to comply. These classifications are presented below:

- *Ambient or chemical-specific requirements* are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment.

- *Performance, design, or other action-specific requirements* are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous substances.

- *Location-specific requirements* are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations.

ARARs and TBCs must be attained for hazardous substances, pollutants, or contaminants remaining on-site at the completion of the removal action, unless waiver of an ARAR is justified. In addition, EPA intends that the implementation of removal actions should also comply with ARARs and TBCs to protect human health and the environment. ARARs and TBCs identified for the removal action at the LLRBS are presented in Table 2.1.

2.2.3 Cleanup Goals

Because the removal action is intended to address primarily the radiological contamination present in the burial pits at the LLRBS, cleanup goals were developed for radionuclide contaminants detected to date outside of the confines of the site. These radionuclides are those used in the RESRAD modeling of the site presented in Section 1.5.1 and include: C^{14}, Cl^{36}, tritium, Ni^{63}, Ra^{226}, and Sr^{90}. Because the removal action is not meant to completely remediate the site, cleanup goals were established for potential exposure via direct contact with contaminated soil during excavation of the burial pits, which is equivalent to the 5th scenario modeled under RESRAD. It is noted that this scenario resulted in much less dramatic exposures compared to the groundwater ingestion scenarios modeled. Groundwater and subsurface soil contamination will be addressed as part of the ongoing RI/FS process.

Table 2.2 presents the 6 radionuclides modeled for this particular scenario; their assumed concentrations (no actual concentrations of the radionuclides in the waste pits are available); their dose in mrem/yr for external exposure, inhalation, and soil ingestion; and the estimated concentration required to meet the exposure limit of 15 mrem/yr. This concentration was derived from the graphs presented in Appendix D which depict estimated exposure over the course of time for these 6 radionuclides and 3 exposure routes. The 15 mrem/yr concentrations were arrived at by simple graphical interpretation. For example, if 100 pCi/g yields a maximum rate of exposure of 150 mrem/yr, it is assumed 10 pCi/g would yield 15 mrem/yr exposure. This in essence assumes a decrease in activity is proportional to a decrease in the exposure

Table 2.1. List of Potential ARARs for the Low-Level Radiation Burial Site

REGULATIONS	CFR/COMAR LISTING	POTENTIAL ARARs
RCRA	40 CFR 268; COMAR 26 Subtitle 13 (Hazardous Waste Disposal)	Land Disposal Restrictions Applicable for RCRA designated wastes. Contaminated soils, sediments, leachates, etc. must be managed as RCRA wastes. COMAR likely to take precedence for most RCRA requirements.
	40 CFR 264; COMAR Subtitle 13 (Hazardous Waste Disposal)	Disposal and Closure Requirements RCRA requirements for disposal and site closure (removal area) may become relevant and appropriate if contaminated materials are excavated from the site during the removal action. COMAR likely to take precedence for most RCRA requirements.
	40 CFR 264.251 (c) (d); 40 CFR 264.273 (c) (d); 40 CFR 264.301 (c) (d); 40 CFR 264.258 (b); 40 CFR 264.310; COMAR 26.04.07.21	Surface Water Control Control and prevent run-on and run-off from a 24 hour, 25 year storm (waste piles, land treatment facilities, and landfills). Maryland requirements may also be applicable and may take precedence.
	40 CFR 262.30 through 31	Transport Requirements Materials removed from the burial site, which are classified as hazardous waste, will be required to follow packaging and labeling regulations, prior to transport.
	40 CFR 261.10 (261.24 Toxicity Characteristic; COMAR 26.13.01 through 10	Criteria for Identifying the Characteristics of Hazardous Waste Hazardous wastes (including soils, debris, etc.) may potentially be excavated from the burial site. The characteristics of these wastes will determine if RCRA disposal requirements apply. Maryland requirements may also be applicable and may take precedence.

Table 2.1. List of Potential ARARs for the Low-Level Radiation Burial Site (continued)

REGULATIONS	CFR/COMAR LISTING	POTENTIAL ARARs
SDWA	40 CFR 141.11 through 12, 40 CFR 15 through 16; COMAR 26.04.01.06 through 35.	National Primary Drinking Water Regulations Maximum contaminate levels (MCLs) for radionuclides, organic chemicals, and inorganic chemicals in community drinking systems may be a consideration during remedial activities. MCLS and non-zero MCLGs may be relevant to groundwater at the site, although the surficial aquifer is not believed to be a current source of drinking water. Criteria may be used as threshold levels for selection of contaminates of concern (COPCs) to assess potential impact to the environment.
	40 CFR 143.3; COMAR 26.20.20.01	Secondary Maximum Contaminate Levels Secondary Maximum Contaminate levels may be applicable to groundwater quality at the site. Groundwater quality must be suitable for its intended use.
DOT	49 CFR 173.24; 49 CFR 178.350	General Requirements for Packagings and Packages Specifications for the packaging of materials and the packages prior to transport. DOT regulations may be applicable or relevant to hazardous materials removed from the site.
	49 CFR 177.848	Segregation of Hazardous Materials Provides instructions for using the segregation table for hazardous materials, which outlines specifications for the transport of different types or classes of hazardous materials. These requirements would be applicable or relevant to materials and/or debris excavated from the burial site.
	49 CFR 173.3	Shipping Requirements for Hazardous Materials - Specifications for the transport of hazardous materials. These requirements may be applicable for contaminated soils, debris, etc. during the remedial action.
	49 CFR 177.842	Carriage by Public Highway - Class 7 (radioactive) material Provides specifications for the transport of radioactive materials. Requirements may be applicable or relevant to waste materials excavated from the site.

Table 2.1. List of Potential ARARs for the Low-Level Radiation Burial Site (continued)

REGULATIONS	CFR/COMAR LISTING	POTENTIAL ARARs
CAA	NAAQS 40 CFR 50, NESHAP 40 CFR 60, 40 CFR 61; COMAR 26.11.115.10, 26.11.15.11	Chemical Discharges from Remedial Activities or Treatment Discharges to ambient air from remedial activities must not cause nuisance odors or pose excess risk to human health or the environment. Includes National Ambient Air Quality Standards (NAAQS), National Emission Standards for Hazardous Air Pollutants (NESHAP) and New Source Performance Standards (NSPS); Maryland Air Toxics program.
	CAA Section 101 and 40 CFR 52	Fugitive and Odor Emission Control Plan Action Odor regulations are intended to limit nuisance conditions from air pollution emissions. Fugitive emission controls are one feature of the state implementation plan used to achieve/maintain the ambient air quality standards for particulate matter. Maryland Administers provisions of the CAA.
Endangered Species Act of 1973	50 CFR 200, 50 CFR 402; COMAR 26.11.15.10	Endangered Species Act - The determination/protection of endanger species or threatened species at the site may be applicable.
Radiation (DOE)	10 CFR 20.101, 10 CFR 20.104	Radiation Protection Programs For the protection of workers during the remediation, DOE programs may be applicable or relevant. Programs consist of a variety of radiation exposure limits including dose limits of 1.25 rem/quarter to whole body
	10 CFR 20.1701-20.1702 10 CFR 20.1703	Respiratory Protection and Controls to Restrict Internal Exposure in Restricted Areas - The best available measures, to the extent practicable, should be considered to control the concentration of radioactive materials in the air. The use of individual respiratory equipment should be required to limit the intake of radioactive materials in the air. In addition, a respiratory protection program should be implemented through the entire duration of the remediation.
	10 CFR 61.41	Protection of the General Population from Releases of Radioactivity - Limits the concentration of radioactive material that may be released into the air, water, soil, plants, and animals.

Table 2.1. List of Potential ARARs for the Low-Level Radiation Burial Site (continued)

REGULATIONS	CFR/COMAR LISTING	POTENTIAL ARARs
Radiation (DOE)	10 CFR 61.50; COMAR 26.15.01, 26.15.02	Technical Requirements for Land Disposal Facilities Following the excavation, the elimination of radioactively contaminated materials or wastes will be required to comply with appropriate disposal site suitability criteria.
	10 CFR 71.43-71.47	General Standards and External Radiation Standards for Packages - The transport of radioactive wastes must meet specific packaging and external radiation standards. Requirements may be applicable to potential debris and soils removed from the burial site.
OSHA	29 CFR 1910.96; 29 CFR 1926.53	Ionizing Radiation Provides specifications and requirements for the protection of human health from exposure to radiation in restricted areas. This may be applicable to personnel during the site remediation.
	29 CFR 1910.120; 29 CFR 1926.65	Hazardous Waste Operations and Emergency Response Provides employee exposure specifications for dealing with clean-up of NPL sites, corrective actions of RCRA sites, voluntary clean-up of federal property, and emergency response operations for releases, or potential releases of hazardous substances.
	29 CFR 1910.120; 29CFR 1926.103	Respiratory Protection Outline of respiratory protection requirements for employees that may be exposed to harmful dusts, fogs, fumes, mists, gases, smokes, etc., while working on site. The use of respirators or and respiratory protection program may be applicable during remedial activities.
	29 CFR 1926.55	Gases, Vapors, Fumes, Dusts, and Mists Provides exposure limits and compliance specifications for inhalation, ingestion, skin absorption, or contact with any substance at a concentration above those specified in the "Threshold Limit Values of Airborne Contaminates for 1970". Provisions for the protection of employees during remedial activities.
	29 CFR 1926.651; 29 CFR 1926.652	Specific Excavation Requirements and Requirements for Protective Systems Safety requirements and protective systems for excavations will be relevant and applicable to excavation activities during the site remediation. Specifications include: underground installations (utilities), access and egress (structural ramps), oxygen monitoring, exposure to vehicular traffic, protection from cave in, etc.

Table 2.1. List of Potential ARARs for the Low-Level Radiation Burial Site (continued)

REGULATIONS	CFR/COMAR LISTING	POTENTIAL ARARs
To Be Considered	EPA BTAG Tables (August 1995) EPA RBC Tables (October 1998)	<u>EPA RBCs and BTAG Tables</u> Surface and subsurface soils at the site must not pose excess risks to human health or the environment. EPA RBCs and BTAG Tables are TBCs to assess potential risk arising from exposure to these media at the site.

Table 2.2. Estimated Radionuclide Concentrations Required to Yield 15 mrem/yr Exposure During Excavation

Radionuclide	Estimated Soil Concentration (pCi/g)	Maximum External Exposure Rate (mrem/yr)	Inhalation Exposure Rate (mrem/yr)	Soil Ingestion Exposure Rate (mrem/yr)	Estimated Concentration[1] to Achieve 15 mrem/yr Exposure (pCi/g)
C^{14}	7,120	0	0.05	0	7,120
Cl^{36}	0.882	0	0	0	0.882
Tritium	47,700	0	2.1	0	47,700
Ni^{63}	1,810	0	0	0.05	1,810
Ra^{226}	78.3	275	0.05	2.0	4.3
Sr^{90}	62.0	0	0	0.25	62.0

1 - If all exposure routes are less than 15 mrem/yr limit, concentration is equivalent to estimated soil concentration used in RESRAD.

rate, which is equivalent to how exposures are treated in the RESRAD model. Appendix E presents the 6th exposure scenario in which estimated soil concentrations are 1/100th that in the 5th scenario. The graphs for external exposure, inhalation, and ingestion present exposure rates 1/100th the results of the 5th scenario.

Based on these assumptions, only the estimated concentration of Ra^{226} yields an exposure rate greater than 15 mrem/yr for external exposure. Reduction of the concentration of Ra^{226} to an estimated 4.3 pCi/g would meet the 15 mrem/yr requirement; therefore, the cleanup goal for soils immediately beneath and adjacent to the waste pits is proposed as 4.3 pCi/g of Ra^{226}.

2.3 Schedule

The estimated period for performing the limited excavation removal action at the LLRBS is 20 weeks. This estimate assumes that the party, or parties, responsible for the field work will focus their excavation and segregation activities on an individual pit location, and will complete the excavation in a manner which limits the breaking of any container encountered and limits the spread of contamination into the surrounding soil. Simultaneous excavation at multiple pits may accelerate the project, but will be allowed only if the responsible party(ies) can prove competency and equipment availability.

The schedule does not include pre-mobilization activities such as developing work plans, acquiring subcontractors, and acquiring any necessary permits. The schedule also does not include post-removal action activities such as development of a removal action report. Site closeout at the LLRBS will not occur until residual contamination is addressed via the ongoing RI/FS process.

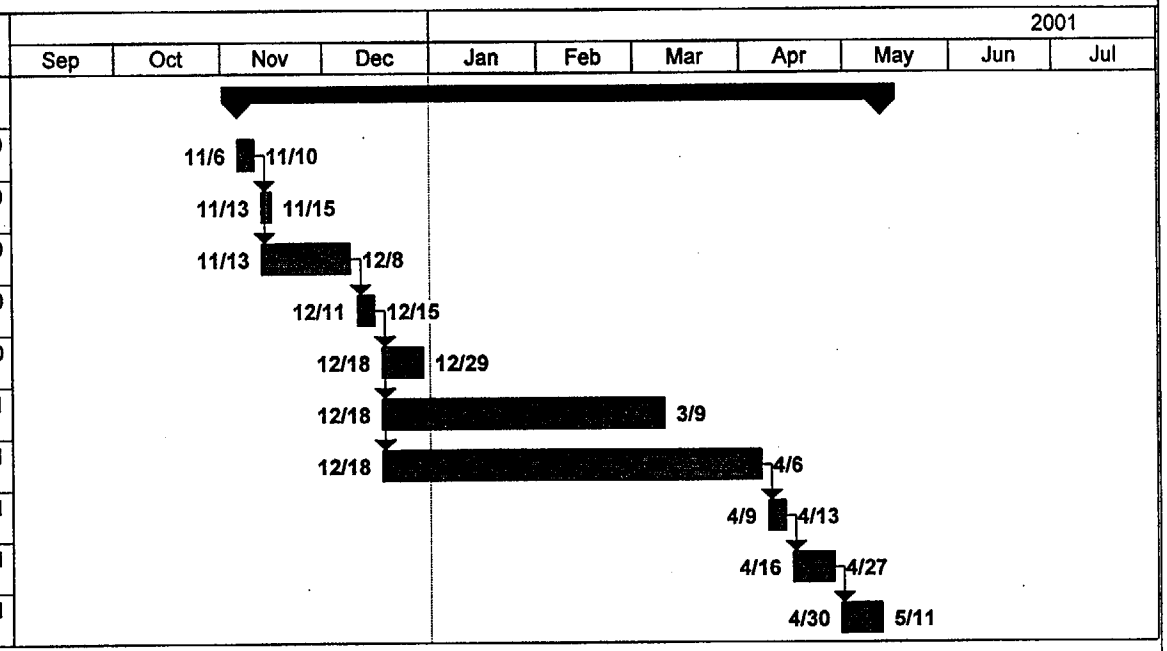
Preliminary schedules for the limited excavation (preferred alternative), bulk excavation, and hybrid excavation alternatives are presented in Figures 2.1, 2.2, and 2.3 respectively.

2.4 Planned Remedial Activities

At the present time, no remedial activities are current planned for the LLRBS. Any remedial activities will be implemented after completion of the RI/FS and selection of a remedy as documented in a ROD. Potential remedial activities to address subsurface soil and groundwater contamination at the LLRBS after completion of the removal action may include: soil flushing, soil vapor extraction, air sparging and vapor extraction of the groundwater, and groundwater pump and treat.

Figure 2.1. Low-Level Radiation Burial Site
Limited Excavation Alternative

Task Name	Duration	Start	Finish
Limited Excavation	**135 days**	**11/6/00**	**5/11/01**
Mobilization	5 days	11/6/00	11/10/00
Remove Fence	3 days	11/13/00	11/15/00
Erect Building	20 days	11/13/00	12/8/00
Excavate Clean Soil	5 days	12/11/00	12/15/00
Excavate Waste and Dirty Soil	10 days	12/18/00	12/29/00
Sort Waste and Soils	60 days	12/18/00	3/9/01
Sampling and Analysis	80 days	12/18/00	4/6/01
Backfill and Compact	5 days	4/9/01	4/13/01
Demob Building	10 days	4/16/01	4/27/01
Decon and Demob Site	10 days	4/30/01	5/11/01



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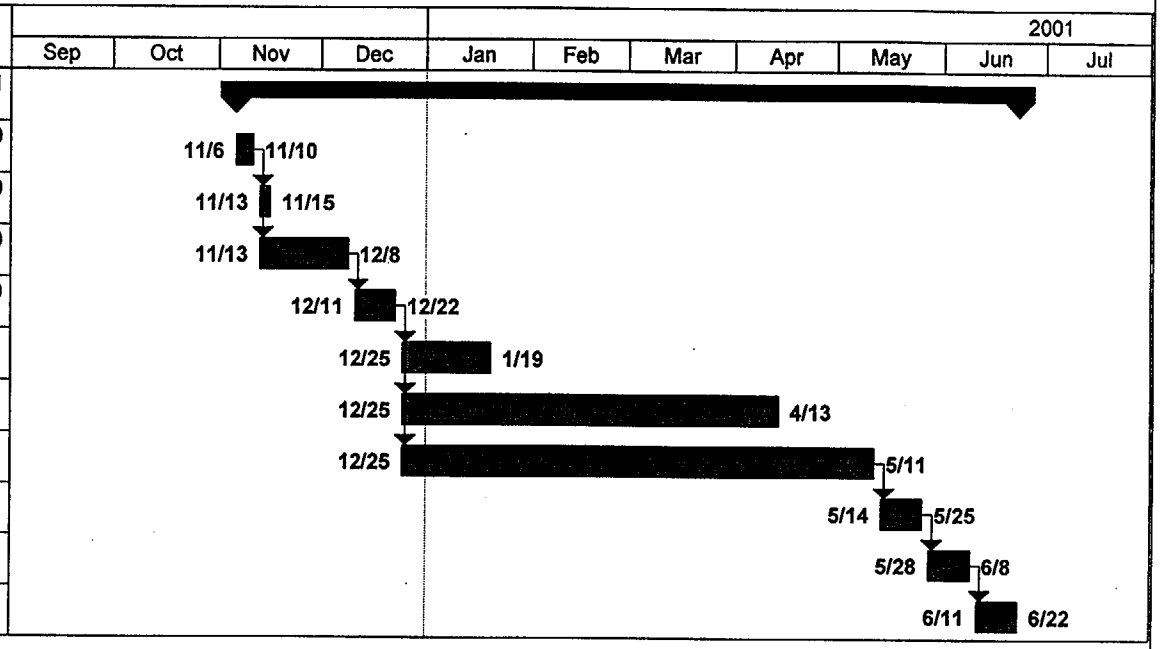
Task Summary

Figure 2.2. Low-Level Radiation Burial Site
Bulk Excavation Alternative

Task Name	Duration	Start	Finish
Bulk Excavation	**165 days**	**11/6/00**	**6/22/01**
Mobilization	5 days	11/6/00	11/10/00
Remove Fence	3 days	11/13/00	11/15/00
Erect Building	20 days	11/13/00	12/8/00
Excavate Clean Soil	10 days	12/11/00	12/22/00
Excavate Waste and Dirty Soil	20 days	12/25/00	1/19/01
Sort Waste and Soils	80 days	12/25/00	4/13/01
Sampling and Analysis	100 days	12/25/00	5/11/01
Backfill and Compact	10 days	5/14/01	5/25/01
Demob Building	10 days	5/28/01	6/8/01
Decon and Demob Site	10 days	6/11/01	6/22/01



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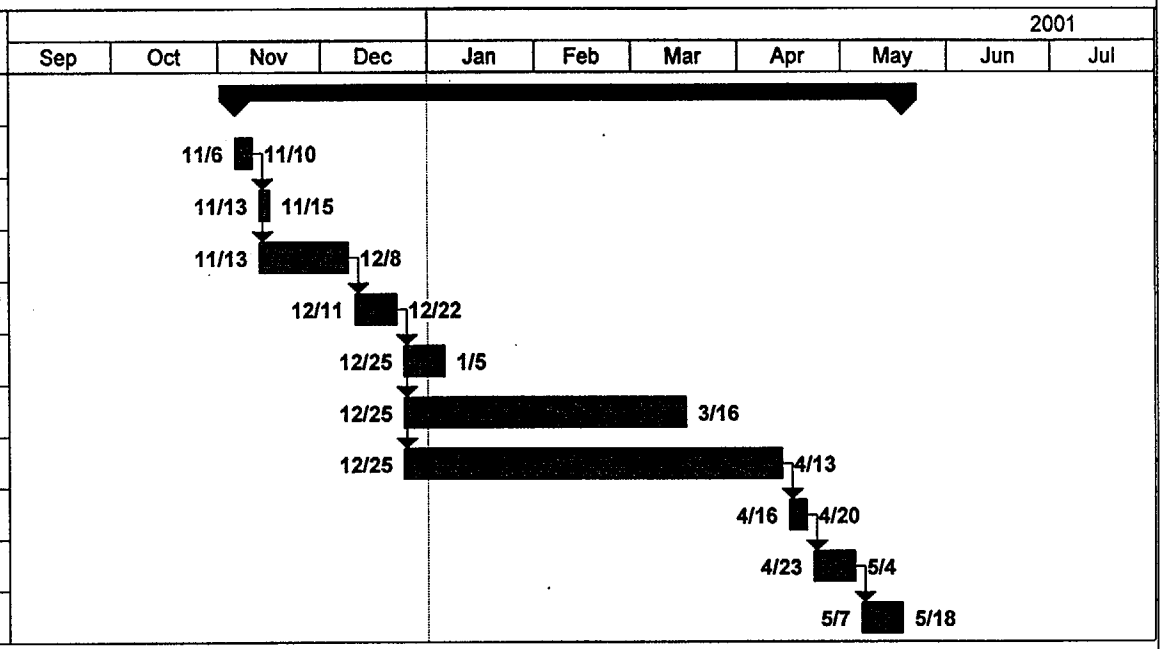
Task Summary

Figure 2.3. Low-Level Radiation Burial Site
Hybrid Excavation Alternative

Task Name	Duration	Start	Finish
Hybrid Excavation	**140 days**	**11/6/00**	**5/18/01**
Mobilization	5 days	11/6/00	11/10/00
Remove Fence	3 days	11/13/00	11/15/00
Erect Building	20 days	11/13/00	12/8/00
Excavate Clean Soil	10 days	12/11/00	12/22/00
Excavate Waste and Dirty Soil	10 days	12/25/00	1/5/01
Sort Waste and Soils	60 days	12/25/00	3/16/01
Sampling and Analysis	80 days	12/25/00	4/13/01
Backfill and Compact	5 days	4/16/01	4/20/01
Demob Building	10 days	4/23/01	5/4/01
Decon and Demob Site	10 days	5/7/01	5/18/01



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Task Summary

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3. IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section identifies technologies that may be applicable for addressing the source material at the LLRBS. Additionally, these technologies are screened against site-specific objectives to determine those that are viable. General response actions (e.g., containment, removal, and treatment) are utilized to determine estimates of areas or volumes of each medium to which treatment, containment, and/or disposal technology may be applied. Technology types and process options then are identified and screened against site objectives to develop viable alternatives for comparative analysis in Section 4.

3.1 Identification of Containment Options

3.1.1 Subsurface Barriers

The term *subsurface barriers* refers to a variety of methods whereby low-permeability cutoff walls or diversions are installed below ground to contain source areas or groundwater plumes. The most commonly used subsurface barriers are slurry walls, particularly soil-bentonite slurry walls. Less common are cement-bentonite slurry walls, grouted barriers, and sheet piling cutoffs. Grouting may also be used to create horizontal barriers for sealing the bottom of source areas.

Slurry walls are constructed in a vertical trench that is excavated under a slurry. The slurry, usually a mixture of bentonite and water, acts essentially like a drilling fluid. The slurry hydraulically shores the trench to prevent collapse, and, at the same time, forms a filter cake on the trench walls to prevent fluid migration to the surrounding ground. A slurry wall constructed around the perimeter of the disposal pits at the LLRBS, in conjunction with a grouted, horizontal barrier below the depth of the pits (acting much like a landfill liner) and a cap with low permeability (see Section 3.1.2) will isolate the wastes in place.

3.1.2 Capping

In general, caps consist of a single confining layer constructed of geomembrane or low-permeability soils, plus other functional layers. Due to the lack of an economical supply of low permeability soils around the LLRBS, a low permeability geomembrane would be used as the confining layer. The function of the cap is to prevent infiltration of rainwater into the waste pits. Rainwater creates leachate and provides mobility for contamination to reach groundwater. The cap would be constructed in accordance with Resource Conservation and Recovery Act (RCRA) solid waste regulations pertaining to landfills (40 CFR 264.310), and the layers would consist, from the bottom layer up; a geotextile filter fabric layer; a 12-inch gas venting layer of soils with a minimum permeability of 1×10^{-3} cm/sec; the confining layer; a 24-inch protection layer; and a 6-inch topsoil layer with vegetation. A secondary function of the gas venting layer is that it

acts as a protective layer for the geomembrane. A primary requirement for capping of landfills is that the permeability of the cap be less than the permeability of any liner system beneath the waste materials. Since the disposal areas within the site are unlined, this requirement would be fulfilled. If used in conjunction with containment barriers as described above, the cap would be designed with a lower permeability than the horizontal barrier below the LLRBS.

3.1.3 Viability of Containment

Effectiveness: Containment via subsurface barriers and capping would be effective in limiting human and ecological exposure to the wastes at the LLRBS. Use of one of these technologies as a stand-alone option would allow for continuing releases from the site. Use of containment technology would not meet the goal of unrestricted future use.

Implementability: Containment of the burial pits at the LLRBS could be implemented with available technologies. The potential impacts on human health and the environment during the construction and implementation phase of this option are negligible since excavation within the waste pits would not be required.

Cost: Costs for implementation of these containment technologies are relatively reasonable. Higher costs would likely be associated with installation of a horizontal containment layer beneath the site.

Although implementation of these options would isolate the waste from potential human and ecological receptors, this option will not achieve the goal of unrestricted future use and is therefore eliminated from further consideration.

3.2 Identification of In-Situ Treatment Options

3.2.1 Ground Freezing

Artificial ground freezing involves the installation of freezing loops in the ground and a self-contained refrigeration system that pumps coolant around the freezing loop. Although never used in an actual waste-containment operation, the technology is being used increasingly as a construction method in civil engineering projects. Freezing of soils has been employed to give load-bearing strength to soil during construction of foundations, to seal tunnels and other subsurface structures against flooding by groundwater, and to stabilize soils during excavation. Ground freezing is not applied to the waste itself, which may have a freezing point much lower than that of the surrounding soils, but on the uncontaminated soil surrounding the source material. This method renders the soil practically impermeable, but is useful

only as a temporary treatment approach due to the cost associated with long-term use and maintenance of the system.

3.2.2 Vitrification

In-situ vitrification (ISV) involves the electric melting of contaminated solids for purposes of destroying or removing hazardous organics and immobilizing hazardous inorganic contaminants in a glass and microcrystalline residual product form. Organics are destroyed by pyrolysis; inorganics and radionuclides are immobilized by incorporation in the melt and the resulting residual byproduct. The major benefit of ISV is that it does not require excavation, waste classification, and/or disposal.

ISV may be applied to contaminated solid media such as soil, sediment, tailings, and sludges. Electrodes are used in an array for treating individual melts of up to 1,000 tons. The process is initiated with the use of starter flux distributed at the surface or subsurface. Electrical power passing between the electrodes causes the starter material, then the soil, to heat up, beginning the melt process. The molten soil conducts the electricity, allowing the heating to continue as the molten region grows. Typical soil melt temperatures are between 1,600 and 2,000 degrees centigrade. Large-scale processing rates are 4 to 6 tons per hour, with the process operating 24 hours per day. Off-gases released during the melting process are trapped in a hood placed over the area and treated before venting.

3.2.3 Bioremediation

Bioremediation is a technique for treating zones of contamination by microbial degradation. The basic concept involves altering environmental conditions to enhance microbial metabolism of organic contaminants, resulting in the breakdown and detoxification of these wastes. The method that has been most developed and is most feasible for in-situ treatment is one which relies on aerobic microbial processes. This method involves altering subsurface environmental conditions by providing an oxygen source and nutrients to naturally occurring microorganisms. Oxygen and nutrients are delivered to the subsurface through an injection well or infiltration system to enhance microbial activity. Specially adapted microorganisms may also be used to inoculate the subsurface soils to enhance remediation.

