FINAL

Record of Decision for Operable Unit 3

Redstone Arsenal

Madison County, Alabama
US EPA ID No. AL7 210 020 742

September 1999

Alabama Department of Environmental Management

U.S. Army Aviation and Missile Command

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List of Acronyms

ADEM	Alabama Department of Environmental Management
AMCOM	U.S. Army Aviation and Missile Command
BHHRA	baseline human health risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	chemical(s) of potential concern
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ERDEC	Edgewood Research, Development, and Engineering Center
GB	sarin
HD	distilled mustard
HI	hazard index
HQ	hazard quotient
ILCR	incremental lifetime cancer risk
MCL	maximum contaminant level
µg/kg	micrograms per kilogram
MSFC	George C. Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
OU	Operable Unit
PCB	polychlorinated biphenyl
RBC	risk-based concentration
RI	remedial investigation
ROD	record of decision
RSA-47	Former Chemical Training Facility
SARA	Superfund Amendments and Reauthorization Act
SVOC	semivolatile organic compound
TAL	target analyte list
VOC	volatile organic compound

1.0 Declaration

1.1 Site Name and Location

Operable Unit (OU)-3 containing the Former Chemical Training Facility (RSA-47)
Redstone Arsenal
Madison County, Alabama

1.2 Statement of Basis and Purpose

No further action has been selected for OU-3 at the Redstone Arsenal in Madison County, Alabama. OU-3 contains only one site, RSA-47; therefore, this record of decision (ROD) is for the entire OU-3. No further action was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This ROD is based on the administrative record for the RSA-47 site.

The decision for no further action for OU-3 has been made by the U.S. Army Aviation and Missile Command (AMCOM) at Redstone Arsenal in partnership with the Alabama Department of Environmental Management (ADEM) and the U.S. Environmental Protection Agency (EPA), Region IV.

1.3 Assessment of the Site

OU-3 contains RSA-47 which is a former chemical training facility used from 1972 until 1986 to train military students in the handling and use of chemical agents (mustard and nerve agents) including detection and decontamination. The 32 square foot pad at the end of the gravel strips used for training exercises and the primary personnel decontamination area (near Building 3536) were the most likely locations for potential contaminants. Concrete catch basins with multiple impermeable liners were used for the equipment decontamination. Materials that were used to decontaminate equipment or neutralize chemical agents included chlorinated solvent mixtures (trichloroethene and perchloroethene), bleach, caustic soda, and sodium hydroxide. Sampling and analysis efforts revealed low concentrations of organic compounds and metals in soil, sediment, surface water, and groundwater. A baseline human health risk assessment (BHHRA) and an ecological risk assessment (ERA) were conducted to identify potential threats from these constituents and to determine if current or anticipated conditions at RSA-47 warrant remedial action.

During the BHHRA (Draft-Final Remedial Investigation Report for OU-3, 1998a), four types of individuals (receptors) were evaluated for potential exposure to contaminants at RSA-47: future groundskeeper, future construction worker, current and future sportsman, and future onsite resident (adult and child, and child only). The first three scenarios were based on current and future land use plans for Redstone Arsenal as presented in the Redstone Arsenal Master Plan (1989). The last scenario, the future onsite resident, was included as a conservative measure but is not a likely scenario.

The risk assessment results indicated no unacceptable risk for current or future industrial scenarios. The total cancer risk, or the incremental lifetime cancer risk (ILCR), was 1.7×10^{-6} for the groundskeeper, 6.8×10^{-8} for the construction worker, and 6.7×10^{-6} for the on-site adult resident. These ILCRs resulted from exposure to the bedrock groundwater. The ILCR for the sportsman was not calculated because no chemicals of potential concern (COPC) were selected in soil at RSA-47. The ILCR for the on-site adult resident was used as the conservative value since the adult will have a longer exposure duration than will a child. The calculated ILCRs were all within the range of 1×10^{-4} to 1×10^{-6}, generally considered to be acceptable (EPA Risk Assessment Guidance for Superfund, 1989). All of the noncancer hazard indices (HI) were within the acceptable range (i.e., HI less than 1.0), except for a future child resident, who had a calculated HI of 3.1. This HI was based on the maximum detected concentration of acetone, which was significantly greater than other detected values of acetone in groundwater and is likely to be an anomaly (i.e., common sampling and laboratory contaminant). In addition, because the future land use at this site will continue to be industrial, an on-site resident is not a likely scenario for exposure. Thus, the human health risks calculated in the BHHRA support a no further action decision for OU-3.

Analyses of impacts of contaminants on terrestrial species provided the basis for evaluating potential ecological impacts. The ERA revealed no significant risks to terrestrial habitat and receptors. A permanent aquatic system does not exist within OU-3; consequently, the ERA did not evaluate the aquatic exposure pathway.

1.4 Description of the Selected Remedy

The recommended solution for addressing the minimal levels of contamination at OU-3 is no further action. No further action is appropriate because there is no unacceptable site risk associated with current and future industrial land use.

1.5 Statutory Determinations

No further action has been selected for OU-3 since this remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to this remedial action, and is a cost-effective application of public funds. This remedy will not leave in place hazardous substances at concentrations that require limiting the future industrial use of OU-3, or that require land use control restrictions to exposure. Therefore, a 5-year review will not be required. There will be no further remedial costs associated with implementing no further action at OU-3.

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13 Sep 99
Date

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2.0 Decision Summary

2.1 Site Name, Location, and Description

Redstone Arsenal is located in southern Madison County, Alabama and is bounded on the north and east by the city of Huntsville; on the northwest by the town of Madison, on the south by Wheeler National Wildlife Refuge and the Tennessee River; and on the west by agricultural, residential, and light industrial areas (Figure 1).

OU-3 is located in the north-central portion of Redstone Arsenal (Figure 1) and covers an elliptically-shaped area (approximately 1 by 3 miles in size) consisting of uplands along the southeastern, eastern, and northern flanks of Weeden Mountain and the eastern flank of Madkin Mountain. RSA-47 is the only site within OU-3. RSA-47 is located north of Madkin Mountain in a cove known locally as Skunk Hollow. This site is within the eastern portion of OU-3 and occupies approximately 30 acres of land that is primarily wooded. A small creek flows along the southern border of the site. The creek is normally dry, but will contain water following heavy rains. A paved road extends through the center of the site. The road provided access to the training areas and contains spurs extending on the sides. RSA-47 is a former chemical agent training facility for military students that operated between 1972 and 1986.

