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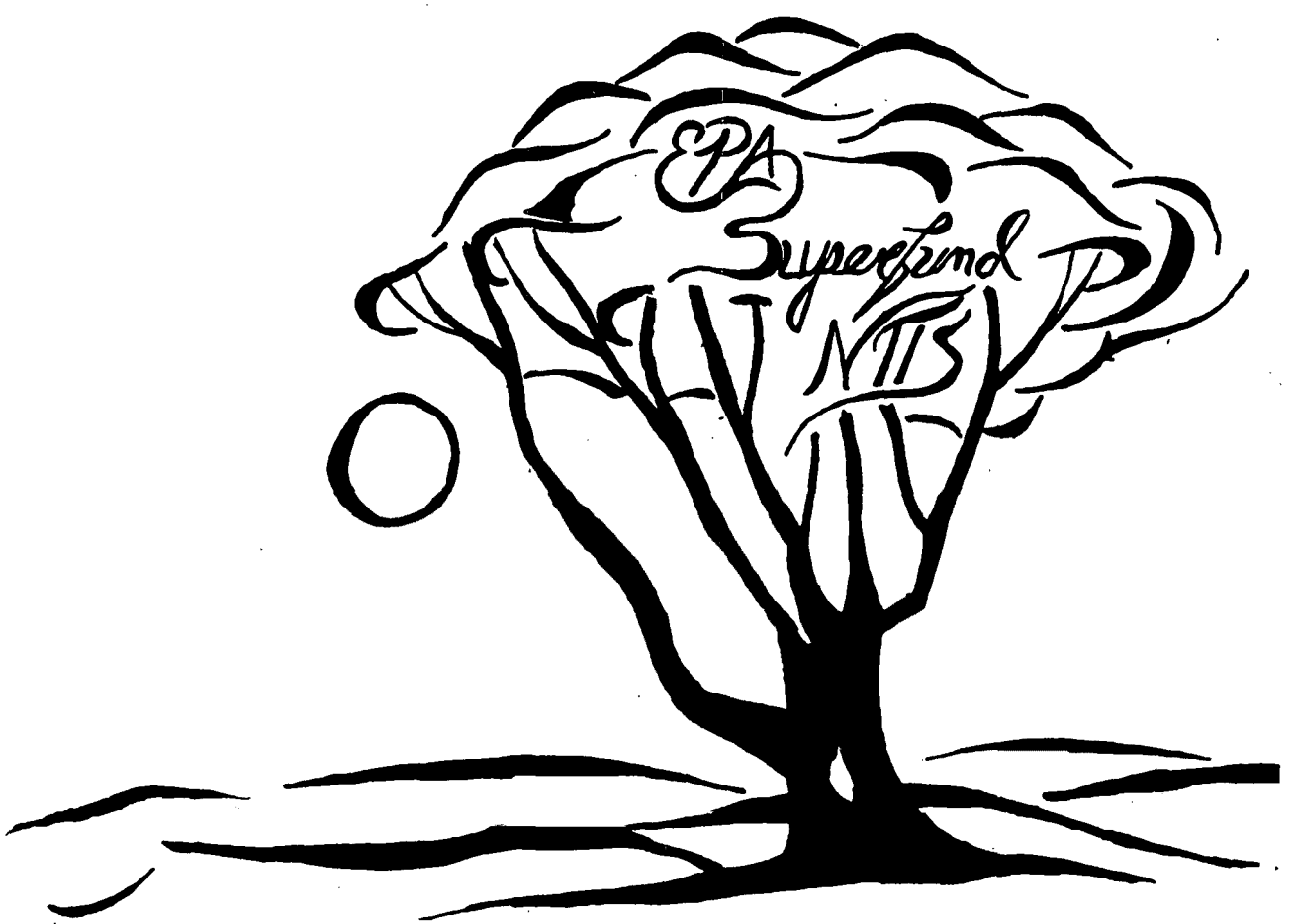
EPA Superfund Record of Decision:

Robins Air Force Base (O.U. 2), Houston County, GA 3/29/1994



FINAL

U.S. AIR FORCE INSTALLATION
RESTORATION PROGRAM

SUPERFUND
INTERIM RECORD OF DECISION

ROBINS AFB ZONE 1, GEORGIA
OPERABLE UNIT 2
IMPACT ON WETLANDS

FEBRUARY 22, 1994

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RESPONSIVENESS SUMMARY

DECLARATION FOR THE INTERIM ACTION RECORD OF DECISION

DECLARATION FOR THE INTERIM ACTION RECORD OF DECISION

SITE NAME AND ADDRESS

Zone 1 Robins Air Force Base
Operable Unit 2, Impact on Wetlands
Warner Robins, Houston County, Georgia

STATEMENT OF PURPOSE

This Decision Document presents the interim selected remedial action for Operable Unit 2 of the Zone 1 Robins Air Force Base (AFB) Site, Houston County, Georgia 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 decision is based on the Administrative Record for this site, which is on the file in the Directorate of Environmental Management office, Robins AFB, Georgia 31098.

This interim remedial action is taken to protect human health and the environment from the threat, while final remedial solutions are being developed. The State of Georgia and Region IV, USEPA concur with the selected interim remedy.

ASSESSMENT OF THE SITE

The wetlands associated with Zone 1, OU2 provide an important habitat for a variety of wetlands plant and animal species, and protection of the wetlands should be given a relatively

high priority. Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Interim Action Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare or the environment.

DESCRIPTION OF THE SELECTED REMEDY

The Zone 1 Robins AFB site is divided into three operable units. Operable Unit 1 (OU1) addresses Landfill No. 4 and the Sludge Lagoon and comprises source control. Operable Unit 2 (OU2) is a phase to determine the degree of impact that has occurred in the downgradient wetlands area (east and southeast of Landfill No. 4). Operable Unit 3 (OU3) addresses the groundwater beneath and adjacent to Landfill No. 4 and the Sludge Lagoon. The scope of this ROD is limited to OU2.

The selected interim remedy for OU2, limited action, includes the following:

- Institutional controls (i.e., fence construction to restrict access, posting signs) for future site access and water use restrictions
- Comprehensive monitoring for a minimum of one year not to exceed three years in support of physical/chemical and ecological/biological monitoring plans to be developed to monitor stabilization of the site following redirection of runoff discharge around the landfill and diversion of industrial wastewater discharge from upgradient of the landfill and wetlands, so that a final remedial action can be developed from the current and expected future conditions.
- Development of a contingency plan that describes containment measures to be implemented in the event that predetermined "trigger values" are exceeded.

Both the physical and chemical characteristics of the wetlands may have been altered since the collection of data used to determine the need for remediation. The possible changes were caused by two events. One event was the redirection of runoff from a 400-acre watershed from through the landfill to around the landfill.

The second event was the completion of a pipeline that now routes approximately 2 million gallons a day of domestic and industrial wastewater directly to the Ocmulgee River. This discharge used to be into and through the wetlands to the Ocmulgee River. One purpose of the monitoring program is to evaluate the expected changes so that the final action can be developed to address the current/future conditions.

STATUTORY DETERMINATION

This interim action is protective of human health and the environment, waives Federal and State Applicable or Relevant and Appropriate Requirements for this limited scope action, and is cost-effective. This action is interim and is not intended to provide permanent solutions and alternative treatment or recovery technologies, to the maximum extent practicable for OU2. Because the action will not constitute the final remedy for OU2, the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element will be addressed by the final response action. Subsequent actions are planned to address fully the threats posed by the conditions at OU2. Because this remedy will result in hazardous substances remaining on site above health-based levels, a review will be conducted to ensure that the remedy continues to provide adequate protection of human health and the environment within five years after commencement of the remedial action. Because this is an interim action ROD, review of this site and this remedy will be ongoing as the Air Force continues to develop remedial alternatives for OU2.

ALAN P. BABBITT
Acting Deputy Assistant Secretary of the Air Force
(Environmental, Safety and Occupational Health)

5/28/94
Date

Assistant Administrator/Regional Administrator
U.S. Environmental Protection Agency, Region 4

Date

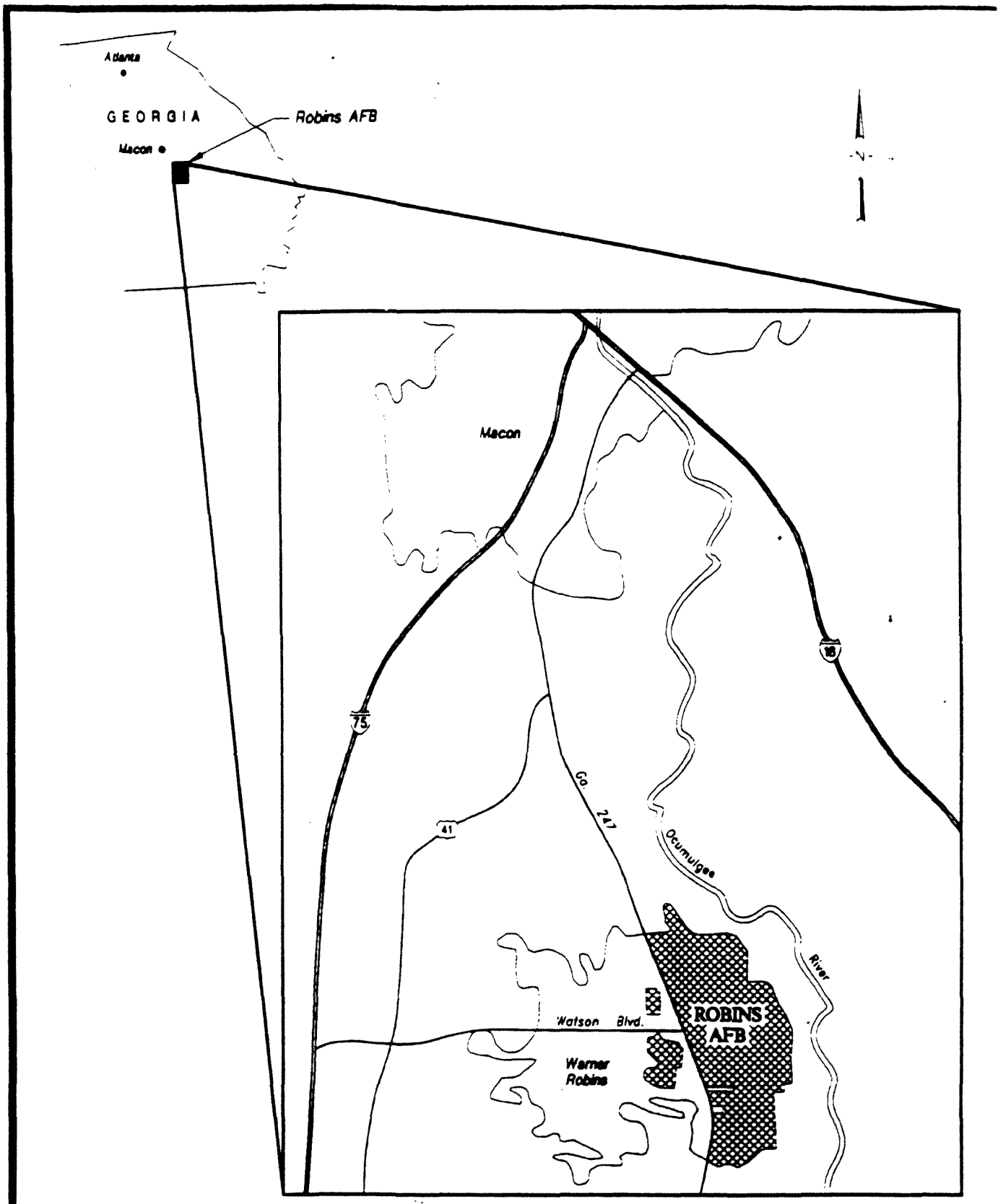
DECISION SUMMARY

1.0 SITE NAME, LOCATION AND DESCRIPTION

Robins AFB is an active facility occupying 8,855 acres about 18 miles south of Macon, Georgia (Figure 1). Robins AFB is bounded on the immediate west by the City of Warner Robins, on the north by a housing subdivision in Houston County, on the south by unincorporated Bonaire, and on the east by the Ocmulgee River and its floodplain.

The Zone 1, Robins AFB, National Priority List (NPL) site is located in the central portion of the base. Zone 1 consists of Landfill No. 4, which covers 45 acres, and an adjacent 1.5 acre sludge lagoon (Figure 2). The study area associated with OU2 is located east and southeast of Landfill No. 4 (Figure 2).

Zone 1 is located adjacent to a bluff that forms the western boundary of the Ocmulgee River floodplain. The floodplain extends about 1 to 2 miles eastward to the river. Landfill No. 4 was originally constructed by disposing of fill material into the floodplain and wetland area from the bluff and advancing to the east. The sludge lagoon was constructed on the northern boundary of Landfill No. 4 by excavating and building earthen dikes. Surface water at Robins AFB generally drains from west to east into the Ocmulgee River floodplain.



VICINITY MAP

RI/FS ZONE 1, OPERABLE UNIT 2

ROBINS AFB, GEORGIA

CDM FEDERAL PROGRAMS CORPORATION
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FIGURE No. 1

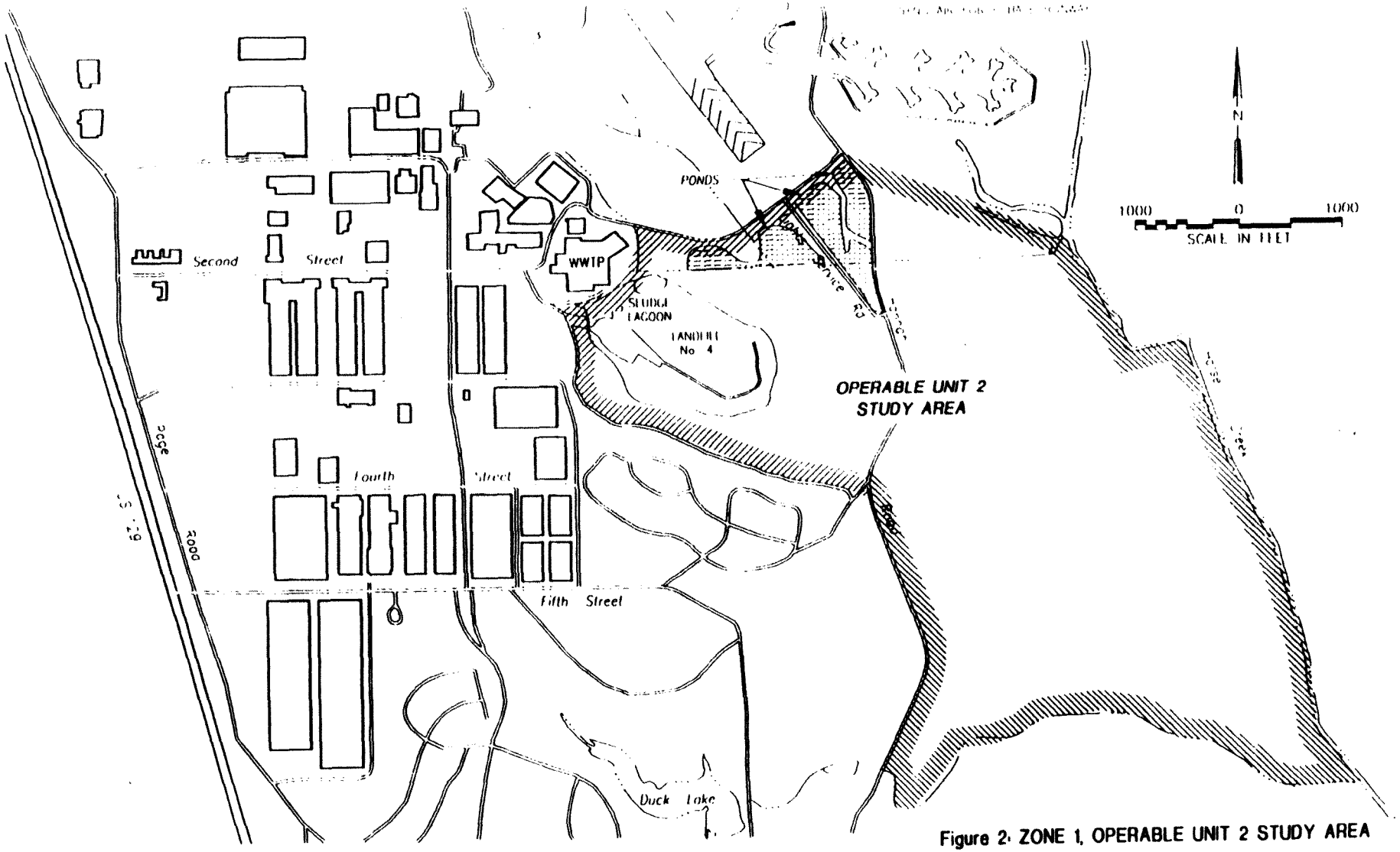


Figure 2: ZONE 1, OPERABLE UNIT 2 STUDY AREA

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

Robins AFB currently serves as a worldwide logistics management center for aircraft, missiles and support systems. and is a major repair center for aircraft and airborne electronic systems.

Robins AFB has generated various types of solid wastes over the years, including refuse and hazardous wastes. The hazardous wastes include electroplating wastes containing heavy metals and cyanide, organic solvents from cleaning operations and fire training exercises, and off-specification chemicals such as pesticides.

In 1982, Robins AFB conducted a base-wide survey to identify and assess past hazardous waste disposal practices. Disposal areas were grouped into eight zones based primarily on location and type of disposal activity. Zone 1 (Landfill No. 4 and the Sludge Lagoon) was considered to have the highest potential for migration of hazardous substances and as a result was placed on the CERCLA NPL by the U.S. Environmental Protection Agency (EPA) in 1987. Landfill No. 4 reportedly operated from 1965 until 1978 for disposal of general refuse and industrial wastes. The Sludge Lagoon was used for disposal of industrial wastewater treatment plant sludges and other liquid wastes from 1962 to 1978. The Landfill and the Sludge Lagoon were both closed and covered with clean fill in 1978.

In June of 1989, Robins AFB entered into a Federal Facilities Agreement with the Georgia Department of Environmental Protection (GEPD) and the EPA to establish a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions at the site in accordance with CERCLA, the NCP, Superfund guidance and policy, and the Georgia Hazardous Waste Management Act (GHWMA).

The initial remedial investigation/feasibility study (RI/FS) for Zone 1 was completed in 1990. The initial RI focused primarily on the sludge lagoon and Landfill No. 4, and identified both organic and inorganic contamination in groundwater, surface water, sediment, and soil. The

initial FS focused primarily on Zone 1 under OU1. The remedial action goals developed for protection of human health and described in the FS study and ROD under OU1 focused on source control.

A supplemental RI was performed and completed in 1992 to further assess the ecological risks associated with the site as it relates to the study area associated with OU2.

The following reports describe the results of investigations at Zone 1, OU2 to date:

- HAZWRAP, U.S. Air Force Installation Restoration Program, Supplemental Remedial Investigation, Zone 1, Operable Unit 2. Robins AFB, November 1992.
- HAZWRAP, U.S. Air Force Installation Restoration Program, Feasibility Study, Zone 1, Operable Unit 2. Robins AFB, July 1993.

3.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

The RI for the Robins AFB Zone 1 OU2 impact on wetlands was released to the public in November 1992, and the FS in July 1993. The Proposed Plan was released on August 16, 1993 for public comment. These documents were made available to the public in the Administrative Record located at the Directorate of Environmental Management, Robins AFB and at the Environmental Information Repository at the Nola Brantley Memorial Library in Warner Robins. The notice of availability of these documents was published in the Macon Telegraph and the Daily Sun. A public comment period was held from August 16, 1993 through September 29, 1993. A public meeting for OU2 was held on September 16, 1993. At this meeting, representatives of Robins AFB, EPA, and the GEPD answered questions about the site and the remedial alternatives under consideration. A transcript of the public meeting can be reviewed at the information repository.

