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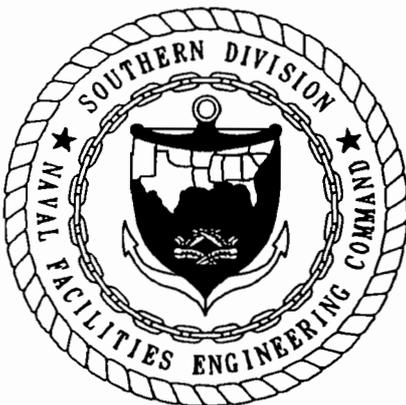


**ONSITE DELINEATION WORKPLAN
ADMINISTRATIVE ORDERS NO. 3193-96 AND
NO. 3194-96**

**NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI**

**UNIT IDENTIFICATION CODE: N62604
CONTRACT NO. N62467-89-D-0317/096**

SEPTEMBER 1996



**SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NORTH CHARLESTON, SOUTH CAROLINA
29419-9010**

**ONSITE DELINEATION WORKPLAN
SITE 8, FORMER HERBICIDE ORANGE STORAGE AREAS**

**NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI**

Unit Identification No. N62604

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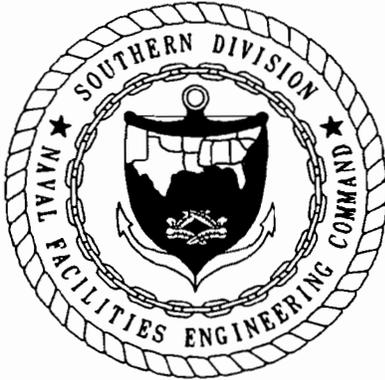
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August 1996



FOREWORD

To meet its mission objectives, the U.S. Navy performs a variety of operations, some requiring the use, handling, storage, or disposal of hazardous materials. Through accidental spills and leaks and conventional methods of past disposal, hazardous materials may have entered the environment in ways unacceptable by today's standards. With growing knowledge of the long-term effects of hazardous materials on the environment, the Department of Defense initiated various programs to investigate and remediate conditions related to suspected past releases of hazardous materials at their facilities.

One of these programs is the Installation Restoration program. This program complies with the Comprehensive Environmental Response, Compensation, and Liability Act as amended by the Superfund Amendments and Reauthorization Act, the Resource Conservation and Recovery Act (RCRA), and the Hazardous and Solid Waste Amendments (HSWA) of 1984. These acts establish the means to assess and clean up hazardous waste sites for both private-sector and Federal facilities.

The program that has been adopted to address present hazardous material management is RCRA and the HSWA (RCRA/HSWA) corrective action program. RCRA ensures that solid and hazardous wastes are managed in an environmentally sound manner. The law applies to facilities generating or handling hazardous waste. The HSWA corrective action program is designed to identify and clean up releases of hazardous substances at RCRA-permitted facilities.

The RCRA/HSWA program is conducted in four stages, as follows:

- RCRA Facility Assessment
- RCRA Facility Investigation
- Corrective Measures Study
- Corrective Measures Implementation

The Southern Division, Naval Facilities Engineering Command manages and the U.S. Environmental Protection Agency and the Mississippi State Department of Environmental Quality oversee the Navy environmental program at Naval Construction Battalion Center (NCBC), Gulfport, Mississippi. All aspects of the program are conducted in compliance with State and Federal regulations, as ensured by the participation of these regulatory agencies.

Questions regarding the RCRA program at NCBC Gulfport should be addressed to Mr. Art Conrad, Code 1865, at (803) 820-5520.

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Naval Construction Battalion Center
Gulfport, Mississippi

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GLOSSARY

ABB-ES	ABB Environmental Services, Inc.
AO	administrative order
ASTM	American Society for Testing and Materials
2,4-D	2,4-dichloro-phenoxyacetic acid
DO	dissolved oxygen
DQO	data quality objective
GPS	global positioning satellite
HAZWRAP	Hazardous Waste Remedial Action Program
HO	herbicide orange
IDW	investigative-derived waste
MILCON	Military Construction
MS/MSD	matrix spike and matrix spike duplicate
MSDEQ	Mississippi State Department of Environmental Quality
NCBC	Naval Construction Battalion Center
NCF	Naval Construction Force
NEESA	Naval Energy and Environmental Support Activity
ORP	oxidation/reduction potential
PARCC	precision, accuracy, representativeness, completeness, and comparability
2,3,7,8-PeCDD	2,3,7,8-pentachloro-p-dioxin
ppb	part per billion
ppq	parts per quadrillion
ppt	parts per trillion
QA/QC	quality assurance and quality control
QC	quality control
RI/FS	remedial investigation and feasibility study
RPD	relative percent difference
SAP	sampling and analysis plan
SOUTHNAV- FACENCOM	Southern Division, Naval Facilities Engineering Command
2,4,5-T	2,4,5-trichlorophenoxyacetic acid
TCDD	tetrachlorodibenzo-p-dioxin
TCLP	toxicity characteristic leachate procedure
TDS	total dissolved solids
TEF	toxicity equivalency factor

GLOSSARY (Continued)

TEQ	toxicity equivalency quotient
™	trademark
TOC	total organic carbon
TSS	total suspended solids
USAF	U.S. Air Force
USEPA	U.S. Environmental Protection Agency

1.0 INTRODUCTION

Under contract to the U.S. Department of the Navy, Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM), this Onsite Delineation Workplan was prepared for the Naval Construction Battalion Center (NCBC) in Gulfport, Mississippi. This workplan was prepared under the Comprehensive Long-term Environmental Action, Navy, Contract No. N62467-89-D-0317, Contract Task Order No. 096.

On February 14, 1996, administrative orders (AOs) No. 3193-96 and No. 3194-96 were issued to the U.S. Navy and U.S. Air Force (USAF), respectively, by the Mississippi State Department of Environmental Quality (MSDEQ) as a result of environmental issues at NCBC Gulfport. These orders contained identical requirements of the Navy and USAF. These orders require an Onsite Delineation Workplan to be submitted to MSDEQ by May 1, 1996. This workplan describes the field investigation to be performed onsite (on the base) in order to identify and delineate dioxin-impacted sediment, surface water, soil, and groundwater. A meeting to clarify the AO requirements was held between the Navy and MSDEQ on March 21, 1996. During this meeting, MSDEQ clarified that onsite meant onbase and offsite meant offbase. The chemicals of potential concern were also identified in this meeting as herbicide orange (HO) and its impurity, dioxin.

The purpose of this workplan is to guide the efforts to identify and delineate environmental media containing dioxin within the boundaries of NCBC Gulfport that relate to the storage and handling of HO. The following sections provide the objectives, purpose, and scope of the Onsite Delineation Workplan; site history; a conceptual model to facilitate an understanding of the existing conditions at the site; and an overview of the organization of the workplan.

A note here about how toxicity equivalents are developed for dioxin results. To start with, 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) is considered to be the most toxic of the polychlorinated dibenzodioxin and dibenzofuran families. Polychlorinated dibenzodioxins and polychlorinated dibenzofurans (congeners) with chlorine atoms at the 2, 3, 7, and 8 positions (2,3,7,8 substituted compounds) in their molecules can mimic the toxic properties of 2,3,7,8-TCDD. The U.S. Environmental Protection Agency (USEPA) (USEPA, 1989) developed toxicity equivalency factors (TEFs) for each of the congeners with 2,3,7,8-substituted chlorine atoms to quantify the toxicity of these compounds relative to 2,3,7,8-TCDD, which is given a TEF of one. To determine the toxicity equivalence quotient (TEQ) of a particular sample result, the result of each congener is multiplied by the assigned TEF to determine a 2,3,7,8-TCDD equivalent concentration. The equivalent total concentrations are then summed to obtain the toxicity equivalent or TEQ. Those congeners without substitutions at the 2,3,7,8 molecular positions were not considered toxic, at least in terms of carcinogenic potency, and were assigned a TEF of zero.

For example, 2,3,7,8-pentachloro-p-dioxin (2,3,7,8-PeCDD) has a TEF of 0.5. If the sample result reported 100 picograms per liter of 2,3,7,8-PeCDD, the TEQ for this congener would be 50 picograms per liter ($100 \times 0.5 = 50$).

1.1 OBJECTIVES, PURPOSE, AND SCOPE OF THE ONSITE DELINEATION WORKPLAN. The main objective of this workplan is to identify and delineate environmental media

(sediment, surface water, soil, and groundwater) that may contain dioxin within the boundaries of NCBC Gulfport. This workplan will address the media that became dioxin-impacted as a result of the storage and handling of HO on the base.

The field investigation will be performed in two phases. The first phase (Phase I) will identify areas where environmental media contain dioxin, and the second phase will delineate the dioxin-impacted areas that require further investigation. The work will include

- characterizing surface soil at Site 8,
- identifying areas that may contain dioxin in sediment and surface water in the base's drainage system, and
- collecting seepage and groundwater samples from Sites 4 and 5.

The results of the first phase of the work will be used to update the conceptual models and focus the efforts in the second phase.

1.2 SITE HISTORY. NCBC Gulfport is located in the western part of Gulfport, Mississippi, in Harrison County, in the southeastern corner of the state, approximately 2 miles north of the Gulf of Mexico (Figure 1-1). The base is located on the north side of Gulfport (Figure 1-2) approximately 1 mile from Highway 49.

The primary mission of NCBC Gulfport is the support of four battalions of the Naval Construction Force (NCF) and the storage and maintenance of prepositioned War Reserve Material Stock. The NCF support consists of both homeport services and deployed support. Approximately 4,000 military and 1,600 civilian personnel are assigned to or employed by the base. The base occupies 1,100 acres and has an elevation averaging 30 feet above sea level (Figure 1-3), with the only significant exception being the linear piles of bauxite stored on the surface. These bauxite piles range from 30 to 40 feet above the grade of the base. Surface soils are primarily sand to sandy loam with minor clays (Hazardous Waste Remedial Action Program [HAZWRAP], 1991).

From 1968 through 1977, about 12 acres of the base (Site 8, Area A) were used for storage and handling of approximately 850,000 gallons of HO in 55-gallon drums (Figure 1-4). Spills and leaks of HO occurred during that period in the area later known as Site 8 (Areas A, B, and C, Figure 1-4). The magnitude of the release of HO and dioxin was investigated in 1977 and was known as the Initial HO Monitoring Program (Occupational and Environmental Health Laboratory, 1979). Followup investigations in 1986 and 1987 delineated the horizontal and vertical extent of dioxin in soil to 1 part per billion (ppb). The delineation work was followed by full-scale incineration of the soil at Site 8 that was contaminated above 1 ppb. The incineration was completed in 1988, and the resulting ash was stored in piles on Area A of Site 8 (HAZWRAP, 1991).

1.3 REGULATORY SETTING. This workplan was initiated following the issuance of the AO by MSDEQ on February 14, 1996. The direction of the AO was clarified by MSDEQ in a meeting on March 21, 1996. In that meeting it was determined that

- the AO would address dioxin and the constituents of HO;

