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CORRECTIVE MEASURES STUDY REPORT FOR SOLID WASTE MANAGEMENT UNIT 2
NAS KEY WEST FL
3/1/1998
BROWN AND ROOT ENVIRONMENTAL

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Rev. 3
03/13/98

Corrective Measures Study Report
for
Solid Waste Management Unit 2 (SWMU 2)

Naval Air Station Key West
Boca Chica Key, Florida

Southern Division
Naval Facilities Engineering Command
Contract Number N62467-94-D-0888
Contract Task Order 0007

March 1998

Brown & Root Environmental
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C-49-01-8-088
January 15, 1998
Project Number 7046

Commanding Officer
Department of the Navy
SOUTHNAVFACENGCOM
ATTN: Mr. Dudley Patrick, code 1858
2155 Eagle Drive
North Charleston, South Carolina 29406

Reference: CLEAN Contract No. N62467-94-D-0888
Contract Task Order No. 0007

Subject: Corrective Measure Study Report for SWMU2
Boca Chica Key
Naval Air Station Key West, Florida

Dear Mr. Patrick:

Brown and Root Environmental (B&R Environmental) is pleased to submit one copy of Revision 2 of the Corrective Measure Study Report for SWMU2 on Boca Chica Key, Florida

At your request, copies of the enclosed report are being distributed to the Partnering Team and RAB members.

Please call me at (803) 649-7963 ext. 345 if you have any questions regarding the enclosed report.

Sincerely,

Mark P. Speranza
for C.M. Bryan
Task Order Manager

CMB/dt
Enclosures

c: Ms. M. Berry, U.S. Environmental Protection Agency, Region IV (2 copies)
Mr. J. Caspary, Florida Department of Environmental Protection (2 copies)
Mr. R. Demes, NAS Key West
Mr. P. Williams, NAS Key West
Mr. R. Hoekstra, Bechtel Environmental, Inc.
Mr. M. Ingram, Community RAB Member
Ms. S. Loder, Community RAB Member
Ms. R. Orlandi, Community RAB Member
Ms. D. Perez, Community RAB Member
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Ms. M. Stafford, Community RAB Member
Ms. D. Wroblewski (w/o enclosures)
Mr. M. Perry
File 7046

Rev. 3
3/13/98

CORRECTIVE MEASURES STUDY REPORT FOR SOLID WASTE MANAGEMENT UNIT 2 (SWMU 2)

NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

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:
Brown & Root Environmental
661 Andersen Drive
Foster Plaza 7
Pittsburgh, Pennsylvania 15220

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0007

MARCH 1998

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CERTIFICATION OF TECHNICAL CONFORMITY

Name:	Mark P. Speranza
Signature:	Mark P. Speranza
Professional Engineer Certificate Number:	PE0050304
Date:	January 13, 1998

This Professional Engineer Certificate indicates that this document complies with the State of Florida's regulatory requirements for an engineering document. The Professional Engineering Certificate does not indicate that this report can be used for construction.

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ARARs	Applicable or Relevant and Appropriate Requirements
AWQC	Ambient Water Quality Criteria
B&R Environmental	Brown & Root Environmental
BDAT	Best Demonstrated Available Technology
bgs	Below Ground Surface
BTAG	Biological Technical Assistance Group
CAA	Clean Air Act
CAMP	Corrective Action Management Plan
CAO	Corrective Action Objective
CAP	Corrective Action Program
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
cm/sec	centimeters per second
CMS	Corrective Measure Study
COC	Chemical of Concern
COPC	Chemicals of Potential Concern
CWA	Clean Water Act
cy	cubic yard
DDD	Dichlorodiphenyl Dichloroethane
DDE	Dichlorodiphenyl Dichloroethylene
DDT	Dichlorodiphenyl Trichloroethane
dl	deciliter
DOD	Department of Defense
DOT	Department of Transportation
ECC	Ecological Chemicals of Concern
EPA	United States Environmental Protection Agency
ERA	Ecological Risk Assessment
ER-L	Effects Range Low
ER-M	Effects Range Median
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection

ft	feet
ft^2	square feet
g	gram
gpd	gallons per day
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
HSWA	Hazardous and Solid Waste Amendments
ICR	Incremental Cancer Risk
IEUBK	Integrated Exposure and Uptake Biokinetic
IRA	Interim Remedial Action
IRP	Installation Restoration Program
kg	kilogram
L	Liter
LDR	Land Disposal Restriction
MCL	Maximum Contaminant Levels
MCLG	Maximum Contaminant Level Goal
meq	milliequivalent
μg	microgram
mg	milligram
msl	mean sea level
NAAQS	National Ambient Air Quality Standards
NACIP	Naval Assessment and Control of Installation Pollutants Program
NAS	Naval Air Station
NAVFACENGCOM	Naval Facilities Engineering Command
NCP	National Contingency Plan
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFA	No Further Action
NPDES	National Pollution Discharge Elimination System
NSPS	New Source Performance Standards
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
ppb	parts per billion
PPE	Personal Protective Equipment

ppm	parts per million
QA	Quality Assurance
QC	Quality Control
RAB	Restoration Advisory Board
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RFI	RCRA Facility Investigation
RGO	Remedial Goal Options
RI	Remedial Investigation
SAL	Screening Action Level
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SCG	Soil Clean-up Goals
SDWA	Safe Drinking Water Act
SIP	State Implementation Plan
SPT	Standard Penetration Test
SVOC	Semi-Volatile Organic Compound
SWMU	Solid Waste Management Unit
TBC	To Be Considered
TOC	Total Organic Compound
TSDF	Treatment, Storage, and Disposal Facility
yd	yard
yd^3	cubic yards
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