Redstone Arsenal encompasses approximately 38,300 acres. The Department of the Army controls 36,459 acres of that total, of which approximately 15,500 acres are woodlands, 5,360 acres are leased for agricultural use, and approximately 12,000 acres are used for test ranges. The National Aeronautics and Space Administration (NASA) George C. Marshall Space Flight Center (MSFC) leases 1,841 acres of land within the central region of Redstone Arsenal. Morton-Thiokol Chemical Corporation, a government contractor that began development of various types of rocket propellants at Redstone Arsenal in 1949, previously operated facilities within the Redstone Arsenal Rocket Engine facility area. International Specialty Products leases approximately 10 acres of land in the central portion of Redstone Arsenal for production of iron carbonyl. Approximately 2,900 acres owned by the Tennessee Valley Authority, and 4,100 acres of Wheeler National Wildlife Refuge are within the Redstone Arsenal boundaries.

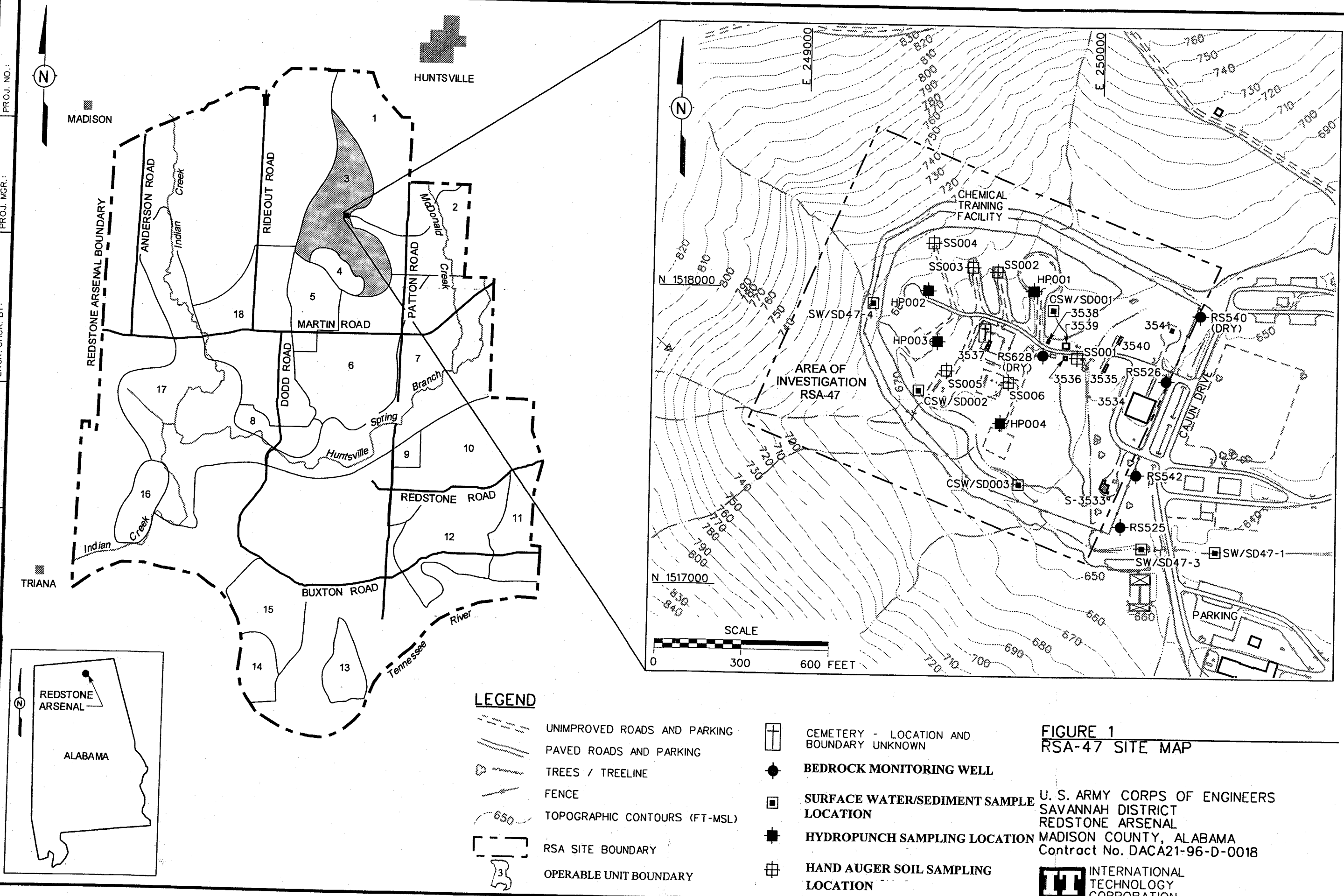

FIGURE 1
RSA-47 SITE MAP

U. S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT
REDSTONE ARSENAL
MADISON COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

INTERNATIONAL TECHNOLOGY CORPORATION

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2.2 Site History and Enforcement Activities

2.2.1 History of Site Activities

Very limited quantities of chemical agents (five gallons of decontaminant for each 20 milliliters of agent), including distilled mustard (HD) and nerve agents (sarin [GB] and VX), were used at the site from 1972 through 1986 at RSA-47 to train military students in detection and decontamination of these agents. The 32 square foot gravel pad at the end of the gravel strips used for training exercises and the primary personnel decontamination area (shower and captive sump near Building 3536) were the most likely locations for potential contaminants (Figure 1). Decontaminated clothing was bagged and stored in fenced area 3537 near the center of the site. Building 3539 was used as the mixing facility where the live agent, up to 10 milligrams, was mixed for the training exercises. Concrete catch basins, which contained nested (multiple) impermeable liners, were used for the equipment decontamination. Materials typically used to decontaminate equipment or neutralize chemical agents included bleach, caustic soda, sodium hydroxide, and solvent mixtures containing trichloroethene and perchloroethene. These fluids were collected and neutralized in the concrete catch basins and then pumped into drums for off-site disposal. Training exercises with chemical agents also predated the use of lined catch basins. The training area was surrounded by a 450-meter-radius safety circle for containment and cleanup, if necessary. Currently, the facility is still active; however, training is limited to using simulated chemical agents.

2.2.2 Previous Investigations

The earliest attempt to quantify the degree of environmental contamination at RSA-47 was conducted in 1986. At that time, the Army collected and analyzed 135 soil samples for the chemical agents GB, VX, and HD. Six samples contained GB and nineteen contained VX at maximum concentrations of 1.05 and 1.92 micrograms per kilogram (µg/kg), respectively.