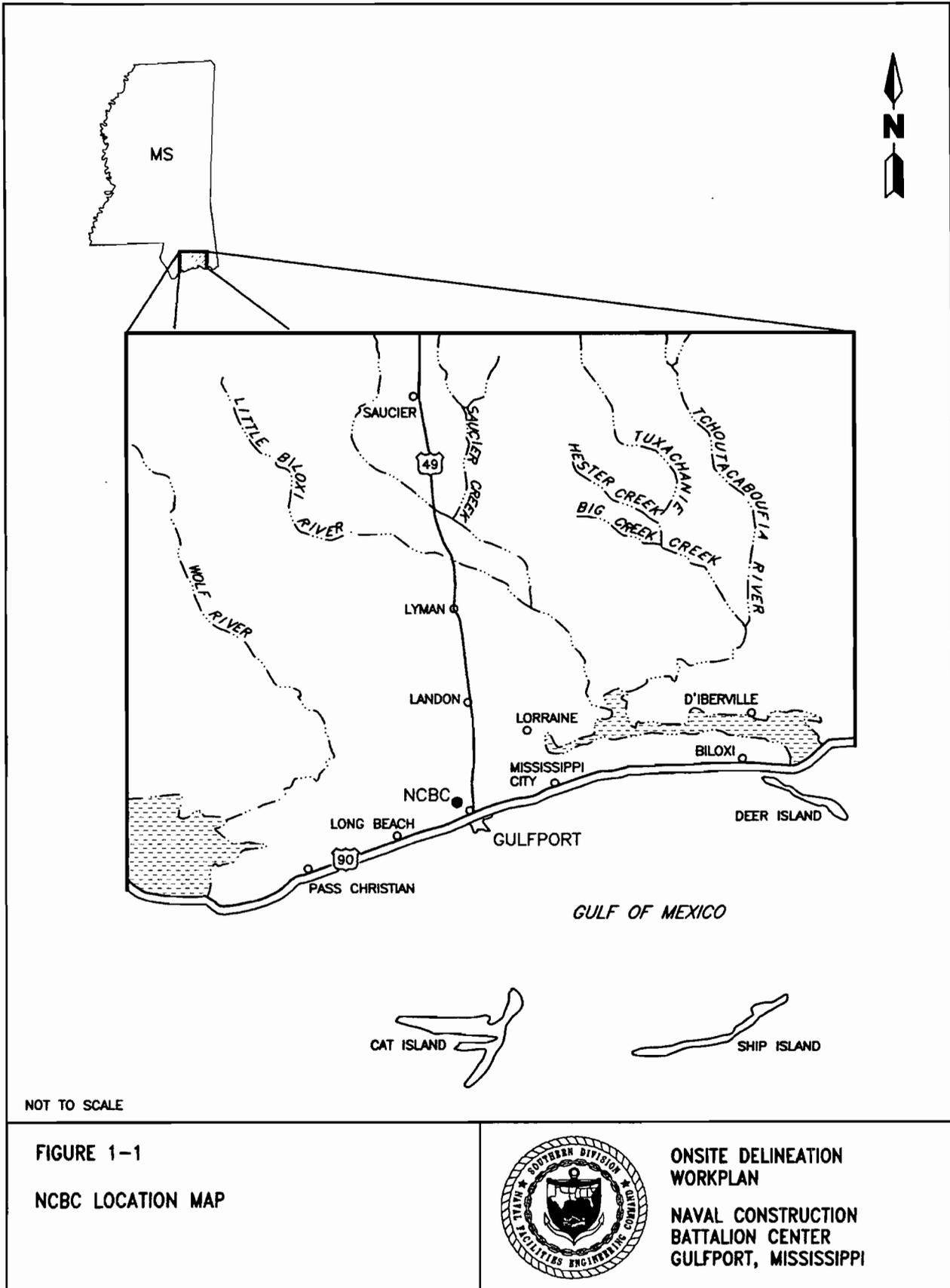


FIGURE 1-1
 NCBC LOCATION MAP



ONSITE DELINEATION
 WORKPLAN
 NAVAL CONSTRUCTION
 BATTALION CENTER
 GULFPORT, MISSISSIPPI

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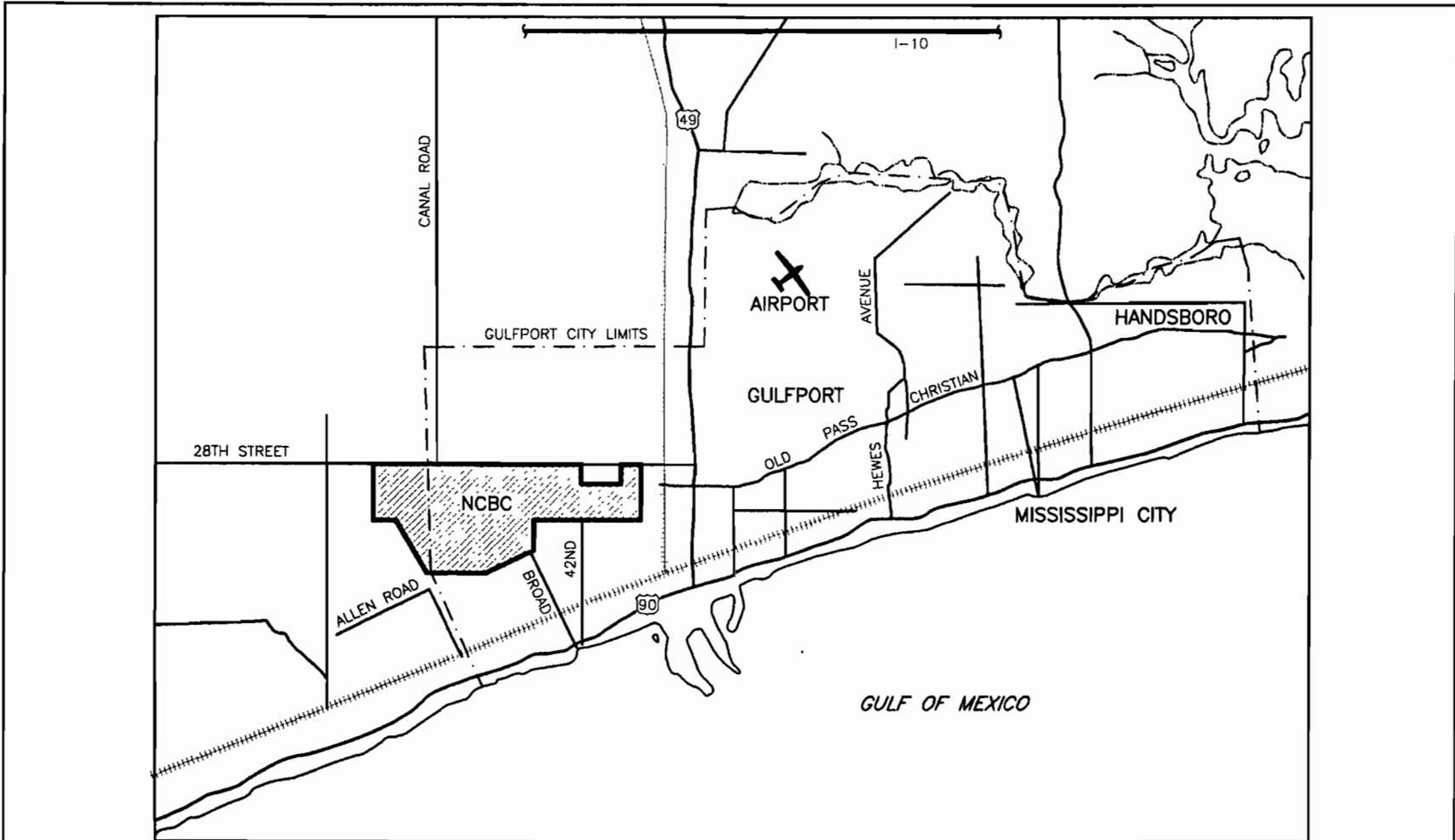
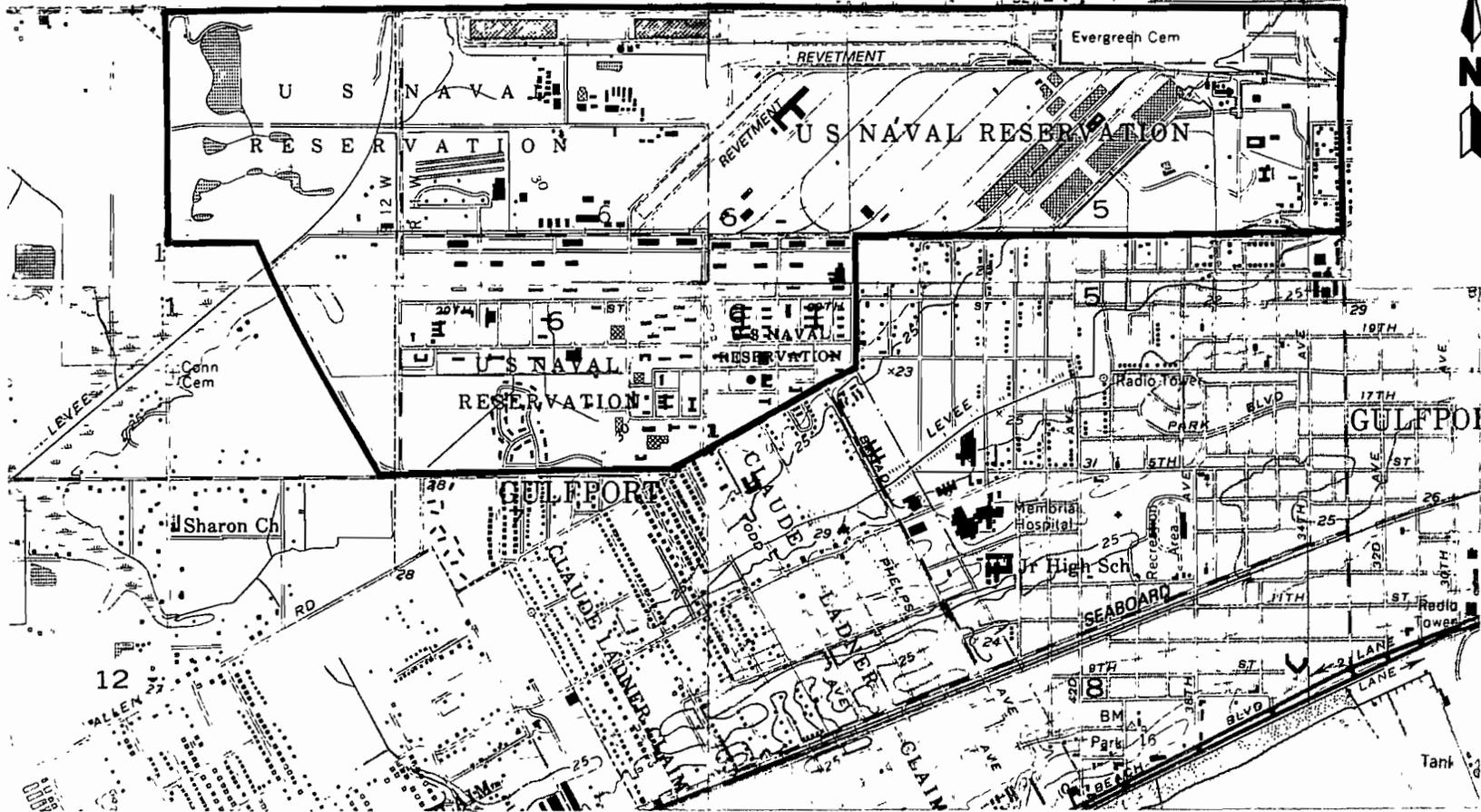


FIGURE 1-2
VICINITY MAP

NOT TO SCALE



ONSITE DELINEATION
WORKPLAN
NAVAL CONSTRUCTION
BATTALION CENTER
GULFPORT, MISSISSIPPI



SOURCE: USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLES GULFPORT NW, GULFPORT NORTH, PASS CHRISTIAN AND GULFPORT SOUTH MISSISSIPPI QUADS.

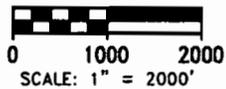


FIGURE 1-3
TOPOGRAPHIC MAP OF SITE VICINITY



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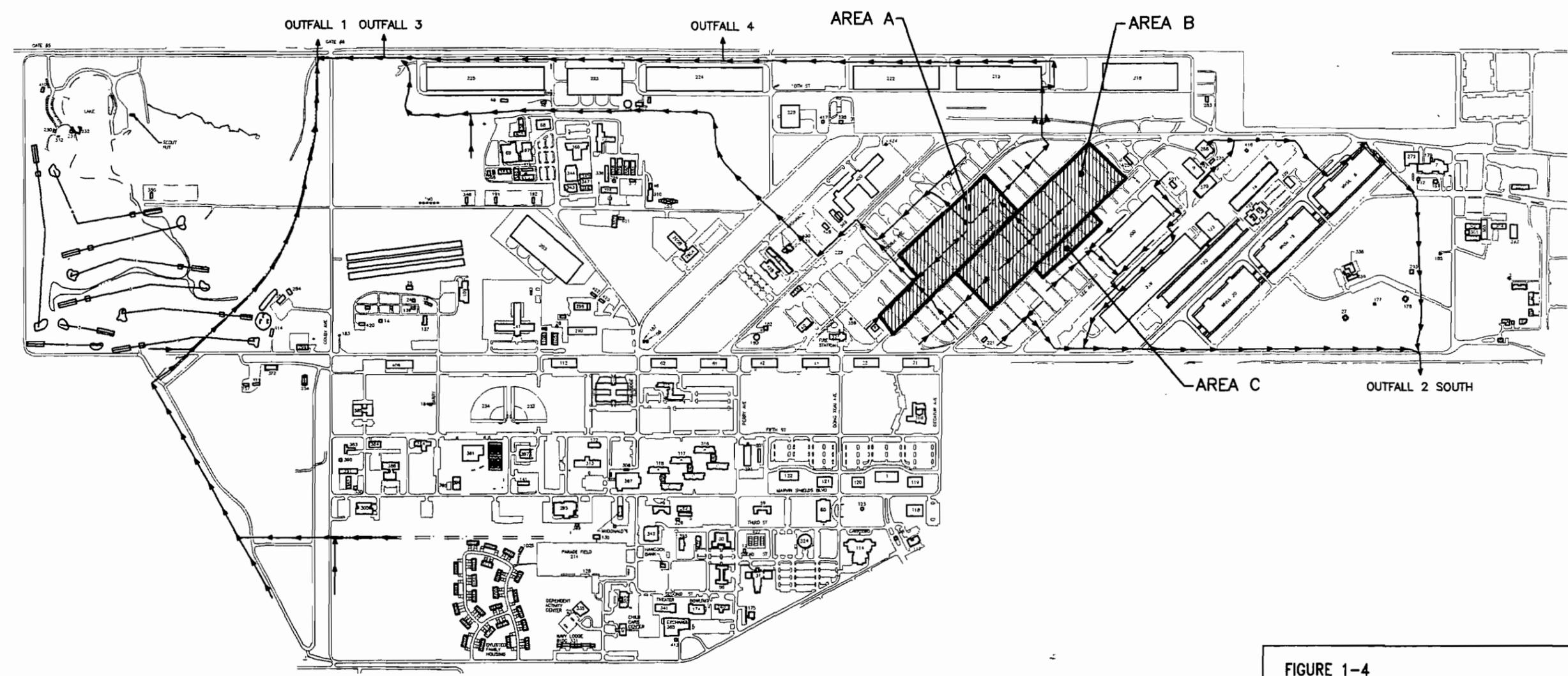


FIGURE 1-4
LOCATION OF FORMER HERBICIDE ORANGE
STORAGE AREAS



ONSITE DELINEATION
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- onsite was defined as onbase and offsite was defined as offbase;
- the ash at Site 8 would be handled under the Resource Conservation and Recovery Act, and the remaining impacted media would be handled under the Comprehensive Environmental Response, Compensation, and Liability Act; and
- the method for removing and placing dioxin-impacted sediment and soil at Site 8, employed during the 28th Street Emergency Action, would be used for remediating dioxin-impacted sediments and soils encountered during onbase and offbase delineation activities.

1.4 PREVIOUS INVESTIGATIONS. In 1984, the results of the initial assessment were reported on Site 8A. This study provided the initial definition of HO leakage and spillage through limited sampling and analysis programs. The major findings on the Initial Monitoring Program (HAZWRAP, 1991) were

- soil samples from approximately 2 to 4 acres of the 12-acre former storage area were found to contain HO and associated dioxin;
- TCDD was detected in sediment biological specimen samples collected from the drainage system leading away from Site 8; and
- the movement of dioxin from the storage site seemed to occur primarily through soil erosion, caused by water, wind, or human activity.

The results of this investigation promoted the Comprehensive Soil Characterization Study (EG&G, 1987 and 1988). The original sampling and analysis program focused on a portion of the storage site now designated as Area A. This was believed to be the area where HO drums were stored. However, two additional areas designated as Areas B and C, located outside the original HO storage area, were identified and verified as sites of additional drum storage. This prompted a Comprehensive Characterization of Sites 8A, 8B, and 8C. The comprehensive study was performed to delineate the horizontal and vertical extent of HO (2,4-dichloro-phenoxyacetic acid [2,4-D] and 2,4,5-trichlorophenoxyacetic acid [2,4,5-T]) and dioxin in the soil at the former HO storage area. This study proceeded in two parts: (1) Area A and (2) Areas B and C as add-on studies. The results of this study were

- TEQs for dioxin and furan congeners ranged from nondetect to 1,000 ppb;
- TEQs for dioxin and furan congeners above 1 ppb were limited to 2 feet in depth with a strong trend toward decreasing TEQs with increasing depth; and
- a 95 percent confidence level was estimated for excavating the majority of soil containing TCDD to 1 ppb (26,990 cubic yards) (HAZWRAP, 1991).

Under an USEPA Research Development and Demonstration permit issued in July 1986 (USEPA, 1986a), remediation of Areas A, B, and C was undertaken, with approximately 26,990 cubic yards of impacted soil excavated from the storage

areas and incinerated based upon a cleanup criterion for dioxin of 1 ppb (HAZWRAP, 1991). The resulting ash from the incineration was placed back upon approximately one-third of Area A. At that time, no decision had been reached on the petition to delist the ash, characterized as FO28 waste, due to discrepancies in the analytical data submitted with the delisting petition.

In November 1987, USEPA Region IV provided final approval to conduct full-scale treatment of the NCBC Site 8 soil. Incineration of the impacted soil containing dioxin above 1 ppb was completed in 1988.

An offsite dioxin contamination survey was performed during the Comprehensive Soil Study (EG&G, 1988) to evaluate potential health impacts from exposure to sediments containing TCDD and to evaluate potential impacts on people who may consume fish and crayfish caught in the drainage system. That study reached the following conclusions:

- no TCDD was detected in potable water supply wells at NCBC;
- concentrations of TCDD in the sediment (greater than 270 parts per trillion [ppt]) and biota samples from the NCBC HO storage site drainage system suggest that offsite migration had occurred; and
- at that time, the concentrations of TCDD were below established health risk levels.

On April 10, 1991, SOUTHNAVFACENCOM authorized sampling of surface soil, surface water, and sediment near the HO site. A characterization of the surface soil was conducted in the area of a construction site known as the Military Construction project P-745, which lies adjacent to the HO site in Area C. Results from these field activities suggest the presence of dioxin at 187 ppt in sediment (ABB Environmental Services, Inc. [ABB-ES], 1993a).

A Sampling and Analysis Plan (SAP), in support of the delisting petition, was prepared in November 1990 (Versar, 1990). The SAP proposed collecting and analyzing additional ash samples. An addendum to the SAP was completed, which focused on the field investigation, analytical methods, and quality assurance and quality control procedures.

A hydrogeologic assessment at Site 8 was performed in 1994 and 1995 (ABB-ES, 1994, 1995a, 1995b, 1995c, 1995d, and 1996a) as an addendum to the Versar (1990) SAP to determine the impact of HO storage on groundwater. Quarterly groundwater samples were collected from 4 monitoring wells along with 10 samples of ash. Below are results from these sampling activities.

- Groundwater flow across Site 8 is generally to the west-northwest.
- Ash sample results for TCDD ranged from nondetect to approximately 70 ppt, although toxicity characteristic leaching procedure results on the samples with highest results were less than 3 ppt.
- TCDD was detected in groundwater samples collected from shallow monitoring wells at concentrations up to 60 parts per quadrillion (ppq), which is above the maximum contaminant level of 30 ppq.

- TCDD concentrations fluctuated with groundwater levels. For example, during periods of higher groundwater elevations at monitoring well GPT-A-2, TCDD TEQs were approximately 60 ppq and during periods of lower groundwater elevations, TCDD TEQs were 0.15 ppq.

The results from the addendum will be used in the Delisting Petition Addendum (ABB-ES, 1996b, in progress).