This Corrective Measure Study (CMS) for Solid Waste Management Unit (SWMU) 2, Boca Chica Dichlorodiphenyl Trichloroethane (DDT) Mixing Area, at the Naval Air Station (NAS) located in Key West, Florida has been prepared for the Southern Division, Naval Facilities Engineering Command (NAVFACENGCOM). This work has been authorized under Contract Task Order No. 0007 under Contract N62467-94-D-0888. This report is based on the results of previous investigations as listed below.

Investigation	Date	Regulatory Driver
Initial Assessment Study performed by Envirodyne Engineers	1985	Naval Assessment and Control of Installation Pollutants Program (NACIP)
Verification Study performed by Geraghty and Miller	1987	NACIP
Visual Site Inspection conducted by the United States Environmental Protection Agency (EPA)	1988	Resource Conservation and Recovery Act (RCRA)
Preliminary Remedial Investigation (RI) conducted by IT Corporation	1991	Comprehensive Environmental Response Compensation and Liability Act (CERCLA)
RCRA Facility Investigation/Remedial Investigation (RFI/RI) conducted by IT Corporation	1994	RCRA/CERCLA
Delineation Sampling Report for Interim Remedial Action (IRA) at SWMU 1 conducted by Bechtel Environmental, Inc.	1996	RCRA/CERCLA
Supplemental RFI/RI conducted by B&R Environmental	1997	RCRA/CERCLA

SITE DESCRIPTION

SWMU 2 (previously identified as Site No. 5) consists of the former location of Building 915 and its surrounding area, which was used for the storage and mixing of pesticides. Two aboveground tanks on concrete foundations (a 500-gallon mixing tank and a 1,000-gallon storage tank) were located to the west of the building. Mixing operations for DDT were conducted at this location from the mid-1940s to the early 1970s. Building 915 was demolished in 1982 and the site is a vacant, sparsely vegetated lot covering approximately 0.25 acre. It is on the northern edge of a manmade ditch that connects with a lagoon, that has formed in a borrow pit. The ditch receives surface-water runoff from the vicinity of SWMU 2 and the area north of the site. The lagoon and ditch are inhabited by fish and wading birds and support mangroves and other plant life.

In Spring of 1996, an IRA was conducted at SWMU 2 to prevent the further migration of pesticide contaminants from soil and sediment into other media and biota at the site. This CMS addresses residual contaminants remaining after the IRA.

PURPOSE

The purpose of this CMS is to identify corrective action objectives (CAOs), identify and screen corrective measure technologies, develop corrective measure alternatives, evaluate corrective measure alternatives, and justify and recommend a final corrective action for soil, sediment, and surface-water contamination within SWMU 2. The classes of chemicals of concern (COCs) addressed in this CMS report consist of pesticides and inorganics for soil and surface water and pesticides for sediment.

CORRECTIVE ACTION OBJECTIVES

CAOs specify COCs, media of interest, exposure pathways, and cleanup goals or acceptable contaminant concentrations. CAOs may be developed to permit consideration of a range of treatment and containment alternatives. This CMS addresses soil, sediment, and surface-water contamination within SWMU 2. To protect the public from potential current and future health risks, as well as to protect the environment, the following CAOs have been developed for SWMU 2 soil, sediment, and surface water to address the primary exposure pathways:

- Prevent human and ecological receptors from contacting contaminants in the soil, sediment, and surface water at concentrations which would result in adverse effects.
- Prevent the migration of surface soil contaminants to the drainage ditch via runoff and subsequent migration to surface water and sediment.
- Compliance at SWMU 2 with contaminant-specific, location-specific, and action-specific Federal and state applicable or relevant and appropriate requirements (ARARs)

CORRECTIVE MEASURE ALTERNATIVE DEVELOPMENT

Alternatives were developed which evaluate corrective measures in each of the three media that address the COCs and exposure pathways in order to achieve the CAOs. Alternatives were developed that range from no action to those that address all contaminants that could potentially affect human and ecological receptors. The alternatives that were assembled are briefly described below.

SWMU 2 Alternatives

Alternative 1 - No Action: The No Action alternative is a general response action wherein the status quo is maintained at the site. This alternative is retained to provide a baseline for comparison to other alternatives and therefore, does not address the remaining contamination of the soil, sediment, surface water, and groundwater.