EPA conducted a visual site inspection at RSA-47 in 1989; no samples were collected. A preliminary assessment was performed in 1989 to aid in the identification of potential solid waste management units (Final Identification and Evaluation of Potential Solid Waste Management Units and Areas of Concern, 1991). On June 30, 1994, Redstone Arsenal was added to the National Priorities List. As a result, RSA-47 was placed administratively under the CERCLA program.

Under CERCLA, a Phase I remedial investigation (RI) (Final Site Characterization Report, 1996) and a Phase II RI (Draft-Final Remedial Investigation Report for OU-3, 1998a), which included a

BHHRA and ERA, were conducted. Field activities for the Phase I RI conducted from August through October 1994 included a soil gas survey at 25 locations, the collection and analysis of three surface water and sediment samples, subsurface soil sampling, the installation of three bedrock monitoring wells, and groundwater sampling from each well. An attempt was made to install a fourth well (designated as RS540); however, this location was dry upon completion of the boring and the borehole was grouted to the surface. Site characterization sampling locations are shown on Figure 1. The Phase II RI sampling program was conducted in January and February 1997 and consisted of the collection and analysis of three collocated surface water/ sediment samples, six surface soil samples, and seven subsurface soil samples. The three existing bedrock wells were re-sampled as part of this effort and one additional boring (RS628) was drilled into the bedrock for installation of a monitoring well; however, no groundwater was present and the boring was subsequently grouted to the surface.

The sampling and analysis efforts during the RI revealed low concentrations of organic compounds and metals in surface soil, subsurface soil, sediment, surface water, and groundwater. No chemical agents were detected in any of the site media in either the Phase I or Phase II RI. Studies found in literature have shown that both VX and GB degrade very rapidly in soil which would explain why the nerve agents that were detected in the soil by the Army at the conclusion of the training in 1986 were no longer present in the mid- to late 1990s (Environmental Chemistry and Fate of Chemical Warfare Agents, 1994).

2.2.3 Remedial Actions

No remedial actions were conducted at RSA-47.

2.3 Highlights of Community Participation

AMCOM at Redstone Arsenal solicited input from the community on the proposed plan for the ROD at OU-3. The final proposed plan was released in early April 1999 to information repositories which are available to the public. The notice of availability for this plan and other documents in the Administrative Record was published in the *Huntsville Times* on Sunday, April 11, and Wednesday, April 14, 1999. AMCOM set a public comment period from April 11, 1999 to May 10, 1999 to encourage public participation in the selection process. A public meeting was held on April 20, 1999 at the "Path to Nature," Redstone Arsenal (in conjunction with an open house and "Earth Day Celebration") from 10 a.m. to 4 p.m. to present the proposed plan, answer questions, and accept comments. Neither written or oral comments on OU-3 were received from the public during the meeting or during the public comment period.

2.4 Scope and Role of Operable Unit Within Site Strategy

Under CERCLA, a site is a discrete area that is part of a larger area or OU. At Redstone Arsenal, 18 OUs (OU-1 through OU-18) have been identified based on the following primary delineation criteria: watersheds, critical and sensitive ecological habitats, soil types, and land use patterns. Major watershed boundaries provided the initial delineation of the OUs at Redstone Arsenal. Within these boundaries, additional OUs were established to accommodate critical and sensitive ecological habitats. Different soil types support distinctive vegetation patterns and, where definitive, additional OUs were established to reflect these patterns and to facilitate evaluation of potential contaminant impacts on these areas. Location of high human activity can impact ecological receptors; this played a role in the further refinement of OUs into the current grouping of 18 OUs at Redstone Arsenal. Because environmental impacts upon specific sites may impact a larger area, response actions are considered with respect to the entire OU.

2.5 Summary of Site Characteristics

2.5.1 Source of Contamination

RSA-47 is a former chemical training facility that was used to train military students about use and handling of chemical agents. The facility was operational from 1972 through 1986. The facility is still operational; however, training is conducted using simulated chemical agents. Equipment contaminated with live chemical agents was decontaminated inside concrete catch basins that contained multiple impermeable liners. Some decontamination activities with chemical agents predated the use of liners. Equipment decontamination and training exercises occurred at the shower/sump located near Building 3536 and at the end of the gravel strips. In 1986, the Army conducted sampling and analysis of site soils and an inspection of the site to verify that the site was free of any live chemical agents. Subsequent sampling efforts during the two phases of the RI (1994 and 1997) did not detect chemical agents in soil. Low concentrations of organics (below EPA Region III risk-based concentrations [RBC]) and metals (below Redstone Arsenal background levels) were detected in site soils, which demonstrates that site soils were not significantly impacted by the very limited quantities of chemical agents and decontamination fluids used in the training activities. A source for future groundwater contamination does not exist in the site soils.

2.5.2 Description of Contamination

The field investigations for the RI at RSA-47 included a soil gas survey, surface water and sediment sampling, surface and subsurface soil sampling, bedrock monitoring well installation, and groundwater sampling. The following subsections summarize the results of these

investigations by medium. A more detailed description of the nature and extent of contamination at RSA-47 is presented in the RI reports (Final Site Characterization Report, 1996 and Draft-Final Remedial Investigation Report for OU-3, 1998a).

2.5.2.1 Soil

Soil samples were collected from locations where training activities, including equipment and personnel decontamination, were performed. This included the ends of the gravel spurs and the primary personnel decontamination facility near Building 3536. The samples were analyzed for volatile organic compounds (VOC), semivolatile organic compounds (SVOC), pesticides/poly-chlorinated biphenyls (PCB), target analyte list (TAL) metals, cyanide, thiodiglycol, and pH (surface soil only). Additionally, the Edgewood Research, Development, and Engineering Center (ERDEC) screened the soil samples for the presence of HD, Lewisite (not expected at RSA-47 based on operational history but ERDEC equipment was calibrated for it), GB, and VX. In surface soil, three VOCs were detected at low concentrations. Metals were detected in the surface soil samples at concentrations below Redstone Arsenal background values (Draft-Final Installation-Wide Background Soil Study Report, 1998b), except for two essential nutrient metals. Five organic compounds were detected in subsurface soil samples at low concentrations. All metals concentrations in subsurface soil were below the values established in the Redstone Arsenal background study (Draft-Final Installation-Wide Background Study Report, 1998b). Tables 1 and 2 present the summary of constituents detected in surface soil and subsurface soil, respectively, at RSA-47. No chemical agents were detected in surface soil or subsurface soil.