In 1995, NCBC contracted ABB-ES to take five soil samples along a fenceline on the south end of Site 8A to assess whether or not detectable concentrations of dioxin were present in the soil. The sampling activity was conducted because the base proposed moving the fence back approximately 20 feet so that a rail line would be located on the outside of the fence rather than inside the fenced area. There was no dioxin detected in the samples, and the fence was relocated (ABB-ES, 1995e).

Also in 1995, ABB-ES (ABB-ES, 1995f) reported on an investigation of surface water and sediments at major outfalls and onflows around NCBC, and collected groundwater samples from all existing monitoring wells at Installation Restoration sites. The results of this study indicate

- dioxin was detected in the sediment samples collected along Outfalls 1 (0.2 ppt), 3 (150 ppt), and 4 (0.8 ppt) and Onflow 1 (74 ppt);
- dioxin was detected in a groundwater sample from one monitoring well at Site 4 (34.1 ppq);
- dioxin was detected at 1.2 ppq in a surface water sample; and
- sediment containing dioxin is likely migrating offbase through Outfalls 1, 3, and 4.

In mid-1995, a Defense Construction Roadway project along 28th Street coupled with the presence of sediment containing dioxin at the base boundaries prompted additional sediment sampling along the north side of the base. Sediments containing dioxin were found up to 3 feet below grade at Outfalls 1, 3, and 4. This discovery initiated the Interim Removal Action 28th Street (ABB-ES, 1995g). A plan to remove the affected sediments at the identified outfalls and place them on Site 8 was approved by MSDEQ. The excavation was completed in July 1995.

1.5 WORKPLAN ORGANIZATION. This Onsite Delineation Workplan is organized into five chapters, which outline the technical approach for identification and delineation of dioxin in environmental media as outlined in the AO. The contents of each chapter are described below.

Chapter 1.0, Introduction, presents the purpose, scope, regulatory setting, site history, previous investigations, and organization of the Onsite Delineation Workplan.

Chapter 2.0, Site 8 Conceptual Models, provides a visualization and description of potential sources of dioxin, media of interest, target analytes, nature of

dioxin, transport and deposition of dioxin in environmental media, and the phased approach for sample collection.

Chapter 3.0, Field Investigation, presents the phased approach to identify and delineate dioxin in the environmental media within the boundaries of the base.

Chapter 4.0, Analytical Program, outlines the guidelines for sample collection, sample analysis, and data validation.

Chapter 5.0, Data Evaluation and Interpretation, provides the general outlines for the summary of Phase I activities. The recommendations of the summary report will be used to guide the Phase II activities.



2.0 CONCEPTUAL MODELS

The conceptual models and logic diagrams developed in this chapter will be used to guide the investigative and remedial processes in the most efficient manner possible. These conceptual models provide the rationale for selection and sampling locations, and eventually will help in selecting the most effective remedial options. The conceptual models will be updated during the investigative process as new information is assimilated. The logic diagrams illustrate the process for evaluating Phase I sample results and provide the decision matrix for Phase II actions.

2.1 POTENTIAL SOURCES. Currently, the former storage and handling of HO is suspected as the source of the dioxin detected in soil, surface water, sediment, and groundwater samples on and off the base. Dioxin is a by-product of the HO manufacturing process. HO is the only suspected source of dioxin because of the unique chemical family members, or congeners, of its constituent dioxins and furans. Of these congeners, TCDD is a good indicator that the source of the dioxin is HO.

From 1965 to 1977, nearly 850,000 gallons of HO were stored at Site 8 in 55-gallon drums. No liners, covers, or protective barriers were placed on or around the drums to mitigate potential spills. In 1984, the former storage areas were initially characterized for the presence of TCDD. A subsequent investigation in 1986 identified an area of approximately 4 acres impacted with dioxin (HAZWRAP, 1991). Nearly all of the samples collected in that area contained TCDD above 1 ppb. This area is believed to be the primary source of dioxin contamination in the ditch systems that drain the Site 8 area (Figure 2-1). By 1988, incineration of impacted soils at Site 8 had reduced the levels to approximately 1 ppb or less.

Another possible source of dioxin is the disposition of HO drums. Interviews of base personnel reported an unknown quantity of drums were removed from the storage area at Site 8 after they were damaged; they were then placed in the landfills at Sites 4 and 5. The disposal of damaged HO drums in this manner could be a source at these locations. Potentially, the HO could adversely impact groundwater and seeps flowing into the ditches, which could impact surface water and sediment leading away from Sites 4 and 5.

2.2 AREAS OF INTEREST. Figure 2-1 indicates that surface water is conveyed through four primary drainage areas at Site 8. Dioxin has been confirmed in drainage Area 1 and drainage Area 2. Areas 3 and 4 still need to be investigated. The potential sources for contamination in these four areas are now considered to be residual concentrations of dioxin in soil at the former storage areas and impacted bed load in the ditch systems that drain Site 8.

Groundwater sample results from monitoring well GPT-4-3 at Site 4 suggest the presence of dioxin above drinking water limits (ABB-ES, 1995f). Groundwater flow at Site 4 is generally to the west toward Canal No. 1 (Figure 2-2). Impacted seepage may enter Canal No. 1 along the east side of Site 4. Neither the seeps nor the sediment directly adjacent to Site 4 have been investigated for the presence of dioxin.

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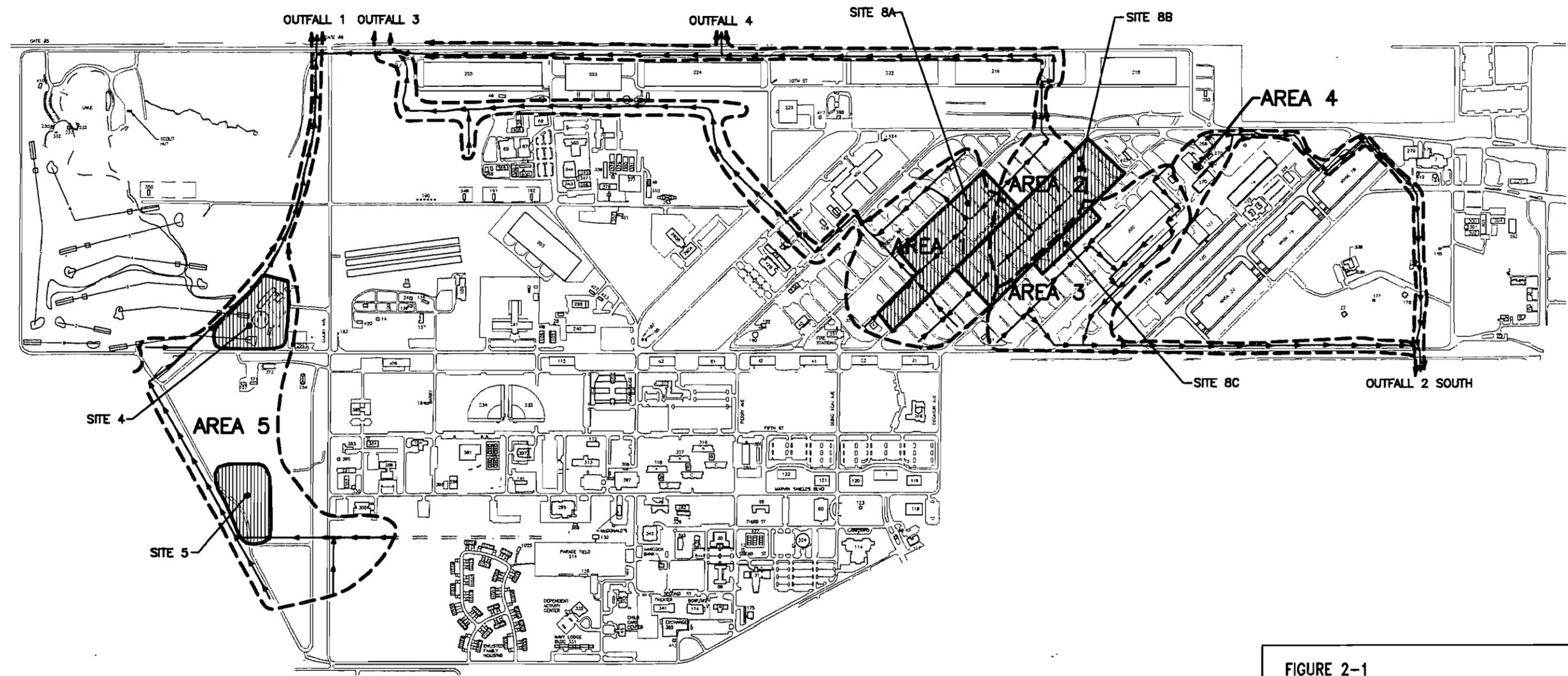
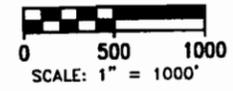
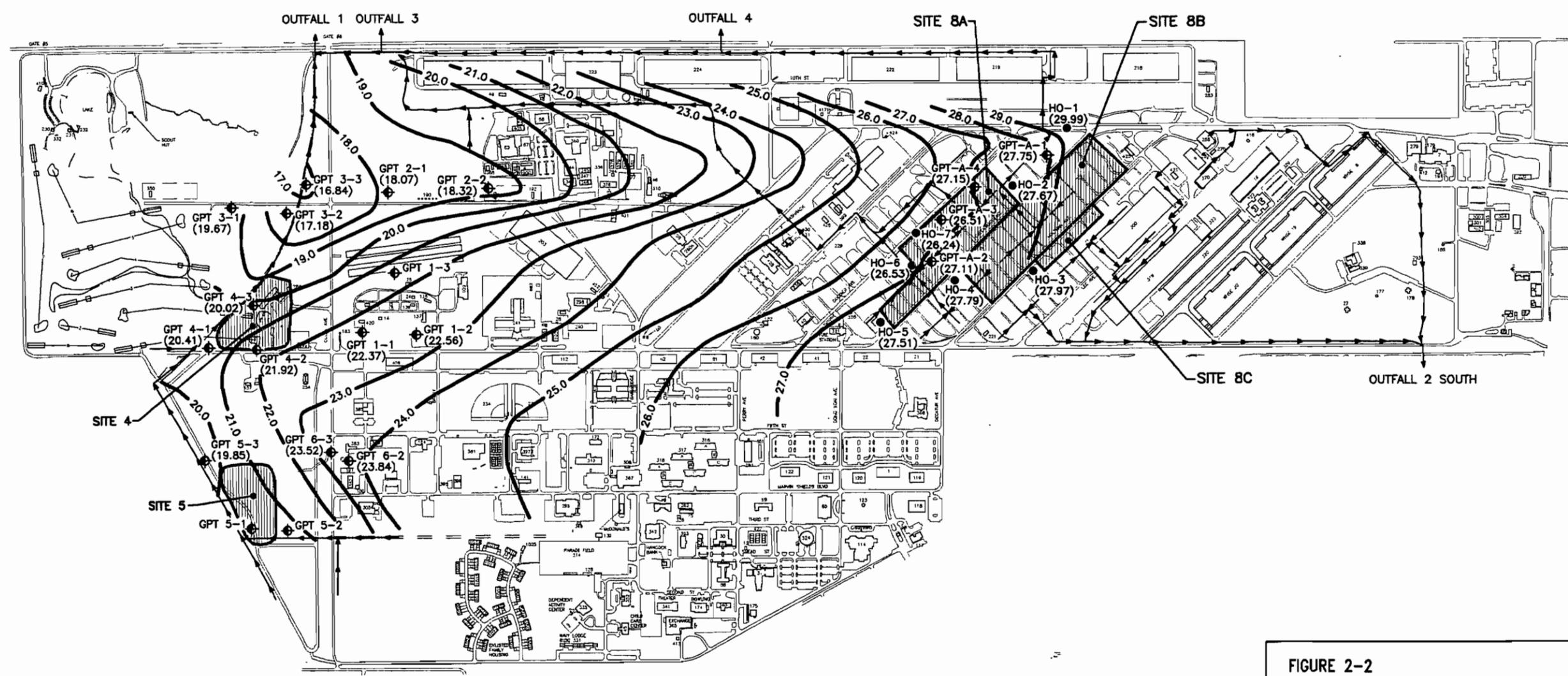


FIGURE 2-1
BASEWIDE DRAINAGE



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LEGEND	
◆ (27.15)	MONITORING WELL LOCATION WITH GROUNDWATER ELEVATION
● (29.99)	WELL POINT LOCATION WITH GROUNDWATER ELEVATION
— 28.0 —	POTENTIOMETRIC SURFACE CONTOUR, 1.0' INTERVALS

FIGURE 2-2
GROUNDWATER POTENTIOMETRIC MAP OF
DECEMBER 1994



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TCDD in the sediments (Figure 2-1) downstream of Site 5, but upstream of Site 4, suggests that HO drums may have been stored at Site 5 as well.

Sites 4 and 5 comprise drainage Area 5 (see Figure 2-1). The suspected primary sources of dioxin contamination in Area 5 are HO drum storage in the two landfills, groundwater that potentially seeps to the ditches, and sediment contamination resulting from the seepage.

A groundwater sample result from monitoring well GPT-2-3 at Site 7 contained TCDD at 5.5 picograms per liter (ABB-ES, 1995f). Because there has been no reported disposal of HO at Site 7, the monitoring well will be resampled before further investigative work is performed.

2.3 TARGET ANALYTES. The target analytes during this investigation, as outlined in the AO, are the dioxin and furan congeners and the constituents that make up HO (2,4-D and 2,4,5-T). The phenoxy-herbicides 2,4-D and 2,4,5-T are known to be in HO, in which the dioxin congeners form as a trace impurity. Total organic carbon (TOC) will be determined in the sediment and soil samples. TOC has proven to be an indicator for likely areas of dioxin deposition. The effectiveness of TOC as a dioxin indicator will be used to guide sampling efforts. TOC results also could prove especially useful during any remedial activities that require removal of impacted sediment or surface soil. Groundwater samples from Sites 4 and 5 will be analyzed for the full suite of Appendix IX analytes (USEPA, 1994a), in addition to dioxins and furans.

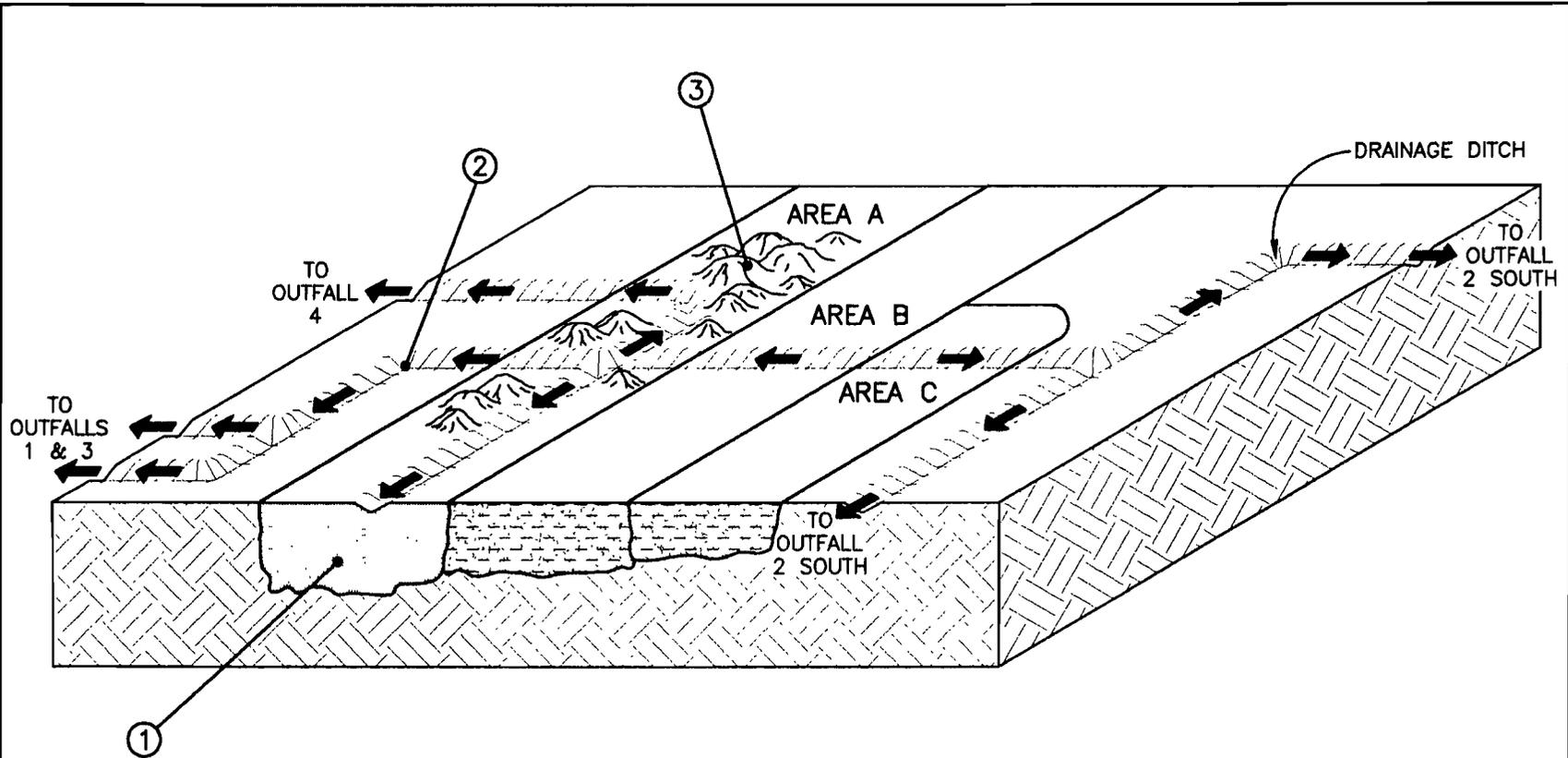
2.4 MEDIA OF INTEREST. The environmental media of interest, as outlined in the AO, are soil, surface water, sediment, and groundwater. This investigation will focus on these media and the mechanisms that may have resulted in the release of HO and dioxin to the environment.