3.2.4 Viability of In-Situ Treatment

Effectiveness: Ground freezing and vitrification would both be effective in minimizing or eliminating contaminant transport from the LLRBS. The wastes would not be altered through use of ground freezing, but organic materials would be destroyed while inorganics and radionuclides would be incorporated into a molten block of soil if vitrification is employed. Bioremediation would only be effective in treating organic

contaminants present at the site. None of these technologies would meet the goal of unrestricted future use of the site.

Implementability: Although not as common as other commercial processes, ground freezing units and experienced installers could be obtained to implement this process at the LLRBS. In-situ treatment is another potential option; however, the burial of animal remains and sealed liquid waste could not be treated safely. The short-term risks from such technologies as ISV also limit their applicability. Bioremediation systems are readily available; however, this option would only treat the organic portion of the contaminants.

Cost: In-situ treatment costs would vary for each of these 3 options. The long-term cost for ground freezing would be the most expensive due to the large, continuous energy needs of the system. ISV would be less expensive than ground freezing, but would also require a large amount of energy to implement the process and continue the melt to the necessary depth. Bioremediation is the cheapest of the 3 options, but would only treat a portion of the buried waste. In-situ treatment costs may be less than excavation and removal of the pit contents.

The nature of the waste disposed within the burial pits at the LLRBS is heterogeneous and unique. The limited ability to sample the waste and perform treatability studies limits the potential for in-situ treatment. In addition, none of these 3 options will meet the goal of unrestricted future use of the site; therefore, treatment of the pits in-situ will not be carried forward for further consideration.

3.3 Identification of Ex-Situ Treatment Technologies

Ex-situ treatment refers to a broad category of methods and technologies that could be used to reduce or eliminate the hazardous waste status of the liquids and solids (including soil) removed from the pits at the LLRBS. The goal of ex-situ treatment is to reduce contaminant levels in liquids and solids prior to their off-site disposal to minimize disposal cost. Plans for any onsite ex-situ treatment systems at the LLRBS would be submitted to regulators for review and approval prior to use.

Many different parameters affect the selection of the correct treatment method, including the type of contamination, volume of wastes to be treated, and desired clean up goals. Potential ex-situ methods for treating stockpiles of inorganically contaminated soils are: solidification and stabilization, soil washing, and acid extraction. The same soils may also require treatment for organic constituents. In this case, the piles may be treated by soil vapor extraction, low temperature thermal desorption, bioremediation, or thermal treatment (incineration). Ex-situ treatment of any liquids (the majority of which would be recovered from intact containers) would likely occur at an offsite facility, as opposed to onsite treatment. Volumes of

liquids are anticipated to be minimal relative to the volume of solids recovered from the trenches. The methods selected for ex-situ treatment at the LLRBS would be based on treatability study results which would be conducted by a subcontractor to determine their effectiveness in treating wastes from the LLRBS.

3.3.1 Solidification and Stabilization

Solidification and stabilization processes immobilize contaminants in soils by binding them in a concrete-like, leach-resistant matrix. Contaminated soils are collected, screened to remove oversized material, and introduced to a batch mixer. Necessary binding additives are mixed with the waste, and, after thorough mixing, discharged from the mixer. The treated waste is a solidified mass with significant unconfined compressive strength, high stability, and a rigid texture similar to concrete. A wide spectrum of reagents are available for bonding the contaminants to the soils, as well as for forming the stabilized matrix. The specific reagents utilized would be based on treatability study results. Solidification and stabilization processes use standard engineering techniques and common construction equipment. These processes have been demonstrated to be effective for inorganic and radioactive wastes; however, the solidification and stabilization processes may be impeded by the presence of organic contaminants.

3.3.2 Soil Washing

Soil washing is a physical/chemical separation process in which contaminated soil is excavated, screened to remove debris and large objects, and then washed with fluids to remove the contaminants. Washing fluids may include surfactants, dilute acids and bases, and water. To be effective, soil washing must either transfer the contaminants to the wash fluids or use size separation techniques to concentrate the contaminants in a fraction of the original volume. Other treatment technologies can then be used to treat the wash fluids and the fraction of soil containing most of the contaminants. Typically the soil is prepared prior to washing by mechanically screening the soil to remove debris and large objects. The entire process usually consists of mixing, washing, rinsing, and size separation steps.

The flexibility inherent in soil washing allows a wide degree of latitude in remediating a potential combination of soil contaminants. The system is capable of treating soils contaminated with organics, heavy metals and radionuclides. Soils that are contaminated with combinations of these contaminants can be treated in separate phases using surfactants specific to a particular type of contaminant in each phase. Most systems are based upon commonly available mineral treatment equipment.

3.3.3 Acid Extraction

Acid extraction is one methodology covered by the broader category of *solvent extraction*. Solvent extraction in terms of the LLRBS is the separation of contaminants from solids by contact with a liquid in which the contaminants dissolve. Acid extraction is an ex-situ process that leaches inorganics and radionuclides from contaminated soil, dust, sludge, or sediment with an acidic aqueous leaching solution. Common acid extraction systems deal with most metal contaminants (e.g., Cd, Cu, Pb, Ni, Zn, Hg). Acid extraction differs from soil washing in that it removes primarily inorganic material, and usually with a stronger acid (or base) than that which may be employed during soil washing. Soil preparation and processing steps are similar to those noted above for soil washing.

3.3.4 Soil Vapor Extraction

Soil vapor extraction (SVE) systems utilize air as a carrier gas to volatilize contaminants in-situ from unsaturated soils. Ex-situ SVE involves moving a carrier gas through excavated soils in a batch-type vessel under vacuum to remove volatile constituents. Heating of the carrier gas, air in the majority of systems, can improve recovery rates. The extracted soil vapors are typically treated with carbon adsorption or catalytic oxidation units prior to venting to the atmosphere. In the case of the LLRBS, this technology could be applied to the soil stockpiled at the site. This technology has been used for many years to remove volatile organic compounds and, to a lesser extent, semi-volatiles, from the soil. This technology is ineffective in the removal of inorganics and radionuclides from soil.

3.3.5 Low Temperature Thermal Desorption

Low temperature thermal desorption (LTTD) systems consist of a rotating, unlined horizontal unit with a steel shell surrounding an inner chamber into which contaminated soils are placed. A secondary unit is attached for treating off-gases. The main unit is heated indirectly by transferring heat to the inside chamber from hot gases circulating through the outer shell. This heat may be supplied by recirculated gases from the secondary unit. Water and volatile compounds are vaporized in the main chamber, and then combusted or otherwise treated in the secondary chamber. Since the soil is indirectly heated, no combustion products are generated in the unit, and the off-gas flow is relatively small.

These units have been primarily used to treat soils that are lightly contaminated with VOCs and SVOCs; and are typically a continuous, transportable, cost-effective alternative for soil decontamination. Thermal desorption systems have been used for several years and have demonstrated effective removal of chlorinated phenols, pesticides, polynuclear aromatics, dioxins, PCBs, solvents and mercury.

3.3.6 Bioremediation

Ex-situ bioremediation is usually recommended for treatment of soils/waste material contaminated with organics and can be accomplished using prepared bed (solid-phase) or bioreactor systems (slurry phase). Landfarming and composting are other types of ex-situ bioremediation processes commonly used to remediate soils.

One form of ex-situ bioremediation involves placing excavated soils inside of a bioreactor unit, mixing, and aerating the soils. During mixing and aeration, various nutrients and oxygen may be added to enhance treatment. Several factors must be taken into consideration when using ex-situ bioremediation. Contaminant biodegradability varies amongst different types of organic compounds. High levels of contaminants in the soil may inhibit microbial growth or prove to be toxic to microorganisms. Bench-scale studies are typically recommended to determine the proper nutrient balance. Common nutrients added to bioreactors include nitrogen and phosphorous. The pH of the unit would need to be closely monitored, as any reading outside of a range of 6 to 8 will inhibit microbial growth. Aeration of the soil with air may be provide a sufficient supply of oxygen, but some systems may require a supplemental source for better performance. Maintaining a suitable temperature for microbial growth and therefore destruction of contaminants is another concern. Again, a bench-scale test is typically performed to determine the optimum temperature range for treatment of the soil. Anaerobic treatment is also possible in a similar system, although aeration and the addition of oxygen is not used.

The mixing and aeration of soil in a bioreactor can be relatively expensive compared to other forms of ex-situ bioremediation, due to energy requirements involved. A more economical means of ex-situ treatment is composting. During composting, the contaminated soils are mixed with amendments which provide both nitrogen and phosphorous sources and allowed to degrade on a containment pad, occasionally inside a containment structure. Aeration is supplied by daily turning, or the installation of a piping system in the pile through which air is supplied on a continuous basis. In this type of system, the moisture content of the pile is measured on a daily basis, and water added when necessary. Treatment of contaminated soil can be accomplished in as little as 20 days using this method.

3.3.7 Thermal Destruction

Thermal destruction (incineration) is a treatment method which uses high-temperature oxidation under controlled conditions to degrade a contaminant into products that generally include CO_2, water vapor, SO_2, NO_x, hydrogen chloride gas, and ash. Some radioactive contamination would likely be vented (C^{14} as carbon dioxide, and tritium in water vapor) and may require special treatment. Exit gases are typically treated before venting to the atmosphere. Thermal destruction is applicable to a wide range of organic

wastes and has been shown to be effective in treating soils, sediments, sludge, and liquids containing contaminants such as halogenated and non-halogenated volatiles and semivolatiles, PCBs, pesticides, organic corrosives and cyanides. The most common technologies applicable to thermal destruction of contaminated soil include use of a rotary kiln or a fluidized bed.

A rotary kiln consists primarily of a horizontal rotating cylinder with the load to be heated tumbling on the inside. Waste material to be processed is introduced at one end of the kiln and rolls slowly down the length of the unit and is discharged at the opposite end after treatment. Rotary kilns can be directly heated by firing gas or oil burners into the interior or indirectly heated by heating the kiln's outside diameter with burners, radiant elements, or induction coils.

A fluidized bed may be of either a circulating bed or bubbling bed type. Both consist of a combustion vessel using high-velocity air to either fluidize the bed (bubbling bed) or entrain the bed (circulating bed). In the circulating bed design, air velocities are higher and the solids are blown overhead, separated in a cyclone, and returned to the combustion chamber. Operating temperatures are normally between 1,400° F and 1,600° F.

3.3.8 Viability of Ex-Situ Treatment

Effectiveness: Treatment of the waste after excavation via solidification and stabilization is effective, provided the product is properly disposed as low-level waste due to the radionuclides present. This treatment may not be required as the solid wastes are likely amenable to direct containerization and burial without solidification and stabilization. Soil washing, acid extraction, and soil vapor extraction may be partially effective in that they can reduce the total volume of waste required for disposal provided organics, inorganics, and radionuclides are removed from the soil matrix. Low temperature thermal desorption, bioremediation, and thermal treatment are not considered effective since they would not treat any inorganic or radionuclide contamination present.

Implementability: All of these options have been employed in various degrees to contaminated soils, and therefore could be implemented at the LLRBS. Onsite requirements vary for each option, and several may require a treatability study to optimize treatment parameters.

Cost: Ex-situ treatment of a large volume of excavated soils (approximately 41,250 ft^3) would be expensive relative to excavation, containerization of the soil and heterogeneous debris, and offsite disposal as appropriate.

The wastes buried at the LLRBS are heterogeneous in nature. The majority of ex-situ treatment options require a relatively homogenous waste. The driving factor in disposal cost for this site is the low-level waste internment cost. Of the ex-situ options considered, soil washing and acid extraction may be amenable to removing radionuclide contamination from the soil matrix. Solidification and stabilization will only increase disposal volume. The other treatment methods considered will not address the radioactive contamination. For these reasons, ex-situ treatment of excavated waste is eliminated from further consideration.

3.4 Identification of Removal Technologies

This section of the report addresses identification of removal technologies applicable to the buried contaminated waste within the LLRBS. Excavation at landfill sites is usually limited to those sites that are within practical size limitations, have well defined and accessible waste areas, waste volumes that are less than 100,000 cubic yards (CY), and waste that would continue to pose a threat with the implementation of only containment and institutional controls. Excavation of waste materials at the LLRBS will remove the sources of contamination and thereby no longer pose a threat to humans or the environment.

An RA at the LLRBS would consist of several phases including: construction of engineering controls to minimize contaminant migration, excavation of soil and waste, removal of source materials, and disposal of all waste types. By dividing the work into these phases, the effort to identify the most feasible technologies from each phase is simplified.

3.4.1 Institutional Controls

Institutional controls identified for the LLRBS include ongoing access and use restrictions for the site, as well as long-term monitoring of the groundwater. Access to the LLRBS is currently limited to BARC personnel, and intrusive activities of the area within the confines of the fence are prohibited. A semi-annual groundwater sampling program to monitor the extent of contaminant migration has been implemented for the 13 existing monitoring wells.

3.4.1.1 Access and Use Restrictions

The objectives of access and use restrictions are to prevent prolonged exposure to contaminants, control future intrusion and development of the site, and prevent destruction of any potential remedial constructs engineered at the site. These objectives can be accomplished by placing site usage and deed restrictions on all property within potentially contaminated areas. In addition, current fencing and posted warnings at the site would need to be maintained.

3.4.1.2 Monitoring

Long-term monitoring of contaminant levels in groundwater is used primarily to quantify current and future conditions, evaluate the effectiveness of a chosen removal action, and determine whether existing or future receptors are threatened. BARC currently monitors groundwater contamination semi-annually in the 13 existing wells at the LLRBS. Selection of monitoring as part of a remedial strategy for the site may require installation of additional monitoring wells should groundwater contamination migrate past the extent of the current well network.

3.4.1.3 Viability of Institutional Controls

Access and Use Restrictions

Effectiveness: The effectiveness of this response depends on its continued implementation into the future. Access restrictions are subject to change in political jurisdiction, legal interpretations, and regulatory enforcement, and the current restrictions require maintenance of fencing and posting. When properly implemented, access restrictions protect against direct contact with the contaminants. Access and use restrictions alone will not meet the goal of unrestricted future use.

Implementability: This process option is a readily available technical solution. Procedures are currently in place that will adequately restrict access and control the site.

Cost: The continuance of institutional controls will require periodic inspection of the site, security fence and warning sign maintenance, and submittal of a site status report every 5 years.

Although institutional controls will not meet the goal of unrestricted future use, institutional controls are retained as a process option for use in conjunction with an appropriate site remedy.

Monitoring

Effectiveness: The monitoring of groundwater alone would not meet any of the objectives for the LLRBS. The potential impacts on human health and the environment during the construction and implementation phase of this option are negligible since monitoring wells are currently in place. The only additional exposure to the contaminated groundwater would be by personnel performing the sampling and analysis. When properly implemented, monitoring will assist in identifying future potential releases to groundwater at relatively low cost.

Implementability: Thirteen (13) monitoring wells currently exist around the LLRBS. Also, additional wells could be installed quickly, and equipment and services are readily available. Approved sampling and analysis procedures already are developed and are being followed.

Cost: Groundwater monitoring can be implemented utilizing existing monitoring wells and sampling procedures. Compliance with field sampling and analytical procedures should require minimal costs to monitor current contamination and potential future releases to the groundwater.

Although monitoring of the LLRBS as a stand-alone option will not meet the unrestricted future use goal for this site, monitoring is retained as a process option for use in conjunction with an appropriate site remedy.

3.4.2 Excavation of Soil and Waste at the LLRBS

The field effort for this option includes site preparation and excavation of animal carcasses, containers, debris, and contaminated soils for disposal in accordance with regulatory guidelines. Generally, there are two approaches to excavation, controlled excavation (containers are separated and removed individually) and bulk excavation (machines and equipment remove the soils, containers, and debris en mass with separation afterwards by sorting equipment).

The pits and their contents have not been disturbed since original placement. Excavation will require removing the overburden, estimated at an average depth of 5 feet, and stockpiling the soil. As excavation reaches the buried waste, the material will be initially segregated on a lined surface. By keeping the size of the stockpiles relatively small and conducting regular field screening of soils, cross-contamination of clean and contaminated soils can be minimized.

Many parameters affect the choice of the method of excavation. One is maintenance of a safe work environment. It is unknown if the chemicals in the containers are explosive or reactive, thus during removal they may pose a risk to personnel. It is also a goal to minimize the breakage of containers, which could possibly release contaminants to subsurface soils and eventually the groundwater. Field screening for radionuclides and VOCs will also be necessary to protect workers and prevent the spread of contamination. These activities will slow the rate of work; therefore, productivity rates at the LLRBS will be significantly lower than for clean commercial soil excavations.

3.4.2.1 Engineering Controls to Minimize Contaminant Migration

Various engineering controls may be applicable to minimize contaminant migration, including the application of dust suppressants, the use of temporary containment structures, and the covering of excavation areas and stockpiles with plastic sheeting. A combination of these controls or all may be needed to control contaminant migration.

Dust Suppressants

Wind erosion, vehicular traffic, and site excavation permit particles to be raised which becomes an air pollution control problem. Fugitive dust from vehicular traffic, exposed surfaces, excavation, and stockpiled materials can be controlled with dust suppressants. In some cases, a simple water spray is sufficient. In most cases, dust suppressants are required to enhance a bond between soil particles to inhibit their potential to become airborne. Commercially available dust suppressants include straw mulch with emulsified asphalt, vegetable gum, synthetic copolymers, lignosulfonate, vinyl acetate resin, and petroleum resins. A wind fence, made of polyester or a similar material, may also be constructed to heights of 3 to 10 feet to minimize wind erosion; however, inhalable particles, less than 10 micrometers (μm), are not consistently controlled.

Temporary Containment Structures

A temporary containment structure may be required to enclose the work area if intact containers are opened or crushed onsite, and to prevent precipitation from entering the excavated waste pits. This structure may be a fixed building, a temporary 'clamshell' type structure, or a mobile structure that can be moved from waste pit to waste pit. Negative air pressure and high efficiency particulate air (HEPA) filtration could be used inside the structure to control airborne contamination.

Plastic Sheeting

Plastic sheeting would be used to cover the exposed faces of the excavation and stockpiles during work stoppages to minimize contaminant migration. Plastic sheeting will also inhibit soil runoff from the faces of the excavation and stockpiles during precipitation events.

3.4.2.2 Type of Excavation

Open Pit Excavation

This method allows for simple vehicular access to the excavation area during the work and allows standard excavation practices to be applied. It is simple because it does not require additional materials for supporting the walls of the excavation to prevent cave-in.

In many cases at the LLRBS, the delineated waste pits are in close proximity to each other. Under these circumstances, an open pit excavation would include the clean, lateral soils between the pits, which would be excavated in order to maintain safe slopes at the sides of the excavation. Due to the sandy soils present at the LLRBS, it is likely that one-and-one-half horizontal (1:1.5) sides lopes would be used. The cost for open-pit excavation is low relative to shoring/sheet piling and grouting.

Shoring/Sheet Piling

Shoring or sheet piling can be used to prevent cave-in of the side walls of an excavation. If an open pit excavation is not used, the sides walls of the excavation will need to be shored in accordance with Department of Labor (DOL) regulations since the excavation will likely be at least 10 feet deep. DOL regulations [29 CFR 1926.652(a)(1)(ii)] require shoring for trenches/excavations in excess of 5 feet deep. Interlocking metal sheet piling to support the sidewalls of the excavation will minimize excavation volumes, and would protect the pits from caving in during removal activities. However, installation of shoring beams or metal sheet piling may require further delineation of the burial pit boundaries in order to prevent breaking intact bottles and the release of contaminants. Damage or deflection of the sheet piling may occur in rocky soils, resulting in ineffective shoring of the excavation walls. Shoring and sheet piling add additional expense to the work, and may be unnecessary since there is sufficient room to utilize open pit excavation at the LLRBS.

Grouting

Grouting is an option that could be used in order to shore the sides of the excavation and minimize the volume of material removed from each pit. Grouting could also be used to protect adjacent areas from lateral migration of contamination. Grouting refers to a process whereby one of a variety of fluids is pressure injected into the soil where it is set in place to strengthen the soil matrix and reduce the potential of cave-in during subsequent excavation. Cement grout utilizes hydraulic cement which sets, hardens, and does not disintegrate in water. Cement grouts have been used for both soil-consolidation and water-cutoff applications, but their use is primarily restricted to more open soils. Typically, cement grouts cannot

be used in fine-grained soils with cracks less than 0.1 mm wide.

In the highly permeable, sandy soils found at the LLRBS, grout would have a tendency to dissipate quickly and would require an additive to accelerate its rate of solidification. By limiting the excavation to the delineated area of the pits, it would be necessary to take additional soil borings from the perimeter of the LLRBS to ensure the complete removal of contaminated soils.

The cost of a cement grout wall is approximately 40 - 50 percent greater than shoring/sheet piling. Considering that the benefit provided by this technology does not outweigh its cost compared to using open pit excavation, the use of grouting to provide structural support to the excavation walls has been eliminated from further consideration.

3.4.2.3 Excavation Systems

Manual Excavation

Under this scenario, workers would hand excavate the overlying soils, and also pick up and remove debris and intact containers. This method can greatly reduce the quantity of containers broken during excavation; however, there are disadvantages associated with this technique. The limited knowledge of the contents of the containers allows for the possibility that there may be shock, heat, or light sensitive chemicals present, as well as radioactive materials. Handling these containers could result in an explosion and injury to personnel. Thus, manual removal of each container would be a time consuming task and would expose workers to a risk of injury from the dangers posed by the unknown chemicals. The uncertainties associated with the contamination dictates that personnel would have to wear personnel protection equipment and utilize air purifying respirators at a minimum, resulting in increased labor costs, decreased worker productivity, and increased risk of heat stress to workers during warm weather months.

Conventional Excavation Equipment

Conventional excavation equipment, such as backhoes and tracked excavators, has advantages in performing site excavations. Qualified operators are readily available, equipment productivity rates are well documented, and this equipment represents a relatively low-cost way to remove large volumes of soil and debris. This equipment also reduces the risk of worker exposure to contaminants because of the distance of the operators in the vehicles' cab from the excavation and stockpile areas.

The disadvantage of this technique is that it does not provide the ability to pick up individual containers, and presents a high potential to break a substantial number of containers during the excavation.

Chemical releases to the permeable soils at the LLRBS must be minimized, although if containers are broken and chemicals are released, it is believed the excavation equipment is capable of removing soil faster than the chemicals could infiltrate through underlying soils. Assuming breakage, a necessary precondition of employing this method of excavation at the LLRBS is that once excavation starts in the debris of a pit, excavation does not stop until all of the debris is removed from that particular pit.

Modified Conventional Excavation Equipment

The benefits of the low relative cost and reliability of conventional excavation equipment are enhanced by adding specially designed devices to the equipment to improve productivity, safety, and performance. An example is the addition of a vibrating, rubber coated, screened bucket to an excavator. This equipment would allow the separation of soils and debris as the excavation proceeds, and the rubber coating would be of sufficient thickness to provide a resilient surface upon which containers could bump, reducing the risk of breakage. It is possible excavation contractors would suggest other equipment modifications to improve the quality of work, decrease breakage, and increase productivity.

Equipment modifications may reduce the disadvantages of conventional excavation equipment by reducing the breakage of containers. There is, however, little documented evidence of the degree of improvement in performance these modifications would provide. Modified equipment may also require additional maintenance by specially-trained personnel.

Remote-Controlled Excavation Equipment

The advantages of conventional excavation equipment are combined with an increase in operator safety by use of remote control. With this method, the operator is no longer in the vehicle, but operating it safely at even a greater distance from the work area. The remote control modifications would add cost to the use of the vehicle. Concurrent with remote control would be a decrease in productivity and performance, as most equipment operators also rely on the sensory stimulations received while sitting in the cab of the vehicle to determine ground resistance to excavation, obtain visual cues, and other information. The field of view provided by remote video cameras is not as complete as that provided by the view from inside the vehicle itself.

Robotic Excavation

Robotic excavation equipment has the highest cost and lowest reliability, per cubic meter of excavated material, compared to the other excavation equipment discussed above. It is anticipated that work in the dirty, outdoor environment would also have an adverse effect on the reliability of the devices. However,

robotics provide flexibility; and robotic devices could be used for soil removal, container segregation and removal, and also lower the risk of worker injury from explosion of sensitive chemicals, as the equipment is designed to operate at remote distances.

Air Lance/Vacuum Excavation

High-pressure air could be used to uncover debris and containers in conjunction with a vacuum system to remove soil and rock out of the pits to a stockpile area. As debris and containers are uncovered, they could be manually picked up and removed from the pits.

This technique is being studied by Idaho National Engineering and Environmental Laboratory (INEEL), and utilizes a robotic control arm supported by a gantry crane that has air lance and vacuum nozzles attached. A demonstration of this combination of devices to uncover buried bottles by INEEL is planned; however, it is conceivable that commercially available air pressure and vacuum equipment could be used and handled by mobile robots or laborers to accomplish the same efforts as the robotic arms.

3.4.2.4 Removal of Containers

The waste area of the pits will contain a mix of soils, debris, and broken and intact containers. Intact containers could be separated and removed from the pits individually, or removed along with surrounding soils and separated at the surface prior to processing and crushing.

Separation

The intact containers can be separated from the other pit contents, such as sand, gravel, debris, or broken glass, by at least three methods: manually by laborers; remotely by robots; or, after excavating the material from the pit, using a screen apparatus. The first method subjects the workers to the highest risk of injury. The container's contents could potentially be light, shock, or thermal sensitive and may explode under normal handling procedures. The second method is likely to be the slowest and most costly, although it poses the lowest risk to workers. The third method, using a screen apparatus, has the greatest potential for breakage of the containers, although it is probably the cheapest and the fastest option. This method also can have an adverse impact on worker safety because of the risk of mixing incompatible chemicals.

Crushing

Crushing the mix of soil, debris, and broken and intact containers either in place or more likely in drums would reduce the contamination characterization effort by homogenizing the contents of intact containers with the surrounding waste excavated from the pits. It would also eliminate the risk to workers who would have to handle individual intact bottles. Crushing of intact containers would occur after segregation of like types of contents via visual examination of labels and/or identification of contents via onsite field screening kits and/or laboratory analysis. Compatible materials would be crushed to reduce waste volume.

3.4.2.5 Disposal

Final disposal of wastes will depend on the type of waste encountered, the level of contamination, and the potential for the waste to undergo treatment. To facilitate disposal activity, the waste will first be segregated according to type during excavation and screening, then further characterized via field or laboratory procedures to determine if it can be returned to the pit as backfill or disposed offsite.

Soils and Solids

Soils which do not exceed the cleanup criteria may be used as backfill. Soil determined to be radioactive above cleanup levels will be disposed at an appropriately licensed low-level waste (LLW) disposal facility. Based on historical burial records, process knowledge of site operations, and sampling of the groundwater near the burial areas, the presence of hazardous waste or mixed waste (RCRA hazardous and low-level combined) is not anticipated. For subsequent RCRA waste storage and disposal alternatives, it is assumed the solid contents of the waste pits will require LLW or RCRA non-hazardous disposal only.

Liquids

It may be cost effective to lab pack compatible containers in oversized drums or combine similar or compatible liquids in a drum for offsite disposal. At the present time, the costs for incinerating many types of chemical waste are relatively low, and disposal of non-radioactive waste in this manner does not have to address possible land disposal restrictions.

Biological Waste

Past disposal practices at the LLRBS included disposal of animal carcasses, animal wastes, and incinerator ash from thermal treatment of animal carcasses. This waste will be segregated, sampled, and analyzed to determine proper disposal options. Intact remains and wastes may be disposed of as low-

level waste, biohazardous waste, or incinerated and disposed as low-level waste or non-hazardous solid waste, pending analytical results. Incinerator ash excavated may likewise be disposed as low-level waste or non-hazardous solid waste as determined by laboratory results.

