N62604.AR.000557
NCBC GULFPORT
5090.3a

FOCUSED FEASIBILITY STUDY SITE 8 NCBC GULFPORT MS
3/1/2003
TETRA TECH NUS

Focused Feasibility Study

Site 8
Herbicide Orange Storage Area

at

Naval Construction Battalion Center

Gulfport, Mississippi

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0143

March 2003

FOCUSED FEASIBILITY STUDY

SITE 8
HERBICIDE ORANGE STORAGE AREA

NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
Tetra Tech NUS, Inc.
661 Andersen Drive
Foster Plaza 7
Pittsburgh, Pennsylvania 15220

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0143

MARCH 2003

PREPARED UNDER THE SUPERVISION OF:

for ROBERT FISHER
TASK ORDER MANAGER
TETRA TECH NUS, INC.
TALLAHASSEE, FLORIDA

APPROVED FOR SUBMITTAL BY:

DEBBIE WROBLEWSKI
PROGRAM MANAGER
TETRA TECH NUS, INC.
PITTSBURGH, PENNSYLVANIA

FOREWORD

This edition of the Focused FS (FFS) is the second revision since the initial publication of the FFS in December 2001. The revision history of this FFS and rationale for the revisions are presented as follows:

- Rev. 0, Dated December 2001 - First version of the FFS.
- Rev. 1, Dated April 2002 - The FFS was revised to include a preliminary remediation goal developed for off-base deepwater sediment.
- Rev. 2, Dated March 2003 - The FFS was revised to address June 2002 USEPA comments and include information contained in the Human Health Risk Assessment Amendment of Groundwater Associated with Site 8 Former Herbicide Orange Storage Area.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLES

FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

AASHTO	American Association of State Highway Officials
ABB-ES	ABB Environmental Services, Inc.
AFESC	Air Force Engineering and Service Center
AO	Agreed Order
AOC	Area of Contamination
ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society for Testing and Materials
bgs	Below ground surface
BTU	British Thermal Unit
CAA	Clean Air Act
CBR	California Bearing Ratio
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CKD	Cement kiln dust
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	Chemical of concern
COPC	Chemical of potential concern
CTE	Central tedency exposure
CTO	Contract Task Order
°F	Degree Farenheit
DPT	Direct push technology
DRE	Destruction and removal efficiency
FFS	Focused Feasibility Study
ft^2	Square foot/feet
ft^3	Cubic foot/feet
GAC	Granular activated carbon
GRA	General Response Action
HASP	Health and Safety Plan
HLA	Harding Lawson Associates
HO	Herbicide Orange
H20	Highway 20
HpCDD	1,2,3,4,6,7,8-Heptachloro-p-dibenzodioxin
HpCDF	1,2,3,4,6,7,8-Heptachloro-p-dibenzofuran
HxCDD	2,3,4,6,7,8-Hexachloro-p-dibenzodioxin

HxCDF	2,3,4,6,7,8-Hexachloro-p-dibenzofuran
ILCR	Incremental lifetime cancer risk
µg/kg	microgam(s) per kilogram
MDEQ	Mississippi Department of Environmental Quality
NA	not available
Navy	U.S. Department of the Navy
NCBC	Naval Construction Battalion Center
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
ng/kg	nanogram(s) per kilogram
NPW	net present worth
OCDD	Octachloro-p-dibenzodioxin
OCDF	Octachlorodibenzofuran
O&M	operation and maintenance
OSHA	Occupational Safety and Health Act
pcf	pound(s) per cubic foot
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinted biphenyl
PeCDD	2,3,6,7,8-Pentachloro-p-dibenzodioxin
PeCDF	2,3,6,7,8-Pentachloro-p-dibenzofuran
pg/L	Picogram per liter
PPE	personal protection equipment
PRG	Preliminary Remedial Goal
PRSCs	post-removal site controls
psi	pound(s) per square inch
PVC	polyvinyl chloride
RAO	Remedial Action Objective
RBC	Risk Based Concentration
RCRA	Resource Conservation and Recovery Act
RGO	Remedial Goal Option
RME	reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments Reauthorization Act
SOUTHDIVNAVFACENGCOM	Southern Division Naval Facility Engineering Command
SPLP	Synthetic Precipitation Leaching Procedure
SRT	sediment recovery trap
SVOC	semivolatile organic compound
TBC	To Be Considered (criterion)
TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin

TCDF	2,3,7,8-Tetrachloro-p-dibenzofuran
TCLP	Toxicity Characteristics Leaching Procedure (USEPA's)
TPH	total petroleum hydrocarbon
TRG	Target Remediation Goals (MDEQ's)
TtNUS	Tetra Tech NUS, Inc.
UCS	unconfined compressive strength
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
VOC	Volatile organic compound
yd^3	cubic yard(s)

EXECUTIVE SUMMARY

E.1 PURPOSE OF THE REPORT

The purpose of this Focused Feasibility Study (FFS) Report is to develop and evaluate options for the remediation of contaminated soil, soil ash, sediment, and groundwater at the Herbicide Orange Storage Area (Site 8) and associated contiguous Areas of Contamination (AOCs) at the Naval Construction Battalion Center (NCBC) in Gulfport, Mississippi.

E.2 SITE DESCRIPTION AND HISTORY

Site 8 occupies approximately 30 acres in the north-central portion of the NCBC. Prior to 1968, Site 8 was used for equipment storage and staging. Between 1968 and 1977, the site was used for the storage and handling of Herbicide Orange (HO). HO is a herbicide formulation used during the Vietnam war to defoliate trees and shrubbery. It is an equal mix of two agricultural herbicides (2,4,5-T and 2,4-D) in diesel fuel or jet fuel. HO is also known as “Agent Orange,” a code name for the orange band that was used to mark the drums used to store the herbicide mix. In 1977, the HO was removed from the site and incinerated off-site, after which the site was fenced in and left inactive.

Site 8 was divided into three areas (A, B, and C), based on the level of storage of HO, with Area 8A continually in use while Areas 8B and 8C were periodically used as overflow storage areas. Area 8A covers approximately 13 acres and Areas 8B and 8C cover approximately 17 and 1 acres, respectively. Area 8A includes the upper reaches of the surface drainage system for the eastern two-thirds of NCBC Gulfport, which exits the base at Outfall 3 into a swampy area that is part of the Turkey Creek basin. Areas 8B and 8C also include the upper reaches of local drainage systems, with the Area 8B system exiting the base at Outfall 4 and the Area 8C system exiting the base at Outfall 2 into Brickyard Creek.

Spills and leaks of HO occurred at all three areas of Site 8, contaminating the surface soil and sediment with the mixture components, 2,4,5-T and 2,4-D; as well as the byproduct contaminants (dioxins and furans), primarily 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). From 1985 to 1987, Site 8 soil and sediment containing in excess of 1.0 microgram per kilogram (μg/kg) TCDD were excavated and incinerated on-site with the ash being stockpiled on Area 8A. This remedial action did not include soil and sediment from the associated drainage systems.

Between 1987 and January 2001, access to Site 8A was restricted and operations were not conducted within site boundaries. Since January 2001, activities conducted within Site 8A include the construction of a new loading ramp and the performance of a pilot-scale treatability study for remediating HO-impacted soil ash and on-base and off-base sediment (activities outlined in Alternative 3 of this FFS). In August 2002, the Navy performed a sediment removal action in the drainage ditches of Sites 8B and 8C. The excavated sediments were transported to Site 8A.

In February 2000, the Air Force and the Navy proposed to clean up the off-base dioxin-contaminated areas under the Mississippi Brownfields Program. Under this program, the contaminated properties would be remediated under program levels that are protective of human health and the environment. This action would allow these off-base areas to be developed expediently as a light industrial complex and be put to productive use. The Brownfields program also provides owners of the contaminated properties protection from future state litigation.

Several environmental investigations were performed at Site 8, starting with the Initial HO Monitoring Programs from 1977 to 1984 through the Dioxin Delineation Studies from 1995 to 2000. These investigations showed that significant areas of surface soil and sediment at Site 8 and associated surface drainage systems were contaminated with TCDD, but that this contamination did not extend beyond a depth of 2 feet below ground surface (bgs) and had not migrated to either the surface water or groundwater.

E.3 SUMMARY OF THE INVESTIGATIONS FINDINGS

Early investigations (pre-1995) have identified 2,4-D; 2,4,5-T; and the 2,3,7,8-substituted dioxins and furans (hereafter referred to as “dioxins”) in media related to the storage and handling of HO at Site 8. More recent investigations (post-1995) have confirmed the earlier levels of 2,3,7,8-substitiuted dioxins and furans, but have not produced results with measurable 2,4-D or 2,4,5-T. These observations have been attributed to the persistence (low volatility, resistance to chemical breakdown) of dioxins and furans in the environment. However, the results of herbicide analyses have confirmed the chemical breakdown of 2,4-D and 2,4,5-T below detectable limits. The results of hundreds of other analyses [volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), total petroleum hydrocarbons (TPH), pesticides and polychlorinated biphenyls (PCBs)] from all potentially impacted media have consistently confirmed historical data; that HO and its related contaminants were the only hazardous material present at Site 8 and related ditch systems.

A human health risk assessment performed as part of recent investigations showed that unacceptable incremental lifetime cancer risks (ILCRs) were associated with exposure to Site 8 soil, sediment, and groundwater, and identified dioxin as the only chemical of concern (COC) responsible for these unacceptable risks.

Comprehensive ecological investigations did not detect any chemical at concentrations high enough to be considered of potential concern.

E.4 REMEDIAL ACTION OBJECTIVES, PRELIMINARY REMEDIAL ACTION GOALS, AND VOLUME OF CONTAMINATED GROUNDWATER

The Remedial Action Objectives (RAOs) identified for the Site 8 soil and sediment are as follows:

RAO 1: Protect human health from the carcinogenic and noncarcinogenic risks associated with incidental ingestion of, inhalation of, and dermal contact with contaminated surface soil and sediment.

RAO2: Protect human health from the carcinogenic risks associated with ingestion and dermal contact with on-site and off-site groundwater.

RAO 3: Comply with Federal and State applicable or relevant and appropriate requirements (ARARs) and To-Be-Considered (TBCs) guidance criteria in accordance with accepted United States Environmental Protection Agency (USEPA) and Mississippi Department of Environmental Quality (MDEQ) guidelines.

The Preliminary Remedial Action Goals (PRGs) for dioxin in the Site 8 soil and sediment can be summarized as follows:

Area & Medium	PRG
Site 8 Surface Soil	38 ng/kg
Non-Site 8 (on-base) Surface Soil	38 ng/kg
Off-Base Soil	5 ng/kg
Sediment (shallow water) - on base	38 ng/kg
Sediment (deep water) - off base	1,000 ng/kg
Groundwater - on and off base	30 pg/L

The total volume of incinerated soil ash, soil, and sediment contaminated in excess of PRGs is estimated at approximately 71,000 cubic yards (yd^3), which can be broken down as follows:

Material	Estimated Volume (yd^3)
Area 8A Incinerated Soil Ash	21,000
On-Base Ditches Contaminated Sediment	24,000
Off-Base Swampland Contaminated Sediment	26,000
Total	**71,000**

E.5 SCREENING OF GENERAL RESPONSE ACTIONS, REMEDIATION TECHNOLOGIES, AND PROCESS OPTIONS

General Response Actions (GRAs) and associated technologies and processes were screened for effectiveness, implementability, and cost. Technologies that were determined to be ineffective or too difficult to implement were eliminated from further consideration. The following GRAs, remediation technologies, and process options were retained to develop soil, soil ash, and sediment remedial alternatives for Site 8:

GRA	Remediaton Technology	Process Options
No Action	None	Not Applicable
Limited Action	Institutional Controls	Access Restrictions (fencing) and post-removal site controls (PRSCs)
	Monitoring	Sampling and Analysis
Containment	Capping	In-Situ or Ex-Situ Permeable or Impervious Cover System
	Surface Water Controls	Vertical Barriers, Site Grading, Storm Water Management
Removal	Mechanical Removal	Excavation and Dredging
Ex-situ Treatment	Physical	Dewatering
	Chemical	Stabilization/Fixation
	Thermal	Incineration, Pyrolysis
Discharge/Disposal	Landfilling	On-Base Landfilling
		Off-Base Landfilling

Remedial alternatives were not developed to directly address groundwater; however, remedial actions taken to address soil, soil ash, and sediment contamination are expected to indirectly address dioxin impacts to groundwater.

E.6 DEVELOPMENT OF REMEDIAL ALTERNATIVES

The following remedial alternatives were developed for Site 8:

- **Alternative 1: No Action**. No action would be taken. Retained as a baseline for comparison with other alternatives.

- **Alternative 2: Institutional Controls and Monitoring**. Institutional controls would consist of restricting site access and controlling site development through development and implementation of post-removal site controls (PRSCs). Monitoring would consist of regularly collecting and analyzing soil, sediment, and groundwater samples to assess possible natural attenuation and detect potential contaminant migration.

- **Alternative 3: Excavation, Surface Water Controls, Dewatering, Chemical Stabilization, On-Base Landfilling, Capping, Institutional Controls, and Monitoring**. A total of approximately 71,000 yd^3 of soil ash, soil, and sediment would be excavated from Area 8A, on-base surface drainage ditches and off-base swampland. Sheet piling and pumping would be used to divert surface water from areas of sediment excavation and silt screens would be installed to minimize contaminated sediment migration. Wet sediment would be dewatered through static stockpiling. The mixture of soil ash, soil, and dewatered sediment would be spread in four lifts, each approximately 10-inch thick, over Area 8A. Each lift would be chemically stabilized with Portland Cement. The stabilized material would then be covered with a rigid pavement cap designed in accordance with MDEQ regulations and the American Association of State Highway Officials (AASHTO) Highway 20 (H20) specifications. The Institutional controls component of Alternative 3 would be identical to that for Alternative 2. Monitoring would consist of regularly collecting groundwater samples from monitoring wells located downgradient from the landfill to detect any potential migration of dioxin.

- **Alternative 4: Excavation, Surface Water Controls, Dewatering, and Off-Base Incineration**. The excavation, surface water controls, and dewatering of Alternative 4 would be identical to those for Alternative 3. The soil ash, soil, and dewatered sediment would then be transported to a permitted off-base treatment storage and disposal facility (TSDF) for high-temperature incineration and disposal of incineration residues.

E.7 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

The remedial alternatives were analyzed in detail using seven of the nine criteria provided in the USEPA's National Oil and Hazardous Substance Pollution Contingency Plan (NCP) and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). These seven criteria are as follows:

- Overall Protection of Human Health and the Environment,
- Compliance with ARARs and TBCs guidance criteria,
- Long-term Effectiveness and Permanence,
- Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment,
- Short-term Effectiveness,
- Implementability, and
- Cost

Two other criteria, State and Community Acceptance were not evaluated in this report. They will be evaluated after regulatory and public comments are available.

E.8 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

The remedial alternatives were compared to each other using the same criteria that were used for detailed analysis. The following is a summary of these comparisons:

- **Overall Protection of Human Health and Environment**

Alternative 1 would not provide protection of human health and the environment because dioxin would remain in soil, soil ash, sediment, and groundwater in excess of PRGs and could result in unacceptable risk to human receptors. Also, under this alternative, no warning would be provided of the potential for the migration of dioxin to continue in sediment, surface water, and groundwater since no monitoring would occur.

Although Alternative 2 would allow dioxin to remain in soil, soil ash, sediment, and groundwater, and possibly continued contaminant migration, it would be protective of human health by restricting access to contaminated media and providing a warning of potential contaminant migration.

Alternative 3 would be more protective than Alternative 2 because it would essentially eliminate the potential for exposure to dioxin by removing and chemically stabilizing contaminated soil, soil ash, and sediment and containing them within an on-base landfill. Alternative 3 would also provide a warning of the unlikely potential migration of dioxin from the landfill. The landfill cap will be used as a storage area for heavy equipment.

Alternative 4 would provide the highest level of protection because it would not only remove contaminated soil, soil ash, and sediment from their present locations but also destroy their dioxin content through high-temperature incineration.

- **Compliance with ARARs and TBCs**

Alternative 1 would not comply with chemical- and location-specific ARARs. Action-specific ARARs or TBCs would not apply.

In the short-term, Alternatives 2 and 3 would not comply with chemical-specific ARARs and TBCs, but these alternatives might eventually achieve compliance as they attain the dioxin PRGs through natural attenuation. Alternatives 2 and 3 would comply with location- and action-specific ARARs and TBCs.

Alternative 4 would comply with chemical-, location-, and action-specific ARARs and TBCs.

- **Long-term Effectiveness and Permanence**

Alternative 1 would have very limited long-term effectiveness and permanence because no contaminant removal or reduction would occur through treatment although, over time, some contaminant reduction might occur through natural attenuation. As there would be no institutional controls to restrict access to areas of contaminated soil, soil ash, sediment, and groundwater, the potential would also exist for unacceptable risk to develop due to exposure to dioxin. Since there would be no monitoring, potential dioxin migration would remain undetected.

Alternative 2 would provide some long-term effectiveness and permanence since it would reduce risk from exposure to contaminated soil, soil ash, sediment, and groundwater, and would warn of potential dioxin migration while natural attenuation might eventually reduce dioxin concentrations down to the PRGs.

Alternative 3 would be more long-term effective and permanent than Alternative 2 because it would remove contaminated soil, soil ash, and sediment from their present locations and effectively stabilize them and contain them within a landfill, thereby minimizing the risk of exposure to dioxin. Alternative 3 would also effectively warn of possible dioxin migration and preserve the structural integrity of the landfill cap.

Alternative 4 would be most long-term effective and permanent. This alternative would remove the contaminated soil, soil ash, and sediment from their present locations and, although high-temperature incineration might not achieve the required 99.9999 percent destruction and removal efficiency (DRE), it would nonetheless effectively and permanently destroy most of the dioxin content.

- **Reduction of Toxicity, Mobility, or Volume through Treatment**

Alternatives 1 and 2 would not achieve any reduction of toxicity, mobility, or volume of dioxin-contaminated media through treatment. Both alternatives might eventually achieve reduction of contaminant toxicity and volume through natural attenuation, however, under Alternative 1, this reduction would neither be verified nor quantified. There would be no treatment residuals associated with Alternative 2.

Alternative 3 would not achieve any reduction of toxicity or volume of dioxin-contaminated media through treatment. However, Alternative 3 would significantly reduce dioxin mobility through chemical stabilization and containment in a landfill. A wastewater residual might be generated by the sediment dewatering step, but it is anticipated that this wastewater would satisfy regulatory requirements and could be recycled and/or discharged to surface water without treatment.

Alternative 4 would achieve a significant reduction of toxicity, mobility, and volume of dioxin contaminated media through removal and high-temperature incineration. An estimated 71,000 yd^3 of contaminated material would be permanently removed from the site by this alternative and the dioxin content of this material would be irreversibly destroyed. Alternative 4 might generate the same wastewater residual from the sediment dewatering operations as Alternative 3. In addition, as a result of incineration of dioxin-contaminated media, Alternative 4 would also generate an ash residual and, possibly, a liquid waste residual from off-gas treatment. These incineration residuals would require proper handling and disposal.

- **Short-term Effectiveness**

Implementation of Alternative 1 would not result in risks to site workers or adversely impact the surrounding community or environment since no remedial activities would be performed. Alternative 1 would never achieve the RAOs and although the dioxin PRGs might eventually be attained through natural processes, this would not be verified.

Implementation of Alternative 2 would result in a slight possibility of exposing site workers to dioxin contamination during long-term monitoring activities. However, this risk of exposure would be effectively controlled through compliance with proper site-specific health and safety procedures. Implementation of Alternative 2 would not adversely impact the surrounding community or environment. Alternative 2 would be expected to achieve the RAOs immediately upon implementation of institutional controls and monitoring. The dioxin PRGs might be attained through natural attenuation but the required timeframe cannot be accurately estimated.

Implementation of Alternatives 3 and 4 would result in the real possibility of exposing construction workers to dioxin contamination during remedial activities. However, the risk of exposure would be effectively controlled by the implementation of engineering controls (e.g., dust suppression) and compliance with applicable regulations and proper site-specific health and safety procedures. Implementation of Alternatives 3 and 4 would potentially impact the surrounding community because dioxin-contaminated material would be transported over public roads. In addition, Alternative 4 could impact the surrounding community because of off-gas emissions from the incineration facility. However, the potential for adverse impact would be effectively addressed through implementation of such appropriate measures as decontamination of transport vehicles, traffic control, spill prevention and emergency response, and incineration emissions treatment.

Alternatives 3 and 4 would be expected to achieve the RAOs immediately upon removal of the contaminated soil, soil ash, and sediment. Alternative 3 might attain the dioxin PRGs through natural attenuation but the required timeframe cannot be accurately estimated. Alternative 4 would attain the dioxin PRGs upon completion of the excavation operations, that are anticipated to require less than one year.

- **Implementability**

Alternative 1 would be extremely simple to implement since no action would occur.

The technical implementability of Alternative 2 would be very simple, since it would only require implementation of the institutional controls and monitoring.

The technical implementability of Alternative 3 would be somewhat more difficult than that of Alternative 2. In addition to institutional controls and monitoring, this alternative would require a number of sequential activities involving the handling, transportation, and staging of large volumes of materials. However, these activities would be technically implementable and their effectiveness would be verified prior to full-scale implementation through pilot-scale testing. Resources, equipment, and materials are readily available to perform the tasks associated with Alternative 3.

Although it would require a reduced number of sequential operational steps as compared to Alternative 3, Alternative 4 would be somewhat harder to implement. Resources, equipment and materials are readily available to perform the excavation, dewatering, and transportation activities but the number of off-base incineration facilities that might accept the dioxin-contaminated material for treatment is likely to be extremely limited and securing acceptance of this material might be quite difficult.

Administratively, Alternatives 2 and 3 would require the development and implementation of PRSCs and the performance of long-term monitoring and 5-year site reviews. Alternative 3 would also require authorizations for the excavation of the off-base sediment and a permit for the construction of the on-base landfill. Alternative 4 would not require PRSCs or long-term monitoring or 5-year reviews but it would require authorization for the excavation of the off-base sediment, manifesting of the material to be transported off-base, and formal acceptance of this material by the off-base incineration facility. These administrative requirements could be met.

- **Cost**

The capital and operation and maintenance (O&M) costs and net present worth (NPW) of the remedial alternatives were estimated to be as follows:

Alternative	Capital ($)	30-Year NPW of O&M ($)	30-Year NPW ($)
1	0	0	0
2	32,000	277,000	309,000
3	10,714,000	277,000	10,991,000
4	61,516,000	0	61,516,000

The above cost figures have been rounded to the nearest $1,000 to reflect the preliminary nature of these estimates. A detailed breakdown of cost estimates is provided in Appendix B.

1.0 INTRODUCTION

Under contract to the U.S. Department of the Navy (Navy), Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM), this Focused Feasibility Study (FFS) was prepared for Site 8 and the associated contiguous Areas of Contamination (AOCs) on the Naval Construction Battalion Center (NCBC) in Gulfport, Mississippi. This FFS was prepared under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Program, Contract Number N62467-94-D-0888, Contract Task Order (CTO) 0143.

On November 6, 1997, the Agreed Order (AO) No. 3466-97 was finalized by the Navy, the United States Air Force (USAF), and the Mississippi State Department of Environmental Quality (MDEQ). The AO requires adequate identification, delineation, and remediation of all impacted media related to the storage and handling of Herbicide Orange (HO) and related chemicals at Site 8.

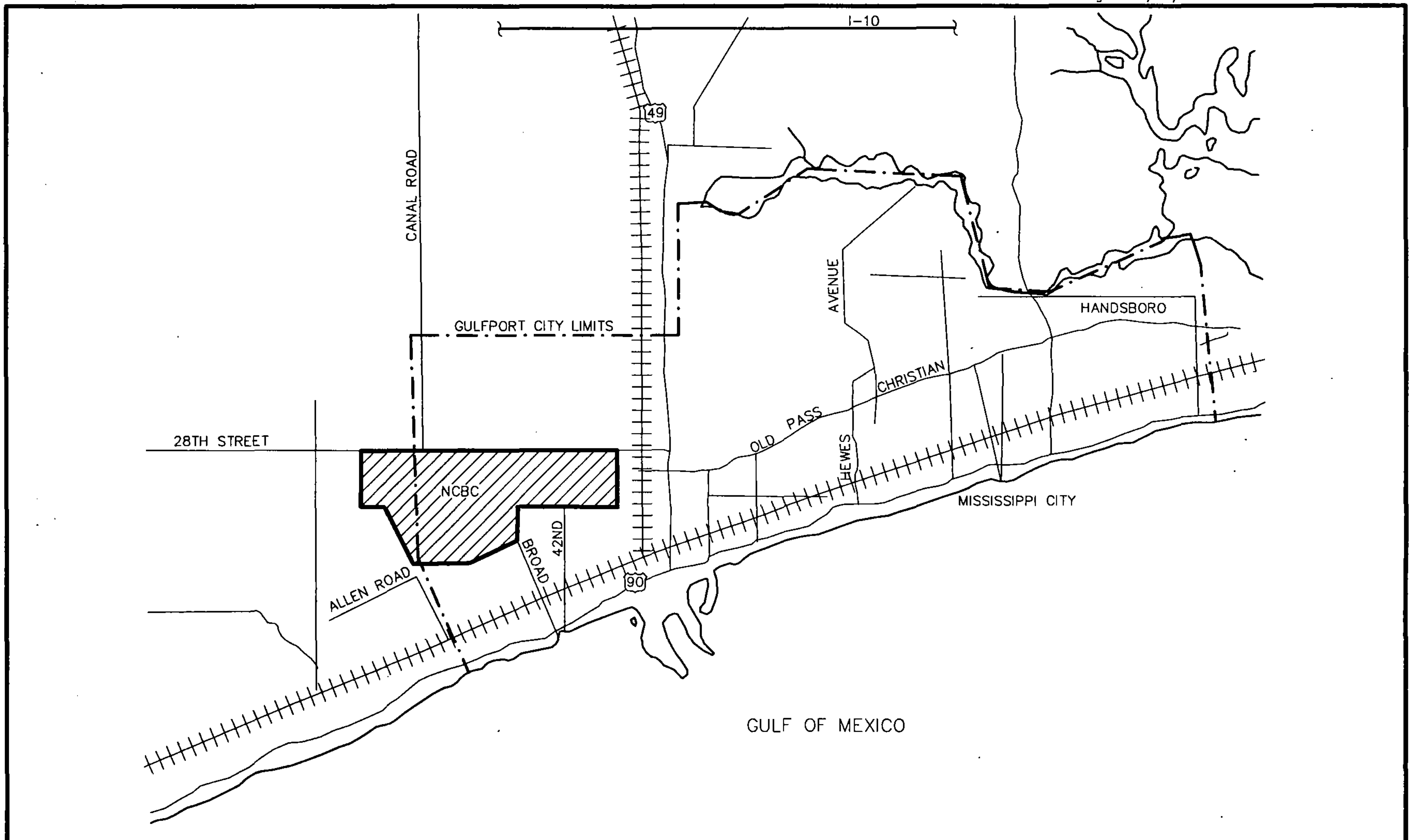
1.1 SITE BACKGROUND

As shown on Figure 1-1, NCBC Gulfport is located in the western part of Gulfport, in Harrison County, in the southeastern corner of the State of Mississippi, approximately 2 miles north of the Gulf of Mexico. The base occupies approximately 1,100 acres and has an elevation averaging 30 feet above mean sea level (msl), with the only significant exceptions being the large piles of bauxite (aluminum ore) stored on the base.