2.5.2.2 Groundwater

Drilling and sampling activities completed at RSA-47 during the RI suggest that the unconsolidated sediments or overburden beneath the site do not contain a distinct groundwater-bearing zone that could support continued or ongoing groundwater monitoring. Groundwater is present in the limestone bedrock aquifer beneath the site as determined in bedrock monitoring wells RS525, RS526, and RS542. The available groundwater elevation data indicate that groundwater flow is directed to the east, generally follows the surface topography, and is generally conformable to regional flow patterns.

Six organic compounds were detected in groundwater and include acetone, benzene, carbon disulfide, ethyl benzene, xylene, and bis(2-ethylhexyl)phthalate. Of these, acetone and bis(2-ethylhexyl)phthalate are suspected laboratory or sampling contaminants. Only the metal barium (excluding nutrient metals) exceeded its respective background value in groundwater (Draft-Final

Table 1

Summary of Constituents Detected in Surface Soil, RSA-47
Redstone Arsenal, Alabama

Analyte	Units	Frequency of Detection	Range of Detected Concentrations	Redstone Arsenal Background Concentration[a]
ORGANICS				
Acetone	mg/kg	1/6	0.033	NA
Chloroform	mg/kg	1/6	0.0048 J	NA
Trichloroethene	mg/kg	5/6	0.0023 J - 0.01	NA
INORGANICS				
Aluminum	mg/kg	1/1	18100	27000
Arsenic	mg/kg	1/1	5.3	9.47
Barium	mg/kg	1/1	86.6	294
Beryllium	mg/kg	1/1	0.84	1.57
Calcium (nutrient)	mg/kg	1/1	2860	6920
Chromium	mg/kg	1/1	35.5 J	57.8
Cobalt	mg/kg	1/1	11.6	23
Copper	mg/kg	1/1	8.4	19.5
Iron	mg/kg	1/1	20000	36400
Lead	mg/kg	1/1	17.4	45.1
Magnesium (nutrient)	mg/kg	1/1	1640	1483
Manganese	mg/kg	1/1	1130	3360
Nickel	mg/kg	1/1	15.6	19.43
Potassium (nutrient)	mg/kg	1/1	1930	980.3
Vanadium	mg/kg	1/1	39.0	70.6
Zinc	mg/kg	1/1	89.5 J	110

[a] *Draft-Final Installation-Wide Background Soil Study Report, Redstone Arsenal,* April 1998.
mg/kg - Milligrams per kilogram.
NA - Not available.
■ Shaded value represents a concentration greater than the Redstone Arsenal background value (inorganics) or for which a background value is not available (organics).
J - Data qualifier indicating a qualitative value below the laboratory reporting limit but above the instrument detection limit.

Table 2

Summary of Constituents Detected in Subsurface Soil, RSA-47 Redstone Arsenal, Alabama

Analyte	Units	Frequency of Detection	Range of Detected Concentrations	Redstone Arsenal Background Concentration[a]
ORGANICS				
Acetone	mg/kg	1/15	0.033	NA
bis(2-Ethylhexyl)phthalate	mg/kg	1/5	0.11 J	NA
Chlorobenzene	mg/kg	1/15	0.00088 J	NA
Styrene	mg/kg	2/15	0.00065 J-0.0023 J	NA
Trichloroethene	mg/kg	3/15	0.0012 J-0.0066 J	NA
INORGANICS				
Aluminum	mg/kg	1/1	10500	30802
Arsenic	mg/kg	5/5	0.697-6.1	12.5
Barium	mg/kg	5/5	51.0-100	171
Cadmium	mg/kg	2/5	0.981-1.1	1.1
Calcium (Nutrient)	mg/kg	1/1	656	3890
Chromium	mg/kg	1/5	21.6-40.8	111
Cobalt	mg/kg	1/1	12.8	21.7
Copper	mg/kg	1/1	7.6	19.7
Iron	mg/kg	1/1	16300	65146
Lead	mg/kg	5/5	14.0-19.9	33.9
Manganese	mg/kg	1/1	688	1864
Mercury	mg/kg	1/5	0.055	0.08
Nickel	mg/kg	1/1	6.4	20.41
Selenium	mg/kg	1/5	0.67	1.17
Vanadium	mg/kg	1/1	28.6	121
Zinc	mg/kg	1/1	42.0 J	145

[a] *Draft-Final Installation-Wide Background Soil Study Report, Redstone Arsenal*, April 1998.

mg/kg - Milligrams per kilogram.

NA - Not available.

■ Shaded value represents a concentration greater than the Redstone Arsenal background value (inorganics) or for which a background value is not available (organics).

J - Data qualifier indicating a qualitative value below the laboratory reporting limit but above the instrument detection limit.

Report of MSFC Background Sampling, 1997). No compounds detected in the groundwater samples exceeded federal or state maximum contaminant levels (MCL). No chemical agents were detected in any of the groundwater samples. Table 3 presents a summary of constituents detected in groundwater from the Phase I and Phase II RI.

2.5.2.3 Surface Water and Sediment

One organic compound, bis(2-ethylhexyl)phthalate, a common laboratory contaminant, was detected in a surface water sample from the adjacent intermittent stream. Five metals (aluminum, chromium, iron, lead, and zinc) were detected in surface water above the background values determined for Redstone Arsenal. Table 4 presents a summary of constituents detected in the surface water during the RI. Total petroleum hydrocarbons were detected in one sediment sample. No organics were detected in any sediment samples and all sediment metals concentrations were below background values, except for lead and three essential nutrient metals. Table 5 presents a summary of constituents detected in sediment during the RI.

2.5.3 Contaminant Migration

The analytical results for the site surface soil, subsurface soil, and sediment show only a few organic compound detections and only a few metals detections exceeding background. This supports the conclusion that the site soils were not impacted by the small quantities of chemical agents and decontamination fluids used in past training activities at the site. The lack of soil contamination suggests there is no long-term source for groundwater contamination from the site soils. This conclusion is supported by contaminant fate and transport modeling performed for the site.

2.6 Summary of Site Risks

A CERCLA BHHRA and ERA were performed in 1997 and presented in the Draft-Final RI Report for OU-3 prepared in 1998. The BHHRA and ERA evaluated the potential health impacts of contaminants detected in soil, sediment, surface water, and groundwater on exposed and potentially exposed human populations and ecological receptors, respectively, if no action is taken to remedy conditions (i.e., clean up) at RSA-47.