3.4.2.6 Viability of Excavation

Effectiveness: Mechanical excavation is effective for removal of contaminated soils and debris. Excavation of the contaminated material is the most effective solution for eliminating long-term risk from the site. However, handling of the contaminated material during excavation, characterization, treatment, and disposal may cause a short-term risk to workers and the surrounding environment if proper safety precautions are not followed. Depending on the type of materials encountered during excavation, additional process options may include radiological scanning, dewatering, waste-water treatment, manual sorting, magnetic sorting, and/or screening/sizing of the waste. Excavation of the waste pits will assist in meeting the unrestricted future use goal.

Implementability: The equipment necessary for the removal of soils and debris is conventional and readily available. An interim on-site waste storage facility probably would be required to temporarily house the waste during excavation and laboratory analysis prior to offsite disposal.

Cost: Excavation of the buried waste pits would require significant costs and would be highly dependent on the final volume exhumed and characteristics of the wastes. For evaluation of the alternatives at this stage of analysis it is estimated that 41,250 ft^3 of buried waste will be generated and will require disposal as low-level waste.

Mechanical excavation of the buried waste aids in meeting the unrestricted future use requirement for the site, and is therefore retained as a process option for the LLRBS.

3.5 Analysis of Viable Alternatives

As directed under 40 CFR 300.430(e)(7), a variety of alternatives were presented and screened earlier in this section. Four (4) viable alternatives (including the No Action alternative) are carried forward for further evaluation and analysis in this subsection.

3.5.1 Evaluation Criteria

The technologies and process options identified as potentially applicable to the LLRBS are evaluated based on their effectiveness, implementability, and cost [as per 40 CFR 300.430(e)(7)]. The objective of

this screening step is to select representative process options for each technology and thereby simplify the subsequent comparative analysis of alternatives in Section 4. This process limits the number of options used in the alternative development without losing the flexibility of reevaluating these options at a later phase in the process.

The following is a brief description of the screening criteria effectiveness, implementability, and cost. A detailed description of each process option retained, as well as a brief discussion of relevant aspects of its effectiveness, implementability, and cost is then presented.

3.5.1.1 Effectiveness

This criterion focuses on the degree to which an alternative minimizes residual risks and affords long-term protection; complies with ARARs; achieves long-term effectiveness and permanence; reduces toxicity, mobility, or volume through treatment; and minimizes short-term impacts. Alternatives providing significantly less effectiveness than other, more promising alternatives are eliminated. Alternatives that do not provide adequate protection of human health and the environment are eliminated from further consideration.

Overall Protection of Human Health and the Environment

Alternatives are assessed to determine whether they can adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks posed by hazardous and/or radioactive substances, pollutants, or contaminants present at the site. This is accomplished by eliminating, reducing, or controlling exposures to levels determined during establishment of remediation goals. Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

Compliance with ARARs

The alternatives are assessed to determine whether they attain ARARs under Federal and State environmental laws, or provide grounds for a waiver under 40 CFR 300.430(f)(1)(ii)(C).

Long-Term Effectiveness and Permanence

Alternatives are assessed for their long-term effectiveness and permanence they yield, along with the degree of uncertainty that they will prove successful. The effectiveness of the alternative is evaluated in

terms of the magnitude of risk from residual contamination or untreated wastes remaining on site at the conclusion of the action. The adequacy and reliability of post action site controls, which are necessary to ensure the continuing effectiveness of a completed action, are-also considered.

Reduction of Toxicity, Mobility, or Volume Through Treatment

The degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume is assessed, including how treatment is used to address the principal threats posed by the LLRBS. Consideration of this evaluation criterion is a result of EPA's policy preference for selecting alternatives that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances.

Short-Term Effectiveness

The short-term impacts of the alternatives are assessed to determine the short-term risks to the community surrounding the site, the potential impacts on workers during the remedial action, potential environmental impacts of the remedial action, and the time until protection is achieved.

3.5.1.2 Implementability

This criterion focuses on the technical and administrative feasibility, availability of the technologies each alternative would employ, and the likelihood of state and community acceptance. Alternatives that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period of time may be eliminated from further consideration.

Technical Feasibility

The ability of the technology proposed to implement the removal action must be assessed. The reliability of the technology is also a concern, as technical problems associated with implementation may impact the schedule. Potential impacts on the local community during construction operations are also evaluated. Certain technology may be vulnerable to environmental conditions encountered at the site, including local terrain and weather conditions. The technology must also be consistent with future remedial actions to be performed (if any) at the site.

Administrative Feasibility

Administrative feasibility evaluates those activities needed to coordinate the removal action with outside offices and agencies. This evaluation would factor in the need for off-site permits, adherence to non-

environmental laws during the conduct of the removal action, and concerns of other regulatory agencies (possibly outside of EPA, MDE, and NRC).

Availability of Services and Materials

It is necessary to determine if off-site treatment, storage, and disposal capacity; equipment; personnel; services and materials; and other resources necessary to implement an alternative will be available in time to maintain the removal schedule.

State Acceptance

Assessment of state concerns are typically addressed during the comment resolution period of EE/CA development. State concerns may be addressed, to the extent possible, prior to the EE/CA being released for public comment.

Community Acceptance

Community acceptance includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose. This assessment is typically not performed until public comments on the EE/CA are received.

3.5.1.3 Cost

The types of costs that are assessed include capital costs, annual O&M costs, and net present value of capital and O&M costs. For the purposes of this EE/CA, an approximate total cost is presented in Appendix F for each viable excavation alternative. Capital costs include both direct and indirect costs required to implement the alternative. Direct costs consist of construction costs for equipment, materials, labor, transportation, and disposal; indirect costs include those associated with engineering and design, permitting, and construction management. Annual O&M costs include labor and materials associated with the operation and maintenance of the site following the implementation of the alternative; and auxiliary costs such as energy, monitoring, and laboratory costs.

3.5.2 No Action Alternative

3.5.2.1 Description

The No Action alternative is required by 40 CFR 300.430(e)(6) and provides a basis for comparing current site conditions with conditions resulting from implementation of the other alternatives. Under the No Action alternative, no removal actions are implemented and the current status of the site remains unchanged. The wastes are left in place and no additional cover material is added to the soil cover currently present on the LLRBS. EPA and NRC requirements are followed for groundwater monitoring. Periodic releases of contamination, as identified by groundwater monitoring, would potentially continue; thus, natural leaching of contaminants into soils and groundwater would likely continue under this alternative.

The No Action alternative incorporates semi-annual site inspections, maintenance on existing fencing and warning signs, and five-year reviews of the remedial action as required by the NRC and under 40 CFR 300.430(f)(5)(iii)(C) of CERCLA. Semi-annual site inspections are conducted to assure that existing institutional controls are still in place and additional risks are not present at the site. The condition of the security fence and warning signs is documented and any necessary repairs made. Semi-annual groundwater monitoring continues, and the data are compiled and an analysis of contaminant trends conducted. The five-year analysis is documented and submitted to regulatory agencies and the public for review and comment.

Monitoring of the site would include groundwater sampling and analysis to assess the potential for contaminant migration to shallow groundwater and downgradient of the LLRBS. Good monitoring practices dictate a minimum of 1 upgradient and 3 downgradient monitoring wells, or well clusters for multiple water-bearing units, with a maximum downgradient perimeter spacing of 500 feet between wells. These criteria are met utilizing the existing well network at the site. This monitoring well network will allow for comparison of upgradient and downgradient concentrations in the groundwater beneath the LLRBS to determine if additional releases have occurred, and will provide input for potential modeling of contaminant transport further downgradient of the site.

The groundwater at the LLRBS will be monitored using existing monitoring wells, and will meet all EPA/NRC requirements. Currently, there are 13 monitoring wells installed at the LLRBS that may be used to monitor groundwater quality; 4 upgradient and 9 downgradient. Five (5) of these monitoring wells were recently installed as part of the ongoing RI/FS. All 13 wells will be sampled twice yearly for the first 5 years, and annually for the following 25 years.

Semi-annual site inspections will be conducted to assess the condition of the burial area and institutional controls. Inspection of warning signs and fencing will be conducted and routine maintenance will ensure the site is not accessible to unauthorized personnel. Since this alternative does not allow unrestricted use of the site, five-year reviews of this alternative are required under CERCLA.

3.5.2.2 Effectiveness

The No Action alternative is not considered effective in protecting human health or the environment. Periodic sampling of the groundwater, and routine visual site inspections will support evaluation of site conditions, but will not reduce the potential for further migration of contaminants to the groundwater. The effects of natural attenuation of contaminants over time (i.e., biodegradation of contaminants within the pits, and adsorption of contaminants to soil particles) may not, by itself, be protective of human health and the environment. Maintenance of institutional controls will be effective in limiting unauthorized intrusion into the waste pits.

This alternative will not comply with NRC closure requirements for LLW burial sites or with State ARARs pertaining to proper closure of municipal solid waste landfills. The state regulation, which is an action-specific ARAR, requires that municipal solid waste landfills be closed with a low-permeability cap to minimize the infiltration of precipitation. This regulation also requires a gas collection system for the cap, a groundwater monitoring system, and an off-site gas monitoring system. Although this regulation is not considered directly applicable, it is considered relevant and appropriate for the LLRBS, due to the wastes that were disposed in the burial trenches.

This alternative will also not involve treatment to reduce toxicity, mobility, or volume of waste materials. The contents of the site and all current and potential hazards will remain. RESRAD modeling was performed on available data from the LLRBS in April 1998. Results of this modeling indicate that receptor dose and risk are dominated almost entirely by the drinking water ingestion pathway. While no individuals are currently drinking groundwater in the general vicinity of the site, the LLRBS is located in the homogenous sand recharge zone of the Patuxent Aquifer, which is a source of drinking water in Prince Georges County, Maryland.

This alternative will have minimal short-term impacts to workers and USDA staff during its implementation. These risks will be minimized by the use of an approved health and safety plan during monitoring or maintenance activities.

3.5.2.3 Implementability

There are no technical or administrative difficulties associated with this alternative, nor problems with the availability of services and materials since only periodic monitoring is required. Continued use of institutional controls and monitoring of groundwater contamination will not likely be acceptable to state regulatory authorities or the local community. Remediation to allow unrestricted use of the site would likely be required to obtain state and community acceptance.

3.5.2.4 Cost

There are no capital costs associated with this alternative. This alternative will only require O&M costs for groundwater monitoring, semi-annual inspections, institutional controls, and five-year reviews. The estimated present value of these costs over the next 30 years is $300,000.

3.5.3 Limited Excavation of Buried Waste and Surrounding Soil

3.5.3.1 Description

This alternative includes excavation of the contents of the individual waste pits after removal of the 5 feet of clean overburden from above each pit. This technique would progress from one pit to the next, following a pattern of overburden removal, waste removal, sampling, offsite disposal, and backfilling. The waste is sorted from any surrounding soil as part of the removal process. The intact and broken containers, debris, and soil within the pit are removed by the excavator and separated at the surface. Excavation is initiated at each burial location using burial records, aerial photographic records, and potentially geophysical characterization information to focus the removal on the buried waste and limit the amount of lateral soil removed. The bottom and walls of the pit are sampled to confirm contamination has been removed to achieve cleanup goals. Once analytical results indicate the pit is ready to be backfilled, the overburden is then placed back into the pits, and clean fill is then used to fill in the remainder of the pit and contoured to promote runoff and minimize infiltration.

A comparison of shoring/sheet piling techniques and open pit excavation is necessary to determine the most effective means of accessing the pit wastes while minimizing cost. Shoring/sheet piling would require accurate information on the lateral extent of each of the disposal pits in order to ensure all of the waste to be excavated was within the confines of the reinforced sidewalls. Open pit excavation would allow for removal of additional soil and debris from outside the defined limits of the burial pits, as necessary, as onsite personnel proceed with the excavation. Shoring/sheet piling would increase the cost

of the removal action relative to the cost of an open pit excavation. Both of these techniques would require a means of dust control during excavation.

Because of the additional cost of shoring/sheet piling relative to open excavation, and the fact that other site requirements for each technique are similar in cost and scope, it is determined that open pit excavation is the most cost effective. OSHA (Occupational Safety and Health Administration) requirements support this alternative since an open pit excavation with 1:1.5 side slopes will provide a sufficient margin of safety, and will prevent caving-in of the sidewalls.

Removal of soil and waste is performed using standard excavation equipment. The excavator would have a bucket capacity of 1.5 cubic meters (2 cubic yards). The excavator operator and any other personnel within the exclusion zone would be in personnel protection equipment and air purifying respirators. Dust suppressants would be used during excavation to minimize airborne migration of contamination. The faces of the excavation to be left exposed at the end of a work period would be covered with plastic sheeting. Based on previous assumptions, soil above and between the pits is assumed initially clean. In addition, soils which do not exceed the proposed cleanup goals would be used for backfill. The excavation areas will be covered with clean fill, and an additional application of a 0.15 meter-thick layer of top soil and seed to minimize soil erosion.

Excavation with conventional mechanical equipment requires an estimate of how many containers may break as a result of the digging action of the excavator bucket. Given a random distribution of contaminated debris in the pits, it is estimated 25% of the containers may break as a result of crushing by the sides or bottom of the bucket as the bucket is pulled through the pit. An additional 10% are assumed to break as a result of the screening and separation process.

Segregation of Wastes

As soil and waste materials are excavated from the pits, they are segregated according to the type of material (soil or debris/containers), and subsequently separated based on the screening analytical results from VOC detectors and hand-held radiation monitoring equipment, field screening kits for unknown chemicals, and visual evaluation of the debris and containers. Sampling of these stockpiles as described in the next section determines how these materials are disposed.

As noted above, soil and debris are segregated in an area adjacent to the pit into 2 separate stockpiles ("clean" and contaminated) using field analytical screening instruments and visual observation. The contaminated stockpile may contain RCRA non-hazardous or radioactive waste. The volume of the soil

stockpiles is kept relatively small to assist in subsequent sampling activities, and to minimize the potential for mixing clean soil with contaminated soil.

Initial segregation activities also include separation of intact waste containers from debris and soil. Intact waste containers are placed in a staging area after radiation prescreening and visual sorting. The visual sorting is for physical characteristics, such as container type (e.g., bottle, size and glass color), labeling and possible visible chemical properties (e.g., such as crystallization around the bottle cap). Prior to removal of their contents, the intact waste containers recovered from the pits would be pre-screened for radiation to avoid mixing radiological and chemical contaminants. Following initial screening, like wastes will be consolidated into 55-gallon drums. The waste containers are emptied by mechanical crushing, and the liquid contents and remaining container material are drummed separately.

It is assumed that the 3 excavation alternatives will use a waste container crushing technique. (Crushing is defined as any technology that breaks or empties the fluid from waste containers into a larger container, allowing a composite sample to be taken for testing prior to disposal.) One advantage associated with waste container crushing is a reduction in the number of samples to be tested, which speeds up the overall waste characterization. As an alternative to crushing, the containers can be assayed individually, any liquids bulked, and the containers disposed of as non-hazardous waste (RCRA-empty).

Sampling

A thorough sampling and analytical program is developed and implemented to ensure proper categorization of soil and waste, as well as proper disposal of these materials. Representative samples of materials from each segregated waste pile are collected to ensure proper characterization. Assumptions pertaining to the sampling and analytical program include:

- Confirmatory sampling is performed in the excavated areas, with one sample collected from the bottom of each pit, or 50 samples randomly distributed over the bottom of the bulk excavated area. These samples may be taken from the soil contained in an excavator bucket to reduce the potential for worker exposure to site contaminants by entering the pit.

- The initial sampling of segregated and potentially contaminated soils is performed at a frequency of one sample per 25 cubic yards of material, with quick-turnaround fixed laboratory analysis.

- Sampling of the clean soil (overburden) excavated is conducted at a frequency of one sample per 1,000 cubic yards.

- The sampling of segregated debris takes place at a frequency of one sample per 50 cubic yards.

- Sampling of the consolidated liquid waste is conducted at a frequency of one sample per drum. Twenty (20) drums of liquids are assumed to be generated during the field work.

- Field blanks and duplicates are also collected in accordance with standard quality assurance/quality control (QA/QC) methodology.

- The types of analyses performed on the waste materials is based on the reported contents of the pits and the results of the ongoing sampling program at the LLRBS.

Disposal of Wastes

The soil excavated from the pits is sampled and analyzed, and if below the clean up criteria (e.g., soil concentrations in pCi/g equivalent to a 15 mrem/yr or less potential exposure, or below action levels for organic and inorganic constituents), is used as backfill for the pits. The remaining volume of soil required for backfilling the pits and excavation is obtained from clean borrow areas. Non-radioactive soil above the clean up criteria, but designated non-hazardous, is shipped offsite for disposal in a RCRA Subtitle D facility.

Radiological data from collected samples and process knowledge may indicate that soils in the LLRBS are above cleanup levels for individual radionuclides. Based on the available analytical data and historical disposal information, at least a portion of the excavated materials from the LLRBS are expected to be classified as low-level radioactive waste. Radioactive soils would be temporarily stored at the LLRBS and subsequently disposed offsite in a LLW facility.

The process of categorizing the liquids, debris, and any treated residual wastes for offsite disposal also requires several assumptions. Potential waste types include RCRA non-hazardous and radiological waste. Final disposal of waste liquids, debris, and treated wastes is dependent upon analytical data from the segregated materials. Disposal of drums containing liquid waste and debris occurs after characterization of their contents. The drums are sent offsite for any potential treatment and disposal. Empty intact waste containers are considered RCRA-empty, and disposed of as non-hazardous waste.

3.5.3.2 Effectiveness

The Limited Excavation alternative will significantly reduce the risks to human health and the environment by eliminating the contaminant source, and reducing groundwater contamination due to contaminant

migration from the LLRBS. Since the buried waste is the primary source of the groundwater contamination, removal of the waste will eliminate the potential for further releases.

This alternative will comply with Federal and State ARARs. Location-specific clean up criteria will be satisfied, including the protection of any potential nearby wetlands, flood plains, historic sites, and critical habitats.

Limited Excavation will be effective in reducing migration of contamination to groundwater. Removal of the source of contamination should eliminate further impacts to groundwater. In addition, this alternative will not include treatment of the waste. Waste will be segregated and stored for offsite disposal. This type of excavation will also ensure that the source and contaminated soils that pose a continued threat to groundwater degradation are removed, thereby reducing contaminant mobility.

This alternative has the potential for short-term impacts during implementation of the removal action. During excavation of the LLRBS, there is a potential for risks to workers and a limited potential for risk to USDA staff from direct exposure to wastes and dust emissions created by excavation activities. Along with continuous monitoring of waste materials during excavation, these risks will be minimized by utilizing personal protective equipment for workers and dust suppression measures at the site. Risks to the local community are anticipated only due to increased vehicular traffic during transportation of the excavated materials.

3.5.3.3 Implementability

The Limited Excavation alternative is both technically and administratively feasible, and is readily implementable. Contractors are available that have the technical capabilities to provide removal, characterization, temporary onsite storage and offsite disposal of the waste. Health and safety measures will be implemented that will ensure protection of workers and the surrounding environment. This alternative would likely obtain state and community acceptance since it would remove the contaminant source and allow for unrestricted use of the site.

3.5.3.4 Cost

This alternative will require moderate costs for the excavation, with significant waste management costs. Costs for the offsite disposal of the buried waste will be the majority of the total cost for this alternative. There will be no post-action O&M costs at the LLRBS associated with this alternative since the site will be remediated via the RI/FS process to allow unrestricted use. Total cost for this alternative is estimated at $3.4M.

3.5.4 Bulk Excavation of Buried Waste and Surrounding Soil

3.5.4.1 Description

This alternative includes excavation of the overburden from the entire northern section of the LLRBS and subsequent excavation of the contents of the waste pits and intervening soil between each pit. The 5 feet of overburden covering the waste pits is removed, analyzed, then placed back into the pits after the contents have been exhumed if the overburden is determined to be "clean." The excavation proceeds from the outer edge of the burial ground perimeter, and removes intervening soil until all waste materials have been exhumed from all pits.

The excavator accesses the waste by constructing a large open pit with a maximum side slope ratio of 1:1.5. The open excavation allows more direct access to the excavated areas; therefore field personnel can delineate the excavations visually and with survey instruments to confirm the removal of all contaminated material. Confirmation samples from the bottom of the excavation are collected with the excavator bucket and packaged by personnel outside of the excavation.

The containers, debris, and soil within the pit are removed by the excavator and separated at the surface. Clean soil from between the pits will be stockpiled separately. After the contents of all 50 pits and intervening soil have been removed and analyses performed, the clean overburden is placed back in the excavation. Clean fill is then used to fill in the remainder of the excavated area and contoured to promote runoff and minimize infiltration. Materials handling, laboratory analysis, and disposal of excavated materials are managed as in the Limited Excavation alternative described earlier.

3.5.4.2 Effectiveness

The Bulk Excavation alternative will significantly reduce the risks to human health and the environment by removing the debris and contaminated soils from the site. Removal of the buried waste and the surrounding soils will eliminate the sources of groundwater contamination. This alternative will also comply with Federal and State ARARs. Location-specific clean up criteria will be satisfied, including the protection of any potential nearby wetlands, flood plains, historic sites, and critical habitats.

Bulk Excavation will also be effective in eliminating further contamination of groundwater. Risks from direct contact to the buried waste and surrounding soil will also be eliminated. This alternative will not include treatment of the buried waste or the excavated soils. Waste will be segregated, characterized, and stored pending offsite shipment to a RCRA Subtitle D facility, or a LLW disposal site.

This alternative also creates the potential for short term risks to workers. In addition to the short-term risks identified for the Limited Excavation alternative, the increased volume of excavated soil anticipated for Bulk Excavation will increase the potential for construction-related risks to workers.

3.5.4.3 Implementability

This alternative is technically and administratively feasible and implementable utilizing the same technologies required for the Limited Excavation alternative. The waste can be readily sorted, characterized, temporarily stored onsite, and disposed of in an appropriate RCRA Subtitle D or LLW facility. This alternative would likely obtain state and community acceptance since it would remove the contaminant source and allow for unrestricted use of the site.

3.5.4.4 Cost

This alternative will incur the greatest costs. Complete excavation and removal of the buried waste plus the surrounding soil will generate the greatest volume of waste of the 3 excavation alternatives. Because waste disposal costs represent the majority of the overall cost of this alternative, the large volume of waste soil generated makes this the most expensive alternative, with an estimated cost of $6.0M. There will be no post-action O&M costs at the LLRBS associated with this alternative since the site will be remediated via the RI/FS process to allow unrestricted use.

3.5.5 Hybrid Excavation of Buried Waste and Surrounding Soil

3.5.5.1 Description

The Hybrid Excavation alternative represents an option intermediate of the 2 previously discussed. This alternative includes excavation of the overburden from the footprint of all the burial pits first, and then excavation of the contents of individual waste pits. The 5 feet of overburden covering the waste pits is removed, analyzed, then placed back into the pits if determined "clean" after the contents have been exhumed. The overburden excavation proceeds from the outer edge of the burial area perimeter, and removes soil until all 5 feet of cover material has been exhumed. Excavation then proceeds at each individual burial pit.

The excavator accesses the waste by constructing a large open pit with a maximum side slope ratio of 1:1.5. The open excavation allows more direct access to the excavated areas; therefore field personnel can delineate the excavations visually and with survey instruments to confirm the removal of all contaminated material, and collect confirmation samples at the bottom of the excavation.

The containers, debris, and any soil within each pit are removed by the excavator and separated at the surface. Clean soil will be stockpiled separately. After the contents of all 50 pits have been removed, the clean overburden is placed back in the excavation. Clean fill is then used to fill in the remainder of the excavated area and contoured to promote runoff and minimize infiltration. Materials handling, laboratory analysis, and disposal of excavated materials are managed as in the Limited Excavation alternative described earlier.

3.5.5.2 Effectiveness

The Hybrid Excavation alternative will significantly reduce the risks to human health and the environment by removing the wastes and contaminated soils from the site. Removal of the buried waste and the surrounding soils will eliminate the sources of groundwater contamination. This alternative will also comply with Federal and State ARARs. Location-specific clean up criteria will be satisfied, including the protection of any potential nearby wetlands, flood plains, historic sites, and critical habitats.

The Hybrid Excavation alternative will also be effective in eliminating further contamination of groundwater. Risks from direct contact to the buried waste and surrounding soil will also be eliminated. This alternative will not include treatment of the buried waste or the excavated soils. Waste will be segregated, characterized, and stored pending offsite shipment to a RCRA Subtitle D facility, or a LLW disposal site. This alternative also creates the potential for short term risks to workers. In addition to the short-term risks identified for the Limited Excavation alternative, the increased volume of excavated soil anticipated for this alternative (though not as great as the Bulk Excavation alternative) will increase the potential for construction-related risks to workers.

3.5.5.3 Implementability

This alternative is technically and administratively feasible and implementable utilizing the same technologies required for the Limited Excavation alternative. The waste can be readily sorted, characterized, temporarily stored onsite, and disposed of in an appropriate RCRA or LLW facility. This alternative would likely obtain state and community acceptance since it would remove the contaminant source and allow for unrestricted use of the site.

3.5.5.4 Cost

This alternative will incur costs similar to those for the Limited Excavation alternative. Excavation and removal of the buried waste plus all of the overburden soil from the disposal area footprint will generate a greater volume of waste than the Limited Excavation alternative. Because waste disposal costs represent

the majority of the overall cost of this alternative, the larger volume of waste soil generated makes this slightly more expensive than the Limited Excavation alternative, with an estimated cost of $3.5M. There will be no post-action O&M costs at the LLRBS associated with this alternative since the site will be remediated via the RI/FS process to allow unrestricted use.

4. COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

Four (4) alternatives have been selected from the preceding technology screening in Section 3. Each of these 4 alternatives is evaluated in a comparative analysis in this Section to allow selection of a recommended alternative presented in Section 5.

4.1 Effectiveness

4.1.1 Overall Protection of Human Health and the Environment

The No Action alternative will not be protective of human health and the environment, since the risks posed by the site will not be reduced. Source material will not be removed, and the migration of contaminants to the groundwater will only be minimized by natural attenuation. Monitoring the groundwater will only serve to identify whether contaminants are continuing to migrate away from the site.

The 3 excavation alternatives will significantly reduce the risks to human health and the environment by eliminating the contaminant source, and reducing groundwater contamination due to contaminant migration from the LLRBS. Since the buried waste is the primary source of the groundwater contamination, removal of the waste will eliminate the potential for further releases.

4.1.2 Compliance with ARARs

The No Action alternative will not comply with NRC regulations or State ARARs pertaining to proper closure of municipal solid waste landfills. The State regulation, which is an action-specific ARAR, requires that municipal solid waste landfills be closed with a low-permeability cap to minimize the infiltration of precipitation.

The 3 excavation alternatives will comply with Federal and State ARARs. Location-specific clean up criteria will be satisfied, including the protection of any potential nearby wetlands, flood plains, historic sites, and critical habitats.

4.1.3 Long-Term Effectiveness and Permanence

The No Action alternative is not considered effective in protecting human health or the environment. Periodic sampling of the groundwater, and routine visual site inspections will support evaluation of site conditions, but will not reduce the potential for further migration of contaminants to the groundwater. The effects of natural attenuation of contaminants over time (i.e., biodegradation of contaminants within the

landfill, and adsorption of contaminants to soil particles) may not, by itself, be protective of human health and the environment. Maintenance of institutional controls will, however, be effective in limiting unauthorized intrusion into the waste pits.

The 3 excavation alternatives will be effective in reducing migration of contamination to groundwater. Removal of the source of contamination should eliminate further impacts to groundwater.

4.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The No Action alternative will not involve treatment to reduce toxicity, mobility, or volume of waste materials. The contents of the site and all current and potential hazards will remain. RESRAD modeling was performed on available data from the LLRBS in April 1998. Results of this modeling indicate that receptor dose and risk are dominated almost entirely by the drinking water ingestion pathway. While no individuals are currently drinking groundwater in the general vicinity of the site, the LLRBS is located in the homogenous sand recharge zone of the Patuxent Aquifer, which is a source of drinking water in Prince Georges County, Maryland.

The 3 excavation alternatives will not include treatment of the waste. Waste will be segregated and stored for offsite disposal. The excavation alternatives will, however, ensure that the source and contaminated soils that pose a continued threat to groundwater degradation are removed, thereby reducing contaminant mobility.