From 1968 through 1977, about 30 acres of the base, now known as Site 8, were used for the storage and handling of approximately 850,000 gallons of HO in 55-gallon drums. HO is a herbicide formulation used during the Vietnam war to defoliate trees and shrubbery. It is an equal mix of two agricultural herbicides (2,4,5-T and 2,4-D) in diesel fuel or jet fuel. HO is also known as "Agent Orange," a code name for the orange band that was used to mark the drums used to store the herbicide mix. As shown on Figure 1-2, Site 8 was divided into three areas (A, B, and C), based on the level of storage and handling of HO; Areas 8B and 8C were periodically used as overflow storage areas while Area 8A was continually in use.

Spills and leaks of HO occurred at all three areas of Site 8, contaminating the surface soil and sediment with the mixture components, 2,4,5-T and 2,4-D, as well as the byproduct contaminants (dioxins and furans), primarily 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD).

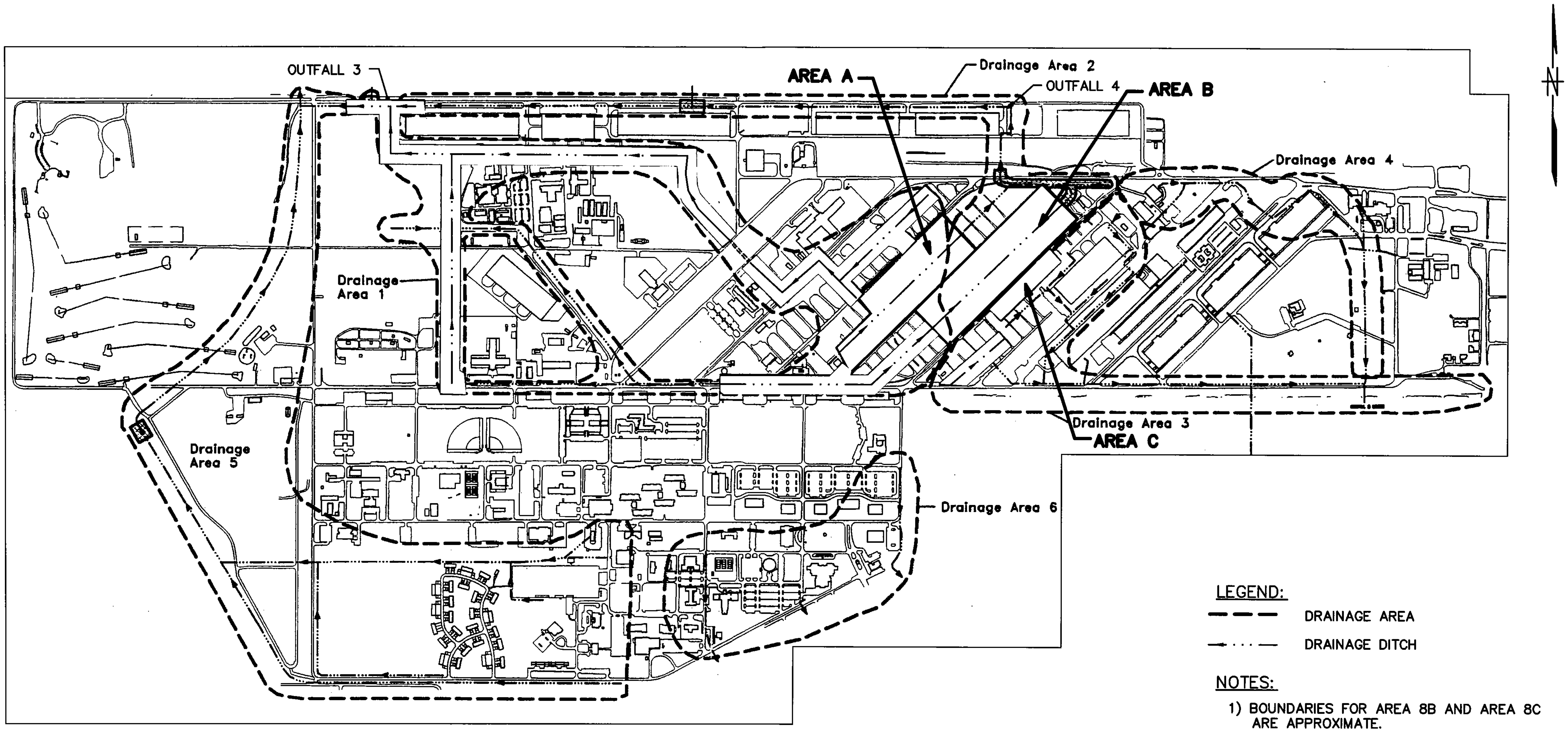
ACAD: 0567CM16.dwg 07/10/01 DT



DRAWN BY DLT DATE 7/9/01		VICINITY MAP SITE 8 FFS NAVAL CONSTRUCTION BATTALION CENTER GULFPORT, MISSISSIPPI	CONTRACT NO. 0567
CHECKED BY DATE			APPROVED BY [signature] DATE 03/28/01
COST/SCHED-AREA			APPROVED BY DATE
SCALE NOT TO SCALE			DRAWING NO. FIGURE 1-1 REV. 0

FORM CADD NO. SDIV_AH.DWG - REV 0 - 1/20/98

ACAD: 0567CM38.dwg 03/07/03 HJB PIT



LEGEND:

— — — DRAINAGE AREA

—·—··—·— DRAINAGE DITCH

NOTES:

1) BOUNDARIES FOR AREA 8B AND AREA 8C ARE APPROXIMATE.

2) WIDTHS ACROSS DRAINAGE DITCHES ARE NOT TO SCALE.

0 1000 2000
APPROXIMATE SCALE IN FEET

SOURCE: REMEDIATION GUIDANCE DOCUMENT, HARDING LAWSON ASSOCIATES, MARCH 2000.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJB DATE 3/7/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

LOCATION OF FORMER HERBICIDE ORANGE STORAGE AREAS
SITE 8 FFS
NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

CONTRACT NO. 0567
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 1-2
REV. 2

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

1.1.1 Site Description

Site 8 consists of three adjacent areas; A, B, and C. The main storage area, Area 8A, which encompasses approximately 13 acres, has an undulating surface due to earlier remedial activities and light vegetation. The surface soil, in non-stabilized areas, is typically a fine to medium sand. Approximately one-third of the site consists of stabilized areas (soil cement) that were used as the lay-down areas for the HO drums. Area 8A includes the upper reaches of the drainage areas for the eastern two-thirds of the base. Surface drainage from Area 8A flows to the northwest, exiting the Base at Outfall 3 into a swampy area that is part of the Turkey Creek Basin.

Areas 8B and 8C, encompassing a total of approximately 18 acres, are relatively flat with almost no vegetation. The surface soils consist of a fine-to-medium sand and approximately one-third of these areas are stabilized with cement. Areas 8B and 8C are also located at the head of local drainage basins; surface water from Area 8B flows north and exits the base at Outfall 4, and surface water from Area 8C drains to the southeast, exiting the base at Outfall 2 (south) into Brickyard Creek.

1.1.2 Site History

The area now known as Site 8 has been used as an equipment storage and staging area prior to 1968. Between 1968 and 1977, the area was used by the USAF as a storage and handling area for HO in support of the defoliation program in Vietnam known as Operation Ranchhand. In 1977, the HO was removed from Site 8, transported to port by railroad, and placed on an incinerator ship for destruction at sea in the South Pacific. The release of associated dioxins was confirmed in 1977 and the site was fenced in and left inactive until 1985.

Between 1985 and 1987 the soil at Site 8 was remediated to the current United States Environmental Protection Agency (USEPA) criterion of 1.0 microgram per kilogram (µg/kg). The excavated soil and sediment with dioxin concentrations above that level were incinerated and placed on Area 8A. However, the investigation and remediation did not include the drainage systems carrying surface water and sediment from the site into lower reaches of the local drainage basins (Figure 1-2).

During the Defense Construction Roadway project along the 28th Street in mid-1995, sediments containing dioxins were generally found at less than 1 foot, but up to 3 feet below ground surface (bgs) at stormwater Outfalls 1, 3, and 4. An interim removal action was conducted to excavate the contaminated sediments and place them on Area 8A. Between 1995 and 1997, two interim corrective measures were implemented to control migration of dioxin contamination off base. These interim corrective measures involved the installation and upgrade of 15 sediment recovery traps (SRTs) at various points along the drainage ditches associated with Site 8 to stop erosion of dioxin-contaminated sediment.

Between 1987 and January 2001, access to Site 8A was restricted and operations were not conducted within site boundaries. Since January 2001, activities conducted within Site 8A include the construction of a new loading ramp and the performance of a pilot-scale treatability study for remediating HO-impacted soil ash and on-base and off-base sediment (activities outlined in Alternative 3 of this FFS). In August 2002, the Navy performed a sediment removal action in the drainage ditches of Sites 8B and 8C. The excavated sediments were transported to Site 8A.

In February 2000, the Air Force and the Navy proposed to clean up the off-base dioxin-contaminated areas under the Mississippi Brownfields Program. Under this program, the contaminated properties would be remediated under program levels that are protective of human health and the environment. This action would allow these off-base areas to be developed expediently as a light industrial complex and be put to productive use. The Brownfields program also provides owners of the contaminated properties protection from future state litigation.

1.1.3 Previous Investigations

Dioxin-related investigations at Site 8 have been conducted since 1977. These investigations are summarized below.

Initial HO Monitoring Programs (1977-1984) – Conducted by the USAF Occupational and Environmental Health Laboratory as part of the plan to incinerate all remaining HO stockpiles at sea [Air Force Engineering and Service Center (AFESC), 1984]. These investigations focused on the following issues:

- Offsite migration of dioxin.
- Migration levels of 2,4-D, 2,4,5-T and dioxins at Site 8.
- Long-term degradation potential of 2,4-D, 2,4,5-T and dioxins.
- Potential vertical migration.

These studies included collection of soil, surface water, sediment, and biota samples for analysis using the best method available at that time (what is currently referred to as a low-resolution method). The findings were:

- Confirmation that Area 8A was contaminated with HO and TCDD.

- Soil levels of 2,4-D and 2,4,5-T were rapidly decreasing (a reported 60 percent reduction over a six-month period in 1981-1982).

- TCDD levels were consistent, suggesting significant persistence in the environment.

- TCDD was never detected in the surface water.

- Low levels [less than 50 nanograms per kilogram (ng/kg)] of TCDD were discovered in sediment and biota samples downstream of Area 8A.

- Movement of dioxin from Site 8 occurs primarily through soil erosion.

Comprehensive Soil Characterization and Confirmation Studies (1984 - 1988) – Conducted by the EG&G Idaho, Inc., and the AFESC to delineate the horizontal and vertical extent of HO and dioxin at Site 8 and to provide an estimate of contaminated soil potentially requiring remediation (AFESC, 1998).

A total of approximately 2,500 samples were collected and analyzed using a grid sampling approach with a 20-foot node spacing. The major findings of these investigations were:

- Concentrations of TCDD above 1 μg/kg were restricted to 2 feet in depth.

- Soil samples contained a maximum level of 310 μg/kg TCDD.

- Soil cement contained up to 1,000 μg/kg TCDD.

- Assuming an action level of 1.0 μg/kg TCDD, approximately 27,000 cubic yards (yd^3) of soil were above action levels at Site 8 in 1987.

- Analysis of confirmation samples collected from the excavated areas and of the resulting ash showed that residual concentrations of dioxins and furans were below 4.7 μg/kg.

Dioxin Delineation Studies (1995-2000) – A series of studies were conducted from 1995 through 1999 to assess the remaining dioxin contaminated soil and sediment [ABB Environmental Services, Inc. (ABB-ES), 2000]. These studies included the following:

- Delineation and characterization of dioxin in on-base soil and sediment.

- Delineation and characterization of dioxin in off-base soil and sediment. Included in the off-base studies were several phases of additional delineation activities north of Outfall 3 known then as the Outfall 3 Swamp, and referred to as the Off-Base Area of Contamination.

- Examination of potential impacts to groundwater at Site 8, Site 4, and Site 5. It was shown that dioxin contamination at Site 8 was restricted to a shallow zone of soil and that it was not migrating into groundwater.

- Baseline human health and ecological risk assessment.

Technical Memorandums No 1 Through 6, Former Herbicide Orange Storage Area, Groundwater Sampling Events (May 1994 - August 1995) - A quarterly groundwater monitoring program conducted by ABB–Environmental Services (ABB-ES) designed to determine the impact of the dioxin-contaminated ash on groundwater quality at Site 8A (ABB-ES, 1997). Activities included the following:

- Six rounds of quarterly groundwater samples were collected from the shallow aquifer from four permanent monitoring wells.

- The first four rounds of sampling were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), herbicides, dioxins, metals, and miscellaneous parameters. Samples collected during the final two rounds were collected for confirmatory purposes and were analyzed for dioxins only.

- Monitoring well locations were installed surrounding the soil ash piles.

Groundwater Monitoring Report (October 1998 - February 1999) - A supplemental investigation designed to further define and characterize site-related contamination in groundwater resulting from the storage of incinerated soils at Site 8A (HLA September, 1999). Activities included the following:

- During Phase I (October 1998), shallow and intermediate groundwater samples were collected from 24 temporary well locations using Direct Push Technology (DPT) boring techniques. Six samples were collected for characterization purposes, and were analyzed for VOCs, SVOCs, pesticide/PCBs, selected chlorinated herbicides and dioxins. Eighteen samples were collected for delineation purposes and were analyzed for dioxins and VOCs only.

- During Phase II (February 1999), groundwater samples were collected from 10 permanent monitoring well locations. The phase II monitoring wells were screened at shallow, intermediate, and deep depths. Groundwater samples collected from all ten well locations were analyzed for VOC, SVOC, pesticide/PCBs and chlorinated herbicides. Groundwater samples collected from seven of ten well locations were analyzed for dioxins only.

Site Characterization Work Plan for NCBC Gulfport Offbase Area of Contamination (February and April 2002) - A study to characterize the vertical extent of sediment contamination in the swamp north of Outfall 3 and the shallow groundwater directly below sediment contamination (TtNUS, 2003b).

- Shallow groundwater samples were collected from six temporary well locations within the area of sediment contamination north of Outfall 3.
- Seven sediment samples were collected at the surface and at a depth of 12 to 18 inches bgs.
- Sediment contamination was limited to the top 18 inches of sediment.

1.2 ENVIRONMENTAL CONDITIONS

In this section the environmental conditions, including the nature and extent of contamination and risk assessment results, will be briefly reviewed.

1.2.1 Nature and Extent of Contamination

The earliest investigations (pre-1995) identified 2,4-D; 2,4,5-T; and the 2,3,7,8-substituted dioxins and furans (hereafter referred to as “dioxins”) in media related to the storage and handling of HO at Site 8. More recent investigations (post-1995) have confirmed the earlier levels of 2,3,7,8-substitiuted dioxins and furans, but have not produced results with measurable 2,4-D or 2,4,5-T. These observations have been attributed to the persistence (low volatility, resistance to chemical breakdown) of dioxins and furans in the environment. The results of herbicide analyses have confirmed the chemical breakdown of 2,4-D and 2,4,5-T below detectable limits. The results of hundreds of other analyses [VOCs, SVOCs, total petroleum hydrocarbons (TPH), pesticides/PCBs] from all potentially impacted media have consistently confirmed historical data that HO and its related contaminants were the only hazardous material stored at Site 8.

The dioxin delineation studies (ABB-ES, 2000) identified a large area of surface soil and sediment dioxin contamination. The source for this dioxin contamination was the 55-gallon drums of HO stored at Site 8. Leaks from these drums contaminated surface soil over a large area of Site 8. Subsequent soil erosion, transportation and deposition in the hydrologically connected ditch systems resulted in contamination of the sediment deposited in these ditches. The levels of 2,3,7,8-TCDD (the dioxin most associated with

HO) in sediment diminish significantly in the wetlands immediately north of the base at Outfall 3. The hydrogeologic conditions in these wetlands [a combination of relatively lower maximum stream velocity and highly organic sediment (ABB-ES, 2000)] result in a favorable depositional environment, and hence very low (<10 ng/kg) levels of dioxin migrating past the Edwards property located along the southern branch of Turkey Creek, approximately 3,000 feet from Outfall 3 (see Figures 2-1 and 2-2).

The highly organophillic nature of dioxins has prevented contamination from migrating deeper than approximately 3 feet bgs and from significantly impacting shallow groundwater. In on-base (Site 8) groundwater samples, dioxins were detected at several monitoring well locations; however, only the dioxin concentrations reported for a 1995 groundwater sample exceed the MDEQ Target Remediation Goal (TRG) of 30 picogram per liter (pg/L). Using more recent groundwater data collected in 1999, the presence of dioxin in groundwater below the Mississippi dioxin TRG is limited to the boundary of Site 8. In off-base groundwater samples collected with the Off-Base Area of Contamination, dioxins were detected in the shallow groundwater. However, many of the samples were highly turbid, which may account for much of the observed dioxin contamination (TtNUS, 2003a).

1.2.2 Human Health and Ecological Screening Results

A risk assessment (HLA, 2001) was conducted to determine if contamination in surface soil, groundwater, and sediment related to the storage and handling of HO at NCBC Gulfport poses potential health risks to individuals under current and/or foreseeable future site conditions. Further, the analytical methods and quantitation limits of the data set were reviewed to ensure that the information was usable for the risk assessment.

Selection of the chemicals of potential concern (COPC) was defined as HO-related chemicals that were detected in at least one sample above risk-based screening concentrations [USEPA Region III Risk-Based Concentration (RBC) values] and MDEQ Tier 1 screening levels. The results indicated that 2,3,7,8-substituted dioxins/furans exceeded screening levels for soil and sediment at Site 8 and related drainage systems. None of the surface water samples exceeded screening levels concentrations. None of the biological samples exceeded screening level concentrations. The effected media are discussed below.

Surface Soil: Samples for surface soil were separated into two categories: on-base and off-base. Dioxin levels in surface soil at Site 8 and related drainage systems exceeded screening levels for direct soil exposure in both categories. The incremental lifetime cancer risks (ILCRs) associated with reasonable maximum exposure (RME) of both on-base and off-base receptors to contaminated surface soil are summarized in Table 1-1. The primary on-base risk driver for soil is the on-base resident population where the RME was above the MDEQ acceptable risk range.

Sediment: Sediment samples were also separated into on-base and off-base categories. Dioxin levels in sediment (on-base and off-base) exceeded screening levels established by the USEPA and MDEQ. The ILCRs associated with RME of both on-base and off-base receptors to contaminated sediment are also summarized in Table 1-1. The primary risk driver for sediment is the on-base resident population, which had an RME above the MDEQ acceptable risk range.

Groundwater: A human health risk assessment amendment was performed for Site 8 to address groundwater risks for current and potential future land-use scenarios (TtNUS, 2003a). Similar to surface soil and sediment, groundwater samples were separated into on-base and off-base categories. Dioxin levels in groundwater (both on-base and off-base) exceeded screening levels established by the USEPA and MDEQ. However, many of the samples were turbid, which may account for much of the detected dioxin concentrations. The ILCRs associated with RME and central tendency exposure (CTE) of both on-base and off-base receptors to contaminated sediment are also summarized in Table 1-2. The primary risk driver for groundwater is the hypothetical on-site resident that is also exposed to surface water/groundwater in the swamp north of Outfall 3. Under RME, adult and life-long (child and adult) residents had risks above the MDEQ acceptable risk range.

Ecological: A total of 56 biological samples were collected (whole fish and fillets) and analyzed for dioxins. The data set included most edible species found in the study area, including largemouth bass, catfish, striped mullet, and bluegill. No analytes were detected in these edible species at concentrations above ecological screening criteria and, thus, no ecological COPC was identified.

1.3 DOCUMENT ORGANIZATION

This FFS Report has been organized with the intent of meeting the general format requirements specified in the RI/FS Guidance Document (USEPA, 1988). This report consists of the following five sections:

- Section 1.0, Introduction - summarizes the purpose of the report, provides site background information, summarizes findings of the previous investigations, and provides the report outline.

- Section 2.0, Remedial Action Objectives (RAOs) and General Response Actions (GRAs) - presents the RAOs, identifies Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) criteria, develops Preliminary Remedial Action Goals (PRGs) and associated GRAs, and provides an estimate of the volume of contaminated media to be remediated.

TABLE 1-1

SUMMARY OF HUMAN HEALTH RISKS - SOIL AND SEDIMENT
CURRENT AND POTENTIAL FUTURE LAND USE SCENARIOS
SITE 8 FOCUSED FEASIBILITY STUDY
NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI
PAGE 1 OF 2

Receptor	Media of Concern	Exposure Route	Total ILCR	
			RME	CTE
Current Land Use				
On-base Receptors				
Total Resident	Non-Site 8 soil, on-base sediment	Ingestion, dermal contact, and fugitive dust inhalation	3.0E-05	1.0E-05
Total Trespasser	Site 8 soil, non-Site 8 soil, on-base sediment	Ingestion, dermal contact, and fugitive dust inhalation	6.0E-06	2.0E-06
Occupational Worker	Site 8 soil, non-Site 8 soil, on-base sediment	Ingestion, dermal contact, and fugitive dust inhalation	7.0E-06	2.0E-06
Site Worker	Site 8 soil, non-Site 8 soil, on-base sediment	Ingestion, dermal contact, and fugitive dust inhalation	2.0E-06	NC
Excavation Worker	Site 8 soil, non-Site 8 soil, on-base sediment	Ingestion, dermal contact, and fugitive dust inhalation	7.0E-07	NC
Off-base receptors				
Total Resident	Off-base sediment	Ingestion and dermal contact	8.0E-07	NC
Total Trespasser	Off-base sediment	Ingestion and dermal contact	2.0E-07	NC
Occupational Worker	Off-base sediment	Ingestion and dermal contact	1.0E-07	NC
Site Worker	Off-base sediment	Ingestion and dermal contact	8.0E-08	NC
Excavation Worker	Off-base sediment	Ingestion and dermal contact	4.0E-08	NC
Future Land Use				
On-base Receptors				
Total Resident	Non-Site 8 soil, on-base sediment	Ingestion, dermal contact, and fugitive dust inhalation	6.0E-05	1.0E-05
Total Trespasser	Site 8 soil, non-Site 8 soil, on-base sediment	Ingestion, dermal contact, and fugitive dust inhalation	6.0E-06	2.0E-06
Occupational Worker	Site 8 soil, non-Site 8 soil, on-base sediment	Ingestion, dermal contact, and fugitive dust inhalation	7.0E-06	2.0E-06
Site Worker	Site 8 soil, non-Site 8 soil, on-base sediment	Ingestion, dermal contact, and fugitive dust inhalation	2.0E-06	NC
Excavation Worker	Site 8 soil, non-Site 8 soil, on-base sediment	Ingestion, dermal contact, and fugitive dust inhalation	7.0E-07	NC
Off-base Receptors				
Total Resident	Off-base sediment	Ingestion and dermal contact	8.0E-07	NC
Total Trespasser	Off-base sediment	Ingestion and dermal contact	2.0E-07	NC
Occupational Worker	Off-base sediment	Ingestion and dermal contact	1.0E-07	NC
Site Worker	Off-base sediment	Ingestion and dermal contact	8.0E-08	NC
Excavation Worker	Off-base sediment	Ingestion and dermal contact	4.0E-08	NC

TABLE 1-1

SUMMARY OF HUMAN HEALTH RISKS - SOIL AND SEDIMENT
CURRENT AND POTENTIAL FUTURE LAND USE SCENARIOS
SITE 8 FOCUSED FEASIBILITY STUDY
NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

NOTES:

Details of the human health risk assessment assumptions and computations are provided in the Site 8 risk assessment study (HLA, 2001).

CTE	central tendency exposure
ILCR	incremental lifetime cancer risk
NC	not calculated
RME	reasonable maximum exposure

TABLE 1-2

SUMMARY OF HUMAN HEALTH RISKS - GROUNDWATER
CURRENT AND POTENTIAL FUTURE LAND USE SCENARIOS
SITE 8 FOCUSED FEASIBILITY STUDY
NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

Receptors	On-Site Groundwater	Off-Site Groundwater/ Surface Water	Total Risk
Reasonable Maximum Exposure			
Excavation Worker	8E-08	3E-06	3E-06
Occupational Worker	NA	7E-05	7E-05
On-Site Worker	NA	3E-05	3E-05
Adolescent Trespasser	NA	4E-05	4E-05
Adult Trespasser	NA	4E-05	4E-05
Off-Site Child Resident	NA	1E-05	1E-05
Off-Site Adult Resident	NA	7E-05	7E-05
Off-Site Lifelong Resident	NA	8E-05	8E-05
On-Site Child Resident	2E-05	1E-05	4E-05
On-Site Adult Resident	5E-05	7E-05	1E-04
On-Site Lifelong (Child and Adult) Resident	7E-05	8E-05	2E-04
Central Tendency Exposure			
Excavation Worker	3E-08	1E-06	1E-06
Occupational Worker	NA	3E-05	3E-05
On-Site Worker	NA	1E-05	1E-05
Adolescent Trespasser	NA	1E-05	1E-05
Adult Trespasser	NA	2E-05	2E-05
Off-Site Child Resident	NA	5E-06	5E-06
Off-Site Adult Resident	NA	3E-05	3E-05
Off-Site Lifelong Resident	NA	3E-05	3E-05
On-Site Child Resident	9E-06	5E-06	1E-05
On-Site Adult Resident	2E-05	3E-05	5E-05
On-Site Lifelong (Child and Adult) Resident	3E-05	3E-05	6E-05

Notes:
NA - Not applicable for this receptor.

- Section 3.0, Screening of Remediation Technologies and Process Options - provides a two-tiered screening of potentially applicable remediation technologies and identifies the technologies that will be assembled into remedial alternatives.

- Section 4.0, Assembly and Detailed Analysis of Remedial Alternatives - assembles the remedial technologies retained from the Section 3.0 screening process into multiple remedial alternatives, describes these alternatives, and performs a detailed analysis of these alternatives in accordance to the seven Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) criteria.

- Section 5.0, Comparative Analysis of Remedial Alternatives - compares the remedial alternatives on a criterion-by-criterion basis, for each of the seven CERCLA analysis criteria used in Section 4.

2.0 REMEDIAL ACTION OBJECTIVES AND GENERAL RESPONSE ACTIONS

This section presents the RAOs, ARARs, and TBCs for Site 8 as well as a brief overview of the Risk Assessment (HLA, 2000) that was used to identify the RAOs. This section also develops PRGs, identifies GRAs, and estimated volumes of contaminated media.

2.1 REMEDIAL ACTION OBJECTIVES

The objectives and goals for remedial actions at Site 8 and associated ditch systems provide the basis for selecting RAOs and identifying remedial technologies to address unacceptable human health risks associated with direct exposure to surface soil, sediment, and groundwater.