2.5 NATURE OF HO AND DIOXIN. Dioxin is a colorless and odorless solid at room temperature, has a very low aqueous solubility (octanol-water partition coefficient equals 1.93×10^{-5}), and is not likely to be dissolved in water at concentrations above 20 ppt (Arienti and others, 1988). However, dioxin is soluble in oils, fats, and organic solvents. Dioxin has a specific gravity greater than water and a strong affinity for organic carbon. Dioxin is known to have a long half life in nature before breaking down. HO was mixed with diesel fuel prior to application as a herbicide and was stored at Site 8 already mixed with diesel fuel.

Considering the nature of dioxin, it is likely that dioxin has adhered to soil or organic particles and is mobile primarily in the sediment bed load in drainage ditches, or through erosion of impacted surface soil. This trend has been verified through a comparison of sediment, surface water, and surface soil samples (ABB-ES, 1995f and 1995g).

2.6 TRANSPORTATION AND DEPOSITION OF DIOXIN.

2.6.1 Transportation of Dioxin The main mechanism for dioxin transportation is the erosion and mobilization of dioxin-impacted soil from Site 8. Figure 2-3 is



LEGEND

- ① SOIL CONTAMINATION DUE TO HERBICIDE ORANGE STORAGE
- ② SEDIMENT RUNOFF
* SOIL EROSION/RUNOFF
- ③ ASH EROSION
- ← FLOW PATH LINES

NOT TO SCALE

FIGURE 2-3
CONCEPTUAL MODEL - SITE 8



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the conceptual model for Site 8 and associated drainage areas. In this figure, dioxin-impacted soils eroded from the former storage area could potentially migrate to Outfalls 1 and 3 North through drainage Area 1 (Figure 2-1). The highest sediment sample results have been obtained from samples collected in this drainage area. Transport of dioxin to Outfall 4 North could potentially occur through the sediment bed load transfer from drainage Area 2. Drainage Areas 3 and 4 receive runoff from the eastern area of Site 8 and discharge through Outfall 2 South.

The major transport mechanisms for dioxin at Sites 4 and 5 would be through groundwater contamination directly seeping into the drainage Area 5 (Figure 2-1). Conceptually, this mechanism is possible at these sites and not at Site 8 because the drainage ditches cut into the sides of the landfills.

Seeps have been observed at both Sites 4 and 5 directly flowing into drainage ditches. The conceptual model for Sites 4 and 5 (Figure 2-4) displays up-to-date information about the sites and illustrates how this mechanism is possible. Once in the ditches of Area 5, the dioxin is transported along with the sediment bed load to Canal No. 1 and toward Outfall 1 North.

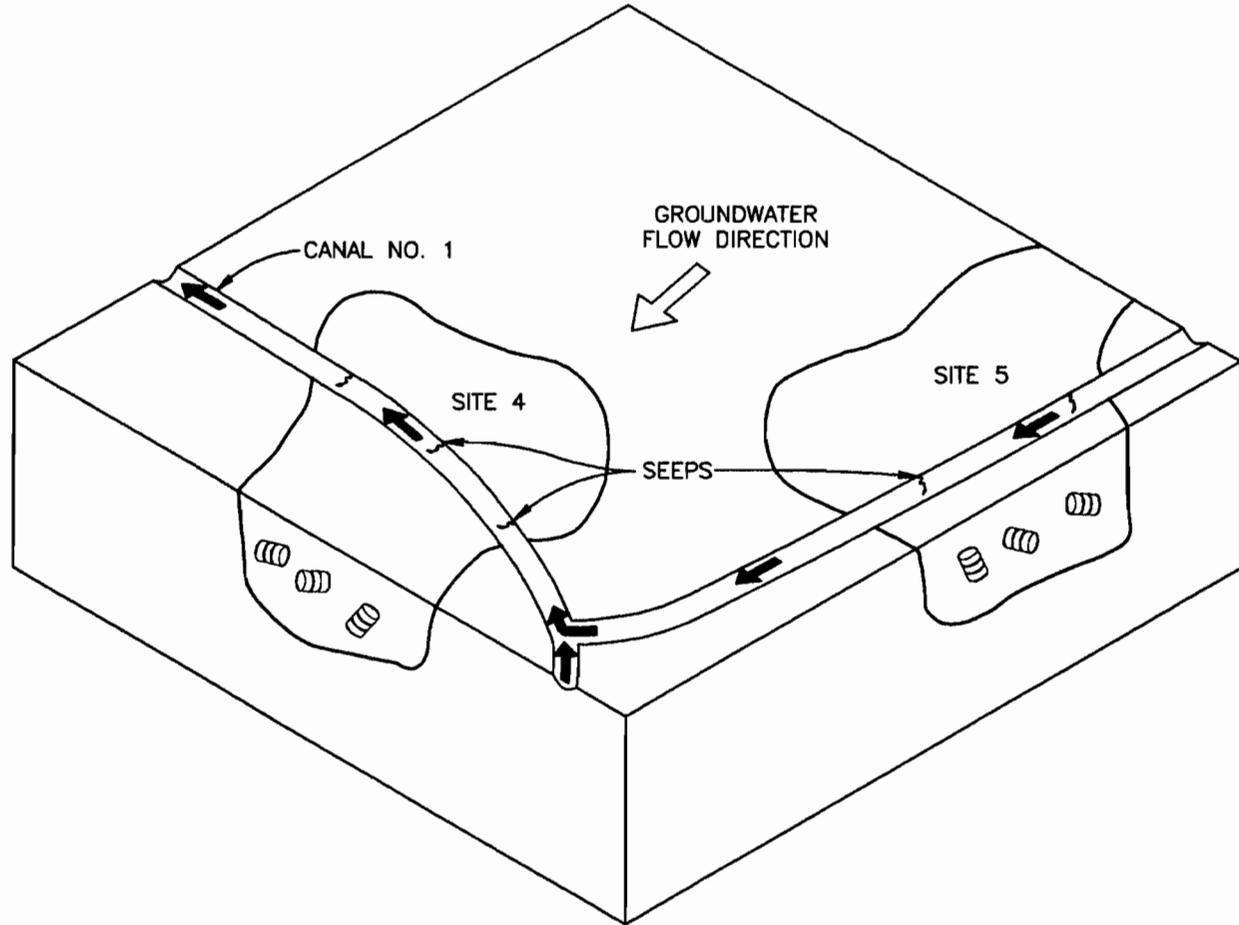
2.6.2 Deposition of Dioxin Deposition of dioxin occurs through four mechanisms: (1) dioxin-impacted sediment settles out in the bed load in low-velocity environments in the ditches; (2) the dioxin becomes adhered to the organic-rich muck commonly found in the ditches, regardless of stream velocity; (3) impacted sediment is deposited outside the banks of the ditches during high-flow periods; and (4) wind-blown materials are blown off Site 8 and deposited downwind. The first three mechanisms have all been substantiated through sampling, while the wind blown deposits have been observed but not quantified.

Dioxin has been detected in groundwater samples at Site 8 but is currently not considered a major mechanism for dioxin transport or deposition there. This mechanism is excluded based on dioxin's hydrophobic nature and affinity for soil particles, although seeps at Sites 4 and 5 may be a mechanism for dioxin transport and deposition to sediment in Canal No. 1.

The relationship between organic carbon and dioxin TEQs in the sediment sample results has been observed and reported in the Removal Action Technical Support (ABB-ES, 1995h) and Soil and Sediment Triplicate Study (ABB-ES, 1996d). Both studies determined that as dioxin levels increased a corresponding increase in organic carbon was observed.

This relationship will be used in the field to attempt to locate the potential area of highest dioxin deposition in the ditch systems by locating the areas of greatest organic carbon deposition. In this manner, a biased sample would be collected that can be reasonably assumed to contain the highest levels of dioxin in that particular ditch segment. This method of biased "maximum" samples will be verified by including organic carbon analysis on all sediment samples, even areas where little organic carbon appears to exist.

2.7 POTENTIAL EXPOSURE PATHWAYS AND RECEPTORS. An exposure assessment that will start in May 1996 and be completed in August 1996 will identify exposure pathways and potential receptors of the contaminants identified in the AO. The results of that study will be incorporated into the site conceptual models generated for



NOT TO SCALE

LEGEND

- ~ SEEPS
- ☉ 55-GALLON DRUM
- ← FLOW PATH LINES

FIGURE 2-4
CONCEPTUAL MODEL - SITES 4 AND 5



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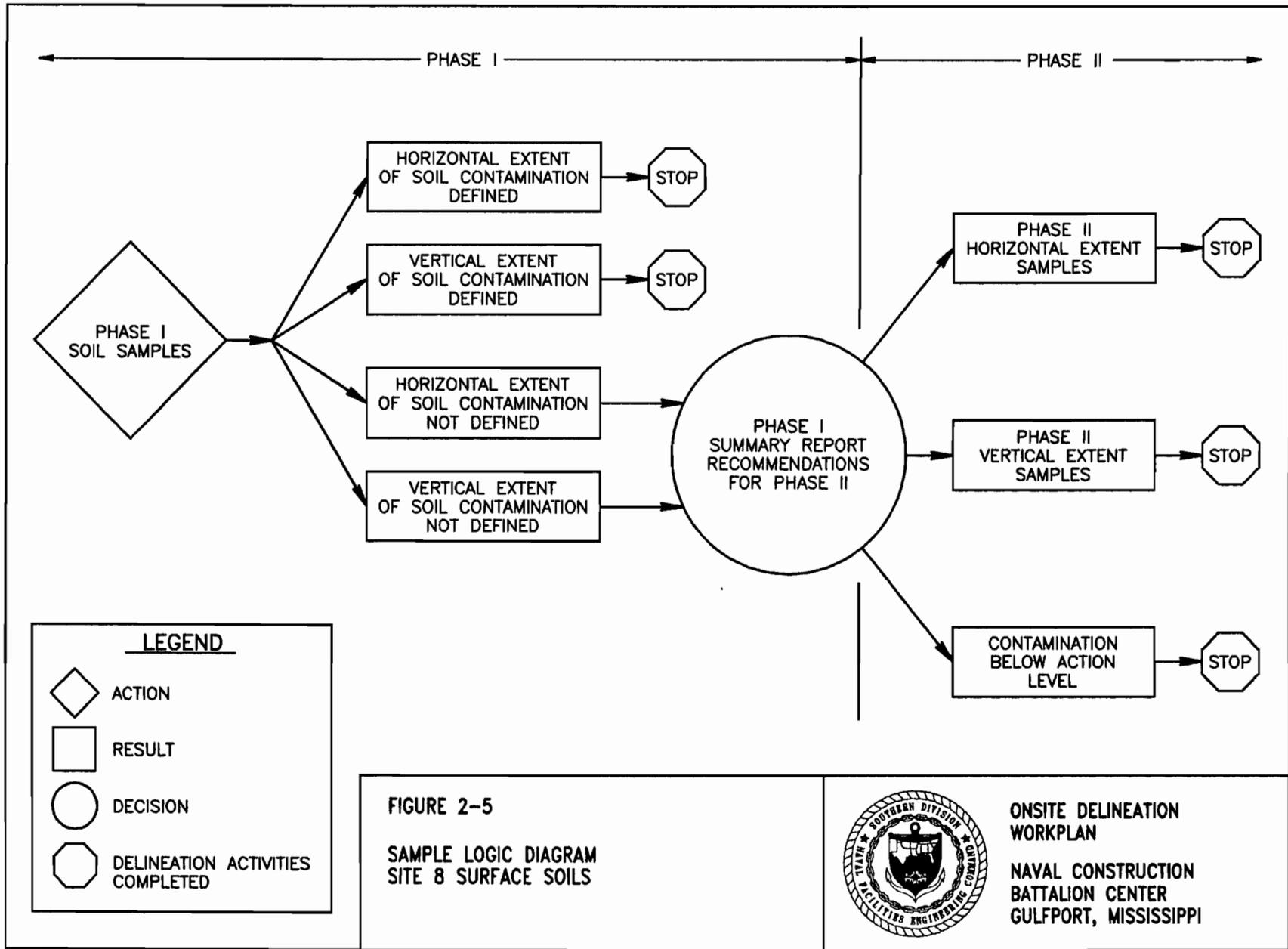
Sites 8, 4, and 5. The information from the exposure assessment may provide additional guidance for the need to collect additional samples in Phase II, as well as determine the need for, and to some extent the scope of, future remedial actions.