4.1.5 Short-Term Effectiveness

The No Action alternative will have minimal short-term impacts to workers and USDA staff during its implementation. These risks will be minimized by the use of an approved health and safety plan during monitoring or maintenance activities.

The 3 excavation alternatives have the potential for short-term impacts during implementation of the removal action. During excavation of the LLRBS, there is a potential for risks to workers and a limited potential for risk to USDA staff from direct exposure to wastes and dust emissions created by excavation activities. Along with continuous monitoring of waste materials during excavation, these risks will be minimized by utilizing personal protective equipment for workers and dust suppression measures at the site. Risks to the local community are anticipated only due to increased vehicular traffic during transportation of the excavated materials.

4.2 Implementability

There are no technical or administrative difficulties associated with the No Action alternative, nor problems with the availability of services and materials. Continued use of institutional controls and monitoring of groundwater contamination will not likely be acceptable to state regulatory authorities or the local community.

The 3 excavation alternatives are technically and administratively feasible, and are readily implementable. These alternatives would likely obtain state and community acceptance since they would remove the contaminant source and allow for unrestricted use of the site once remediation is completed following the RI/FS process.

4.3 Cost

The No Action alternative will require O&M costs for groundwater monitoring, semi-annual inspections, institutional controls, and five-year reviews. The estimated present value of these costs over the next 30 years is $300,000.

The Limited Excavation alternative will require moderate costs for the excavation, with significant waste management costs. Costs for the offsite disposal of the buried waste will be the majority of the total cost for this alternative. There will be no post-action O&M costs at the LLRBS associated with this alternative since the site will be remediated via the RI/FS process. Total cost for this alternative is estimated at $3.4M.

The Bulk Excavation alternative will incur the greatest costs. Complete excavation and removal of the buried waste plus the surrounding soil will likely generate the greatest volume of waste of the 3 excavation alternatives. Because waste disposal costs represent the majority of the overall cost of this alternative, the large volume of waste soil generated makes this the most expensive alternative, with an estimated cost of $6.0M. There will be no post-action O&M costs at the LLRBS associated with this alternative since the site will be remediated via the RI/FS process.

The Hybrid Excavation alternative will incur costs similar to those for the Limited Excavation alternative. Because waste disposal costs represent the majority of the overall cost of this alternative, the larger volume of waste soil generated makes this alternative slightly more expensive than Limited Excavation, with an estimated cost of $3.5M. There will be no post-action O&M costs associated with this alternative since the site will be remediated via the RI/FS process.

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5. RECOMMENDATION OF ALTERNATIVE

5.1 Overview

Based on the comparative analysis of the 4 viable alternatives in Section 4, the USDA ARS selected alternative for removal of the contents of the waste pits at the LLRBS area is the Limited Excavation of Buried Waste and Surrounding Soil. This alternative was selected because it assists in meeting the unrestricted future use goal and is the most cost effective of the 3 excavation alternatives. This alternative involves the excavation of buried waste within the limits of the pits, as well as the surrounding soil as necessary, using a hydraulic excavator. The locations and sizes of the target excavation regions in the LLRBS will be based on the results of aerial photography, analysis of any geophysical and analytical data, and visual inspection. Off-site disposal of waste shall be minimized to the extent practical.

Based on existing data, the soils adjacent to the LLRBS are not anticipated to exceed cleanup criteria for radionuclides. Radioactive soils that are excavated from the LLRBS will be temporarily stored at the site and disposed offsite. It is assumed that USDA ARS will continue to operate as a government facility with Federal controls for the next 50 years, at which point the LLRBS could be released for unrestricted use. Implementation of additional controls, such as potential deed restrictions, to ensure safe land use beyond this period will be addressed in the LLRBS ROD.

5.2 Implementation

5.2.1 Engineering Controls

Excavation areas will be subjected to strict engineering controls in order to minimize contaminant migration to clean areas during waste excavation, handling, and stockpiling. Prior to performing work within a given area, an exclusion zone will be established with construction fencing and other measures to control site access. Within the exclusion zone, specific areas will be established for temporary storage of wastes following screening until such wastes can be segregated and characterized to determine their disposal requirements. Temporary storage areas will be kept small and manageable to prevent mixing of waste.

Clean soil will be set aside to be used as backfill for the LLRBS excavation. Soil and debris characterized as waste requiring offsite disposal will be transported to an onsite location for temporary storage until it can be transported offsite. Prior to exiting the exclusion zone , all vehicles transporting waste will be inspected, scanned for radiation, and decontaminated (mainly tires and undercarriage) at a temporary decontamination facility.

Staging areas will be constructed and used for the temporary storage of solid waste and liquid waste-bearing containers. The staging areas will be lined with a geomembrane or an equivalent material to prevent leaching into the underlying soils; spill adsorbent will be readily accessible. During periods of precipitation, staging areas will be covered to prevent entrance of rain.

Dust suppressants, such as water, calcium chloride solution, or other environmentally safe products manufactured for this purpose, will be used during excavation to minimize migration of airborne contamination. Contaminated soil stockpiles and faces of excavations to be left exposed at the end of a work period will be covered with plastic sheeting. Runoff controls will be placed around open excavations and staging areas to prevent entrance of runoff water into excavations and transport of contaminated materials to clean areas.

Onsite conditions will be monitored using radiation meters and photoionization detectors (PIDs) for detecting the presence of radiation and VOCs respectively. Other health and safety measures, such as dosimetry badges, will be implemented to monitor personnel exposure. Health and safety monitoring will be developed in detail during the design phase of this project.

5.2.2 Excavation of Soil and Waste

Open excavations will be used, which will allow personnel to access the excavated areas if necessary to perform surveys with field instruments, and to collect confirmatory samples from the bottom of each pit. The excavator operator and any other personnel within the exclusion zone will be in level C personal protective equipment (PPE) for protection from any dust or vapors which may be present.

The excavator will access the waste mass by using an open pit with a maximum side slope of 1 on vertical to 1.5 on horizontal. This technique eliminates costs associated with confirmatory sampling of excavation sidewalls because the pits will be "over excavated" into clean soils adjacent to the pits to meet the specified slope. For example, the horizontal limits of excavation for a pit that is 10 feet deep would extend an additional 15 feet beyond the pit footprint into clean soil, angled toward the ground surface. This technique also minimizes risks associated with sidewall collapse to workers entering excavations.

The containers, debris, and soils within the pit will be removed by the excavator and separated at pit side. During this process, the excavation will move at a rate which will prevent any liquids encountered as a result of container breakage from infiltrating into the soils below the bottom of the pit. Spill adsorbent will be readily available at all excavations areas and shall be used to adsorb any liquids observed during excavation.

Once pit excavation starts, the excavation will not stop until all waste is removed from the pit area, and the native soils are exposed. Confirmatory samples will be collected from the base of each excavation. Additional excavation and sampling will be performed in an iterative manner until the cleanup goals have been confirmed. Excavated soils which do not exceed these goals, and are not mixed with waste debris or fragments thereof will be stockpiled and used as backfill material for excavations that have been confirmed clean. The remaining portion of excavations will be backfilled with clean fill materials.

5.2.3 Segregation, Characterization, and Disposal of Liquid Wastes

Excavation will be followed by separation of the intact containers from debris and soil. Approximately 35% of the containers are assumed to be broken during the excavation (25%) and screening (10%) activities, and the liquid discharged from the bottles will contaminate the pit soil. The containers which remain intact will be placed in a staging area after pre-screening for radionuclides and waste compatibility, as well as visual sorting. Pre-screening for radiation will prevent the potential mixing of radiological and chemical contaminated wastes; waste compatibility prescreening will prevent mixing potentially reactive wastes. Visual sorting will be used to separate wastes based upon physical characteristics, such as container size, glass color, labeling, and visible chemical properties (i.e., crystallization around the bottle cap). After initial separation, like wastes will be consolidated in a controlled environment to minimize characterization sampling.

5.2.4 Segregation, Characterization, and Disposal of Soil and Debris

Excavated soil and debris will be initially segregated into separate piles near the pit (or groups of pits if multiple excavations occur concurrently). This segregation will be based upon results from organic vapor detectors, hand-held radiation monitoring equipment, and visual evaluation. Separate piles, each with a bottom liner and cover, will be created for each pile of segregated soil and debris. Characterization samples will be initially collected from each pile at the rate of one sample per 25 CY of material, or a minimum of 2 samples per stockpile, and analyzed by an onsite laboratory. Based on these sample results, like wastes can be consolidated into larger stockpiles. Further characterization of soil and debris for chemical and radiological contamination will be conducted once like wastes from all of the pits have been consolidated.

Excavated soils which comply with cleanup goals and are not mixed with waste debris or fragments thereof will be used as backfill material for excavations. The USDA field representative will use professional judgement to reject the use of soil and debris which meet these criteria, but are inappropriate for use as backfill or rough grading material based on their physical characteristics. Materials exceeding these criteria will be disposed offsite at a permitted disposal facility.

Overburden soils and side-slope soils will be initially assumed to be clean. Characterization samples will be collected at a frequency of one sample per 1,000 CY, or a minimum of one sample per stockpile, and analyzed by an onsite laboratory. Soils which comply with cleanup goals will be used as backfill material for excavations.

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Appendix A: Analytical Results Tables

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Table A.1. Radiological Parameters, Low-Level Radiation Burial Site, ENTECH Geoprobe Sampling

Date Collected Matrix	LLRBS-E1-GW 6/30/97 W	Q	LLRBS-E2-GW 6/30/97 W	Q	LLRBS-F2-GW 6/30/97 W	Q	LLRBS-E3-GW 7/1/97 W	Q	LLRBS-F1-GW 6/30/97 W	Q	LLRBS-T1-GW 6/30/97 W	Q
Radiological Parameters												
Gross Alpha (pCi/L)	62.19	4.10	142.18	5.01	44.16	2.71	157.13	6.00	162.19	5.85	148.35	5.38
Gross Beta (pCi/L)	47.20	2.63	65.60	2.01	27.81	1.34	58.04	1.84	84.49	2.51	75.17	1.94
Tritium (pCi/L)	70.27	138.77	400.90	151.83	463.96	154.63	3860.81	251.31	-8.11	134.81	24.32	137.10

Q = Uncertainty

Field Sample I.D. Date Collected Matrix	LLRBS-H2-GW 6/30/97 W	Q	LLRBS-G2-GW 6/30/97 W	Q	LLRBS-G3-GW 7/1/97 W	Q	LLRBS-H3-GW 7/1/97 W	Q	MW2GP-75E 7/2/97 W	Q	MW2GP-10E 7/2/97 W	Q
Radiological Parameters												
Gross Alpha (pCi/L)	97.29	4.66	123.96	4.89	147.90	5.38	74.11	3.30	127.43	5.19	88.03	4.51
Gross Beta (pCi/L)	60.23	2.00	66.55	2.18	74.86	2.22	57.88	1.99	94.90	2.61	40.62	1.71
Tritium (pCi/L)	132.43	141.96	148.65	142.43	290.99	147.50	543.69	156.39	73.87	138.58	4652.25	265.98

Q = Uncertainty

Field Sample I.D. Date Collected Matrix	MW2GP-75S 7/2/97 W	Q	MW2GP-75N 7/2/97 W	Q	E2F1-GW 7/2/97 W	Q	LLRBS10-G4-GW 7/2/97 W	Q	E2G2-GW 7/2/97 W	Q	LLRBS-BG2-GW 7/3/97 W	Q
Radiological Parameters												
Gross Alpha (pCi/L)	49.27	4.16	62.51	3.64	140.15	6.06	118.64	4.13	200.71	7.87	114.56	4.48
Gross Beta (pCi/L)	26.70	1.68	33.78	1.47	85.12	3.16	58.50	1.68	108.15	3.52	73.51	2.24
Tritium (pCi/L)	1845.95	195.04	312.61	144.11	222.52	140.66	545.95	152.83	230.18	141.07	93.24	134.36

Q = Uncertainty

Field Sample I.D. Date Collected Matrix	LRLBS-C0-GW 7/3/97 W	Q	LLRBS-D1-GW 7/3/97 W	Q	LLRBS-E4-GW 7/3/97 W	Q	LLRBS-F2-83W 7/3/97 W	Q	LLRBS-I3-GW 7/7/97 W	Q	LLRBS-J3-GW 7/7/97 W	Q
Radiological Parameters												
Gross Alpha (pCi/L)	45.12	2.96	181.82	7.06	58.21	3.21	199.18	6.56	77.94	3.40	37.90	3.34
Gross Beta (pCi/L)	24.72	2.03	55.98	2.83	34.40	1.99	85.28	2.49	52.32	1.64	34.53	1.98
Tritium (pCi/L)	47.30	133.41	185.14	139.00	148.65	137.97	741.44	161.27	450.45	159.99	546.85	163.16

Q = Uncertainty

Table A.1. Radiological Parameters, Low-Level Radiation Burial Site, ENTECH Geoprobe Sampling

Field Sample I.D.	LLRBS-I4-GW		LLRBS-H4-GW		LLRBS-F4-GW		LLRBS-C2-GW		LLRBS-K4-GW		LLRBS-J2-GW	
Date Collected	7/7/97		7/7/97		7/7/97		7/7/97		7/7/97		7/7/97	
Matrix	W	Q	W	Q	W	Q	W	Q	W	Q	W	Q
Radiological Parameters												
Gross Alpha (pCi/L)	38.93	2.81	64.75	3.20	155.68	5.70	64.70	3.49	66.98	4.08	93.58	5.52
Gross Beta (pCi/L)	29.59	1.69	33.25	1.44	55.15	1.99	36.01	1.71	50.94	2.44	54.70	2.80
Tritium (pCi/L)	215.77	151.31	659.01	167.54	39.64	144.46	-54.05	140.87	335.59	155.70	59.91	145.18

Q = Uncertainty

Field Sample I.D.	LLRBS-G2H2-GW		LLRBS-MW275NE		LLRBS-110N-GW		LLRBS-C3-GW		LLRBS-K3-GW		LLRBS-L3-GW	
Date Collected	7/7/97		7/7/97		7/7/97		7/7/97		7/7/97		7/7/97	
Matrix	W	Q	W	Q	W	Q	W	Q	W	Q	W	Q
Radiological Parameters												
Gross Alpha (pCi/L)	130.21	6.24	141.20	6.43	316.38	10.02	24.46	1.78	24.78	2.02	22.42	2.91
Gross Beta (pCi/L)	84.24	3.15	74.39	2.91	132.02	3.83	9.17	0.66	21.82	1.23	33.37	2.72
Tritium (pCi/L)	105.86	147.10	-32.43	141.64	10.81	143.39	84.68	154.77	26.58	152.02	416.22	166.28

Q = Uncertainty

Field Sample I.D.	LLRBS-G5-GW		LLRBS-I5-GW		LLRBS-H2-GW		LLRBS-L2-GW		LLRBS-K5-GW		LLRBS-H5-GW	
Date Collected												
Matrix	W	Q	W	Q	W	Q	W	Q	W	Q	W	Q
Radiological Parameters												
Gross Alpha (pCi/L)	178.88	6.73	101.56	5.66	71.51	3.75	123.93	6.09	62.83	4.04	140.04	5.17
Gross Beta (pCi/L)	131.36	3.55	60.95	2.41	67.38	2.21	64.12	2.70	33.42	2.38	57.61	1.72
Tritium (pCi/L)	1851.80	210.10	461.71	167.75	-74.77	148.22	130.18	146.18	78.83	153.81	2011.26	213.98

Q = Uncertainty

Field Sample I.D.	LLRBS-SF1-GW		LLRBS-SF3-GW		LLRBS-B3-GW		LLRBS-B6-GW		LLRBS-E6-GW		LLRBS-H6-GW	
Date Collected												
Matrix	W	Q	W	Q	W	Q	W	Q	W	Q	W	Q
Radiological Parameters												
Gross Alpha (pCi/L)	115.25	4.88	99.80	4.05	141.47	4.56	65.29	3.95	100.80	4.39	74.62	4.07
Gross Beta (pCi/L)	44.60	2.09	51.78	1.93	49.47	1.52	20.37	1.41	41.04	1.79	39.21	1.83
Tritium (pCi/L)	77.93	140.26	55.86	139.29	150.45	143.27	55.41	139.40	93.24	141.16	162.61	143.41

Q = Uncertainty

Table A.1. Radiological Parameters, Low-Level Radiation Burial Site,
ENTECH Geoprobe Sampling

Field Sample I.D.	LLRBS-I1-GW		LLRBS-N2-GW		LLRBS-SF4-GW		LLRBS-SF5-GW		LLRBS-N4-GW		LLRBS-B4-GW	
Date Collected												
Matrix	W	Q	W	Q	W	Q	W	Q	W	Q	W	Q
Radiological Parameters												
Gross Alpha (pCi/L)	58.56	3.12	25.05	3.01	82.42	4.18	114.82	5.11	20.58	2.56	92.01	3.06
Gross Beta (pCi/L)	37.16	1.66	18.73	2.39	35.34	2.04	44.02	2.32	16.37	1.85	40.37	1.27
Tritium (pCi/L)	74.77	140.00	105.41	141.09	40.09	138.34	77.03	140.18	118.02	141.91	50.90	139.02

Q = Uncertainty

Low-Level Radiation Burial Site, Positive Analytical Results

Notes
ND - Not detected
NA - Not analyzed
Results in bold equal or exceed RBC levels.
Shaded results equal or exceed BTAG screening levels.

Definition of Qualifiers
B - Not detected substantially above the level reported in laboratory or field blanks.
J - Analyte present. Reported value may or may not be accurate or precise.
K - Analyte present. Reported value is biased high.
L - Analyte present. Reported value is biased low.

Table A.2. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997- Groundwater

Field Sample I.D.	Method Detection Limit	RBC[1] 4/15/98		MW1-25		MW2-30		MW3		MW4-38		MW5-30	
Date Collected				10/22/97		10/20/97		10/16/97		10/20/97		10/20/97	
Date Analyzed				11/4/97		10/24/97		10/24/97		10/24/97		10/24/97	
Matrix	Water	Tap Water		Water		Water		Water		Water		Water	
Reporting Units	ug/L	ug/L	Basis	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
VOCs (SW8260A)													
Acetone	1.6	370	N	ND		ND		ND		ND		ND	
Methylene chloride	0.18	4.1	C	**4.1**	B	2.7	B	2.0	B	1.5	B	1.4	B
Chloroform	0.08	0.15	C	ND		**1.9**	B	ND		ND		ND	
m + p-Xylene	0.44	1,200	N	ND		ND		ND		ND		ND	

Field Sample I.D.	Method Detection Limit	RBC[1] 4/15/98		MW1-25		MW2-30		MW3		MW4-38		MW5-30	
Date Collected				10/22/97		10/20/97		10/16/97		10/20/97		10/20/97	
Date Extracted				10/27/97		10/27/97		10/22/97		10/27/97		10/27/97	
Date Analyzed				11/11/97		11/11/97		10/29/97		11/11/97		11/11/97	
Matrix	Water	Tap Water		Water		Water		Water		Water		Water	
Reporting Units	ug/L	ug/L	Basis	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
SVOCs (SW8270B)													
Di-n-butylphthalate	0.90	370	N	ND		ND		ND		1.1	J	ND	
Bis (2-ethylhexyl)phthalate	2.21	4.8	C	ND		1.1	J	ND		1.3	J	1.1	J

Field Sample I.D.	Method Detection Limit	RBC[1] 4/15/98		MW1-25		MW2-30		MW3		MW4-38		MW5-30	
Date Collected				10/22/97		10/20/97		10/16/97		10/20/97		10/20/97	
Date Extracted				10/28/97		10/22/97		10/22/97		10/22/97		10/22/97	
Date Analyzed				10/30/97		10/24/97		10/24/97		10/24/97		10/24/97	
Matrix	Water	Tap Water		Water		Water		Water		Water		Water	
Reporting Limit'	ug/L	ug/L	Basis	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
Pest/PCBs (SW8081)													
delta-BHC	0.003	Not Available		ND		ND		ND		ND		ND	
4,4'-DDD	0.002	0.28	C	ND		ND		ND		ND		ND	
4,4'-DDT	0.004	0.2	C	0.060	J	ND		ND		ND		ND	
Methoxychlor	0.022	18	N	0.066	J	ND		ND		ND		ND	

Notes:

1. EPA Region III RBC Table, 4/15/98. Non-carcinogens are evaluated against one-tenth the RBC values.

Table A.2. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997- Groundwater

Field Sample I.D.	MW6-25		MW7-32		MW8		MW9-41		MW10-60		MW11-40		MW12-25	
Date Collected	10/21/97		10/22/97		10/17/97		10/17/97		10/17/97		10/20/97		10/20/97	
Date Analyzed	10/24/97		11/4/97		10/24/97		10/24/97		10/24/97		10/24/97		10/24/97	
Matrix	Water		Water		Water		Water		Water		Water		Water	
Reporting Units	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
VOCs (SW8260A)														
Acetone	ND		4.8	L	ND		ND		ND		ND		ND	
Methylene chloride	1.4	B	**5.5**	B	2.4	B	2.0	B	1.9	B	2.4	B	1.3	B
Chloroform	ND		**16.0**		ND		ND		ND		ND		**29.0**	B
m + p-Xylene	ND		ND		ND		ND		ND		ND		1.1	

Field Sample I.D.	MW6-25		MW7-32		MW8		MW9-41		MW10-60		MW11-40		MW12-25	
Date Collected	10/21/97		10/22/97		10/17/97		10/17/97		10/17/97		10/20/97		10/20/97	
Date Extracted	10/27/97		10/27/97		10/22/97		10/22/97		10/22/97		10/27/97		10/27/97	
Date Analyzed	11/1/97		11/12/97		10/29/97		10/29/97		10/29/97		10/31/97		10/31/97	
Matrix	Water		Water		Water		Water		Water		Water		Water	
Reporting Units	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
SVOCs (SW8270B)														
Di-n-butylphthalate	ND		ND		ND		ND		ND		ND		ND	
Bis (2-ethylhexyl)phthalate	ND		1.5	J	ND		ND		ND		ND		ND	

Field Sample I.D.	MW6-25		MW7-32		MW8		MW9-41		MW10-60		MW11-40		MW12-25	
Date Collected	10/21/97		10/22/97		10/17/97		10/17/97		10/17/97		10/20/97		10/20/97	
Date Extracted	10/22/97		10/28/97		10/22/97		10/22/97		10/22/97		10/22/97		10/22/97	
Date Analyzed	10/24/97		10/30/97		10/24/97		10/24/97		10/24/97		10/24/97		10/24/97	
Matrix	Water		Water		Water		Water		Water		Water		Water	
Reporting Limit'	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
Pest/PCBs (SW8081)														
delta-BHC	ND		0.033	J	ND		ND		ND		ND		ND	
4,4'-DDD	ND		0.051	J	ND		ND		ND		ND		ND	
4,4'-DDT	ND		ND		ND		ND		ND		ND		ND	
Methoxychlor	ND		ND		ND		ND		ND		ND		ND	

Table A.2. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997- Groundwater

	Sample		Duplicate	
Field Sample I.D.	MW13-20		MW15	
Date Collected	10/21/97		10/21/97	
Date Analyzed	11/11/97		10/24/97	
Matrix	Water		Water	
Reporting Units	ug/L	Qual	ug/L	Qual
VOCs (SW8260A)				
Acetone	ND		ND	
Methylene chloride	1.2		1.2	B
Chloroform	ND		ND	
m + p-Xylene	ND		ND	

	Sample		Duplicate	
Field Sample I.D.	MW13-20		MW15	
Date Collected	10/21/97		10/21/97	
Date Extracted	10/27/97		10/27/97	
Date Analyzed	11/11/97		11/11/97	
Matrix	Water		Water	
Reporting Units	ug/L	Qual	ug/L	Qual
SVOCs (SW8270B)				
Di-n-butylphthalate	ND		ND	
Bis (2-ethylhexyl)phthalate	1.0	J	ND	

	Sample		Duplicate	
Field Sample I.D.	MW13-20		MW15	
Date Collected	10/21/97		10/21/97	
Date Extracted	10/22/97		10/22/97	
Date Analyzed	10/24/97		10/24/97	
Matrix	Water		Water	
Reporting Limit'	ug/L	Qual	ug/L	Qual
Pest/PCBs (SW8081)				
delta-BHC	ND		ND	
4,4'-DDD	ND		ND	
4,4'-DDT	ND		ND	
Methoxychlor	ND		ND	

Table A.2. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997- Groundwater

Field Sample I.D. Date Collected Date Prepared Date Analyzed Matrix Reporting Units	Method Detection Limit Water ug/L	RBC [1] 4/15/98 Tap Water ug/L	Basis	MW1-25 10/22/97 11/3/97 11/10/97 Water ug/L	Qual	MW2-30 10/20/97 10/25/97 10/29/97 Water ug/L	Qual	MW3 10/16/97 10/28/97 10/28/97 Water ug/L	Qual	MW4-38 10/20/97 10/25/97 10/29/97 Water ug/L	Qual	MW5-30 10/20/97 10/25/97 10/29/97 Water ug/L	Qual
Total Metals (SW6010A)													
Aluminum	16.2	3,700	N	410	K	157	B	134	B	169	B	245	B
Antimony	2.7	1.5	N	ND		**4.0**	B	**4.1**	B	**3.4**	B	**3.0**	B
Arsenic	3.1	0.045	C	ND		ND		**3.8**	J	ND		ND	
Barium	0.78	260	N	79.7	J	113		65.5	J	52.8	B	132	
Cadmium	0.30	1.8	N	ND		ND		0.45	J	ND		ND	
Calcium	18.6	Not Available		3,030		5,680		3,760		3,630		7,170	
Chromium	0.9	18	N	2.1	J	3.4	B	2.1	B	1.4	B	1.4	B
Cobalt	3.6	220	N	5.5	J	5.7	B	10	B	ND		ND	
Copper	0.8	150	N	2.9	B	2.6	B	4.9	B	ND		1.7	B
Iron	46.5	1,100	N	258	K	430	J	69.8	B	419	J	193	J
Lead	2.3	15 [2]		7.2	J	3.3	B	8.3	B	5.7	B	2.9	B
Magnesium	8.7	Not Available		4,760		4,440		4,130		2,680		4,680	
Manganese	0.33	73	N	25.2	J	39.1		22.3	B	18.6	B	30.8	
Nickel	0.93	73	N	3.8	B	6.4	B	7.1	B	2.6	B	4.6	B
Potassium	25.50	Not Available		5,090		2,270		961	J	4,890		3,780	
Selenium	3.5	18	N	ND		ND		ND		ND		ND	
Silver	0.63	18	N	ND		1.6	B	1.5	B	2.0	B	1.5	B
Sodium	245	Not Available		6,390		10,300	J	18,200		6,720	J	13,000	J
Thallium	5.1	0.26	N	ND		ND		**5.2**	B	**6.4**	B	ND	
Vanadium	0.51	26	N	2.2	B	1.6	B	2.6	B	ND		ND	
Zinc	14.8	1,100	N	15.6	J	ND		20.2	J	ND		ND	

Notes:

1. EPA Region III RBC Table, 4/15/98. Non-carcinogens are evaluated against one-tenth the RBC values.
2. Federal Action Level for lead.