To establish RAOs, regulatory requirements, or ARARs, were identified. RAOs are then defined primarily on consideration of ARARs and the results and conclusions of the sediment and surface water dioxin delineation studies (ABB-ES, 1999 & 2000), the basewide groundwater assessment [Harding Lawson, Associates (HLA), 1999], and the human health and ecological risk assessments (HLA, 2001) and human health risk assessment amendment (TtNUS, 2003a). Action levels, or PRGs, for each media of concern are defined, and the resulting volumes of affected media are calculated. The general response actions that satisfy the RAOs are discussed later in this section.

2.1.1 Statement of Remedial Action Objectives

RAOs, or the media specific goals established to protect human health and the environment (USEPA, 1988), are based on the chemicals of concern (COCs), the exposure pathway, and the receptors present at the site. The RAOs identified in this section are based on the COCs (dioxins and furans) identified in the exposure pathways for the potential on-base receptor populations.

For this FFS, RAOs have been formulated based on the following criteria:

- Unacceptable human health risks from direct exposure to surface soil or sediment based on current and future uses of Site 8 and the associated ditch systems.
- Unacceptable risks from exposure to groundwater based on residential future use scenarios for Site 8 and the swampland north of Outfall 3.
- MDEQ TRGs for both restricted (commercial/industrial) and unrestricted (residential) uses.

The potential for the leaching of dioxins and furans from stabilized soil at Site 8 into subsurface soil and groundwater was evaluated during a pilot-scale treatability study (TtNUS, 2001). Results from this study showed that such leaching is extremely unlikely to occur. The current and future use of Site 8 and associated ditch systems is considered industrial. Based on current and future use, receptors are occupational and construction workers in direct contact with the soil and sediment. Three RAOs have been identified for Site 8. They are:

RAO 1: Protect human health from the carcinogenic and noncarcinogenic risks associated with incidental ingestion of, inhalation of, and dermal contact with contaminated surface soil and sediment.

RAO 2: Protect human health from the carcinogenic risks associated with ingestion and dermal contact with on-site and off-site groundwater.

RAO 3: Comply with Federal and State ARARs and TBC guidance criteria in accordance with accepted USEPA and MDEQ guidelines.

2.1.2 ARARs and To Be Considered Criteria

ARARs for this FFS are the Federal and State environmental requirements used to define the appropriate extent of site cleanup, identity sensitive land areas or land uses, develop remedial alternatives, and direct site remediation. CERCLA and the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) require remedial actions to comply with State ARARs when they are more stringent than Federal ARARs.

The NCP defines two ARAR components: (1) applicable requirements and (2) relevant and appropriate requirements. Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal or State environmental or facility siting laws specifically addressing a hazardous substance, pollutant, contaminant, remedial action, or other circumstance found at a CERCLA site. Applicable State standards are only those (1) identified by the State in a timely manner, (2) consistently enforced, and (3) more stringent than Federal requirements.

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, under Federal and State environmental and facility siting laws that, while not “applicable” to a hazardous substance, pollutant, contaminant, or remedial action, address situations sufficiently similar to those encountered at the CERCLA site so their use is well suited to the particular site. Only those State standards identified (1) in a timely manner and (2) more stringent than Federal requirements may be relevant and appropriate.

"Applicability" is a legal determination of jurisdiction of existing statutes and regulations, whereas "relevant and appropriate" is a site-specific determination of the appropriateness of existing statutes and regulations. Therefore, relevant and appropriate requirements allow flexibility not provided by applicable requirements in the final determination of cleanup levels. Once a requirement is identified as an ARAR, the selected remedy must comply or be waived from the ARAR, even if the ARAR is not required to assure protectiveness. Applicable requirements apply to both on- and off-site remedial actions.

TBC guidance criteria are Federal and State non-promulgated advisories or guidance not legally binding and do not have the status of potential ARARs. However, if there are no specific ARARs for a chemical or site condition, or if ARARs are not deemed sufficiently protective, then guidance or advisory criteria should be identified and used to ensure the protection of human health and the environment.

Under the description of ARARs set forth in the NCP and the Superfund Amendments Reauthorization Act (SARA), State and Federal ARARs are categorized as:

- Chemical-Specific: Controlling the extent of site remediation with regard to specific contaminants and pollutants.

- Location-Specific: Governing site features such as wetlands, floodplains, and sensitive ecosystems (including features of historical significance).

- Action-Specific: Pertaining to the proposed site remedies and governing the implementation of the selected site remedy.

During the detailed analysis of remedial alternatives, each alternative will be analyzed to determine its compliance with ARARs. Chemical-, location-, and action-specific ARARs are presented in Table 2-1.

2.1.3 <u>Media of Concern</u>

The media of concern have been determined by evaluating the site conceptual model (HLA, 2001) and the results of the sediment and surface water dioxin delineation studies (ABB-ES, 1999 & 2000) to determine the source, transport and receiving media. Based on that information, the media of concern are as follows:

- Site 8 surface soil.
- Area 8A incinerated soil ash.

TABLE 2-1

ARARs AND TBC CRITERIA
SITE 8 FOCUSED FEASIBILITY STUDY
NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI
PAGE 1 OF 2

Name and Regulatory Citation	Description	Consideration in the Remedial Action Process	Type
		Federal	
USEPA Region III Risk-Based Concentration Table	Provides risk-based concentrations for screening of soil and groundwater.	Relevant and Appropriate. These guidelines aid in the screening of chemicals in soil and groundwater.	Chemical-specific
Safe Drinking Water Act MCLs (40 CFR 140-143)	Protective levels for groundwater that is current or potential drinking water sources.	Applicable if on-base and off-base groundwater were to be used for potable purposes in the future.	Chemical specific
CERCLA and the NCP Regulations (40 CFR, Section 300.430)	Discusses the types of PRSCs to be established at CERCLA sites.	Applicable. These requirements may be used as guidance in establishing appropriate PRSCs at Site 8.	Action-specific
Occupational Safety and Health Act (OSHA) (29 CFR Part 1910)	Requires establishment of programs to ensure worker health and safety at hazardous waste sites.	Applicable. These requirements apply to response activities conducted in accordance with the NCP. During the implementation of any remedial alternative for Site 8, these regulations must be followed.	Action-specific
Hazardous Materials Transportation Act Regulations (49 CFR 171-179)	Provides requirements for packaging, labeling, manifesting and transporting hazardous materials.	Applicable. If soil is excavated and transported and is found to be hazardous, the soil would need to be handled, manifested, and transported as a hazardous waste.	Action-specific
National Emissions Standards for Hazardous Air Pollutants (40 CFR Part 61)	Standards promulgated under the Clean Air Act for significant sources of hazardous air pollutants.	Relevant and Appropriate. Remedial Action (e.g., soil excavation) may result in release of hazardous air pollutants.	Action-specific
Resource Conservation and Recovery Act (RCRA) Treatment Storage, and Disposal of Hazardous Waste (40 CFR 262-266)	Regulates the treatment, storage, and disposal of hazardous waste.	Relevant and Appropriate. Hazardous waste generated by site remediation must meet RCRA generator and treatment, storage, or disposal requirements.	Action-specific
Land Disposal Restrictions (40 CFR Part 61)	Restricts certain listed or characteristic hazardous waste from placement or disposal on land without treatment.	Relevant and Appropriate. Excavated soil or treatment residuals (such as spent granular activated carbon) may require disposal in a landfill.	Action-specific

TABLE 2-1

ARARs AND TBC CRITERIA
SITE 8 FOCUSED FEASIBILITY STUDY
NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

Name and Regulatory Citation	Description	Consideration in the Remedial Action Process	Type
State			
MDEQ Target Risk Goals (TRGs) (MS Code Section 49-35-21)	Default Screening Levels. Human Health risk-based cleanup goals for soil and groundwater.	Applicable. These regulations apply to all remedial actions in the State of Mississippi.	Chemical Specific
MDEQ Risk Evaluation Procedures for Voluntary Cleanup and Redevelopment	Risk-based procedures and rationale for site evaluation and remediation.	TBC. These regulations apply to all Voluntary Cleanup and Brownfield actions in the State of Mississippi.	Guidance
MDEQ Office of Pollution Control Hazardous Waste Management Regulations	Adopts by reference, specific sections of the Federal Hazardous Waste regulations.	Relevant and Appropriate. These regulations may apply if material is removed from the Base.	Action Specific

- Associated drainage systems sediment.
- Associated drainage systems surface soil (overbank deposits).
- Groundwater.

Groundwater is retained as a medium of concern in this FFS; however, remedial alternatives are not developed to directly address impacts to groundwater. Dioxins are highly organophillic in nature and many of the groundwater samples with elevated dioxin concentrations were turbid. As a result, the elevated dioxin levels are likely associated with the overlying soil/sediment contamination. Remedial actions taken to address soil and sediment are expected to indirectly address dioxin impacts to groundwater.

Deep water sediment is not considered a medium of concern at Site 8 because: 1) there is no complete exposure pathway to this medium, 2) the results of the Risk Assessment study (HLA, 2001) eliminated this medium as a potential threat, and 3) the dioxin in the deep water sediment is not likely results of activities at NCBC Gulfport.

2.1.4 Chemicals of Concern for Remediation

The COCs are the 17 dioxin and furan compounds related to the production of HO shown in Table 2-2. While TCDD is the primary dioxin compound associated with the production of HO, the USEPA recognizes 16 additional dioxin and furan compounds (congeners) that have similar toxicological effects as TCDD. These other 16 congeners are related to TCDD by toxicity equivalency factors as shown in the table below. Therefore, in the context of this FFS and future remedial activities, these dioxin and furan congeners will be expressed as a single “dioxin” result, which is the sum of the toxicity equivalents.

TABLE 2-2

USEPA DIOXIN AND FURAN TOXIC EQUIVALENCY FACTORS
SITE 8 FOCUSED FEASIBILITY STUDY
NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

Congener	Toxic Equivalency Factor(1)
Dioxins	
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1
1,2,3,7,8-Pentachloro-p-dibenzodioxin (PeCDD)	0.5
1,2,3,4,7,8-Hexachloro-p-dibenzodixin (HxCDD)	0.1
1,2,3,6,7,8-Hexachloro-p-dibenzodixin (HxCDD)	0.1
1,2,3,7,8,9-Hexachloro-p-dibenzodixin (HxCDD)	0.1

Congener	Toxic Equivalency Factor[1]
1,2,3,4,6,7,8-Heptacholoro-p-dibenzodioxin (HpCDD)	0.01
Octachloro-p-dibenzodioxin (OCDD)	0.001
Furans	
2,3,7,8- Tetrachloro-p-dibenzofuran (TCDF)	0.1
1,2,3,7,8- Pentachloro-p-dibenzofuran (PeDF)	0.05
2,3,4,7,8- Pentachloro-p-dibenzofuran (PeCDF)	0.5
1,2,3,4,7,8- Hexachloro-p-dibenzofuran (HxCDF)	0.1
1,2,3,7,8,9- Hexachloro-p-dibenzofuran (HxCDF)	0.1
1,2,3,6,7,8- Hexachloro-p-dibenzofuran (HxCDF)	0.1
2,3,4,6,7,8- Hexachloro-p-dibenzofuran (HxCDF)	0.1
1,2,3,4,6,7,8- Heptachloro-p-dibenzofuran (HpCDF)	0.01
1,2,3,4,7,8,9- Heptachloro-p-dibenzofuran (HpCDF)	0.01
Ocatchloro-p-dibenzofuran (OCDF)	0.001

1 USEPA Guidelines for carcinogen Risk Assessment (USEPA, 1986)

2.2 PRELIMINARY REMEDIAL GOALS

PRGs establish acceptable exposure levels protective of human health and the environment. PRGs are based on regulatory requirements, USEPA and MDEQ-acceptable risk levels, and assumptions regarding ultimate land uses, as well as contaminant pathways. As part of the CERCLA process, PRGs are periodically revised because of new guidance requirements and promulgated or updated ARARs. Final Remediation Goals will not be formally established until the approval of the Record of Decision (ROD).

The PRGs presented here are based on ARARs; site-specific Remedial Goal Options (RGOs) developed during the human health and ecological risk assessments (HLA, 2001); chemicals and media of concern; and exposure pathways. Those media with estimated ILCRs greater than 1 excess case per million population (1.0E-06) under a reasonable maximum exposure (RME) scenario were selected for development of PRGs in accordance with USEPA Region IV guidance (USEPA, 1995).

In addition to being media specific, the PRGs presented in this FFS are location/land use specific as well. The following discussion presents the rationale for selecting location specific goals for the identified media. Table 2-3 provides a list of the surface soil, soil ash, and sediment direct contact PRGs.

2.2.1 <u>On-Base Soil, Soil Ash, and Sediment PRGs</u>

On-Base soil, soil ash, and sediment in areas previously identified (ABB-ES, 1999 & 2000) as containing dioxin contamination above 15 ng/kg (known as the area of contamination) will be remediated until the resulting 95-percent upper confidence limit (UCL) concentration is at or below 38 ng/kg. The 95-percent

TABLE 2-3

DETERMINATION OF PRGS
SITE 8 FOCUSED FEASIBILITY STUDY
NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

COCs	Area	Units	Screening Level[1]	RGO[2]	MDEQ Tier 1 TRG (Restricted)	MDEQ Tier 1 TRG (Unrestricted)	PRG
Dioxins and Furans	Site 8 Surface Soil, Soil Ash, & Sediment	ng/kg	4.3	50	38	NA	38
	Non-Site 8 (on-base) Surface Soil & Sediment	ng/kg	4.3	50	38	NA	38
	Off-Base Soil, Area 2	ng/kg	4.3	50	38	15[4]	15
	Off-Base Sediment[3] (shallow water), Area 1	ng/kg	4.3	42	38	NA	38
	Off-Base Sediment[3] (deep water), Area 3	ng/kg	4.3	1,000	NA	NA	102
	On-Base and Off-Base Groundwater	pg/L	0.45	30	30	30	30

<u>NOTES</u>:

1 The screening values are the lower of the USEPA Region III RBCs for residential exposure (USEPA, 2000) or the MDEQ TRG Unrestricted Residential Screening Level (MDEQ, 1999).

2 Site-specific RGOs were developed in the Human Health and Screening Level Ecological Risk Assessment (HLA, 2001).

Shallow sediment will be treated the same as surface soil due to frequent aerial exposure.

Unrestricted TRG for residential off-base areas is listed as 4.3 ng/kg; however, studies have shown that the practical lower quantifiable limit of the method is actually 15 ng/kg as stated in the Human Health Risk Assessment (HLA, 2001).

COCs	chemicals of concern
HLA	Harding Lawson Associates
MDEQ	Mississippi Department of Environmental Quality
NA	not available
ng/kg	nanograms per kilogram
pg/L	picograms per liter
PRG	Preliminary Remedial Action Goal
RBCs	Risk-Based Concentrations
RGOs	Remedial Goal Options
TRG	Target Remedial Goal
USEPA	United States Environmental Protection Agency

UCL will be calculated using data only from within the area of contamination to ensure that background data do not bias the resulting calculations.

On-Base soil, soil ash, and sediment includes the surface soil at Areas 8B and 8C, the incinerated soil ash stockpiled at Area 8A, the contaminated surface soil associated with overbank deposits near drainage systems, and all identified contaminated sediment in base drainage systems hydraulically connected to Site 8 as shown on Figure 1-2. On-base soil, soil ash, and sediment will be remediated to the same levels due to the fact that sediment and soil are consistently interacting due to periodic erosion and redeposition.

2.2.2 Off-Base Soil and Sediment PRGs

As illustrated on Figure 2-1, off-Base soil and sediment have been divided into three areas based on hydrology and regulatory program oversight as described below.

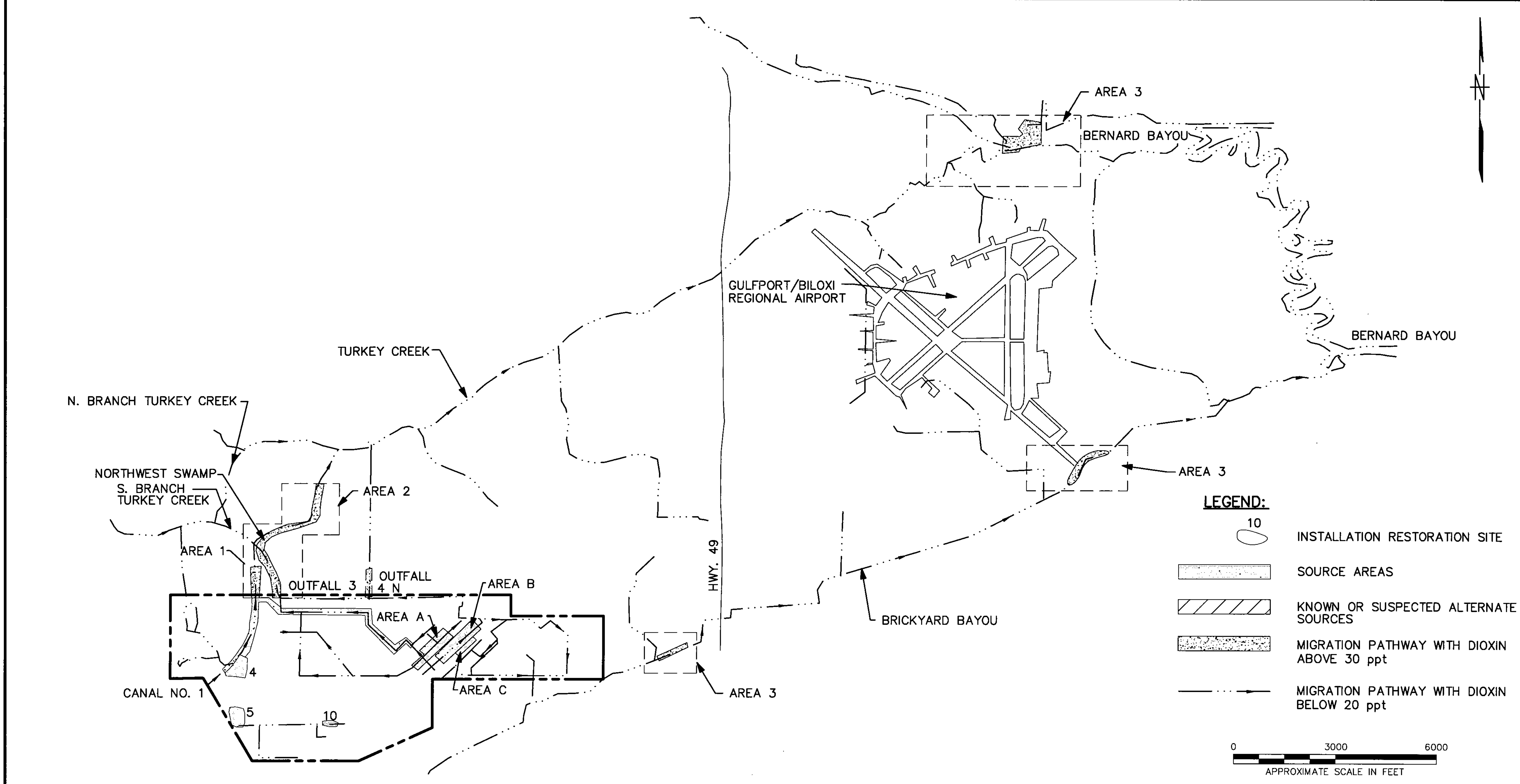
Off-Base Area 1: Off-Base Area 1 includes the Arndt and Bennett properties located immediately north of Outfall 3. This area has been included in the MDEQ Brownfields Redevelopment Program, and includes contaminated soil and sediment in a shallow intermittent drainage system. The PRG within this area is 38 ng/kg based on the MDEQ requirements for non-residential (restricted) uses.

Off-Base Area 2: Off-Base Area 2 includes the Edwards property to the northeast of Area 1. This area also contains contaminated soil and sediment in a shallow intermittent drainage system. It is proposed that an unrestricted use (residential) PRG of 15 ng/kg be established for Area 2 rather than the MDEQ TRG of 4.3 ng/kg because it was determined that the practical detection limit for USEPA Method 8290 is 15 ng/kg (ABB-ES, 1999). Based on a PRG of 15 ng/kg for surface soil and intermittently exposed sediment, Off-Base Area 2 represents the furthest migration of HO-related dioxin contamination.

Off-Base Area 3: Off-Base Area 3 includes the downstream section Turkey Creek at its confluence with Bernard Bayou. Off-Base Area 3 also includes two small sections of Brickyard Bayou, including one just downstream of the base and the other south of the Gulfport/Biloxi Regional Airport. The hydrology of Off-Base Area 3 includes deeper water and tidally influenced creek and bayou surface water bodies and continuously submerged sediment. It should be noted that only the sediments along the bottom of the channels contained measurable levels of dioxin. Testing along the banks and flood plains produced no measurable levels of detection. Based on potential exposure scenarios discussed in Appendix C, the PRG for Area 3 is 1,000 ng/kg. Based on the results of earlier investigations, the observed levels of dioxin contamination in Off-Base Area 3 have not exceeded this 1,000 ng/kg PRG.

This page intentionally left blank.

ACAD: 0567CM39.dwg 03/07/03 HJB PIT



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJB DATE 3/7/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

OFF BASE SOIL/SEDIMENT AREAS
SITE 8 FFS
NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

CONTRACT NO. 0567
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-1 REV. 2

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

2.2.3 Groundwater

Remediation of off-base sediment and on-base soil, soil ash, and sediment is expected to address dioxin impacts to on-base and off-base groundwater. The PRG established for groundwater upon completion of soil and sediment remedial activities is 30 pg/L based on the Mississippi TRG and USEPA maximum contaminant level (MCL) for total toxicity equivalents of dioxin.

2.3 GENERAL RESPONSE ACTIONS

GRAs describe categories of actions that could be implemented to satisfy or address a component of the RAOs for the site. Remedial alternatives will be developed using one or more GRAs to meet the RAOs. These remedial alternatives will be capable of achieving the RAOs for each contaminated medium at the site. The following GRAs will be considered for soil, soil ash, and sediment at Site 8:

- No Action,
- Limited Action (e.g., Monitored Natural Attenuation, Institutional Controls, Monitoring),
- Containment,
- Removal,
- In-Situ Treatment,
- Ex-Situ (On-Site) Treatment, and
- Disposal.

2.4 ESTIMATED VOLUME OF CONTAMINATED SOIL, SOIL ASH, AND SEDIMENT

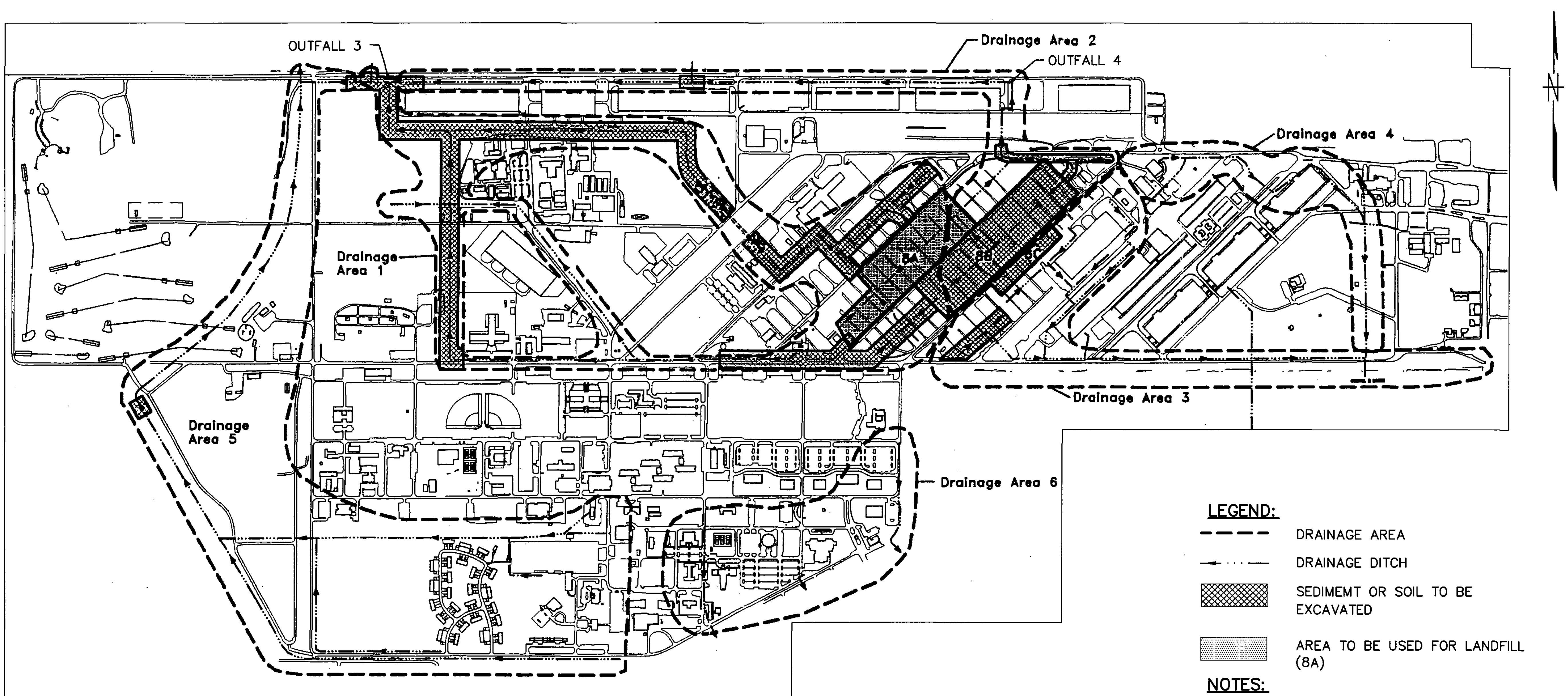
Based on the PRGs presented on Table 2-3 and vertical delineation sampling conducted in 2002 (TtNUS, 2003), it is estimated that a total of approximately 71,000 yd^3 of contaminated media will have to be remediated at Site 8, as follows:

Material	Estimated Volume (yd^3)
Area 8A Incinerated Soil Ash	21,000
On-Base Ditches Contaminated Sediment	24,000
Off-Base Swampland Contaminated Sediment	26,000
TOTAL	**71,000**

Figures 2-2 and 2-3 illustrate the approximate areal extent of the on-base and off-base contaminated media, respectively. Computations of contaminated media volumes are presented in Appendix A.

This page intentionally left blank.

ACAD: 0567CM40.dwg 03/07/03 HJB PIT



LEGEND:

- DRAINAGE AREA
- DRAINAGE DITCH
- SEDIMEMT OR SOIL TO BE EXCAVATED
- AREA TO BE USED FOR LANDFILL (8A)

NOTES:

1) BOUNDARIES FOR AREA 8B AND AREA 8C ARE APPROXIMATE.
2) WIDTHS ACROSS DRAINAGE DITCHES ARE NOT TO SCALE.