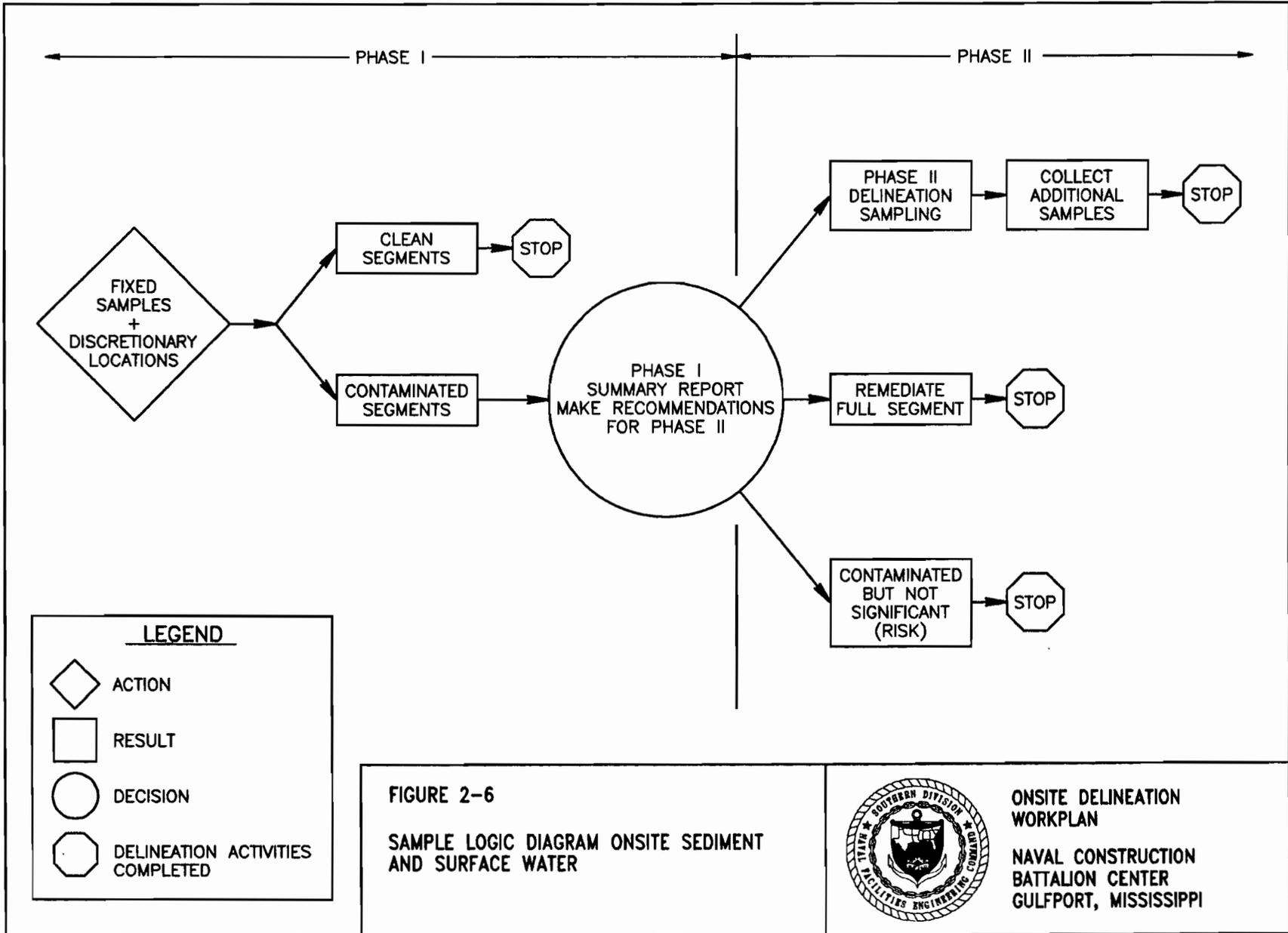
2.8 SAMPLE LOGIC DIAGRAMS. The sample logic diagrams included in this section illustrate the process for evaluating Phase I sample results and provide the decision matrix for Phase II actions. Sampling logic diagrams have been developed for the following: surface soil collection at Site 8, sediment and surface water collection throughout the base, and seep and groundwater sample collection from Sites 4 and 5.

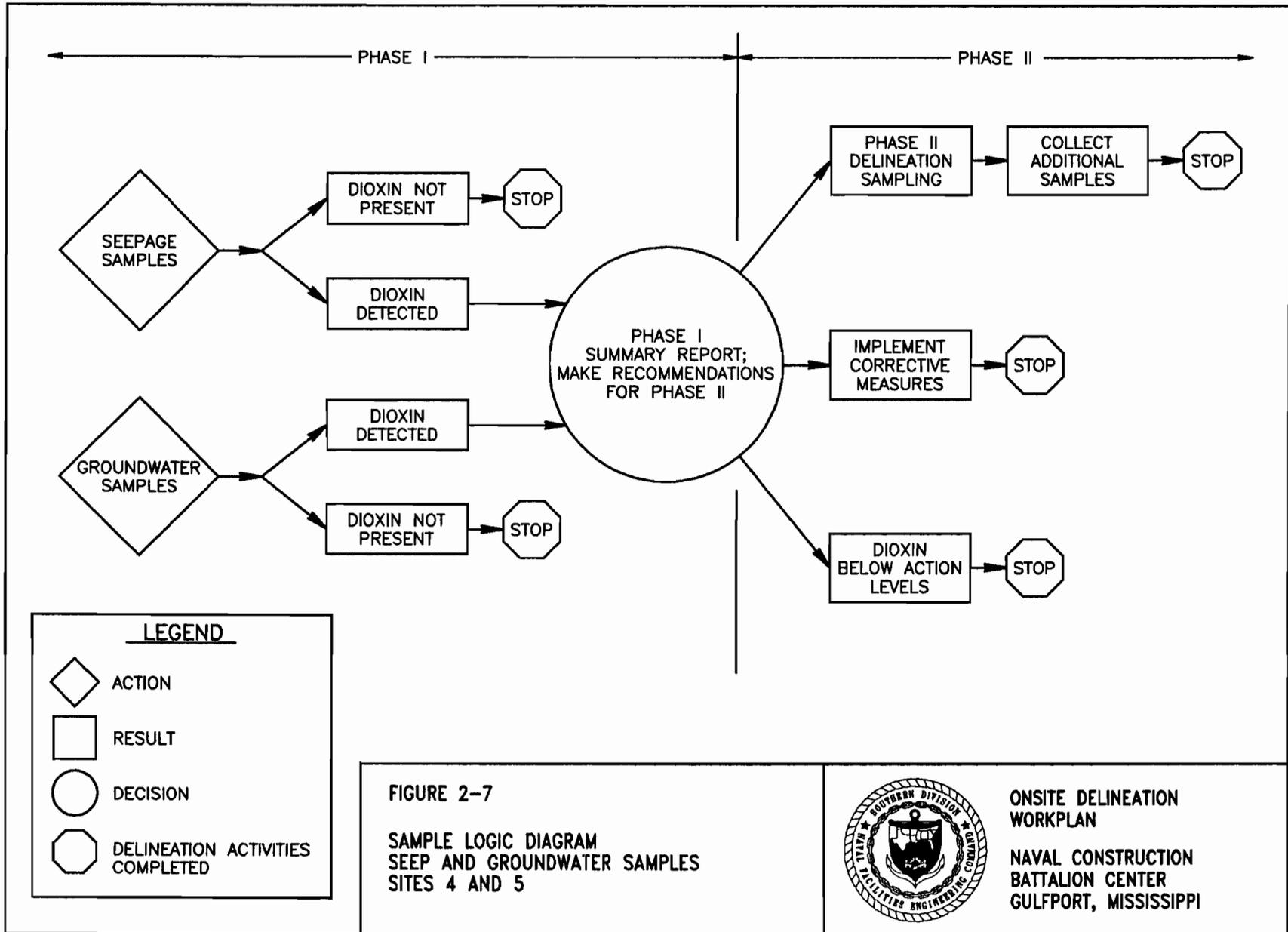
2.8.1 Surface Soil at Site 8 The main objective of surface soil sampling at Site 8 is to characterize the horizontal and vertical extent of dioxin contamination that may need remediation. The decisions for any additional sampling (Phase II) beyond the initial fixed points (Phase I) would be based on engineering requirements for corrective measures. The sample logic diagram developed to evaluate the Phase I sample results is shown on Figure 2-5.

2.8.2 Sediment and Surface Water Onbase Sediment and surface water samples collected on the base suggest that these media have been impacted and could act as a secondary source. The proposed sediment and surface water samples onbase have the following objectives: identify which drainage areas onbase have been affected by HO, collect samples in Phase I to subdivide the drainage areas, and use the results of Phase I sampling to guide Phase II actions. The decision points in the sampling logic diagram (Figure 2-6) occur prior to Phase II sample collection.

2.8.3 Groundwater and Seep Sampling at Sites 4 and 5 Groundwater and seeps emanating from Sites 4 and 5 have been identified as a potential source of HO and or dioxin in surface water and sediment in drainage Area 5 (Figure 2-1). The objective of groundwater and seep sampling at Sites 4 and 5 is to determine whether or not either site emits dioxin and to isolate the release points. Three to five seep samples and groundwater samples are proposed in Phase I. Interpretation of Phase I data will determine if these sites are emitting dioxin to the surface water, sediment, or groundwater. The sample logic diagram (Figure 2-7) illustrates the decision points prior to Phase II sampling. Phase II samples will be collected only if either Sites 4 or 5 have been confirmed to be seeping dioxin to the drainage system that passes both sites. Phase II samples will focus on isolating those emission points.









3.0 FIELD INVESTIGATION

The field investigation will focus on the four environmental media identified in the AO: sediment, surface water, soil, and groundwater at Sites 4 and 5. The objectives of the field investigation are a phased approach designed to meet the requirements of the AO, and they include identifying and delineating HO and dioxin contamination related to the storage and handling of HO at Site 8. The areas covered in this workplan include soils at Site 8, surface water and sediment in drainage ditches that have been impacted, soil in and near ditches that have received impacted sediment, and groundwater and seep from Sites 4 and 5, where drums of HO were potentially disposed.

The results of the first phase of the work will be used to update the conceptual models and focus the efforts in the second phase. By focusing sample collection in a phased approach, fewer samples will be required to confidently identify and delineate impacted areas and meet the needs of the AO.

3.1 PRELIMINARY ACTIVITIES. Prior to initiation of field activities, various mobilization tasks must be completed to ensure efficient field sampling events. The project team will develop specifications to initiate procurement of subcontractors and vendors for specialized services and equipment. Standard items for mobilization will be handled in accordance with Federal Acquisitions Regulations with individual items being coordinated through the field operations leader and the task order manager.

Efforts also will be expended to ensure that coordination exists among the contractor, the base environmental coordinator, and a representative from Public Works while activities are occurring on the base. The contractor will keep the environmental coordinator informed of the scheduled field activities to prevent interference with base activities.

3.2 FIELD INVESTIGATION. Phase I of the investigation will focus on identifying dioxin-impacted areas on the base. Phase II of the investigation will refine the Phase I delineation. Specifically, Phase II will refine the delineation of the impacted sediments, which may reduce the total volume necessary for potential future remediation. Additional soil sampling may be required at Site 8, but only if specific engineering requirements necessitate additional samples. Additional seep samples at Sites 4 and 5 may be collected if the Phase I sample results indicate a dioxin release to Canal No. 1. The number of samples and locations collected during Phase II will be determined when the results of Phase I sampling is available. Technical justification for these samples will be included in the reporting outlined in Chapter 5.0 of this workplan. The analytical program for all samples is summarized in Chapter 4.0 of this workplan.

3.2.1 Site 8 Soil Ongoing erosion of Site 8 soil continues to pose the potential for further contamination of the ditch systems. According to the *Summary Report Remedial Characterization and Soil Remediation Technology Review* (HAZWRAP, 1991), the soil at Site 8 was remediated down to 1 ppb, the remediation standard at the time. Characterization of the Site 8 soil will be performed to determine the extent of soil contamination above the current dioxin TEQ action level and

that potentially could act as a source for sediment and surface water contamination. The results of this soil characterization will be used to determine the future course of remedial activities at Site 8 that would mitigate the erosion and transportation of dioxin-impacted soils.

In Phase I, between 30 to 40 surface soil (0- to 0.5-foot interval) grab samples will be collected from the three areas that comprise Site 8. The 0- to 0.5-foot interval will be sampled because dioxin contamination at Site 8 is greatest in the 0- to 0.5-foot interval and decreases rapidly below 0.5 foot (HAZWRAP, 1991). These fixed sample locations are shown on Figure 3-1. Thirty-three fixed sample locations at Site 8 are based on relation to drainage ways, areal coverage, and known contamination. Up to seven discretionary samples may be collected if observations warrant.

An area 200 feet south of Area C (see Figure 3-1) was investigated for the presence of dioxins by the Navy in 1993 prior to the construction of a warehouse. The findings of that MILCON (Military Construction) Site Assessment Report (ABB-ES, 1993a) included the discovery of surface soil contamination at 69.4 ppt in one sample. Otherwise, the results ranged from 2.7 to 8.6 ppt. The 69.4 ppt sample location will be field checked to determine if it is in an area that received overflow deposition from the ditch. If it does not receive ditch sediments, three surface soil samples will be collected in the area (Figure 3-1).

Phase II samples will be collected if (1) the area of contamination above the action level is outside the bounds of Phase I or (2) greater characterization of the contamination onsite is required for the engineering evaluation of remedial activities. These decision points are outlined in the sample logic diagram (Figure 2-5), and justification for Phase II activities samples will be provided in reporting outlined in Chapter 5.0.

3.2.2 Sediment and Surface Water Five drainage areas have been identified that receive surface water and sediment from HO storage areas and areas known to be impacted by the storage and handling of HO. These areas include four areas in and around Site 8 and one that encompasses Sites 4 and 5 (Figure 2-1).

The focus of Phase I is to identify which of the drainage areas have been impacted by dioxin and isolate impacted segments of the drainage areas by determining approximate lines of delineation.

The location of surface water and sediment samples in Phase I (Figure 3-2) were selected by considering the following five components: known dioxin contamination, areas likely for deposition, horizontal coverage, engineering requirements, and drainage basin analysis. The surface water and sediment samples collected at the chosen locations will be biased towards the most impacted location in the sample area. Collecting a biased sample is important for two reasons: (1) the sample result will be a maximum for that segment of the ditch and (2) fewer samples will be needed to achieve a confident rough delineation.

Approximately 52 fixed sample locations have been identified for this phase. Ten side wall and eight discretionary samples are planned. Surface water samples will be collected at 20 percent of the sediment sample locations. This is proposed because of consistent data (ABB-ES, 1995f and 1995g) showing that dioxin is generally absent in surface water.