The current industrial use of Redstone Arsenal will continue into the future, as the Army does not intend to change the current mission of the Arsenal. The potential for residential development of RSA-47, therefore, is extremely unlikely. Despite this unlikely scenario, future residential exposures were evaluated to provide a perspective on the level of contamination at the site.

Table 3

Summary of Constituents Detected in Bedrock Groundwater, RSA-47
Redstone Arsenal, Alabama

Analyte	Units	Frequency of Detection	Range of Detected Concentrations	Maximum Contaminant Level[a]	MSFC Background Concentration[b]
ORGANICS					
Acetone	µg/L	4/5	7.7 J-4200	NA	NA
Benzene	µg/L	1/7	0.28 J	5	NA
Carbon Disulfide	µg/L	1/7	5.0	NA	NA
Ethyl Benzene	µg/L	1/7	4.4	700	NA
Xylene, Total	µg/L	1/7	15.0	10000	NA
bis(2-Ethylhexyl)phthalate	µg/L	2/4	5.5-7.8	NA	NA
INORGANICS					
Aluminum	µg/L	1/1	1260 J	NA	1690
Barium	µg/L	4/4	44.1-337	2000	39.3
Calcium (nutrient)	µg/L	1/1	48400	NA	70200
Iron	µg/L	1/1	699 J	NA	7280
Magnesium (nutrient)	µg/L	1/1	36300	NA	7190
Manganese	µg/L	1/1	83.8 J	NA	76.1
Potassium (nutrient)	µg/L	1/1	9840	NA	8120
Sodium (nutrient)	µg/L	1/1	47500	NA	86700

[a]MCL - Maximum contaminant level from EPA, 1997, *Drinking Water Regulations and Health Advisories*, Office of Water, Washington, DC, August.
[b]*Draft-Final Report of MSFC Background Sampling*, February 1997.
µg/L - Micrograms per liter.
NA - Not available.
■ Shaded value represents a concentration greater than the George C. Marshall Space Flight Center (MSFC) background value (inorganics) or for which a background value is not available (organics)
J - Data qualifier indicating a qualitative value below the laboratory reporting limit but above the instrument detection limit.

Table 4

Summary of Constituents Detected in Surface Water, RSA-47
Redstone Arsenal, Alabama

Analyte	Units	Frequency of Detection	Range of Detected Concentrations	Revised MSFC Background Concentration[a]
ORGANICS				
bis(2-Ethylhexyl)phthalate	µg/L	1/4	26 J	NA
INORGANICS				
Aluminum	µg/L	1/1	1770	842
Barium	µg/L	2/4	24.2-27.7	64.0
Calcium (nutrient)	µg/L	1/1	58300	69300
Chromium	µg/L	1/4	15.1	NA
Iron	µg/L	1/1	1640	1510
Lead	µg/L	2/4	6.2-13.5	3.53
Manganese	µg/L	1/1	25.6	415
Zinc	µg/L	1/1	47.3	NA

[a] *Draft-Final Report of MSFC Background Sampling*, February 1997.
µg/L - Micrograms per liter.
NA - Not available.
■ Shaded value represents a concentration greater than the revised George C. Marshall Space Flight Center (MSFC) background value (inorganics) or for which a background value is not available (organics).
J - Data qualifier indicating a qualitative value below the laboratory reporting limit but above the instrument detection limit.

Table 5

Summary of Constituents Detected in Sediment, RSA-47
Redstone Arsenal, Alabama

Analyte	Units	Frequency of Detection	Range of Detected Concentrations	Revised MSFC Background Concentration[a]
INORGANICS				
Aluminum	mg/kg	1/1	10900	27300
Arsenic	mg/kg	4/4	0.45-5.3	8.79
Barium	mg/kg	4/4	65.2-97.4	161
Cadmium	mg/kg	3/4	1.25-1.81	2.60
Calcium (nutrient)	mg/kg	1/1	6880	4040
Chromium	mg/kg	4/4	26.0-70.2	122
Cobalt	mg/kg	1/1	10.1	19.5
Copper	mg/kg	1/1	6.9	16.3
Iron	mg/kg	1/1	17600	47700
Lead	mg/kg	3/4	21.9-28.6	22.1
Magnesium (nutrient)	mg/kg	1/1	1240	948
Manganese	mg/kg	1/1	1410	1760
Nickel	mg/kg	1/1	10.9	23.2
Potassium (nutrient)	mg/kg	1/1	805	779
Vanadium	mg/kg	1/1	33.8	118
Zinc	mg/kg	1/1	68.7 J	137
MISCELLANEOUS				
Total Petroleum Hydrocarbons	mg/kg	1/3	49.3	NA

[a] Draft-Final Report of MSFC Background Sampling, February 1997.
mg/kg - Milligrams per kilogram.
NA - Not available.
▩ Shaded value represents a concentration greater than the revised George C. Marshall Space Flight Center (MSFC) background value (inorganics) or for which a background value is not available (organics).
J - Data qualifier indicating a qualitative value below the laboratory reporting limit but above the instrument detection limit.

2.6.1 Baseline Human Health Risk Assessment

Analytical data used in the BHHRA were obtained from the Phase I and Phase II RI. Media sampled included surface soil, subsurface soil, sediment, surface water, and groundwater. The BHHRA for RSA-47 is summarized from the Draft-Final Remedial Investigation Report for OU-3 in the following sections. In summary, only low concentrations of organics and metals were detected in the site media. In surface soil, three VOCs were detected at low concentrations and metals detected were all below applicable background values except for two essential nutrient metals. In subsurface soil, five organic compounds were detected at low concentrations and no metals were detected above applicable background values. In groundwater, five organic compounds were detected (including two that are common laboratory or sampling contaminants) and barium was the only metal exceeding the applicable background value other than nutrient metals. In surface water, one organic compound (a common laboratory contaminant) was detected and five metals were detected above applicable background values. In sediment, no organics were detected and lead was the only metal above applicable background values except for nutrient metals.

2.6.1.1 Contaminant Identification

The data evaluation process includes evaluating the sample collection and analytical methods used, evaluating the quality of the data, and comparing the concentrations to RBCs and to background concentrations. This process then allows the identification of those chemicals potentially harmful to human health if present at the site (i.e., COPC). These COPC are then carried through the risk assessment process. Of the four media examined, only groundwater and surface water had COPC selected to carry forward into the BHHRA.