0 1000 2000
APPROXIMATE SCALE IN FEET

SOURCE: REMEDIATION GUIDANCE DOCUMENT, HARDING LAWSON ASSOCIATES, MARCH 2000.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJB DATE 3/7/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

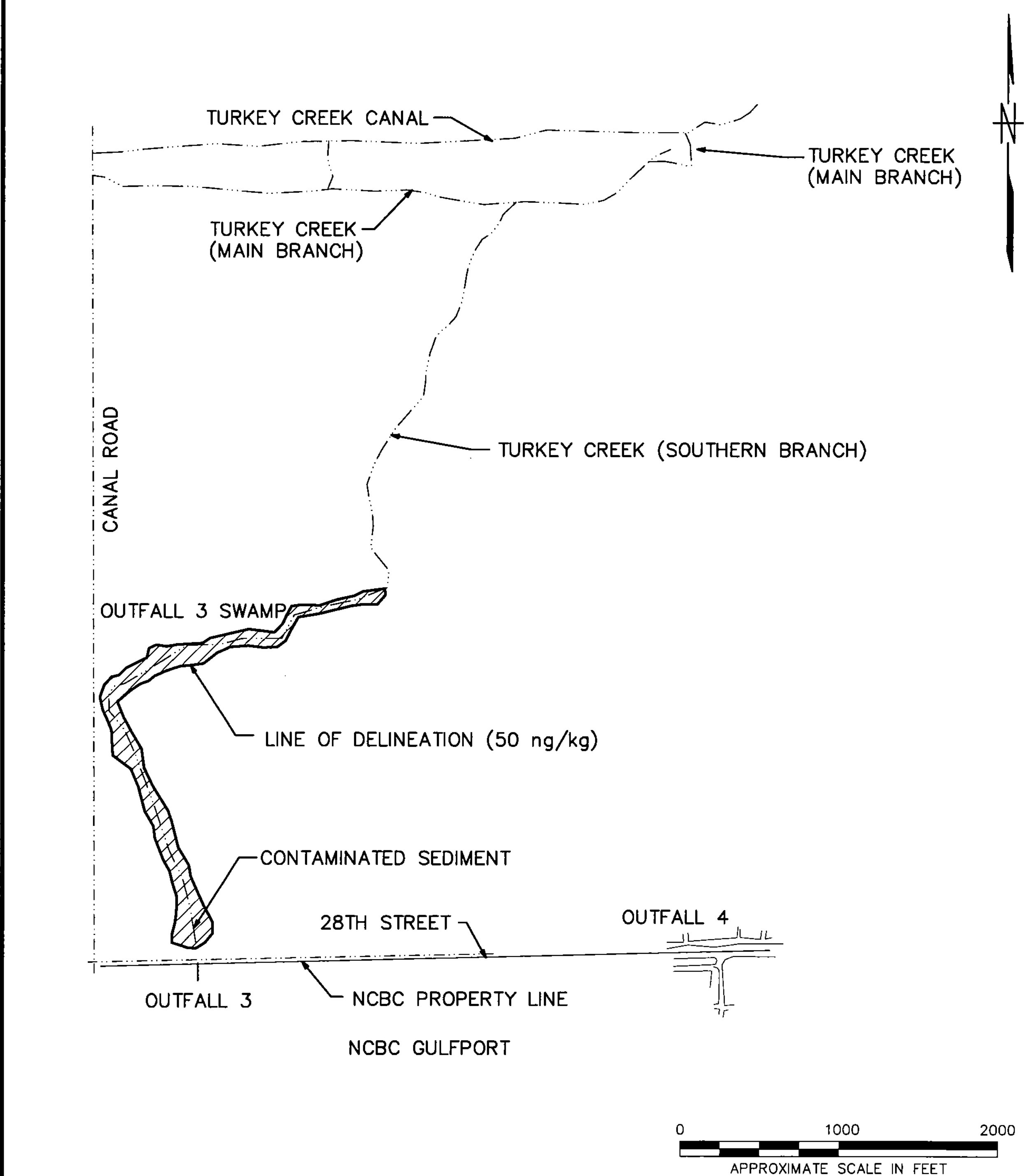
DEPARTMENT OF THE NAVY ★ SOUTHERN DIV FACILITIES ENGINEERING COMD

AREAL EXTENT OF ON-BASE CONTAMINATED MEDIA
SITE 8 FFS
NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

CONTRACT NO. 0567
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-2
REV. 2

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

ACAD:0567CM37.dwg 03/07/03 HJB PIT



SOURCE: REMEDIATION GUIDANCE DOCUMENT, HARDING LAWSON ASSOCIATES, MARCH 2000.

DRAWN BY HJB — DATE 3/7/03	DEPARTMENT OF THE NAVY ★ SOUTHERN DIV FACILITIES ENGINEERING COMD ★	**AREAL EXTENT OF OFF-BASE CONTAMINATED MEDIA SITE 8 FFS NAVAL CONSTRUCTION BATTALION CENTER GULFPORT, MISSISSIPPI**	CONTRACT NO. 0567
CHECKED BY — DATE			APPROVED BY — DATE
COST/SCHED-AREA			APPROVED BY — DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-3 — REV. 2

FORM CADD NO. SDIV_AV.DWG – REV 0 – 1/20/98

3.0 SCREENING OF REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

This section identifies, screens, and evaluates the potential remediation technologies and process options that may be applicable to soil, soil ash, and sediment remedial alternatives for Site 8 at NCBC Gulfport. The primary objective of this phase of the FFS is to develop an appropriate range of remedial technologies and process options that will be used for developing remedial alternatives.

The basis for remediation technology identification and screening began in Section 2.0 with a series of discussions that included the following:

- Identification of ARARs
- Development of RAOs
- Identification of GRAs
- Identification of volumes and areas of media of concern

Remediation technology screening is performed in this section with the completion of the following analytical steps:

- Identification and screening of remediation technologies and process options
- Evaluation and selection of representative process options

In this section a variety of remediation technologies and process options is first identified for each of the GRAs listed in Section 2.3 and then screened. The selection of remediation technologies and process options for initial screening is based on the Guidance for Conducting Remedial Investigations/Feasibility Studies under CERCLA (USEPA, 1988). The screening is first conducted at a preliminary level to focus on relevant remediation technologies and process options. Then the screening is conducted at a more detailed level based on certain evaluation criteria. Finally, process options are selected to represent the remediation technologies that have passed the detailed evaluation and screening.

The evaluation criteria for detailed screening of remediation technologies and process options that have been retained after the preliminary screening are effectiveness, implementability, and cost. The following are descriptions of these evaluation criteria:

- Effectiveness
  - Protection of human health and environment; reduction in toxicity, mobility, or volume; and permanence of solution.
  - Ability of the technology to address the estimated areas or volumes of contaminated media.
  - Ability of the technology to attain the PRGs required to meet the RAOs.
  - Technical reliability (innovative versus well-proven) with respect to contaminants and site conditions.

- Implementability
  - Overall technical feasibility at the site.
  - Availability of vendors, mobile units, storage and disposal services, etc.
  - Administrative feasibility.
  - Special long-term considerations (e.g., maintenance and operation requirements).

- Cost (Qualitative)
  - Capital cost.
  - Operation and maintenance (O&M) costs.

3.1 PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

This section identifies and screens remediation technologies and process options for soil, soil ash, and sediment at a preliminary stage based on implementation with respect to site conditions and contaminants of concern. Table 3-1 summarizes the preliminary screening of remediation technologies and process options. This table presents the GRAs, identifies the remediation technologies and process options, and provides a brief description of each process option followed by a screening comment.

The following are the soil, soil ash, and sediment remediation technologies and process options remaining for detailed screening:

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS
SITE 8 FOCUSED FEASIBILITY STUDY
NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI
PAGE 1 OF 4

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
GENERAL RESPONSE ACTION: NO ACTION				
No Action	No Action	No Action	Must be retained as baseline for comparison.	Yes
GENERAL RESPONSE ACTION: INSTITUTIONAL CONTROLS				
Access Restrictions	Deed Restrictions	Property deed would contain notice regarding site contamination and would restrict disturbance of soil and sediment.	Would prevent exposure of human receptors. Would not prevent exposure of ecological receptors. Could be used in conjunction with containment response actions.	Yes
	Fencing	A physical barrier would prevent unauthorized site access.	Would prevent exposure of human receptors. Would not prevent exposure of ecological receptors. Could be used in conjunction with containment.	Yes
Monitoring	Monitoring	Sampling and analysis of environmental media.	Would assess on-site contaminant concentrations and off-site contaminant migration.	Yes
GENERAL RESPONSE ACTION: CONTAINMENT				
Capping	Permeable Cap	Soil and/or geotextile membrane cover placed over contaminated areas to minimize direct contact and erosion.	Would not reduce toxicity of contaminants, but would provide a barrier to direct exposure pathways. Could be used for in-situ or ex-situ containment of contaminated media. Would not be compatible with swampland restoration.	Yes
	Impervious Cap	Clay, and/or asphalt, and/or membrane cover placed over contaminated areas to minimize direct contact, erosion, and migration to groundwater.	Would not reduce toxicity of contaminants, but would provide a barrier to direct exposure pathways. Could be used for in-situ or ex-situ containment of contaminated media. Would not be compatible with swampland restoration.	Yes
Surface Water Controls	Vertical Barriers	Use of sheet pilings and silt curtains to minimize sediment transport.	Would not reduce toxicity of contaminants, but would minimize contaminant migration during sediment dredging.	Yes
	Site Grading and Stormwater Management	Grading and stormwater diversion systems to prevent transport of contaminants from surface soil or sediment.	Would not reduce contaminant toxicity but would reduce contaminant migration due to erosion. Would be effective for runoff diversion during excavation or dredging.	Yes
GENERAL RESPONSE ACTION: REMOVAL				
Excavation	Mechanical	Physical removal of contaminated soil by mechanical equipment such as backhoe, bulldozer, loader, etc.	Would be effective for the removal of contaminated soil and drier sediment.	Yes
Dredging	Mechanical	Physical removal of contaminated sediment by mechanical dredging type equipment.	Would be effective for the removal of the wetter contaminated sediment. Maximizes solids concentrations of removed sediment.	Yes
	Hydraulic	Removal of contaminated sediment in a liquid slurry form.	Would be effective for the removal of the wetter contaminated sediment but would generate excessive volumes of wastewater.	No
	Pneumatic	Air conveyance type pump hydraulically removes contaminated sediment.	Typically applicable to deep sediment. Not applicable to shallow depths such as 4 feet or less at this site.	No
GENERAL RESPONSE ACTION: IN SITU TREATMENT				
Biological	Aerobic Degradation	Enhancement of natural biological activity by the addition of oxygen, nutrients and sometimes cultured microorganisms.	Aerobic biodegradation might be effective for dioxin in combination with an anaerobic biodegradation. However, implementation in non-homogeneous site conditions would be difficult. Not proven in field scale for dioxin treatment.	No

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS
SITE 8 FOCUSED FEASIBILITY STUDY
NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
		GENERAL RESPONSE ACTION: IN SITU TREATMENT (continued)		
Biological (continued)	Anaerobic Degradation	Anaerobic microbial species and conditions are developed to enhance utilization of target compounds.	Anaerobic biodegradation might be effective for dioxin in combination with aerobic degradation. However, in-situ implementation in non-homogeneous site conditions would be difficult. Not proven in field scale for dioxin treatment.	No
Physical/ Chemical	Soil Venting/Air Sparging	Injection and extraction wells pump ambient air through soil to remove contaminants.	Not effective for relatively nonvolatile organic compounds such as dioxin. Would be difficult to implement due to the shallow depth of contaminated soil/sediment.	No
	Soil Washing	Removal of contaminants from soil by flushing soil with aqueous surfactants or solvents.	Would be marginally effective due to the relatively low solubility of dioxin. Would be difficult to implement due to the shallow depth of contaminated soil/sediment.	No
	Steam Injection	Steam is injected into the soil to enhance the recovery of petroleum hydrocarbons.	Would be marginally effective due to the low volatility of dioxin. Would be difficult to implementt due to the shallow depth of contaminated soil/sediment.	No
	Stabilization	Subsurface materials solidified, fixated or encapsulated to prevent leaching of contaminants.	Would impact site hydrogeology and might impede wetland restoration.	No
Thermal	Vitrification	Electrically heating contaminated materials into a glass/crystalline structure.	Relatively unproven technology. Would not be applicable to the wetter sediment.	No
	Electro-Acoustic	Application of direct current and acoustic fields to increase migration of leachable contaminants through material.	Technology is in the research and development stage. Removal of dioxin by leaching is questionable because of its very low mobility.	No
	Radio-Frequency Destruction	Radio-frequency electrodes placed along the ground surface heat the subsurface and volatilize and/or destroy organics.	Technology is in the research and development stage. Removal of dioxin by leaching is questionable because of its very low mobility.	No
		GENERAL RESPONSE ACTION: EX-SITU TREATMENT		
Biological	Landfarming	Controlled application of contaminated soil, nutrients, and microbes to land area that is tilled.	Not proven on a large scale for dioxin. Would require spreading of contaminated soil and sediment over a large area. No site available for this application.	No
	Composting	Degradation of wastes using thermophilic aerobic microbes under forced air conditions.	Not proven for dioxin. Would require upfront anaerobic dechlorination.	No
	Bioslurry	Enhanced biodegradation by increasing the mass transfer of organic compounds into the aqueous phase.	Not proven on a large scale for dioxin. Questionable effectiveness for dioxin degradation and difficult to implement with silty loam material mixed with vegetative material.	No
	Anaerobic Degradation	Anaerobic microbial species and conditions are developed to enhance utilization of hazardous constituents.	Not proven on a large scale for dioxin. Anaerobic biodegradation may be effective when followed by aerobic degradation. Implementation would be easier than with in-situ treatment because of better process control.	No

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS
SITE 8 FOCUSED FEASIBILITY STUDY
NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI
PAGE 3 OF 4

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
		GENERAL RESPONSE ACTION: EX-SITU TREATMENT (continued)		
Physical/ Chemical	Steam Stripping	Steam is pumped through contaminated soil to remove contaminants.	Marginally effective for low volatility organic compounds such as dioxin.	No
	Air Stripping	Air is pumped through contaminated soil to remove contaminants.	Not effective for low volatility organic compounds such as dioxin.	No
	Dechlorination/ Hydro-dehalogenation	Chemical dechlorination using a sodium reagent (HAPEG).	Treated solids/wastewater phase separation would be difficult to implement for silty/loam soil and sediment mixed with vegetative matter.	No
	Oxidation	Process by which oxidizing agents decompose organic compounds to carbon dioxide and water, and inorganic compounds to salts.	Treated solids/wastewater phase separation would be difficult to implement for silty/loam soil and sediment mixed with vegetative matter.	No
	Dewatering	Use of passive, gravity-aided removal of excess water from soil/sediment or use of a mechanical technique such as centrifuge, filter press, etc.	May be effective as pretreatment to reduce moisture content.	Yes
	Soil Washing/ Acidic Leaching	Extraction of contaminants from soil by aqueous solutions and solvents.	May be effective for dioxin. Treated solids/wastewater phase separation would be difficult to implement for silty/loam soil and sediment mixed with vegetative matter. Acid would adversely impact soil/sediment geochemistry and make them unsuitable for on-base reuse.	No
	Solvent Extraction	Extraction of contaminants from soil by use of solvents or superficial fluids.	May be effective for dioxin. Treated solids/wastewater phase separation would be difficult to implement for silty/loam soil and sediment mixed with vegetative matter.	No
	Supercritical Fluid Extraction	Use of supercritical carbon dioxide to extract organic contaminants.	Bench-scale studies show that the process is effective for dioxin. But the technology has not been demonstrated in the field.	No
	Stabilization/ Fixation	Excavated material is stabilized/fixated to improve bearing capacity and/or minimize leaching of contaminants.	Would improve load-bearing characteristics of soil/sediment. Might reduce mobility of dioxin-contaminated soil and sediment but would not reduce their toxicity and would still require containment.	Yes
Thermal	Incineration	High temperature oxidation of organics in a controlled combustion process.	Very effective in destroying all types of organic contamination.	Yes
	Pyrolysis	High temperature heating of materials in the absence of air to thermally degrade wastes to a volatile gaseous portion and residual solid comprised of fixed carbons and ash.	Very effective in destroying organic contamination.	Yes
	Thermal Desorption	Separation of contaminants from solids by heating the mixture to drive off contaminants.	Potentially effective for removal of dioxin from contaminated soil/sediment. Would not by itself destroy dioxin and would require further treatment and/or disposal of residuals.	No

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS
SITE 8 FOCUSED FEASIBILITY STUDY
NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
		GENERAL RESPONSE ACTION: DISPOSAL		
On-Base Landfill	Solid Waste Disposal Area	Removal and transportation of wastes to an existing or newly constructed landfill on-base permitted to handle nonhazardous solid waste.	Site 8A would be well suited for construction of a new landfill.	Yes
	RCRA Landfill	Removal and transportation of wastes to an existing or newly constructed landfill on-base permitted to handle dioxin and/or hazardous waste.	Not required. No site available on-base for such a landfill.	No
Off-Base Landfill	Solid Waste Disposal Area	Removal and transportation of wastes to an existing landfill permitted to handle nonhazardous solid waste.	Applicable to non-RCRA wastes such as soil/sediment at this site.	Yes
	RCRA Landfill	Removal and transportation of wastes to an existing landfill permitted to handle dioxin and/or hazardous waste.	Applicable to all types of wastes.	Yes
On-Base Reuse	Fill after Treatment	Use of treated soil as landfill material in non-regulated areas.	Not applicable because of degree of treatment required to meet PRGs is typically not achievable.	No
Off-Base Reuse	Use in Asphalt Batch Plant	Removal and transportation of wastes to an existing batch plant to be used as supplemental aggregate. In the aggregate kiln, organics are volatized and incinerated.	Primarily applicable to petroleum hydrocarbons and PAH. Not applicable to dioxin contaminated soil/sediment.	No
	Fill after Treatment	Use of treated sediment as landfill material in non-regulated areas.	High degree of treatment required for soil to be classified as "clean" fill. There are potential long term liabilities associated with this option.	No
	Fuel for Boilers or Kilns	Use of wastes as supplemental fuel in industrial boilers or kilns.	Wastes must have heat value generally greater than 5,000 BTU/lb. None of the soil or sediment meet this criterion.	No

GRA	Remediaton Technology	Process Options
No Action	None	Not Applicable
Limited Action	Institutional Controls	Access Restrictions (fencing) and Post-Removal Site Controls (PRSCs)
	Monitoring	Sampling and Analysis
Containment	Capping	In-Situ or Ex-Situ Permeable or Impervious Cover System
	Surface Water Controls	Vertical Barriers, Site Grading, Storm Water Management
Removal	Mechanical Removal	Excavation and Dredging
Ex-Situ Treatment	Physical	Dewatering
	Chemical	Stabilization/Fixation
	Thermal	Incineration, Pyrolysis
Discharge/Disposal	Landfilling	On-Base Landfilling
		Off-Base Landfilling

3.2 DETAILED SCREENING OF REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

3.2.1 No Action

No action consists of maintaining status quo at the site. As required under CERCLA regulations, the No Action alternative is carried through the FFS to provide a baseline for comparison of alternatives and their effectiveness in mitigating risks posed by site contaminants. Since no remedial actions are conducted under this alternative, there are no costs associated with "walking away from" the site. Neither is there a reduction in risk through exposure control or treatment.

Effectiveness

No action would not be effective in meeting the RAOs for the site. No action would not be effective in evaluating either potential contaminant reduction through natural attenuation or potential contaminant migration off-site since no monitoring would be performed.

Implementability

There would be no implementability concerns since no actions would be implemented.

Cost

There would be no costs associated with no action.

Conclusion

No action is retained for comparison to other options.

3.2.2 Limited Action

3.2.2.1 Institutional Controls

Institutional controls would consist of access restrictions and PRSCs. Access restrictions would consist of fencing the site to prevent access to trespassers. Site security to prevent trespassing would also be assumed to be present as long as the Navy continues to own the property. PRSCs would consist of prohibiting use of surface water and groundwater and placing restrictions on the sale and transfer of property.

Effectiveness

Access restrictions and PRSCs would be effective in preventing unacceptable risk from exposure of human receptors to contaminated soil, soil ash, sediment, surface water, and groundwater. However, ecological receptors would not be protected. Therefore, institutional controls cannot be used as a permanent solution that would protect ecological receptors.

Implementability

Institutional controls would be implementable. Legal requirements for property transfer would need to be met in the event of base closure. Fencing and site security would be implementable.

Cost

Costs associated with institutional controls would be low to moderate. The costs would be typically a minor component when included in remedial actions.

Conclusion

Institutional controls are retained in combination with other process options for the development of remedial alternatives.

3.2.2.2 Monitoring

Monitoring would consist of periodically taking samples of soil, soil ash, sediment, surface water, and groundwater to assess the migration of contaminants in the environment. Monitoring would also include assessing site restoration following remediation.

Effectiveness

Monitoring would not of itself remedy soil, soil ash, sediment, surface water, and groundwater contamination, but it would be an effective tool to evaluate potential migration of contaminants and to determine the direction of future actions if adverse effects to human or ecological receptors occur. Monitoring during remedial activity would be an important tool to minimize adverse effects to the human health and the environment during remedial activity and also to determine if PRGs are being met.

Implementability

A soil, soil ash, sediment, surface water, and groundwater monitoring program would be readily implementable.

Cost

Costs associated with monitoring would be moderate. Except for dioxin analyses, sampling costs would be low.

Conclusion

Monitoring is retained in combination with other process options for the development of remedial alternatives.

3.2.3 Containment

3.2.3.1 Capping

Capping would consist of placing a horizontal cover system over the contaminated soil, soil ash, and sediment. The cover system could either be placed in-situ, i.e., without prior removal of the contaminated media, or ex-situ, i.e., after the contaminated media have been removed and stockpiled in a remote area. The cover system could be permeable or impervious. A permeable cover system typically consists of a layer of clean soil ash with or without a geotextile membrane and a topsoil vegetative cover. An impervious cover system typically consists of a layer of compacted clay with one or more impervious membranes and, depending on the final use of the site, either a topsoil vegetative cover or a hard asphalt or concrete surface.

Effectiveness

Capping with a permeable or impervious cover would not reduce dioxin concentration but it would effectively minimize exposure of human and ecological receptors from direct contact with contaminated soil, soil ash, and sediment. Capping with a permeable or impervious cover would also be effective in reducing contaminant migration through erosion. Capping with an impervious cover would also minimize potential contaminant migration to groundwater through infiltration and would generally provide more durable protection because of more substantial construction. In-situ capping of the Area 8A incinerated soil ash would not be effective because these ashes are currently stored in discrete stockpiles which would lead to an ineffective cover system design. Use of an impervious cover system would be required for effective in-situ capping of the on-base drainage ditch and off-base swampland sediment because of the potential for the cover to be submerged. Because of this, there would also be a concern about the long-term effectiveness of the in-situ capping of these areas and frequent inspections of the cap integrity would be required.

Implementability

Ex-situ capping of soil, incinerated soil ash, and sediment after their removal would be easy to implement. In-situ capping of the Area 8A incinerated soil ash would be somewhat more difficult because of the previously-mentioned multiple stockpile configuration. In-situ capping of the on-base drainage ditch sediment would be more difficult yet, as it would require temporary surface water diversion in the areas to be capped. Capping of the off-base swampland areas would be most difficult because, in addition to temporary surface water diversion, it would also require removal and disposal of the existing vegetation and wetland restoration. Specialized tracked and/or amphibious equipment might also be required for construction of a cap in the off-base swampland area. However, in all cases, capping would be implementable and the necessary resources, equipment , and material are readily available.

Cost

The capital and O&M costs of ex-situ capping would be low to moderate. The capital and O&M costs of in-situ capping would be moderate to high.

Conclusion

Ex-situ capping with an impervious cover is retained in conjunction with other remedial technologies for the formulation of remedial alternatives because it would be most effective and easiest to implement. In-situ capping is eliminated from further consideration because of long-term effectiveness and implementability concerns.

3.2.3.2 Surface Water Controls

Surface water controls would consist of using vertical barriers, site grading, and storm water diversion to contain or divert surface or storm water so as to minimize the potential for infiltration and/or migration of contaminated soil, soil ash, and sediment.

Vertical barriers would consist of sheet piling and silt curtains. Sheet piling are impervious barriers that would be installed around areas to be remediated to divert surface water from these areas. Silt curtains are permeable barriers that would be installed immediately downstream/downgradient from areas of concern to prevent migration of contaminated soil ash or sediment from these areas.

Site grading would consist of imparting to the areas being remediated a grade sufficient to prevent accumulation of storm water in these areas.

Storm water diversion would consist of installing structures, such as ditches or culverts, around the areas to be remediated to intercept storm water and divert it away from these areas.

Effectiveness

Surface water controls would not reduce dioxin concentrations but they would generally be effective in diverting surface water from areas being remediated and minimizing migration of contaminated soil ash or sediment particles entrained in surface water.

Sheet piling in conjunction with pumping would be effective in diverting water around specific sections of the on-base drainage ditches or designated areas of the off-base swampland. The effectiveness of sheet piling for containment of surface water will be verified through pilot-scale testing. Silt curtains would be effective for capturing suspended soil ash or sediment particles resulting either from natural surface water erosion or on-going remedial activities, such as excavation or dredging.

Proper site grading is a well-proven method of avoiding accumulation of storm water in environmentally-sensitive areas to minimize potential for infiltration which could result in contaminant migration from soil ash or sediment to groundwater. Site grading criteria are typically included in the design requirements of a landfill cover system.

Storm water diversion systems would effectively reduce and control the flow of storm water running on the remediation areas, thereby minimizing the potential for erosion or infiltration. As with site grading, storm water diversion systems are typically included in the design requirements of a landfill cover system.

Implementability

Surface water controls would be easy to implement. The resources, equipment, and materials required for the installation and maintenance of sheet piling and silt curtains, the grading of sites, and the installation and maintenance of storm water diversion systems are readily available.

Cost

The cost of installing, operating, and maintaining sheet piling and pumping systems would be low to moderate, depending on the size of the area around which surface water would have to be diverted. The cost of installing, operating, and maintaining silt curtains would be low. The cost of site grading would be low to moderate, depending on initial topography and predicted hydrology. The cost of installing storm water diversion systems would be low to moderate.

Conclusion

Surface water controls, including sheet piling and silt curtains, site grading, and storm water diversion systems are retained in conjunction with other remedial technologies for the formulation of remedial alternatives for the on-base drainage ditches and off-base swampland sediment.

3.2.4 Removal

The two technologies being considered for removal are mechanical excavation and mechanical dredging. Mechanical excavation would be performed with a front-end loader for the removal of dry media such as soil ash, and with a Gradall-type excavator for the removal of wetter media such as drainage ditch or swampland sediment. Mechanical dredging would be performed with a drag line for the removal of drainage ditch and swampland sediment.

Effectiveness

Removal would not reduce dioxin concentrations but it would be an effective means for removing from the site any soil, soil ash, and sediment with a dioxin concentrations greater than the PRGs. The use of a front end loader is a well-proven and generally accepted method for the excavation of a dry material, such as the Area 8A incinerated soil ash. Use of a Gradall-type excavator should be well-suited for the mechanical excavation of sediment in drainage ditches or swampland areas and the effectiveness of this technology was verified through pilot-testing (TtNUS, 2001). Mechanical dredging with a dragline would also be effective for the removal of drainage ditch and swampland sediment, but it would entrain more water than a Gradall-type excavator and therefore result in a wetter removed material. Mechanical excavation or dredging would permanently remove contaminated sediment from the off-base swampland but it would also essentially destroy the ecological habitat of the dredged areas, which would subsequently require a relatively lengthy restoration.