Table A.2. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997- Groundwater

Field Sample I.D.	MW6-25		MW7-32		MW8		MW9-41		MW10-50		MW11-40		MW12-25	
Date Collected	10/21/97		10/22/97		10/17/97		10/17/97		10/17/97		10/20/97		10/20/97	
Date Prepared	11/3/97		11/3/97		10/28/97		10/28/97		10/28/97		10/25/97		10/25/97	
Date Analyzed	11/4/97		11/4/97		10/28/97		10/28/97		10/28/97		10/29/97		10/29/97	
Matrix	Water		Water		Water		Water		Water		Water		Water	
Reporting Units	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
Total Metals (SW6010A)														
Aluminum	120	B	855	K	365	B	575	B	3,380		**4,340**	J	204	B
Antimony	ND		ND		ND		**4.4**	B	**4.3**	B	ND		**4.4**	B
Arsenic	ND		ND		ND		ND		**4.9**	J	**3.8**	B	ND	
Barium	63.9	B	86.7	J	95.5	J	68.3	J	38.4	B	105		120	
Cadmium	ND		ND		0.37	J	0.34	J	1.3	J	0.88	B	ND	
Calcium	4,120		4,450		6,240		3,750		5,240		6,790		4,010	
Chromium	1.3	B	4.0	J	2.5	B	10.1		17.8		17.6	B	2.5	B
Cobalt	ND		8.0	J	8.0	B	5.8	B	4.0	B	4.9	B	7.7	B
Copper	2.5	B	5.1	J	3.5	B	5.2	B	26.8		18.4	J	2.7	B
Iron	63.5	J	**1,320**	K	124	B	314	B	**5,750**		**6,320**	J	341	J
Lead	2.8	B	5.5	J	8.4	B	4.5	B	7.8	B	9.3	B	6.1	B
Magnesium	3,360		5010		6,300		3,640		1,860		4,610		5,180	
Manganese	23.2	B	**87.7**	J	38.0		34.0		36.3		**89.4**		**122**	
Nickel	2.9	B	7.4	J	9.2	B	10.4	B	7.0	B	10.6	B	6.0	B
Potassium	5,820		2,070		1,410		953	J	29,500		6,810		2,100	
Selenium	ND		ND		ND		3.6	J	ND		ND		4.1	J
Silver	ND		0.95	J	0.93	B	0.98	B	1.3	B	1.7	B	2.4	B
Sodium	8,190	J	9,390		24,400		8,230		18,200		11,600	J	8,650	J
Thallium	ND		ND		ND		ND		ND		ND		ND	
Vanadium	ND		3.6	B	1.7	B	1.6	B	**26.5**		22.0		2.1	B
Zinc	ND		15.5	J	23.1	J	40.2	J	38.6	J	21.6		ND	

Table A.2. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997- Groundwater

	Sample		Duplicate	
Field Sample I.D.	MW13-20		MW15	
Date Collected	10/21/97		10/21/97	
Date Prepared	11/3/97		11/3/97	
Date Analyzed	11/4/97		11/4/97	
Matrix	Water		Water	
Reporting Units	ug/L	Qual	ug/L	Qual
Total Metals (SW6010A)				
Aluminum	174	B	171	B
Antimony	ND		ND	
Arsenic	ND		ND	
Barium	87.9	J	88.8	J
Cadmium	ND		0.32	B
Calcium	5,650		5,720	
Chromium	1.5	B	1.3	B
Cobalt	5.6	B	5.1	B
Copper	5.6	B	5.8	B
Iron	106	J	102	J
Lead	11.0	B	10.2	B
Magnesium	5,770		5,860	
Manganese	60.8		60.6	
Nickel	7.7	B	7.8	B
Potassium	1,670		1,680	
Selenium	4.0	J	ND	
Silver	ND		ND	
Sodium	17,200	J	17,400	J
Thallium	ND		ND	
Vanadium	0.61	B	ND	
Zinc	ND		15.1	J

Table A.2. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997 - Groundwater

Field Sample I.D.	Method Detection Limit	Tap Water RBC		BA18-MW1		BA18-MW2		Background BA18-MW3		BA18-MW4		BA18-MW5		BA18-MW6	
Date Sampled				10/22/97		10/20/97		10/16/97		10/20/97		10/20/97		10/21/97	
Date Prepared				11/3/97		10/25/97		10/28/97		10/25/97		10/25/97		11/3/97	
Date Analyzed				11/10/97		10/29/97		10/28/97		10/29/97		10/29/97		11/4/97	
Matrix	Water	Water		GW		GW		GW		GW		GW		GW	
Reporting Units	ug/L	ug/L	Basis	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
Total Metals (SW6010A/SW7470)															
Aluminum	16.2	3,700	N	410	K	157	B	134	B	169	B	245	B	120	B
Antimony	2.7	1.5	N	ND		**4.0**	B	**4.1**	B	**3.4**	B	**3.0**	B	ND	
Arsenic	3.1	0.045	C	ND		ND		**3.8**	J	ND		ND		ND	
Barium	0.78	260	N	79.7	J	113		65.5	J	52.8	B	132		63.9	B
Cadmium	0.30	1.8	N	ND		ND		0.45	J	ND		ND		ND	
Calcium	18.6	Not Available		3,030		5,680		3,760		3,630		7,170		4,120	
Chromium	0.9	18	N	2.1	J	3.4	B	2.1	B	1.4	B	1.4	B	1.3	B
Cobalt	3.6	220	N	5.5	J	5.7	B	10	B	ND		ND		ND	
Copper	0.8	150	N	2.9	B	2.6	B	4.9	B	ND		1.7	B	2.5	B
Iron	46.5	1,100	N	258	K	430	J	69.8	B	419	J	193	J	63.5	J
Lead	2.3	15 [2]		7.2	J	3.3	B	8.3	B	5.7	B	2.9	B	2.8	B
Magnesium	8.7	Not Available		4,760		4,440		4,130		2,680		4,680		3,360	
Manganese	0.33	73	N	25.2	J	39.1		22.3	B	18.6	B	30.8		23.2	B
Nickel	0.93	73	N	3.8	B	6.4	B	7.1	B	2.6	B	4.6	B	2.9	B
Potassium	25.50	Not Available		5,090		2,270		961	J	4,890		3,780		5,820	
Selenium	3.5	18	N	ND		ND		ND		ND		ND		ND	
Silver	0.63	18	N	ND		1.6	B	1.5	B	2.0	B	1.5	B	ND	
Sodium	245	Not Available		6,390		10,300	J	18,200		6,720	J	13,000	J	8,190	J
Thallium	5.1	0.26	N	ND		ND		**5.2**	B	**6.4**	B	ND		ND	
Vanadium	0.51	26	N	2.2	B	1.6	B	2.6	B	ND		ND		ND	
Zinc	14.8	1,100	N	15.6	J	ND		20.2	J	ND		ND		ND	

Notes:
1. RBC Table 4/15/98, one-tenth values
2. Federal Action Level for lead.

Table A.2. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997 - Groundwater

Field Sample I.D.	Method Detection Limit	Tap Water RBC[1]		BA18-MW7		BA18-MW8		Background BA18-MW9		Background BA18-MW10		BA18-MW11		BA18-MW12	
Date Sampled				10/22/97		10/17/97		10/17/97		10/17/97		10/20/97		10/20/97	
Date Prepared				11/3/97		10/28/97		10/28/97		10/28/97		10/25/97		10/25/97	
Date Analyzed				11/4/97		10/28/97		10/28/97		10/28/97		10/29/97		10/29/97	
Matrix	Water	Water		GW		GW		GW		GW		GW		W	
Reporting Units	ug/L	ug/L	Basis	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
Total Metals (SW6010A/SW7470)															
Aluminum	16.2	3,700	N	855	K	365	B	575	B	3,380		**4,340**	J	204	B
Antimony	2.7	1.5	N	ND		ND		**4.4**	B	**4.3**	B	ND		**4.4**	B
Arsenic	3.1	0.045	C	ND		ND		ND		**4.9**	J	**3.8**	B	ND	
Barium	0.78	260	N	86.7	J	95.5	J	68.3	J	38.4	B	105		120	
Cadmium	0.30	1.8	N	ND		0.37	J	0.34	J	1.3	J	0.88	B	ND	
Calcium	18.6	Not Available		4,450		6,240		3,750		5,240		6,790		4,010	
Chromium	0.9	18	N	4.0	J	2.5	B	10.1		17.8		17.6	B	2.5	B
Cobalt	3.6	220	N	8.0	J	8.0	B	5.8	B	4.0	B	4.9	B	7.7	B
Copper	0.8	150	N	5.1	J	3.5	B	5.2	B	26.8		18.4	J	2.7	B
Iron	46.5	1,100	N	**1,320**	K	124	B	314	B	**5,750**		**6,320**	J	341	J
Lead	2.3	15[2]		5.5	J	8.4	B	4.5	B	7.8	B	9.3	B	6.1	B
Magnesium	8.7	Not Available		5010		6,300		3,640		1,860		4,610		5,180	
Manganese	0.33	73	N	**87.7**	J	38.0		34.0		36.3		**89.4**		**122**	
Nickel	0.93	73	N	7.4	J	9.2	B	10.4	B	7.0	B	10.6	B	6.0	B
Potassium	25.50	Not Available		2,070		1,410		953	J	29,500		6,810		2,100	
Selenium	3.5	18	N	ND		ND		3.6	J	ND		ND		4.1	J
Silver	0.63	18	N	0.95	J	0.93	B	0.98	B	1.3	B	1.7	B	2.4	B
Sodium	245	Not Available		9,390		24,400		8,230		18,200		11,600	J	8,650	J
Thallium	5.1	0.26	N	ND		ND		ND		ND		ND		ND	
Vanadium	0.51	26	N	3.6	B	1.7	B	1.6	B	**26.5**		22.0		2.1	B
Zinc	14.8	1,100	N	15.5	J	23.1	J	40.2	J	38.6	J	21.6		ND	

Notes:
1. RBC Table 4/15/98, one-tenth values
2. Federal Action Level for lead.

Table A.2. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997 - Groundwater

				Sample		Duplicate	
Field Sample I.D.	Method Detection Limit	Tap Water RBC		BA18-MW13		BA18-MW15	
Date Sampled				10/21/97		10/21/97	
Date Prepared				11/3/97		11/3/97	
Date Analyzed				11/4/97		11/4/97	
Matrix	Water	Water		GW		GW	
Reporting Units	ug/L	ug/L	Basis	ug/L	Qual	ug/L	Qual
Total Metals (SW6010A/SW7470)							
Aluminum	16.2	3,700	N	174	B	171	B
Antimony	2.7	1.5	N	ND		ND	
Arsenic	3.1	0.045	C	ND		ND	
Barium	0.78	260	N	87.9	J	88.8	J
Cadmium	0.30	1.8	N	ND		0.32	B
Calcium	18.6	Not Available		5,650		5,720	
Chromium	0.9	18	N	1.5	B	1.3	B
Cobalt	3.6	220	N	5.6	B	5.1	B
Copper	0.8	150	N	5.6	B	5.8	B
Iron	46.5	1,100	N	106	J	102	J
Lead	2.3	15 [2]		11.0	B	10.2	B
Magnesium	8.7	Not Available		5,770		5,860	
Manganese	0.33	73	N	60.8		60.6	
Nickel	0.93	73	N	7.7	B	7.8	B
Potassium	25.50	Not Available		1,670		1,680	
Selenium	3.5	18	N	4.0	J	ND	
Silver	0.63	18	N	ND		ND	
Sodium	245	Not Available		17,200	J	17,400	J
Thallium	5.1	0.26	N	ND		ND	
Vanadium	0.51	26	N	0.61	B	ND	
Zinc	14.8	1,100	N	ND		15.1	J

Notes:
1. RBC Table 4/15/98, one-tenth values
2. Federal Action Level for lead.

Low-Level Radiation Burial Site, Positive Analytical Results

Notes
ND - Not detected
NA - Not analyzed
Results in bold equal or exceed RBC levels.
Shaded results equal or exceed BTAG screening levels.

Definition of Qualifiers
B - Not detected substantially above the level reported in laboratory or field blanks.
J - Analyte present. Reported value may or may not be accurate or precise.
K - Analyte present. Reported value is biased high.
L - Analyte present. Reported value is biased low.

Table A.3. Low-Level Radiation Burial Site, Positive Analytical Results, May 1998 - Groundwater

Field Sample I.D.	Method Detection Limit	RBC[1] 4/15/98		MW1-25		MW2-30		MW3		MW4-38	
Date Collected				5/6/98		5/6/98		5/7/98		5/6/98	
Date Analyzed				5/19/98		5/19/98		5/19/98		5/19/98	
Matrix	Water	Tap Water		Water		Water		Water		Water	
Reporting Units	ug/L	ug/L	Basis	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
VOCs (SW8260A)											
Acetone	1.6	370	N	ND		ND		ND		ND	
Carbon Disulfide	0.2	100	N	ND		ND		1	B	ND	
Chloroform	0.12	0.15	C	ND		**15**		ND		ND	

Field Sample I.D.	Method Detection Limit	RBC[1] 4/15/98		MW1-25		MW2-30		MW3		MW4-38	
Date Collected				5/6/98		5/6/98		5/7/98		5/6/98	
Date Extracted				5/13/98		5/13/98		5/13/98		5/13/98	
Date Analyzed				5/19/98		5/21/98		5/21/98		5/21/98	
Matrix	Water	Tap Water		Water		Water		Water		Water	
Reporting Units	ug/L	ug/L	Basis	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
SVOCs (SW82780B)											
bis(2-Ethylhexyl)phthalate	0.58	4.8	C	ND		ND		ND		ND	

Field Sample I.D.	Method Detection Limit	RBC[1] 4/15/98		MW1-25		MW2-30		MW3		MW4-38	
Date Collected				5/6/98		5/6/98		5/7/98		5/6/98	
Date Extracted				5/11/98		5/11/98		5/11/98		5/11/98	
Date Analyzed				5/21/98		5/21/98		5/21/98		5/21/98	
Matrix	Water	Tap Water		Water		Water		Water		Water	
Reporting Units	ug/L	ug/L	Basis	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
Pest/PCBs (SW8081)											
beta-BHC	0.0022	0.037	C	ND		ND		ND		ND	
delta-BHC	0.0025	Not Available		ND		ND		ND		ND	
alpha-Chlordane	0.0039	0.19	C	ND		ND		ND		ND	
gamma-Chlordane	0.0048	0.19	C	ND		ND		ND		ND	
Heptachlor epoxide	0.0043	0.0012	C	ND		ND		ND		ND	

Notes:

1. EPA Region III RBC Table, 4/15/98. Non-carcinogens are evaluated against one-tenth the RBC values.

Table A.3. Low-Level Radiation Burial Site, Positive Analytical Results, May 1998 - Groundwater

Field Sample I.D.	MW5-30		MW6-25		MW7-32		MW8		MW9-41		MW10-50	
Date Collected	5/6/98		5/6/98		5/8/98		5/7/98		5/7/98		5/7/98	
Date Analyzed	5/19/98		5/19/98		5/22/98		5/19/98		5/21/98		5/21/98	
Matrix	Water		Water		Water		Water		Water		Water	
Reporting Units	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
VOCs (SW8260A)												
Acetone	ND		3	B	ND		ND		ND		4	B
Carbon Disulfide	ND		ND		ND		ND		ND		ND	
Chloroform	ND		**3**		**110**		ND		ND		ND	

Field Sample I.D.	MW5-30		MW6-25		MW7-32		MW8		MW9-41		MW10-50	
Date Collected	5/6/98		5/6/98		5/8/98		5/7/98		5/7/98		5/7/98	
Date Extracted	5/13/98		5/13/98		5/13/98		5/13/98		5/13/98		5/13/98	
Date Analyzed	5/21/98		5/21/98		5/22/98		5/21/98		5/22/98		5/21/98	
Matrix	Water		Water		Water		Water		Water		Water	
Reporting Units	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
SVOCs (SW82780B)												
bis(2-Ethylhexyl)phthalate	ND		ND		ND		1	J	ND		ND	

Field Sample I.D.	MW5-30		MW6-25		MW7-32		MW8		MW9-41		MW10-50	
Date Collected	5/6/98		5/6/98		5/8/98		5/7/98		5/7/98		5/7/98	
Date Extracted	5/11/98		5/11/98		5/14/98		5/11/98		5/14/98		5/14/98	
Date Analyzed	5/21/98		5/21/98		5/29/98		5/21/98		5/29/98		5/29/98	
Matrix	Water		Water		Water		Water		Water		Water	
Reporting Units	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
Pest/PCBs (SW8081)												
beta-BHC	ND		ND		ND		ND		ND		ND	
delta-BHC	ND		ND		ND		ND		ND		0.0066	J
alpha-Chlordane	ND		ND		0.0073	J	ND		ND		ND	
gamma-Chlordane	ND		ND		ND		ND		ND		ND	
Heptachlor epoxide	ND		ND		**0.027**		ND		ND		ND	

Table A.3. Low-Level Radiation Burial Site, Positive Analytical Results, May 1998 - Groundwater

Field Sample I.D.	MW11-40		MW12-25		MW13-20	
Date Collected	5/8/98		5/8/98		5/8/98	
Date Analyzed	5/21/98		5/21/98		5/21/98	
Matrix	Water		Water		Water	
Reporting Units	ug/L	Qual	ug/L	Qual	ug/L	Qual
VOCs (SW8260A)						
Acetone	ND		ND		ND	
Carbon Disulfide	ND		ND		ND	
Chloroform	ND		**57**	J	ND	

Field Sample I.D.	MW11-40		MW12-25		MW13-20	
Date Collected	5/8/98		5/8/98		5/8/98	
Date Extracted	5/13/98		5/13/98		5/13/98	
Date Analyzed	5/21/98		5/21/98		5/21/98	
Matrix	Water		Water		Water	
Reporting Units	ug/L	Qual	ug/L	Qual	ug/L	Qual
SVOCs (SW82780B)						
bis(2-Ethylhexyl)phthalate	ND		ND		ND	

Field Sample I.D.	MW11-40		MW12-25		MW13-20	
Date Collected	5/8/98		5/8/98		5/8/98	
Date Extracted	5/14/98		5/14/98		5/14/98	
Date Analyzed	5/29/98		5/29/98		5/28/98	
Matrix	Water		Water		Water	
Reporting Units	ug/L	Qual	ug/L	Qual	ug/L	Qual
Pest/PCBs (SW8081)						
beta-BHC	0.0055	J	ND		ND	
delta-BHC	ND		ND		ND	
alpha-Chlordane	ND		ND		ND	
gamma-Chlordane	ND		0.010		ND	
Heptachlor epoxide	ND		ND		ND	

Table A.3. Low-Level Radiation Burial Site, Positive Analytical Results, May 1998 - Groundwater

Field Sample I.D.	Method Detection Limit	RBC[1]		MW1-25		MW2-30		MW3		MW4-38	
Date Collected		4/15/98		5/6/98		5/6/98		5/7/98		5/6/98	
Date Digested				5/13/98		5/13/98		5/13/98		5/13/98	
Date Analyzed				5/18/98		5/18/98		5/18/98		5/18/98	
Matrix	Water	Tap Water		Water		Water		Water		Water	
Reporting Units	ug/L	ug/L	Basis	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
Total Metals (SW6010A)											
Aluminum	28.5	3,700	N	77.2	B	103	B	161	B	225	B
Arsenic	2.33	0.045	C	ND		**2.68**	B	ND		ND	
Barium	0.310	260	N	30.4		80.2		76.0		116	
Beryllium	0.300	7.3	N	0.630	B	0.670	B	0.670	B	0.810	B
Calcium	61.7	Not Available		842	J	4,020	J	4,360	J	8,170	
Chromium	0.840	18	N	1.86	J	2.17	J	4.15	J	1.69	J
Cobalt	0.440	220	N	0.490	J	2.36	J	3.32	J	3.57	J
Copper	0.550	150	N	1.59	J	0.780	J	3.57	J	2.08	J
Iron	24.4	1,100	N	38.9	J	34.2	J	105		34.9	J
Lead	0.910	15[2]		4.00		2.96	J	8.37		3.71	
Magnesium	31.2	Not Available		2,290	J	4,120	J	5,150		6,660	
Manganese	0.410	73	N	9.71	J	39.5		25.0		42.4	
Nickel	0.690	73	N	2.54	B	4.22	B	7.67	J	4.67	B
Potassium	55.1	Not Available		2,050	J	2,280	J	1,250	J	10,500	
Selenium	2.55	18	N	ND		ND		ND		ND	
Sodium	388	Not Available		2,320	J	7,940		17,800		11,600	
Thallium	3.26	0.26	N	ND		**3.51**	B	ND		ND	
Vanadium	0.460	26	N	ND		ND		ND		ND	
Zinc	8.04	1,100	N	27.6	J	15.9	J	14.8	J	16.8	J

Notes:

1. EPA Region III RBC Table, 4/15/98. Non-carcinogens are evaluated against one-tenth the RBC values.
2. Federal Action Level for lead.

Table A.3. Low-Level Radiation Burial Site, Positive Analytical Results, May 1998 - Groundwater

Field Sample I.D.	MW5-30		MW6-25		MW7-32		MW8		MW9-41		MW10-60	
Date Collected	5/6/98		5/6/98		5/8/98		5/7/98		5/7/98		5/7/98	
Date Digested	5/13/98		5/13/98		5/13/98		5/13/98		5/13/98		5/13/98	
Date Analyzed	5/18/98		5/18/98		5/18/98		5/18/98		5/18/98		5/18/98	
Matrix	Water		Water		Water		Water		Water		Water	
Reporting Units	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
Total Metals (SW6010A)												
Aluminum	147	B	148	B	162	B	186	B	1,690		1,990	
Arsenic	ND		ND		ND		ND		**3.79**	B	ND	
Barium	113		25.2		87.6		81.1		57.8		19.7	
Beryllium	0.720	B	0.770	B	0.660	B	0.820	B	0.570	B	0.640	B
Calcium	6,780		837	J	3,910	J	5,060		3,410	J	39,300	
Chromium	1.85	J	2.54	J	5.76	J	4.57	J	**46.7**		9.99	J
Cobalt	2.58	J	1.49	J	3.21	J	3.85	J	2.83	J	ND	
Copper	2.10	J	ND		8.96	J	3.48	J	15.8	J	16.9	J
Iron	37.6	J	164		314		173		**5,030**		860	
Lead	4.51		4.19		8.15		9.89		4.94	B	4.03	B
Magnesium	4,440	J	2,740	J	4,410	J	5,600		3,510	J	319	J
Manganese	24.8		28.4		**78.7**		30.6		24.4		7.00	J
Nickel	4.17	B	3.32	B	6.25	J	8.51	J	30.9		6.79	J
Potassium	3,630	J	1,330	J	2,470	J	1,580	J	1,220	J	27,300	
Selenium	ND		ND		ND		ND		ND		2.60	J
Sodium	11,800		3,400	J	10,000		19,600		6,610		26,600	
Thallium	ND		ND		ND		ND		**3.94**	B	ND	
Vanadium	ND		ND		1.03	J	0.800	J	15.3	J	23.9	J
Zinc	25.7	J	14.4	J	34.0	B	16.6	J	26.7	B	85.3	

Table A.3. Low-Level Radiation Burial Site, Positive Analytical Results, May 1998 - Groundwater

Field Sample I.D.	MW11-40		MW12-25		MW13-20	
Date Collected	5/8/98		5/8/98		5/8/98	
Date Digested	5/13/98		5/13/98		5/13/98	
Date Analyzed	5/18/98		5/18/98		5/18/98	
Matrix	Water		Water		Water	
Reporting Units	ug/L	Qual	ug/L	Qual	ug/L	Qual
Total Metals (SW6010A)						
Aluminum	781		652		111	B
Arsenic	ND		ND		ND	
Barium	45.5		64.2		59.7	
Beryllium	0.610	B	0.610	B	0.500	B
Calcium	11,000		2,550	J	4,030	J
Chromium	5.30	J	8.54	J	3.88	J
Cobalt	2.11	J	3.59	J	3.37	J
Copper	12.3	J	6.28	B	5.20	B
Iron	498		1,060		71.8	J
Lead	2.47	B	4.51	B	10.0	
Magnesium	3,180	J	3,080	J	4,140	J
Manganese	35.2		67.8		32.9	
Nickel	4.85	B	6.16	J	5.53	B
Potassium	15,100		1,700	J	1,430	J
Selenium	ND		ND		ND	
Sodium	19,900		4,140	J	15,200	
Thallium	ND		ND		ND	
Vanadium	5.79	J	2.78	J	ND	
Zinc	63.5	B	112		18.3	B

Table A.3. Low-Level Radiation Burial Site, Positive Analytical Results, May 1998 - Groundwater

Field Sample I.D. Date Collected Date Digested Date Analyzed Matrix Reporting Units	Method Detection Limit Water ug/L	RBC[1] 4/15/98 Tap Water ug/L	Basis	MW1-25-D 5/6/98 5/18/98 5/26/98 Water ug/L	Qual	MW2-30-D 5/6/98 5/18/98 5/26/98 Water ug/L	Qual	MW3-D 5/7/98 5/18/98 5/26/98 Water ug/L	Qual	MW4-38-D 5/6/98 5/18/98 5/26/98 Water ug/L	Qual
Diss Metals (SW6010A)											
Aluminum	28.5	3,700	N	42.5	J	49.2	J	78.6	J	173	J
Antimony	1.95	1.5	N	ND		ND		ND		ND	
Barium	0.310	260	N	28.8		77.3		72.8		115	
Beryllium	0.300	7.3	N	0.700	B	0.430	B	0.730	B	0.550	B
Cadmium	0.250	1.8	N	ND		ND		ND		ND	
Calcium	61.7	Not Available		984	J	4,290	J	4,580	J	8,660	
Chromium	0.840	18	N	2.58	J	2.00	J	2.54	J	1.85	J
Cobalt	0.440	220	N	0.540	J	5.37	J	3.34	J	3.88	J
Copper	0.550	150	N	3.55	J	3.75	J	5.50	J	4.62	J
Iron	24.4	1,100	N	ND		ND		ND		ND	
Lead	0.910	15 [2]		4.08		1.87	J	6.40		2.59	J
Magnesium	31.2	Not Available		2,270	J	4,090	J	5,200		6,840	
Manganese	0.410	73	N	9.74	J	46.2		24.8		44.2	
Nickel	0.690	73	N	1.91	J	3.48	J	5.85	J	3.72	J
Potassium	55.1	Not Available		1,950	J	2,180	J	1,240	J	10,100	
Selenium	2.55	18	N	ND		ND		ND		ND	
Sodium	388	Not Available		2,610	B	8,020		18,000		11,700	
Vanadium	0.460	26	N	ND		ND		ND		ND	
Zinc	8.04	1,100	N	25.4	J	24.3	J	17.6	J	17.7	J

Notes:

1. EPA Region III RBC Table, 4/15/98. Non-carcinogens are evaluated against one-tenth the RBC values.
2. Federal Action Level for lead.