2.6.1.2 Exposure Assessment

An exposure assessment estimates the type and magnitude of potential exposure of a receptor to COPC found at or migrating from the site under current and future land use scenarios. Redstone Arsenal is under the control of the U.S. Army as an active facility and is expected to remain so for the foreseeable future. Currently, RSA-47 is fully fenced. Much of the area for OU-3 is wooded and a small intermittent creek flows along the southern border. Groundwater at RSA-47 is not used as a source of drinking water.

Four types of individuals (receptors) were evaluated for potential exposure to contaminants at RSA-47:

- Future groundskeeper
- Future construction worker
- Current and future sportsman (covers a trespasser scenario)
- Future on-site resident (adult and child, and child only).

The first three scenarios were based on current and future land use plans for Redstone Arsenal as presented in the Redstone Arsenal Master Plan (1989). The last scenario was included as a conservative measure but is not a likely scenario.

2.6.1.3 Risk Characterization

Excess ILCRs are probabilities that are generally expressed in scientific notation. EPA has determined that a cancer risk range of 1×10^{-6} to 1×10^{-4} is generally considered to be acceptable. An ILCR of 1×10^{-6} indicates that, as a plausible upper bound, an individual has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure to a potential carcinogen over a 70-year lifetime under the specific exposure conditions previously described.

Potential concern for noncancer effects of a single contaminant in a single medium is expressed as the hazard quotient (HQ). By adding the HQs for all contaminants within a medium and across all media to which a given population may reasonably be exposed, the HI is generated. The HI provides a useful reference point for gauging the potential significance of multiple contaminant exposure within or across media. A HI less than 1.0 indicates an acceptable exposure for a particular chemical or type of exposure.

The ILCR and HI estimates for the plausible receptor scenarios are presented in Table 6. The total cancer risk for each receptor is well below the range (1×10^{-6} to 1×10^{-4}) generally considered acceptable in CERCLA programs (EPA, 1990). The noncancer HIs were within the acceptable range for all receptors except for ingestion of groundwater by a future child resident (i.e., exceeded 1.0). This risk for the future child resident was based on the maximum detected value of acetone at one well (RS526) during the first-phase RI, which was significantly greater than other detected values of acetone in groundwater during either phase of the RI (including the resampling of RS526 in Phase II) and is likely to be an anomaly (i.e., sampling or laboratory artifact). In addition, because the future land use at OU-3 will continue to be industrial, an on-site resident is not a likely scenario for exposure.

Uncertainties are associated with the information and data used in each phase of the BHHRA. There is one uncertainty associated with the analytical data that is unique to the BHHRA for RSA-47. This uncertainty deals with the using the maximum value of acetone (4,200 micro-

Table 6

Summary of Site Risks and Hazards, RSA-47
Redstone Arsenal, Alabama

Receptor/Medium	Total Cancer Risk	Total Noncancer Hazard Index[a]	Risk Drivers[b]
INDUSTRIAL LAND USE			
Future groundskeeper/groundwater	1.7×10^{-5}	0.48	None
Future construction worker/groundwater	6.8×10^{-5}	0.48	None
RESIDENTIAL LAND USE			
Future adult resident/groundwater	6.7×10^{-5}	NA	None
Future child resident/groundwater	NA	3.1	Acetone
Maximum Acceptable Risk Value	1.0×10^{-4}	1.0	

[a]Shaded value indicates an unacceptable total noncancer hazard index (greater than 1.0).
[b]The chemical listed is that primarily contributing to the unacceptable hazard, as indicated.
NA - Not applicable.

grams per liter) in groundwater at monitoring well RS526, which was significantly greater than the other detected values of acetone during both phases of the RI. It is likely that this value represents an outlier; no documentation (i.e., validation) was available from the Phase I RI and the Phase II RI resampling from RS526 revealed considerably less acetone (7.7 J micrograms per liter). However, to be conservative the high value of acetone was kept and acetone was maintained as a COPC.

2.6.2 Ecological Risk Assessment

The ERA evaluated the potential exposure of land-based wildlife to chemicals in surface soil. A permanent aquatic system does not exist within OU-3 as noted during the site reconnaissance; consequently, the aquatic exposure pathway was not evaluated.

A screening risk analysis was conducted to address ecological risks and involved using the ecotoxicity quotient, which is the ratio of the estimated exposure concentration to the concentration in literature reported to cause an adverse effect. Values less than 1.0 are considered to be acceptable.

Two constituents, acetone and bis(2-ethylhexyl)phthalate, were identified as chemicals of potential ecological concern. Although bis(2-ethylhexyl)phthalate was suspected to be a laboratory contaminant, it was identified as a chemical of potential ecological concern to be conservative. Exposure modeling on surrogate terrestrial receptors (e.g., White-footed mouse, American robin, Red-tailed hawk, and Red fox) and effects characterization resulted in development of species specific hazard quotients. Results of this modeling indicated that neither of the chemicals were detected at concentrations that exceeded plant or soil invertebrate benchmarks. Consequently, all ecotoxicity quotients were less than 1.0.

2.6.3 Conclusions of the Human Health and Ecological Risk Assessments

The quantitative risk estimates indicate that the likelihood of adverse effects on plausible human receptors exposed to soil, or on terrestrial receptors is low, i.e., within acceptable risk limits. The noncancer HI results are acceptable except that the groundwater at RSA-47 may pose adverse noncancer health effects to a future child resident, based on exposure assumptions evaluated. However, the hazard was based on a maximum value of acetone in groundwater that is likely to be an anomaly. Additionally, the future land use at OU-3 will continue to be industrial in the future. Thus, the risks calculated in the BHHRA and ERA are within acceptable limits and support a no further action decision at OU-3.

2.7 The Selected Remedy

The recommended solution for addressing the minimal levels of contamination at OU-3 is no further action. No further action is appropriate because there is no unacceptable site risk associated with current and future industrial land use.

The following cost and time data are associated with conducting no further action at RSA-47:

Capital Cost:	$0
Annual Operation and Maintenance Costs:	$0
Present Worth Cost:	$0
Months to Implement:	None

2.8 Statutory Determinations

This final remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to this remedy, and is a cost-effective application of public funds. This remedy will not leave in place hazardous substances at concentrations that require limiting the future industrial use of OU-3, or that require land use control restrictions to exposure. Therefore, a 5-year review will not be required. There will be no further remedial costs associated with implementing no further action at OU-3.