Implementability

Removal of contaminated soil, soil ash, and sediment through mechanical excavation or mechanical dredging would be easy to implement. The necessary resources, equipment, and materials are readily available. Depnding on site conditions at the time of excavation in the off-base swampland, specialized tracked or even amphibious equipment may be required to access the areas to be dredged.

Cost

The cost of removal of contaminated soil, soil ash, and sediment through mechanical excavation or mechanical dredging would be low to moderate, depending on the ease of access of the areas to be excavated and the extent of the needed site restoration.

Conclusion

Mechanical excavation with a front-end loader is retained for the removal of the Area 8A incinerated soil. Mechanical excavation with a Gradall-type excavator is retained for the removal of drainage ditch and swampland sediment. Mechanical dredging is eliminated from further consideration because it is not expected to be as effective as mechanical excavation.

3.2.5 Ex-Situ Treatment

Dewatering, chemical stabilization, and thermal treatment are the technologies being considered for ex-situ treatment.

3.2.5.1 Dewatering

Dewatering is a process for reducing the free water content of solid wastes. Dewatering would likely be required to reduce the free water present in the contaminated sediment removed from certain sections of the on-base drainage ditches and off-base swampland to improve handling and reduce volumes/weights prior to additional treatment and disposal.

Dewatering can be achieved either through passive (gravity-aided) decantation, such as drainage of free water from stockpiled material or by mechanical expression. Depending on the physical characteristics of the material to be dewatered, specialized mechanical equipment such as belt filter presses, plate-and-frame filter presses, vacuum filters, centrifuges, etc., may be used.

Stockpiling of wet sediment on a lined pad would cause most of the free water to decant from that sediment due to gravity and to some extent to mechanical compression of the lower layers of stockpiled sediment by the weight of the upper layers. The separated water could then be collected into a sump. If necessary, the removed free water would be treated on site using such technologies as granular activated carbon (GAC) adsorption prior to discharge to local surface water or sewage treatment system.

Mechanical dewatering techniques would utilize pressure, vacuum or centrifugal forces to force the liquid phase through semipermeable membranes or to separate free water from sediment. As with stockpiling, the released water would be treated if required and discharged to local surface water or sewage treatment system.

Effectiveness

Both stockpiling and mechanical dewatering would be effective in removing sufficient water from sediment excavated from certain areas of the on-base drainage ditches and off-base swampland, so that this sediment can be more easily and effectively be transported, treated, and disposed. Mechanical dewatering is usually more efficient than stockpiling because the rate and extent of dewatering are usually higher when forces greater than gravity alone are applied to separate solids from liquids. However, the presence of significant fractions of vegetative matter (i.e., matted leaves, twigs and stems) would be expected to make mechanical expression of water difficult. The effectiveness of stockpiling was verified through pilot-scale testing (TtNUS, 2001).

Implementability

Stockpiling and mechanical dewatering would be relatively easy to implement. The resources, equipment, and materials required for the application of both technologies are readily available. Stockpiling would be simpler to implement than mechanical dewatering but would require significantly more space. Mechanical dewatering equipment, unlike stockpiling, would also require electrical power (that may not be readily available on site) for their operation. Moreover, mechanical equipment typically would require more maintenance and service than stockpiling.

Cost

The capital and O&M costs of stockpiling would be low. The capital and O&M costs of mechanical dewatering would be moderate.

Conclusion

Stockpiling is retained in conjunction with other remedial technologies for the formulation of remedial alternatives for soil, soil ash, and sediment. Mechanical dewatering is eliminated from further consideration because its greater effectiveness is not required and it would be more difficult and more costly to implement than stockpiling. Also, abundant space is available at Area 8A for stockpiling.

3.2.5.2 Chemical Stabilization/Fixation

Chemical stabilization/fixation would consist of blending the material to be treated with one or more chemical additives, typically pozzolanic products such as Portland Cement or cement kiln dust (CKD). Typically, the chemical additive is blended with the material to be treated by a mechanical device such as a pug mill. Alternately, when space is available and the treated material is to be left in place, the blending can be accomplished by spreading the additive over a layer of the material to be treated and working it in with such equipment as discs. The chemical additives react with the matrix of the treated material to create a lattice network which limits the mobility of certain contaminants. Chemical stabilization can also be used to improve the geotechnical characteristics of weak materials and make them suitable for use as structural fill. For the remediation of Site 8, both of these aspects of chemical stabilization are required.

Effectiveness

Chemical stabilization is a very well proven technology for the treatment of soil, soil ash, and sediment to immobilize inorganic compounds such as metals. Chemical stabilization has also been proven effective for the fixation of relatively low concentrations of high molecular weight low-mobility organic compounds such as PAHs, PCBs, and dioxin. The effectiveness of chemical stabilization for the treatment of the dioxin-contaminated soil, soil ash, and sediment at Site 8 was verified through bench-and pilot-scale testing (TtNUS, 2000 and 2001).

Implementability

Chemical stabilization would be easy to implement. The resources, equipment and material required for the implementation of this technology are readily available. Ease of implementation of the blending of chemical additives with Site 8 soil, soil ash, and sediment through spreading and disking in was verified through pilot-scale testing (TtNUS, 2001).

Cost

The capital and O&M costs of chemical stabilization would be low.

Conclusion

Chemical stabilization is retained in conjunction with other remedial technologies for the formulation of remedial alternatives for soil, soil ash, and sediment.

3.2.5.3 Thermal Treatment

The two technologies being considered for thermal treatment are incineration and pyrolysis. These technologies differ mainly in operating conditions, such as the presence or absence of oxygen, the type of carrier gas, and in the nature of the waste residues produced. Either of these remedial technologies could be used as part of off-site disposal.

Incineration uses very high temperatures (1,400 to 2,200°F) to volatilize the contaminants and combust them in the presence of excess air. Commercial units are typically rotary kilns equipped with an after burner. The rotary kiln is a refractory-lined, slightly-inclined, rotating cylinder wherein the wastes are fed at one end and discharged as ash on the other end. The off-gases are treated to remove particulates (in a baghouse), quenched to cool, and scrubbed to remove the acid gases formed by the combustion of organics. For dioxin destruction, the operating temperature would have to be high enough (around 2,200°F) to achieve complete combustion.

Pyrolysis is the chemical decomposition of organic compounds in an oxygen-deficient atmosphere. This requires temperatures exceeding 800°F under a vacuum or under pressure with an oxygen-free atmosphere. The products of pyrolysis are vaporized organics, concentrated liquids, water vapor, and ash. Depending on the composition of the waste that is being treated, combustible gases (such as hydrogen and methane) may also be formed. If other volatiles in the gas do not adversely impact its heating value, the gases from pyrolysis may be used as fuel. However, such an ideal situation is less likely for applications other than wastes containing predominantly vegetative material. Pyrolysis is an emerging technology for the treatment of wastes.

Effectiveness

Incinerators would be effective for removal of dioxin from soil ash/sediment. Pyrolytic units are also expected to be effective but their efficiency is not as well proven on a field scale. Incineration and pyrolysis can achieve destruction and removal efficiency (DRE) in excess of 99.99 percent and incineration has previously been successfully at Site 8 for the treatment of highly contaminated soil ash. For treatment of materials with low concentrations of dioxin, such as the remaining contaminated soil and sediment at NCBC Gulfport, incineration would be more effective than pyrolysis, although it may not achieve the 99.9999 percent DRE that is currently mandated for dioxin. Thermal treatment is an irreversible and permanent technology for removal/destruction of organics.

Implementability

Incineration and pyrolysis would be implementable. A very limited number of contractors could provide this service. Extensive waste characterization and trial burning would likely be required prior to acceptance of the contaminated soil, soil ash, and sediment. Rigorous manifesting would also be required for transportation of this material from NCBC Gulfport to the incineration or pyrolysis facility.

Cost

The unit cost of incineration and pyrolysis would be very high.

Conclusion

Although there are some concerns about its effectiveness and implementability, incineration is retained as the thermal treatment option of choice for the formulation of remedial alternatives because this technology remains one of the very few proven means of dioxin destruction. Pyrolysis is eliminated from further consideration because its effectiveness is not as well proven as that of incineration.

3.2.6 Disposal

The two technologies being considered for disposal are on-base and off-base landfilling. As previously mentioned, the thermal treatment technologies evaluated above can also be considered as off-base disposal options.

3.2.6.1 On-Base Landfilling

The contaminated soil, soil ash, and sediment at Site 8 are expected to be non-hazardous because the maximum detected dioxin concentration was 4.0 μg/kg, which corresponds to an ILCR of 5.0E-04, whereas USEPA has established that the ILCR threshold for establishing a waste as hazardous is 1.0E-03. Therefore, only non-hazardous solid waste landfilling is considered.

Non-hazardous solid waste landfilling is regulated by state and local municipal regulations. Typically, non-hazardous solid waste landfills cannot accept wastes that contain free liquids and fail the "Paint Filter

Liquids Test", as defined by USEPA SW-846, Method 9095. Also the cover system of non-hazardous landfills typically consist of multiple layers of compacted impervious material, such as clay, and synthetic membrane with a minimum overall thickness of two feet. The top layer of the cover system is typically to consist either of vegetated topsoil or, if the surface of the landfill is to be used as a storage or parking area, of roadway asphalt or concrete. To promote stability, the sides of the landfill cover must not exceed a certain slope, typically 25 percent. To prevent water accumulation the top of the landfill cover is typically sloped a minimum of 2 percent and a maximum of 5 percent. If necessary, a leachate collection and treatment system is provided.

Effectiveness

Landfilling would not permanently and irreversibly reduce the dioxin concentrations in the soil, soil ash, and sediment. CERCLA preference for treatment relegates landfilling to a less preferable option, however, it can be an effective disposal option for lightly-contaminated media, such as the soil, soil ash, and sediment at Site 8. The effectiveness of a landfill as a means of disposal is secured by the standards which regulate its design, construction, and operation and maintenance.

Implementability

On-base landfilling would be implementable. The space for such a landfill is available at Area 8A and, following remediation at the completion of the landfill, this space could be used for the storage of heavy equipment. The resources, equipment, and material required for the design, construction, and maintenance of such a landfill are readily available.

Cost

The capital cost of on-base landfilling would be moderate. The O&M costs would be low.

Conclusion

On-base landfilling is retained in conjunction with other remedial technologies for the formulation of remedial alternatives for soil, soil ash, and sediment.

3.2.6.2 Off-Base Landfilling

Off-base landfilling would be identical to on-base landfilling, except that it would involve transportation of the contaminated soil, soil ash, and sediment to a remote facility.

Effectiveness

Off-base landfilling would be as effective as on-base landfilling. However, transportation of contaminated soil, soil ash, and sediment to a remote disposal site would introduce an additional element of risk due to potential spillage.

Implementability

Off-base landfilling would be implementable. A number of permitted facilities are available which could provide this service. The administrative aspects of off-base landfilling would be significantly more complex than those of on-base landfilling due to the need for more rigorous waste profiling as part of the acceptance process and because of the waste manifesting associated with off-site transportation.

Cost

The unit cost of off-base landfilling would be moderate.

Conclusion

Off-base landfilling is eliminated from further consideration because it would be no more effective than on-base landfilling, but would be more difficult to implement and more costly.

3.3 SELECTION OF REPRESENTATIVE PROCESS OPTIONS

The following technologies and process options are retained for the formulation of soil, soil ash, and sediment remedial alternatives for Site 8:

- No Action
- Institutional Controls (fencing and PRSCs)
- Monitoring
- Ex-Situ Capping (impervious cover system)
- Surface Water Controls (sheet piping, silt curtains, site grading, storm water diversion)
- Mechanical Excavation
- Gravity Dewatering
- Chemical Stabilization/Fixation
- On-Base Landfilling
- Off-Base Incineration

4.0 ASSEMBLY AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

4.1 INTRODUCTION

This section presents an evaluation of each remedial alternative with respect to the criteria of the NCP of 40 Code of Federal Regulations (CFR) Part 300, as revised in 1990. The criteria as required by the NCP and the relative importance of these criteria are described in the following subsections.

4.1.1 Evaluation Criteria

In accordance to the NCP (40 CFR 300.430), the following nine criteria are used for the evaluation of remedial alternatives:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs
- Long-term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, and Volume through Treatment
- Short-term Effectiveness
- Implementability
- Cost
- State Acceptance
- Community Acceptance

4.1.1.1 Overall Protection of Human Health and the Environment

Alternatives must be assessed for adequate protection of human health and the environment, in both the short-and long-term, from unacceptable risks posed by hazardous substances, or contaminants present at the site. For this purpose, alternatives should eliminate, reduce, or control exposure to levels exceeding remediation goals. Overall protection draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

4.1.1.2 Compliance with ARARs

Alternatives must be assessed to determine whether they attain ARARs under Federal and state environmental or facility siting regulations. If one or more regulations that are applicable cannot be complied with, then a waiver must be invoked by the appropriate regulatory body for the alternative to be considered acceptable. Grounds for invoking a waiver would depend on the following circumstances:

- The alternative is an interim measure and will become part of a total remedial action that will attain the ARAR.

- Compliance will result in greater risk to human health and the environment.

- Compliance is technically impracticable from an engineering perspective.

- The alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, or limit through use of another method or approach.

- A state requirement has not been consistently applied, or the state has not demonstrated the intention to consistently apply the promulgated requirement in similar circumstances at other remedial actions within the state.

- For CERCLA-financed response actions only, an alternative that attains the ARAR will not provide a balance between the need for protection of human health and the environment at the site and the availability of CERCLA monies to respond to other sites that may present a threat to human health and the environment.

4.1.1.3 Long-term Effectiveness and Permanence

Alternatives must be assessed for the long-term effectiveness and permanence they offer, along with the degree of certainty that the alternative will prove successful. Factors that shall be considered as appropriate include the following:

- Magnitude of Residual Risk - Residual risk is risk posed by untreated waste or treatment residuals at the conclusion of remedial activities. The characteristics of residuals should be considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate.

- Adequacy and Reliability of Controls - Controls such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste must be shown to be reliable. In particular, the following should be addressed: the uncertainties associated with land disposal for providing long-term protection from residuals; the potential need to replace technical components of the alternative such as a cap, a slurry wall, or a treatment system; and the potential exposure pathways and risks posed should the remedial action need replacement.

4.1.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The degree to which the alternative employs recycling or treatment that reduces the toxicity, mobility, or volume shall be assessed, including how treatment is used to address the principal threats posed by the site. Factors that shall be considered, as appropriate, include the following:

- The treatment or recycling processes the alternative employs and the materials that they will treat.
- The amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled.
- The degree of expected reduction in toxicity, mobility, or volume of waste due to treatment or recycling and the specification of which reduction(s) are occurring.
- The degree to which the treatment is irreversible.
- The type and quantity of residuals that will remain following treatment considering the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents.
- The degree to which treatment reduces the inherent hazards posed by principal threats at the site.

4.1.1.5 Short-Term Effectiveness

The short-term impacts of the alternative shall be assessed considering the following:

- Short-term risks that might be posed to the community during implementation.
- Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures.
- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation.
- Time until protection is achieved.

4.1.1.6 Implementability

The ease or difficulty of implementing the alternatives shall be assessed by considering the following types of factors, as appropriate:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.

- Administrative feasibility, including activities needed to coordinate with other offices and agencies, and the ability and time required obtaining any necessary approvals and permits from other agencies (for off-site actions).

- Availability of services and materials, including the availability of adequate off-site treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure necessary additional resources; the availability of services and materials; and availability of prospective technologies.

4.1.1.7 Cost

Capital costs shall include both direct and indirect costs. Annual O&M costs shall be provided. A net present value of the capital and O&M costs shall also be provided. Typically, the cost estimate accuracy range is plus 50 percent to minus 30 percent.

4.1.1.8 State Acceptance

The state's concerns that must be assessed include the following:

- The state's position and key concerns related to the preferred alternative and other alternatives.
- State comments on ARARs or the proposed use of waivers.

These concerns cannot be evaluated at this time in the FFS until the state has reviewed and commented on the FFS. These concerns will be discussed, to the extent possible, in the proposed plan to be issued for public comment.

4.1.1.9 Community Acceptance

This assessment consists of responses of the community to the proposed plan. This assessment includes determining which components of the alternative interested persons in the community support, have reservations about, or oppose. This assessment can be done after comments on the proposed plan are received from the public.

4.1.2 Relative Importance of Criteria

Among the nine criteria, the threshold criteria are considered to be:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs (excluding those that may be waived)

The threshold criteria must be satisfied in order for an alternative to be eligible for selection.

Among the remaining criteria, the following five criteria are considered to be the primary balancing criteria:

- Long-term Effectiveness and Permanence
- Reduction of Contaminant Toxicity, Mobility, or Volume Through Treatment
- Short-Term Effectiveness
- Implementability
- Cost

The balancing criteria are used to weigh the relative merits of alternatives.

The remaining two of the nine criteria, namely: State Acceptance and Community Acceptance, are considered to be modifying criteria that must be considered during remedy selection. These last two criteria can be evaluated after the document has been reviewed by MDEQ and the proposed plan has been discussed in a public meeting. Therefore, this document addresses only seven out of the nine criteria.

4.1.3 Selection of Remedy

The selection of a remedy is a two-step process. The first step consists of identification of a preferred alternative and presentation of the alternative in a proposed plan to the community for review and comment. The preferred alternative must meet the following criteria:

- Protection of human health and the environment.
- Compliance with ARARs unless a waiver is justified.
- Cost effectiveness in protecting human health and the environment and in complying with ARARs.
- Utilization of permanent solutions and alternate treatment technologies or resource recovery technologies to the maximum extent practicable.

The second step consists of the review of the public comments and determination of whether or not the preferred alternative continues to be the most appropriate remedial action for the site, in consultation with the MDEQ.

4.2 ASSEMBLY OF REMEDIAL ALTERNATIVES

Based on the technology screening presented in Section 3.2, the following four remedial alternatives were developed.

- Alternative 1: No Action
- Alternative 2: Institutional Controls and Monitoring
- Alternative 3: Excavation, Surface Water Controls, Dewatering, Chemical Stabilization and On-Base Landfilling, Capping, Institutional Controls, and Monitoring
- Alternative 4: Excavation, Surface Water Controls, Dewatering, and Off-Base Incineration

Alternative 1 was developed and analyzed to serve as a baseline for other alternatives, as required by CERCLA and the NCP. Alternative 2 was formulated and analyzed to evaluate the adequacy of minimal action. Alternatives 3 and 4 were formulated and analyzed to evaluate active remediation of the contaminated soil, soil ash, and sediment. A description and detailed analysis of these alternatives are presented in the following sections.

4.3 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

4.3.1 <u>Alternative 1: No Action</u>

4.3.1.1 Description

The No Action alternative maintains the site as is. This alternative does not address the soil, soil ash, sediment, and groundwater contamination and is only retained to provide a baseline for comparison to other alternatives. There would be no reduction in toxicity, mobility, or volume of dioxin other than what might result from natural dispersion, dilution, biodegradation, and other attenuating factors. Existing monitoring programs and institutional controls would be discontinued, and the site would be available for unrestricted use.

4.3.1.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 1 would not provide protection of human health and the environment. Under the current land use scenarios (military for on-base, residential for off-base), the potential for unacceptable risks to human health from exposure to contaminated soil, soil ash, sediment, and groundwater would remain. Dioxin contamination might continue to migrate in the off-base swampland area and, since no monitoring would be performed, this potential migration would not be detected.

Compliance with ARARs and TBCs

Alternative 1 would not comply with chemical-specific ARARs or TBCs since no action would be taken to reduce contaminant concentrations. Compliance with location-specific ARARs or TBCs would be purely coincidental. Action-specific ARARs or TBCs are not applicable.

Long-term Effectiveness and Permanence

Alternative 1 would have no long-term effectiveness and permanence because contaminated soil, soil ash, sediment, and groundwater would remain on site. As there would be no institutional controls to control land use, the potential would exist for unacceptable risk to develop for human receptors. Since there would be no monitoring, potential dioxin migration would not be detected. Although dioxin concentrations might eventually decrease to acceptable levels through natural attenuation, no monitoring would verify this.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 would not reduce toxicity, mobility, or volume of dioxin through treatment since no treatment would occur. Some reduction of dioxin toxicity or volume might occur through natural dispersion, dilution, or other attenuation process but no monitoring would be performed to verify this.

Short-term Effectiveness

Since no action would occur, implementation of Alternative 1 would not pose any risks to on-site workers or result in short-term adverse impact to the local community and the environment. Alternative 1 would never achieve the RAOs and, although the dioxin PRGs might eventually be achieved through natural attenuation, no monitoring would verify this.

Implementability

Since no action would occur, Alternative 1 would be readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable. Implementability of administrative measures is not applicable since no such measures would be taken.

Cost

There would be no costs associated with the no action alternative.

4.3.2 Alternative 2: Institutional Controls and Monitoring

4.3.2.1 Description

Alternative 2 is illustrated on Figure 4-1 and would consist of two major components: (1) institutional controls and (2) monitoring.

Component 1: Institutional Controls

Institutional controls would consist of restricting access to areas of contaminated soil, soil ash, sediment, and groundwater and controlling future land use. Areas 8A, 8B, and 8C would continue to be fenced in and posted. Access to contaminated on-base drainage ditches and off-base swampland would be restricted and controlled through fencing and posting of warning signs. PRSCs would be formulated and implemented to prevent residential development of the off-base contaminated swampland and use of surface water and groundwater.

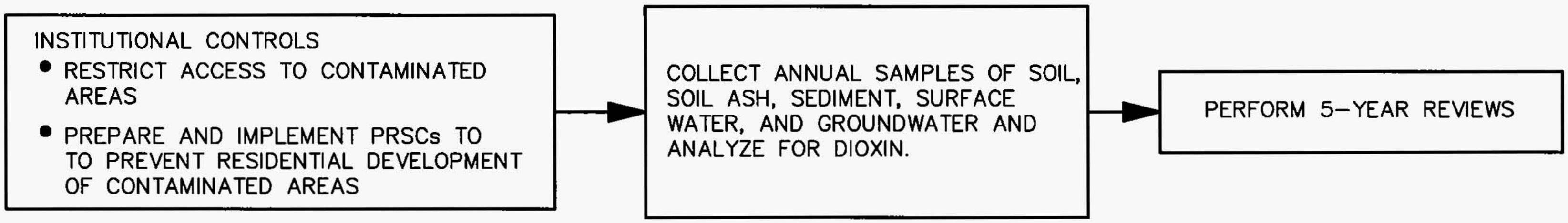
Component 2: Monitoring

Monitoring would consist of regularly collecting samples of soil, soil ash, sediment, surface water, and groundwater and analyzing these samples for dioxin. Samples would be collected both in the areas of known contamination to assess possible natural attenuation and immediately outside of these areas to detect potential migration. Monitoring would be performed with annual sampling for a period of 30 years. Every 5 years, the status of the site would be formally reviewed and evaluated to determine the continued effectiveness of this alternative.

ACAD: 0567PF04.dwg 11/28/01 HJB

080111/P

INSTITUTIONAL CONTROLS AND MONITORING



NOTE:

PRSCs POST-REMOVAL SITE CONTROLS

DRAWN BY DLT DATE 7/10/01	BLOCK FLOW DIAGRAM ALTERNATIVE 2 SITE 8 FFS NAVAL CONSTRUCTION BATTALION CENTER GULFPORT, MISSISSIPPI	CONTRACT NO. 0567	
CHECKED BY DATE		APPROVED BY	DATE 12/03/01
COST/SCHED-AREA		APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. FIGURE 4-1	REV. 0

FORM CADD NO. SDIV_AH.DWG - REV 0 - 1/20/98

CTO 0143

Rev. 2
03/24/03

4.3.2.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 2 would be somewhat protective of human health and the environment.

Although some contaminant migration might continue to occur, natural attenuation might eventually reduce dioxin concentrations to below the PRGs. If the results of the monitoring conducted as part of this alternative indicate that continued contaminant migration could have a negative environmental impact, contingency remedies would be implemented to prevent such an occurrence.

Institutional controls would be protective of human health and the environment. Restricting access to contaminated areas and prohibiting future residential development would be protective of human health by preventing unacceptable risks from exposure to contaminated soil, soil ash, sediment, and groundwater.

Monitoring would be protective of the environment by assessing possible natural attenuation and detecting potential migration of contaminated groundwater so that appropriate contingency measures can be taken, if required.

Some short-term risks could be incurred by workers from exposure to contamination during implementation of this alternative. However, the potential for such exposure would be minimized by the wearing of appropriate personal protective equipment (PPE) and compliance with site-specific health and safety procedures.

No adverse short-term or cross-media effects are anticipated as a result of implementing this alternative.

Compliance with ARARs and TBCs

Alternative 2 would comply with location-, and action-specific ARARs and TBCs. This alternative would not comply with chemical-specific ARARs due to the pervasiveness of dioxin in the environment.

Long-term Effectiveness and Permanence

Alternative 2 would provide long-term effectiveness and permanence. Although no removal or treatment of contaminated soil, soil ash, sediment, and groundwater would occur and contamination might migrate, risks to human health and the environment would be controlled and monitored.

Site access restrictions and PRSCs would effectively prevent the unacceptable risk from exposure of human receptors to contaminated soil, soil ash, sediment, and groundwater until the dioxin PRGs have been achieved.

Long-term monitoring would be an effective means to assess the occurrence of natural attenuation and detect the potential migration of contamination.

Reduction of Toxicity, Mobility, or Volume through Treatment

Although no active treatment is included in Alternative 2, dioxin volume and toxicity might eventually be reduced over time through natural degradation processes. Alternative 2 would also not provide an immediate reduction in dioxin mobility since no containment, removal, or treatment of soil, soil ash, sediment, and groundwater is proposed. Human health toxicity posed by exposure to dioxin in soil, soil ash, sediment, and groundwater would remain until its concentration has been sufficiently reduced by natural processes. No treatment residuals would be produced if Alternative 2 was implemented.

Short-term Effectiveness

Alternative 2 would have minimal short-term effectiveness concerns. Exposure of workers to contamination during monitoring activities would be minimized by compliance with site-specific health and safety procedures, including the wearing of appropriate PPE. Alternative 2 would also not adversely impact the surrounding community or the environment.

The RAOs would be achieved immediately upon implementation of institutional controls and monitoring. Alternative 2 might eventually meet the dioxin PRGs through natural attenuation but the timeframe for compliance cannot be accurately estimated. As additional site-specific data becomes available, modeling might be performed to predict this timeframe.

Implementability

Alternative 2 would be readily implementable.

Installation and maintenance of site access restrictions; development and implementation of PRSCs; sampling and analysis of soil ash, sediment, surface water, and groundwater; and performance of 5-year site reviews could readily be accomplished. The resources, equipment, and materials required to implement these activities are readily available.

The administrative aspects of Alternative 2 would be relatively simple to implement. No construction permits would be required for this alternative. Deed restrictions would ensure continued implementation of PRSCs in case of change of ownership of any of the contaminated areas. However, continued implementation of PRSCs under private ownership could be more difficult.