Alternative 2 - Limited Action: Institutional Controls : This alternative consists of one major component, institutional controls (i.e. limited site access, monitoring, site development restrictions, and educational programs). Limited site access would be imposed to eliminate or reduce the pathways of human exposure to contaminants at the site. In addition, surface-water, sediment, and groundwater sampling and biomonitoring would be conducted. A reevaluation of the site would be performed every 5 years to determine if any changes to the controls would be required. The site reevaluation every 5 years would include recommendations for further action at the site (i.e. continued monitoring, additional remedial action, no further action, etc.).

Alternative 3 - Remove, Treat, and Dispose of Soil Contaminated at Concentrations Greater than Florida Department of Environmental Protection (FDEP) Industrial Remedial Goal Options (RGOs) and Contaminated Sediment at Concentrations Greater than ER-M Sediment Guideline Values; Treat Associated Surface Water: Under this alternative, approximately 140 cubic yards (yd^3) of soil contaminated in excess of FDEP Industrial RGOs would be excavated from one hot-spot outside the perimeter of the IRA. Approximately 470 yd^3 of contaminated sediment would be excavated from the entire drainage ditch. After sediment removal, about 237,000 gallons of surface water in the entire ditch could be contaminated with pesticides and if necessary, will be treated on-site using carbon adsorption units with a bag prefilter for suspended solids removal. Treatment of the surface water would continue until the clean-up goals [under the National Pollution Discharge Elimination System (NPDES) requirements] have been reached. Stockpiled soils and sediments will be transported to an off-site RCRA permitted treatment, storage, and disposal facility (TSDF) for treatment, if required, and disposal. This alternative would also include the implementation of institutional controls (i.e., limited site access, site development restrictions, and educational programs) to eliminate or reduce pathways of exposure from residual contaminants at the site and monitoring to verify that unacceptable risk did not exist. A reevaluation of the site would be performed every 5 years to determine if changes to the controls would be required.

Alternative 4 - Remove, Treat, and Dispose of Contaminated Soil and Sediment at Concentrations Greater Than the Most Stringent Soil and Sediment RGOs and Treat Associated Surface Water: Under this alternative, approximately 4,400 yd^3 of contaminated soil would be excavated outside the perimeter of the IRA excavation to remove the primary sediment and surface-water contamination source. Approximately

470 yd^3 of contaminated sediment would be excavated from the drainage ditch. After sediment removal, about 237,000 gallons of surface water remaining in the ditch could be contaminated with pesticides. If necessary, it will be treated on-site using carbon adsorption units with a bag prefilter for suspended solids. Treatment of the surface water would continue until the RGOs (under NPDES requirements) have been reached. Stockpiled soils and sediments will be transported to an off-site RCRA permitted TSDF for treatment, if required, and disposal. This alternative would also include the implementation of institutional controls (e.g., limit site access and monitoring) to prevent groundwater consumption and to verify that unacceptable risk from residual contaminants did not exist.

EVALUATION OF CORRECTIVE MEASURE ALTERNATIVES

Each alternative was evaluated using the nine criteria specified in the Guidance for RCRA Corrective Action Plan (OSWER Directive 9902.3-2A, U.S. EPA May, 1994). These criteria include Protection of Human Health and the Environment; Media Clean-up Standards; Source Control; Waste Management Standards; Long-Term Reliability and Effectiveness; Reduction in Toxicity, Mobility, or Volume; Short-Term Effectiveness; Implementability; and Cost. The development and evaluation of these alternatives take into consideration the effects of an IRA completed in the Spring of 1996. Section 5.0 of this report presents the results of this evaluation process.

A comparative analysis of each alternative was completed. This comparative analysis was performed with respect to specific factors for each of the nine above-mentioned criteria and differences among the alternatives were identified. The results of this analysis is presented in Section 5.0. The estimated costs for each alternative are as follows:

Alternative	Capital ($)	Operating ($/year)	Present Worth ($)
1	0	0	0
2	1,614	13,500-54,000	219,768
3	1,002,348	13,500-54,000	1,220,502
4	6,230,131	10,500-54,000	6,350,432

The costs are itemized in the detailed cost sheets presented in Appendix C.

It should be also noted that, to date, the Navy has spent approximately 7.9 million dollars on IRAs at nine sites/SWMUs/Areas of Concern. SWMU 2 was one of the SWMUs where an IRA was performed.

The recommended alternative for this site is Alternative 2 - Limited Action. The site is within an active air strip (surrounded by runways or taxiways) on an active military base with no planned change in usage for the foreseeable future. This alternative would involve sediment, surface-water, and groundwater sampling and biomonitoring to determine the effectiveness of the IRA and would provide for 5 year reviews of the data collected. If the planned land usage of the site changes or if the IRA is not found to be protective, Alternative 3 or 4 should be reconsidered or a new CMS should be conducted.