The Proposed Plan identified the preferred interim remedy for the area associated with OU2 Alternative 2, from the FS (see Section 4); use of institutional controls for future site access and water use restrictions, and a Comprehensive Monitoring Program that will be used to determine the stability of the site. Robins AFB, EPA, and GEPD reviewed all written and verbal comments submitted during the public comment period. Upon review of these comments, it was determined that significant changes to the Proposed Plan preferred interim remedy were not necessary.

4.0 SCOPE AND ROLE OF OPERABLE UNIT 2

The overall strategy of Zone 1 is divided into three operable units. The interim remedial action selected in this ROD is applicable to OU2.

OU2 is directed at determining the degree of impact that may have occurred in the wetlands area and surface waters from the known source of contamination in OU1 and remediation of the impacts identified. OU1 addresses Landfill No. 4 and the Sludge Lagoon, and comprises source control. OU3 is directed at determining the degree of impact that may have occurred in the groundwater beneath and adjacent to Landfill No. 4 and the Sludge Lagoon, and remediation of impacts identified.

The overall goals of the selected interim remedy for the area associated with OU2 are:

- Protect existing habitat
- Minimize the potential direct exposure of the public and base personnel to hazardous substances
- Monitor water balance stabilization of the site following redirection of runoff discharge and diversion of industrial wastewater discharge.

These goals would be achieved by the use of institutional controls for future site access and water use restrictions. In addition, the comprehensive monitoring program will be used to evaluate changes to the site caused by the completion of a runoff diversion system which redirects runoff from a 400-acre watershed from through the landfill to around the landfill and the completion of a pipeline that routes 2 million gallons a day of industrial waste into the Ocmulgee River that had formerly been discharged through the wetlands. This information can be used to develop a final action for the site which addresses current and future conditions.

5.0 SUMMARY OF SITE CHARACTERISTICS

5.1 SUMMARY OF ZONE 1 HYDROLOGY

The local topography, soils, and climate determine how water moves through the site. Zone 1 of the Robins AFB is located on the western edge of the floodplain of the Ocmulgee River (Figure 2). The floodplain in Zone 1 is a low flat region covered by wetlands and standing water. The surface and groundwater flow across Zone 1 is generally to the east toward Horse Creek, a south-flowing tributary of the Ocmulgee River, and to the Ocmulgee River.

The Zone 1 wetland soils consist of approximately 6 ft of saturated organic matter and peat, underlain by a layer of clay ranging in thickness up to approximately 10 ft. The clay layer is underlain by an interbedded sand and gravel deposit that constitute the alluvial aquifer unit under most of Zone 1. The clay layer is thought to restrict water flow between the wetlands and the alluvial aquifer, and to cause the alluvial aquifer to exist under semi-confined conditions. Landfill No. 4 and sludge lagoon were placed on the western edge of the floodplain wetland deposits. Fill materials associated with the landfill are partially saturated and comprise the surficial fill aquifer unit.

The western edge of the Ocmulgee River floodplain is defined by a relatively steep 30 to 40 ft increase in elevation along the southern, western, and northern boundaries of Zone 1. The upland areas adjacent to the Ocmulgee River floodplain consist of sand, gravel, and clay layers of the Providence Formation. Portions of these upland areas adjacent to Zone 1 are within the topographic basin that drains into the Zone 1 wetlands. The Zone 1 wetlands are, therefore, the hydrologic sink or receptor area for the topographically higher portions of its drainage basin.

The Robins AFB is located in a humid, temperate region characterized by high rainfall. Average annual precipitation at the base is 44.9 in., with an estimated evapotranspiration rate of approximately 38.4 in. per year. The difference between precipitation and evapotran-

spiration, approximately 6.5 in. per year, results in a large quantity of water available for recharge to the groundwater and surface water systems. Urbanization and development associated with base activities in the uplands portion of the Zone 1 drainage basin have resulted in a predominance of paved areas. The decrease in vegetation in the developed areas reduces evapotranspiration losses while the impervious surfaces prevent infiltration and recharge of the groundwater system. The result is that in the developed portions of the Zone 1 drainage basin, most of the precipitation that falls will flow via surface water runoff into and through the Zone 1 wetlands.

Most of the surface water runoff that leaves the upland areas of the Zone 1 drainage basin is concentrated into several storm sewers, which discharge at numerous locations near the eastern edge. The remainder of the surface water entering Zone 1 flows directly into Horse Creek from north of Zone 1, east of the Base runways.

Hannah Road and Lights Service Road traverse portions of Zone 1 (Figure 2) and influence surface water flow in the area. The roads are built on embankments of imported soil that restrict the flow of surface water across Zone 1. Surface water located in the floodplain portion of Zone 1 west of Hannah Road leaves the area primarily through two pipe structures under Hannah Road. Surface water present in the wetlands west of the overflow control structures tend to flow toward the structures. Rates of flow near the entrance of these structures would therefore be expected to be higher than would surface water flow rates further away from these control structures.

Groundwater is present in Zone 1 in several aquifer units. Although flow rates through these aquifers is low compared to surface water flow, the aquifer units exhibit relatively high contaminant concentrations and may therefore contain a majority of the contaminant mass that is present in Zone 1. The important aquifers include the surficial fill, alluvial gravel, and the Providence Formation. Beneath the Providence Formation aquifer is the Cusseta Clay Formation and Blufftown Aquifer.

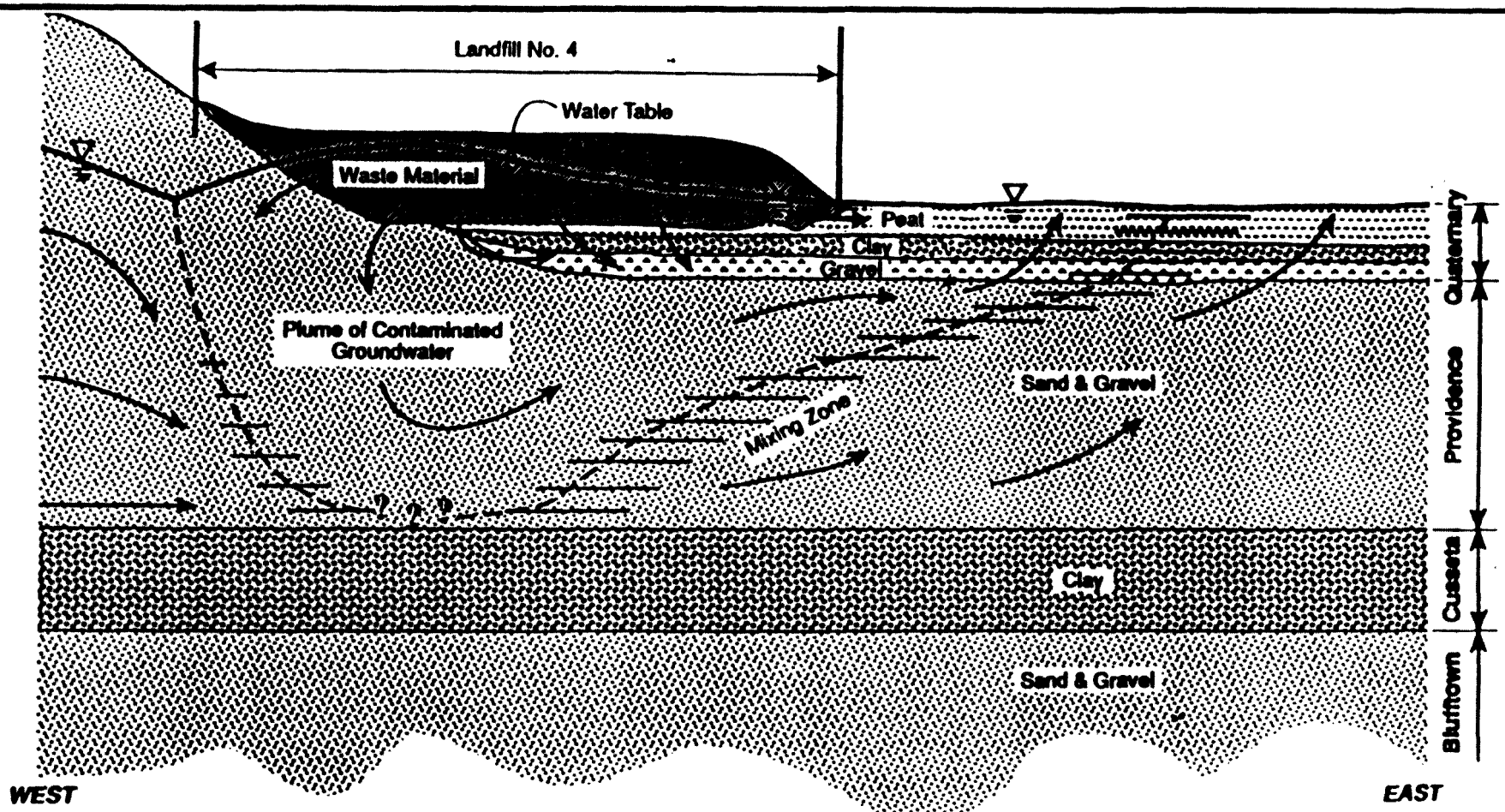
The surficial fill aquifer exists in Landfill No. 4, the sludge lagoon, and in isolated areas associated with the Hannah and Lights Service road embankments, where artificial fill has been placed into the wetlands peat and clay deposits. A schematic cross-sectional view of Zone 1 showing assumed groundwater flow directions and interactions is shown on Figure 3.

The alluvial gravel aquifer is present under the peat and clay deposits throughout the floodplain area in Zone 1 except for the west portion of the landfill. Groundwater flow is consistently to the east. Water levels in wells penetrating this aquifer rise above the top of the aquifer surface, indicating that the aquifer is under semi-confined conditions. The alluvial gravel deposits, like the clay and peat layers above it, decrease in thickness toward the west and disappear along the western edge of the Ocmulgee River floodplain in Zone 1. Cross sections compiled from existing borehole data suggest that the peat, clay, and alluvial gravel deposits all disappear somewhere beneath the western portion of Landfill No. 4.

Beneath the alluvial gravel aquifer is the Providence Formation. This geologic unit extends across the entire site and comprises the upland surface immediately west of Zone 1. Lateral groundwater flow in this aquifer is also toward the east. Based on limited data, the vertical component of flow between the alluvial gravel and Providence Formation aquifers within Zone 1 appears to be generally upward toward the alluvial gravel aquifer throughout Zone 1. The landfill solids and surficial fill aquifer may be in direct hydraulic communication with the Providence aquifer in the western portion of the landfill, where the intervening peat, clay, and alluvial gravel deposits are thin or absent. The alluvial aquifer is not present west of the landfill where vertical gradients in the providence are downward.

5.2 AQUATIC BIOLOGY

Macroinvertebrate sampling conducted during the Zone 1, OU2 RI field investigation demonstrated that stations located downgradient generally exhibit greater species diversity and larger populations than upgradient stations. The results of a Rapid Bioassessment



LEGEND

- Groundwater Flow
- Boundary of Plume of Contaminated Groundwater
- Mixing Zone Between Plume and Natural Waters

Not to Scale

ADAPTED FROM CH2M HILL (1991)

SCHEMATIC CROSS-SECTION OF THE CONCEPTUAL GROUNDWATER FLOW SYSTEM ROBINS AFB, GEORGIA

Figure 3

CDM FEDERAL PROGRAMS CORPORATION
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Protocol III analysis conducted for the OU2 RI showed some locations in both upgradient and downgradient areas demonstrate nonimpairment while others are severely impaired.

5.3 WETLAND ECOLOGY

Vegetation surveys conducted during the Zone 1, OU2 RI field investigation indicated numerous vegetative zones and habitats and a diverse flora associated with open water, emergent wetlands, and mature bottomland hardwood forest. Potentially occurring threatened and endangered species in the OU2 study area include dwarf witch-alder, fly-catchers, hooded pitcher-plant, sweet pitcher-plant, and Florida willow.

5.4 WILDLIFE BIOLOGY

A breeding bird survey conducted during the Zone 1, OU2 RI field investigation showed no significant differences or trends in the types of species observed in the study and reference areas. The survey showed that there are numerous species present that are indicative of healthy bottomland forest ecosystems. Results are summarized on Table 1. Potentially occurring threatened and endangered species in the OU2 study area include American alligator, Bald eagle, Florida panther, and Wood stork.

5.5 EVALUATION OF CONTAMINANT SOURCES

The OU2 field investigations were designed to collect information necessary to assess the relationship between compounds detected in the wetlands and compounds present in the Landfill No. 4 and sludge lagoon. The site conceptual flow model indicates that most of the flow through Zone 1 is surface water, and that a majority of the surface water inflow to Zone 1 originates from sources hydrologically upgradient of the Zone 1 study area

TABLE 1
SUMMARY OF BREEDING BIRD SPECIES OBSERVED
RI/FS ZONE 1, OU2
Robins AFB, Georgia

Cattle Egret	*Bubulcus ibis*
Great Egret	*Casmerodius albus*
Great Blue Heron	*Ardea herodias*
Mallard	*Anas platyrhynchos*
Killdeer	*Charadrius vociferus*
Lesser Yellowlegs	*Tringa flavipes*
Solitary Sandpiper	*Tringa solitaria*
Sanderling	*Calidris alba*
Turkey Vulture	*Cathartes aura*
Northern Bobwhite	*Circus virginianus*
Rock Dove	*Columba livia*
Mourning Dove	*Zenaida macroura*
Yellow-billed Cuckoo	*Coccyzus americanus*
Barred Owl	*Strix varia*
Common Nighthawk	*Chordeiles minor*
Chimney Swift	*Cohaetura pelagica*
Ruby Throated Hummingbird	*Archilochus alexandri*
Belted Kingfisher	*Ceryle alcyon*
Red-bellied Woodpecker	*Melanerpes carolinus*
Common Flicker	*Colaptes auratus*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Pileated Woodpecker	*Dryocopus pileatus*
Eastern Kingbird	*Tyrannus tyrannus*
Great-crested Flycatcher	*Myiarchus crinitus*

TABLE 1 (Cont.)
SUMMARY OF BREEDING BIRD SPECIES OBSERVED
RI/FS ZONE 1, OU2
Robins AFB, Georgia

Eastern Wood Peewee	*Contous virens*
Eastern Phoebe	*Sayornis phoebe*
Acadian Flycatcher	*Empidonax virescens*
Tree Swallow	*Tachycineta bicolor*
Northern Rough-winged Swallow	*Steigidopteryx serripennis*
Barn Swallow	*Hirundo rustica*
Blue Jay	*Cyanocitta cristata*
American (Common) Crow	*Corvus brachyrhynchos*
Fish Crow	*Corvus ossifragus*
Tufted Titmouse	*Parus bicolor*
Carolina Chickadee	*Parus carolinensis*
White-breasted Nuthatch	*Sitta carolinensis*
Carolina Wren	*Thryothorus ludovicianus*
Blue-gray Gnatcatcher	*Polioptila caerulea*
Eastern Bluebird	*Sialia sialis*
Wood Thrush	*Hylocichia mustelina*
American Robin	*Turdus migratorius*
Loggerhead Shrike	*Lanius ludovicianus*
Gray Catbird	*Dumetella carolinensis*
Northern Mockingbird	*Mimus polyglottos*
Brown Thrasher	*Toxostoma rufum*
European Starling	*Sturnus vulgaris*
White-eyed Vireo	*Vireo griseus*
Yellow-throated Vireo	*Vireo flavifrons*
Red-eyed Vireo	*Vireo olivaceus*

TABLE 1 (Cont.)
SUMMARY OF BREEDING BIRD SPECIES OBSERVED
RI/FS ZONE 1, OU2
Robins AFB, Georgia

Prothonotary Warbler	*Prothontaria citrea*
Northern Parula	*Parula americana*
Black and White Warbler	*Mniotilta varia*
Cerulean Warbler	*Dendroica cerulea*
Magnolia Warbler	*Dendroica magnolia*
Yellow-rumped Warbler	*Dendroica coronata*
Yellow-throated Warbler	*Dendroica dominica*
Prairie Warbler	*Dendroica discolor*
Pine Warbler	*Dendroica palmarum*
Yellow Warbler	*Pendroica petechia*
Kentucky Warbler	*Oporornis formosus*
Hooded Warbler	*Wilsonia citrina*
Worm-eating Warbler	*Helmitheros vermivorus*
Swainson's Warbler	*Limnothlypis swainsonii*
Ovenbird	*Seiurus aurocapillus*
Louisiana Waterthrush	*Seiurus motacilla*
Common Yellowthroat	*Geothlypis trichas*
Yellow-breasted Chat	*Octeroa virens*
Northern Cardinal	*Cardinalis cardinalis*
Indigo Bunting	*Passerina cyanea*
Rufous-sided Towhee	*Pipilo erythrophthalmus*
Eastern Meadowlark	*Sturnella magna*
Red-winged Blackbird	*Agelaius phoeniceus*
Brown-headed Cowbird	*Molothrus ater*
Common Grackle	*Quiscalus quiscula*