3.0 Responsiveness Summary

The selected remedy for OU-3 is no further action. A public comment period was held from April 11, 1999 through May 10, 1999 to allow the public to raise concerns or questions about the proposed remedy at OU-3. A public meeting was held on April 20, 1999 at the "Path to Nature", Redstone Arsenal to present the Proposed Plan for OU-3 and to answer any questions on the proposed plan and on the documents in the information repositories.

No comments were received during the public meeting or during the public comment period. EPA, AMCOM, and ADEM concur that the selected remedy is protective of human health and the environment.

Background on Community Involvement. The public is encouraged to review site-related documents to gain a more thorough understanding of the site and the CERCLA activities that have been conducted at RSA. AMCOM provides information to the public concerning the locations of public repositories for such documents. AMCOM also provides addresses and points of contact where members of the public can direct written questions. A public meeting was held where members of the public could ask questions, address concerns, and provide other input regarding the site and aforementioned documents.

Community relations activities for the selected remedy at OU-3 include:

- The documents concerning the investigation and analysis at RSA-47, as well as a copy of the proposed plan, were placed in the information repositories.
- Newspaper announcements on the availability of the documents and the public comment period/public meeting date were placed in the local newspaper.
- AMCOM established a 30-day public comment period starting April 11, 1999 and ending May 10, 1999 to present the proposed plan.
- A public meeting was held on April 20, 1999 to answer questions concerning the proposed plan for OU-3.

4.0 References

A. T. Kearney, 1989, ***Interim RCRA Facility Assessment of the Redstone Arsenal,*** Prepared for the U.S. Environmental Protection Agency, September.

CH2M Hill, 1997, ***Draft-Final Report of MSFC Background Sampling,*** Prepared for the National Aeronautics and Space Administration, George C. Marshall Space Flight Center, February.

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IT Corporation, 1998a, ***Draft-Final Remedial Investigation Report for Operable Unit 3, Redstone Arsenal,*** Prepared for U.S. Army Corps of Engineers, July.

IT Corporation, 1998b, ***Draft-Final Installation-Wide Background Soil Study Report, Redstone Arsenal,*** Prepared for U.S. Army Corps of Engineers, April.

Southwest Research Institute, 1994, ***Environmental Chemistry and Fate of Chemical Warfare Agents, Final Report,*** Prepared for Department of the Army Corps of Engineers, Huntsville, March.

U.S. Army Aviation and Missile Command, Alabama Department of Environmental Management, and U.S. Environmental Protection Agency, 1998, ***Proposed Plan for the Record of Decision at Operable Unit 3,*** April.

U.S. Army Corps of Engineers, 1989, ***Master Plan Narrative for Redstone Arsenal, Alabama,*** Prepared by Kimley-Horn and Associates, Inc.

U.S. Environmental Protection Agency, 1990, ***Exposure Factors Handbook,*** Office of Health and Environmental Assessment, Washington, DC, EPA/600/8-89/043.

U.S. Environmental Protection Agency, 1989, ***Risk Assessment Guidance for Superfund (RAGS), Volume I - Human Health Evaluation Manual (Part A),*** Office of Emergency & Remedial Response, Washington, DC, EPA/540/1-89/002, December.

COMMENTS AND RESPONSES

Response to AMCOM
Comments on
Record of Decision for Operable Unit 3 (Draft)
May 1999
Redstone Arsenal, Alabama

Comment from Mr. Ken Hewitt, REM, dated June 23, 1999.

Comment 1: **I have reviewed the Draft ROD for OU-3 and it looks good, except for the signature page. Please delete General Gibson's name on page 3 and replace with:**

Steven C. Hamilton
Colonel
Commander, RASA.

The date line is okay.

Response 1: The signature page has now been revised as directed in the comment and as modified in Mr. Hewitt's 8/3/99 e-mail.

Comment from Mr. Ken Hewitt, REM, dated August 11, 1999.

Comment 1: **Page 1, Paragraph 1.2, 2nd paragraph. We don't have the regulator's concurrence yet. I suggest re0wording the text to state something like "The decision for 'no further action' has been made in partnership with Alabama...and Region IV." Some other variation on the suggested text would be fine. Jim Barksdale is supposed to send the Army a concurrence letter after we submit the signed ROD to his office. The rest of the document looks good. Nice work.**

Response 1: The text has been reworded to state "The decision for no further action for OU-3 has been made by the U.S. Army Aviation and Missile Command (AMCOM) at Redstone Arsenal in partnership with the Alabama Department of Environmental Management (ADEM) and the U.S. environmental Protection Agency (EPA), Region IV."

Response to U.S. Environmental Protection Agency
Comments on
Record of Decision for Operable Unit 3 (Draft)
May 1999
Redstone Arsenal, Alabama

Comment from Mr. Jim Barksdale, EPA, dated July 16, 1999.

Comment 1: **The draft ROD for RSA OU-3 has no further action as its recommended solution. One basis for the selection of the no further action alternative is that the future land use of the site will continue to be industrial. The draft ROD does not provide assurance that land use controls which are presently in place or which will need to be put in place will be continued in the future. There is needed a Memorandum of Agreement (MOA) between the Department of Army and EPA and ADEM on this and the ROD should reference such MOA. As you see the mentioning of LUCs creates other requirements for OU-3, RSA-47, these requirements are not needs. OU-3 passes all risk evaluations for no further action as it is. Therefore, the ROD needs to be revised removing any suggestion of LUC. The ROD at OU-3 needs to focus on NFA. That is "No Further Action" from those already taken in the past because all human health and eco risk are within criteria as a result of the past actions.**

Response 1: The ROD has been revised to delete any language suggesting land-use controls.

Response to U.S. Army Corps of Engineers
Comments on
Record of Decision for Operable Unit 3 (Draft)
May 1999
Redstone Arsenal, Alabama

Comments from Mr. Mead, USACE-MRD received on July 28, 1999.

Comment 1:

Comment Number 6720581-222, Para. 1.3. Please revise the first paragraph to emphasize the most probable future industrial use (i.e., (i.e., four types of receptors were evaluated for potential exposure to contaminants at RSA-47. The first three scenarios were based on current and future industrial land use plans for Redstone Arsenal.... The future onsite resident, although not a likely scenario, was included as a conservative measure.) Revise the rest of paragraph accordingly (i.e., no unacceptable risk for future industrial scenarios, etc) If groundwater is not usable (Para. 2.5.2.2 states groundwater monitoring wells could not be supported, and presumably that would apply to drinking water wells also), please state so in addition to stating that the only contaminant present in groundwater above risk-based levels or MCLs is acetone, a laboratory contaminant.