Table A.3. Low-Level Radiation Burial Site, Positive Analytical Results, May 1998 - Groundwater

Field Sample I.D.	MW5-30-D		MW6-25-D		MW7-32-D		MW8-D		MW9-41-D		MW10-60-D	
Date Collected	5/6/98		5/6/98		5/8/98		5/7/98		5/7/98		5/7/98	
Date Digested	5/18/98		5/18/98		5/18/98		5/18/98		5/18/98		5/18/98	
Date Analyzed	5/26/98		5/26/98		5/26/98		5/26/98		5/26/98		5/26/98	
Matrix	Water		Water		Water		Water		Water		Water	
Reporting Units	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
Diss Metals (SW6010A)												
Aluminum	92.9	J	52.8	J	70.8	J	67.5	J	70.4	J	1,860	
Antimony	ND		**2.97**	J	ND		ND		**2.17**	B	**2.29**	B
Barium	108		22.8		95.0		75.6		54.2		16.9	
Beryllium	0.470	B	0.670	B	0.780	B	0.750	B	0.890	B	0.850	B
Cadmium	ND		ND		ND		ND		ND		ND	
Calcium	6,960		961	J	4,340	J	5,090		3,850	J	41,700	
Chromium	2.40	J	2.05	J	1.98	B	2.27	J	2.90	B	2.43	B
Cobalt	5.07	J	1.25	J	3.42	J	3.22	J	2.81	J	ND	
Copper	7.21	J	2.65	J	5.23	J	4.84	J	4.54	J	2.29	J
Iron	ND		ND		ND		ND		27.5	J	ND	
Lead	5.45		3.34		4.72	B	9.39		2.16	B	1.15	B
Magnesium	4,440	J	2,550	J	4,950	J	5,440		3,990	J	82.6	J
Manganese	32.5		26.0		**83.5**		29.2		17.3		1.56	J
Nickel	4.83	J	1.27	J	5.03	J	5.75	J	15.8		ND	
Potassium	3,450	J	1,160	J	2,620	J	1,450	J	999	J	31,500	
Selenium	ND		ND		5.23		ND		ND		ND	
Sodium	11,500		3,020	J	10,800		18,800		7,510		30,300	
Vanadium	ND		ND		ND		ND		ND		25.8	J
Zinc	29.8	J	21.4	J	27.0	B	15.1	J	23.5	B	11.7	B

Table A.3. Low-Level Radiation Burial Site, Positive Analytical Results, May 1998 - Groundwater

Field Sample I.D.	MW11-40-D		MW12-25-D		MW13-20-D	
Date Collected	5/8/98		5/8/98		5/8/98	
Date Digested	5/18/98		5/18/98		5/18/98	
Date Analyzed	5/26/98		5/26/98		5/26/98	
Matrix	Water		Water		Water	
Reporting Units	ug/L	Qual	ug/L	Qual	ug/L	Qual
Diss Metals (SW6010A)						
Aluminum	301		39.7	J	88.5	J
Antimony	ND		ND		ND	
Barium	48.5		70.1		59.9	
Beryllium	0.850	B	0.810	B	0.780	B
Cadmium	ND		0.270	J	ND	
Calcium	13,000		2,920	J	4,410	J
Chromium	1.78	B	2.15	B	1.66	B
Cobalt	ND		4.20	J	3.64	J
Copper	1.32	J	2.51	J	7.82	J
Iron	ND		ND		ND	
Lead	ND		1.76	B	7.74	
Magnesium	3,170	J	3,610	J	4,360	J
Manganese	10.4	J	72.3		34.1	
Nickel	ND		4.96	J	6.06	J
Potassium	17,700		1,880	J	1,450	J
Selenium	5.89		ND		ND	
Sodium	23,400		4,790	J	16,100	
Vanadium	4.27	J	ND		ND	
Zinc	12.7	B	111		21.9	B

Table A.3. Low Level Radiation Burial Site, Radiological Results, May 1998 - Groundwater

Field Sample I.D.	Drinking Water Standard	MW1-25		MW2-30		MW3-56		MW4-38		MW5-30		MW6-25	
Date Collected		5/6/98		5/6/98		5/7/98		5/6/98		5/6/98		5/6/98	
Matrix		Water		Water		Water		Water		Water		Water	
Reporting Units	pCi/L	pCi/L	Q[2]	pCi/L	Q	pCi/L	Q	pCi/L	Q	pCi/L	Q	pCi/L	Q
Carbon-14		20.96	4.10	38.59	4.43	5.64	3.79	2.52	3.73	1.53	3.71	67.32	4.92
Chlorine-36		-0.22	3.39	0.05	3.39	1.69	3.42	-2.53	3.34	2.73	3.44	0.69	3.40
Gross Alpha	15	0.17	0.36	2.61	0.95	4.51	0.62	7.01	0.83	3.59	1.29	0.43	0.38
Gross Beta		3.13	0.73	2.55	0.66	3.84	0.50	14.87	0.69	5.53	0.96	2.00	0.68
Gamma		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
U-234	20	0.02	0.05	0.05	0.06	0.12	0.07	0.07	0.07	0.02	0.06	-0.01	0.06
U-235	20	-0.01	0.03	-0.02	0.05	0.04	0.05	-0.04	0.05	-0.01	0.02	0.01	0.05
U-238	20	0.00	0.05	0.04	0.06	0.02	0.05	0.09	0.05	0.03	0.03	0.03	0.05
Nickel-63		2.68	6.96	-0.49	4.97	1.03	5.00	-0.02	4.98	2.36	5.03	-2.33	4.96
Ra-226	5[1]	0.15	0.14	**1.70**	0.22	**2.19**	0.25	**4.10**	0.39	**3.52**	0.50	0.12	0.18
Ra-228	5[1]	-2.83	0.91	**3.66**	0.98	**3.23**	1.13	**3.23**	1.11	**5.41**	1.08	1.12	0.83
Sr-90		0.13	0.28	0.24	0.37	0.05	0.24	0.39	0.26	0.16	0.26	0.24	0.26
Tritium	20,000	-3.60	139.04	1739.64	201.47	54.05	142.00	163.96	147.13	163.96	146.25	3229.28	245.44

Notes:

1. Drinking water standard is for combined Ra-226 and Ra-228. Results in bold indicate the combined Ra-226 and Ra-228 concentrations exceed 5 pCi/L, and H-3 exceeds 20,000 pCi/L.
2. Q = Uncertainty

Table A.3. Low Level Radiation Burial Site, Radiological Results, May 1998 - Groundwater

Field Sample I.D.	MW7-32		MW8-58		MW9-41		MW10-60		MW11-40		MW12-25		MW13-20	
Date Collected	5/8/98		5/7/98		5/7/98		5/7/98		5/8/98		5/8/98		5/8/98	
Matrix	Water		Water		Water		Water		Water		Water		Water	
Reporting Units	pCi/L	Q	pCi/L	Q	pCi/L	Q	pCi/L	Q	pCi/L	Q	pCi/L	Q	pCi/L	Q
Carbon-14	236.04	7.16	1.68	3.71	4.92	3.78	5.08	3.78	6.48	3.81	80.82	5.14	19.52	4.07
Chlorine-36	0.91	3.41	-0.89	3.37	0.66	3.40	-0.09	3.39	3.10	3.44	2.75	3.44	-1.22	3.37
Gross Alpha	4.84	0.52	4.89	0.69	4.50	1.24	2.09	0.99	9.86	1.04	1.64	0.73	3.79	1.44
Gross Beta	6.55	0.42	5.45	0.54	4.26	0.84	22.78	1.46	18.48	0.94	9.17	1.07	3.49	0.83
Gamma	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
U-234	0.12	0.07	0.07	0.06	0.19	0.11	0.31	0.12	0.20	0.09	0.09	0.07	0.06	0.11
U-235	0.04	0.04	0.02	0.03	0.01	0.07	0.03	0.05	0.03	0.04	-0.02	0.06	0.02	0.08
U-238	0.14	0.07	0.07	0.04	0.18	0.11	0.30	0.11	0.25	0.08	0.07	0.08	0.04	0.11
Nickel-63	3.13	6.01	-0.29	4.98	-0.47	4.98	-2.74	4.94	2.18	5.02	0.00	8.64	-2.40	4.94
Ra-226	1.88	0.24	2.21	0.24	1.74	0.23	0.29	0.16	0.91	0.16	0.96	0.19	**1.23**	0.22
Ra-228	3.04	1.05	-1.84	0.99	2.80	1.07	0.72	1.16	1.17	0.86	3.39	1.03	**4.31**	1.75
Sr-90	0.08	0.21	0.05	0.23	0.21	0.23	-0.19	0.20	0.05	0.18	1.35	0.30	0.01	0.78
Tritium	**27386.49**	604.86	125.68	144.26	36.49	140.54	107.21	144.18	111.26	143.73	14884.23	449.35	33.33	140.83

Table A.3. Low-Level Radiation Burial Site, Positive Analytical Results, May 1998 - Footnotes

Notes

ND - Not detected

NA - Not analyzed

Results in bold equal or exceed RBC levels.

Shaded results equal or exceed BTAG screening levels.

Definition of Qualifiers

B - Not detected substantially above the level reported in laboratory or field blanks.

J - Analyte present. Reported value may or may not be accurate or precise.

K - Analyte present. Reported value is biased high.

L - Analyte present. Reported value is biased low.

Table A.4. Low-Level Burial Site, Positive Analytical Results, December 1998 - Groundwater

Field Sample I.D.	DUP 1		LLRBS-MW1		LLRBS-MW11		LLRBS-MW12	
Date Sampled	12/10/98		12/10/98		12/11/98		12/11/98	
Date Analyzed	12/18/98		12/18/98		12/18/98		12/18/98	
Matrix	WATER		WATER		WATER		WATER	
Reporting Units	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
VOCs (SW8260A)								
Acetone	0.9	J	ND		4.3	J	ND	
Chloroform	ND		ND		0.62	J	9	
Toluene	0.19	J	0.2	J	ND		0.16	J

Field Sample I.D.	LLRBS-MW2		LLRBS-MW4		LLRBS-MW5		LLRBS-MW6	
Date Sampled	12/10/98		12/10/98		12/10/98		12/10/98	
Date Analyzed	12/18/98		12/18/98		12/18/98		12/18/98	
Matrix	WATER		WATER		WATER		WATER	
Reporting Units	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
VOCs (SW8260A)								
Acetone	4.9	J	4.7	J	ND		5.9	
Chloroform	3.9		ND		ND		ND	
Toluene	0.2	J	ND		ND		0.23	J

Field Sample I.D.	LLRBS-MW7		TRIP BLANK	
Date Sampled	12/11/98		12/11/98	
Date Analyzed	12/18/98		12/18/98	
Matrix	WATER		WATER	
Reporting Units	ug/L	Qual	ug/L	Qual
VOCs (SW8260A)				
Acetone	5		5.1	
Chloroform	13		ND	
Toluene	ND		ND	

Table A.4. Low-Level Radiation Burial Site, Positive Analytical Results, December 1998 - Groundwater

Field Sample I.D.	BARC 19-LLRBS-MW10		BARC 19-LLRBS-MW13		BARC 19-LLRBS-MW93	
Date Sampled	12/9/98		12/8/98		12/9/98	
Date Analyzed	12/17/98		12/17/98		12/17/98	
Matrix	WATER		WATER		WATER	
Reporting Units	UG/L	Qual	UG/L	Qual	UG/L	Qual
VOCs (SW8260A)						
Acetone	5		ND		5.7	
Chloroform	ND		0.3	J	ND	
Chloromethane	0.45	J	ND		0.31	J
Methylene chloride	ND		ND		ND	
Tetrachloroethene	ND		ND		ND	
Toluene	0.81	J	1.2	J	0.29	J

Field Sample I.D.	BARC 19-LLRBS-MW8		BARC 19-LLRBS-MW9		TRIP BLANK	
Date Sampled	12/9/98		12/9/98		12/9/98	
Date Analyzed	12/17/98		12/17/98		12/17/98	
Matrix	WATER		WATER		WATER	
Reporting Units	UG/L	Qual	UG/L	Qual	UG/L	Qual
VOCs (SW8260A)						
Acetone	ND		ND		ND	
Chloroform	ND		ND		ND	
Chloromethane	ND		0.33	J	ND	
Methylene chloride	ND		ND		0.17	J
Tetrachloroethene	ND		ND		0.15	J
Toluene	0.18	J	0.18	J	ND	

Table A.4. Low-Level Radiation Burial Site, Positive Analytical Results, December 1998 - Groundwater

Field Sample I.D.	BARC 18 DUP 1			MW 1			MW 2		
Date Sampled	12/10/98			12/10/98			12/10/98		
Date Analyzed	12/17/98			12/17/98			12/31/98		
Matrix	WATER			WATER			WATER		
Reporting Units	PCI/L	Qual	Error	PCI/L	Qual	Error	PCI/L	Qual	Error
Radionuclides									
Carbon-14	7.18	J	3.97	11.2	J	4.06	29.9	J	4.62
Radium-226	1.67		0.63	1.62		0.57	2.2		0.62
Radium-228	ND	J		ND			ND		

Field Sample I.D.	MW 3			MW 4			MW 5		
Date Sampled	12/9/98			12/10/98			12/10/98		
Date Analyzed	12/27/98			12/31/98			12/31/98		
Matrix	WATER			WATER			WATER		
Reporting Units	PCI/L	Qual	Error	PCI/L	Qual	Error	PCI/L	Qual	Error
Radionuclides									
Carbon-14	ND			ND			ND		
Radium-226	4.4		0.99	2.21		0.66	2.51		0.68
Radium-228	4.38		1.13	ND			2.87		1.21
Tritium	ND			ND			ND		

Field Sample I.D.	MW 6			MW 7			MW 8		
Date Sampled	12/10/98			12/11/98			12/9/98		
Date Analyzed	12/31/98			12/23/98			12/28/98		
Matrix	WATER			WATER			WATER		
Reporting Units	PCI/L	Qual	Error	PCI/L	Qual	Error	PCI/L	Qual	Error
Radionuclides									
Carbon-14	ND			53.15		6.63	ND		
Radium-226	1.56		0.56	2.21		0.77	4.47		0.97
Radium-228	ND			ND			3.43		1.31
Tritium	ND			1.96		333.54	ND		

Table A.4. Low-Level Radiation Burial Site, Positive Analytical Results, December 1998 - Groundwater

Field Sample I.D.	MW 9			MW 10			MW 11		
Date Sampled	12/9/98			12/8/98			12/11/98		
Date Analyzed	12/17/98			12/27/98			12/21/98		
Matrix	WATER			WATER			WATER		
Reporting Units	PCI/L	Qual	Error	PCI/L	Qual	Error	PCI/L	Qual	Error
Radionuclides									
Carbon-14	8.66	J	4	ND			ND		
Radium-226	1.46		0.6	0.56	J	0.38	1.86		0.69
Radium-228	4.29		1.26	ND			ND		
Tritium	ND			ND			ND		

Field Sample I.D.	MW 12			MW 13		
Date Sampled	12/11/98			12/9/98		
Date Analyzed	12/28/98			12/17/98		
Matrix	WATER			WATER		
Reporting Units	PCI/L	Qual	Error	PCI/L	Qual	Error
Radionuclides						
Carbon-14	28.55	J	6.15	11.61	J	4.21
Radium-226	2.7		0.83	1.83		0.66
Radium-228	3.01		0.8	2.42		1.21
Tritium	909.96		295.1	0.56	J	0.38

Low-Level Radiation Burial Site, Positive Analytical Results

Notes
ND - Not detected
NA - Not analyzed
Results in bold equal or exceed RBC levels.
Shaded results equal or exceed BTAG screening levels.

Definition of Qualifiers
B - Not detected substantially above the level reported in laboratory or field blanks.
J - Analyte present. Reported value may or may not be accurate or precise.
K - Analyte present. Reported value is biased high.
L - Analyte present. Reported value is biased low.

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Table A.5. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997 - Surface Water

Field Sample I.D.	Method Detection Limit	BTAG[1] Screening Level 8/9/95	RBC[2] 4/15/98		BA18-SW1		BA18-SW2		Sample BA18-SW3		BA18-SW4	
Date Collected					10/22/97		10/22/97		10/22/97		10/22/97	
Date Analyzed					11/4/97		11/4/97		11/4/97		11/4/97	
Matrix	Water	Aquatic Freshwater	Tap Water		Water		Water		Water		Water	
Reporting Units	ug/L	ug/L	ug/L	Basis	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
VOCs (SW8260A)												
Acetone	1.6	9,000,000	370	N	3.2	L	ND		ND		ND	
Methylene chloride	0.18	11,000	4.1	C	3.4	B	1.2	B	2.2	B	2.9	B
2-Hexanone	0.62	428,000	150	N	ND		3.3	J	ND		ND	

Field Sample I.D.	Method Detection Limit	BTAG[1] Screening Level 8/9/95	RBC[2] 4/15/98		BA18-SW1		BA18-SW2		Sample BA18-SW3		BA18-SW4	
Date Collected					10/22/97		10/22/97		10/22/97		10/22/97	
Date Extracted					10/27/97		10/27/97		10/27/97		10/27/97	
Date Analyzed					11/11/97		11/11/97		11/11/97		11/12/97	
Matrix	Water	Aquatic Freshwater	Tap Water		Water		Water		Water		Water	
Reporting Units	ug/L	ug/L	ug/L	Basis	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
SVOCs (SW8270B)												
Di-n-butylphthalate	0.90	0.3	370	N	ND		1.9	J	ND		ND	
Bis (2-ethylhexyl)phthalate	2.21	30	4.8	C	ND		5.1		1.8	J	1.3	L

Field Sample I.D.	Method Detection Limit	BTAG[1] Screening Level 8/9/95	RBC[2] 4/15/98		BA18-SW1		BA18-SW2		Sample BA18-SW3		BA18-SW4	
Date Collected					10/22/97		10/22/97		10/22/97		10/22/97	
Date Extracted					10/28/97		10/28/97		10/28/97		10/28/97	
Date Analyzed					10/30/97		10/30/97		10/30/97		10/30/97	
Matrix	Water	Aquatic Freshwater	Tap Water		Water		Water		Water		Water	
Reporting Units	ug/L	ug/L	ug/L	Basis	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
Pest/PCBs (SW8081)												
delta-BHC	0.003	Not Available	Not Available		ND		0.034	J	ND		ND	
4,4'-DDD	0.002	0.6	0.28	C	0.045	J	ND		ND		ND	
4,4'-DDT	0.004	0.001	0.2	C	ND		0.055	J	ND		ND	

Notes:

1. EPA Region III BTAG Screening Level Table, 8/9/95.
2. EPA Region III RBC Table, 4/15/98. Non-carcinogens are evaluated against one-tenth the RBC values.

Table A.5. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997 - Surface Water

	Duplicate	
Field Sample I.D.	BA18-SW5	
Date Collected	10/22/97	
Date Analyzed	11/4/97	
Matrix	Water	
Reporting Units	W	Qual
VOCs (SW8260A)		
Acetone	ND	
Methylene chloride	2.3	B
2-Hexanone	ND	

	Duplicate	
Field Sample I.D.	BA18-SW5	
Date Collected	10/22/97	
Date Extracted	10/27/97	
Date Analyzed	11/11/97	
Matrix	Water	
Reporting Units	ug/L	Qual
SVOCs (SW8270B)		
Di-n-butylphthalate	ND	
Bis (2-ethylhexyl)phthalate	1.3	J

	Duplicate	
Field Sample I.D.	BA18-SW5	
Date Collected	10/22/97	
Date Extracted	10/28/97	
Date Analyzed	10/30/97	
Matrix	Water	
Reporting Units	ug/L	Qual
Pest/PCBs (SW8081)		
delta-BHC	ND	
4,4'-DDD	ND	
4,4'-DDT	ND	

Table A.5. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997 - Surface Water

Field Sample I.D.	Method Detection Limit	BTAG[1] Screening Level 8/9/95	RBC[2] 4/15/98		BA18-SW1		BA18-SW2		Sample BA18-SW3		BA18-SW4	
Date Collected					10/22/97		10/22/97		10/22/97		10/22/97	
Date Analyzed					11/4/97		11/4/97		11/4/97		11/4/97	
Matrix	Water	Aquatic Freshwater	Tap Water		Water		Water		Water		Water	
Reporting Units	ug/L	ug/L	ug/L	Basis	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
VOCs (SW8260A)												
Acetone	1.6	9,000,000	370	N	3.2	L	ND		ND		ND	
Methylene chloride	0.18	11,000	4.1	C	3.4	B	1.2	B	2.2	B	2.9	B
2-Hexanone	0.62	428,000	150	N	ND		3.3	J	ND		ND	

Field Sample I.D.	Method Detection Limit	BTAG[1] Screening Level 8/9/95	RBC[2] 4/15/98		BA18-SW1		BA18-SW2		Sample BA18-SW3		BA18-SW4	
Date Collected					10/22/97		10/22/97		10/22/97		10/22/97	
Date Extracted					10/27/97		10/27/97		10/27/97		10/27/97	
Date Analyzed					11/11/97		11/11/97		11/11/97		11/12/97	
Matrix	Water	Aquatic Freshwater	Tap Water		Water		Water		Water		Water	
Reporting Units	ug/L	ug/L	ug/L	Basis	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
SVOCs (SW8270B)												
Di-n-butylphthalate	0.90	0.3	370	N	ND		1.9	J	ND		ND	
Bis (2-ethylhexyl)phthalate	2.21	30	4.8	C	ND		5.1		1.8	J	1.3	L

Field Sample I.D.	Method Detection Limit	BTAG[1] Screening Level 8/9/95	RBC[2] 4/15/98		BA18-SW1		BA18-SW2		Sample BA18-SW3		BA18-SW4	
Date Collected					10/22/97		10/22/97		10/22/97		10/22/97	
Date Extracted					10/28/97		10/28/97		10/28/97		10/28/97	
Date Analyzed					10/30/97		10/30/97		10/30/97		10/30/97	
Matrix	Water	Aquatic Freshwater	Tap Water		Water		Water		Water		Water	
Reporting Units	ug/L	ug/L	ug/L	Basis	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
Pest/PCBs (SW8081)												
delta-BHC	0.003	Not Available	Not Available		ND		0.034	J	ND		ND	
4,4'-DDD	0.002	0.6	0.28	C	0.045	J	ND		ND		ND	
4,4'-DDT	0.004	0.001	0.2	C	ND		0.055	J	ND		ND	

Notes:

1. EPA Region III BTAG Screening Level Table, 8/9/95.
2. EPA Region III RBC Table, 4/15/98. Non-carcinogens are evaluated against one-tenth the RBC values.

Table A.5. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997 - Surface Water

	Duplicate	
Field Sample I.D.	BA18-SW5	
Date Collected	10/22/97	
Date Analyzed	11/4/97	
Matrix	Water	
Reporting Units	W	Qual
VOCs (SW8260A)		
Acetone	ND	
Methylene chloride	2.3	B
2-Hexanone	ND	

	Duplicate	
Field Sample I.D.	BA18-SW5	
Date Collected	10/22/97	
Date Extracted	10/27/97	
Date Analyzed	11/4/97	
Matrix	Water	
Reporting Units	ug/L	Qual
SVOCs (SW8270B)		
Di-n-butylphthalate	ND	
Bis (2-ethylhexyl)phthalate	1.3	J

	Duplicate	
Field Sample I.D.	BA18-SW5	
Date Collected	10/22/97	
Date Extracted	10/28/97	
Date Analyzed	10/30/97	
Matrix	Water	
Reporting Units	ug/L	Qual
Pest/PCBs (SW8081)		
delta-BHC	ND	
4,4'-DDD	ND	
4,4'-DDT	ND	

Table A.5. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997 - Surface Water

Field Sample I.D.	Method Detection Limit	BTAG[1] Screening Level 8/9/95	RBC[2] 4/15/98		Sample BA18-SW1		BA18-SW2		BA18-SW3		BA18-SW4	
Date Collected					10/22/97		10/22/97		10/22/97		10/22/97	
Date Prepared					11/3/97		11/3/97		11/3/97		11/3/97	
Date Analyzed					11/4/97		11/4/97		11/4/97		11/4/97	
Matrix	Water	Aquatic Freshwater	Tap Water		Water		Water		Water		Water	
Reporting Units	ug/L	ug/L	ug/L	Basis	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual
Total Metals (SW6010A)												
Aluminum	16.2	25	3,700	N	1,420	K	6,430	K	4,360	K	1,610	K
Antimony	2.7	30	1.5	N	ND		ND		ND		ND	
Arsenic	3.1	874	0.045	C	ND		**5.5**	B	**5.4**	B	ND	
Barium	0.78	10,000	260	N	129	J	255	J	**345**	J	95.4	J
Cadmium	0.30	0.53	1.8	N	**0.35**	J	4.5		2.2	J	1.0	J
Calcium	18.6	Not Available	Not Available		9,660		7080		20,200		7,060	
Chromium	0.9	2.0	18	N	1.8	J	8.2	J	9.1	J	2.8	J
Cobalt	3.6	35,000	220	N	ND		10	J	13.3	J	5.7	J
Copper	0.8	6.5	150	N	2.5	B	18.4	J	11.2	J	5.7	J
Iron	46.5	320	1,100	N	2,780	K	23,200	K	22,100	K	3,110	K
Lead	2.3	3.2	15[3]		6.2	J	31.0		15.0		9.2	J
Magnesium	8.7	Not Available	Not Available		5,030		5,840		7,180		4,920	
Manganese	0.33	14,500	73	N	**293**	J	**615**	J	**7,470**	J	**248**	J
Nickel	0.93	160	73	N	2.0	B	10	J	12.5	J	6.6	J
Potassium	25.50	Not Available	Not Available		8,150		5,930		4,980		1,580	
Selenium	3.5	5.0	18	N	ND		3.7	J	ND		ND	
Silver	0.63	0.0001	18	N	1.2	J	ND		1.1	J	ND	
Sodium	245	Not Available	Not Available		7,810		8,810		8,960		11,100	
Vanadium	0.51	10,000	26	N	3.5	B	**29.4**		11.0	J	4.5	B
Zinc	14.8	30	1,100	N	20.2	J	86.2	J	104	J	28.6	J

Notes:

1. EPA Region III BTAG Screening Level Table, 8/9/95.
2. EPA Region III RBC Table, 4/15/98. Non-carcinogens are evaluated against one-tenth the RBC values.
3. Federal Action Level for lead.

Table A.5. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997 - Surface Water

	Duplicate	
Field Sample I.D.	BA18-SW5	
Date Collected	10/22/97	
Date Prepared	11/3/97	
Date Analyzed	11/4/97	
Matrix	Water	
Reporting Units	ug/L	Qual
Total Metals (SW6010A)		
Aluminum	2,080	K
Antimony	ND	
Arsenic	ND	
Barium	191	J
Cadmium	1.2	J
Calcium	14,400	
Chromium	5.3	J
Cobalt	8.1	J
Copper	7.2	J
Iron	9170	K
Lead	7.8	J
Magnesium	6,160	
Manganese	**4,030**	J
Nickel	7.8	J
Potassium	4,460	
Selenium	ND	
Silver	1.4	J
Sodium	9,820	
Vanadium	6.4	B
Zinc	58.4	J

Table A.5. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997 - Surface Water

									Sample				Duplicate
Field Sample I.D.	Method Detection Limit	Freshwater BTA Screening Level	Tap Water RBC[1]		BA18-SW1		BA18-SW2		BA18-SW3		BA18-SW4		BA18-SW5
Date Sampled					10/22/97		10/22/97		10/22/97		10/22/97		10/22/97
Date Prepared					11/3/97		11/3/97		11/3/97		11/3/97		11/3/97
Date Analyzed					11/4/97		11/4/97		11/4/97		11/4/97		11/4/97
Matrix	Water				Water		Water		Water		Water		Water
Reporting Units	ug/L	ug/L	ug/L	Basis	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L	Qual	ug/L
Total Metals (SW6010A)													
Aluminum	16.2	25	3,700	N	1,420	K	6,430	K	4,360	K	1,610	K	2,080
Antimony	2.7	30	1.5	N	ND		ND		ND		ND		ND
Arsenic	3.1	874	0.045	C	ND		**5.5**	B	**5.4**	B	ND		ND
Barium	0.78	10,000	260	N	129	J	255	J	**345**	J	95.4	J	191
Cadmium	0.30	0.53	1.8	N	0.35	J	4.5		2.2	J	1.0	J	1.2
Calcium	18.6	Not Available	Not Available		9,660		7080		20,200		7,060		14,400
Chromium	0.9	2.0	18	N	1.8	J	8.2	J	9.1	J	2.8	J	5.3
Cobalt	3.6	35,000	220	N	ND		10	J	13.3	J	5.7	J	8.1
Copper	0.8	6.5	150	N	2.5	B	18.4	J	11.2	J	5.7	J	7.2
Iron	46.5	320	1,100	N	2,780	K	23,200	K	22,100	K	3,110	K	**9170**
Lead	2.3	3.2	15[2]		6.2	J	31.0		15.0		9.2	J	7.8
Magnesium	8.7	Not Available	Not Available		5,030		5,840		7,180		4,920		6,160
Manganese	0.33	14,500	73	N	**293**	J	**615**	J	**7,470**	J	**248**	J	**4,030**
Nickel	0.93	160	73	N	2.0	B	10	J	12.5	J	6.6	J	7.8
Potassium	25.50	Not Available	Not Available		8,150		5,930		4,980		1,580		4,460
Selenium	3.5	5.0	18	N	ND		3.7	J	ND		ND		ND
Silver	0.63	0.0001	18	N	1.2	J	ND		1.1	J	ND		1.4
Sodium	245	Not Available	Not Available		7,810		8,810		8,960		11,100		9,820
Vanadium	0.51	10,000	26	N	3.5	B	**29.4**		11.0	J	4.5	B	6.4
Zinc	14.8	30	1,100	N	20.2	J	86.2	J	104	J	28.6	J	58.4

Notes:

1. RBC Table 4/15/98, one-tenth values
2. Federal Action Level for lead.

Table A.5. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997 - Surface Water

Field Sample I.D. Date Sampled Date Prepared Date Analyzed Matrix Reporting Units	Method Detection Limit Water ug/L	Freshwater BTA Screening Level ug/L	Tap Water RBC [1] ug/L	Basis	Qual
Total Metals (SW6010A)					
Aluminum	16.2	25	3,700	N	K
Antimony	2.7	30	1.5	N	
Arsenic	3.1	874	0.045	C	
Barium	0.78	10,000	260	N	J
Cadmium	0.30	0.53	1.8	N	J
Calcium	18.6	Not Available	Not Available		
Chromium	0.9	2.0	18	N	J
Cobalt	3.6	35,000	220	N	J
Copper	0.8	6.5	150	N	J
Iron	46.5	320	1,100	N	K
Lead	2.3	3.2	15 [2]		J
Magnesium	8.7	Not Available	Not Available		
Manganese	0.33	14,500	73	N	J
Nickel	0.93	160	73	N	J
Potassium	25.50	Not Available	Not Available		
Selenium	3.5	5.0	18	N	
Silver	0.63	0.0001	18	N	J
Sodium	245	Not Available	Not Available		
Vanadium	0.51	10,000	26	N	B
Zinc	14.8	30	1,100	N	J

Notes:
1. RBC Table 4/15/98, one-tenth values
2. Federal Action Level for lead.