TABLE 1 (Cont.)
SUMMARY OF BREEDING BIRD SPECIES OBSERVED
RI/FS ZONE 1, OU2
Robins AFB, Georgia

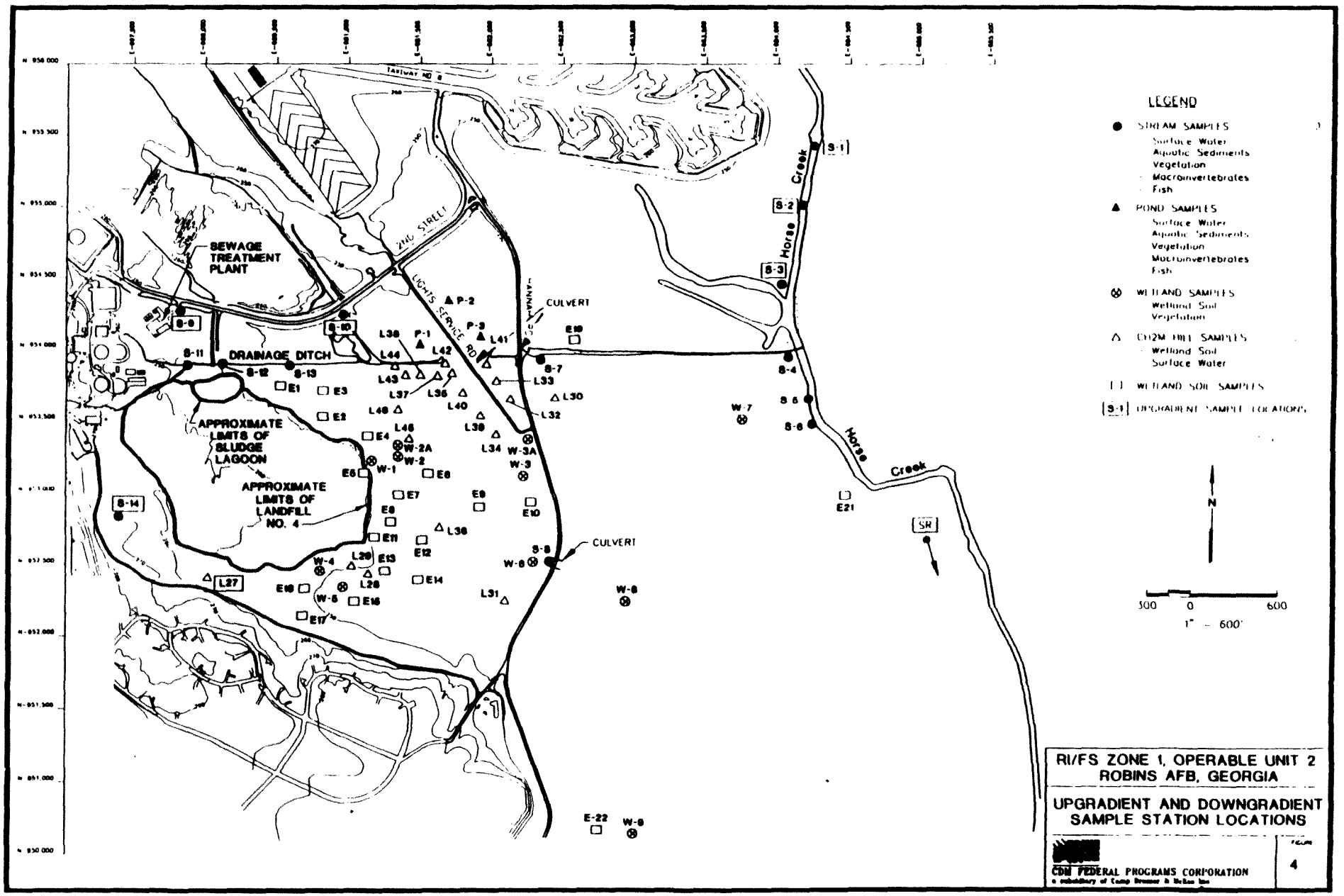
Scarlet Tanager	*Piranga olivacea*
Summer Tanager	*Piranga rubra*
Double-crested Cormorant	*Phalacrocorax auritus*
Anhinga	*Anhinga anhinga*
Wood duck	*Aix sponsa*
Red-tailed Hawk	*Buteo jamaicensis*
Green Heron	*Butorides striatus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Song Sparrow	*Melospiza melodia*
White Ibis	*Eudocimus albus*
Little Blue Heron	*Egretta Caerulea*
American Red start	*Setophaga ruticilla*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Northern Harrier	*Circus cyaneus*
Red-shouldered Hawk	*Buteo lineatus*
Broad-winged Hawk	*Buteo platypterus*

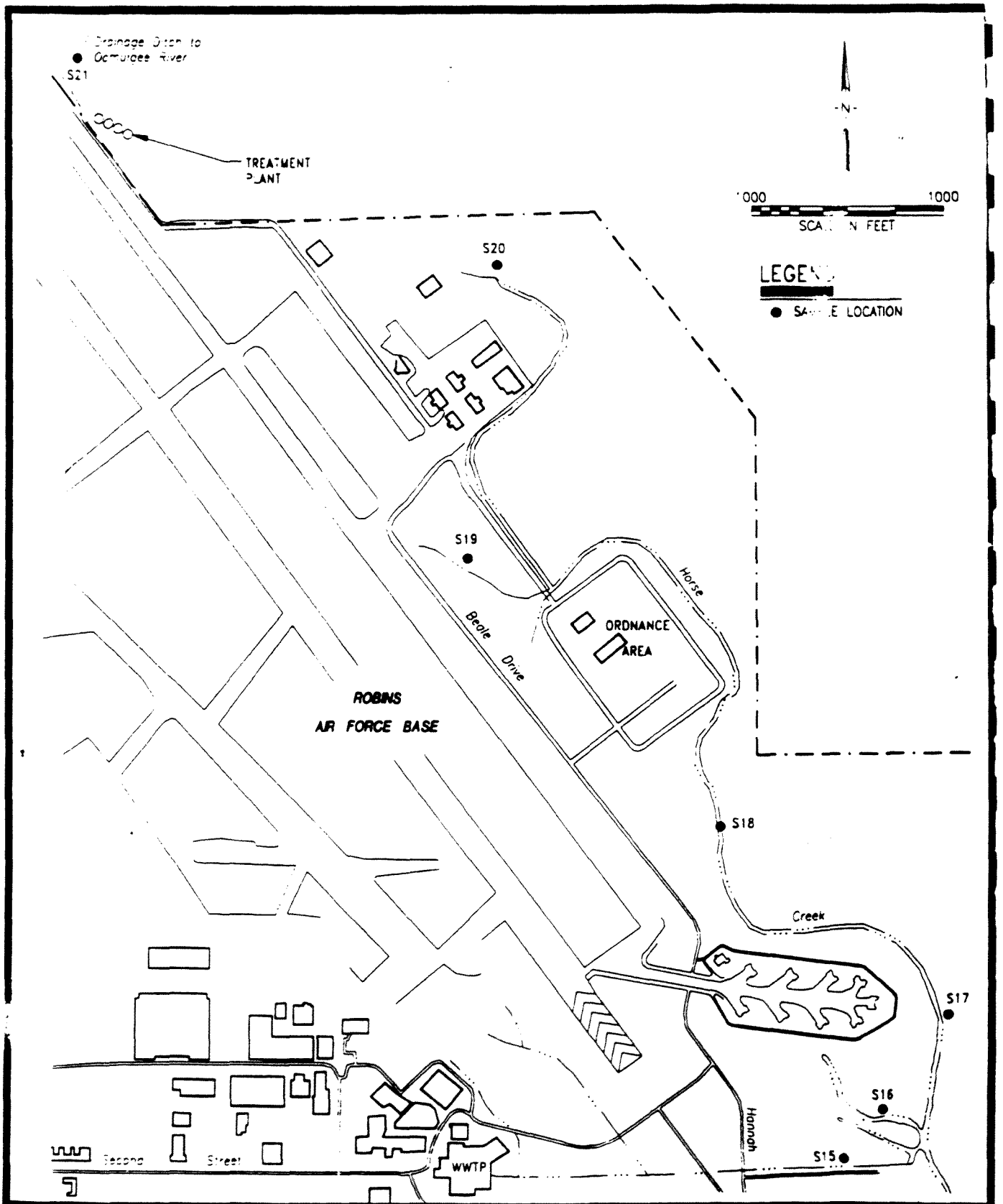
boundaries. The following surface water, aquatic sediment, or wetland soil samples sites were determined to be located hydraulically upgradient of the landfill and sludge lagoon or not effected by Zone 1 contaminants.

CDM Sample Sites:	S1, S2, S3, S9, S10, S14, SR
CH2M HILL Sites:	BCG-SED-01, -02, -03
	BCG-SW-01, -02, -03, LF27

At most sample sites, more than one type of sample (e.g., surface water, sediment, wetland soil, biota samples) were collected. Refer to Figures 4 and 5 for sample site locations. Figure 6 illustrates the CH2M Hill background samples. The site conceptual model also suggests that the surficial fill aquifer, located beneath the landfill and sludge lagoon, discharges water laterally into the wetlands surface water or peat deposits east and northeast of the landfill, and also vertically into the underlying alluvial gravel and Providence Formation aquifers along the western margins of the floodplain. Groundwater in the alluvial gravel and Providence Formation aquifers is likely to be isolated from the overlying wetlands east of the landfill due to the presence of an extensive clay layer.

Summaries of detected compounds for all samples were used to evaluate potential source areas. Listings of both the number of detections and the maximum detected concentrations were compiled separately for upgradient and downgradient sample populations for the groundwater, surface water, and sediment results. Wetland soil sample results were included with sediment results for this evaluation. The individual lists were then combined into two tables based on media type. Table 2 lists the summary results for all liquid media samples, including landfill and sludge lagoon leachate, groundwater, and surface water. Table 3 lists the summary results for all solids media samples, including sludge lagoon and landfill sludge samples, landfill surface soil (listed as Landfill soils), and sediment/soil. Compounds detected in any of the listed sample media were included on both Tables 2 and 3, to aid in the evaluation of potential source areas.


LEGEND
STREAM SAMPLES
Surface Water
Aquatic Sediments
Vegetation
Macroinvertebrates
Fish
POND SAMPLES
Surface Water
Aquatic Sediments
Vegetation
Macroinvertebrates
Fish
WETLAND SAMPLES
Wetland Soil
Vegetation
CH2M HILL SAMPLES
Wetland Soil
Surface Water
WETLAND SOIL SAMPLES
UPGRADIENT SAMPLE LOCATIONS
SEWAGE TREATMENT PLANT
DRAINAGE DITCH
APPROXIMATE LIMITS OF SLUDGE LAGOON
APPROXIMATE LIMITS OF LANDFILL NO. 4
2ND STREET
LIGHTS SERVICE RD
CULVERT
Horse Creek
N
300 0 600
1" = 600'
RI/FS ZONE 1, OPERABLE UNIT 2
ROBINS AFB, GEORGIA
UPGRADIENT AND DOWNGRADIENT SAMPLE STATION LOCATIONS
CDM FEDERAL PROGRAMS CORPORATION
FIGURE
4



ADDITIONAL SURFACE WATER/SEDIMENT SAMPLE LOCATIONS

RI/FS ZONE 1, OPERABLE UNIT 2

ROBINS AFB, GEORGIA

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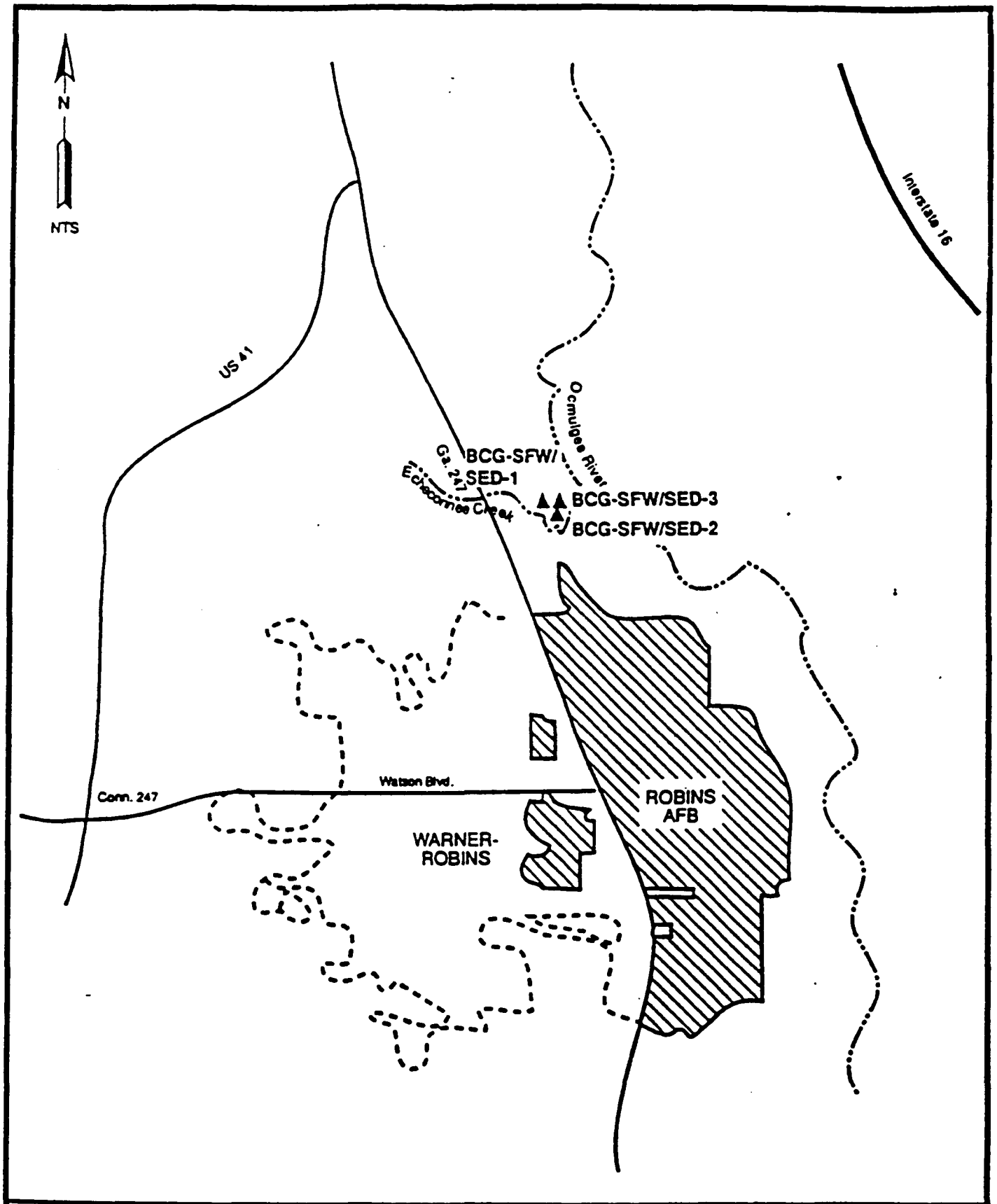
a subsidiary of Camp Dresser & McKee Inc.

FIGURE No. 5



CDM FEDERAL PROGRAMS CORPORATION
a subsidiary of Camp Dresser & McKee Inc.

CH2M HILL BACKGROUND SAMPLING LOCATIONS ROBINS AFB, GEORGIA

Figure 6

TABLE 2

DETECTIONS OF ANALYTES IN LIQUID MEDIA

COMPOUNDS DETECTED IN AT LEAST ONE MEDIUM	SOURCE AREA LEACHATE*				GROUNDWATER*				SURFACE WATER			
ORGANIC	SLUDGE LAGOO		LANDFILL		UPGRADIENT		DOWNGRADIENT		UPGRADIENT		DOWNGRADIENT	
COMPOUND (in ug/l)	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC
1,1-DICHLOROETHANE	6/9	300	2/15	11			6/114	100				
1,1-DICHLOROETHENE	2/9	100	1/15	1.2			3/114	49			1/38	5.00
1,1,1-TRICHLOROETHANE	1/9	130	5/15	33	1/7	2					1/38	2.00
1,1,2-TRICHLOROETHANE	1/9	59										
1,1,2,2-TETRACHLOROETHANE												
1,2-DICHLOROBENZENE	2/5	28000					7/43	5200	1/11	2.00		
1,2-DICHLOROETHANE	1/9	620					4/114	470				
1,2-DICHLOROETHENE (1,2-DCE)	6/9	36000	3/15	31							10/38	13.00
1,2-DICHLOROETHENE (TOTAL)							27/114	19000	4/11	12.00	4/38	21.00
1,2-DICHLOROPROPANE							1/114	2				
1,2,4-TRICHLOROBENZENE												
1,3-DICHLOROBENZENE	2/5	950					4/43	2100			1/38	9.00
1,3-DICHLOROPROPENE (CIS)							1/119	0.500				
1,4-DICHLOROBENZENE	2/5	13000	3/5	120			7/43	2600	1/11	3.00		
1,4-PENTADIENS, 2,3,4-TRIMET												
11H-CYCLOPENTA[A]PHENANTHREN												
1H-INDENE, OCTAHYDRO-2,3A,4-												
2-BUTANONE	4/9	890	3/15	120			10/11	15000			2/38	9.00
2-FURANMETHANOL, 5-ETHENYLTE												
2-HEXANONE			1/15	8.2			2/114	40				
2-METHYLNAPHTHALENE							2/43	64				
2,4-DIMETHYLPHENOL	3/8	11000					6/69	2200				
3,4-BENZOFLUORANTHENE											1/38	3.00
3-HEXENE-2,5-DIONE												
4,4'-DDD	4/5	12	3/3	7							1/38	0.07
4,4'-DDE	2/5	0.26	3/3	5					1/11	0.03	2/38	0.08
4,4'-DDT	4/5	8	2/3	0.1							1/38	0.05
4-CHLORO-3-METHYLPHENOL												
4-METHYL-2-PENTANONE	2/9	650	1/15	6.6	1/7	56	5/112	420				
ACENAPHTHENE			1/5	15								
ACENAPHTHYLENE												

TABLE 2 (Cont.)

DETECTIONS OF ANALYTES IN LIQUID MEDIA

OMPOUNDS DETECTED IN T LEAST ONE MEDIUM	SOURCE AREA LEACHATE*				GROUNDWATER*				SURFACE WATER			
RGANIC	SLUDGE LAGOO		LANDFILL		UPGRADIENT		DOWNGRADIENT		UPGRADIENT		DOWNGRADIENT	
OMPOUND (in ug/l)	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC
CETONE	7/9	4300	9/14	61			49/114	13000	3/11	30	11/38	50
LDRIN												
NTHRACENE												
ZULENE, 1,4-DIMETHYL-7-(1-M												
ENZENE	7/9	660	11/15	85	2/7	13	8/114	91	1/11	3.00		
ENZO(A)ANTHRACENE											1/38	3.00
ENZO(A)PYRENE											1/38	3.00
ENZO(G,H,I)PERYLENE												
ENZO(B)FLUORANTHENE											1/38	3
ENZO(K)FLUORANTHENE											1/38	3.00
ENZOIC ACID							1/16	8			3/38	10.00
ENZYL ALCOHOL											2/38	3.00
CYCLO[2.2.1]HEPTAN-2-OL, 1												
CYCLO[2.2.1]HEPTAN-2-ONE												
S(2-CHLOROISOPROPYL)ETHER							1/43	2.50				
S(1,1-DIMETHYLETHYL)PHENOL												
S(2-ETHYLHEXYL)PHTHALATE	1/5	14	2/5	660			16/43	26	8/11	30.00	13/38	120.00
ORNEOI (8CI)												
ROMODICHLOROMETHANE	1/9	1									9/38	5.00
UTYLBENZYLPHTHALATE							3/43	2				
AMPHENE (DOT) (8CI)												
ARBON DISULFIDE							4/114	29			4/38	5.00
ARBON TETRACHLORIDE					3/7	110	22/114	83			1/38	4.00
ARYOPHYLLENE (VAN)												
HLORDANE, TECHNICAL	2/5	0.100	1/3	37.0								
HLORDANE, ALPHA									NA		2/38	0.04
HLORDANE, GAMMA												
HLOROBENZENE	6/9	4000	9/15	150			13/114	810	3/11	59.00	4/38	4.00
HLOROETHANE			1/15	81								
HLOROFORM	2/9	28	3/15	3	2/7	3	23/114	600			20/38	26.00
HLOROMETHANE							1/114	3			1/38	29.00
HRYSENE											1/38	3.00

TABLE 2 (Cont.)

DETECTIONS OF ANALYTES IN LIQUID MEDIA

IPOUNDS DETECTED IN EAST ONE MEDIUM	SOURCE AREA LEACHATE*				GROUNDWATER*				SURFACE WATER			
ANIC	SLUDGE LAGOO		LANDFILL		UPGRADIENT		DOWNGRADIENT		UPGRADIENT		DOWNGRADIENT	
IPOUND (in ug/l)	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC
OLE (VAN)												
SOL-O	3/7	2200					4/64	290	1/11	0.70		
SOL-M,P	3/7	7900	4/14	170			4/64	1900			2/38	220.00
LOHEXANE ISOMER									NA		2/38	48.00
LOHEXANOL,2-BROMO-TRANS-(									NA		1/38	18.00
NZO(a,h) ANTHRACENE												
TYL PHTHALATE	1/5	550					3/43	3				
BUTYLPHTHALATE											1/38	2.00
OCTYLPHTHALATE							9/43	16				
NZOFURAN												
OMOCHLOROMETHANE											4/38	3.00
LORO-CYCLOHEXANE ISOMER									NA		2/38	120.00
DRIN	2/5	0.02			1/7	0.18			2/11	0.02	6/38	0.08
HYL PHTHALATE												
IMETHYL-4-NAPHTHALENE												
THYL PHTHALALTE												
LBENZENE	5/9	410	7/15	6.3	2/11	6	5/114	70				
RANTHENE			1/5	21							1/38	5.00
RENE			1/5	17								
ACHLOR												
NO(1,2,3-CD)PYRENE											1/38	2.00
METHANE									NA		1/38	14.00
ORNEOL(8Cl)												
ANE, TOTAL (g-BHC)											1/38	0.02
HYLENE CHLORIDE	6/9	6000	9/15	110			73/114	19000	3/11	12	12/38	12.00
ROSODIPHENYLAMINE							1/43	7				
THALENE	2/5	560	4/5	30			3/43	50			1/30	0.7
THALENE, 1,2,3,4,4A,5,6												
THALENE, 1,2,3,4-TETRAHY												
THALENE, 1,2,4A,5,6,8A-H												
DECANAL ISOMER												
1254	2/5	0.7	1/3	100								

TABLE 2 (Cont.)