Cost

The estimated costs for Alternative 2 are:

- Capital Cost: $32,000
- 30-Year net present worth (NPW) of O&M Costs: $277,000
- 30-Year NPW: $309,000

The above figures have been rounded to the nearest $1,000 to reflect the preliminary nature of these estimates. A detailed breakdown of the cost estimate for this alternative is provided in Appendix B.

4.3.3 Alternative 3: Excavation, Surface Water Controls, Dewatering, Chemical Stabilization and On-Base Landfilling, Capping, Institutional Controls, and Monitoring

4.3.3.1 Description

Alternative 3 is illustrated on Figure 4-2 and would consist of seven major components: (1) excavation of contaminated soil, soil ash, and sediment, (2) surface water controls, (3) dewatering of excavated sediment, (4) chemical stabilization and on-base landfilling of excavated soil, soil ash, and sediment, (5) capping of stabilized soil, soil ash, and sediment, (6) institutional controls, and (7) monitoring.

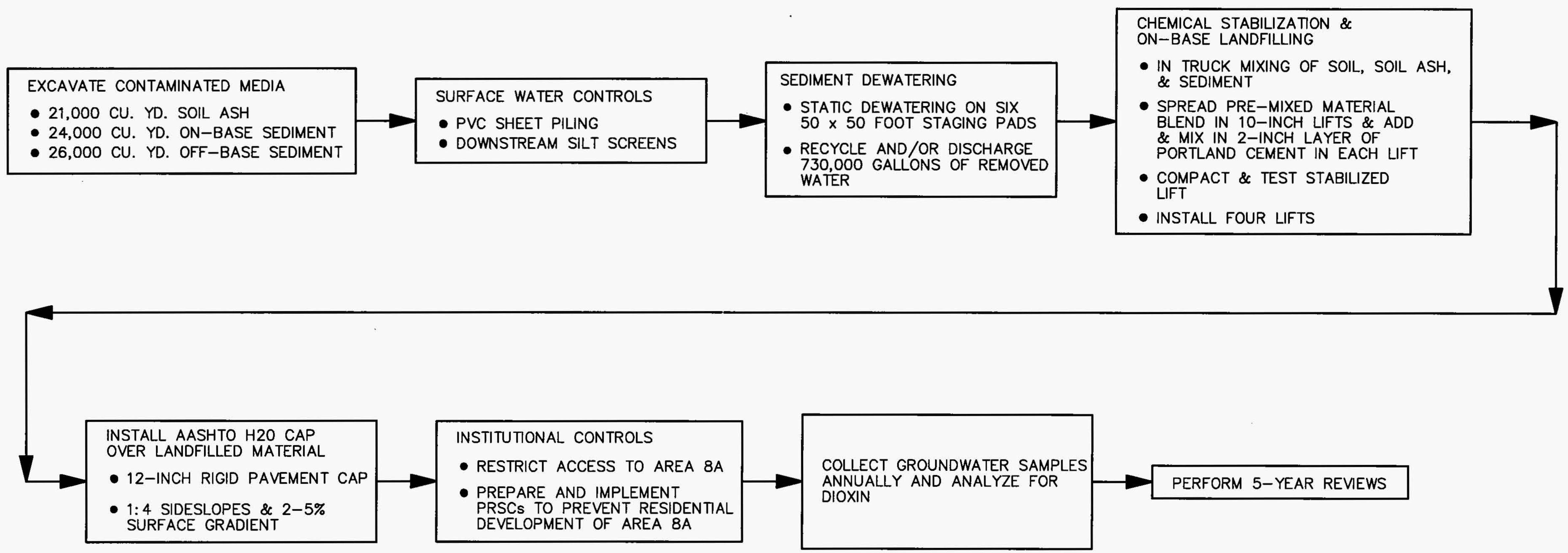
Component 1: Excavation of Contaminated Soil, Soil Ash, and Sediment

Media contaminated in excess of PRGs would be excavated, including Area 8A incinerated soil ash, on-base drainage ditches sediment, and off-base swampland sediment. As discussed in Section 2.4, it is estimated that a total of approximately 71,000 yd^3 of would be excavated, tabulated as follows:

Material	Estimated Volume (yd^3)
Area 8A Incinerated Soil Ash	21,000
On-Base Drainage Ditches Sediment	24,000
Off-Base Swampland Sediment	26,000
TOTAL	**71,000**

ACAD: 0567PF07.dwg 03/06/03 HJB PIT

EXCAVATION, SURFACE WATER CONTROLS, DEWATERING, CHEMICAL STABILIZATION AND ON-BASE LANDFILLING, CAPPING, INSTITUTIONAL CONTROLS, AND MONITORING



NOTES:

AASHTO	AMERICAN ASSOCIATIONS OF STATE HIGHWAY OFFICIALS
H20	HIGHWAY 20
PRSCs	POST-REMOVAL SITE CONTROLS

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJB DATE 3/6/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

BLOCK FLOW DIAGRAM
ALTERNATIVE 3
SITE 8 FFS
NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

CONTRACT NO. 0567
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 4-2 REV. 2

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

Excavation of the Area 8A incinerated soil ash would be accomplished with a front-end loader. Excavation of the on-base drainage ditch and off-base swampland sediment would be accomplished with a Gradall-type excavator, which was successfully demonstrated through pilot-scale testing (TtNUS, 2001). Surface water would be diverted from the areas of sediment excavation as described under Component 2 of this alternative. Excavated sediment would be loaded onto trucks for staging at Area 8A. The trucks would be lined with plastic sheeting or have gasketed tailgates to prevent liquid contained in saturated sediments from leaking from the truck. The excavated areas would be sampled to verify that the soil, soil ash, and sediment containing dioxin in excess of the PRGs have been removed.

Component 2: Surface Water Controls

Surface water controls would divert water from the areas of sediment excavation through installation of marine-grade polyvinyl chloride (PVC) sheet piling and pumping with bladder-type mud pumps to remove water from the areas to be excavated. Surface water controls would also consist of installing silt screens downstream of the excavation areas to capture potentially contaminated sediment particles that may have migrated as a result of excavation activities.

Component 3: Sediment Dewatering

This component would consist of dewatering the excavated sediment by stockpiling it in staging/dewatering cells constructed for this purpose at Area 8A. The free water draining from the cells would be collected in a sump and used for dust control or, if necessary, treated through liquid-phase GAC adsorption prior to surface water discharge. The effectiveness of this method of dewatering, the design of the dewatering/staging cells, and the need for treatment of the drainage water was verified through pilot-scale testing (TtNUS, 2001). Results from this testing showed that stockpiling was an effective sediment dewatering technique. Testing also showed that any water removed would not require treatment prior to surface discharge. This FFS assumes that a total of six sediment staging/dewatering cells would be constructed and operated at Area 8A. Each staging/dewatering cell would measure approximately 50 feet (ft) by 50 ft and be lined with an impervious geomembrane and surrounded with an earthen berm. Each cell would be designed to stage and dewater approximately 270 yd^3 of sediment over a 24-hour period.

Component 4: Chemical Stabilization and On-Base Landfilling

This component would consist of blending the various excavated materials in proportion to their respective volumes to form a Material Blend, to amend this Material Blend with Portland Cement, and to stockpile this amended Material Blend in a designated area of Area 8A.

The incinerated soil ash, on-base drainage ditch sediment, and off-base swampland sediment would be removed from their respective Area 8A stockpiles or staging/dewatering cells with front-end loaders and placed into dump trucks in alternating layers and at a volume ratio of approximately 1:1:1, respectively, until the trucks are full. The purpose of alternating the materials being loaded into the trucks is to provide an initial blending of the various materials and the effectiveness of this approach was demonstrated through pilot-scale testing (TtNUS, 2001).

The pre-mixed Material Blend would then be spread by the dump trucks and bulldozers as loose lifts over the location of Area 8A dedicated to this purpose. A layer of Portland Cement would be pneumatically spread over each loose lift of Material Blend by a tanker truck. Based upon the results of the bench-scale treatability testing, and subject to confirmation by the upcoming pilot-scale treatability testing, it is anticipated that the loose thickness of each lift of Material Blend and layer of Portland Cement would be 10-inch and 2-inch, respectively. The Portland Cement would then be mixed into the Material Blend by multiple passes of a single-shaft traverse mixer, as determined through visual inspection. As with the in-truck pre-blending, the effectiveness of this mixing approach was verified through pilot-scale testing (TtNUS, 2001). Upon successful blending of a lift of Material Blend with Portland Cement, samples of the amended Material Blend would be collected and tested for moisture-density relationship in accordance with the American Society for Testing and Materials (ASTM) Method D698.

Following this test, each loose lift of amended Material Blend would be leveled with a bulldozer and then compacted with a vibrating roller. The density of the compacted lift would be field-tested in accordance with ASTM Method D2922 (nuclear method) to determine when the amended Material Blend has been compacted to 90 percent of its maximum dry density. After the desired density has been achieved, the load bearing capacity of the compacted lift would be field-tested to measure its California Bearing Ratio (CBR) in accordance with ASTM Method D4429.

For the purpose of this FFS, it is anticipated that four such lifts of Material Blend would be spread, chemically stabilized, and compacted one on top of another.

Component 5: Capping

Following compaction of the final lift of amended Material Blend, it would be capped with 12 inches of rigid pavement (e.g., roller compacted concrete) designed in accordance with the American Association of State Highway Officials (AASHTO) Highway 20 (H20) specifications (AASHTO, 1973). This would allow the cap to be used as a storage area for heavy equipment. The grade of the sideslopes of the cap would not exceed 25 percent (1:4) and its top surface would have a gradient of not less than 2 percent or more than 5 percent to preclude ponding of storm water.

Component 6: Institutional Controls

Institutional controls would consist of restricting access to the Area 8A landfill and controlling future land use. Area 8A would continue to be fenced-in and posted. PRSCs would be developed and implemented to prevent residential development and the use of surface water and groundwater. Institutional controls would also include regular inspection, maintenance, and repair of the Area 8A landfill cover system to ensure its continued structural integrity.

Component 7: Monitoring

Monitoring would consist of regularly collecting and analyzing samples of groundwater from monitoring wells installed downgradient from the Area 8A landfill to verify that no dioxin is leaching from the landfilled material to the groundwater. Monitoring would be performed with annual samplings for a period of 30 years. Additionally, monitoring wells would be installed in the off-base area north of Outfall 3 and sampled to determine whether dioxin concentrations in groundwater are below PRGs. Every 5 years, the status of the site would be formally reviewed and evaluated to determine the continued effectiveness of this alternative.

4.3.3.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 3 would be protective of human health and the environment.

Removal of contaminated soil, soil ash, and sediment from their present locations, and stabilization and on-base landfilling of these materials would significantly reduce human health and environmental risk from exposure of human and ecological receptors to dioxin. These remedial activities would also protect human health and the environment by minimizing the potential for future migration of dioxin.

Institutional controls would be protective of human health by restricting access to the Site 8A landfill area, preventing future residential development of the site, and ensuring continued structural integrity of the cover system.

Monitoring would be protective of human health and the environment by verifying that no dioxin is migrating from the landfilled materials to groundwater and that dioxin concentrations in off-base groundwater are at levels below PRGs.

Some short-term risks could be incurred by workers from exposure to contamination during the implementation of this alternative. However, the potential for this exposure would be minimized by compliance with site-specific health and safety procedures, including the wearing of appropriate PPE.

No adverse short-term or cross-media effects are anticipated as a result of implementing this alternative.

Compliance with ARARs and TBCs

Alternative 3 would comply with location-, and action-specific ARARs and TBCs. This alternative would not comply with chemical-specific ARARs due to the pervasiveness of dioxin in the environment.

Long-term Effectiveness and Permanence

Alternative 3 would provide long-term effectiveness and permanence. Although no treatment would be used to reduce dioxin concentrations from contaminated soil, soil ash, sediment, and groundwater, these materials would be effectively removed from their present locations, stabilized and contained to prevent exposure of human and ecological receptor and to minimize the potential for migration.

Site access restrictions and PRSCs would effectively prevent unacceptable risk from exposure of human receptors to contaminated soil, soil ash, sediment, and groundwater. Inspection, maintenance, and repair of the landfill cover system would effectively ensure its continued structural integrity and effectiveness.

Monitoring would be an effective means to verify that dioxin is not migrating from the landfill to groundwater and to verify that dioxin concentrations in off-base groundwater are below PRGs.

Reduction of Toxicity, Mobility, or Volume through Treatment

Although there would be no reduction of toxicity or volume through treatment, Alternative 3 would achieve a significant reduction in the mobility of dioxin through stabilization and containment of the contaminated soil, soil ash, and sediment. Dioxin volume and toxicity might also eventually be reduced over time through natural degradation processes. No treatment residuals would be produced if this alternative were implemented.

Short-term Effectiveness

Alternative 3 would have some short-term effectiveness concerns. Exposure of workers to contamination during remediation and monitoring activities would be minimized by implementation of engineering controls (e.g., dust suppression) and compliance with the requirements of OSHA and adherence to site-specific health and safety procedures, including the wearing of appropriate PPE. Alternative 3 would result in a significant destruction of ecological habitat in the area of off-base swampland to be excavated. However, this destruction would be mitigated through post-excavation restoration. The transportation of contaminated sediment from off-base swampland areas to their on-base disposal area could impact the surrounding community. This impact would be minimized through the implementation of truck decontamination, spill prevention, and traffic control measures.

The RAOs are expected to be achieved immediately upon completion of the on-base landfill and implementation of institutional controls and monitoring. Although the PRGs would be achieved in the current areas of contaminated soil, soil ash, and sediment upon completion of excavation, dioxin contamination would remain in the Area 8A landfill. This dioxin might eventually degrade through naturally-occurring processes, but the time frame within which this would occur cannot be reasonably quantified. Due to the highly organophillic nature of dioxins, removal of off-base sediment is anticipated to reduce off-base groundwater concentrations to levels below PRGs.

Implementability

Alternative 3 would be readily implementable.

Excavation of contaminated soil, soil ash, and sediment; implementation of surface water controls; dewatering of sediment, stabilization and on-base landfilling of excavated materials; installation and maintenance of site access restrictions; preparation and implementation of PRSCs; sampling and analysis of groundwater; and performance of 5-year site reviews could readily be accomplished. The resources, equipment, and materials required to implement these activities are readily available.

The administrative aspects of Alternative 3 would be relatively simple to implement. Construction permits would be needed and access authorization would have to be secured for several off-base swampland areas, but all of these could be acquired with relative ease. Deed restrictions would ensure continued implementation of PRSCs in case NCBC Gulfport changes from military to civilian ownership.

Cost

The estimated costs for Alternative 3 are:

- Capital Cost: $10,714,000
- 30-Year NPW of O&M Cost: $277,000
- 30-Year NPW: $10,991,000

A detailed breakdown of the cost estimate for this alternative is provided in Appendix B.

4.3.4 Alternative 4: Excavation, Surface Water Controls, Dewatering, and Off-Base Incineration

4.3.4.1 Description

Alternative 4 is illustrated on Figure 4-3 and would consist of four major components: (1) excavation of contaminated soil, soil ash, and sediment, (2) surface water controls, (3) dewatering of excavated sediment, and (4) off-base incineration of excavated soil, soil ash, and sediment.

Component 1: Excavation of Contaminated Soil, Soil Ash, and Sediment

This component would be identical to Component 1 of Alternative 3.

Component 2: Surface Water Controls

This component would be identical to Component 2 of Alternative 3.

Component 3: Dewatering of Excavated Sediment

This component would be identical to Component 3 of Alternative 3.

Component 4: Off-Base Incineration of Excavated Soil, Soil Ash, and Sediment

This component would consist of transporting the excavated soil ash and dewatered sediment to a permitted off-base facility that would treat these materials through high-temperature incineration and dispose of the resulting ashes. This component would also include the manifesting of the waste materials to be transported.

4.3.4.2 Detailed Analysis

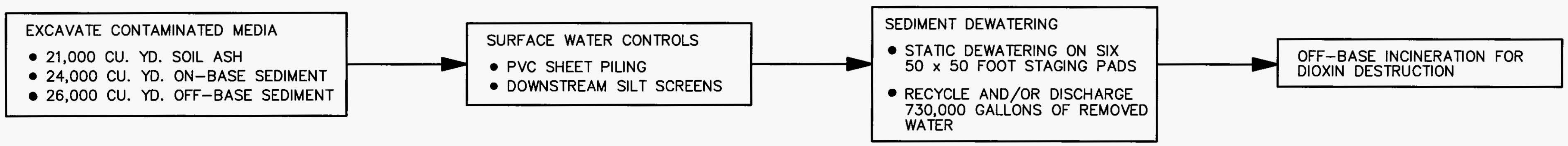
Overall Protection of Human Health and the Environment

Alternative 4 would be protective of human health and the environment.

Removal of contaminated soil, soil ash, and sediment from their present locations and off-base incineration of these materials would eliminate human health and environmental risk from exposure of human and ecological receptors to dioxin. These remedial activities would also protect human health and the environment by removing the potential for future migration of dioxin. Some short-term risks could be incurred by workers from exposure to contamination during the implementation of this alternative.

ACAD: 0567PF08.dwg 03/06/03 HJB PIT

EXCAVATION, SURFACE WATER CONTROLS, DEWATERING, AND OFF-BASE INCINERATION



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJB DATE 3/6/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

DEPARTMENT OF THE NAVY ★ SOUTHERN DIV FACILITIES ENGINEERING COMD ★

BLOCK FLOW DIAGRAM
ALTERNATIVE 4
SITE 8 FFS
NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

CONTRACT NO. 0567
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 4-3 REV. 2

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

However, the potential for this exposure would be minimized by the wearing of appropriate PPE and compliance with site-specific health and safety procedures.

No adverse short-term or cross-media effects are anticipated as a result of implementing this alternative.

Compliance with ARARs and TBCs

Alternative 4 would comply with chemical-, location-, and action-specific ARARs and TBCs.

Long-term Effectiveness and Permanence

Alternative 4 would provide long-term effectiveness and permanence. Contaminated soil, soil ash, and sediment would be removed from their present locations and their dioxin content would be permanently and irreversibly destroyed through high-temperature incineration. However, high-temperature incineration of materials with low dioxin concentration, such as the remaining contaminated soil and sediment at NCBC Gulfport, might not achieve the 99.9999 percent DRE currently required for this chemical. A test burn would be required. Due to the highly organophillic nature of dioxins, removal of overlying soil/soil ash/sediment is anticipated to reduce groundwater concentrations to levels below PRGs.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 4 would achieve a significant reduction in the toxicity, mobility, and volume of dioxin through removal and treatment. An estimated 71,000 yd^3 of contaminated material would be permanently removed from the site and the dioxin content of this material would be irreversibly destroyed through high-temperature incineration. A non-contaminated ash residual would be produced if this alternative were implemented.

Short-term Effectiveness

Alternative 4 would have some short-term effectiveness concerns. Exposure of workers to contamination during remediation activities would be minimized by implementation of engineering controls (e.g., dust suppression) and compliance with site-specific health and safety procedures, including the wearing of appropriate PPE. Alternative 4 would result in a significant destruction of ecological habitat in the area of off-base swampland to be excavated. However, this destruction would be mitigated through post-excavation restoration. The transportation of contaminated sediment from off-base swampland areas to the off-base incineration facility could impact the surrounding community. This impact would be minimized through the implementation of truck decontamination, spill prevention, and traffic control measures.

The RAOs would be achieved immediately upon completion of the excavation of contaminated soil, soil ash, and sediment. The PRGs would be attained upon successful incineration of these contaminated media.

Implementability

Alternative 4 would be readily implementable.

Excavation of contaminated soil, soil ash, and sediment; implementation of surface water controls; dewatering of excavated sediment; and off-base transportation of excavated soil, soil ash, and sediment could readily be accomplished. The resources, equipment, and materials required to implement these activities are readily available. However, the number of off-base incineration facilities that might accept the dioxin-contaminated material for treatment is likely to be extremely limited and securing acceptance of this material might be quite difficult.

Implementation of Alternative 4 would require multiple administrative tasks. Construction permits would have to be obtained, authorizations would have to be secured for acceptance of the wastes by the incineration facility and for access to several off-base swampland locations, and manifests would have to be prepared for waste transportation. However, all of these tasks could be accomplished with relative ease.

Cost

The estimated costs for Alternative 4 are:

- Capital Cost: $61,516,000
- 30-Year NPW of O&M Cost: $0
- 30-Year NPW: $61,516,000

A detailed breakdown of the cost estimate for this alternative is provided in Appendix B.

5.0 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

This section compares the analyses that were presented for each of the remedial alternatives in Section 4.0 of this FFS. The criteria for comparison are identical to those used for the detailed analysis of individual alternatives.

5.1 COMPARISON OF REMEDIAL ALTERNATIVES BY CRITERIA

The following remedial alternatives for soil, soil ash, and sediment are being compared in this section:

- Alternative 1: No Action
- Alternative 2: Institutional Controls and Monitoring
- Alternative 3: Excavation, Surface Water Controls, Dewatering, Chemical Stabilization and On-Base Landfilling, Capping, Institutional Controls, and Monitoring
- Alternative 4: Excavation, Surface Water Controls, Dewatering, and Off-Base Incineration

5.1.1 Overall Protection of Human Health and the Environment

Alternative 1 would not provide protection of human health and the environment because dioxin would remain in soil, soil ash, sediment, and groundwater in excess of PRGs and could result in unacceptable risk to human receptors. Also, under this alternative, no warning would be provided of the potential for migration of dioxin to continue in sediment, surface water, and groundwater since no monitoring would occur.

Although Alternative 2 would allow dioxin to remain in soil, soil ash, and sediment, and possibly to continue migrating from the contaminated areas, it would provide some protection by restricting access to contaminated media and warning of potential contaminant migration.

Alternative 3 would be more protective than Alternative 2 because it would essentially eliminate the potential for exposure to dioxin by removing contaminated soil, soil ash, and sediment and stabilizing and containing these media within an on-base landfill. Alternative 3 would also provide a warning of the unlikely migration of dioxin from the landfilled material to groundwater and prevent any future site development which would compromise the structural integrity of the landfill.

Alternative 4 would provide the highest level of protection because it would not only remove contaminated soil, soil ash, and sediment from their present locations, but also destroy their dioxin content through high-temperature incineration.

5.1.2 Compliance with ARARs and TBCs

Alternative 1 would not comply with chemical- and location-specific ARARs. Action-specific ARARs or TBCs would not apply.

Alternatives 2 and 3 would not comply with chemical-specific ARARs and TBCs due to the pervasiveness of dioxin through the environment. Alternatives 2 and 3 would comply with location- and action-specific ARARs and TBCs.

Alternative 4 would comply with chemical-, location-, and action-specific ARARs and TBCs.

5.1.3 Long-term Effectiveness and Permanence

Alternative 1 would have very limited long-term effectiveness and permanence because no contaminant removal or reduction would occur through treatment although, over time, some contaminant reduction might occur through natural attenuation. As there would be no institutional controls to restrict access to areas of contaminated soil, soil ash, sediment, and groundwater, the potential would also exist for unacceptable risk to develop due to exposure to dioxin. Since there would be no monitoring, potential dioxin migration would remain undetected.

Alternative 2 would provide some long-term effectiveness and permanence since it would reduce risk from exposure to contaminated soil, soil ash, sediment, and groundwater, and would warn of potential dioxin migration while natural attenuation might eventually reduce dioxin concentrations down to the PRGs.

Alternatives 3 would be more long-term effective and permanent than Alternative 2 because it would remove contaminated soil, soil ash, and sediment from their present locations and effectively stabilize them and contain them within a landfill, thereby minimizing the risk of exposure to dioxin. Alternative 3 would also effectively warn of possible dioxin migration and preserve the structural integrity of the landfill cap.

Alternative 4 would be the most long-term effective and permanent remedy. This alternative would remove the contaminated soil, soil ash, and sediment from their present locations and, although high-temperature incineration might not achieve the required 99.9999 percent DRE, it would nonetheless effectively and permanently destroy most of their dioxin content.

5.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives 1 and 2 would not achieve any reduction of toxicity, mobility, or volume of dioxin-contaminated media through treatment. Both alternatives might eventually achieve reduction of contaminant toxicity and volume through natural attenuation, however, under Alternative 1, this reduction would neither be verified or quantified. There would be no treatment residuals associated with Alternative 2.

Alternative 3 would not achieve any reduction of toxicity or volume of dioxin-contaminated media through treatment. However, Alternative 3 would significantly reduce dioxin mobility through chemical stabilization and containment in a landfill. A wastewater residual might be generated by the sediment dewatering step, but it is anticipated that this wastewater could be discharged to surface water without treatment.

Alternative 4 would achieve a significant reduction of toxicity, mobility, and volume of dioxin contaminated media through removal and treatment. An estimated 71,000 yd^3 of contaminated material would be permanently removed from the site and the dioxin content of this material would be irreversibly destroyed through high-temperature incineration. Alternative 4 might generate the same wastewater residual from the sediment dewatering operations as Alternative 3. In addition, as a result of incineration of dioxin-contaminated media, Alternative 4 would also generate an ash residual and, possibly, a liquid waste residual from offgas treatment. These incineration residuals would require proper handling and disposal.

5.1.5 Short-term Effectiveness

Implementation of Alternative 1 would not result in risks to site workers or adversely impact the surrounding community or environment since no remedial activities would be performed. Alternative 1 would never achieve the RAOs and although the dioxin PRGs might eventually be attained through natural attenuation processes, this would not be verified.

Implementation of Alternative 2 would result in a slight possibility of exposing site workers to dioxin contamination during long-term monitoring activities. However, this risk of exposure would be effectively controlled through compliance with proper site-specific health and safety procedures. Implementation of Alternative 2 would not adversely impact the surrounding community or environment. Alternative 2 would be expected to achieve the RAOs immediately upon implementation of institutional controls and monitoring. The dioxin PRGs might be attained through natural attenuation, but the required timeframe cannot be accurately estimated.

Implementation of Alternatives 3 and 4 would result in the possibility of exposing construction workers to dioxin contamination during remedial activities. However, the risk of exposure would be effectively controlled by the implementation of engineering controls (e.g., dust suppression) and compliance with applicable OSHA regulations and proper site-specific health and safety procedures. Implementation of Alternatives 3 and 4 would potentially impact the surrounding community because dioxin-contaminated material would be transported over public roads. In addition, Alternative 4 could impact the surrounding community because of offgas emissions from the incineration facility. However, the potential for adverse impact would be effectively addressed through implementation of such appropriate measures as decontamination of transport vehicles, traffic control, spill prevention and emergency response, and incineration emissions treatment.

Alternatives 3 and 4 would be expected to achieve the RAOs immediately upon removal of the contaminated soil, soil ash, and sediment. Alternative 3 might attain the dioxin PRGs through natural attenuation, but the required timeframe cannot be accurately estimated. Alternative 4 would attain the dioxin PRGs within less than one year.

5.1.6 Implementability

Alternative 1 would be extremely simple to implement since no action would occur.

The technical implementability of Alternative 2 would be very simple, since it would only require implementation of the institutional controls and monitoring.

The technical implementability of Alternative 3 would be somewhat more difficult than that of Alternative 2. In addition to institutional controls and monitoring, this alternative would require the excavation of contaminated soil, soil ash, and sediment with surface water controls, the dewatering of sediment, the chemical stabilization and on-base landfilling of the excavated materials, and the capping of the stabilized materials. However, these activities would be technically implementable and their effectiveness was verified through pilot-scale testing (TtNUS, 2001). Resources, equipment and materials are readily available to perform the tasks associated with Alternative 3.