Table A.5. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997 - Surface Water

Field Sample I.D. Date Sampled Date Prepared Date Analyzed Matrix Reporting Units	Method Detection Limit Water ug/L	Freshwater BTA Screening Level ug/L	Tap Water RBC ug/L	Basis	RINSE BLANK 10/16/97 11/3/97 11/4/97 Water ug/L	Qual	RINSE BLANK 10/17/97 11/3/97 11/4/97 Water ug/L	Qual	RINSE BLANK 10/20/97 11/3/97 11/4/97 Water ug/L	Qual
Total Metals (SW6010A)										
Aluminum	16.2	25	3,700	N	58.5	B	59.0	B	53.5	B
Antimony	2.7	30	1.5	N	ND		3.5	B	ND	
Arsenic	3.1	874	0.045	C	ND		ND		ND	
Barium	0.78	10,000	260	N	2.6	B	ND		1.1	B
Cadmium	0.30	0.53	1.8	N	ND		ND		ND	
Calcium	18.6	Not Available	Not Available		56.8	B	41.9	B	617	B
Chromium	0.9	2.0	18	N	ND		ND		1.5	B
Cobalt	3.6	35,000	220	N	ND		ND		ND	
Copper	0.8	6.5	150	N	ND		ND		ND	
Iron	46.5	320	1,100	N	192	B	46.6	B	1,100	J
Lead	2.3	3.2	15 [2]		ND		ND		ND	
Magnesium	8.7	Not Available	Not Available		33.0	B	20.4	B	158	B
Manganese	0.33	14,500	73	N	1.7	B	ND		1.1	B
Nickel	0.93	160	73	N	ND		ND		ND	
Potassium	25.50	Not Available	Not Available		37.6	B	47.1	B	74.2	B
Selenium	3.5	5.0	18	N	ND		ND		ND	
Silver	0.63	0.0001	18	N	ND		1.2	B	1.0	B
Sodium	245	Not Available	Not Available		350	J	339	J	628	J
Vanadium	0.51	10,000	26	N	1.1	B	ND		ND	
Zinc	14.8	30	1,100	N	26.8	J	21.7	J	ND	

Notes:
1. RBC Table 4/15/98, one-tenth values
2. Federal Action Level for lead.

Low-Level Radiation Burial Site, Positive Analytical Results

Notes
ND - Not detected
NA - Not analyzed
Results in bold equal or exceed RBC levels.
Shaded results equal or exceed BTAG screening levels.

Definition of Qualifiers
B - Not detected substantially above the level reported in laboratory or field blanks.
J - Analyte present. Reported value may or may not be accurate or precise.
K - Analyte present. Reported value is biased high.
L - Analyte present. Reported value is biased low.

Table A.6. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997 - Sediment

Field Sample I.D.	Method Detection Limit	BTAG Screening Level	BA18-SED1		BA18-SED2		BA18-SED3		BA18-SED4	
Date Collected			10/21/97		10/21/97		10/22/97		10/22/97	
Date Analyzed		8/9/95	11/10/97		11/10/97		11/5/97		11/5/97	
Matrix	Soil	Sediment	Sed		Sed		Sed		Sed	
Reporting Units	ug/kg	ug/kg	ug/kg	Qual	ug/kg	Qual	ug/kg	Qual	ug/kg	Qual
VOCs (SW8260A)										
Acetone	1.6	Not Available	8.3	J	ND		82	B	270	B
Methylene chloride	0.55	Not Available	20		26		58	B	83	B

Field Sample I.D.	Method Detection Limit	BTAG Screening Level	BA18-SED1		BA18-SED2		BA18-SED3		BA18-SED4	
Date Collected			10/21/97		10/21/97		10/22/97		10/22/97	
Date Extracted		8/9/95	10/22/97		10/22/97		10/28/97		10/28/97	
Date Analyzed			10/31/97		10/31/97		11/12/97		11/12/97	
Matrix	Soil	Sediment	Sed		Sed		Sed		Sed	
Reporting Units	ug/kg	ug/kg	ug/kg	Qual	ug/kg	Qual	ug/kg	Qual	ug/kg	Qual
SVOCs (SW8270B)										
Diethylphthalate	32	200	ND		ND		ND		74	J
Phenanthrene	30	240	88	J	ND		ND		ND	
Fluoranthene	33	600	124	J	ND		ND		ND	
Pyrene	36	665	91	J	ND		ND		ND	
Benzo(a)anthracene	27	261	51	J	ND		ND		ND	
Chrysene	24	384	64	J	ND		ND		ND	
Bis (2-ethylhexyl)phthalate	36	1300	ND		ND		96	J	220	
Benzo(a)pyrene	18	430	48	J	ND		ND		ND	

Field Sample I.D.	Method Detection Limit	BTAG Screening Level	BA18-SED1		BA18-SED2		BA18-SED3		BA18-SED4	
Date Collected			10/21/97		10/21/97		10/22/97		10/22/97	
Date Extracted		8/9/95	10/30/97		10/30/97		10/30/97		10/30/97	
Date Analyzed			11/13/97		11/13/97		11/13/97		11/14/97	
Matrix	Soil	Sediment	Sed		Sed		Sed		Sed	
Reporting Units	ug/kg	ug/kg	ug/kg	Qual	ug/kg	Qual	ug/kg	Qual	ug/kg	Qual
Pest/PCBs (SW8081)										
4,4'-DDE	3	2.2	7.5	J	6.6	J	7.2	J	66	J
4,4'-DDD	3	16	ND		ND		ND		16	J
4,4'-DDT	2	1.58	ND		ND		ND		36	J

Notes:
1. EPA Region III BTAG Screening Level Table, 8/9/95.

Table A.6. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997 - Sediment

Field Sample I.D.	Method Detection Limit	BTAG Screening Level	BA18-SED1		BA18-SED2		BA18-SED3		BA18-SED4	
Date Collected		8/9/96	10/21/97		10/21/97		10/22/97		10/22/97	
Date Prepared			10/25/97		10/25/97		10/25/97		10/25/97	
Date Analyzed			10/27/97		10/27/97		10/27/97		10/27/97	
Matrix	Soil	Sediment	Sed		Sed		Sed		Sed	
Reporting Units	mg/kg	mg/kg	mg/kg	Qual	mg/kg	Qual	mg/kg	Qual	mg/kg	Qual
Total Metals (SW6010A)										
Aluminum	1.6	Not Available	9,060	L	7,160	L	2,390		8,320	
Arsenic	0.31	8.2	2.4	B	3.6	B	2.9	B	4.9	B
Barium	0.08	Not Available	67.2		31.7	B	17.6		42.0	
Beryllium	0.01	Not Available	0.42	B	0.25	B	0.38	J	0.53	
Cadmium	0.03	1.2	1.1	B	1.5	B	1.0		1.4	
Calcium	1.9	Not Available	715	B	704	B	418		1,250	
Chromium	0.09	0.005	12.2	B	10.2	B	6.0		19.5	
Cobalt	0.36	Not Available	3.3	B	1.8	B	0.47	J	3.7	J
Copper	0.08	34	7.4	B	7.6	B	1.8	B	6.3	
Iron	0.47	Not Available	8,240	K	11,300	K	7,260	J	9,820	J
Lead	0.23	46.7	12.4	B	8.2	B	7.9		19.9	
Magnesium	0.87	Not Available	913	B	498	B	228		1,180	
Manganese	0.03	Not Available	117	J	279	J	48.4		131	
Mercury **(SW7470/7471)**	0.04	0.15	0.07		ND		ND		ND	
Nickel	0.09	20.9	7.1	B	4.6	B	2.5	B	10.1	J
Potassium	2.6	Not Available	436		358		75.1	J	429	
Sodium	0.25	Not Available	149	J	125	J	79.1	J	113	J
Vanadium	0.05	Not Available	17.3		15.8	B	11.9		19.5	
Zinc	1.5	150	24.0		20.0		19.1		29.0	

Notes:

1. EPA Region III BTAG Screening Level Table, 8/9/95.

Table A.6. Low-Level Radiation Burial Site, Positive Analytical Results, October 1997 - Sediment

Field Sample I.D. Date Sampled Date Prepared Date Analyzed Matrix Reporting Units	Method Detection Limit Soil mg/kg	Sediment BTAG Screening Level mg/kg	Residential Soil RBC mg/kg	Basis	BA18-SED1 10/21/97 10/25/97 10/27/97 Sed mg/kg	Qual	BA18-SED2 10/21/97 10/25/97 10/27/97 Sed mg/kg	Qual	BA18-SED3 10/22/97 10/25/97 10/27/97 Sed mg/kg	Qual	BA18-SED4 10/22/97 10/25/97 10/27/97 Sed mg/kg	Qual
Total Metals (SW6010A)												
Aluminum	1.6	Not Available	7,800	N	**9,060**	L	7,160	L	2,390		**8,320**	
Arsenic	0.31	8.2	0.43	C	**2.4**	B	**3.6**	B	**2.9**	B	4.9	B
Barium	0.08	Not Available	550	N	67.2		31.7	B	17.6		42.0	
Beryllium	0.01	Not Available	16	N	0.42	B	0.25	B	0.38	J	0.53	
Cadmium	0.03	1.2	3.9	N	1.1	B	1.5	B	1.0		1.4	
Calcium	1.9	Not Available	Not Available	N	715	B	704	B	418		1,250	
Chromium	0.09	0.005	39	N	12.2	B	10.2	B	6.0		19.5	
Cobalt	0.36	Not Available	470	N	3.3	B	1.8	B	0.47	J	3.7	J
Copper	0.08	34	310	N	7.4	B	7.6	B	1.8	B	6.3	
Iron	0.47	Not Available	2,300	N	**8,240**	K	**11,300**	K	**7,260**	J	**9,820**	J
Lead	0.23	46.7	400	N	12.4	B	8.2	B	7.9		19.9	
Magnesium	0.87	Not Available	Not Available	N	913	B	498	B	228		1,180	
Manganese	0.03	Not Available	160	N	117	J	**279**	J	48.4		131	
Mercury (SW7470/7471)					0.07		ND		ND		ND	
Nickel	0.09	20.9	160	N	7.1	B	4.6	B	2.5	B	10.1	J
Potassium	2.6	Not Available	Not Available	N	436		358		75.1	J	429	
Sodium	0.25	Not Available	Not Available	N	149	J	125	J	79.1	J	113	J
Vanadium	0.05	Not Available	55	N	17.3		15.8	B	11.9		19.5	
Zinc	1.5	150	2,300	N	24.0		20.0		19.1		29.0	

Notes:
1. RBC Table 4/15/98, one-tenth values
2. Federal Action Level for lead.

Low-Level Radiation Burial Site, Positive Analytical Results

Notes
ND - Not detected
NA - Not analyzed
Results in bold equal or exceed RBC levels.
Shaded results equal or exceed BTAG screening levels.

Definition of Qualifiers
B - Not detected substantially above the level reported in laboratory or field blanks.
J - Analyte present. Reported value may or may not be accurate or precise.
K - Analyte present. Reported value is biased high.
L - Analyte present. Reported value is biased low.

Appendix B: RESRAD Model Input Parameters - Descriptive Text

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RESRAD INPUT DATA REQUIREMENTS

*** SHADED VARIABLES INDICATE AVAILABILITY OF, OR CAPABILITY OF, GENERATING SITE-SPECIFIC DATA ***

VARIABLE	INPUT PARAMETER	DEFAULT VALUE
Dry density (ρ_s) (g/cm^3) (Ratio of Mass (M) to volume (V))	1. Cover material 2. Contaminated zone 3. Unsaturated zone 4. Saturated zone 5. Building foundation	1. 1.5 g/cm^3 2. 1.5 g/cm^3 3. 1.5 g/cm^3 4. 1.5 g/cm^3 5. 2.4 g/cm^3 1.25 FOR SAND (LOOK-UP VALUE)
Total Porosity (P_t) (Ratio of the pore volume to the total volume of a representative sample of the medium)	1. Cover material 2. Contaminated zone 3. Unsaturated zone 4. Saturated zone 5. Building foundation	1. n = 0.4 2. n = 0.4 3. n = 0.4 4. n = 0.4 5. n = 0.1 (LOOK-UP VALUE FOR SAND)
Effective Porosity (P_e) (Ratio of the part of the pore volume where the water can circulate to the total volume)	1. Cover material 2. Contaminated zone 3. Unsaturated zone	1. p_e = 0.2 2. p_e = 0.2 3. p_e = 0.2 0.3 FOR SAND (LOOK-UP VALUE)
Saturated Hydraulic Conductivity (K) (m/yr) (The ability to transmit water when submitted to a hydraulic gradient)	1. Contaminated zone 2. Unsaturated zone 3. Saturated zone	1. 10 m/yr 2. 10 m/yr 3. 100 m/yr
Volumetric Water Constant (θ) (Ratio of a mass per unit volume).	1. Cover zone 2. Building foundation material	1. θ = 0.05 (dimensionless) 2. θ = 0.01 (dimensionless)
Effective Radon Diffusion Coefficient (D^*) (m^2/s) (Net migration of radon gas towards the direction of its decreasing concentration in air).	1. Cover zone 2. Contaminated zone 3. Building foundation material	1. 2.0×10^{-6} m^2/s 2. 2.0×10^{-6} m^2/s 3. 3.0×10^{-7} m^2/s
Radon Emanation Coefficient (ϵ) (Fraction of the total amount of radon produced by radon decay that escapes from the soil particles and gets into the pores of the medium).	1. Radon-222 2. Radon-220	1. ϵ = 0.25 2. ϵ = 0.25
Precipitation Rate (P_r) (LT^{-1}) (The average volume of water that falls per unit area and per unit of time)	1. Annual aerial precipitation rate (P_r) (m/yr)	1. 1 m/yr

VARIABLE	INPUT PARAMETER	DEFAULT VALUE
Runoff Coefficient (C_r) (Fraction of average annual precipitation that does not infiltrate into the soil and is not transferred back into the atmosphere through evapotransportation)	1. Average annual runoff coefficient that represents conditions at the site.	1. 0.2 LOW W/SANDY SOIL (CALCULATION?)
Irrigation Rate (IR_t) (m/yr) (Average volume of water added to the soil at the site per unit of surface area and per unit of time)	1. Average annual irrigation rate	1. 0.2 m/yr NOT APPLICABLE
Evapotranspiration: Evapotranspiration rate (lt^{-1}) (ET_t) (Total volume of water transferred to the atmosphere) Evapotranspiration Coefficient (C_t) (Ratio of water leaving the ground as the result of evapotranspiration ET_t to the total volume of water available within the root zone of the soil during a fixed period of time)	1. C_t	1. 0.5 CALCULATION?
Soil-specific Exponential *b* Parameter (Hydrogeological parameter used to calculate the radionuclide leaching rate of the contaminated zone).	1. Contaminated zone. 2. Unsaturated zone strata. 3. Saturated zone.	1. b = 5.3 2. b = 5.3 3. b = 5.3
Erosion Rate (m/yr) (Average volume of soil material removed per unit of ground surface area per unit of time).	Average annual erosion rate for: 1. Cover zone 2. Contaminated zone	1. 0.001 m/yr 2. 0.001 m/yr
Hydraulic gradient (J_h) (In an unconfined aquifer, the horizontal hydraulic gradient of approximately the slope of the water table)	1. J_h in the dominant groundwater flow direction in the underlying aquifer at the site	1. 0.02
Length of contaminated zone parallel to the aquifer flow (*l*) (m)	1. Length of contaminated zone parallel to the aquifer flow (*l*) (m)	1. 100 m
Watershed area for nearby stream or pond (*F*) (Surface area of the draining region above the discharge measuring points)	1. Area of the watershed region draining into the stream or pond located at the vicinity of the site	1. $1 \times 10^6 m^2$ COE INFO. AVAILABLE
Water table drop rate (lt^{-1}) (Rate at which the depth of the water table is lowered).	1. Average annual water table drop rate.	1. 0.001 m/yr
Well pump intake depth (*l*) (Screened depth of a well within the aquifer (saturated zone))	1. Well pump intake depth	1. 10 m
Radon Vertical Dimension of mixing (*l*) (Height of the atmospheric boundary layer near the ground surface into which the radon gas that emanates from the ground is uniformly mixed in the outdoor air).	1. Radon Vertical Dimension of mixing.	1. 2 m
Average Building Air Exchange Rate (T^{-1}) (total volume of air contained in the building that is being exchanged with the outside air per unit of time).	1. Average building air exchange rate.	1. 0.5 h^{-1}
Building room height (*l*) (average height of the house).	1. Building room height.	1. 2.5 m
Building Indoor Area Factor (fraction of the floor area built on the contaminated area).	1. Building indoor area factor.	1. Zero

VARIABLE	INPUT PARAMETER	DEFAULT VALUE
Thickness of uncontaminated unsaturated zone (Portion of the uncontaminated zone that lies below the bottom of the contaminated zone and above the water table)	1. A value for each stratum used in the calculation (entering a non-zero thickness for a stratum activates that stratum)	1. Defaults are supplied for all parameters of an active stratum.
Building Foundation Thickness (m) (Average thickness of the building shell structure in the subsurface of the soil)	1. Building foundation thickness	1. 0.15 m
Foundation depth below ground surface (m) (vertical distance in the soil from the very bottom of the basement floor slab to the ground surface)	1. Foundation depth below ground surface	1 1.0 m
Fraction of time spent indoors on-site (dimensionless)	1. Fraction of time spent indoors on site	1. 0.5
Fraction of time spent outdoors on-site (dimensionless)	1. Fraction of time spent outdoors on-site	1. 0.25
Area of Contaminated zone (m²) (Locations of soil samples with radionuclide concentrations clearly exceeding background levels)	1. Actual area of the contaminated zone	1. 10,000 m²
Cover depth (m) (Distance on meters from the ground surface to the location of the uppermost soil sample with radionuclide concentrations clearly above background)	1. Cover depth	1. 0 m
Distribution coefficient (K_d) (Ratio of the mass of solute species adsorbed or precipitated on the solids per unit dry mass of the soil S to the solute concentration in the liquids)	1. Distribution coefficients for each element by soil type	1. From Table 32.1 of RESRAD Data Collection Hand book
Radionuclide concentration in groundwater (pCi/L) (Principal radionuclide concentration in a well located at the downgradient edge of the contaminated zone)	1. Radionuclide with non-zero concentrations in groundwater	1. No default
Leach rate (T^{-1}) (Fraction of the available radionuclide leached out from the contaminated zone per unit of time)	1. Leach rate.	1. 0
Mass loading for inhalation (g/m³) (Concentration of soil particles in the air)	1. Mass loading factor for transportable particles at an onsite loading to take into account short periods of high mass loading).	1. 2.0×10^{-4} g/m³
Shielding factor for inhalation pathway (Ratio of airborne dust concentration indoors on-site to the concentration outdoors on site).	1. Shielding factor for dust inhalation.	1. 0.4
Depth of Roots (m) (Average root depth of various plants grown in the contaminated zone).	1. Average root depth.	1. 0.9 m GRASS?
Soil ingestion rate (g/yr) (Accidental ingestion rate of soil material or soil dust)	1. Soil ingestion rate.	1. 36.5 g/yr (assumes an average soil intake rate of 0.1 g/d for 365 d/yr).
Thickness of Contaminated zone (m) (Distance between the uppermost and lowermost soil samples that have radionuclide concentrations clearly above background)	1. Thickness of contaminated zone.	1. 2 m

VARIABLE	INPUT PARAMETER	DEFAULT VALUE
Radiation Dose Limit (The effective dose equivalent from external radiation plus the committed effective dose equivalent from internal radiation)	1. Radiation dose limit	1. 30 mrem/yr
Seafood Consumption Rate (kg/yr)	1. Seafood Consumption Rate.	1. 5.4 kg/yr for fish, 0.9 kg/yr for other seafood.
Fruit, vegetable, and grain consumption rate (kg/yr).	1. Fruit, vegetable, and grain consumption rate	1. 160 kg/yr.
Inhalation Rate (m^3/hr)	1. Inhalation rate	1. 8,400 m^3/yr
Leafy Vegetable Consumption Rate (kg/yr)	1. Leafy Vegetable Consumption Rate	1. 14 kg/yr
Livestock water intake rate for beef cattle and milk cows (L/d)	1. Beef cattle. 2. Milk cows.	1. 50 L/d 2. 160 L/d
Meat and Poultry Consumption Rate (kg/yr)	1. Meat consumption rate 2. Poultry consumption rate.	1. 63 kg/yr 2. 63 kg/yr
Milk Consumption Rate (L/yr)	1. Milk consumption rate.	1. 92 L/yr
Shielding Factor for External Gamma Radiation (ratio of the external gamma radiation level indoors on-site to the radiation level outdoors on-site)	1. External gamma radiation.	1. 0.7
Elapsed Time of Waste Placement (Yrs) (Duration between the placement of radioactive waste on-site and the performance of a radiological survey)	1. Elapsed time of waste placement	1. 0
Shape Factor (external gamma) (used to correct for a non-circular shaped contaminated area on the basis of an ideally circular zone)	1. Shape factor	1. 1
Initial Concentrations of Principal Radionuclides (pCi/g) (A principal radionuclide is a radionuclide with a half life longer that one-half year. Radionuclides with a half-life of one-half year or less are treated as associated nuclides)	1. Initial concentrations of principal radionuclides in the contaminated zones (RESRAD treats the contaminated zone as a uniformly contaminated area with a single radionuclide concentration at every point	1. No default
Drinking Water Intake Rate (L/yr) (Average amount of water consumed by an adult)	1. Drinking Water Intake Rate	1. 510 L/yr

Appendix C: RESRAD Model Input Parameters - Values

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Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.000E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.800E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	7.500E+01	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	1.000E+01	3.000E+00	---	T(3)
R011	Times for calculations (yr)	5.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.000E+02	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+03	1.000E+02	---	T(6)
R011	Times for calculations (yr)	1.000E+04	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+05	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): C-14	7.120E+03	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Cl-36	8.820E-01	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): H-3	4.770E+04	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Ni-63	1.810E+03	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g): Ra-226	7.830E+01	0.000E+00	---	S1(6)
R012	Initial principal radionuclide (pCi/g): Sr-90	6.200E+01	0.000E+00	---	S1(7)
R012	Concentration in groundwater (pCi/L): C-14	1.750E+02	0.000E+00	0.000E+00	W1(1)
R012	Concentration in groundwater (pCi/L): Cl-36	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): H-3	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Ni-63	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L): Ra-226	3.000E+00	0.000E+00	0.000E+00	W1(6)
R012	Concentration in groundwater (pCi/L): Sr-90	not used	0.000E+00	---	W1(7)
R013	Cover depth (m)	1.500E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	1.250E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.250E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	3.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	6.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/cm**3)	8.000E+00	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	7.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.180E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+05	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.250E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	3.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	6.000E+01	1.000E+02	---	HCSZ

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Saturated zone hydraulic gradient	2.500E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	6.500E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.250E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	3.000E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	6.000E+01	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for C-14				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.832E-01	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Cl-36				
R016	Contaminated zone (cm**3/g)	1.000E-01	1.000E-01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	1.000E-01	1.000E-01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	1.000E-01	1.000E-01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.985E-01	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for H-3				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.832E-01	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Ni-63				
R016	Contaminated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.258E-04	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.793E-03	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)

Appendix D: RESRAD Predicted Dose: Direct Contact/Construction Scenario

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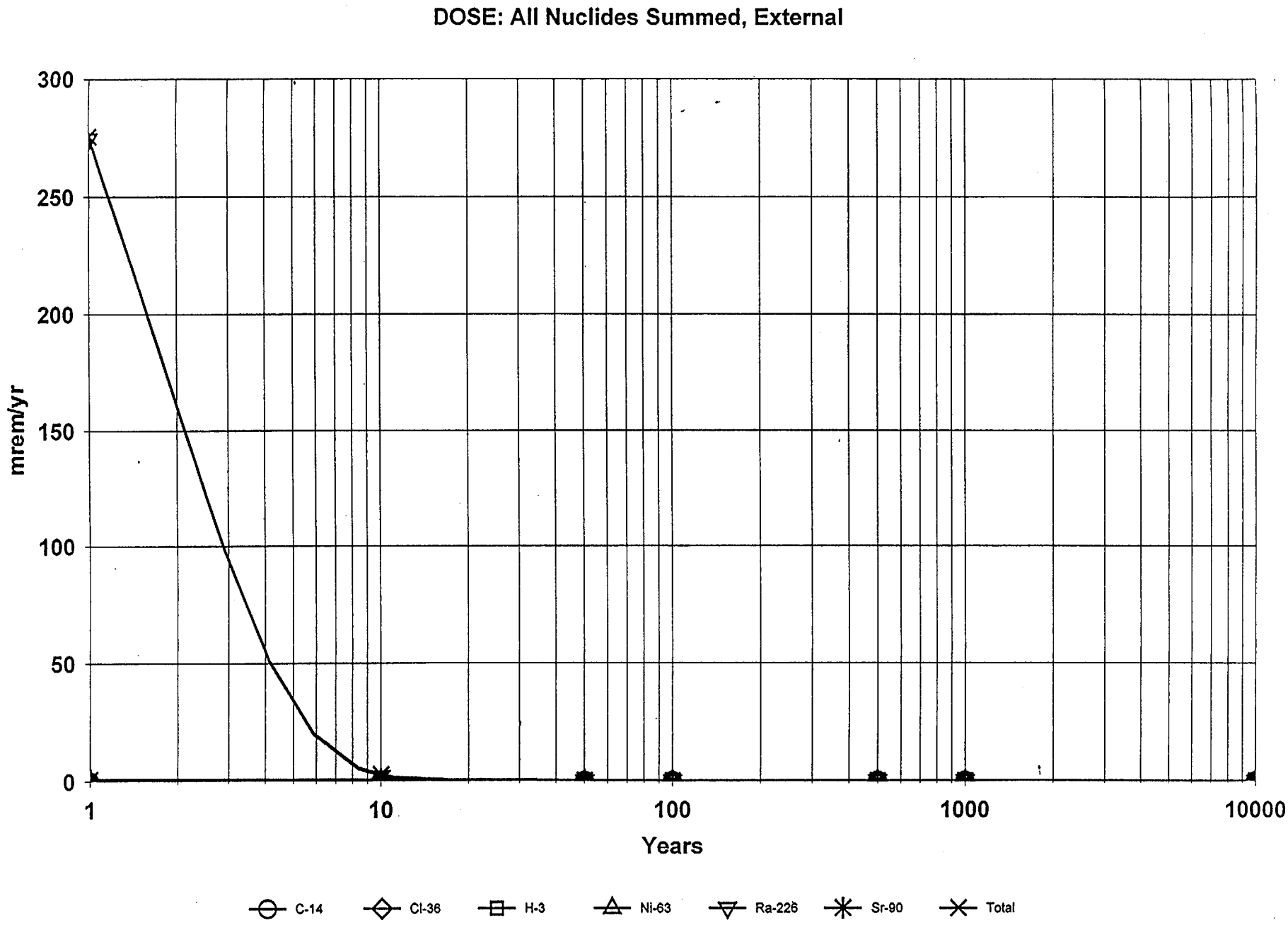
NO COVER: DIRECT CONSTRUCTION WITH 0 MAX SOIL CONC.