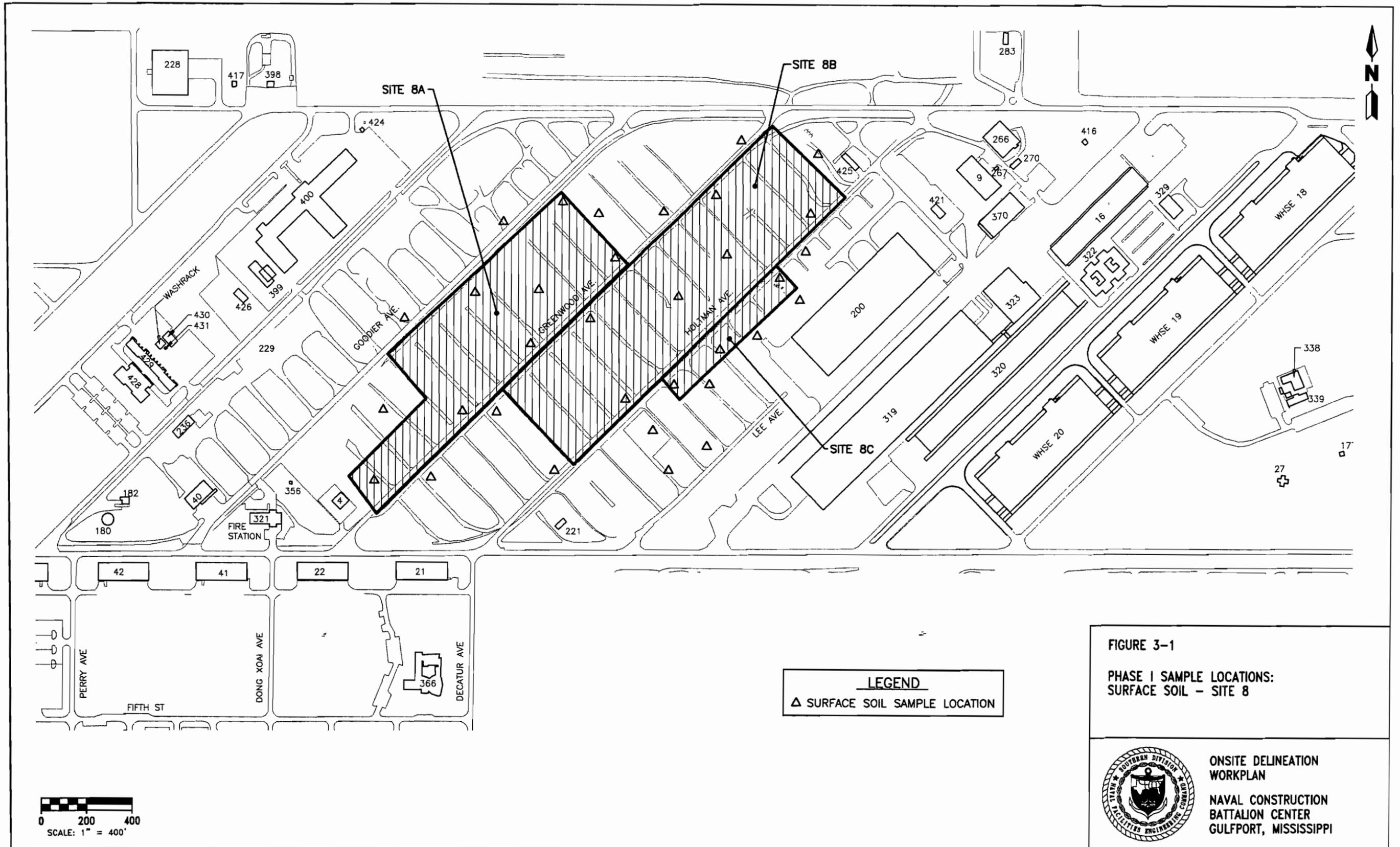
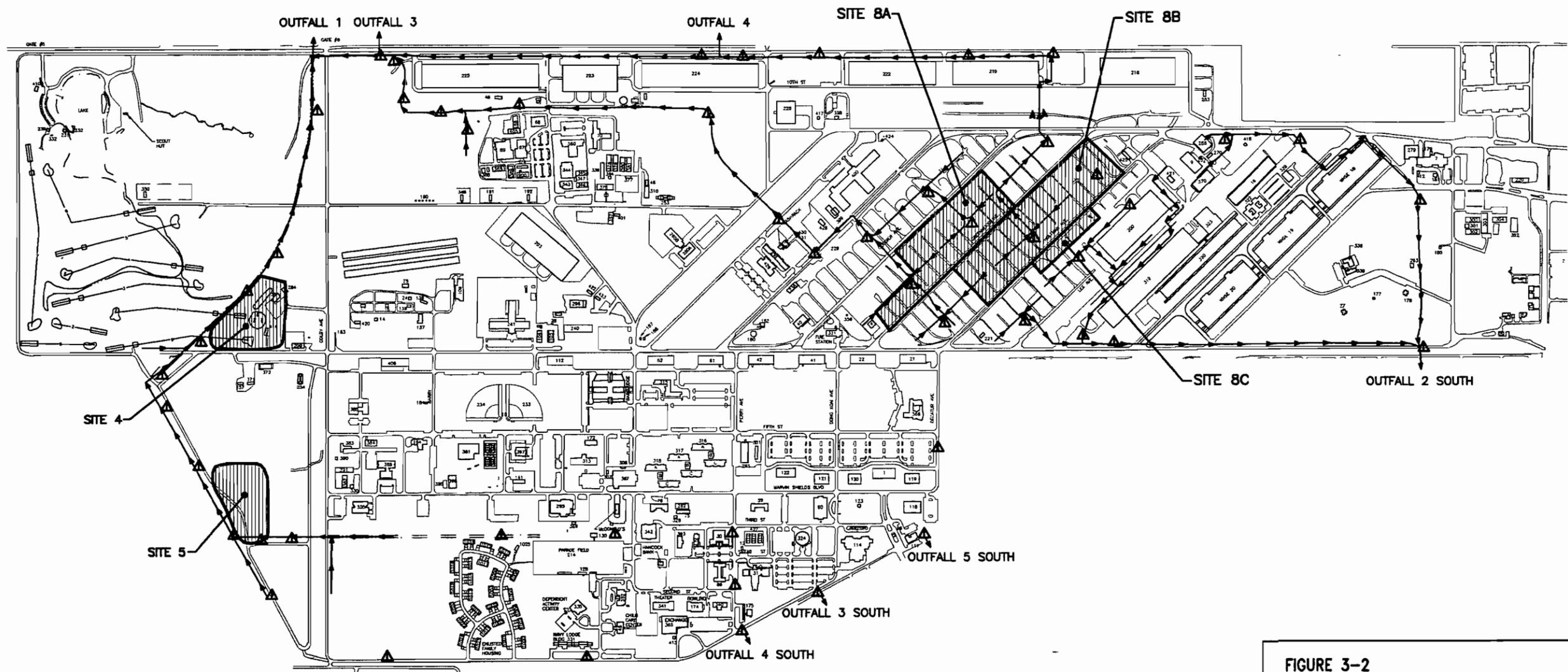


FIGURE 3-1
PHASE I SAMPLE LOCATIONS:
SURFACE SOIL - SITE 8

LEGEND
 ▲ SURFACE SOIL SAMPLE LOCATION

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LEGEND
▲ SURFACE WATER AND SEDIMENT
SAMPLE LOCATIONS

0 500 1000
SCALE: 1" = 1000'

FIGURE 3-2

PHASE I SAMPLE LOCATIONS:
SURFACE WATER AND SEDIMENT



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GULFPORT, MISSISSIPPI

Phase II samples will be collected if technical (engineering or risk) justification is made. The decision for Phase II samples will be collected following the sample logic diagram (Figure 2-6). Justification for these samples will be presented as part of the reporting requirements outlined in Chapter 5.0. Phase II samples will be collected if refinement of the delineation reduces the cost to remediate the sediment, if more information is required to make a risk-based decision that contamination is at insufficient levels to warrant remediation, or if more samples are needed to meet the needs of the AO.

3.2.3 Groundwater and Seeps from Sites 4 and 5 Groundwater and seeps associated with the former landfills at Sites 4 and 5 have been identified as potential sources for dioxin contamination in surface water and sediment in Canal No. 1. Sediment downgradient from Site 5 has contained dioxin with a signature similar to Site 8, and a monitoring well in Site 4 has contained dioxin above MSDEQ maximum contaminant levels for groundwater.

To investigate this potential, samples of seeps that directly enter Canal No.1 from Site 4 and the ditch south and west of Site 5 will be collected. The locations of already identified seeps are shown on Figure 3-3. It is anticipated that three to five seep samples will be collected from each site, although variable precipitation patterns impact the number and viability of seep sampling locations.

To determine the role that the sites have on groundwater and potentially the seeps, groundwater wells will be installed and sampled downgradient of the sites and close to the ditches. Four monitoring wells will be installed at Site 4, and three monitoring wells will be installed at Site 5; their locations are shown on Figure 3-3.

The wells will be installed and completed following SOUTHNAVFACENCOM guidelines (Naval Energy and Environmental Support Activity [NEESA], 1985). The wells will be sampled following the procedures outlined in the Remedial Investigation and Feasibility Study (RI/FS) (ABB-ES, 1993b) developed for NCBC Gulfport.

The Phase I results will be evaluated to determine if additional samples will be required. Additional seep samples would be collected if dioxin contamination is proven to enter Canal No. 1 through the Phase I seep samples. Technical justification for any additional seepage samples will be included in the reporting requirements outlined in Chapter 5.0.

3.2.4 Geotechnical Sample Collection Geotechnical parameters outlined in the Interim Corrective Measures Workplan (ABB-ES, 1996c, in progress) will be collected during Phase I of the field investigation. The samples are collected during this investigation to facilitate an engineering evaluation and to support the generation of the Remedial Action Workplan requested by MSDEQ in the AO. Chapter 4.0, Analytical Program, summarizes the parameters and media that will be collected. Geotechnical samples will be collected along with the Phase I fixed locations.

3.3 TECHNICAL APPROACH TO SAMPLE COLLECTION. This section outlines the sampling method for each of the media identified in this workplan.

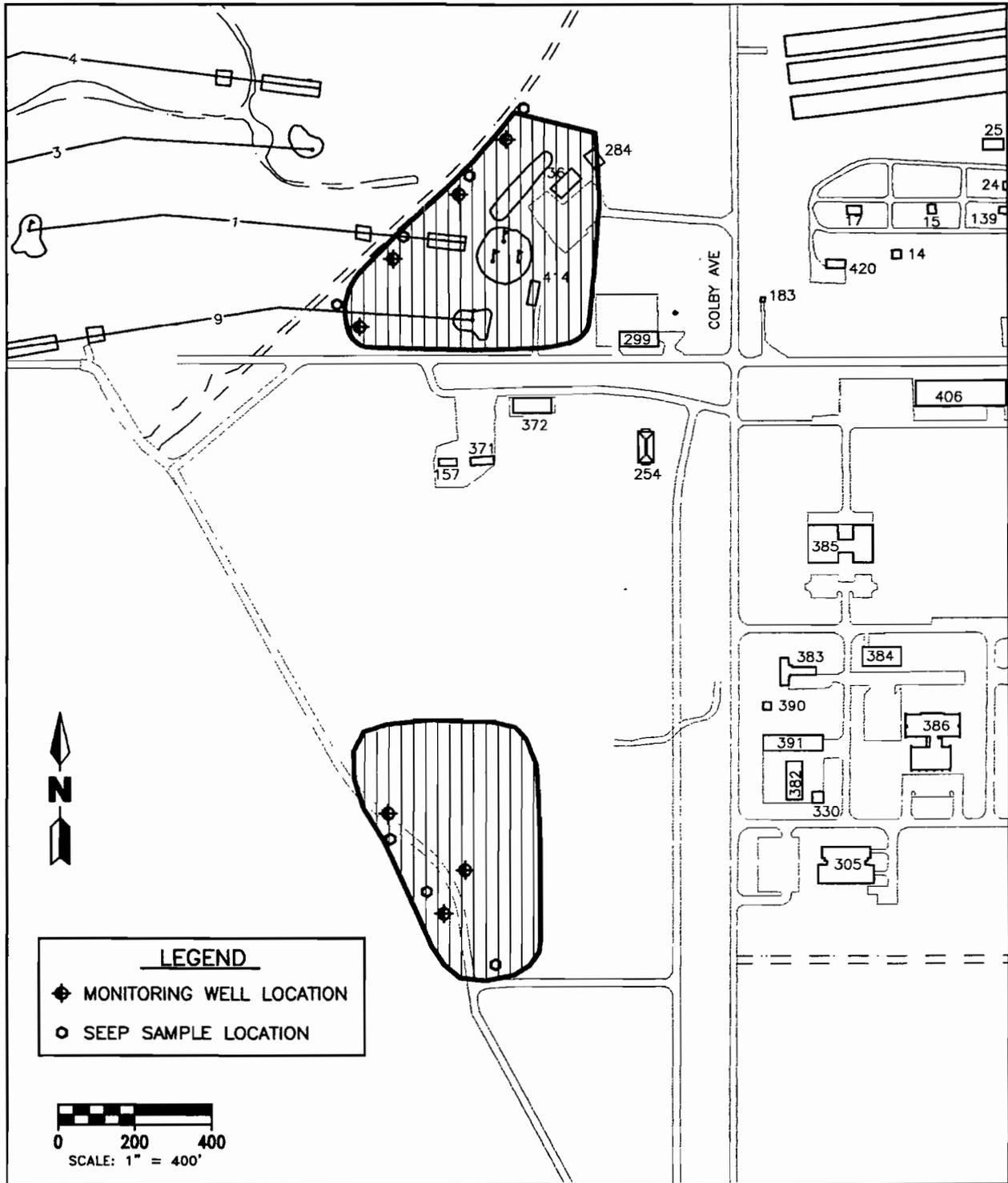


FIGURE 3-3

PHASE I SAMPLE LOCATIONS:
GROUNDWATER AND LEACHATE
FROM SITES 4 AND 5



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WORKPLAN

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GULFPORT, MISSISSIPPI

D:\DWG\ABB\08505-16\ONSITE\FIG_3-3\DMF\960425

3.3.1 Surface Soil Sample Collection Surface soil sample collection will be performed using a stainless-steel hand auger. The samples will be a composite from the surface to 0.5 foot in depth. Mixing of the composite will be performed in a decontaminated glass bowl using a stainless-steel trowel or long-handled spoon. If the sample location is in an area of cement-stabilized soil, then a power auger or pick axe may be used. Interval (2.0 and 3.0 feet) sampling will be collected in Phase II to determine the vertical extent of dioxin.

3.3.2 Surface Water and Sediment Sample Collection A biased sampling method will be used when collecting sediment samples. This method is proposed because of the variable nature of dioxin transportation and deposition. The sediment samples will be collected in low-energy environments, or where organic-rich deposits have accumulated. The Phase I fixed locations provide a guide to the approximate location, within 20 to 50 feet. The final location will be determined and documented in the field as the location with the highest likelihood of containing dioxin. The exact locations for surface water and sediment samples will be documented using a global positioning satellite (GPS) receiver. Using a GPS will be useful because of the large area the surface water and sediment samples cover.

The sample collection will be a composite of the 0- to 1.0-foot interval, using a stainless-steel hand auger and glass mixing bowls. Deeper intervals will not likely be sampled in Phase II because previous studies (ABB-ES, 1995g) have shown that if the 0- to 1.0-foot interval contains significant dioxin accumulation, then that location will also likely produce similar results down to the pre-depositioned cut of the ditch.

The surface water samples will be collected at 20 percent of the sediment locations. The surface water samples will be collected at the same location, but prior to the sediment sample, which will minimize sediment in the surface water sample.

3.3.3 Groundwater and Seep Sample Collection Groundwater samples will be collected through monitoring wells installed hydraulically downgradient of Sites 4 and 5. The monitoring wells will be placed hydraulically downgradient of the sites but upgradient of the ditches that cut through the sites (Figure 3-3). The monitoring wells will be a total of 25 feet deep, constructed of 2-inch polyvinyl chloride, and have 15-foot screened intervals. The groundwater samples will be collected in accordance to the RI/FS (ABB-ES, 1993b) developed for NCBC Gulfport. Monitoring well GPT-2-3 will be resampled as well because of the TCDD results obtained during basewide sampling (ABB-ES, 1995f). All groundwater samples will be analyzed for a full Appendix IX suite (USEPA, 1994a).

The seep samples will be collected from previously identified locations (Figure 3-3) on the downgradient sides of Sites 4 and 5. The collection of seep samples will be impacted by precipitation patterns. Extended dry periods will cause some of the seeps to go dry. Seep sample collection may need to be performed when environmental conditions are optimum. Descriptions of the location and character of each seep sample will be performed in the field.

Collection of seep samples will be performed using a peristaltic pump and Teflon™ tubing. The collected seep will be directly transferred to the sample jars with-

out filtration. For seeps that have low-flow rates, a small basin may be excavated and allowed to fill with seep fluids. The basin should be allowed to stay open for 24 hours before sampling to minimize sediment in the sample.

3.4 FIELD DECONTAMINATION PROCEDURES. Where possible, the field crew will transport sufficient equipment so that the entire study can be conducted without the need for field decontamination. However, when this is not possible, the following field decontamination procedures described below will be followed (ABB-ES, 1993b).

Teflon™, stainless-steel, or glass sampling equipment will be used to collect the samples and will be decontaminated between sample locations as listed below.

1. Wash and scrub equipment with laboratory detergent and tap or deionized water.
2. Rinse thoroughly with organic-free deionized water.
3. Rinse twice with non-polar solvent (pesticide-grade isopropanol). This is especially important when sampling for dioxin because dioxin is not soluble in water.
4. Rinse with organic-free deionized water and allow to air dry for as long as possible.

3.5 CONTROL AND DISPOSAL OF INVESTIGATIVE-DERIVED WASTE. The investigative-derived waste (IDW) will be segregated by medium and stored in 55-gallon drums. Labels will be attached to the drums that describe the content of the specific container (soil or water) and the date of generation. The drums will then be placed on pallets.

Personal protective equipment and other disposable items (Visqueen™, disposable equipment, etc.) will be washed and scrubbed to remove debris, double bagged, and disposed in NCBC waste containers.

At the end of the field investigation, the IDW will be characterized by sampling the waste for toxicity characteristic leachate procedure dioxin. The storage containers will then be labeled as non-hazardous, solid waste, or hazardous waste based on these results.

The laboratory results will be used to determine the final disposition of the containerized IDW. A copy of the laboratory analytical reports will be stored onbase so that comparisons of the results and IDW classification and disposition can be made.