1.0 INTRODUCTION

Brown & Root Environmental (B&R Environmental) conducted a CMS of SWMU 2, Boca Chica DDT Mixing Area, NAS Key West under Contract Number N62467-94-D-0888, Contract Task Order 0007, for the U.S. Navy, NAVFACENGCOM-Southern Division. This CMS was based on the results of previous investigations as listed below.

Investigation	Date	Regulatory Driver
Initial Assessment Study performed by Envirodyne Engineers	1985	NACIP
Verification Study performed by Geraghty and Miller	1987	NACIP
Visual Site Inspection conducted by the EPA	1988	RCRA
Preliminary RI conducted by IT Corporation	1991	CERCLA
RFI/RI conducted by IT Corporation	1994	RCRA/CERCLA
Delineation Sampling Report for IRA at SWMU 1 conducted by Bechtel Environmental, Inc.	1996	RCRA/CERCLA
Supplemental RFI/RI conducted by B&R Environmental	1997	RCRA/CERCLA

SWMU 2 was the subject of an IRA in mid-1996 conducted by a remedial action contractor for NAVFACENGCOM-Southern Division. During this IRA contaminated soil and sediment was removed for off-site treatment and disposal. This CMS addresses what additional corrective measures are necessary and appropriate. All samples of soil, sediment, groundwater, and surface water obtained during the Supplemental RFI/RI in 1996 were taken prior to implementation of the IRA. However, the human health and ecological risk assessments performed under the Supplemental RFI/RI utilized soil and sediment contamination levels remaining following the IRA. The risk assessments verified the necessity for the CMS.

A draft version of this CMS (Rev. 1) was prepared by B&R Environmental in August of 1997 and was submitted to the EPA and FDEP. Additionally, a final version (Rev. 2) was submitted in January 1998. Regulators' comments to the draft and final documents and responses to these comments are provided in Appendix E.

1.1 PURPOSE

The purpose of this CMS is to identify CAOs, identify and screen corrective measure technologies, develop corrective measure alternatives, evaluate corrective measure alternatives, and justify and recommend a final corrective action for soil, sediment, and surface-water contamination within SWMU 2.

1.2 REPORT ORGANIZATION

Section 1.0 of this report provides a brief description of the background and purpose of the CMS conducted for SWMU 2, Boca Chica DDT Mixing Area, NAS Key West. Section 2.0 presents the Description of Current Conditions, including a discussion on the nature and extent of contamination, site conditions, and the IRA. The CAOs for SWMU 2 are described in Section 3.0. In addition, the volume of contaminated media are presented in Section 3.0. Section 4.0 describes the identification, screening, and development of corrective measure alternatives. Section 5.0 presents the detailed evaluation of the corrective measure alternatives. Section 6.0 provides a comparative analysis of the corrective action alternatives and provides the recommendation for the final corrective measure.

1.3 BACKGROUND

RCRA Corrective Action, as mandated by the Hazardous and Solid Waste Amendments (HSWA), is a process by which a hazardous waste TSDF/solid waste disposal unit are investigated and remediated, where necessary, to address routine and systematic releases of hazardous waste or hazardous waste constituents at the facility. RCRA corrective action is generally required for the TSDF/SWMU as part of the Part B permit activities conducted by authorized states or EPA, or through enforcement actions [i.e., RCRA Section 3008(h) orders] by the EPA. The Corrective Action Program (CAP) assists the EPA in developing CAOs [3008(h)] and Corrective Action requirements in permit applications and permits [3004(u)&(v)]. The objective of a CAP at a TSDF/SWMU is to evaluate the nature and extent of the release of hazardous waste or constituents; to evaluate facility characteristics; and to identify, develop, and implement the appropriate corrective measure or measures adequate to protect human health and the environment.

The CAP involves three distinct steps: RFI; CMS, and Corrective Measures Implementation. The objective of an RFI is to thoroughly evaluate the nature and extent of the release of hazardous waste and hazardous constituents and to gather necessary data to support the CMS. The objective of a CMS is to develop and evaluate a corrective measure alternative or alternatives and to recommend the final corrective measure or measures. The objective of the Corrective Measures Implementation is to design, construct, operate, maintain, and monitor the performance of the corrective measure or measures selected.

In addition to RCRA/HSWA sites at NAS Key West, there are several Installation Restoration Program (IRP) sites. Clean-up activities for the IRP are implemented in accordance with the National Contingency Plan (NCP) and CERCLA as amended by the Superfund Amendments and Reauthorization Act (SARA). CERCLA establishes the approach to address and clean up hazardous waste sites at both private and Federal facilities. These remedial investigations are commonly known as RIs.

IT Corporation conducted the Phase I RFI/RI from 1992 through 1994 (IT, 1994). This investigation confirmed the presence of contamination at specific NAS Key West sites. The Supplemental RFI/RI was conducted in accordance with HSWA Permit No. FL6-170-022-952 issued by the EPA. A Corrective Action Management Plan (CAMP) has been prepared to describe the strategy for implementing the RCRA CAP at NAS Key West (ABB, 1995a).