DETECTIONS OF ANALYTES IN LIQUID MEDIA

COMPOUNDS DETECTED IN AT LEAST ONE MEDIUM	SOURCE AREA LEACHATE*				GROUNDWATER*				SURFACE WATER			
ORGANIC	SLUDGE LAGOO		LANDFILL		UPGRADIENT		DOWNGRADIENT		UPGRADIENT		DOWNGRADIENT	
COMPOUND (in ug/l)	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC
PCB-1260												
PENTACHLOROPHENOL	2/8	2.6	2/15	36			4/69	27			1/38	3.00
PHENANTHRENE			1/5	37							1/38	3.00
PHENOL	4/8	3600	8/15	49	1/1	1	6/68	1700			2/38	23.00
PHENOL,2,6-DIMETHOXY-4-(2-												
PYRENE			1/5	14			1/43	1.2			1/38	4.00
STIGMAST-4-EN-3-ONE												
STYRENE												
TETRACHLOROETHYLENE	4/9	1100	1/15	3.2	1/7	29	19/114	290	3/11	15.00		
TOLUENE	6/9	2200	9/15	33	2/11	34	18/114	540	1/11	3.00	8/38	30.00
TRICHLOROETHYLENE	6/9	130000	4/15	8.1	7/7	880	41/114	21000	6/11	72.00	23/38	52.00
TRICHLOROFLUOROMETHANE	1/8	5100					9/58	170				
VINYL CHLORIDE	5/9	12000	3/15	12			8/114	6700			1/38	2.00
XYLENES (TOTAL)	6/9	2200	9/15	26	3/7	49	8/112	220			1/38	2.00

TABLE 2 (Cont.)

DETECTIONS OF ANALYTES IN LIQUID MEDIA

	SOURCE AREA LEACHATE*				GROUNDWATER*				SURFACE WATER			
	SLUDGE LAGOON		LANDFILL		UPGRADIENT		DOWNGRADIENT		UPGRADIENT		DOWNGRADIENT	
:TALS (in ug/l)	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC
UMINUM					9/11	7100	46/46	447000	10/11	927.00	22/38	18153.00
ITIMONY							1/46	136				
ISENIC	6/6	21000	14/14	13000	1/11	8	18/101	109			5/38	14.41
.RIUM	6/6	1600	14/14	4200	7/8	98	104/104	3490	10/11	362	25/38	678.09
RYLLIUM	4/6	80	8/14	22			9/104	29.1	2/11	0.38	12/38	1.2
)RON									4/11	91.20	13/38	178.00
.DMIUM	6/6	34800	14/14	9300	1/11	7.3	8/101	600	1/11	1.96	9/38	26.87
.LCIUM					9/9	18800	48/48	218000	10/11	36100.00	34/38	67613.00
IROMIUM	6/6	13163000	14/14	66000	2/11	63	39/101	2720	1/11	1.42	12/38	272.94
)BALT							4/46	109	NA		3/38	14.11
)PPER	6/6	10600	13/14	3600			45/101	1800	4/11	84.09	18/38	135.53
ANIDE	4/6	320	7/14	574			9/101	403			1/38	11.03
)N					8/9	5400	46/46	317000	11/11	1660.00	33/38	37018.00
AD	5/6	60000	14/14	10400	6/11	28	67/101	5240	2/11	7.30	23/38	318.00
.GNESIUM					7/9	1310	46/46	23600	10/11	4890.00	34/38	5644.30
.NGANESE					10/11	40.7	36/46	5040	6/11	97.42	19/38	477.10
:RCURY	6/6	85	14/14	880	5/11	0.9	20/101	73	2/11	0.33	4/38	0.50
:KEL	6/6	15000	14/14	1300	2/11	17.8	28/101	17.8	2/11	21.17	8/38	23.63
									7/11	7.90	11/38	6.70
)TASSIUM					7/9	1970	43/46	32700	6/11	6870.00	33/38	7038.40
LENIUM	2/6	40	9/14	23	1/11	30	5/101	11.1			4/38	1.04
VER	4/6	80	12/14	40			3/101	986			8/38	52.45
)DIUM					4/9	5950	40/46	70100	10/11	5740.00	34/38	89452.00
LFIDE			10/11	7000			11/46	1.4				
LFUR, MOL. (S8)												
ALLIUM	1/6	5	3/14	6			3/101	3.3	NA		1/38	0.70
NADIUM					3/9	2320	13/46	1160	1/11	1.55	13/38	63.32
IC	6/6	64400	14/14	60000	8/11	55.2	96/101	4600	6/11	492	30/38	1242.40

)TES:

. = Not Analyzed.

ınk spaces indicate compound was analyzed for but not detected.

)ata from CH2M HILL, 1990.

TABLE 3

DETECTIONS OF ANALYTES IN SOLIDS MEDIA

COMPOUNDS DETECTED IN AT LEAST ONE MEDIUM	SOURCE AREA*						SOIL & SEDIMENT			
ORGANIC	SLUDGE LAGOON		LANDFILL		LANDFILL SOILS		UPGRADIENT		DOWNGRADIENT	
COMPOUND (ug/kg)	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC
1,1-DICHLOROETHANE	3/23	260								
1,1-DICHLOROETHENE	1/23	3								
1,1,1-TRICHLOROETHANE							4/11	14.00	5/64	31.00
1,1,2-TRICHLOROETHANE	2/23	400								
1,1,2,2-TETRACHLOROETHANE			1/14	1.40						
1,2-DICHLOROBENZENE	3/11	1700000	1/5	110					3/64	210.00
1,2-DICHLOROETHANE	1/23	70								
1,2-DICHLOROETHENE (1,2-DCE)	9/23	100000							3/64	170.00
1,2-DICHLOROETHENE (TOTAL)									5/64	220.00
1,2-DICHLOROPROPANE										
1,2,4-TRICHLOROBENZENE	1/11	52000								
1,3-DICHLOROBENZENE	3/11	58000							1/64	9.00
1,3-DICHLOROPROPENE (CIS)										
1,4-DICHLOROBENZENE	4/11	690000	2/5	600	1/13	970			4/64	540.00
1,4-PENTADIENS, 2,3,4-TRIMET							NA		1/64	12000.00
11H-CYCLOPENTA[A]PHENANTHREN							NA		1/64	9100.00
1H-INDENE, OCTAHYDRO-2,3A,4-							NA		1/64	9500.00
2-BUTANONE	6/23	3100	3/14	1100					20/64	920.00
2-FURANMETHANOL, 5-ETHENYLTE							NA		1/64	4400.00
2-HEXANONE			2/14	1400						
2-METHYLNAPHTHALENE									6/64	95.00
2,4-DIMETHYLPHENOL	2/23	120000								
3,4-BENZOFLUORANTHENE									7/64	1800.00
3-HEXENE-2,5-DIONE							NA		3/64	9700.00
4,4'-DDD	3/4	930	1/2	2			2/11	20.00	37/64	9000.00
4,4'-DDE	3/4	200	1/2	2			3/11	19.00	47/64	1300.00
4,4'-DDT	3/4	240	1/2	1	1/13	44	2/11	27.00	19/64	51000.00
4-CHLORO-3-METHYLPHENOL	1/23	460								
4-METHYL-2-PENTANONE			1/14	21					1/64	24.00
ACENAPHTHENE	1/11	200	2/5	3800			1/11	25.00	8/64	400.00
ACENAPHTHYLENE							1/11	20.00	7/64	180.00

TABLE 3 (Cont.)

DETECTIONS OF ANALYTES IN SOLIDS MEDIA

COMPOUNDS DETECTED IN AT LEAST ONE MEDIUM	SOURCE AREA*						SOIL & SEDIMENT			
ORGANIC	SLUDGE LAGOON		LANDFILL		LANDFILL SOILS		UPGRADIENT		DOWNGRADIENT	
COMPOUND (ug/kg)	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC
ACETONE	4/8	630	5/7	2100	2/13	320	6/11	630	38/64	22000
ALDRIN	1/4	2.6							17/64	840.00
ANTHRACENE	2/11	600	1/5	6400			2/11	39.00	15/64	830.00
AZULENE, 1,4-DIMETHYL-7-(1-M							NA		2/64	10000.00
BENZENE	5/23	2800	2/14	1.7			1/11	1700.00	6/64	54.00
BENZO(A)ANTHRACENE	2/11	2700	2/5	300			3/11	520.00	20/64	2000.00
BENZO(A)PYRENE	2/11	2200	3/5	400			3/11	530.00	28/64	2300.00
BENZO(G,H,I)PERYLENE	2/11	1300	1/5	200			1/11	74.00	10/64	1200.00
BENZO(B)FLUORANTHENE	2/11	2700	3/5	400	1/13	110	3/11	720.00	14/64	790.00
BENZO(K)FLUORANTHENE	2/11	1600	1/5	300			3/11	600.00	21/64	2000.00
BENZOIC ACID					1/13	210			6/64	10000.00
BENZYL ALCOHOL									1/64	77.00
BICYCLO[2.2.1]HEPTAN-2-OL, 1							NA		2/64	900.00
BICYCLO[2.2.1]HEPTAN-2-ONE							NA		2/64	3300.00
BIS(2-CHLOROISOPROPYL)ETHER										
BIS(1,1-DIMETHYLETHYL)PHENOL							NA		5/64	1700.00
BIS(2-ETHYLHEXYL)PHTHALATE	3/11	76000	3/5	4300	5/13	590	3/11	48000.00	17/64	16000.00
BORNEOL (8CI)							NA		4/64	5900.00
BROMODICHLOROMETHANE										
BUTYLBENZYLPHTHALATE	2/11	7100	1/5	600	12/13	200	1/11	27.00	1/64	72.00
CAMPHENE (DOT) (8CI)							NA		2/64	8500.00
CARBON DISULFIDE	1/23	3	1/14	2					2/64	530.00
CARBON TETRACHLORIDE										
CARYOPHYLLENE (VAN)							NA		7/64	5300.00
CHLORDANE (TECHNICAL)	3/4	8500	2/2	940						
CHLORDANE, ALPHA					1/13	49	NA		8/64	30.00
CHLORDANE, GAMMA					1/13	53			5/64	16.00
CHLOROBENZENE	8/23	20000	2/14	11	2/13	52	4/11	25000.00	10/64	220.00
CHLOROETHANE										
CHLOROFORM	6/23	17000	1/14	2					1/64	3.00
CHLOROMETHANE							1/11	22.00		

TABLE 3 (Cont.)

DETECTIONS OF ANALYTES IN SOLIDS MEDIA

COMPOUNDS DETECTED IN AT LEAST ONE MEDIUM	SOURCE AREA*						SOIL & SEDIMENT			
ORGANIC	SLUDGE LAGOON		LANDFILL		LANDFILL SOILS		UPGRADIENT		DOWNGRADIENT	
COMPOUND (ug/kg)	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC
CHRYSENE	2/11	3100	3/5	300			3/11	890.00	22/64	2100.00
CINEOLE (VAN)							NA		26/64	110000.00
CRESOL-O	2/21	13000								
CRESOL-M,P	2/21	50000	4/13	1800	1/13	70				
CYCLOHEXANE ISOMER										
CYCLOHEXANOL,2-BROMO-TRANS-(										
DIBENZO(a,h) ANTHRACENE	2/11	400								
DIBUTYL PHTHALATE	2/11	35000	2/5	3100	13/13	650				
DI-N-BUTYLPHTHALATE							1/11	23.00	2/64	550.00
DI-N-OCTYLPHTHALATE									5/64	490.00
DIBENZOFURAN									6/64	160.00
DIBROMOCHLOROMETHANE										
DICHLORO-CYCLOHEXANE ISOMER										
DIELDRIN	2/4	200	1/2	1			1	5.5	32/64	2900.00
DIETHYL PHTHALATE	1/11	600	1/5	170	13/13	150			1/64	19.00
1,6-DIMETHYL-4-NAPHTHALENE							NA		16/64	33000.00
DIMETHYL PHTHALALTE									1/64	150.00
ETHYLBENZENE	8/23	5600	4/14	14	2/13	9	1/11	71.00	1/64	3.00
FLUORANTHENE	5/11	4800	3/5	1500			5/11	1500.00	41/64	4100.00
FLUORENE	1/11	200	1/5	3100			2/11	20.00	11/64	360.00
HEPTACHLOR	1/4	2								
INDENO(1,2,3-CD)PYRENE	2/11	1400	1/5	200			1/11	72.00	14/64	1100.00
IODOMETHANE										
ISOBORNEOL (8Cl)							NA		1/64	2900.00
LINDANE, TOTAL (g-BHC)										
METHYLENE CHLORIDE	6/7	950	2/2	130	13/13	120	4/11	11.00	20/64	250.00
N-NITROSODIPHENYLAMINE							1/11	85	1/64	95.00
NAPHTHALENE	6/11	80000	3/5	2100					4/64	87.00
NAPHTHALENE, 1,2,3,4,4A,5,6							NA		10/64	5700.00
NAPHTHALENE, 1,2,3,4-TETRAHY							NA		13/64	17000.00
NAPHTHALENE, 1,2,4A,5,6,8A-H							NA		7/64	13000.00

TABLE 3 (Cont.)

DETECTIONS OF ANALYTES IN SOLIDS MEDIA

COMPOUNDS DETECTED IN AT LEAST ONE MEDIUM	SOURCE AREA*						SOIL & SEDIMENT			
ORGANIC	SLUDGE LAGOON		LANDFILL		LANDFILL SOILS		UPGRADIENT		DOWNGRADIENT	
COMPOUND (ug/kg)	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC
OCTADECANAL ISOMER							NA		1/64	310.00
PCB-1254	2/4	2500	1/2	500						
PCB-1260	1/4	36.0								
PENTACHLOROPHENOL										
PHENANTHRENE	3/11	2900	4/5	5800			3/11	740.00	24/64	3200.00
PHENOL	2/23	18000	3/14	200						
PHENOL,2,6-DIMETHOXY-4-(2-							NA		2/64	6100.00
PYRENE	3/11	3600	3/5	1000			5/11	1800.00	44/64	3200.00
STIGMAST-4-EN-3-ONE							NA		2/64	2000.00
STYRENE									1/64	11.00
TETRACHLOROETHYLENE	5/23	59000					1/11	11.00	7/64	75.00
TOLUENE	13/23	20000	5/14	43	13/13	250	1/11	6	10/64	120.00
TRICHLOROETHYLENE	3/23	2500000					2/11	13.00	8/64	220.00
TRICHLOROFLUOROMETHANE	1/21	68000								
VINYL CHLORIDE	1/23	110								
XYLENES (TOTAL)	8/23	38000	7/14	110	1/13	4	1/11	310.00	5/64	42.00

TABLE 3 (Cont.)

	SOURCE AREA*						SOIL & SEDIMENT			
	SLUDGE LAGOON		LANDFILL		LANDFILL SOILS		UPGRADIENT		DOWNGRADIENT	
METALS (mg/kg)	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC	FREQ.	MAX CONC
ALUMINUM					13/13	7870	11/11	25900.00	64/64	44600.00
ANTIMONY					2/13	5.8				
ARSENIC	22/23	45	14/14	12	5/13	1.9	2/11	3300	14/64	69.00
BARIUM	23/23	387	14/14	202	13/13	57.3	10/11	228	63/64	281.00
BERYLLIUM	6/23	1.00	1/14	0.29			2/11	1500	14/64	1.46
BORON									1/64	35.10
CADMIUM	20/23	599	13/14	15	1/13	18.7	2/11	208.00	23/64	20.50
CALCIUM					13/13	3470	8/11	1030.00	63/64	20400.00
CHROMIUM	23/23	6419	14/14	52	12/13	153	11/11	1080.00	59/64	219.00
COBALT					8/13	3.5	NA		13/64	0.01
COPPER	23/23	722	12/14	55	12/13	33.4	8/11	178.00	21/64	156.00
CYANIDE										
IRON					13/13	7230	11/11	29900.00	64/64	69700.00
LEAD	22/23	972	14/14	155	13/13	122	11/11	451.00	64/64	440.00
MAGNESIUM					13/13	2000	8/11	2020.00	64/64	1700.00
MANGANESE					13/13	121	4/11	186	19/64	0.16
MERCURY	14/23	1.1	10/14	0.1			6/11	0.86	57/64	1.30
NICKEL	20/23	203	11/14	8	2/13	6.1	2/11	68.00	12/64	117.00
PH							5/11	6.80	37/64	7.80
POTASSIUM							3/11	1230.00	16/64	1190.00
SELENIUM	4/23	0.6	5/14	0.7					22/64	42.40
SILVER	14/23	45	7/14	6	1/13	4.3	1/11	60.70	19/64	49.70
SODIUM					13/13	57.2	1/11	130.00	24/64	2150.00
SULFIDE							7/11	12.10	38/64	591.00
SULFUR, MOL. (S8)							NA		5/64	14.00
THALLIUM	1/23	0.76					NA		3/64	0.00
VANADIUM					13/13	18.7	4/11	69.7	19/64	0.07
ZINC	23/23	1091	14/14	457	12/13	124	10/11	297.00	60/64	954.00

NOTES:

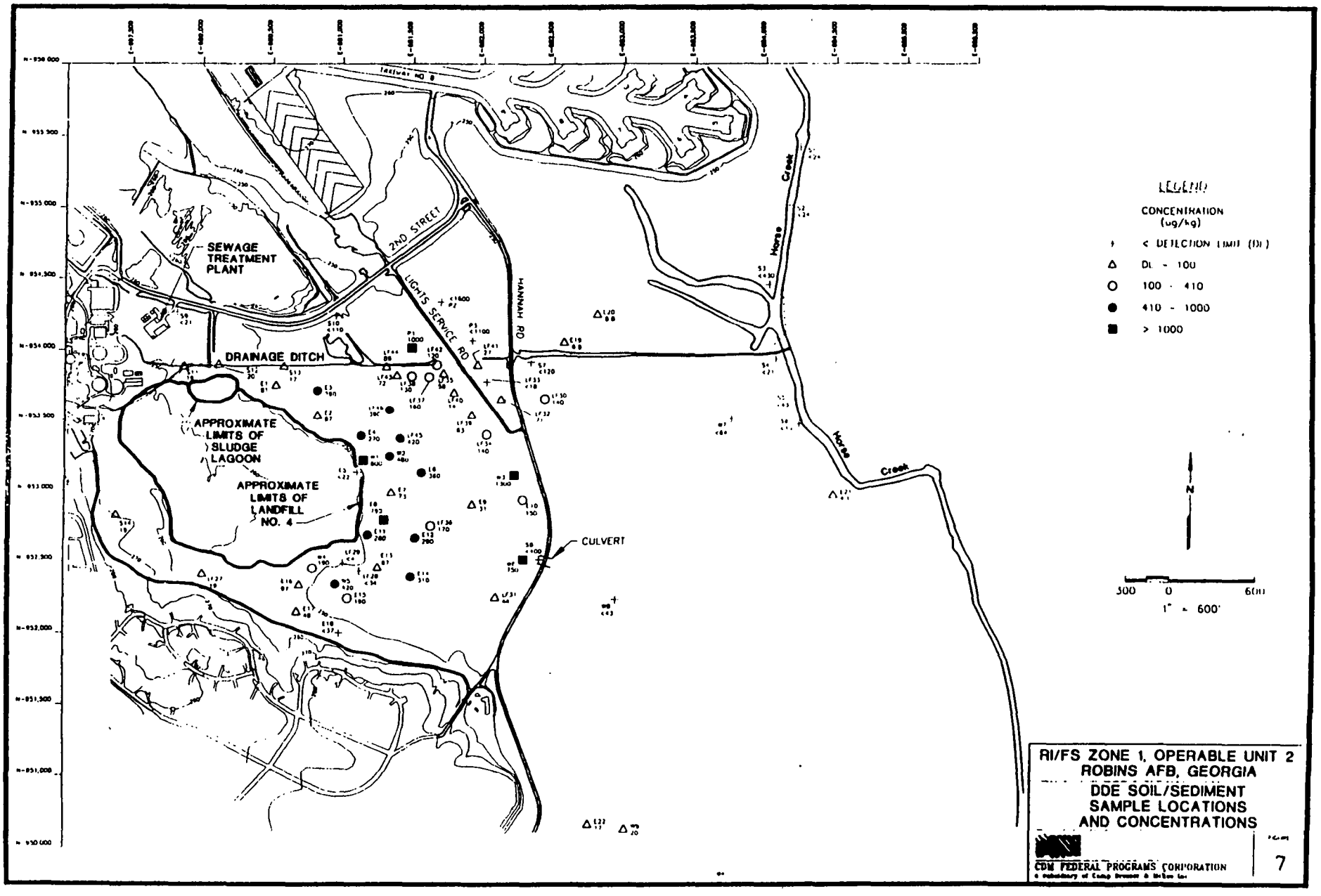
NA = Not Analyzed.