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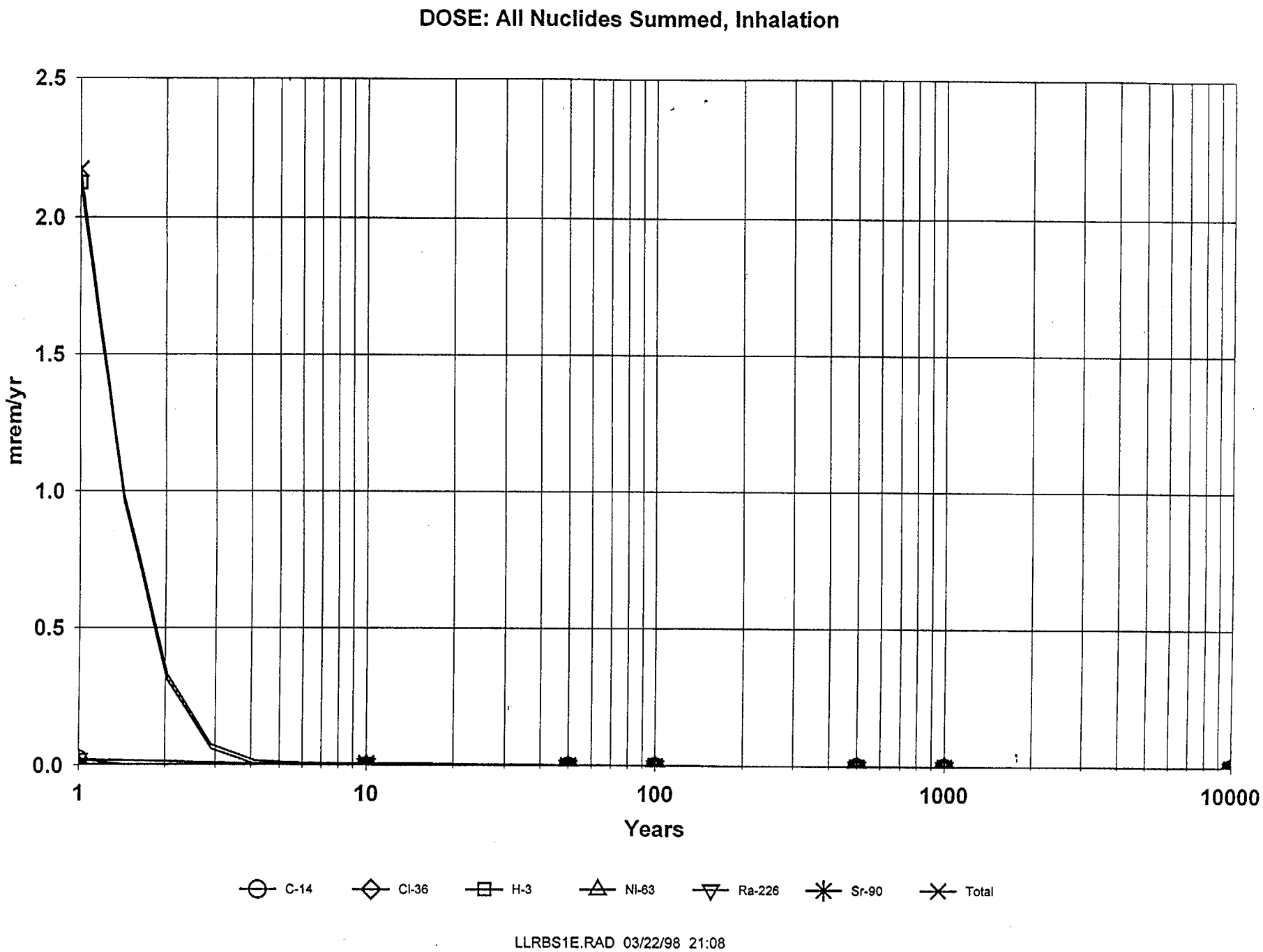
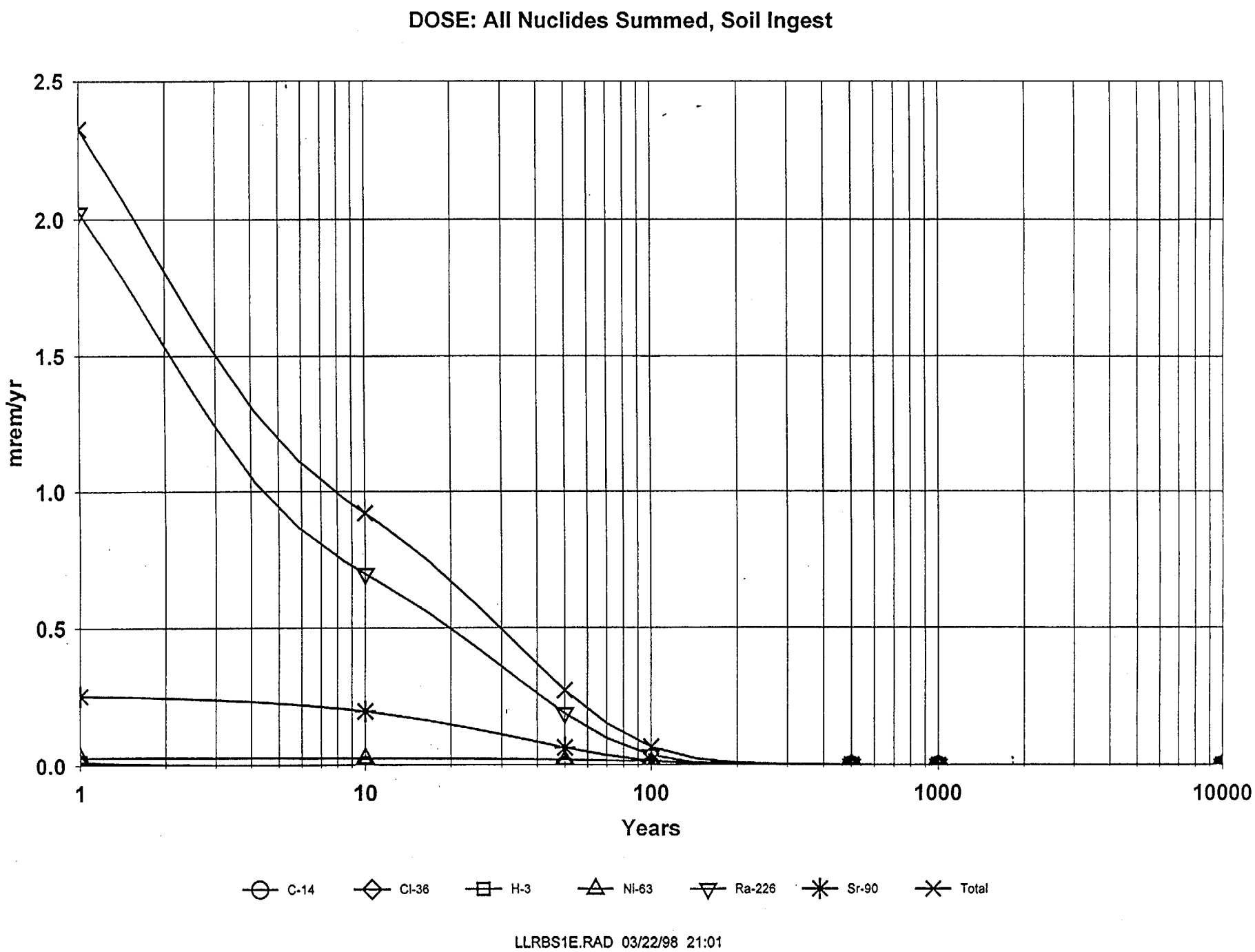

DOSE: All Nuclides Summed, Inhalation
2.5
2.0
1.5
1.0
0.5
0.0
mrem/yr
1
10
100
1000
10000
Years
C-14
Cl-36
H-3
Ni-63
Ra-226
Sr-90
Total
LLRBS1E.RAD 03/22/98 21:08


DOSE: All Nuclides Summed, Soil Ingest
mrem/yr
2.5
2.0
1.5
1.0
0.5
0.0
1
10
100
1000
10000
Years
C-14
Cl-36
H-3
Ni-63
Ra-226
Sr-90
Total
LLRBS1E.RAD 03/22/98 21:01

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Appendix E: RESRAD Predicted Dose: Direct Contact/Construction Scenario 1/100th Estimated Soil Concentration

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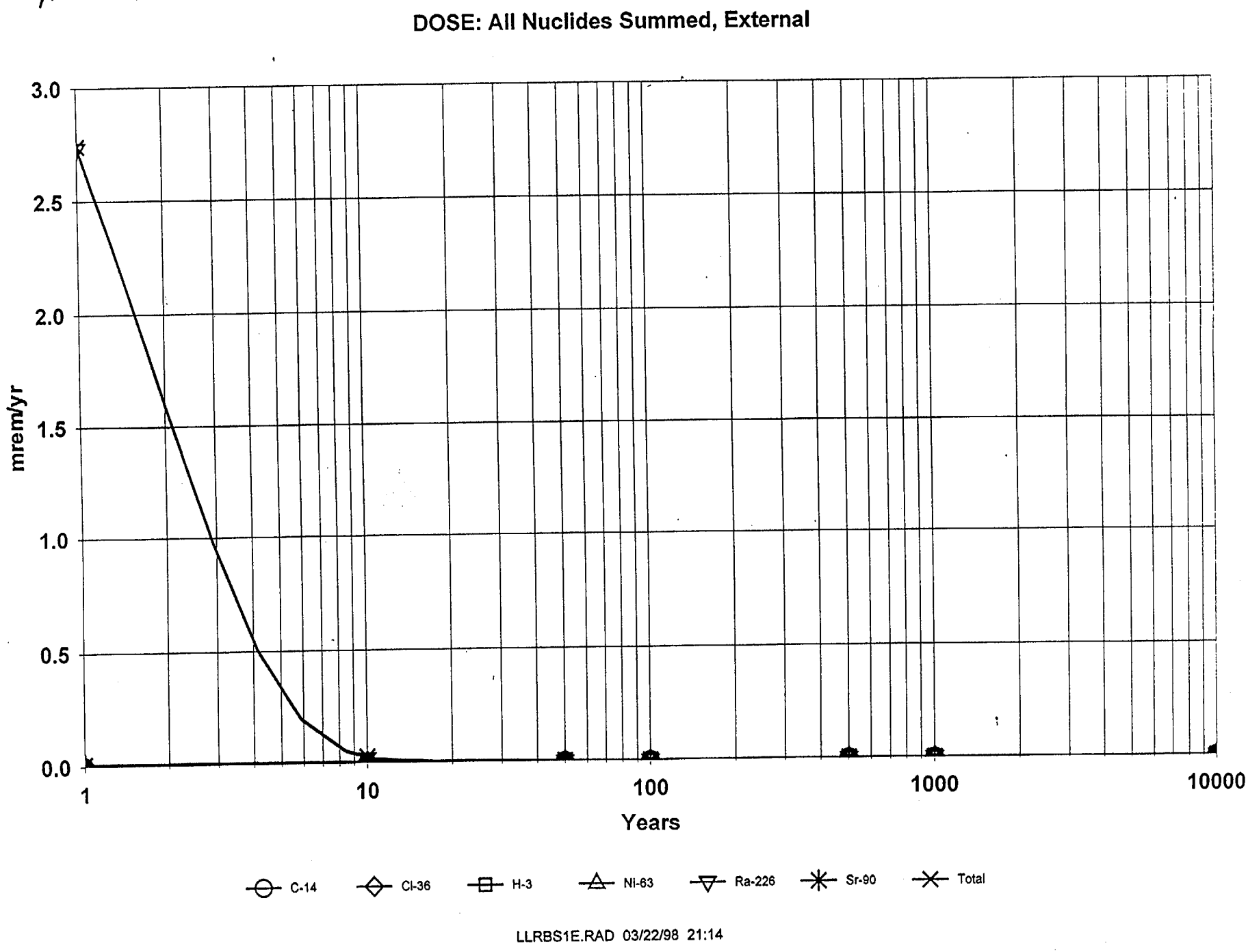
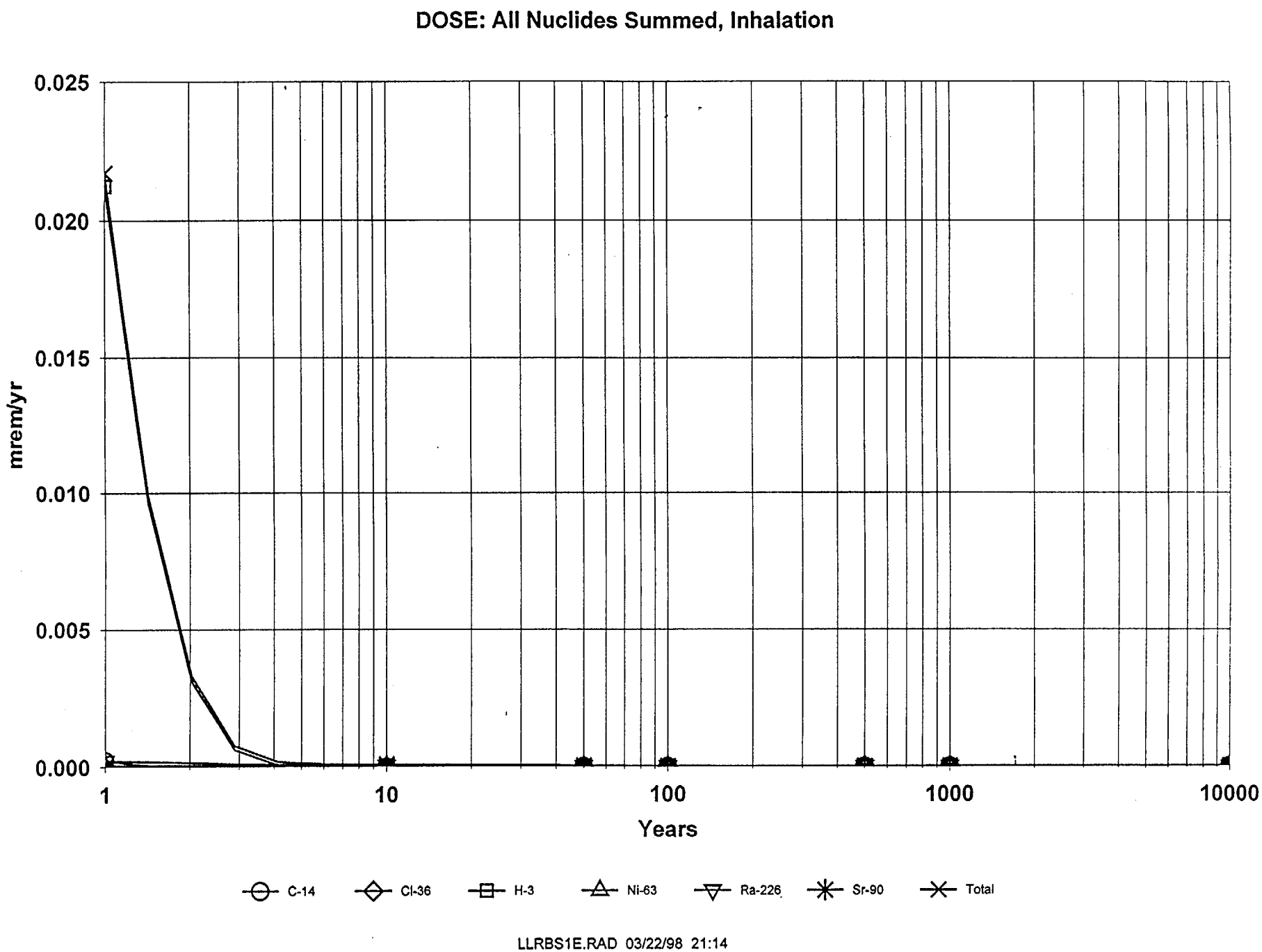
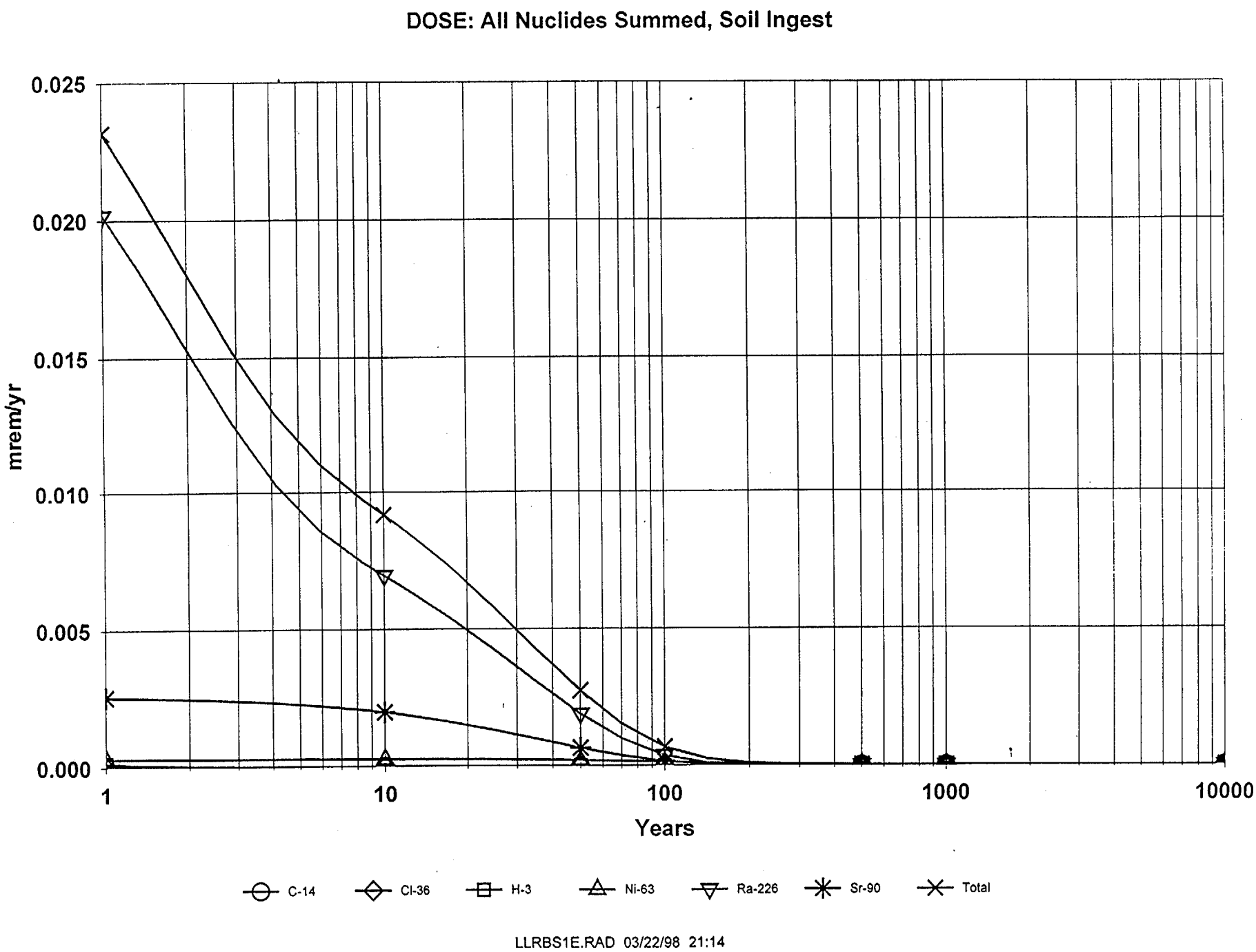
NO COVER - DIRECT CONTACT / CONSTRUCTION SCENARIO
1/100 MAX SOIL CONC.




DOSE: All Nuclides Summed, Inhalation
0.025
0.020
0.015
0.010
0.005
0.000
mrem/yr
1
10
100
1000
10000
Years
C-14
Cl-36
H-3
Ni-63
Ra-226
Sr-90
Total
LLRBS1E.RAD 03/22/98 21:14


DOSE: All Nuclides Summed, Soil Ingest
0.025
0.020
0.015
0.010
0.005
0.000
mrem/yr
1
10
100
1000
10000
Years
C-14
Cl-36
H-3
Ni-63
Ra-226
Sr-90
Total
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Appendix F: Cost Estimates for Limited, Bulk, and Hybrid Excavation Alternatives

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COST SUMMARY

PROJECT NAME:	USDA BELTSVILLE MARYLAND
CLIENT:	USDA
ALTERNATIVE:	LIMITED EXCAVATION

DIRECT COST	$2,773,522.70
OVERHEAD	$368,891.04
PROFIT	$251,393.10
TOTAL SELL	$3,393,806.84

TOTAL PROJECT COST SUMMARY

	LABOR CHARGES	MATERIAL CHARGES	EQUIPMENT CHARGES	SUB-CON. CHARGES	ODC CHARGES	TOTAL PRICE
ADMINISTRATION	$69,673	$0	$0	$0	$0	**$69,673**
MOBILIZATION	$14,257	$3,424	$12,962	$0	$4,752	**$35,394**
REMOVAL OF FENCE AROUND SITE	$6,435	$1,836	$4,320	$0	$0	**$12,591**
EXCAVATE 2000 CY CLEAN DIRT	$24,438	$19,143	$12,960	$0	$0	**$56,541**
EXCAVATE DIRTY DIRT - 1835 CY	$48,876	$6,723	$4,320	$0	$0	**$59,919**
ERECT 50X90BUILDING	$114,247	$6,026	$18,576	$21,600	$0	**$160,449**
DEMOB 50 X 90 BUILDING	$57,124	$0	$21,384	$0	$0	**$78,508**
DECON-DEMOB	$34,284	$3,240	$0	$0	$0	**$37,524**
ENVIRO-CARE DISPOSE RAD DIRT	$0	$0	$0	$2,067,444	$0	**$2,067,444**
SAMPLING-H-P SUB	$0	$0	$0	$490,968	$0	**$490,968**
DATA VALADIATION	$62,208	$0	$0	$0	$0	**$62,208**
ROLL OFF BINS AND TRUCK-DRIVE	$205,701	$10,800	$0	$0	$0	**$216,501**
BACKFILL AND COMPACT	$17,905	$20,650	$5,912	$1,620	$0	**$46,087**
TOTAL SELL	**$655,147**	**$71,842**	**$80,434**	**$2,581,632**	**$4,752**	**$3,393,807**

COST SUMMARY

PROJECT NAME:	USDA BELTSVILLE MARYLAND
CLIENT:	USDA
ALTERNATIVE:	BULK EXCAVATION

DIRECT COST	$5,117,195.00
OVERHEAD	$476,598.12
PROFIT	$447,503.45
TOTAL SELL	$6,041,296.57

TOTAL PROJECT COST SUMMARY

	LABOR CHARGES	MATERIAL CHARGES	EQUIPMENT CHARGES	SUB-CON. CHARGES	ODC CHARGES	TOTAL PRICE
ADMINISTRATION	$69,673	$0	$0	$0	$0	**$69,673**
MOBILIZATION	$14,257	$3,424	$12,962	$0	$4,752	**$35,394**
REMOVAL OF FENCE AROUND SITE	$6,435	$1,836	$4,320	$0	$0	**$12,591**
EXCAVATE 5600 CY CLEAN DIRT	$48,876	$19,683	$12,960	$0	$0	**$81,519**
EXCAVATE INTERVENING SOIL AND	$97,752	$9,423	$4,320	$0	$0	**$111,495**
ERECT 50X90BUILDING	$114,247	$6,026	$18,576	$21,600	$0	**$160,449**
DEMOB 50 X 90 BUILDING	$57,124	$0	$21,384	$0	$0	**$78,508**
DECON-DEMOB	$34,284	$3,240	$0	$0	$0	**$37,524**
ENVIRO-CARE DISPOSE RAD DIRT	$0	$0	$0	$4,263,192	$0	**$4,263,192**
SAMPLING-H-P SUB	$0	$0	$0	$682,128	$0	**$682,128**
DATA VALADIATION	$93,312	$0	$0	$0	$0	**$93,312**
ROLL OFF BINS AND TRUCK-DRIVE	$274,268	$54,000	$0	$0	$0	**$328,268**
BACKFILL AND COMPACT	$35,810	$31,510	$11,824	$8,100	$0	**$87,244**
TOTAL SELL	**$846,037**	**$129,142**	**$86,346**	**$4,975,020**	**$4,752**	**$6,041,297**

COST SUMMARY

PROJECT NAME:	USDA BELTSVILLE MARYLAND
CLIENT:	USDA
ALTERNATIVE:	HYBRID EXCAVATION

DIRECT COST	$2,845,111.70
OVERHEAD	$388,529.88
PROFIT	$258,691.33
TOTAL SELL	$3,492,332.91

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TOTAL PROJECT COST SUMMARY

	LABOR CHARGES	MATERIAL CHARGES	EQUIPMENT CHARGES	SUB-CON. CHARGES	ODC CHARGES	TOTAL PRICE
ADMINISTRATION	$69,673	$0	$0	$0	$0	**$69,673**
MOBILIZATION	$14,257	$3,424	$12,962	$0	$4,752	**$35,394**
REMOVAL OF FENCE AROUND SITE	$6,435	$1,836	$4,320	$0	$0	**$12,591**
EXCAVATE 3800 CY CLEAN DIRT	$48,876	$19,143	$12,960	$0	$0	**$80,979**
EXCAVATE DIRTY DIRT - 1835 CY	$48,876	$6,723	$4,320	$0	$0	**$59,919**
ERECT 50X90BUILDING	$114,247	$6,026	$18,576	$21,600	$0	**$160,449**
DEMOB 50 X 90 BUILDING	$57,124	$0	$21,384	$0	$0	**$78,508**
DECON-DEMOB	$34,284	$3,240	$0	$0	$0	**$37,524**
ENVIRO-CARE DISPOSE RAD DIRT	$0	$0	$0	$2,067,444	$0	**$2,067,444**
SAMPLING-H-P SUB	$0	$0	$0	$554,688	$0	**$554,688**
DATA VALADIATION	$72,576	$0	$0	$0	$0	**$72,576**
ROLL OFF BINS AND TRUCK-DRIVE	$205,701	$10,800	$0	$0	$0	**$216,501**
BACKFILL AND COMPACT	$17,905	$20,650	$5,912	$1,620	$0	**$46,087**
TOTAL SELL	**$689,953**	**$71,842**	**$80,434**	**$2,645,352**	**$4,752**	**$3,492,333**

BETWEEN:

License Fee Management Branch, ARM
and
Regional Licensing Sections

(FOR LFMS USE)
INFORMATION FROM LTS

Program Code: 03613
Status Code: O
Fee Category: EX 3L
Exp. Date: 20050930
Fee Comments: _____
Decom Fin Assur Reqd: Y

LICENSE FEE TRANSMITTAL

A. REGION I

1. APPLICATION ATTACHED
Applicant/Licensee: AGRICULTURE, DEPARTMENT OF
Received Date: 19990702
Docket No: 3004530
Control No.: 126997
License No.: 19-00915-03
Action Type: Notifications

2. FEE ATTACHED
Amount: _____
Check No.: _____

3. COMMENTS

Signed Rebecca J. Brown
Date 7/6/99

B. LICENSE FEE MANAGEMENT BRANCH (Check when milestone 03 is entered /__/)

1. Fee Category and Amount: _____

2. Correct Fee Paid. Application may be processed for:
Amendment _____
Renewal _____
License _____

3. OTHER _____
_____

Signed _____
Date _____

This is to acknowledge the receipt of your letter/application dated

6-28-99, and to inform you that the initial processing which includes an administrative review has been performed.

☒ NOTIF. There were no administrative omissions. Your application was assigned to a technical reviewer. Please note that the technical review may identify additional omissions or require additional information.

☐ Please provide to this office within 30 days of your receipt of this card

_____.

A copy of your action has been forwarded to our License Fee & Accounts Receivable Branch, who will contact you separately if there is a fee issue involved.

Your action has been assigned **Mail Control Number** 126997.
When calling to inquire about this action, please refer to this control number.
You may call us on (610) 337-5398, or 337-5260.

NRC FORM 532 (RI)
(6-96)

Sincerely,
Licensing Assistance Team Leader