In January 1996, B&R Environmental implemented the Supplemental RFI/RI Sampling and Analysis Plan (SAP) in accordance with the regulatory-approved planning documents (ABB 1995a) at SWMU 2. The RFI/RI sample results were used for chemical and toxicological analyses to determine risks to human health and ecological receptors. A limited validation effort was performed for the analytical data collected by B&R Environmental. The data provided in the RFI/RI (IT Corporation, 1994) prepared by IT Corporation was also used to assess site risks. The Supplemental RFI/RI recommended that a CMS be conducted for SWMU 2, Boca Chica DDT Mixing Area.

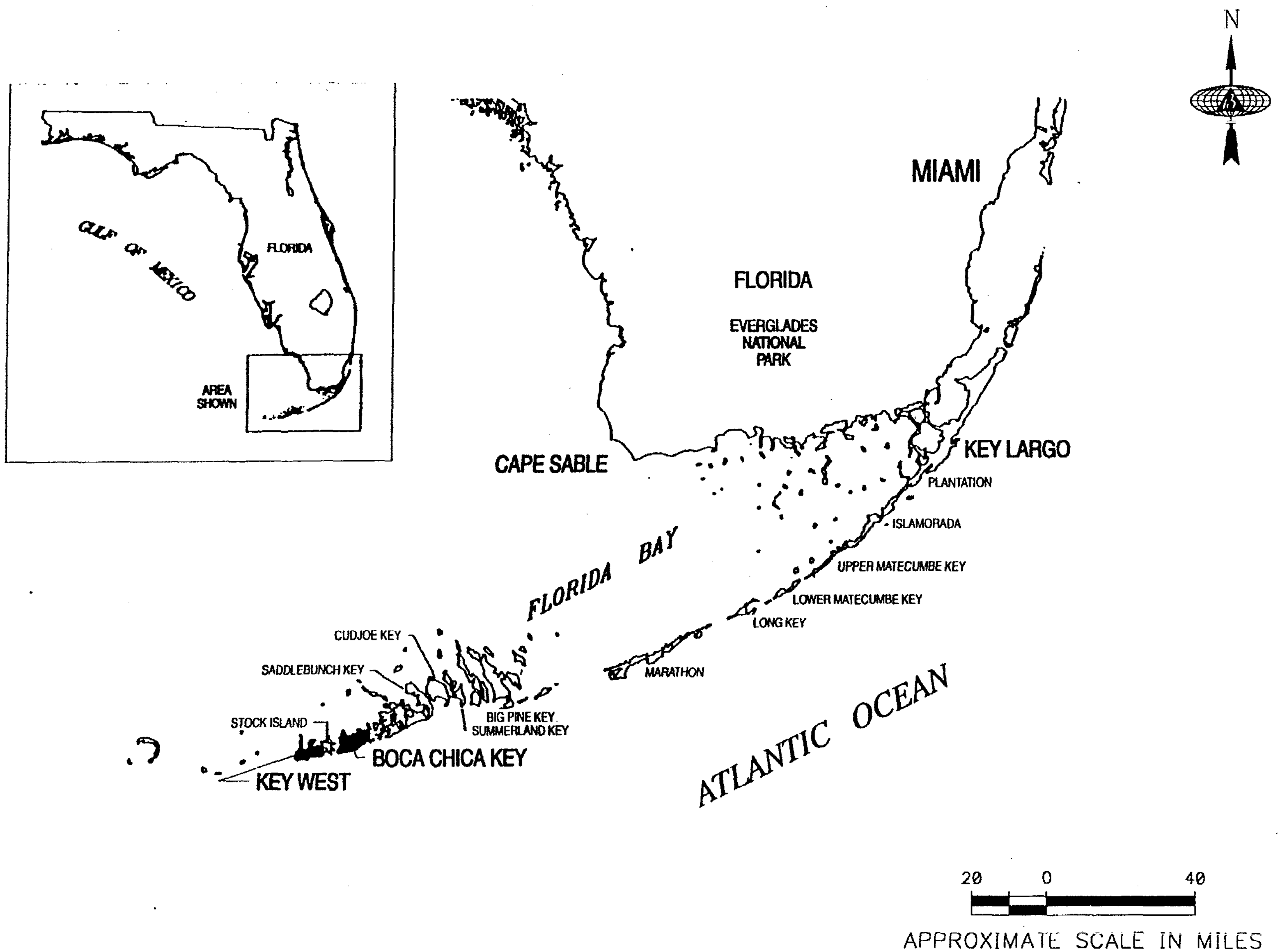
The data obtained from the January 1996 field sampling at SWMU 2 were partially validated using the industry-accepted process described in Section 2.0 of Appendix G of the RFI/RI (B&R Environmental 1997). In general, this data assessment process followed Contract Laboratory Program (CLP) Protocol and Naval Facilities Engineering Service Center data quality assessment guidance. In 1996, data received a limited validation review; approximately 10 percent of 1996 data was fully validated. Historical data were not subjected to any data quality assessment. They were assumed to have been assessed during their investigation activities and were accepted at face value since records of validation were not available.