Blank spaces indicate compound was analyzed for but not detected.

* Data from CH2M Hill, 1990.

The general trends in compound concentrations downgradient of the landfill and sludge lagoon are consistent with the conceptual model of flow presented previously. Groundwater present in the shallow fill aquifer within the landfill and sludge lagoon appears to migrate laterally, discharging directly into the wetlands peat and surface water, and vertically into the underlying alluvial gravel and Providence Formation aquifers. Due to the high organic content of the wetlands peat deposits, it is expected that organic compounds present in the shallow fill groundwater would be adsorbed within a short distance from the landfill or sludge lagoon. DDE and dieldrin are present in wetland soil samples (Figure 7 and 8) at relatively high concentrations in a band parallel to the downgradient edge of the landfill. In contrast, metals compounds are present in a more widespread distribution within the Zone 1 wetlands. This may be due to slightly acidic conditions present within the wetlands, which enhances metals mobility, and because adsorption onto organic matter is not as significant an attenuating mechanism for metals as it is for organic compounds. Figures 9 and 10 show approximate areal extent of contamination above remediation levels in wetlands soil and aquatic sediment in the study area for dieldrin, mercury, and metals. Tables 4 and 5 present a summary of criteria used to select chemicals of concern for the ecological risk assessment.

A total of 136 chemicals, 109 organics and 27 inorganics, were detected in all media. Thirty compounds had the highest detected values within a sample media in upgradient locations. A total of 121 chemicals detected at downgradient locations were determined to be potentially attributable to Landfill No. 4 and the sludge lagoon. Further analysis revealed, however, that 25 of the chemicals detected in downgradient surface water and 32 of the chemicals detected in downgradient soil/sediment were not present in landfill or sludge lagoon source area samples. Further, many of these chemicals were detected only once or twice. The compounds detected only in downgradient sampling locations are considered to be either naturally occurring or are degradation products from some of the compounds detected in the Zone 1 landfill and sludge lagoon.



RI/FS ZONE 1, OPERABLE UNIT 2
ROBINS AFB, GEORGIA
DDE SOIL/SEDIMENT SAMPLE LOCATIONS AND CONCENTRATIONS

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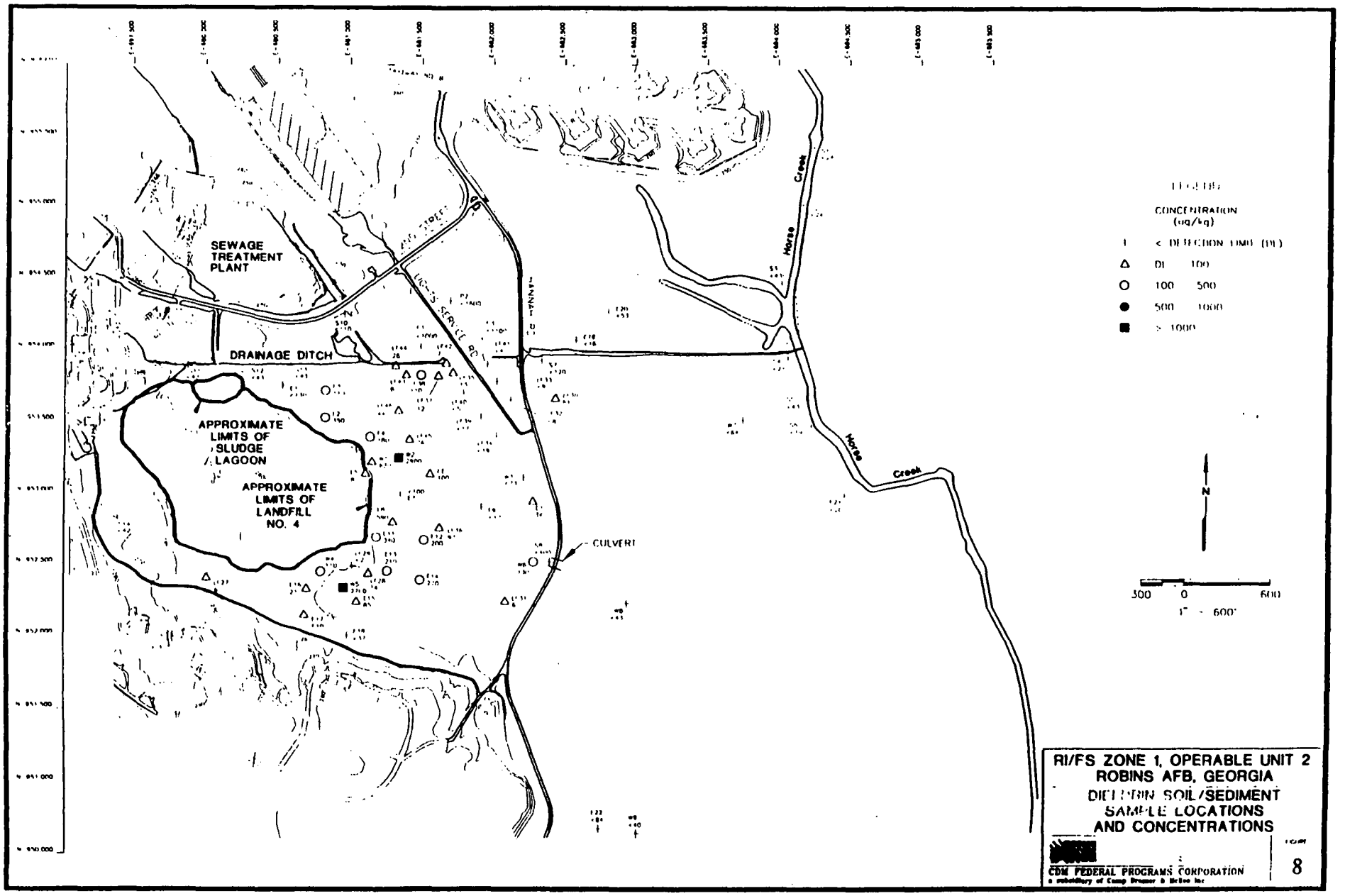
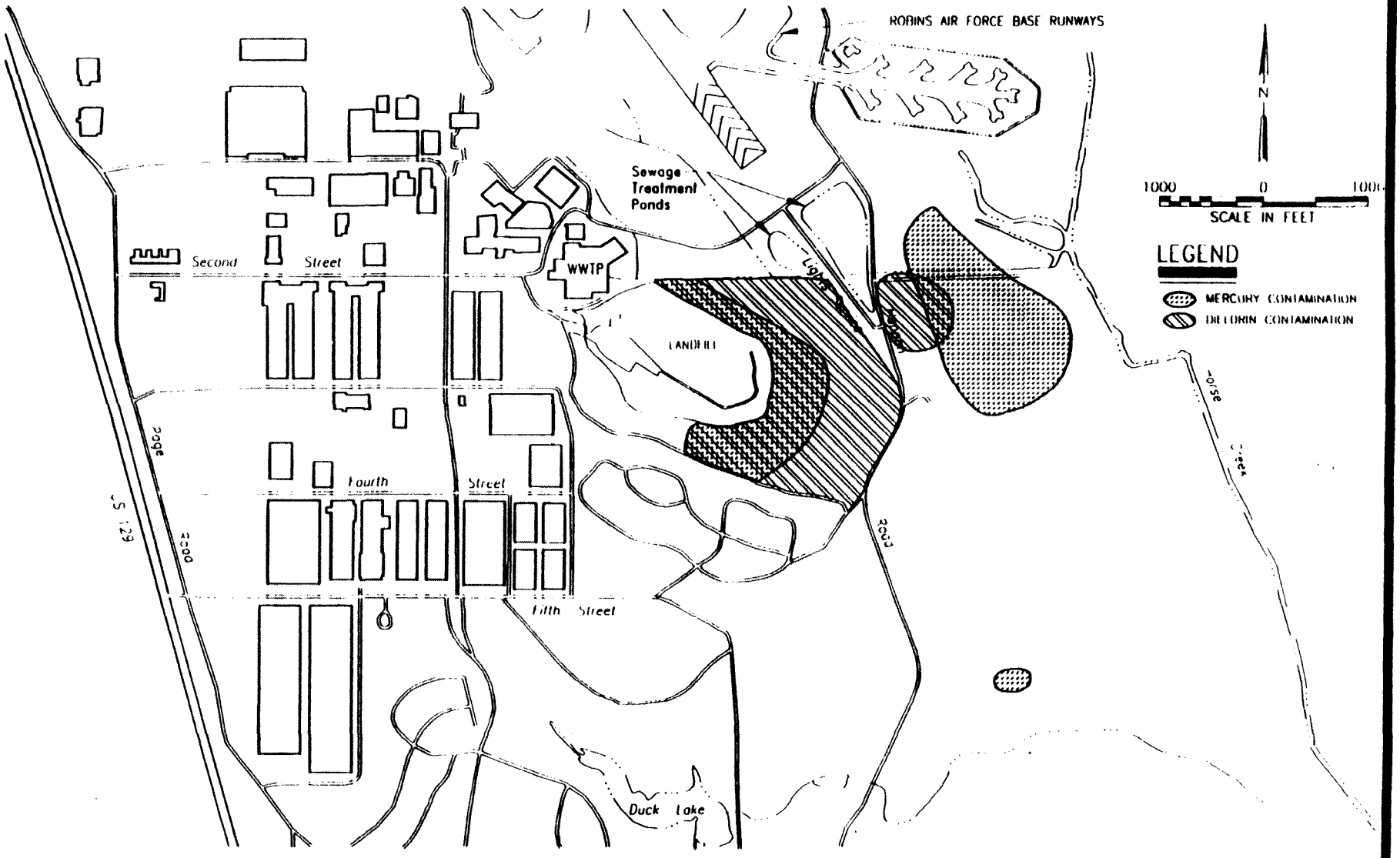


RI/FS ZONE 1, OPERABLE UNIT 2
ROBINS AFB, GEORGIA
DIELDRIN SOIL/SEDIMENT
SAMPLE LOCATIONS
AND CONCENTRATIONS

[redacted]

CDM FEDERAL PROGRAMS CORPORATION
a subsidiary of Camp Dresser & McKee Inc.

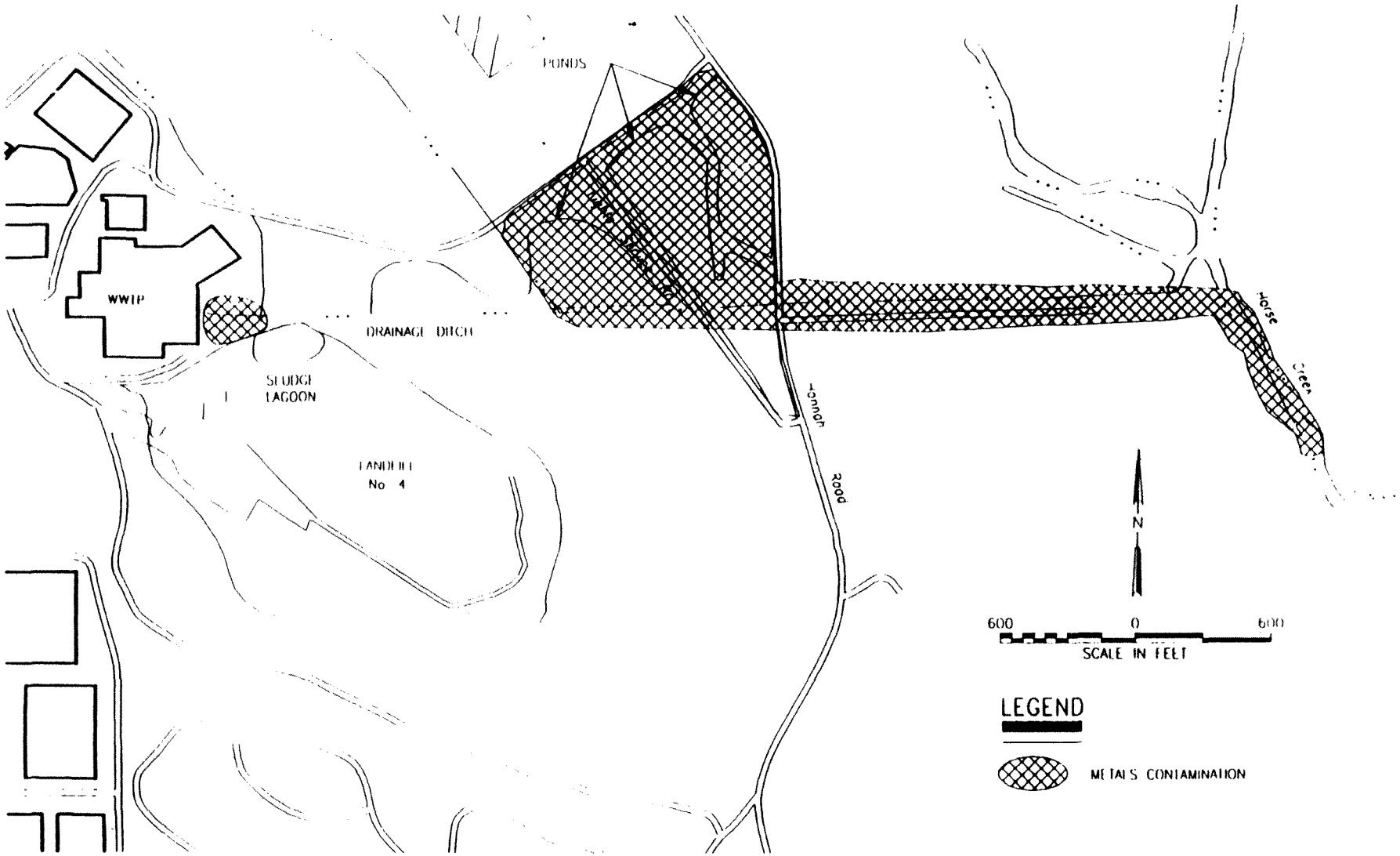
FIGURE 8



APPROXIMATE AREAL EXTENT OF WETLANDS SOIL CONTAMINATION ABOVE REMEDIATION LEVELS RI/FS ZONE 1, OPERABLE UNIT 2 ROBINS AFB, GEORGIA

DM FEDERAL PROGRAMS CORPORATION
ubsidiary of Camp Dresser & McKee Inc.

FIGURE No. 9



APPROXIMATE AREAL EXTENT OF AQUATIC SEDIMENT CONTAMINATION ABOVE REMEDIATION LEVELS RI/FS ZONE 1, OPERABLE UNIT 2

ROBINS AFB, GEORGIA

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FIGURE No. 10

TABLE 4

SUMMARY OF CRITERIA USED TO SELECT CHEMICALS OF CONCERN FOR ECOLOGICAL RISK ASSESSMENT
SURFACE WATER
RI/FS Zone 1, OU 2
Robins AFB, Georgia

Chemical	Maximum Downgradient Concentration (µg/L)	AWQC[a] Acute/Chronic (µg/L)	GWQC[e] µg/L	Bioconcentration Potential	Persistence/Mobility[b]	Decision
ORGANICS						
Bis(2-ethylhexyl)phthalate	120.0	940/3	5.92[f]	Low	High/Low	Retain-Maximum concentration is significantly above the chronic AWQC.
Chloroform	26.0	28,900/1,240	470.8[f]	Low	Low/High	Omit-Maximum concentration is well below the AWQC and bioconcentration is not known to occur.
1,2-Dichloroethene	21.0	11,600/NA[c]	NA	Medium	Low/High	Omit-Maximum concentration is three orders of magnitude below the acute AWQC.
Dieldrin	0.08	2.5/0.0019	0.0019[g]	High	High/Low	Retain-Maximum concentration is above the chronic AWQC and bioconcentration potential is high.
Phenol	23.0	10,200/2,560	NA	Low	Low/High	Omit-Maximum concentration is well below the chronic AWQC.
Toluene	30.0	17,500/NA	301,941[f]	Low	Low/High	Omit-Maximum concentration is well below the AWQC and GWQC and bioconcentration is not known to occur.
INORGANICS						
Arsenic	14.41	360/190	50[g]	Low	High/Low	Omit-Maximum concentration an order of magnitude below the chronic AWQC, and less than half of the GWQC.

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TABLE 4

SUMMARY OF CRITERIA USED TO SELECT CHEMICALS OF CONCERN FOR ECOLOGICAL RISK ASSESSMENT
SURFACE WATER
RI/FS Zone 1, OU 2
Robins AFB, Georgia

Chemical	Maximum Downgradient Concentration (µg/L)	AWQC[a] Acute/Chronic (µg/L)	GWQC[c] µg/L	Bioconcentration Potential	Persistence/Mobility[b]	Decision
INORGANICS (Cont.)						
Barium	678.09	NA/NA	NA	NA	High/Low	Omit-Barium would likely be present in the nontoxic insoluble form in most surface waters, and would have to be present at 50 mg/L to be toxic to aquatic life (USEPA 1986a).
Beryllium	1.20	130/5.3	0.117[f]	NA	High/Low	Omit-Maximum concentration is below the chronic AWQC and bioconcentration is not known to occur.
Cadmium	26.87	39/11	0.7[g]	High	High/Low	Retain-Maximum concentration is above the chronic AWQC, close to the acute AWQC, and considerably higher than GWQC and bioconcentration is known to occur.
Chromium (total)	72.94	16/11 (for CrVI)	120[g] (total)	Low	High/Low	Retain-Maximum concentration is above the AWQC for CrVI, and close to the GWQC.
Lead	318.0	34/1.3[d]	1.3[g]	Medium	High/Low	Retain-Maximum concentration is well above the AWQC and GWQC and bioconcentration is known to occur.
Mercury (total)	[illegible]0	2.4/0.012	0.012[g]	High	High/Low	Retain-Maximum concentration is above the chronic AWQC and bioconcentration is significant in aquatic life.