3.6 HEALTH AND SAFETY PLAN. This field investigation will utilize the Health and Safety Plan developed for the RI/FS (ABB-ES, 1993b) for NCBC Gulfport.



4.0 ANALYTICAL PROGRAM

This chapter outlines the analytical program for chemical and geotechnical data to be collected during onsite delineation activities at the NCBC. The analytical program includes the development of data quality objectives (DQOs) for the program; identification of laboratory methodology for sample analyses; procedures for data assessment, including data validation procedures; and procedures for data management. All procedures and methodology included in this analytical program are consistent with those outlined in the RI/FS study SAP for NCBC Gulfport (ABB-ES, 1993b).

4.1 LABORATORY ANALYSIS. As discussed in Chapter 3.0, environmental samples will be collected from four types of media: soil, groundwater, surface water, and sediment. Samples will be collected for chemical and/or geotechnical analyses. The following subsections identify analytical methods to be followed for each type of sample analysis to be performed.

4.1.1 Chemical Analyses Grab samples collected from each environmental medium, along with associated quality control (QC) samples, will be analyzed for chlorinated herbicide compounds, polychlorinated dibenzo-p-dioxins, and polychlorinated dibenzofurans. All soil and sediment samples will be analyzed for TOC. In addition, groundwater samples will be analyzed for a full Appendix IX (USEPA, 1994a) suite of analytes.

Chemical analysis for the chlorinated herbicides will be in accordance with USEPA SW-846 Method 8150 (USEPA, 1986b). Chemical analysis for polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans will be in accordance with USEPA SW-846 Method 8290 (USEPA, 1986b). TOC analyses will be performed according to USEPA SW-846 Method 9060. Holding times and preservation requirements associated with each of these analytical methods are presented in Table 4-1.

4.1.2 Geotechnical Analyses Surface water samples collected in support of onsite remediation activities will be analyzed for total dissolved solids (TDS), total suspended solids (TSS), dissolved oxygen (DO), and oxidation/reduction potential (ORP). TDS and TSS will be analyzed in accordance with USEPA Methods 160.1 and 160.2, respectively (USEPA, 1983). DO will be analyzed in the field using a YSI-55 DO meter. ORP will also be analyzed in the field using an Orion 250A meter and ORP probe.

Sediment samples collected in support of onsite remediation activities will be analyzed for the following: sieve analysis by American Society for Testing and Materials (ASTM) Method D-421, hydrometer analysis by ASTM Method D-422, Atterberg limits by ASTM Method D-4318, bulk density by ASTM Method E12-70, cation exchange capacity by USEPA SW-846 Method 9081, and pH by USEPA SW-846 Method 150.1. (ASTM, 1985; USEPA, 1986b). Holding times and preservation requirements associated with these analytical methods are presented in Table 4-1.

4.2 DQOs. DQOs for the analytical program were developed to provide data of sufficient quality to support decisions associated with site conditions. The USEPA has defined five DQO levels that correspond to the intended uses of the analytical data (USEPA, 1994b). Tasks for onsite delineation activities at NCBC

**Table 4-1
Summary of Holding Time and Preservation Requirements**

Onsite Delineation Workplan
Naval Construction Battalion Center
Gulfport, Mississippi

Chemical Parameter	Preservation	Holding Time (from date of sample collection)	
		Soil and Sediment	Groundwater and Surface Water
Volatile organic compounds	Cool, 4°C 4 drops concentrated HCl	--	14 days
Extractable organics	Cool, 4°C	--	7 days extraction 40 days analysis
Organophosphorus pesticides	Cool, 4°C	--	7 days extraction 40 days analysis
Organochlorine pesticides and PCBs	Cool, 4°C	--	7 days extraction 40 days analysis
Chlorinated herbicides	Cool, 4°C	14 days extraction 40 days analysis	7 days extraction 40 days analysis
Dioxins and furans	Cool, 4°C	30 days extraction 45 days analysis	30 days extraction 45 days analysis
Metals (other than mercury)	Cool, 4°C HNO ₃ to pH <2	--	180 days
Mercury (CVAA)	Cool, 4°C HNO ₃ to pH <2	--	180 days
Selenium (GFAA)	Cool, 4°C HNO ₃ to pH <2	--	6 months
Thallium (GFAA)	Cool, 4°C HNO ₃ to pH <2	--	6 months
Lead (GFAA)	Cool, 4°C HNO ₃ to pH <2	--	6 months
Total organic carbon	Cool, 4°C H ₂ SO ₄ to pH <2	28 days	--
Total dissolved solids	Cool, 4°C	--	7 days
Total suspended solids	Cool, 4°C	--	7 days
Dissolved oxygen	None	--	Immediately upon collection
Oxidation/reduction potential	None	--	Immediately upon collection
Sieve analysis	None	None	--
Hydrometer analysis	None	None	--
Atterberg limits	None	None	--
Bulk density	None	None	--
Cation exchange capacity	None	None	--
Soil pH	None	Immediately	--
Notes:	°C = degrees Celsius. HCl = hydrochloric acid. HNO ₃ = nitric acid. CVAA = cold vapor atomic adsorption. H ₂ SO ₄ = sulfuric acid.	-- = no data. PCB = polychlorinated biphenyl. < = less than. GFAA = graphite furnace atomic adsorption.	

Gulfport will involve data collection with DQOs ranging from USEPA Level I to Level V. Level I data to be collected will provide qualitative information regarding air quality (for health and safety purposes) and aquifer stabilization during well purging. Level III data to be collected will provide quantitative information used to characterize site conditions, but do not require data validation. Level IV data collected will provide the highest quality of analytical information used to characterize site conditions and support risk assessment activities. Level IV data are required to be validated according to USEPA guidelines. Level V data collected will provide information used to evaluate remedial alternatives and support engineering design. Table 4-2 summarizes the DQO levels for each type of data that will be collected during field activities and lists the current and potential future uses associated with each data set.

**Table 4-2
Summary of Data Quality Levels, Analyses, and Data Uses**

Onsite Delineation Workplan
Naval Construction Battalion Center
Gulfport, Mississippi

DQO Level	NEESA DQO Level	Type of Analysis	Data Uses in RFI	Validation
I	--	Organic vapor screening pH Conductivity Temperature	Health and safety monitoring Qualitative site characterization Well development and groundwater sampling	Not required
III	C	TOC analyses	Indicator parameter for dioxin Site characterization Evaluation of remedial alternatives Engineering design	Not required
IV	D	Chlorinated herbicide analyses Dioxin/furan analyses	Site characterization Risk assessment Evaluation of remedial alternatives Engineering design	Yes
V	E	Geotechnical analyses	Evaluation of remedial alternatives Engineering design	Not required

Notes: DQO = data quality objective.
NEESA = Naval Energy and Environmental Support Activity.
RFI = Resource Conservation and Recovery Act Facility Investigation.
-- = no data.
TOC = total organic carbon.

NEESA has adopted QC levels for sample collection, analysis, and data validation that, when followed, provide data of sufficient quality to meet required DQOs (NEESA, 1988). NEESA QC levels C, D, and E correspond to USEPA DQO levels III, IV, and V, respectively (USEPA, 1994b). In order to meet the required DQOs, investigative samples will be collected and analyzed in accordance with NEESA guidance using standard USEPA-accepted techniques and protocols. As presented in Section 4.1, only USEPA-accepted analytical methods were selected for Level III and Level IV sample analyses. In addition to selecting the appropriate

sampling and analysis protocols, certain QC samples must be collected during sampling activities to meet the required DQOs. A brief description of QC samples and frequency of collection is presented below. Selected definitions were obtained from USEPA Region IV Standard Operating Procedures (USEPA, 1991a) and NEESA guidance (NEESA, 1988).

Field Duplicate Samples. Field duplicate samples are two or more samples collected simultaneously into separate containers from the same source under identical conditions. Analytical data generated from the collection and analysis of field duplicate samples are intended to assess the homogeneity of the sampled media and the precision of the sampling protocol. Field duplicate samples will be collected at a frequency of 10 percent per sample matrix for Level III and Level IV analyses. Field duplicate samples will be collected at a frequency of 5 percent per sample matrix for Level V analyses.

Matrix Spike and Matrix Spike Duplicate (MS/MSD) Samples. MS/MSD samples are additional samples collected in the field from a single sampling location. Analytical data generated from the collection and analysis of MS/MSD samples are intended to assess the precision and accuracy of laboratory procedures. One set of MS/MSD samples will be collected at a frequency of 5 percent per sample matrix for Level IV analyses. Collection of MS/MSD samples for Level III and Level V analyses are not required. However, in accordance with laboratory methodology, laboratory precision and accuracy for Level III analyses will be measured using internal QC procedures.

Equipment Rinsate Blanks. Equipment rinsate blanks are collected by running deionized, organic-free water over and/or through sample collection equipment after it has been decontaminated. Analytical data generated from the collection and analysis of equipment rinsate blanks are used to assess the quality of decontamination procedures and to monitor potential cross-contamination that impacts the representativeness of the investigative data set. Rinsate blanks must be analyzed for the same parameters associated with Level III and IV data.

Equipment rinsate blanks will be collected at a frequency of one every other day per type of sampling tool used. This frequency was modified from the frequency stated in NEESA guidance. NEESA guidance requires that rinsate samples be collected daily, but analysis is only required on every other rinsate collected. If analytical results for blanks indicate the presence of site-related contaminants, then all rinsate samples collected must be analyzed. However, this approach is not feasible because the turn around time for sample results rarely provides enough time to extract archived samples before holding times are exceeded. The modified approach to rinsate collection has been accepted by USEPA and SOUTHNAVFACENCOM and is considered standard protocol.

Source Water Blanks. Source water blanks include a complete set of samples collected from each water source used in the investigation. Analytical data generated from the collection and analysis of equipment rinsate blanks should account for potential artifacts that could be introduced through decontamination, which impacts the representativeness of the investigative data set. One set of samples from each water source will be collected at the beginning of each sampling event. Source water blanks must be analyzed for the same parameters associated with Level III and IV data.

4.3 DATA QUALITY ASSESSMENT. DQOs are based on the premise that different data uses require different levels of data quality. Data quality refers to the degree of uncertainty with respect to precision, accuracy, representativeness, completeness, and comparability (PARCC). NEESA outlines data set deliverable requirements for each DQO level (NEESA, 1988). Based on the intended use of the Level III and Level V data to be collected during onsite delineation activities, laboratory deliverables will be reviewed by the project chemist for adherence to the specified analytical method, data completeness, and precision. Data precision for Level III and Level V data will be measured by evaluating field duplicate sample results and laboratory QC results, if applicable. To meet Level IV DQOs for this project, Level IV laboratory data must be validated according the USEPA guidelines and assessed to determine the validity of the data set. The following subsections discuss the data validation procedures to be followed for Level IV data and define the data quality indicators that are required to be assessed.

4.3.1 Level IV Data Validation Validation of data is a systematic process of reviewing a body of data to provide assurance that the data are adequate for their intended uses. The useability of Level IV data generated during this investigation will be determined by evaluating the data against criteria and procedures established by the USEPA, NEESA, and method-specific QA/QC guidance. In general, USEPA and NEESA guidelines provide a systematic procedure for evaluating laboratory QA/QC measures such as holding times, blank analyses, surrogate recoveries, MS/MSD results, instrument calibration, compound identification, and method performance.

Upon receipt, Level IV data packages will be validated according to USEPA Level IV (NEESA Level D QC criteria) and QA/QC criteria specified by each analytical method. These criteria are described in Subsection 7.3.1 of NEESA Document 20.2-047B (NEESA, 1988). The USEPA *National Functional Guidelines for Organic Data Review* (USEPA, 1991b) will also be used, where applicable, to validate the laboratory data. Validated data will be prepared in three initial formats: raw laboratory data, data marked with validation qualifiers or annotations, and corrected or validated data. The validated data can then be used for site contaminant characterization and assessment.

4.3.2 PARCC Parameter Evaluation The acceptance criteria for PARCC parameters for Level IV DQOs outlined in this subsection are consistent with the QC requirements of the USEPA SW-846 analytical methods chosen and USEPA guidelines for data review.

Precision. Precision is defined as the agreement among individual measurements of the same chemical constituent in a sample, obtained under similar conditions. Precision objectives for analysis of site samples will be measured using field duplicate samples (including matrix spike duplicates). Acceptance criteria for field duplicate precision for Level IV DQOs have been set at 30 and 50 for aqueous and solid analyses, respectively. Acceptance criteria for laboratory duplicate precision for Level IV DQOs have been set at 20 and 35 for aqueous and solid analyses, respectively.

The precision criteria to be used for matrix spike duplicates are compound-specific and will be consistent with the QC requirements of the USEPA SW-846 methods chosen. Precision will be shown as a relative percent difference (RPD) where

$$RPD = |X1 - X2| / \frac{X1 + X2}{2} * 100 \quad (1)$$

where:

RPD = relative percent difference between results

X1 and X2 = results of duplicate analysis

|X1 - X2| = absolute difference between duplicates X1 and X2.

Precision objectives apply to both field and laboratory duplicates. However, field duplicates based on the analytical results take into account the level of error introduced by field sampling techniques, field conditions, and analytical variability. The RPD of all laboratory duplicates will be reported by the laboratory, and the RPD of field duplicates will be calculated to evaluate the sample precision.

Accuracy. Accuracy is defined as the degree to which the analytical measurement reflects the true concentration level present. Accuracy will be measured as percentage recovery for matrix spikes as the primary QC criterion and percentage recovery of surrogate spikes as a secondary QC criterion. The acceptance criteria for data meeting Level IV DQOs will be designated by the laboratory based on their historical performance for each analytical method used and method-specific QC criteria.

A matrix spike is a sample (of a particular matrix) to which predetermined quantities of standard solutions of certain target analytes are added prior to sample extraction and/or digestion and analysis. Samples are split into replicates, one replicate is spiked, and both aliquots are analyzed.

Accuracy can also be evaluated using the recovery of surrogate spikes in the organic analyses. These spikes consist of organic compounds that are similar to analytes of interest in chemical composition, extraction, and chromatography, but which are not normally found in environmental samples. These compounds are spiked into all blanks, standards, and samples prior to analysis.

Percentage recoveries of the surrogate and matrix spikes will be reported by the laboratory for all analyses with the samples. The percentage recovery of the spikes can be calculated from the following equation:

$$\text{Percentage recovery} = (X - B) / T * 100 \quad (2)$$

where:

X = measured amount in sample after spiking

B = background amount in sample

T = amount of spike added.

Representativeness. Representativeness expresses the degree to which sample data depict an existing environmental condition. Representativeness is accomplished through proper selection of sampling locations and sampling techniques and collection of a sufficient number of samples. The sampling locations for this investigation will be chosen in a biased approach based on previous analytical data, screening data collected in the field, and apparent and measured flow directions.

Sampling and analytical protocols were chosen so that measurements of samples will be as representative of the media and conditions being measured as possible. Sample collection, handling, and documentation will be performed in accordance with USEPA Region IV Standard Operating Procedures (USEPA, 1991a) to ensure that collection and handling techniques do not alter the sample and to provide an adequate tracking mechanism from the time of collection through laboratory analysis.

The collection and analysis of field blanks, trip blanks, and equipment rinsate blanks and conformance with requirements for analytical methods, such as extraction and analysis holding times, and analysis of method blanks will also be used to ensure representativeness of sample data.

Completeness. Completeness is a measure of the amount of valid data obtained compared to the amount of data originally intended to be obtained. The completeness goal for DQO Levels III, IV, and V has been chosen as 95 percent.

Comparability. Comparability reflects the confidence with which one data set can be compared with other measurements and the expression of results consistent with other organizations reporting similar data. In general, comparability can be determined by comparing data from replicate split samples that are analyzed by two separate contract laboratories. However, for this investigation, analysis of split samples is not required. Comparability for this investigation will be accomplished through the use of standard, USEPA-approved techniques and procedures for sample collection, handling, analysis, validation, and reporting.