1.4 INSTALLATION DESCRIPTION

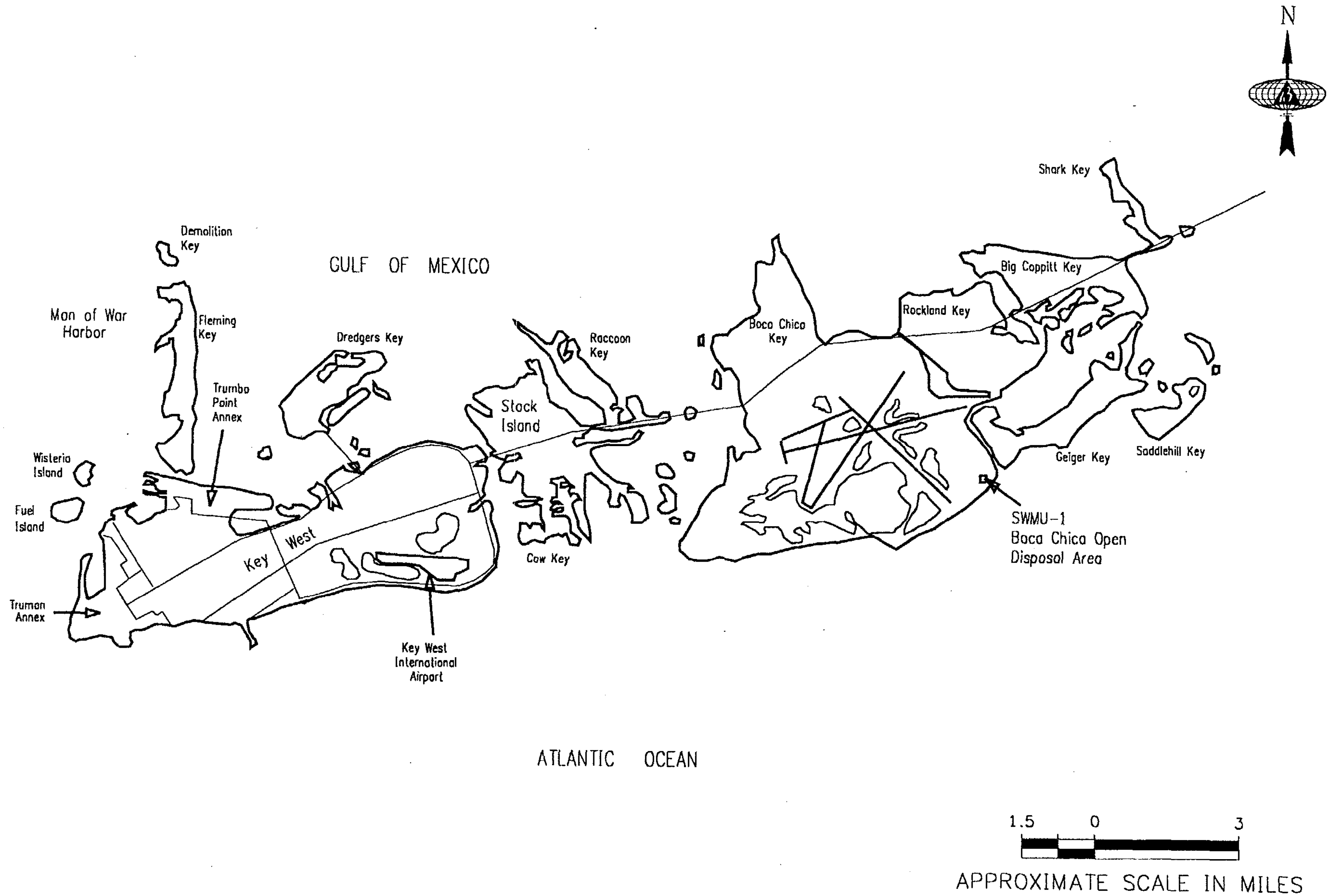
NAS Key West is in southern Monroe County, Florida, on Boca Chica Key. Key West, one of the two westernmost major islands of the Florida Keys, is approximately 150 miles southwest of Miami. Key West is connected to the mainland by the Overseas Highway (U.S. Highway No. 1). Figure 1-1 presents a regional map showing the location of Boca Chica Key and Key West within the Florida Keys. Figure 1-2 presents the location of SWMU 2. Several installations in various parts of the lower Florida Keys comprise what is known as the Naval Complex at Key West. Most of these are on Key West and Boca Chica Key. Other parts of the complex include Trumbo Point, Sigsbee Key (formerly Dredgers Key), Fleming Key, Demolition Key, Truman Annex on Key West, and Big Coppitt Key. The entire complex encompasses approximately 5,000 acres. Boca Chica Key is approximately 3 miles wide and 3 miles long, and the air station encompasses 3,250 acres. With the exception of filled areas that underlie the Overseas Highway, the elevations of Boca Chica Key are less than 5 feet above mean sea level (msl) (IT Corporation, 1994).