Although it would require a reduced number of sequential operational steps as compared to Alternative 3, Alternative 4 would be somewhat harder to implement. Resources, equipment and materials are readily available to perform the excavation, dewatering, and transportation activities but the number of off-base incineration facilities that might accept the dioxin-contaminated material for treatment is likely to be extremely limited and securing acceptance of this material might be quite difficult.

Administratively, Alternatives 2 and 3 would require the development and implementation of PRSCs and the performance of long-term monitoring and 5-year site reviews. Alternative 3 would also require authorizations for the excavation of the off-base sediment and a permit for the construction of the on-base landfill. Alternative 4 would not require PRSCs or long-term monitoring or 5-year reviews, but it would require authorization for the excavation of the off-base sediment, manifesting of the material to be transported off-base, and formal acceptance of this material by the off-base incineration facility. These administrative requirements could readily be met.

5.1.7 Cost

The capital and O&M costs and NPW of the alternatives are summarized as follows:

Alternative	Capital ($)	30-year NPW of O&M ($)	30-year NPW ($)
1	0	0	0
2	32,000	277,000	309,000
3	10,714,000	277,000	10,991,000
4	61,516,000	0	61,516,000

Detailed cost estimates are provided in Appendix B.

5.2 SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

Table 5-1 summarizes the comparative analysis of the four remedial alternatives.

This page intentionally left blank

TABLE 5-1

**SUMMARY OF COMPARATIVE EVALUATION OF REMEDIAL ALTERNATIVES
SITE 8 FOCUSED FEASIBILITY STUDY
NAVAL CONSTRUCTION BATTALION CENTER
GULPORT, MISSISSIPPI**

Evaluation Criteria	Alternative 1: No Action	Alternative 2: Institutional Controls and Monitoring	Alternative 3: Excavation, Surface Water Controls, Dewatering, Chemical Stabilization and On-Base Landfilling, Capping, Institutional Controls, and Monitoring	Alternative 4: Excavation, Surface Water Controls, Dewatering, and Off-base Incineration
Overall Protection of Human Health and Environment	Would not be protective because there would be a continued risk from exposure to contaminants. Also, potential contaminant migration would remain unchecked.	Would be protective by reducing risk from exposure to dioxin by restricting access to contaminated areas and controlling future land use.	Would be more protective than Alternative 2 by further reducing risk from exposure to dioxin through removal of contaminated soil, soil ash, and sediment from their present locations and containment of these materials in a secure on-base landfill.	Would be more protective than Alternative 3 by essentially eliminating risk from exposure to dioxin through removal of contaminated soil, soil ash, and sediment from their present locations and destruction of their dioxin content with off-base incineration.
Compliance with ARARs and TBCs: Chemical-Specific Location-Specific Action-Specific	 Would not comply Would not comply Not applicable	 Might eventually comply Would comply Would comply	 Might eventually comply Would comply Would comply	 Would comply Would comply Would comply
Long-Term Effectiveness and Permanence	Would not be long-term effective and permanent since contaminants would remain on-site. Any long-term effectiveness would not be known since monitoring would not occur.	Would be long-term effective and permanent. Site access and land use restrictions would effectively prevent unacceptable risk from exposure to dioxin. Monitoring would warn of potential dioxin migration.	Would be more long-term effective and permanent than Alternative 2 since it would remove contaminated soil, soil ash, and sediment from their present location and effectively contain these materials in a secure on-base landfill.	Would be more long-term effective and permanent than Alternative 3 since it would not only remove contaminated soil, soil ash, and sediment from their present locations, but it would also effectively destroy most of their dioxin content instead of merely containing it.
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	Would not achieve reduction of toxicity, mobility, or volume of dioxin through treatment. Might achieve reduction of toxicity and volume through natural attenuation, but timeframe is unknown.	Would not achieve reduction of toxicity, mobility, or volume of contaminants through treatment. Might achieve reduction of toxicity and volume through natural attenuation, but timeframe is unknown.	Would achieve reduction of contaminant mobility through treatment. Reduction of toxicity and volume might also be achieved through natural attenuation, but timeframe is unknown.	Would achieve reduction of contaminant toxicity, mobility, and volume through treatment. Approximately 71,000 yd^3 of contaminated material would be permanently removed and its dioxin content would be irreversibly destroyed by incineration.
Short-Term Effectiveness	Would not result in short-term risks to site workers or adversely impact the surrounding community, but would also not achieve RAOs or meet the dioxin PRGs.	Would result in slight risk of exposure to site workers during monitoring. This risk would be adequately controlled through compliance with site-specific health and safety procedures, including wearing of appropriate PPE. RAOs would be achieved immediately upon implementation. Dioxin PRGs might be attained through natural attenuation but the required timeframe is unknown.	Would result in significant risk of exposure to workers and slight risk of impact to surrounding community during remedial activities. These risks would be adequately controlled by engineering controls (e.g., dust suppression, spill prevention) and compliance with site-specific health and safety procedures. RAOs would be expected to be achieved immediately upon implementation. Dioxin PRGs might be attained through natural attenuation, but timeframe is unknown.	Would result in significant risk of exposure to workers and slight risk of impact to surrounding community during remedial activities. These risks would be adequately controlled by engineering controls (e.g., dust suppression, spill prevention) and compliance with site-specific health and safety procedures. RAOs would be expected to be achieved immediately upon implementation. Dioxin PRGs would be attained within 1 year.
Implementability	Not applicable	Would be technically simple to implement. Necessary resources, equipment, and materials are readily available. Administratively, would require a PRSCs and 5-year reviews but no construction permit.	Would be more difficult to implement than Alternative 2 since it would require significant construction activities in addition to institutional controls and monitoring. However, all components would be technically feasible and the necessary resources, equipment, and materials are readily available. Administratively, would require authorization for access to off-base swampland, a construction permit, PRSCs, and 5-year reviews, all of which are achievable.	Would be more difficult to implement than Alternative 3 although on-site activities would be limited to excavation and dewatering, and there would be no institutional controls or monitoring. This is because the number of suitable off-base incineration facilities is very limited. Administratively, would require authorization for access to off-base swampland, a construction permit, waste transportation manifesting, and formal acceptance from the off-base incineration facility. All of these would be readily achievable, except the later which might be quite difficult to obtain.
Costs: Capital 30-Year NPW of O&M 30-Year NPW	 $0 $0 $0	 $32,000 $277,000 $309,000	 $10,714,000 $277,000 $10,991,000	 $61,516,000 $0 $61,516,000

REFERENCES

AASHTO (American Association of State Highway Officials), 1973. *Standard Specifications for Highway Bridges.* Eleventh Edition.

ABB-Environmental Services, Inc., (ABB-ES) 1997. *Technical Memorandums No. 1 through 6, Site A - Former Herbicide Orange Storage Area, Groundwater Sampling Events*. Naval Construction Battalion Center, Gulfport, Mississippi. Prepared for Southern Division Naval Facilities Engineering Command, North Charleston, South Carolina.

ABB-ES, 1999. *Surface Water and Sediment Dioxin Delineation, NCBC, Gulfport, Mississippi.* Prepared for Southern Division Naval Facilities Engineering Command (SOUTHDIVNAVFACENGCOM), Charleston, South Carolina. June.

ABB-ES, 2000. *Agreed Order Dioxin Delineation Studies, NCBC, Gulfport, Mississippi.* Prepared for SOUTHDIVNAVFACENGCOM, Charleston, South Carolina.

AFESC (Air Force Engineering and Service Center), 1984. *Herbicide Orange Monitoring Program at the naval Construction Battalion Center (NCBC), Gulfport, Mississippi.* ESL-TR-83-56.

AFESC, 1998. *Herbicide Orange Characterization Study, NCBC, Gulfport, Mississippi.* ESL-TR-86-21.

HLA (Harding Lawson Associates), 1999. *Groundwater Monitoring Report, NCBC, Gulfport, Mississippi.* Prepared for SOUTHDIVNAVFACENGCOM, Charleston, South Carolina. December.

HLA, 2001. *Human Health Risk Assessment and Screening Level Ecological Risk Assessment of Dioxins and Furans Associated with Former Herbicide Orange Storage at NCBC, Gulfport, Mississippi.* Prepared for SOUTHDIVNAVFACENGCOM, Charleston, South Carolina. March.

MDEQ (Mississippi Department of Environmental Quality), 1997. *Agreed Order No. 3466-97*. November.

MDEQ, 1999. *Final Target Risk Goals, Risk Evaluation* Procedures. Mississippi Code Ann., Section 49-35-21. May.

Tetra Tech NUS, Inc. (TtNUS), 2000. *Report, Bench-Scale Soil/Sediment Treatability Study, Site 8, Herbicide Orange Study Area at Naval Construction Battalion Center, Gulfport, Mississippi.* Prepared for SOUTHDIVNAVFACENGCOM, Charleston, South Carolina. November.

TtNUS, 2001. *Draft Report, Pilot-Scale Soil/Sediment Treatability Study, Site 8, Herbicide Orange Study Area at Naval Construction Battalion Center, Gulfport, Mississippi.* Prepared for SOUTHDIVNAVFACENGCOM, Charleston, South Carolina. November.

TtNUS, 2003a. Draft Report, Human Health Risk Assessment of Groundwater Associated with Site 8 - Former Herbicide Orange Storage Area at the Naval Construction Battalion Center, Gulfport, Mississippi. Prepared for SOUTHDIVNAVFACENGCOM, Charleston, South Carolina. February.

TtNUS 2003b. *Draft Site Characterization Report for NCBC Gulfport, Off-base Area of Contamination, Naval Construction Battalion Center Gulfport, Mississippi*. Prepared for SOUTHDIVNAVFACENGCOM, North Charleston, South Carolina. March.

USEPA (United States Environmental Protection Agency), 1986. *Guidance for Carcinogen Risk Assessment.* 51 Federal Register (FR) 33992. September.

USEPA, 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*. EPA/540/G-89/004. Office of Solid Waste and Emergency Response. Washington, D.C. October.

USEPA, 1995. *Supplemental Guidance For RAGs: Region IV Bulletins, Human Health Risk Assessment*. USEPA Region IV Waste Management Division, Atlanta, Georgia. November.

APPENDIX A

CONTAMINATED ON-BASE DITCH SEDIMENT VOLUMES COMPUTATIONS

Client: NCBC Gulfport		Job Number N0567	
Subject: Volume of Contaminated On-Base Sediment Calculation			
Based On: TtNUS Field Measurements and Observations; HLA Areal Extent of Contamination			
By: J. Brown	Checked By: JRN 11-3-00		Date: November 2, 2000

Purpose:

1. To estimate the volume of on-base sediment in the drainage ditch system originating from Site 8.
2. To estimate the composition of dry sand, saturated sand, and organic fines in the on-base sediment to be excavated.

Approach: The following approach is taken:

- The area of impacted sediment (delineated to 50 ppt) as presented in HLA, 2000 is assumed. This area of impacted sediment is illustrated in Figure A-1.
- Dimensions of drainage ditches were measured in August 2000. The width of the drainage ditch and the vertical depth from the top of bank to the top of ditch sediment were measured. Additionally, an estimate of the depth of sediment that would be excavated was made at this time. These measurements/estimations are presented in Table A-1. A cross section of the drainage ditch is provided in Figure A-2.
- The drainage ditches were segmented based on locations where field measurements were taken. Based on field measurements, field observations, and the areal extent of contamination assumed in HLA, 2000, volumes were calculated. The composition of dry sand, saturated sand, and organic fines were estimated based on the assumptions listed in the following section.

Assumptions: The following assumptions are made:

- The drainage ditch has a cross section as presented in Figure A-2 with 45-degree side slopes.
- On the sides of the drainage ditches, a 1-foot depth of excavation is assumed.
- The bottom third of the drainage ditch side is comprised of saturated sand and the top two thirds is comprised of dry sand.
- Organic fines are assumed to be located in the top 1 foot of sediment in the lower reaches of the drainage ditch system (areas where standing water is present year round). Below the organic fines, the sediment is assumed to be comprised of saturated sandy soil.

Equations: Equations used in the calculation are presented in Figure A-2.

Client: NCBC Gulfport			**Job Number** N0567
Subject: Volume of Contaminated On-Base Sediment Calculation			
Based On: TtNUS Field Measurements and Observations; HLA Areal Extent of Contamination			
By: J. Brown	**Checked By:** JRW 11-3-00		**Date:** November 2, 2000

Calculations: Calculations are presented in Table A-1. The results are summarized as follows.

Volume of On-base Sediment = 24,200 cubic yards

Composition of On-base Sediment

Dry Sand	18.8 percent ~ 20 percent
Saturated Sand	62.6 percent ~ 60 percent
Organic Fines	18.7 percent ~ 20 percent

References:

Harding Lawson Associates, 2000. Remediation Planning Document (Site 8). Naval Construction Battalion Center, Gulfport, Mississippi, August.

TABLE A-1

Assumptions

- Thickness of excavation on sides of ditches (ft) = 1
- Thickness of organic fines at base (ft) = 1

Drainage Area 1

Stream Segment	Soil Composition	Width (W)	Vertical Depth from Top of Bank to Top of Sediment (T)(ft)	Excavation Thickness (D) (ft)	Segment Length (L) (ft)	Volume of Sand (Dry) (ft3)	Volume of Sand (Sat) (ft3)	Volume of Organic Fines (ft3)	Volume Total (ft3)	Excavation Volume (cy)
1	sand	11	2	2	800	3,017	12,708	0	15,725	582
2	sand	11	3	2	600	3,394	7,697	0	11,091	411
3	sand	14	3	3	600	3,394	16,097	0	19,491	722
4	sand	10	2	3	200	754	3,977	0	4,731	175
5	sand	9	3	4	690	3,903	10,232	0	14,135	524
6	sand	22	4	2	240	1,810	7,625	0	9,435	349
7	sand	16	4	2	740	5,581	14,631	0	20,212	749
8	sand	13	3	2	1050	5,940	17,670	0	23,609	874
9	sand	16	5	2	240	2,263	4,011	0	6,274	232
10	organic/sand	22	5.5	2	900	9,334	14,567	9,900	33,801	1,252
11	organic/sand	22	5	2	430	4,054	7,187	5,160	16,401	607
12	organic/sand	30	5	3	2150	20,270	96,135	43,000	159,405	5,904
13	organic/sand	24	5	3	280	2,640	9,160	3,920	15,720	582
14	organic/sand	22	5	3	660	6,222	18,951	7,920	33,094	1,226
15	organic/sand	21	6	4	300	3,394	9,797	2,700	15,891	589
16	organic/sand	24	5	3	2100	19,799	68,699	29,400	117,898	4,367
17	sand	11	2	3	700	2,640	16,020	0	18,660	691
						98,409	335,165	102,000	535,574	19,836

Drainage Area 2

Stream Segment	Soil Composition	Width (W)	Vertical Depth from Top of Bank to Top of Sediment (T)(ft)	Excavation Thickness (D) (ft)	Segment Length (L) (ft)	Volume of Sand (Dry) (ft3)	Volume of Sand (Sat) (ft3)	Volume of Organic Fines (ft3)	Volume Total (ft3)	Excavation Volume (cy)
A	sand	7	2	2	370	1,395	2,918	0	4,313	160
B	sand	8	2.5	2	340	1,603	2,841	0	4,444	165
C	sand	13	3	2	440	2,489	7,404	0	9,893	366
D	sand	11.5	2.5	2	450	2,121	6,911	0	9,032	335
E	sand	12	2	2	470	1,772	8,406	0	10,179	377
F	organic/sand	8	1.5	2	580	1,640	3,720	2,900	8,261	306
G	organic/sand	23	3	2	400	2,263	7,931	6,800	16,994	629
H	organic/sand	25	5	2	0	-	-	-	-	-
I	organic/sand	24	4	2	650	4,903	12,851	10,400	28,154	1,043
J	sand	11	2.5	2	830	3,913	11,916	0	15,829	586
K	sand	11	2	2	550	2,074	8,737	0	10,811	400
						24,173	73,637	20,100	117,910	4,367

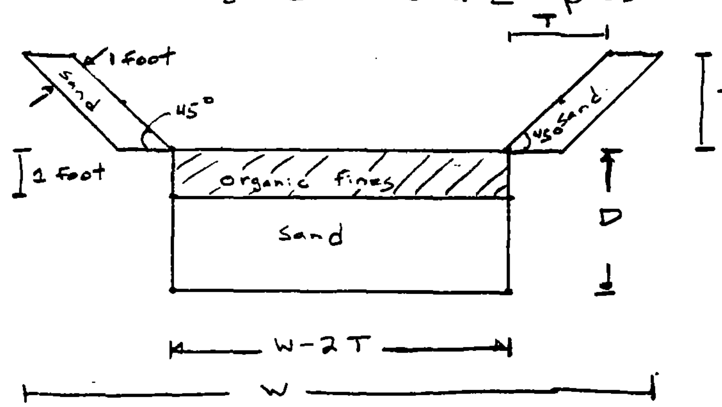
	Volume of Sand (Dry) (ft3)	Volume of Sand (Sat) (ft3)	Volume of Organic Fines (ft3)	Volume Total (ft3)	Excavation Volume (cy)
TOTALS	**122,583**	**408,801**	**122,100**	**653,484**	**24,203**
% material	18.8%	62.6%	18.7%	100%	

CHK'D ~~RM~~ 11-3

CLIENT		JOB NUMBER	
SUBJECT			
BASED ON		DRAWING NUMBER	
BY	CHECKED BY fLW 11-3-00	APPROVED BY	DATE

Figure A-2

Areas where organic fines are present



- Assume bottom 1/3 of T is saturated sands
- Assume 45° side slopes

Equations:

Volume of Organic Fines = (W-2T) (1 foot) (L) ← length of segment

Volume of Sat. Sand = $[(W-2T)(D-1) + \frac{1}{3}(2\sqrt{2}\,T)(1\text{ ft})](L)$

Volume of Dry Sand = $(\frac{2}{3})(2\sqrt{2}\,T)(1\text{ ft})(L)$

For areas comprised of sandy soil,

- assume depth D consists of saturated sands

Equations:

Volume of Saturated Sand = $[(W-2T)(D) + \frac{1}{3}(2T\sqrt{2})(1\text{ ft})(L)$

Volume of dry sand = $(\frac{2}{3})(2\sqrt{2})(T)(1\text{ ft})(L)$

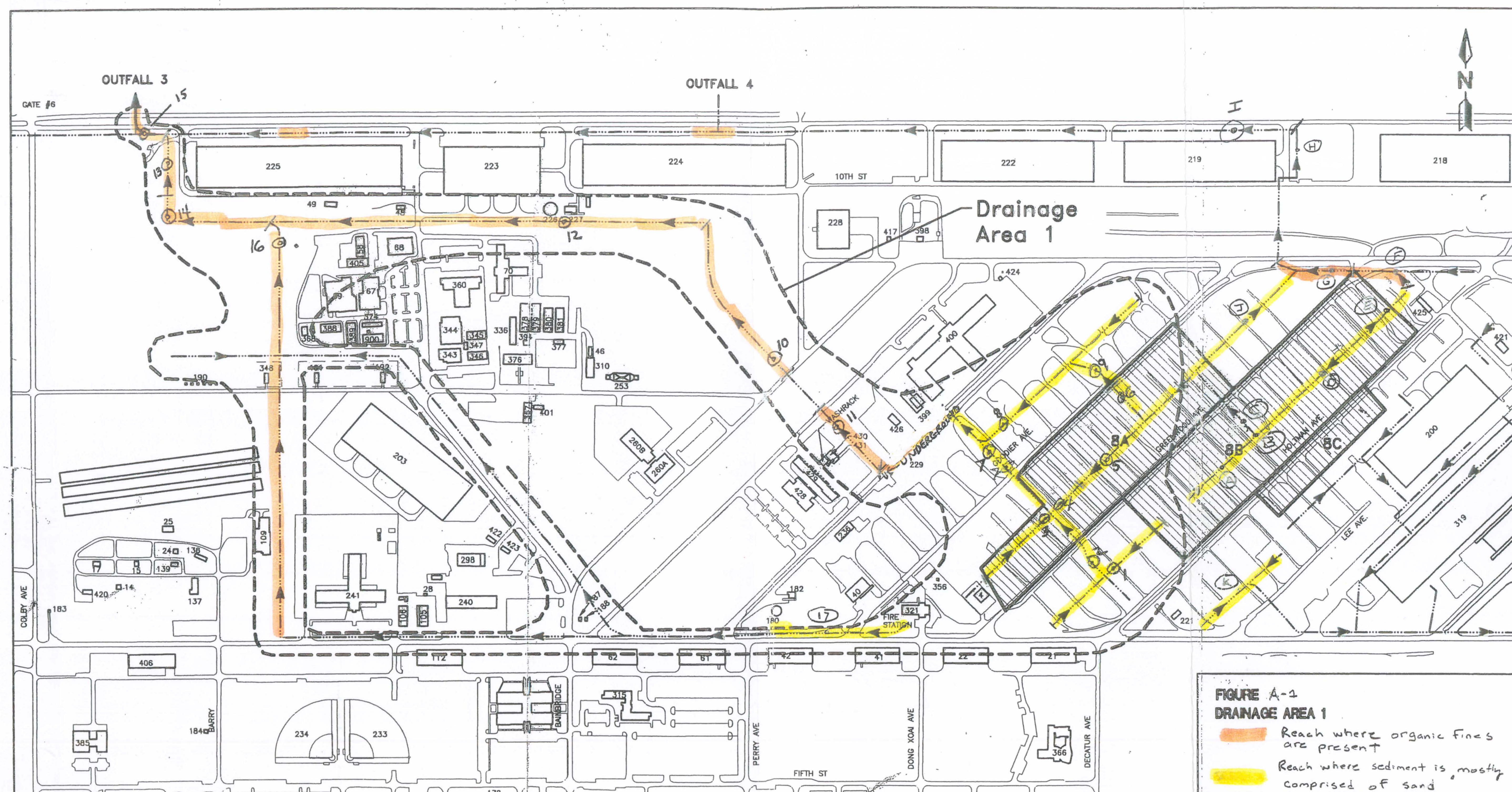


FIGURE A-1
DRAINAGE AREA 1

Reach where organic fines are present

Reach where sediment is mostly comprised of sand

NOTE
Boundaries for Site 8B and Site 8C are approximate.

LEGEND
Drainage area
Drainage ditch

0 250 500
SCALE: 1 INCH = 500 FEET

REMEDIATION PLANNING DOCUMENT

NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

C:\dwg\HLA\44236\0254064\DRAINAGE 1\DMF\000606

APPENDIX B

DETAILED COST ESTIMATES

B.1 Alternative 2
B.2 Alternative 3
B.3 Alternative 4

B.1

ALTERNATIVE 2

NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI
SITE 8, FOCUSED FEASIBILITY STUDY
ALTERNATIVE 2: INSTITUTIONAL CONTROLS AND MONITORING
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	100	hr			$35.00		$0	$0	$3,500	$0	$3,500
2 MOBILIZATION/DEMOBILIZATION											
2.1 Mobilize/Demobilize Drill Rig	1	ls	$2,495.00				$2,495	$0	$0	$0	$2,495
3 DECONTAMINATION											
3.1 Decontamination of Drill Rig	1	ls	$500.00				$500	$0	$0	$0	$500
4 MONITORING WELL INSTALLATION											
4.1 Install Monitoring Well (3)	45	lf	$24.00				$1,080	$0	$0	$0	$1,080
4.2 Well Development	6	hr	$35.00				$210	$0	$0	$0	$210
4.3 Collect/Containerize IDW	3	ea	$50.00				$150	$0	$0	$0	$150
4.4 Transport/Dispose IDW Off Site	3	drum	$150.00				$450	$0	$0	$0	$450
5 INSTITUTIONAL CONTROLS											
5.1 Prepare Deed Restrictions & LUCIPs	150	hr			$35.00		$0	$0	$5,250	$0	$5,250
Subtotal							$4,885	$0	$8,750	$0	$13,635
Local Area Adjustments							100.0%	107.8%	87.1%	87.1%	
							$4,885	$0	$7,621	$0	$12,506
Overhead on Labor Cost @ 30%									$2,286		$2,286
G & A on Labor Cost @ 10%									$762		$762
G & A on Material Cost @ 10%								$0			$0
G & A on Subcontract Cost @ 10%							$489				$489
Total Direct Cost							$5,374	$0	$10,670	$0	$16,043
Indirects on Total Direct Cost @ 35%											$5,615
Profit on Total Direct Cost @ 10%											$1,604
Subtotal											$23,263
Health & Safety Monitoring @ 5%											$1,163
Total Field Cost											$24,426
Contingency on Total Field Costs @ 20%											$4,885
Engineering on Total Field Cost @ 10%											$2,443
TOTAL COST											$31,754

NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI
SITE 8, FOCUSED FEASIBILITY STUDY
ALTERNATIVE 2: INSTITUTIONAL CONTROLS AND MONITORING
Annual Cost

Item	Item Cost per Year [(1)]	Item Cost Every 5 Years	Notes
Sampling	$5,450		Labor, Field Supplies
Analysis/Water	$8,500		Analyze samples from nine wells plus one QA sample for dioxin.
Analysis/Soil	$5,950		Analyze samples from six locations plus one QA sample for dioxin.
Report	$1,200		Document sampling events and results
Site Review		$7,000	Perform 5-Year reviews
TOTALS	$21,100	$7,000	

(1) Sampling would occur annually.