TABLE 4

SUMMARY OF CRITERIA USED TO SELECT CHEMICALS OF CONCERN FOR ECOLOGICAL RISK ASSESSMENT
SURFACE WATER
RI/FS Zone 1, OU 2
Robins AFB, Georgia

Chemical	Maximum Downgradient Concentration (µg/L)	AWQC[a] Acute/Chronic (µg/L)	GWQC[e] µg/L	Bioconcentration Potential	Persistence/Mobility[b]	Decision
INORGANICS (Cont.)						
Nickel	23.63	1,100/56[d]	88[g]	Medium	High/Low	Omit-Maximum concentration is less than half the chronic AWQC.
Selenium	1.04	260/35	5[g]	NA	High/Low	Omit-Maximum concentration is below the AWQC and bioconcentration is not known to occur.
Silver	52.45	4.1/0.12	0.12[g]	NA	High/Low	Retain-Maximum concentration is above the AWQC and GWQC.
Zinc	1,242.40	65/59[d]	60[g]	High	High/Low	Retain-Maximum concentration is well above the AWQC and GWQC.

[a] Source: USEPA 1986a. *Quality Criteria for Water 1986*, EPA/440/5-86-001 Office of Water Regulations and Standards. Washington, D.C.

[b] Persistence/Mobility: Persistence is described by a qualitative estimate of how long the chemical will remain in the environment. Mobility is described by a qualitative estimate of how readily the chemical will move away from its first site of deposition. For volatile compounds, no appreciable deposition may take place.

[c] NA = Not Available

[d] Toxicity of this chemical is dependent on hardness. A mean hardness of 55 mg/L was determined from surface water samples used in bioassay tests, therefore, the AWQC reported is adjusted for a hardness of 50 mg/L (USEPA 1986a).

[e] Georgia Water Quality Criteria (GDNR 1991)

[f] Annual Average Flow Criterion

[g] Low Flow Criterion

TABLE 5

SUMMARY OF CRITERIA USED TO SELECT CHEMICALS OF CONCERN FOR ECOLOGICAL RISK ASSESSMENT
SOIL AND SEDIMENT
RI/FS Zone 1, OU 2
Robins AFB, Georgia

Chemical	Maximum Downgradient Concentration (mg/kg)	Potential Bioaccumulation	Persistence/Mobility[a]	Selected Toxicity Values Description: Value, species	Decision	Reference
ORGANICS						
2-Butanone	0.920	Low	Low/High	Oral LD_{50}[b]: 3,980 mg/kg/day; rat	Omit	USEPA 1976
Carbon disulfide	0.530	Low	Low/High	NA[c]	Omit	—
4,4'-DDD	9.0	High	High/Low	NOEL[d]: 50 mg/kg body weight; rat	Retain	IARC 1973
4,4'-DDE	1.300	High	High/Low	LOAEL[e]: 0.20 mg/kg-bw/day in diet; black duck (*Aves, Anseriformes*)	Retain	Longcore & Samson 1973
4,4'-DDT	51.0	High	High/Low	NOAEL[f]: 0.34 mg/kg-bw/day; pheasant	Retain	Hunt et al. 1969
1,2-Dichlorobenzene	0.21	Medium	Medium/Medium	NOEL: 188 mg/kg/day; rat	Omit	Clayton & Clayton 1981-1982
1,4-Dichlorobenzene	0.540	Medium	Medium/Medium	NOEL: 150 mg/kg/day; rabbit	Omit	Gaines 1986
1,2-Dichloroethene	0.170	Medium	Low/High	NOEL: 1,000 mg/kg/day inhalation; rat, rabbit, dog	Omit	ACGIH 1986
Dieldrin	2.90	High	High/Low	NOAEL: 0.05 mg/kg/day; barn owl (*Aves, Strigiformes*)	Retain	Mendenhall et al. 1983
Benzo(a)pyrene	2.30	High	High/Low	LOAEL: 40 mg/kg; rat	Retain	IARC 1973
Phthalates	0.550	Low	High/Low	NOEL: 1,300 mg/kg/day in diet; dog	Omit	Krauskopf 1973
Tetrachloroethene (PCE)	0.075	Low	Low/High	NOEL: 2,000 mg/kg/day inhalation; rat	Omit	Clayton and Clayton 1981-1982
Toluene	0.120	Low	Low/High	NA	Omit	
1,1,1-Trichloroethane	0.031	Low	Low/High	LOAEL: 500 mg/kg/day inhalation; mice	Omit	USEPA 1981
Trichloroethene	0.220	Low	Low/High	NOEL: 70 mg/kg/day inhalation; rat	Omit	Verschueren 1983

TABLE 5

SUMMARY OF CRITERIA USED TO SELECT CHEMICALS OF CONCERN FOR ECOLOGICAL RISK ASSESSMENT
SOIL AND SEDIMENT
RI/FS Zone 1, OU 2
Robins AFB, Georgia

Chemical	Maximum Downgradient Concentration (mg/kg)	Potential Bioaccumulation	Persistence/Mobility[a]	Selected Toxicity Values Description: Value, species	Decision	Reference
INORGANICS						
Arsenic	69.0	Medium	High/Low to Moderate	NOAEL: 1.2 mg/kg-bw/day; dog	Retain	Byron et al. 1967
Barium	281.0	NA	High/Low	NA	Omit	
Mercury	1.30	High	High/Low	NOAEL: 0.055 mg/kg/day; mallard	Retain	Heinz 1974
Nickel	0.117	NA	High/Low	NOAEL: 2.5 mg/kg; Rat	Omit	Ambrose et al., 1976
Selenium	42.4	NA	High/Low	NOAEL: 10 mg/kg; swine	Retain	Herigstad et al. 1973
Zinc	954.0	High	High/Low	NOAEL: 100 mg/kg; rat	Retain	Schlicker and Cox 1968

[a] Persistence/Mobility: Persistence is described by a qualitative estimate of how long the chemical will remain in the environment. Mobility is described by a qualitative estimate of how readily the chemical will move away from its first site of deposition. For volatile compounds, no appreciable deposition may take place.

[b] LD_{50} = Lethal dose for 50% of the exposed organisms at a specific time of observation.

[c] NA = Data Not Available

[d] NOEL = No observed effect level

[e] LOAEL = Lowest observed adverse effect level

[f] NOAEL = No observed adverse effect level

5.6 CONTAMINANTS OF CONCERN

The Baseline Risk Assessment (RA) conducted for the Zone 1 RI completed in 1990 identified the following contaminants of concern (COCs):

- Carbon Tetrachloride
- 1,2-Dichloroethene
- Tetrachloroethene
- Vinyl chloride
- Arsenic
- Cadmium
- Chromium
- Lead

The Ecological Risk Assessment (ERA) conducted for the Zone 1, OU2 RI completed in 1992 identified the following contaminants of concern related to OU2 ecological receptors.

Surface Water

- Bis(2-ethylhexyl)phthalate
- Dieldrin
- Cadmium
- Chromium
- Lead
- Mercury
- Silver
- Zinc

Soil/Aquatic Sediment

- Benzo(a)pyrene
- 4,4' DDD, DDE, DDT
- Dieldrin
- Arsenic
- Mercury
- Selenium
- Zinc

6.0 SUMMARY OF SITE RISKS

6.1 HUMAN HEALTH RISK ASSESSMENT

A human health risk assessment was completed as part of the Zone 1 RI in 1990. The human health risk assessment identified two potential current human exposure pathways and estimated the risk associated with each. These two exposure pathways are the potential for inhalation of contaminated dust particles and volatile organic compounds for onsite trespassers and offsite residents and ingestion of contaminated soil, sediment, and surface water for onsite trespassers. The first pathway was residential inhalation; risk estimates suggested an excess lifetime cancer risk of 3×10^{-6} for inhalation of contaminated dust particles and 2×10^{-6} for inhalation of VOCs or a cumulative estimated risk level of 5×10^{-6}. The second exposure pathway is incidental ingestion of contaminated soil, sediment, and surface water. The maximum estimated risk for this exposure route was 9×10^{-6} for the incidental ingestion of sediment by child trespassers. The risk associated with these pathways is an acceptable risk under the NCP (10^{-7} to 10^{-4}).

Human health risks associated with aquatic sediment, wetland soil, and surface water ingestion were reassessed based on data collected from locations downgradient of Landfill No. 4 and the sludge lagoon during the Zone 1, OU2 RI field investigation. Hazard Indices did not increase significantly as a result of the reassessment. Carcinogenic risks for arsenic in wetland soil and for arsenic and dieldrin in aquatic sediment were higher than risks presented in the initial human health risk assessment, but still within EPA's acceptable range (1×10^{-6} to 1×10^{-4}).

Tables 6 through 11 illustrate comparisons of initial (CH2M Hill) and reassessed (CDM) hazard index and carcinogenic risk values.

TABLE 6

COMPARISON OF CH2M HILL AND CDM ESTIMATES OF HAZARD INDICES
FOR INGESTION OF WETLAND SOIL[a]
RI/FS Zone 1, OU 2
Robins AFB, Georgia

Chemical	Reference Dose (RfD) (mg/kg/day)	Source[b]	Highest Detected Concentration (CH2M HILL) (μg/kg)	Highest Detected Downgradient Concentration (CDM) (μg/kg)	Hazard Index (CH2M HILL)	Hazard Index (CDM)
Antimony	0.0004	IRIS	5,800	—	0.041429	—
Barium	0.05	IRIS	57,300	281,000	0.003274	0.016
Benzoic acid	4	IRIS	210	10,000	0.000000	0.00000
Bis(2-ethylhexyl)phthalate	0.02	IRIS	590	16,000	0.000084	0.0023
Butyl benzyl phthalate	0.2	HEAST	200	—	0.000003	—
Cadmium	0.001	IRIS	18,700	20,500	0.053	0.058
Chlordane	0.00006	IRIS	102	30	0.004858	0.0014
Chlorobenzene	0.021	SPHEM	52	220	0.000008	0.000034
Chromium VI	0.005	IRIS	153,000	219,000	0.087429	0.13
Copper	0.037	SPHEM	33,400	156,000	0.002579	0.012
DDT	0.0005	IRIS	44	110	0.000251	0.00063
Dibutyl phthalate	0.1	IRIS	650	—	0.000019	—
1,2-Dichlorobenzene	0.09	IRIS	970	210	0.000031	0.0000067
Diethyl phthalate	0.1	IRIS	150	—	0.000008	—
Ethylbenzene	0.1	IRIS	9	3	0.000000	0

TABLE 6 (Cont.)

COMPARISON OF CH2M HILL AND CDM ESTIMATES OF HAZARD INDICES
FOR INGESTION OF WETLAND SOIL[a]
RI/FS Zone 1, OU 2
Robins AFB, Georgia

Chemical	Reference Dose (RfD) (mg/kg/day)	Source[b]	Highest Detected Concentration (CH2M HILL) (µg/kg)	Highest Detected Downgradient Concentration (CDM) (µg/kg)	Hazard Index (CH2M HILL)	Hazard Index (CDM)
Lead	0.0014[d]	IRIS	122,000	360,000	0.248980	0.74
Manganese	0.1	IRIS	121,000	160	0.00346	0.0000046
4-Methylphenol	0.5[d]	IRIS	70	ND[c]	0.000000	—
Silver	0.005	IRIS	4,300	49,700	0.002457	0.0028
Toluene	0.2	IRIS	250	120	0.000003	0.0000014
Vanadium	0.009	IRIS	18,700	70	0.00594	0.000022
Xylenes	2	IRIS	4	42	0.000000	0.00000
Zinc	0.2	HEAST	124,000	954,000	0.001771	0.014

[a] Exposure Assumptions

Exposure Setting	Trespass
Exposure Individual	Child
Soil Intake (grams/day)	0.1
Body Weight (kilograms)	35

[b] Sources of RfDs:
IRIS — Integrated Risk Information System USEPA (1992a).
SPHEM — Superfund Public Health Evaluation Manual USEPA (1986b).
HEAST — Health Effects Assessment Summary Tables - USEPA (1992b).

[c] ND = Not Detected

[d] RFD currently withdrawn pending review (USEPA 1992).

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TABLE 7

COMPARISON OF CH2M HILL AND CDM ESTIMATES OF CARCINOGENIC RISKS
FOR INGESTION OF WETLAND SOIL[a]
RI/FS Zone 1, OU 2
Robins AFB, Georgia

Chemical	USEPA Carcinogen Classification	Carcinogenic Potency Factor (kg-day/mg)	Source[b]	Highest Concentration (CH2M HILL) (µg/kg)	Highest Downgradient Concentration (CDM) (µg/kg)	Excess Lifetime Cancer Risk (CH2MHILL)	Excess Lifetime Cancer Risk (CDM)
Arsenic	A	1.75	HEAST	1,900.0	69,000	1.19×10^{-7}	4.3×10^{-6}
Benzo(b)fluoranthene	B2	11.5	[c]	110.0	1,800	4.64×10^{-8}	7.6×10^{-7}
Bis(2-ethylhexyl)phthalate	B2	0.014	IRIS	590.0	16,000	2.96×10^{-10}	8×10^{-9}
Chlordane	B2	1.3	IRIS	102.0	30	4.76×10^{-9}	1.6×10^{-8}
DDT	B2	0.34	IRIS	44.0	110	5.37×10^{-10}	2.1×10^{-10}
1,4-Dichlorobenzene	B2	0.024	HEAST	970.0	540	8.35×10^{-10}	1×10^{-9}

[a] Exposure Assumptions

Exposure Setting	Trespass
Exposure Individual	Child
Daily Soil Intake (grams/day)	0.1
Body Weight (kilograms)	35
Number of days/week exposed	2
Number weeks/year expose	16
Number of years exposed	10
Lifetime Average Soil Intake (grams/kg body wt./day)	0.000036

[b] Sources of Cancer Potency [illegible]
IRIS — Integrated [illegible] Information System USEPA (1992a).
SPHEM — Superfund Public Health Evaluation Manual USEPA (1986b).
HEAST — Health Effects Assessment Summary Tables - USEPA (1992b).

[c] Based on benzo(a)pyrene.

TABLE 8

COMPARISON OF CH2M HILL AND CDM ESTIMATES OF HAZARD INDICES
FOR AQUATIC SEDIMENT INGESTION[a]
RI/FS Zone 1, OU 2
Robins AFB, Georgia

Chemical	Reference Dose (RfD) (mg/kg/day)	Source[b]	Highest Detected Concentration (CH2M HILL) (µg/kg)	Highest Detected Downgradient Concentration (CDM) (µg/kg)	Hazard Index (CH2M HILL)	Hazard Index (CDM)
Aldrin	0.00003	IRIS	6.50	840	0.0006	0.08
Antimony	0.0004	IRIS	19,300	—	0.1	—
Arsenic	0.0003	IRIS	27,200	69,000	0.27	0.68
Barium	0.05	IRIS	190,000	281,000	0.01	0.01
Benzo(g,h,i)perylene	0.004[c]	HEAST	1,060	1,200	0.0000095	0.0000108
Beryllium	0.005	IRIS	1,800	1,460	0.001	0.001
Bis(2-ethylhexyl)phthalate	0.02	IRIS	2,790	16,000	0.0004	0.002
Bromodichloromethane	0.02	IRIS	20.0	—	0.000003	—
2-Butanone	0.05	IRIS	290	—	0.00002	—
Butyl benzyl phthalate	0.2	HEAST	640	—	0.000009	—
Cadmium	0.001	IRIS	21,000	20,500	0.05	0.05
Carbon disulfide	0.1	IRIS	4.90	530	0.0000001	0.00001
Chlordane	0.00006	IRIS	180	30	0.008	0.001
Chlorobenzene	0.02	IRIS	380	220	0.000054	0.00003
Chloroform	0.01	IRIS	64.0	3	0.00002	0.0000009
Chromium VI	0.005	IRIS	230,000	219,000	0.1	0.1

TABLE 8 (Cont.)

COMPARISON OF CH2M HILL AND CDM ESTIMATES OF HAZARD INDICES
FOR AQUATIC SEDIMENT INGESTION
RI/FS Zone 1, OU 2
Robins AFB, Georgia

Chemical	Reference Dose (RfD) (mg/kg/day)	Source[b]	Highest Detected Concentration (CH2M HILL) (µg/kg)	Highest Detected Downgradient Concentration (CDM) (µg/kg)	Hazard Index (CH2M HILL)	Hazard Index (CDM)
Copper	0.037	SPHEM	97,000	156,000	0.007	0.01
DDT	0.0005	IRIS	180	110	0.001	0.0006
Dibutyl phthalate	0.1	IRIS	930	—	0.00003	—
1,1-Dichloroethene	0.009	IRIS	270	—	0.00009	—
Dieldrin	0.00005	IRIS	880	2,900	0.05	0.2
Diethyl phthalate	0.1	IRIS	750	—	0.000024	—
Ethylbenzene	0.1	IRIS	130	3	0.000004	0.00000009
Lead	0.0014[d]	SPHEM	226,000	360,000	0.5	0.8
Manganese	0.1	SPHEM	696,000	160	0.02	0.0000046
Mercury (alkyl and inorganic)	0.0003	IRIS	1,940	1,300	0.02	0.01
4-Methyl-2-pentanone	0.05[d]	IRIS	7.00	—	0.0000004	—
4-Methylphenol	0.5[d]	IRIS	46.0	—	0.0000003	—
Naphthalene	0.004	HEAST	650	1,700	0.0005	0.0013
Nickel	0.02	[e]	20,900	20	0.003	0.000003
Pyrene	0.03	HEAST	5,100	3,200	0.0005	0.0003
Silver	0.005	IRIS	34,000	49,700	0.018	0.024

TABLE 8 (Cont.)

COMPARISON OF CH2M HILL AND CDM ESTIMATES OF HAZARD INDICES
FOR AQUATIC SEDIMENT INGESTION
RI/FS Zone 1, OU 2
Robins AFB, Georgia

Chemical	Reference Dose (RfD) (mg/kg/day)	Source[b]	Highest Detected Concentration (CH2M HILL) (µg/kg)	Highest Detected Downgradient Concentration (CDM) (µg/kg)	Hazard Index (CH2M HILL)	Hazard Index (CDM)
Tetrachloroethene	0.01	IRIS	33.0	75	0.000009	0.00002
Toluene	0.2	IRIS	1,200	120	0.000015	0.0000015
Vanadium	0.009	IRIS	79,500	70	0.023	0.000023
Xylenes	2	IRIS	820	42	0.000001	0.00000005
Zinc	0.2	HEAST	449,000	954,000	0.006	0.01

[a] Exposure Assumptions

Exposure Setting	Trespass
Exposure Individual	Child
Soil Intake (grams/day)	0.1
Body Weight (kilograms)	35

[b] Sources of RfDs:
IRIS — Integrated Risk Information System USEPA (1992a).
SPHEM — Superfund Public Health Evaluation Manual USEPA (1986b).
HEAST — Health Effects Assessment Summary Tables - USEPA (1992b).

[c] Nickel value base on nickel-soluble salts.

[d] RfD currently withdrawn pending review (USEPA 1992a).

[e] Value is a proxy toxicity value based upon naphthalene.