At present, NAS Key West maintains aviation operations, a research laboratory, communications intelligence, counternarcotics air surveillance operations, a weather service, and several other related activities. In addition to the Naval activities and units, other Department of Defense (DOD) and Federal agencies at NAS Key West include U.S. Air Force squadrons, a U.S. Army Special Forces Division, the U.S. Coast Guard, and a Defense Property Disposal Office.

Key West is approximately 4 miles long and 1.5 miles wide. The City of Key West, which is the county seat of Monroe County, has a residential population of 24,832 (USCBS, 1990). The principal industry is tourism, with about 1,225,000 tourists visiting annually. The major sources of employment in Key West are tourism; fishing; wholesale and retail trade; services; construction; finance; insurance; real estate; Federal, state, and local government; and transportation industries.



SITE MANAGER:	CHECKED BY: BER	Brown & Root Environmental	FIGURE 1-1
DRAWN BY: TAD	DRAWING DATE: 1/12/98		FACILITY LOCATION MAP
SURVEYED BY:	SURVEY DATE:		NAVAL AIR STATION KEY WEST
SCALE: AS SHOWN			BOCA CHICA KEY, FLORIDA
CAD DWG. NO.: 7046CM16	PROJ. NO.: 7046		



SITE MANAGER:	CHECKED BY: BER	Brown & Root Environmental	FIGURE 1-2
DRAWN BY: TAD	DRAWING DATE:		SWMU 2 LOCATION
SURVEYED BY:	SURVEY DATE:		BOCA CHICA KEY, FLORIDA
SCALE: AS SHOWN			
CAD DWG. NO.: 7046CM30	PROJ. NO.: 7046		