NAVAL CONSTRUCTION BATTALION CENTEF
GULFPORT, MISSISSIPPI
SITE 8, FOCUSED FEASIBILITY STUDY
ALTERNATIVE 2: INSTITUTIONAL CONTROLS AND MONITORINC
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$31,754		$31,754	1.000	$31,754
1		$21,100	$21,100	0.935	$19,729
2		$21,100	$21,100	0.873	$18,420
3		$21,100	$21,100	0.816	$17,218
4		$21,100	$21,100	0.763	$16,099
5		$28,100	$28,100	0.713	$20,035
6		$21,100	$21,100	0.666	$14,053
7		$21,100	$21,100	0.623	$13,145
8		$21,100	$21,100	0.582	$12,280
9		$21,100	$21,100	0.544	$11,478
10		$28,100	$28,100	0.508	$14,275
11		$21,100	$21,100	0.475	$10,023
12		$21,100	$21,100	0.444	$9,368
13		$21,100	$21,100	0.415	$8,757
14		$21,100	$21,100	0.388	$8,187
15		$28,100	$28,100	0.362	$10,172
16		$21,100	$21,100	0.339	$7,153
17		$21,100	$21,100	0.317	$6,689
18		$21,100	$21,100	0.296	$6,246
19		$21,100	$21,100	0.277	$5,845
20		$28,100	$28,100	0.258	$7,250
21		$21,100	$21,100	0.242	$5,106
22		$21,100	$21,100	0.226	$4,769
23		$21,100	$21,100	0.211	$4,452
24		$21,100	$21,100	0.197	$4,157
25		$28,100	$28,100	0.184	$5,170
26		$21,100	$21,100	0.172	$3,629
27		$21,100	$21,100	0.161	$3,397
28		$21,100	$21,100	0.150	$3,165
29		$21,100	$21,100	0.141	$2,975
30		$28,100	$28,100	0.131	$3,681
				TOTAL PRESENT WORTH	$308,676

B.2

ALTERNATIVE 3

NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI
SITE 8, FOCUSED FEASIBILITY STUDY
ALTERNATIVE 3: EXCAVATION, SURFACE WATER CONTROLS, DEWATERING, CHEMICAL STABILIZATION, ON-BASE LANDFILLING, CAPPING, INSTITUTIONAL CONTROLS AND MONITORING
Capital Cost

3/20/2003 2:16 PM

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	100	hr			$35.00		$0	$0	$3,500	$0	$3,500
2 MOBILIZATION/DEMOBILIZATION											
2.1 Office Trailer	12	mo	$345.00				$4,140	$0	$0	$0	$4,140
2.2 Field Office Support	12	mo		$136.00			$0	$1,632	$0	$0	$1,632
2.3 Storage Trailer (1)	12	mo	$103.00				$1,236	$0	$0	$0	$1,236
2.4 Utility Connection/Disconnection (phone/electric)	1	ls	$1,500.00				$1,500	$0	$0	$0	$1,500
2.5 Construction Survey	1	ls	$7,500.00				$7,500	$0	$0	$0	$7,500
2.6 Equipment Mobilization/Demobilization	7	ea			$96.00	$396.00	$0	$0	$672	$2,772	$3,444
2.7 Site Utilities	12	mo	$1,000.00				$12,000	$0	$0	$0	$12,000
2.8 Field Construction Mgt. (5p * 5 days/week)	52	mwk			$4,000.00		$0	$0	$208,000	$0	$208,000
2.9 Mobilize/Demobilize Drill Rig	1	ls	$2,495.00				$2,495	$0	$0	$0	$2,495
3 DECONTAMINATION											
3.1 Decontamination Trailer	12	mo	$2,350.00				$28,200	$0	$0	$0	$28,200
3.2 Pressure Washer	12	mo	$1,050.00				$12,600	$0	$0	$0	$12,600
3.3 Equipment Decon Pad	1	ls		$5,800.00	$6,600.00	$670.00	$0	$5,800	$6,600	$670	$13,070
3.4 Decon Water	12,000	gal		$0.20			$0	$2,400	$0	$0	$2,400
3.5 Decon Water Storage Tank, 6,000 gallon	12	mo	$600.00				$7,200	$0	$0	$0	$7,200
3.6 Clean Water Storage Tank, 4,000 gallon	12	mo	$540.00				$6,480	$0	$0	$0	$6,480
3.7 PPE (6 p * 5 days * 26 weeks)	1,560	day		$30.90			$0	$48,204	$0	$0	$48,204
3.8 Disposal of Decon Waste (liquid & solid)	12	mo	$900.00				$10,800	$0	$0	$0	$10,800
3.9 Decontamination of Drill Rig	1	ls	$500.00				$500	$0	$0	$0	$500
4 EXCAVATION											
4.1 Felling Trees	1.3	acre			$445.00	$1,375.00	$0	$0	$579	$1,788	$2,366
4.2 Grade Road/Bury Trees (dozer)	10	day			$334.20	$399.20	$0	$0	$3,342	$3,992	$7,334
4.3 Road Geotextile	4,800	sy		$0.65	$0.15		$0	$3,120	$720	$0	$3,840
4.4 Road Gravel, 8' thick	4,800	sy		$5.45	$1.89	$0.29	$0	$26,160	$9,072	$1,392	$36,624
4.5 Loader, 2.5 cy (ash/construction debris)	260	day			$167.60	$284.40	$0	$0	$43,576	$73,944	$117,520
4.6 Gradall, 1 cy, (ditch sediments)	260	day			$227.60	$774.80	$0	$0	$59,176	$201,448	$260,624
4.7 Verification Sampling (dioxin)	150	ea	$850.00	$20.00	$50.00	$20.00	$127,500	$3,000	$7,500	$3,000	$141,000
5 SURFACE WATER CONTROLS											
5.1 PVC Sheet Pile	1	ls		$1,500.00	$600.00		$0	$1,500	$600	$0	$2,100
5.2 Silt Screens	1	ls		$500.00	$350.00		$0	$500	$350	$0	$850
6 DEWATERING											
6.1 Grade Existing Area	4,200	sy			$0.10	$0.18	$0	$0	$420	$756	$1,176
6.2 Sand Base, 0.5 feet	695	cy		$7.89	$0.91	$1.68	$0	$5,484	$632	$1,168	$7,284
6.3 Earthen Berm	75	cy		$5.00	$0.24	$0.50	$0	$375	$18	$38	$431
6.4 Cell & Sump Liner, 60 mil HDPE	19,250	sf		$0.60	$0.45		$0	$11,550	$8,663	$0	$20,213
6.5 Drainage Net, fabric one side	16,500	sf		$0.33	$0.04	$0.01	$0	$5,445	$660	$165	$6,270
6.6 Sand Working Surface, 0.5 feet	280	cy		$7.89	$0.91	$1.68	$0	$2,209	$255	$470	$2,934
6.7 Piping, 3" PVC	500	lf		$1.89	$1.44		$0	$945	$720	$0	$1,665
6.8 Sump Pump & Hoses	260	day			$83.50	$23.00	$0	$0	$21,710	$5,980	$27,690
6.9 Trucking, 12cy/load	260	day			$191.60	$482.80	$0	$0	$49,816	$125,528	$175,344
6.10 Screen Plant	12	mo	$4,450.00				$53,400	$0	$0	$0	$53,400
6.11 Loader, 2.5 cy	260	day			$167.60	$284.40	$0	$0	$43,576	$73,944	$117,520
6.12 Trucking, 12cy/load	260	day			$191.60	$482.80	$0	$0	$49,816	$125,528	$175,344
7 CHEMICAL FIXATION AND ON-BASE LANDFILLING											
7.1 Loader, 2.5 cy	260	day			$167.60	$284.40	$0	$0	$43,576	$73,944	$117,520
7.2 Dozer, 105 hp	260	day			$167.60	$399.20	$0	$0	$43,576	$103,792	$147,368

NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI
SITE 8, FOCUSED FEASIBILITY STUDY
ALTERNATIVE 3: EXCAVATION, SURFACE WATER CONTROLS, DEWATERING, CHEMICAL STABILIZATION, ON-BASE LANDFILLING, CAPPING, INSTITUTIONAL CONTROLS AND MONITORING
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
7.1 Portland Cement	232,320	cwt		$3.71			$0	$861,907	$0	$0	$861,907
7.2 Tilling Soil/Cement	780	hr			$30.35	$102.54	$0	$0	$23,673	$79,981	$103,654
7.3 Compaction, Sheepsfoot	260	day			$167.60	$616.00	$0	$0	$43,576	$160,160	$203,736
7.4 Lab Moisture/Density (ASTM D698)	260	ea	$125.00		$20.00	$10.00	$32,500	$0	$5,200	$2,600	$40,300
7.5 Density/Moisture, Nuclear (ASTM D2922)	260	day	$350.00				$91,000	$0	$0	$0	$91,000
7.6 California Bearing Ratio (ASTM D4429)	260	ea	$270.00		$20.00	$10.00	$70,200	$0	$5,200	$2,600	$78,000
8 CAPPING											
8.1 Base Prep	62,920	sy			$0.25	$0.38	$0	$0	$15,730	$23,910	$39,640
8.2 Rigid Pavement Cap	62,920	sy	$29.00			$0.71	$1,824,680	$0	$0	$44,673	$1,869,353
9 SITE RESTORATION											
9.1 Import Topsoil	2,200	cy		$10.00			$0	$22,000	$0	$0	$22,000
9.2 Place/Grade Topsoil	2,200	cy			$0.33	$0.74	$0	$0	$726	$1,628	$2,354
9.3 Revegetation	13,400	sy		$0.26	$1.16	$0.18	$0	$3,484	$15,544	$2,412	$21,440
10 MONITORING WELL INSTALLATION											
10.1 Install Monitoring Well (3)	45	lf	$24.00				$1,080	$0	$0	$0	$1,080
10.2 Well Development	6	hr	$35.00				$210	$0	$0	$0	$210
10.3 Collect/Containerize IDW	3	ea	$50.00				$150	$0	$0	$0	$150
10.4 Transport/Dispose IDW Off Site	3	drum	$150.00				$450	$0	$0	$0	$450
11 INSTITUTIONAL CONTROLS											
11.1 Prepare Deed Restrictions & LUCIPs	150	hr			$35.00		$0	$0	$5,250	$0	$5,250
Subtotal							$2,295,821	$1,005,715	$722,023	$1,118,282	$5,141,841
Local Area Adjustments							100.0%	107.8%	87.1%	87.1%	
							$2,295,821	$1,084,161	$628,882	$974,024	$4,982,888
Overhead on Labor Cost @ 30%									$188,665		$188,665
G & A on Labor Cost @ 10%									$62,888		$62,888
G & A on Material Cost @ 10%								$108,416			$108,416
G & A on Subcontract Cost @ 10%							$229,582				$229,582
Total Direct Cost							$2,525,403	$1,192,577	$880,435	$974,024	$5,572,439
Indirects on Total Direct Cost @ 35%											$1,950,354
Profit on Total Direct Cost @ 10%											$557,244
Subtotal											$8,080,036
Health & Safety Monitoring @ 2%											$161,601
Total Field Cost											$8,241,637
Contingency on Total Field Costs @ 25%											$2,060,409
Engineering on Total Field Cost @ 5%											$412,082
TOTAL COST (6 month project)											**$10,714,128**

NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI
SITE 8, FOCUSED FEASIBILITY STUDY
ALTERNATIVE 3: EXCAVATION, SURFACE WATER CONTROLS, DEWATERING, CHEMICAL STABILIZATION, ON-BASE LANDFILLING, CAPPING, INSTITUTIONAL CONTROLS AND MONITORING
Annual Cost

Item	Item Cost per Year [1]	Item Cost Every 5 Years	Notes
Sampling	$5,450		Labor, Field Supplies
Analysis/Water	$8,500		Analyze samples from nine wells plus one QA sample for dioxin.
Analysis/Soil	$5,950		Analyze samples from six locations plus one QA sample for dioxin.
Report	$1,200		Document sampling events and results
Site Review		$7,000	Perform 5-Year reviews
TOTALS	$21,100	$7,000	

(1) Sampling would occur annually.

NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI
SITE 8, FOCUSED FEASIBILITY STUDY
ALTERNATIVE 3: EXCAVATION, SURFACE WATER CONTROLS, DEWATERING, CHEMICAL STABILIZATION, ON-BASE LANDFILLING, CAPPING, INSTITUTIONAL CONTROLS AND MONITORING
Present Worth Analysis

3/20/2003 2:16 PM

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$10,714,128		$10,714,128	1.000	$10,714,128
1		$21,100	$21,100	0.935	$19,729
2		$21,100	$21,100	0.873	$18,420
3		$21,100	$21,100	0.816	$17,218
4		$21,100	$21,100	0.763	$16,099
5		$28,100	$28,100	0.713	$20,035
6		$21,100	$21,100	0.666	$14,053
7		$21,100	$21,100	0.623	$13,145
8		$21,100	$21,100	0.582	$12,280
9		$21,100	$21,100	0.544	$11,478
10		$28,100	$28,100	0.508	$14,275
11		$21,100	$21,100	0.475	$10,023
12		$21,100	$21,100	0.444	$9,368
13		$21,100	$21,100	0.415	$8,757
14		$21,100	$21,100	0.388	$8,187
15		$28,100	$28,100	0.362	$10,172
16		$21,100	$21,100	0.339	$7,153
17		$21,100	$21,100	0.317	$6,689
18		$21,100	$21,100	0.296	$6,246
19		$21,100	$21,100	0.277	$5,845
20		$28,100	$28,100	0.258	$7,250
21		$21,100	$21,100	0.242	$5,106
22		$21,100	$21,100	0.226	$4,769
23		$21,100	$21,100	0.211	$4,452
24		$21,100	$21,100	0.197	$4,157
25		$28,100	$28,100	0.184	$5,170
26		$21,100	$21,100	0.172	$3,629
27		$21,100	$21,100	0.161	$3,397
28		$21,100	$21,100	0.150	$3,165
29		$21,100	$21,100	0.141	$2,975
30		$28,100	$28,100	0.131	$3,681
				TOTAL PRESENT WORTH	$10,991,050

B.3

ALTERNATIVE 4

NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI
SITE 8, FOCUSED FEASIBILITY STUDY
ALTERNATIVE 4: EXCAVATION, SURFACE WATER CONTROLS, DEWATERING AND OFF-BASE INCINERATION
Capital Cost

			Unit Cost				Extended Cost				
Item	Quantity	Unit	Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	100	hr			$35.00		$0	$0	$3,500	$0	$3,500
2 MOBILIZATION/DEMOBILIZATION											
2.1 Office Trailer	12	mo	$345.00				$4,140	$0	$0	$0	$4,140
2.2 Field Office Support	12	mo		$136.00			$0	$1,632	$0	$0	$1,632
2.3 Storage Trailer (1)	12	mo	$103.00				$1,236	$0	$0	$0	$1,236
2.4 Utility Connection/Disconnection (phone/electric)	1	ls	$1,500.00				$1,500	$0	$0	$0	$1,500
2.5 Construction Survey	1	ls	$7,500.00				$7,500	$0	$0	$0	$7,500
2.6 Equipment Mobilization/Demobilization	7	ea			$96.00	$396.00	$0	$0	$672	$2,772	$3,444
2.7 Site Utilities	12	mo	$1,000.00				$12,000	$0	$0	$0	$12,000
2.8 Field Construction Mgt. (5p * 5 days/week)	52	mwk			$4,000.00		$0	$0	$208,000	$0	$208,000
2.9 Mobilize/Demobilize Drill Rig	1	ls	$2,495.00				$2,495	$0	$0	$0	$2,495
3 DECONTAMINATION											
3.1 Decontamination Trailer	12	mo	$2,350.00				$28,200	$0	$0	$0	$28,200
3.2 Pressure Washer	12	mo	$1,050.00				$12,600	$0	$0	$0	$12,600
3.3 Equipment Decon Pad	1	ls		$5,800.00	$6,600.00	$670.00	$0	$5,800	$6,600	$670	$13,070
3.4 Decon Water	12,000	gal		$0.20			$0	$2,400	$0	$0	$2,400
3.5 Decon Water Storage Tank, 6,000 gallon	12	mo	$600.00				$7,200	$0	$0	$0	$7,200
3.6 Clean Water Storage Tank, 4,000 gallon	12	mo	$540.00				$6,480	$0	$0	$0	$6,480
3.7 PPE (6 p * 5 days * 52 weeks)	1,560	day		$30.90			$0	$48,204	$0	$0	$48,204
3.8 Disposal of Decon Waste (liquid & solid)	12	mo	$900.00				$10,800	$0	$0	$0	$10,800
3.9 Decontamination of Drill Rig	1	ls	$500.00				$500	$0	$0	$0	$500
4 EXCAVATION											
4.1 Felling Trees	1.3	acre			$445.00	$1,375.00	$0	$0	$579	$1,788	$2,366
4.2 Grade Road/Bury Trees (dozer)	10	day			$334.20	$399.20	$0	$0	$3,342	$3,992	$7,334
4.3 Road Geotextile	4,800	sy		$0.65	$0.15		$0	$3,120	$720	$0	$3,840
4.4 Road Gravel, 8' thick	4,800	sy		$5.45	$1.89	$0.29	$0	$26,160	$9,072	$1,392	$36,624
4.5 Loader, 2.5 cy (ash/construction debris)	260	day			$167.60	$284.40	$0	$0	$43,576	$73,944	$117,520
4.6 Gradall, 1 cy, (ditch sediments)	260	day			$227.60	$774.80	$0	$0	$59,176	$201,448	$260,624
4.7 Verification Sampling (dioxin)	150	ea	$850.00	$20.00	$50.00	$20.00	$127,500	$3,000	$7,500	$3,000	$141,000
5 SURFACE WATER CONTROLS											
5.1 PVC Sheet Pile	1	ls		$1,500.00	$600.00		$0	$1,500	$600	$0	$2,100
5.2 Silt Screens	1	ls		$500.00	$350.00		$0	$500	$350	$0	$850
6 DEWATERING											
6.1 Grade Existing Area	4,200	sy			$0.10	$0.18	$0	$0	$420	$756	$1,176
6.2 Sand Base, 0.5 feet	695	cy		$7.89	$0.91	$1.68	$0	$5,484	$632	$1,168	$7,284
6.3 Earthen Berm	75	cy		$5.00	$0.24	$0.50	$0	$375	$18	$38	$431
6.4 Cell & Sump Liner, 60 mil HDPE	19,250	sf		$0.60	$0.45		$0	$11,550	$8,663	$0	$20,213
6.5 Drainage Net, fabric one side	16,500	sf		$0.33	$0.04	$0.01	$0	$5,445	$660	$165	$6,270
6.6 Sand Working Surface, 0.5 feet	280	cy		$7.89	$0.91	$1.68	$0	$2,209	$255	$470	$2,934
6.7 Piping, 3" PVC	500	lf		$1.89	$1.44		$0	$945	$720	$0	$1,665
6.8 Sump Pump & Hoses	260	day			$83.50	$23.00	$0	$0	$21,710	$5,980	$27,690
6.9 Trucking, 12cy/load	260	day			$191.60	$482.80	$0	$0	$49,816	$125,528	$175,344
6.10 Screen Plant	12	mo	$4,450.00				$53,400	$0	$0	$0	$53,400
6.11 Loader, 2.5 cy	260	day			$167.60	$284.40	$0	$0	$43,576	$73,944	$117,520
6.12 Trucking, 12cy/load	260	day			$191.60	$482.80	$0	$0	$49,816	$125,528	$175,344

NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI
SITE 8, FOCUSED FEASIBILITY STUDY
ALTERNATIVE 4: EXCAVATION, SURFACE WATER CONTROLS, DEWATERING AND OFF-BASE INCINERATIOI
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
7 OFF-BASE INCINERATION											
7.1 Loader, 2.5 cy	260	day			$167.60	$284.40	$0	$0	$43,576	$73,944	$117,520
7.2 Dozer, 105 hp	260	day			$167.60	$399.20	$0	$0	$43,576	$103,792	$147,368
7.3 Transport/Incinerate/Dispose (TSDF)	55,000	cy	$1,000.00				$55,000,000	$0	$0	$0	$55,000,000
8 SITE RESTORATION											
8.1 Import Topsoil	770	cy		$10.00			$0	$7,700	$0	$0	$7,700
8.2 Place/Grade Topsoil	770	cy			$0.33	$0.74	$0	$0	$254	$570	$824
8.3 Revegetation	4,620	sy		$0.26	$1.16	$0.18	$0	$1,201	$5,359	$832	$7,392
9 MONITORING WELL INSTALLATION											
9.1 Install Monitoring Well (3)	45	lf	$24.00				$1,080	$0	$0	$0	$1,080
9.2 Well Development	6	hr	$35.00				$210	$0	$0	$0	$210
9.3 Collect/Containerize IDW	3	ea	$50.00				$150	$0	$0	$0	$150
9.4 Transport/Dispose IDW Off Site	3	drum	$150.00				$450	$0	$0	$0	$450
10 INSTITUTIONAL CONTROLS											
10.1 Prepare Deed Restrictions & LUCIPs	150	hr			$35.00		$0	$0	$5,250	$0	$5,250
Subtotal								$127,225	$617,988	$801,719	$1,546,932
Local Area Adjustments								107.8%	87.1%	87.1%	
								$137,148	$538,267	$698,298	$1,373,713
Overhead on Labor Cost @ 30%									$161,480		$161,480
G & A on Labor Cost @ 10%									$53,827		$53,827
G & A on Material Cost @ 10%								$13,715			$13,715
Total Direct Cost								$150,863	$753,574	$698,298	$1,602,735
Indirects on Total Direct Cost @ 35%											$560,957
Profit on Total Direct Cost @ 10%											$160,273
Subtotal											$2,323,966
Health & Safety Monitoring @ 2%											$46,479
Total Field Cost											$2,370,445
Contingency on Total Field Costs @ 25%											$592,611
Engineering on Total Field Cost @ 5%											$118,522
Total Subcontracting Cost							$55,277,441				$55,277,441
G & A on Subcontract Cost @ 10%							$5,527,744				$5,527,744
TOTAL COST (12 month project)											**$61,516,319**

APPENDIX C

CALCULATION OF OFF-BASE DEEPWATER RGOs

DRAFT

TECHNICAL MEMORANDUM

TO: Robert Fisher

FROM: Lee Ann Sinagoga

RE: Remediation Goal Options for Deep Sediments Underlying Bernard Bayou and Brickyard Bayou, NCBC Gulfport

DATE: March 16, 2002

This memorandum presents remedial goal options (RGOs) for dioxins/furans detected in the deeper channel (continuously covered by water) sediments underlying Bernard Bayou and Brickyard Bayou, downstream from NCBC Gulfport. Sediments samples were collected from the seven locations shown on Figures 3-4 and 3-5 of the *Surface Water and Sediment Dioxin Delineation Report* (ABB-ES, 1999) and analyzed for dioxins/furans. The dioxin/furan concentrations are presented in terms of toxicity equivalent concentrations (TEQs) of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) and range from 28.1 nanograms per kilograms (ng/kg) to 60.7 ng/kg.

Because the bayou sediments are deep channel sediments, the potential for direct contact exposure is anticipated to be very limited. Unless the sediments are dredged and deposited on surface soils, none of the receptors evaluated in the *Human Health Risk Assessment and Screening Level Ecological Risk Assessment of Dioxin and Furans Associated with Former Herbicide Orange Storage* (Harding Lawson Associates, 2000) would be directly exposed to the dioxin/furans detected in these deep channel sediments. However, assuming that periodic dredging (or some similar industrial activity) in the bayous may occur, workers involved in a dredging operation may directly contact the sediments, particularly if the operation requires a significant amount of manual labor. (The Coast Guard recently raised a similar concern for one of their coastal sites scheduled for dredging.) Consequently, RGOs were developed for this worker assuming incidental ingestion of and dermal contact with the sediments during a dredging operation. Using the basic methodology presented in the aforementioned report from Harding Lawson Associates, the following equations estimate risks for a worker involved in a dredging operation (the maximum detected deep channel concentration [60.7 ng/kg] is used as the exposure point concentration):

$Intake_{ing}$ (mg/kg/day) = (CS * IR * FI * CF * EF * ED) / (BW * AT * 365 days/yr)

Where:

$Intake_{ing}$ = Intake estimated for the ingestion route of exposure (mg/kg/day)

CS = Sediment concentration (60.7 ng/kg)

IR = Sediment ingestion rate (330 mg/day)

FI = Fraction ingested from source area (1, unitless)

CF = Conversion factor (1E-12 kg/ng)

EF = Exposure frequency (30 days per yr)

ED = Exposure duration (1 yr)

BW = Body weight (70 kg)

AT = Averaging time (70 yrs)

Therefore:

$Intake_{ing}$ (mg/kg/day) = (60.7 ng/kg * 330 mg/day * 1 * 1E-12 kg/ng * 30 days/yr * 1 yrs) / (70 kg * 70 yrs * 365 days/yr)

= 3.4 E-13 mg/kg/day

$Intake_{der}$ (mg/kg/day) = (CS * AF * ABS * CF * SA * EF * ED) / (BW * AT * 365 days/yr)

Where:

$Intake_{der}$ = Intake estimated for the dermal route of exposure (mg/kg/day)

CS = Sediment concentration (60.7 ng/kg)

AF = Sediment adherence factor (1 $mg/cm^2/day$)

ABS = Absorption fraction (0.01, unitless)

SA = Skin surface area contacting sediment (5,750 cm^2)

CF = Conversion factor (1E-12 kg/ng)

EF = Exposure frequency (30 days per yr)

ED = Exposure duration (1 yr)

BW = Body weight (70 kg)

AT = Averaging time (70 yrs)

Therefore:

$$Intake_{der}\ (mg/kg/day) = (60.7\ ng/kg * 1\ mg/kg/day * 0.01 * 1E\text{-}12\ kg/ng * 5{,}750\ cm^2 * 30\ days/yr * 1\ yrs) / (70\ kg * 70\ yrs * 365\ days/yr)$$

$$= 5.9E\text{-}14\ mg/kg/day$$

Total intake = $Intake_{ing}$ [3.4 E-13 mg/kg/day] + $Intake_{der}$ [5.9 E-14 mg/kg/day] = 4 E-13 mg/kg/day

Based on a cancer slope factor (CSF) of 1.5 E+5 $(mg/kg/day)^{-1}$, the cancer risk estimate associated with the worker's exposure to the dioxins/furans in the deep channel sediments is:

Total Intake (mg/kg/day) * CSF $(mg/kg/day)^{-1}$ = 4 E-13 mg/kg/day * 1.5 E+5 $(mg/kg/day)^{-1}$ = 6 E-08

Therefore, the cancer risk estimate developed for the worker is less than 1E-07. Expressed another way, the worker has a less than 1 in ten million chance of developing cancer assuming that he/she is exposed as defined above.

Using the basic methodology presented in the aforementioned report from Harding Lawson Associates and a target risk of 1E-06, the exposure point concentration (60.7 ng/kg) and the cancer risk estimate (6 E-08) can be used to calculate a RGO for the worker hypothetically involved in a dredging operation:

$$\frac{\text{Exposure Point Concentration (60.7 ng/kg)}}{\text{Cancer risk estimate (6E-08)}} = \frac{\text{RGO}}{\text{Target risk (1E-06)}}$$

The RGO = 1000 ng/kg.

An RGO of 1000 ng/kg is an order of magnitude greater than the maximum detected dioxin/furan concentrations reported for the deep channel sediment samples collected from Bernard Bayou and Brickyard Bayou. RGOs representing the 1E-05 and 1E-04 target risk levels are 10,000 ng/kg and 100,000 ng/kg, respectively.

The exposure assumptions used to calculate the risk estimates and RGOs presented above are similar to those selected for the excavation worker in the Harding Lawson Associates report. However, a 330 mg/day sediment ingestion rate was used because it is the ingestion rate suggested for a construction worker in the most current EPA SSL guidance document (EPA,2001). The following issues/uncertainties should be considered when interpreting/using 1000 ng/kg RGO:

- The sediment-dredging scenario described above is hypothetical. Currently, there are no planed dredging operations (or any type of construction activities that could bring workers in contact with the submerged sediments) in Bayou Bernard and a single event planned for Brickyard Bayou. The duration of future dredging or major construction activities, if any, may vary dramatically. However, intuitively, the exposure assumptions selected above are conservative as is the resultant RGO. Based on the dioxin/furan results available to date, the exposure frequency and durations would have to increase significantly before risk estimates greater than 1E-06 (and RGOs less than 100 ng/kg) are predicted. (Site-specific information that may become available in the future should be used in the refinement of the RGO).

- Research studies regarding the dermal absorption of chemicals in sediments ***are very limited*** at this time. Consequently, exposure parameters (e.g., skin adherence factors and chemical absorption factors) based on research studies using soils are often used to evaluate human exposure to sediment. This is a ***significant*** source of uncertainty for risk estimates and RGOs developed for sediments.