TABLE 9

COMPARISON OF CARCINOGENIC RISKS FOR AQUATIC SEDIMENT INGESTION
CALCULATED BY CH2M HILL AND CDM[a]
RI/FS Zone 1, OU 2
Robins AFB, Georgia

Chemical	USEPA Carcinogen Classification	Carcinogenic Potency Factor (kg-day/mg)	Source[b]	Highest Downgradient Concentration (CH2M HILL) (μg/kg)	Highest Downgradient Concentration (CDM) (μg/kg)	Excess Lifetime Cancer Risk (CH2M HILL)	Excess Lifetime Cancer Risk (CDM)
Aldrin	B2	17.0	IRIS	6.50	840	3.97×10^{-9}	5.1×10^{-7}
Arsenic	A	1.75	HEAST	27,200	69,000	1.71×10^{-6}	4.3×10^{-6}
Benzene	A	0.029	IRIS	150	54	1.56×10^{-10}	5.6×10^{-11}
Benzo(a)anthracene	B2	11.5	[c]	3,180	2,000	1.31×10^{-6}	8.2×10^{-7}
Benzo(b)fluoranthene	B2	11.5	[c]	4,450	1,800	1.84×10^{-6}	8.2×10^{-7}
Benzo(k)fluoranthene	B2	11.5	[c]	800	2,000	3.30×10^{-7}	8.25×10^{-7}
Benzo(a)pyrene	B2	11.5	SPHEM	2,540	2,300	1.05×10^{-6}	9.5×10^{-7}
Bis(2-ethylhexyl)phthalate	B2	0.014	IRIS	2,790	16,000	1.40×10^{-9}	8×10^{-9}
Bromodichloromethane	B2	0.130	HEAST	20.0	—	9.33×10^{-11}	—
Chlordane	B2	1.30	IRIS	95.0	30	4.43×10^{-9}	1×10^{-9}
Chloroform	B2	0.0061	IRIS	64.0	3	1.40×10^{-11}	6.5×10^{-13}
Chloromethane	C	0.013[d]	HEAST	50.0	—	2.33×10^{-11}	—
Chrysene	C	11.5	[c]	3,070	2,100	1.27×10^{-6}	8.7×10^{-7}
DDD	B2	0.240	IRIS	490	540	4.22×10^{-9}	4.6×10^{-9}
DDE	B2	0.340	IRIS	940	1,300	[illegible]	1.6×10^{-8}
DDT	B2	0.340	IRIS	180	110	2.20×10^{-9}	1.3×10^{-9}
Dibenz(a,h)anthracene	B2	11.5	[c]	650	—	2.68×10^{-7}	—
1,4-Dichlorobenzene	B2	0.024	HEAST	315	540	2.71×10^{-10}	4.6×10^{-10}

TABLE 9 (Cont.)

COMPARISON OF CARCINOGENIC RISKS FOR AQUATIC SEDIMENT INGESTION
CALCULATED BY CH2M HILL AND CDM
RI/FS Zone 1, OU 2
Robins AFB, Georgia

Chemical	USEPA Carcinogen Classification	Carcinogenic Potency Factor (kg-day/mg)	Source[b]	Highest Downgradient Concentration (CH2M HILL) (µg/kg)	Highest Downgradient Concentration (CDM) (µg/kg)	Excess Lifetime Cancer Risk (CH2M HILL)	Excess Lifetime Cancer Risk (CDM)
1,1-Dichloroethane	C	0.091[d]	HEAST	270	—	8.82×10^{-10}	—
Dieldrin	B2	16.0	IRIS	880	2,900	5.05×10^{-7}	1.6×10^{-6}
Indeno(1,2,3-cd)pyrene	B2	11.5	[c]	1,520	1,100	6.27×10^{-7}	4.5×10^{-7}
Tetrachloroethene	B2	0.051[d]	SPHEM	33.0	75	6.04×10^{-11}	1.4×10^{-10}
Trichloroethene	B2	0.011[d]	IRIS	32.0	220	1.26×10^{-11}	8.7×10^{-11}

[a] Exposure Assumptions

Exposure Individual	Child
Exposure Setting	Trespass
Daily Soil Intake (grams/day)	0.1
Body Weight (kilograms)	35
Number of days/week exposed	2
Number weeks/year expose	16
Number of years exposed	10
Lifetime Average Soil Intake (grams/kg body wt./day	0.000036

[b] Sources of Cancer Potency Factors:
IRIS — Integrated Risk Information System USEPA (1992a).
SPHEM — Superfund Public Health Evaluation Manual USEPA (1986d).
HEAST — Health Effects Assessment Summary Tables - USEPA (1992b).

[c] Based on benzo(a)pyrene.

[d] RfD currently withdrawn pending review (USEPA 1992).

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TABLE 10

COMPARISON OF CH2M HILL AND CDM ESTIMATES OF HAZARD INDICES
FOR INGESTION OF SURFACE WATER[a]
RI/FS Zone 1, OU 2
Robins AFB, Georgia

Chemical	Reference Dose (RfD) (mg/kg/day)	Source[b]	Maximum Concentration (CH2M HILL) (µg/kg)	Maximum Downgradient Concentration (CDM) (µg/kg)	Hazard Index (CH2M HILL)	Hazard Index (CDM)
Antimony	0.0004	IRIS	72.8	ND[c]	0.3	—
Arsenic	0.0003	IRIS	12	14.41	0.067	0.08
Barium	0.05	IRIS	1,360	678.09	0.04	0.02
Beryllium	0.005	IRIS	3.8	1.2	0.001	0.0003
Bromodichloromethane	0.02	IRIS	3	5.0	0.0002	0.0003
2-Butanone	0.05	IRIS	11	9.0	0.0003	0.0003
Cadmium	0.001	IRIS	128	26.87	0.2	0.04
Chlorobenzene	0.02	SPHEM	5	4	0.0004	0.0003
Chloroform	0.01	IRIS	11	26.0	0.002	0.005
Chromium VI	0.005	IRIS	1,390	72.94	0.4	0.02
Copper	0.037	SPHEM	856	56.69	0.03	0.002
Cyanide	0.02	[c]	67.1	ND	0.005	—
Lead	0.0014[d]	SPHEM	1,400	318	1.4	0.3
Manganese	0.1	IRIS	2,700	477.10	0.044	0.0078
Mercury (alkyl and inorganic)	0.0003	IRIS	14	0.5	0.07	0.003

TABLE 10 (Cont.)

COMPARISON OF CH2M HILL AND CDM ESTIMATES OF HAZARD INDICES
FOR INGESTION OF SURFACE WATER[a]
RI/FS Zone 1, OU 2
Robins AFB, Georgia

Chemical	Reference Dose (RfD) (mg/kg/day)	Source[b]	Maximum Concentration (CH2M HILL) (µg/kg)	Maximum Downgradient Concentration (CDM) (µg/kg)	Hazard Index (CH2M HILL)	Hazard Index (CDM)
4-Methyl-2-pentanone	0.05[e]	IRIS	4	ND	0.0001	—
Nickel	0.02	[d]	97.6	23.63	0.007	0.002
Pyrene	0.03	HEAST	12	4.0	0.006	0.002
Selenium	0.005	IRIS	5.7	1.04	0.0018	0.0003
Silver	0.005	IRIS	239	52.45	0.06	0.012
Toluene	0.3	IRIS	5	30	0.00002	0.0001
Vanadium	0.009	IRIS	203	63.32	0.03	0.008
Zinc	0.2	HEAST	5,070	1,242.4	0.04	0.01

[a] Exposure Assumptions

Exposure Setting	Trespass
Exposure Individual	Child
Water Intake (liters/day)	0.05
Body Weight (kilograms)	35

[b] Sources of RfDs:
IRIS — Integrated Risk Information System USEPA (1992a).
SPHEM — Superfund Public Health Evaluation Manual USEPA (1986b).
HEAST — Health Effects Assessment Summary Tables - USEPA (1992b).

[c] Cyanide value based on free cyanide.

[d] Nickel value based on nickel-soluble salts.

[e] RfD currently withdrawn pending review, (USEPA 1992a).

TABLE 11

COMPARISON OF CH2M HILL AND CDM ESTIMATES OF CARCINOGENIC RISKS FOR INGESTION OF SURFACE WATER[a]
RI/FS Zone 1, OU 2
Robins AFB, Georgia

Chemical	USEPA Carcinogen Classification	Carcinogenic Potency Factor (kg-day/mg)	Source[b]	Maximum Concentration (CH2M HILL) (µg/L)	Maximum Downgradient Concentration (CDM) (µg/L)	Excess Lifetime Cancer Risk (CH2M HILL)	Excess Lifetime Cancer Risk (CDM)
Arsenic	A	1.75	HEAST	12	14.41	4E-07	5×10^{-7}
Benzene	A	0.029	IRIS	5	—	3E-09	—
Bromodichloromethane	B2	0.13	HEAST	3	5	7E-09	1×10^{-8}
Chloroform	B2	0.0061	IRIS	11	26	1E-09	2×10^{-9}
Trichloroethene	B2	0.011[c]	IRIS	7	52	1E-09	7×10^{-9}

[a] Exposure Assumptions

Exposure Setting	Trespass
Daily Water Intake (liters/day)	0.05
Body Weight (kilograms)	35
Number of days/week exposed	2
Number weeks/year exposed	16
Number of years exposed	10
Lifetime Average Water Intake	0.00002 (liters/kg body wt./day)

[b] Sources of Cancer Potency Factors:
IRIS — Integrated Risk Information System USEPA (1992a).
SPHEM — Superfund Public Health Evaluation Manual USEPA (1986b).
HEAST — Health Effects Assessment Summary Tables - USEPA (1992b).

[c] Carcinogenic Potency Factor currently withdrawn pending review (USEPA 1992a).

6.2 ECOLOGICAL RISK ASSESSMENT

This Ecological Risk Assessment (ERA) used several different approaches for evaluating potential risk to ecological receptors from contaminants attributable to Landfill No. 4 and the adjacent sludge lagoon. Media-specific concentrations of chemicals were measured from samples collected at appropriate reference, upgradient, and downgradient locations. In addition, ecological and toxicological approaches were used to assess site-specific differences in potential impacts from chemical contamination. These ecological and toxicological approaches included macroinvertebrate sampling, a USEPA Rapid Bioassay Protocol (RBP) III evaluation, surface water and sediment toxicity tests, fish and macrophyte tissue analyses, a Wetland Evaluation Technique (WET) assessment, and a breeding bird survey.

6.2.1 AQUATIC ECOSYSTEM

Table 12 summarizes estimated surface water and sediment exposure point concentrations for aquatic receptors along with Ambient Water Quality Criteria (AWQC), sediment toxicity values, and no observed adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) dietary concentrations for higher trophic level species that may consume fish. For chemicals not considered to be aquatic sediment COCs, mean and maximum aquatic sediment values are presented.

A review of Table 12 indicates that the greatest potential risk for aquatic organisms is from direct contact with metals via sediment and surface water. In particular, cadmium, lead, mercury, silver, and zinc exceed both surface water criteria and sediment toxicity values. In addition, mercury and zinc are ubiquitous, occurring in nearly every aquatic sediment sample, while cadmium, lead, and silver occur primarily in pond sediments. For surface water, higher concentrations, including all exceedances of AWQC, consistently occur in the wetland area approximately 800 ft. northeast of the landfill and southwest of the ponds in the study area. No exceedances of AWQC were detected in any permanent water body in the study area. For aquatic sediment and wetland soil, the distribution of metals follows a pattern similar to surface water. Higher concentrations, including most exceedances of

TABLE 12
AQUATIC ECOSYSTEM RISK CHARACTERIZATION SUMMARY
RI/FS ZONE 1, OU2
Robins AFB, Georgia

Chemical	Surface Water[a] (mg/L)	AWQC[b] Acute/Chronic (mg/L)	Aquatic Sediment[a] (mg/kg)	Sediment NOAEL (mg/kg)	Potentially Contaminated Aquatic Plants[d] (mg/kg)	Potentially Contaminated Prey[d] (mg/kg)	Reference Dietary Concentration[e] (mg/kg)
ORGANICS							
Benzo(a)pyrene	NC[f]	NA[g]/NA	1.16	0.4[j]	ND[h]	ND	-
Bis(2-ethylhexyl) phthalate	0.089	0.940/0.003[c]	16(6.2)[i]	33[c]	8	0.97	25 (LOEL, starling)
4,4'DDD	NC	NA/NA	0.048	NA	ND	0.197	2 (LOAEL, black duck)
4,4'DDE	NC	1.05/NA	0.049	NA	ND	0.270	2 (LOAEL, black duck)
Dieldrin	0.00008	0.0025/0.0000019	ND	NA	ND	0.113	0.16/0.5 (NOAEL, rat/ barn owl
INORGANICS							
Cadmium	0.023	0.039/0.011	20(14)[i]	5.1[c]	1.3	1.8	7.1 (NOAEL, sheep)
Chromium	0.067	1.70/0.210(III) 0.016/0.011(IV)	220(50)[i]	260 (total Cr)[c]	ND	ND	-
Lead	0.18	82/0.0032	360(85)[i]	35[j]	2.0	1.09	50 (LOAEL, American kestrel)
Mercury	0.0005	0.0024/0.000012	1.19	0.41[c]	0.010	0.460	0.55 (NOAEL, mallard duck)
Silver	0.044	0.0041/0.00012	61(36)[i]	1.0[j]	ND	ND	-
Zinc	0.54	0.047/NA	856	120[j]	99.4	21.8	100 (NOAEL, rat)

[a] Estimated media concentrations are taken from Table 6-6 (surface water) and Table 6-7 (aquatic sediment) of OU2 RI.
[b] Ambient Water Quality Criteria for protection of aquatic life. Source: USEPA 1986. Quality Criteria for Water, Office of Regulations and Standards, EPA/440/5-86-001.
[c] Source: Washington State Administrative Code 1991. Department of Ecology, Chapter 173-204 Sediment Management Standards; Adopted March 27, 1991, effective April 27, 1992. Title 173.
[d] Estimated aquatic plant and prey concentrations are based on data collected at the following locations: P1, P2, P3, S7, S8, and S13. See Sect. 6.3.3 of OU2 RI for discussion regarding selected values.
[e] Values taken from Table [illegible] of OU2 RI.
[f] NC=Not Calculated. [illegible] a COC for indicated media.
[g] NA=Not Available.
[h] ND-Not Detected.
[i] Not a sediment COC. For reference, maximum downgradient value provided with mean value in parentheses.
[j] Source: National Oceanic and Atmospheric Administration 1990. The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program, NOAA Technical Memorandum NOS OMA 52.

sediment toxicity values, consistently occur in the wetland area northeast of the landfill and southwest of the ponds. In addition, the ponds appear to be accumulating metals.

The organics appear to present a minimal risk in surface water and sediment. Benzo(a)pyrene is not a COC for surface water and the estimated aquatic sediment exposure point concentration is close to the sediment toxicity value. The estimated surface water concentration for bis(2-ethylhexyl)phthalate exceeds the chronic AWQC by an order of magnitude, but the maximum sediment concentration is half the toxicity value. Surface water and sediment concentrations for the pesticides are quite low and are not expected to present a significant risk via direct ingestion or contact.

A comparison of the contaminated prey (fish) data and the NOAEL and LOAEL dietary concentrations for sensitive piscivorous predators indicates that, with the exception of mercury, none of the COCs appear to be accumulating enough to cause a direct risk. However, mercury bioaccumulates rapidly in aquatic environments.

6.2.2 TERRESTRIAL ECOSYSTEM

Table 13 presents estimated exposure point concentrations for wetland soil and potentially contaminated vegetation and prey along with LOAEL or NOAEL dietary concentrations for species at high trophic levels. A review of the estimated exposure point concentrations for wetland soil indicates that direct ingestion of wetland soil may pose a risk due to the concentration of DDT and dieldrin. Although wetland soil would not be ingested at the same rate as food, soil ingestion may be significant for burrowing animals or animals such as the wild boar, which spends a considerable amount of time digging in the soil. Both DDT and dieldrin appear to be ubiquitous in wetland soil, occurring in most wetland soil samples.

Consumption of contaminated prey may pose a risk due to potential levels of cadmium and mercury in prey species. However, the risks associated with cadmium are expected to be much less significant than those associated with mercury. Mercury has a high potential to bioaccumulate and to biomagnify, and the biomagnification of mercury can result in risks to upper trophic level predators.

TABLE 13
TERRESTRIAL ECOSYSTEM RISK CHARACTERIZATION SUMMARY
RI/FS ZONE 1, OU2
Robins AFB, Georgia

Chemical	Wetland Soil[a] (mg/kg)	Potentially Contaminated Vegetation[b] (mg/kg)	Potentially Contaminated Prey[c] (mg/kg)	Reference Dietary Concentration[d] (mg/kg)
ORGANICS				
Benzo(a)pyrene	0.90	ND	NC	30 (NOAEL, mouse)
Bis(2-ethylhexyl)phthalate[e]	ND[f]	9.5	9.5	25 (LOEL, starling)
4,4'DDD	0.87	ND	NC	NA
4,4'DDE	0.28	ND	NC	2 (LOAEL, black duck)
4,4'DDT	7.36	ND	NC	0.3 (NOAEL, pheasant)
Dieldrin	0.53	ND	NC	0.16/0.5 (NOAEL, rat/barn owl)
INORGANICS				
Arsenic	24.77	ND	NC	31 (LOAEL, rat)
Cadmium[d]	ND[e]	1.5	6.0	7.1 (NOAEL, sheep)
Mercury	0.34	0.04	0.44	0.5[illegible] (NOAEL, mallard)
Selenium	9.69	ND	NC	5 (LOAEL, chicken)
Zinc	84.79	27.7	8.3	100 (NOAEL, rat)

ND = Not Detected
NC = Not Calculated
[a] These values are potential exposure point concentrations shown on Table 6-8 of the OU2 RI.
[b] Represents the maximum concentration detected in vegetation from co-located sample stations (Table 6-10 or OU2 RI).
[c] Calculation of these values is discussed in Section 6.3.4 of OU2 RI.
[d] Values taken from Table 6-10 of OU2 RI.
[e] Although this chemical was not selected as a soil and sediment COC, it is included here because it was detected in terrestrial vegetation.
[f] Chemical was not detected in the soil samples that were co-located with vegetation samples.

6.2.3 ERA CONCLUSIONS

The ERA concluded that for ecological receptors, the risks are low or contained to relatively small areas (i.e., the ponds and drainage ditches), and indicated that several external factors may be affecting the wetlands downgradient of Zone 1. These factors include other potential sources of contamination and various AFB management activities that influence the water regime in the wetlands. The ERA also concluded that the wetlands associated with OU2 provide an important habitat for a variety of wetlands plants and animal species and because the ecological risks are low or are confined to relatively small areas, protection of the wetlands should be given a high priority when evaluating remedial alternatives.

The selected interim remedy (Alternative 2, Limited Action) includes the following:

- Institutional controls (i.e., fence construction to restrict access, posting signs) for future site access and water-use restrictions.
- Comprehensive monitoring for a minimum of one year not to exceed three years in support of physical/chemical and ecological/biological monitoring plans to be developed to monitor stabilization of the site following redirection of runoff discharge around the landfill and diversion of industrial wastewater discharge from upgradient of the landfill and wetlands, so that a final remedial action can be developed from the current and expected future conditions.
- Development of a contingency plan that describes containment measures to be implemented in the event that predetermined "trigger values" are exceeded.

7.0 DESCRIPTIONS OF ALTERNATIVES

The following is a summary of the alternatives evaluated for the wetlands associated with Zone 1, OU2. Specific details were developed to allow order-of-magnitude cost estimations.