4.4 DATA MANAGEMENT. Three broad categories make up data management: laboratory data management, sample data management, and field data management. Laboratory data management consists of storing, retrieving, editing, validating, and reporting the results of the laboratory chemical analyses. Sample data management consists of tracking the origin, location, and status of a set of chemical data obtained from the analysis of an environmental sample. Field data management consists of storing, retrieving, and reporting the results of measurements taken in the field.

Laboratory data management begins with receipt of invalidated data (one hard copy and one electronic copy) from the laboratory. The laboratory data manager later receives validated data from the data validator. One hard copy of all chemical data is kept in-house in a locked file cabinet to allow access to the raw data. A second hard copy of the invalidated data is stored offsite. Upon receipt of the validated data, the laboratory data manager uploads the electronic copy into a secure database. Data in the database are backed up daily and the backups are stored for 2 weeks in a fire-safe vault. At the conclusion of the project, the laboratory data manager archives the electronic data and moves the in-house copy of the invalidated data to a storage site separate from the first storage site. This minimizes the risk of catastrophic data loss.

Sample management begins upon creation of the sample. The sample data manager tracks the life cycle of each sample and uses milestones in the life cycle as reference points to judge the status of individual samples. Milestones include sample collection, sample receipt by the laboratory, invalidated sample data receipt, and validated sample receipt, as well as various steps in the process needed to confirm the quality of the electronic data. As each milestone is

achieved, the sample data manager records the achievement in a sample data management database. This database is a secure database backed up daily on a 14-day cycle. The backup is stored in a fire-safe vault for 2 weeks. At the conclusion of the project, the sample data manager archives the database and makes two copies to store in separate storage facilities.

Field data management procedures vary depending on the type of data collected. In all cases, two hard copies of the data exist. One copy resides in the field office, and one copy resides in the home office. Where appropriate, electronic field data also exist. The main objectives of the field data manager are to store the field data and to ensure the integrity of any reproductions of the field data. When the project is completed, the field data manager ensures that two correct copies of all field data exist. The field data manager stores each copy in a separate storage facility.



5.0 DATA EVALUATION AND INTERPRETATION

5.1 DATA EVALUATION. Data evaluation is the process of organizing validated data into a working format and then reviewing it to confirm that project DQOs have been met. Data quality indicators of representativeness and completeness are measured to evaluate conformance to the DQOs.

5.2 DATA INTERPRETATION. Data interpretation is the process of reviewing the validated data and identifying the presence or absence of site-related chemical compounds in environmental samples collected during the investigation. In this investigation, the data interpretation process will be extended to incorporate elements of the baseline risk assessment and engineering evaluation to guide the sample collection process in the Phase II investigation. A summary report of the Phase I analytical results will present the data in graphical and tabular form and make recommendations for Phase II sampling. This summary report will present the technical justification for continuing with Phase II samples.

5.3 PHASE I SUMMARY REPORT. The technical evaluation of Phase I results and recommendations regarding Phase II actions will be provided in the Phase I Summary Report. Included in this report are a graphical interpretation of TOC as an indicator parameter, isoconcentration maps showing the approximate lines of delineation, and a cost analysis, which compares the cost of additional samples versus just remediating areas that are not as well defined. Additionally, justification for additional samples must also meet one of the following criteria: needs of the requirements of the AO, samples required for engineering evaluation, or samples required for baseline risk assessment. The sample logic diagrams in Chapter 2.0 provide the basis for this analysis and the decision points for Phase II samples.

6.0 PROJECT SEQUENCE

6.1 PROJECT SEQUENCE. Activities related to the Onsite Delineation Workplan follow both parallel and sequential tracks with other activities to reach project objectives. A schedule depicting these activities is shown on Figure 6-1. The Onsite and Offsite Delineation Workplan activities will be staggered to allow parallel completion of both.

6.1.1 Review and Approval of the Onsite Delineation Workplan The draft Onsite Delineation Workplan will be delivered to the regulatory agency, MSDEQ, for review and approval. Review comments will be addressed in the final Onsite Delineation Workplan. The workplan becomes final after the MSDEQ comments are addressed.

6.1.2 Contract Award The contract award process will include the preparation of a plan of action, which will be the basis for contract negotiations. When contract negotiations have been completed, a notice to proceed will be issued that will allow preliminary activities to begin.

6.1.3 Preliminary Activities Mobilization tasks must be completed, prior to the initiation of field activities, to ensure efficient field sampling events. The project team will prepare specifications to initiate procurement of subcontractors and vendors for specialized services and equipment. Anticipated items for procurement include a drilling contractor, analytical laboratory, and surveying contractor. Standard items for mobilization will be through the contractor's program office with individual specialized items being coordinated through the field operations leader and task order manager.

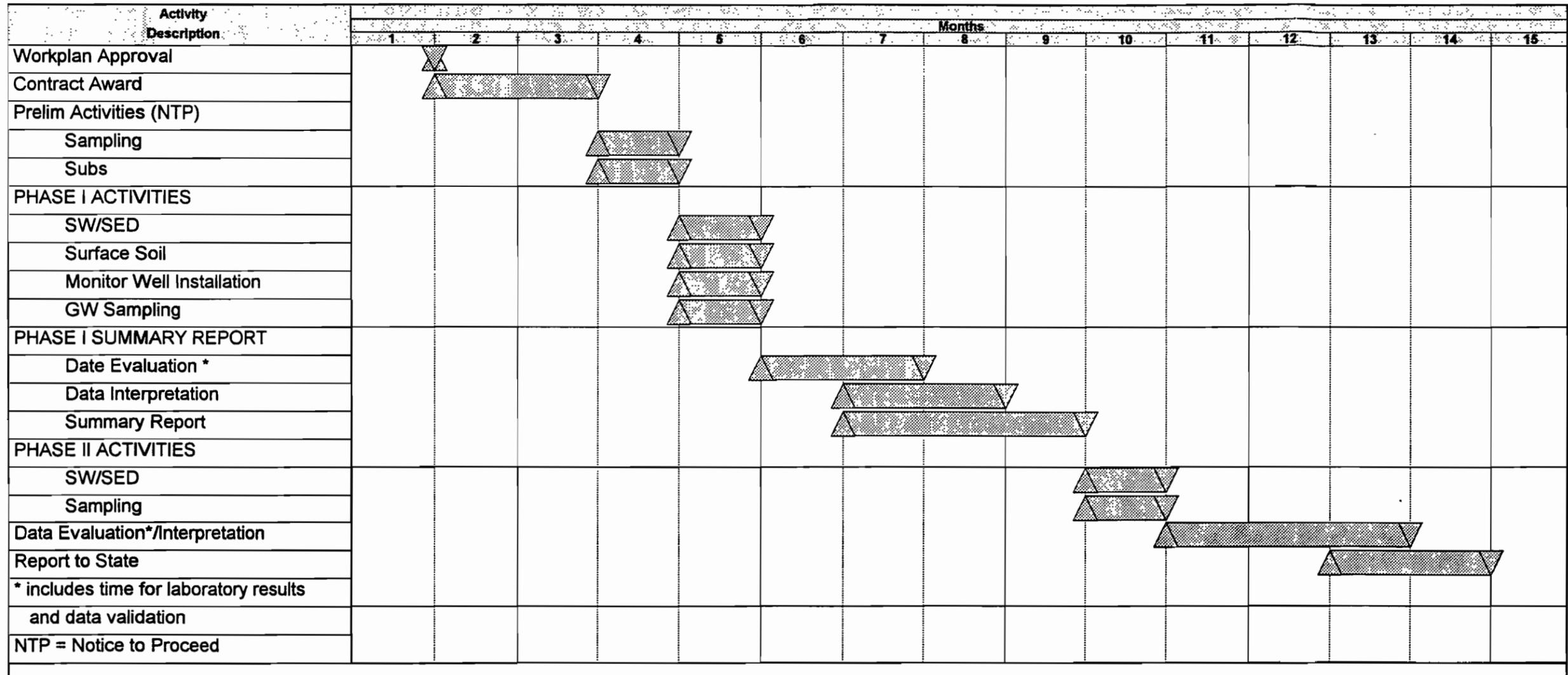
6.1.4 Phase I Activities Phase I activities include surface water and sediment sampling throughout the base drainage system; surface soil sampling at Site 8; and monitoring well installation, groundwater sampling, and seep collection at Sites 4 and 5. The sample collection in Phase I is at locations identified through the conceptual model process and will be followed by a Phase I summary report.

6.1.5 Phase I Summary Report The summary report following the Phase I sampling activities will provide an evaluation of horizontal and vertical delineation activities performed in Phase I. This evaluation will include a data evaluation (validation and useability), data interpretation, and the preparation of the Summary Report. The Summary Report will make recommendations for Phase II activities.

6.1.6 Phase II Activities Phase II activities will follow the Phase I Summary Report. Based on the recommendations of the Summary Report, Phase II activities may be performed to meet engineering requirements or the needs of the AO.

6.1.7 Onsite Delineation Report The Onsite Delineation Report will present the results and findings from both phases of the field activities. A comparison of the requirements of the AO and the results of the field investigations will be provided to demonstrate compliance with the AO.

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Project Start 01 May 1996
 Project Finish 01 May 1996
 Data Date 26 April 1996
 Plot Date

**FIGURE 6-1
SCHEDULE**



ONSITE DELINEATION
 WORKPLAN
 NAVAL CONSTRUCTION
 BATTALION CENTER
 GULFPORT, MISSISSIPPI

REFERENCES



REFERENCES

- ABB Environmental Services, Inc. (ABB-ES), 1993a, MILCON Construction Site Assessment, Project P-745, Technical Memorandum, Naval Construction Battalion Center, Gulfport, Mississippi: prepared for Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM), Task Order No. 096, Contract No. N62467-89-D-0317, September.
- ABB-ES, 1993b, Remedial Investigation and Feasibility Sampling and Analysis Plan, Vols. I. and II, Naval Construction Battalion Center, Gulfport, Mississippi: prepared for SOUTHNAVFACENGCOM, Task Order No. 096, Contract No. N62467-89-D-0317.
- ABB-ES, 1994, Technical Memorandum No. 1, Former Herbicide Orange Storage Area, Gulfport, Mississippi: prepared for SOUTHNAVFACENGCOM, Task Order No. 092, Contract No. N62467-89-D-0317.
- ABB-ES, 1995a, Technical Memorandum No. 2, Former Herbicide Orange Storage Area, Gulfport, Mississippi: prepared for SOUTHNAVFACENGCOM, Task Order No. 092, Contract No. N62467-89-D-0317.
- ABB-ES, 1995b, Technical Memorandum No. 3, Former Herbicide Orange Storage Area, Gulfport, Mississippi: prepared for SOUTHNAVFACENGCOM, Task Order No. 092, Contract No. N62467-89-D-0317.
- ABB-ES, 1995c, Technical Memorandum No. 4, Former Herbicide Orange Storage Area, Gulfport, Mississippi: prepared for SOUTHNAVFACENGCOM, Task Order No. 092, Contract No. N62467-89-D-0317.
- ABB-ES, 1995d, Technical Memorandum No. 5, Former Herbicide Orange Storage Area, Gulfport, Mississippi: prepared for SOUTHNAVFACENGCOM, Task Order No. 092, Contract No. N62467-89-D-0317.
- ABB-ES, 1995e, Letter Report: Surface Soil Sampling Field Program and Analytical Results for Area A, Former Herbicide Orange Storage Area, Naval Construction Battalion Center (NCBC), Gulfport, Mississippi: prepared for SOUTHNAVFACENGCOM, Task Order No. 092, Contract No. N62467-89-D-0317.
- ABB-ES, 1995f, Letter Report: Basewide Groundwater, Sediment and Surface Water Study, Naval Construction Battalion Center, Gulfport, Mississippi: prepared for SOUTHNAVFACENGCOM, Task Order No. 096, Contract No. N62467-89-D-0317.
- ABB-ES, 1995g, Letter Report: Interim Removal Action - 28th Street Road Construction, NCBC, Gulfport, Mississippi: prepared for SOUTHNAVFACENGCOM, Task Order No. 096, Contract No. N62467-89-D-0317.
- ABB-ES, 1995h, Letter Report: Removal Action Technical Support, Contaminated Sediment and Surface Soil and Analytical Results in 28th Street Roadway, NCBC, Gulfport, Mississippi: prepared for SOUTHNAVFACENGCOM, Task Order No. 096, Contract No. N62467-89-D-0317.

REFERENCES (Continued)

- ABB-ES, 1996a, Technical Memorandum No. 6, Former Herbicide Orange Storage Area, Gulfport, Mississippi: prepared for SOUTHNAVFACENGCOC, Task Order No. 092, Contract No. N62467-89-D-0317.
- ABB-ES, 1996b, Addendum to Delisting Petition, Naval Construction Battalion Center, Gulfport, Mississippi: prepared for SOUTHNAVFACENGCOC, Task Order No. 092, Contract No. N62467-89-D-0317 (in progress).
- ABB-ES, 1996c, Interim Corrective Measures Workplan, Site 8, Former Herbicide Orange Storage Areas, Naval Construction Battalion Center, Gulfport Mississippi: prepared for SOUTHNAVFACENGCOC, Task Order No. 096, Contract No. N62467-89-D-0317 (in progress).
- ABB-ES, 1996d, Letter Report: Soil and Sediment Dioxin Triplicate Study, Naval Construction Battalion Center, Gulfport, Mississippi: prepared for SOUTHNAVFACENGCOC, Contract No. N62467-89-D-0317.
- ASTM, 1985, Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants: D 421-85, September.
- Arienti, M., L. Wilk, M. Jasinski, N. Prominski, 1988, Dioxin-Containing Wastes Treatment Technologies, Pollution Technology review No. 160: published by Noyes Data Corporation, park Ridge, New Jersey, U.S.A.
- EG&G Idaho, Inc., Idaho Falls, Idaho, 1987, Naval Construction Battalion Center Trail Burn Report, June 16.
- EG&G, 1988, Comprehensive Soil Study of Naval Construction Battalion Center, Gulfport, Mississippi.
- Hazardous Waste Remedial Action Program (HAZWRAP), 1991, U.S. Air Force Installation Restoration Program, Summary Report Remedial Characterization and Soil Remediation Technology Review for the Former Herbicide Storage Site at the Naval Construction Battalion Center, Gulfport, Mississippi: prepared for U.S. Air Force/CEVV under contract DE-AC05-84OR21400.
- Mississippi State Department of Environmental Quality (MSDEQ), 1996, Administrative Orders No. 3193-96 and No. 3194-96, February 14.
- Naval Energy and Environmental Support Activity (NEESA), 1985, Ground-water Monitoring Guide, Naval Energy and Environmental Support Activity, NEESA 20.2-031A, Port Hueneme, California.
- NEESA, 1988, Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program, Naval Energy and Environmental Support Activity, NEESA 20.2-47B, Port Hueneme, California.
- Occupational and Environmental Health Laboratory, 1979, Initial Herbicide Orange Monitoring Program.

REFERENCES (Continued)

- U.S. Environmental Protection Agency (USEPA), 1983, Methods for Chemical Analysis of Water and Wastes, 600/4-79-02, March.
- USEPA, 1986a, Research Development and Demonstration permit issued in July.
- USEPA, 1986b, Test Methods for Evaluating Solid Waste, Volume 1B: Laboratory Manual Physical/Chemical Methods, 3rd Edition, Office of Solid Waste and Emergency Response, Washington, DC, November.
- USEPA 1989, Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-dioxins and Dibenzofurans, March.
- USEPA, 1991a, Standard Operating Procedures and Quality Assurance Manual, USEPA Region IV, Environmental Compliance Branch, Environmental Services Division, Athens, Georgia, February.
- USEPA, 1991b, National Functional Guideline for Organic Data Review, Office of Energy and Remedial Response, June.
- USEPA, 1994a, Title 40 CFR, Part 264, Appendix IX, Groundwater Monitoring List: July.
- USEPA, 1994b, Guidance for the Data Quality Objectives Process, EPA QA/G-4, USEPA Quality Assurance Management Staff, Washington, D.C., September.
- Versar, 1990, Ground-Water Monitoring Program Plan, Naval Construction Battalion Center, Gulfport, Mississippi, November 20.