Response 1:

The text has been revised as requested on the receptor scenarios. Section 2.5.2.2 states that only the overburden does not contain a distinct groundwater-bearing zone that could support continued or ongoing groundwater monitoring. Groundwater has been found in the bedrock.

Comment 2:

Comment Number 6720581-223, Para. 1.4. Please list the bullets in order of importance: NFA is appropriate because there is no unacceptable site risk associated with current and future industrial land use. If it is true that that no treatment, engineering, or institutional controls are needed (risk is not unacceptable without these controls), delete bullets referring to fencing and access restriction and transport across media.

Response 2:

The text has been revised.

Comment 3:

Comment Number 6720581-224, Para. 2.6.1.2. Please revise the second paragraph to emphasize the most probable future industrial use (i.e., four types of receptors were evaluated for potential exposure to contaminants at RSA-47. The first three scenarios were based on current and future industrial land use plans for Redstone Arsenal. The future onsite resident, although not a likely scenario, was included as a conservative measure.)

Response 3: The text has been revised.

Comment 4: **Comment Number 6720581225, Para. 2.7. Please list the bullets in order of importance: NFA is appropriate because there is no unacceptable site risk associated with current and future industrial land use. Unless unacceptable is dependent on the factors listed in the other bullets, edit or delete bullets referring to fencing and access restriction and transport across media.**

Response 4: The text has been revised.

Comments from Mr. Georgian, USACE-MRD received on July 28, 1999.

Comment 1: **Comment Number 6854248-315. IT Project, Redstone, AL. ROD recommends NFA.**

Response 1: No action necessary since comment is an observation.

Comment 2: **Comment Number 6854248-316. It is recommended that the chemical composition of the "simulated chemical agents" that are currently being used be specified.**

Response 2: The chemical composition of the simulated chemical agents currently in use at the facility will be presented in the ROD if the information can be obtained before the final ROD is submitted. However, the specifics of the current training activities at the site are not relevant to the past activities presented in this ROD and to the CERCLA process. IT has received direction from the USACE-Savannah project manager to move forward and not hold up submittal of the final ROD if we do not obtain this information on the simulated chemical agents in a timely manner.

Comment 3: **Comment Number 6854248-317. When summarizing analytical results, the analytical preparatory and determinative methods of analysis should be specified. For example, Table 1 should list the analytical methods. (Observation: Analytical methodology continues to be inadequately defined.)**

Response 3: Analytical preparatory and determinative methods of analysis are details not appropriate for inclusion in the ROD which presents the selected remedy for the site. This information can be found specific to the work at RSA-47 in the Draft-Final RI Report for OU-3 (IT, July 1998) and in the Installation-Wide Sampling and Analysis Plan (IT, June 1997).

Comment 4: **Comment Number 6854248-318. The report should explain why contaminants such as acetone are suspected to be laboratory contaminants (e.g., because they were found in associated blanks or because they were found throughout the project sporadically at low levels).**

Response 4: The RI Report (July 1998) reports that acetone was "blank corrected out" for soil and groundwater based on concentrations of acetone in an associated equipment rinsate for the samples from the Phase II RI. The blank evaluation is part of the validation process. Certainly, the low detections of acetone reported in the soil and groundwater in the Phase II RI may be attributable to sampling activities. However, the documentation for the Phase I RI where the higher acetone concentration (4,200 µg/L at RS526) was detected does not provide the information necessary to conclusively state as requested in the comment that acetone is suspected to be a laboratory contaminant because it was detected in associated blanks or that it is suspected to be a sampling contaminant because it was detected in equipment rinsates. Monitoring well RS526 was resampled in the Phase II RI and acetone was present at a concentration considerably lower (7.7 µg/L) than in Phase I. It is likely that the high concentration of acetone is an outlier and probably is a result of laboratory or sampling contamination since acetone is a common contaminant in laboratory and sampling activities.

Comment 5: **Comment Number 6854248-319. Though not critical in this investigation, when comparing site concentrations to background concentrations, the site distribution (i.e., entire set of site data) should be compared to the background distribution (i.e., the entire set of background data). It is inappropriate to conclude that background is exceeded on the basis of point wise comparisons (i.e., by comparing individual site detections to some background limit). The representativeness of the background samples (e.g., the soil**

samples) relative to the site samples should have also been discussed. For example, the report does not state if the physical and chemical composition of the background and site soils were demonstrated to be reasonably similar (e.g., by using TOC and pH analyses and grain size determinations). It was also noted that Table 1 compares only one sample to background. Soils are rather homogeneous. It is not clear how one sample can represent the concentrations of metals in the site soils. This may explain why several metals appear to exceed background. (Observation: Though it does not appear to be a critical factor in this investigation, the inadequate treatment of background is a repeated problem for Redstone projects.)

Response 5:

Comment noted. It is agreed that it is better to compare the site distribution to the background distribution when comparing the site concentrations to the background concentrations. However, there is not enough sample data from the investigations at RSA-47 to calculate a site distribution with good confidence. As noted in this comment, this point is not critical in this investigation where the exceedances of background are minimal and the risk is within acceptable levels. The inclusion of details on the representativeness of the background samples relative to site samples is appropriate for a RI report but not a ROD, which is the case here. It is also important to note that the RI report for OU-3 was finalized in July 1998 and approved by EPA/ADEM in April 1999. The report followed approved protocol for background comparisons as presented by the EPA Scientific Management Committee.

Comment 6:

Comment Number 6854248-320. The results of the chemical analyses should be summarized in tables (e.g., that list the quantitation limits, reporting limits, and risk based screening limits). Appropriate data qualifiers should also be applied. None of the results are reported with data qualifiers. For examples, a detection of benzene is reported as "0.28" ppb. It is unlikely that the result of 0.28 ppb is quantitatively reliable to +/- 0.01 ppb. (Observation: Sensitivity continues to be inadequately addressed.)

Response 6: Data qualifiers have been added to the analytical results in Table 1 through 5. The RI Report for OU-3 includes the quantitation limits, reporting limits, and risk-based screening limits.

Comment 7: **Comment Number 6854248-321. The report should address how the quality of the chemical data was evaluated. The data evaluation or "validation" summary report should be enclosed as an appendix of the report.**

Response 7: The Draft-Final RI Report for OU-3 was issued in July 1998. This report addressed the quality of the chemical data in Section 3.3.8, Data Management, and in Appendix E, Data Validation Summary.