7.1 ALTERNATIVE 1 - NO ACTION

No monitoring, institutional controls, remedial or treatment actions will be implemented.

7.2 ALTERNATIVE 2 - LIMITED ACTION

The Limited Action alternative consists of institutional controls (i.e., fence construction to restrict access, posting signs) for future site access and water use restrictions, monitoring for a defined time frame in support of physical/chemical and ecological/biological monitoring plans to be developed and implemented as the remedial design for the Action, and development of a contingency plan that describes containment measures to be implemented in the event that predetermined "trigger values" set in the monitoring plans are exceeded. The monitoring plans will define analysis (contaminants of concern, physical parameters, etc.) media to be sampled (soil, sediment, water, fish, vegetation, etc.), sampling locations and schedule, and hydrological input and output points in the wetlands to be monitored for flow elevation and chemistry.

7.3 ALTERNATIVE 3 - SURFACE WATER COLLECTION, TREATMENT, AND RECIRCULATION

Alternative 3 includes collection of surface water, treatment of the water for organic and inorganic contaminants of concern, recirculation of the treated water back in to the wetlands, and monitoring as described under the limited action alternative.

7.4 ALTERNATIVE 4 - DREDGING/DEWATERING AND SOLIDIFICATION OF AQUATIC SEDIMENTS, WITH ONSITE DISPOSAL

Alternative 4 would require dredging/dewatering and solidification of approximately 171,295 cubic yards of aquatic sediment, onsite disposal, and monitoring as described under the limited action alternative. Dewatered solids would be stockpiled and treatment through solidification/fixation. Final disposal would be in a Resource Conservation and Recovery Act (RCRA) cell constructed on base in a designated area for this purpose.

7.5 ALTERNATIVE 5 - DREDGING/DEWATERING AND OFFSITE DISPOSAL OF AQUATIC SEDIMENTS.

Alternative 5 would require dredging/dewatering of approximately 171,295 cubic yards of aquatic sediments and loading and transporting it to an offsite RCRA-permitted (Subtitle C) landfill.

A remedial design for any of the monitoring or treatment alternatives may require additional field investigation to further delineate the area to be addressed by remediation, and/or define and characterize source areas not included under OU1.

8.0 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The wetlands associated with OU2 are currently providing important habitat for numerous species. Results for the ecological risk assessment show that viable and diverse populations of aquatic and terrestrial wildlife are currently using the habitats in Zone 1.

It should be noted that designing and implementing an action while the wetlands are changing (due to redirection of runoff and diversion of industrial waste discharge) may not be effective or efficient. Any design or implementation can be better performed when the wetlands reach a steady state hydrology or water balance.

8.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternative 1 would not rapidly eliminate exposure pathways. However, over time, natural attenuation may reduce the concentrations of contaminants to below remediation levels, especially once the sources of contamination are controlled. Alternative 2 is similar to Alternative 1 except that institutional controls associated with Alternative 2 would help minimize potential direct exposure to hazardous substances. In addition, the monitoring program associated with Alternative 2 would monitor stabilization of the site following redirection of runoff discharge and diversion of industrial wastewater discharge from upgradient of the landfill and wetlands so that a final Remedial Action can be developed from the current and expected future conditions. Alternative 3 would remove COCs from the drainage ditch, ponds, and surface water at the collection points, but other surface water discharges to Horse Creek would not be controlled. Alternative 4 would remove contaminated sediment affecting aquatic organisms, but would also eliminate all existing benthic organisms and the habitat which are not easily replaced. In addition, dredging would resuspend contaminated sediments which may cause contaminants to enter the ecological food chain. Alternative 5 provides an overall protectiveness similar to that provided by

Alternative 4, but would also eliminate risks associated with the fixation process and release of metals from fixed solids (Alternative 4). Finally, an effective implementation of Alternatives 3, 4 or 5 may not be possible until after the wetlands reach a steady state hydrology or water balance.

8.2 COMPLIANCE WITH ARARs

Chemical-, location-, and action-specific ARARs which potentially apply to OU2 are presented in the OU2 FS. The Wetlands Management Executive Order, Executive Order 11990, Protection of Wetlands (40 CFR 6.302) is also applicable. However, pursuant to CERCLA 121(d)(4) and NCP 300.430(f)(1)(ii)(C)(1), compliance with ARARs is waived because the selected action is an interim remedy; that is, the selected remedial action is only part of a total remedial action that will attain ARARs.

8.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Because the interim action is not designed or expected to be final, and is in place until a final remedial action can be developed from the current and expected future conditions, a comparison of alternatives in terms of long-term effectiveness and permanence is not relevant.

8.4 REDUCTION OF MOBILITY TOXICITY OR VOLUME (M/T/V) THROUGH TREATMENT

Alternative 1 and 2 would not decrease M/T/V, however, toxicity and volume may be reduced through natural attenuation if contaminant concentrations decrease over time. Alternative 3 would provide a net decrease in offsite migration of contaminants. Alternative 4 eliminates mobility and toxicity of contaminants through treatment, however, since solidification/stabilization is required, volume may increase. Alternative 5 eliminates mobility and toxicity of contaminants through offsite disposal.

8.5 SHORT-TERM EFFECTIVENESS

Alternatives 1 and 2 pose minimal short-term risks to onsite workers. Alternative 3 construction activities may disturb sediments and results in the release of additional contaminants to Horse Creek.

The limiting factor in processing time for dredging activities and operations associated with Alternative 4 and 5 will be dewatering. Alternatives 3, 4, and 5 would require approximately two years for implementation. Technical considerations for Alternative 4 include control of sediment spreading during dredging, treatability testing and location and design of a RCRA cell. Technical considerations for Alternative 5 include control of sediment spreading during dredging, obtaining permits and manifests for offsite disposal and facility accepting waste.

8.6 IMPLEMENTABILITY

Alternatives 1 and 2 could be implemented immediately. Development and implementation of a comprehensive monitoring plan and the use of institutional controls, would be required for Alternative 2. Alternative 2 will allow for monitoring the stabilization of the site following redirection of runoff discharge and diversion of industrial wastewater discharge so that a final remedial action can be developed from the current and expected future conditions. Alternative 3 could be implemented in approximately two years and would involve treatment system design, pilot-scale studies, disposal of biological sludge and used carbon. For Alternatives 4 and 5, the limiting factor in processing time would be dewatering. Alternatives 3, 4, and 5 would require approximately two years for implementation. Technical considerations for Alternative 4 include control of sediment spreading during dredging, treatability testing and location and design of a RCRA cell. Technical considerations for Alternative 5 include control of sediment spreading during dredging, obtaining permits and manifests for offsite disposal and facility accepting waste. As an interim remedy, Alternatives 3, 4 or 5 are less feasible than Alternative 2 because of the time required to implement them and because implementation may not be effective or efficient while the water balance in the wetlands is changing.

8.7 COST

The cost for Alternative 2 is estimated to be significantly less than Alternative 3, 4, and 5 (See Table 14). It should be noted that estimated costs for Alternatives 4 and 5 are based on remediation of an areas exceeding National Oceanic and Atmospheric Administration (NOAA) screening values. Costs could potentially be reduced pending further delineation of the area to be addressed by remediation during the remedial design.

8.8 AGENCY ACCEPTANCE

The U.S. EPA and GEPD have accepted Alternative 2 as an interim remedy (contingent upon public acceptance).

8.9 COMMUNITY ACCEPTANCE

Based on comments made by citizens at the public meeting held on September 16, 1993, it is believed that the community is supportive of the selected interim remedy for OU2 (institutional controls and monitoring). One citizen did recommend that Alternative 3 (surface water collection, treatment, and recirculation) be selected for OU2 on the basis that even through sediment contamination would not be changed significantly, treating the water and returning it will not do more damage to the wetlands.

Table 14: Wetlands Alternatives
Robins AFB, Georgia

	Estimated Capital Cost	Estimated Annual O&M Cost	Estimated Total Present Worth Cost
1. No Action	$ 0	$ 0	$ 0
2. Limited Action: Institutional Controls and Monitoring	225,000	67,550	889,011
3. Surface water collection treatment, and recirculation	1,818,375	672,933	7,350,448
4. Dredging/dewatering and solidification of aquatic sediments with onsite disposal	23,382,316	184,081	24,862,852
5. Dredging/dewatering and offsite disposal of aquatic sediments	54,223,219	43,900	54,413,283

9.0 SELECTED REMEDY

Based upon consideration of the requirements of CERCLA, the detailed analysis of the alternatives, and public comments, Robins AFB in consultation with U.S. EPA and GEPD has determined that the most appropriate interim remedy for the wetlands associated with OU2 is Alternative 2.

The interim remedy for OU2 Impact on Wetlands includes:

- Institutional controls (i.e., fence construction to restrict access, posting signs) for future site access and water use restrictions.
- Comprehensive monitoring for a minimum of one year not to exceed three years in support of physical/chemical and ecological/biological monitoring plans to be developed to monitor stabilization of the site following redirection of runoff discharge around the landfill and diversion of industrial wastewater discharge from upgradient of the landfill and wetlands so that a final remedial action can be developed from the current and expected future conditions.
- Development of a contingency plan that describes containment measures to be implemented in the event that predetermined "trigger values" set in the monitoring plan are exceeded.

A remedial design for the monitoring alternative may require additional field investigation to further delineate the area to be addressed by remediation, and/or define and characterize source areas not included under OU1.

The estimated cost of the selected interim remedy is presented in Table 15.

Table 15: Selected Interim Remedy Cost Estimate

Estimated Capital Cost:	$225,000
Estimated Annual O&M Cost:	$ 67,550
Estimated Total Present Worth Cost:	$889,011

9.1 REMEDIATION GOALS

The specific objectives of the selected interim remedy are to:

1. Protect existing habitat.

2. Minimize the potential direct and indirect exposure of the public to hazardous substances.

3. Monitor the stabilization of the site following redirection of runoff discharge around the landfill and diversion of industrial wastewater discharge from upgradient of the landfill and wetlands, so that a final remedial action can be developed from the current and expected future conditions.

10.0 STATUTORY DETERMINATIONS

Under its legal authorities, the EPA's primary responsibility at Superfund sites is to undertake remedial actions that achieve adequate protection of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences. These specify that when complete, the selected remedial action for this site must comply with applicable or relevant and appropriate environmental standards established under Federal and State environmental laws unless a statutory waiver is justified. The selected remedy also must be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatments that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes as their principal element. The following sections discuss how the selected remedy meets these statutory requirements.

As the lead Agency, the Air Force is required to comply with CERCLA 120, (Executive Order 12580 of January 23, 1987), and EPA is to determine that they are complying with CERCLA 120.

10.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected interim remedy protects human health and the environment through; 1) the use of institutional controls (i.e., fence construction, posting signs) for future site access and water use restrictions and 2) the development and implementation of a comprehensive monitoring program to monitor stabilization of the site following redirection of runoff discharge and diversion of industrial wastewater discharge, so that a final remedial action can be developed from the current and expected future conditions. Further protection of human health and the environment is provided through the development of a contingency plan that

describes containment measures to be implemented in the event that predetermined "trigger values" set in the monitoring plan are exceeded.

This interim action does not employ a remedy that permanently and significantly reduces the toxicity, mobility, or volume of the contaminants because the interim action is not designed or expected to be final. More specifically, designing and implementing a permanent action while the wetlands are changing may not be effective or efficient. Any permanent design or implementation can be better performed when the wetlands reach a steady state hydrology or water balance.

10.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

ARARs for this limited scope action (described in the OU2 FS), and including the Wetlands Management Executive Order, Executive Order 11990, Protection of Wetlands (40 CFR 6.302) have been waived pursuant to CERCLA 121(d)4 and NCP 300.430(f)(1)(ii)(C)(1), because the selected interim action is only part of a total remedial action that will attain ARARs.

10.3 COST EFFECTIVENESS

The selected interim remedy for the wetlands associated with OU2 has been determined to provide overall effectiveness proportional to its cost, and provides a reasonable value for the money. The total present worth cost is $889,011. The cost/effectiveness relationships for Alternatives 3, 4 and 5 do not compare to Alternative 2, because as indicated previously, designing and implementing an action while the wetlands are changing may not be effective or efficient.

10.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES (OR RESOURCE RECOVERY TECHNOLOGIES) TO THE MAXIMUM EXTENT PRACTICABLE

The selected action is interim and is not designed or expected to be final. The selected interim remedy represents the best balance of tradeoffs among alternatives with respect to pertinent criteria, given the limited scope of action.

10.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

The statutory preference for remedies that employ treatment as a principal element will be addressed in the final decision document for OU2.

10.6 DOCUMENTATION OF SIGNIFICANT CHANGES

No significant changes from the proposed plan were made.

COMMUNITY RELATIONS
RESPONSIVENESS SUMMARY

COMMUNITY RELATIONS RESPONSIVENESS SUMMARY

1.0 OVERVIEW

Robins AFB along with the U.S. EPA and GEPD held a public meeting on September 16, 1993 at the Warner Robins City Hall to discuss the results of the RI/FS for OU2, present the proposed interim plan for OU2, and solicit comments and questions from the public. All of the comments received during the public comment period (August 10, 1993 to September 29, 1993) were received during the public meeting, however, several were not directly related to OU2.

2.0 BACKGROUND ON COMMUNITY INVOLVEMENT

An active community relations program providing information and soliciting input has been conducted by Robins AFB for Zone 1. Interviews of citizens on base and in Warner Robins were conducted in the summer of 1990 to identify community concerns. No significant concerns that required focused response were identified. Regular informational project updates have been provided to the public through television programs, the Robins AFB newspaper, *The Rev-Up*, the *Warner Robins Daily Sun*, and the *Macon Telegraph*. *Robins Report*, a weekly 15-minute television program produced by the Office of Public Affairs has provided routine progress updates. This program is aired Sunday mornings on WMAZ-TV in Macon, Georgia. It also is telecast on Cox Cable and Watson Communications Cable, which are available to Robins AFB and Warner Robins residents. Weekly informational articles have appeared in *The Rev-Up* newspaper. In addition, NPL site and IRP fact sheets have been prepared and made available in the Environmental Information Repository, located in the Nola Brantley Memorial Library in Warner Robins.

3.0 SUMMARY OF PUBLIC COMMENT AND AGENCY RESPONSE

Comments and questions raised during the public meeting held on September 16, 1993 are summarized below. No other comments or questions were received during the public comment period.

1. A concerned citizen asked why a cost associated with an alternative (Alternative 2 - Limited Action) was listed as 0 dollars on one slide and 520,000 dollars on a second slide. She did not understand the difference between the two.

Robins AFB Response: When the proposed plan was originally submitted, the 520,000 dollar cost was omitted. The second slide was included to clarify that there is a cost associated with the alternative. It should be noted that cost figures are not presented to present an exact cost estimate of each alternative, but rather to serve as a comparison between one alternative to another. Because the omission was made in each of the alternatives, a consistent comparison was made.

2. A concerned citizen asked if Alternative 2 (Limited Action) has been selected for this Operable Unit (OU2).

Robins AFB Response: The proposed plan (Alternative 2) is the bench program. The reason Alternative 2 was selected was to allow further characterization of the site because significant changes in water flow had occurred. Rather than making measurements without knowing what the water balance is going to be, Alternative 2 allows us to study the effect of potentially significant changes to the water balance.

3. The same concerned citizen asked for an update on the status of Operable Unit 1 because she understood that the alternative selected for the stabilization of contamination was not working and wanted to know what would happen if the solidification process did not work.

Robins AFB Response: Solidification is the alternative for stabilization. A technology evaluation for solidification of the sludges was solely a demonstration. That particular demonstration was to demonstrate a particular technology. It was not meant to be the final remedy. That particular technology did not work, but it is not the only available technology. Since then, we have contracted five contractors to evaluate their technologies and narrowed the list to three contractors. We have evaluated their proposals, studied bench- and pilot-scale studies for the past year and will soon announce which of the contractors will perform the work. All of the studies from the three remaining contractors indicate that their technologies worked in their bench- and pilot- scale studies.

4. The same concerned citizen commented that her group's research indicated that almost all of the solidification processes were experimental to an extent in that they did not represent long-term solutions, and requested that another alternative be chosen for OU1. The commentor also requested that alterative number 3 (surface water collection, treatment, and recirculation) be chosen for OU2, because public hearings at the base indicate there are significant amounts of pollution coming from all sorts of different areas, and it would not cause any damage to start treating the water now and return it to the swamp. Finally, the commentor expressed concern that the interim plan does not address bioaccumulation. She indicated that DDT is one of the contaminants coming out of the waste dump and stated that a link exists between bald eagles and DDT, as well as breast cancer in women and DDT, and that arsenic and lead never disappear in terms

of biological contamination. She expressed concern over people eating fish when pollutants bioaccumulate in the Ocmulgee River and that pollution from the base as well as the pipeline is putting an even greater strain on the river and its ecosystems.

Robins AFB Response: Your concern is appreciated. All appropriate alternatives are being studied.

EPA Response: The wetland area is a very diverse bio-environment. The plumes from the landfill into the wetlands are fairly well-defined, and because they are fairly well-defined and the migration rate known, we would be looking at some other kind of action if nothing else were occurring. However, approximately 70% of the inflow is not going into the wetlands anymore, so the environment is changing. The concern with conducting a remedial action at this point, is that more damage than good will be done because we don't know enough in terms of the changing water level and its effect on the wetlands.

5. A concerned citizen commented on the previous commentor's statements. He indicated that the speaker made some rather sweeping assertions that she should be able to document because the press was present and they would pick up on her assertions as being true and certain, which would be a disservice to the effort being conducted. The commentor stated that the previous commentor's assertions should be recorded as her belief as to what is happening and not as a matter of fact. The previous commentor responded that she did not believe she had made any assertions and would stand behind her convictions.

Robins AFB Response: No response was made.

6. A concerned citizen asked for a review of the status of OU1 including cost and time frame for completion. The commentor stated his understanding of the situation which was that the Air Force would be proceeding with the remediation of the sludge and correcting the problem from the landfill. The concern then is what the correction process does to water flow in the wetlands, so the plan is to select an alternative which provides for intensive monitoring. The commentor also stated his understanding that the process has been in progress for about ten years and an agreement between EPA, Georgia Department of Resources and the Air Force has been made to try and speed up the process.

Robins AFB Response: The alternative selected for OU2 is an Interim Plan. It is not the final action. The final action will be determined after additional monitoring results are obtained and evaluated. The ultimate completion of the cycle (OU1 source control) is projected for 1998. Solidification studies will be completed and evaluated and contractual proceedings will then be initiated. A construction contract could be let within the first quarter of 1997. The lagoon will be solidified first and the material placed on the landfill. A new cap will then be placed on the landfill. The cost will probably be in excess of over 100 million dollars for the whole cycle (source control)

7. The same concerned citizen asked if the Air Force was in a position to adjust or change the remedial action if something was not working.

Robins AFB Response: The Air Force in conjunction with the regulatory authority is required to review the remediation effort every five years and make sure that any remedial actions taken are effective. This process is required by the regulatory authority.

8. A concerned citizen expressed concern about trichloroethylene and methylene chloride levels in the lagoon, a chemical to treat fire ants in the swamp area, and potential toxic materials buried in the swamps and wetlands and their effect on the aquifer. He spoke of lead levels where a pipeline was constructed on a Mr. Robinson's property, and stated that he would like to bring three individuals who could point out areas on-site where the hazards he discussed exist.

Robins AFB Response: The comment period is open through September 29. Written comments may be submitted to the address provided on the handout received at the door. For more information, contact the public affairs office at Robins AFB.