2.0 DESCRIPTION OF CURRENT CONDITIONS

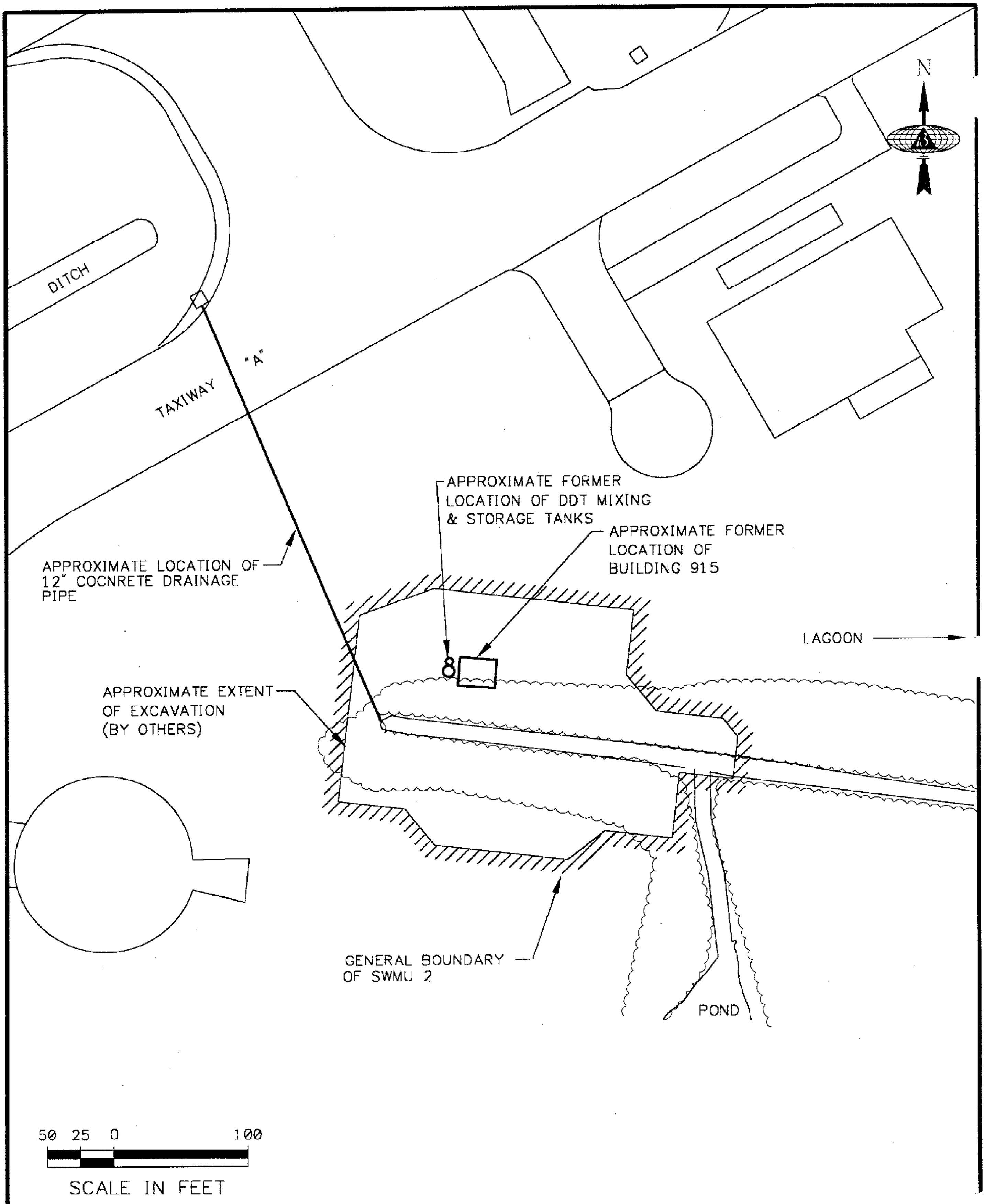
2.1 SITE DESCRIPTION

SWMU 2 (previously identified as Site No. 5) consists of the former location of Building 915 and its surrounding area, which was used for the storage and mixing of pesticides, as shown on Figure 2-1. Two aboveground tanks on concrete foundations (a 500-gallon mixing tank and a 1,000-gallon storage tank) were located to the west of the building. Mixing operations for DDT were conducted at this location from the mid-1940s to the early 1970s. Building 915 was demolished in 1982 and the site is a vacant, sparsely vegetated lot covering approximately 0.25 acre. It is on the northern edge of a manmade ditch that connects with a lagoon, that has formed in a borrow pit. The ditch receives surface-water runoff from the vicinity of SWMU 2 and the area north of the site. The lagoon and ditch are inhabited by fish and wading birds and support mangroves and other plant life.

2.2 SITE GEOLOGY AND HYDROGEOLOGY

The site-specific geology and hydrogeology of the unit were determined from soil borings and monitoring wells installed during the Preliminary RI (IT, 1991), the RFI/RI (IT, 1994), and the Supplemental RFI/RI (B&R Environmental, 1997). The subsurface lithology at the site was characterized from descriptions of split-spoon samples collected during installation of the borings. Samples collected from borings directly adjacent to the manmade drainage ditch revealed the presence of fill material from the surface to approximately 4 feet (ft) below ground surface (bgs). The fill material was composed of loosely consolidated sand and gravel, crushed limestone, and minor amounts of clay. The indigenous oolitic limestone was encountered at the surface in two borings, below the fill in the balance of the borings, and was observed to total depth of each boring (approximately 13 ft bgs). The standard penetration test (SPT) blow counts recorded during soil borings show that the limestone is of medium density.

Geotechnical data obtained from a composite surface soil sample during the Preliminary RI (IT, 1991) included: grain size distribution, moisture content, soil pH, cation exchange capacity, Total Organic Carbon (TOC) content, and permeability. The grain size analysis indicated that the soil is a silty, medium- to fine-grained sand with 12 percent passing a 200-mesh sieve. The soil has a pH of 8.25, slightly alkaline due to the abundance of carbonate rock. The ion exchange capacity of the soil (the ability to capture and retain cations) was 35.74 milliequivalent/gram (meq/g) and is representative of a low value. The TOC value of 1.04 milligrams per kilogram (mg/kg) indicates little organic matter and the medium's inability to



SITE MANAGER: KW	CHECKED BY: BER
DRAWN BY: TAD	DRAWING DATE: 12/29/97
SURVEYED BY:	SURVEY DATE:
SCALE: 1" = 100'	
CAD DWG. NO.: 7046CM29	PROJ. NO.: 7046

Brown & Root Environmental

FIGURE 2-1
SITE LOCATION MAP
SWMU 2
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

attenuate organic contaminants. The permeability of the soil was 2.29E-06 centimeters per second (cm/sec), which is representative of a low-permeability material (IT Corporation, 1994).

A series of wells were installed at SWMU 2 during the Preliminary RI (IT, 1991), the RFI/RI (IT, 1994), and the Supplemental RFI/RI field activities (B&R Environmental, 1997). Based on the construction logs and groundwater level measurements, the depth to groundwater was between 1.5 and 2.5 ft bgs. Data from the logs also indicate that oolitic limestone was encountered to the maximum depth of 13 ft bgs penetrated on the site. The hydrogeologic unit associated with the oolitic limestone is the surficial aquifer. Due to the highly permeable nature of the oolitic limestone, the surficial aquifer is likely to have hydraulic conductivity values at the high-end range of 72 gallons per day per square feet (gpd/ft^2) to 1,024 gpd/ft^2.

Groundwater flow direction was determined during the RFI/RI to be southerly toward the ditch and the lagoon with a hydraulic gradient of 0.0017 ft/ft. However, groundwater gradients at NAS Key West are extremely flat, tidally influenced, and probably radial in some instances. Groundwater level measurements collected in January 1996 indicate groundwater elevations at approximately 1 foot below msl. Seasonal variations appear to affect groundwater levels (IT Corporation, 1994). Figure 2-2 shows groundwater flow directions observed at SWMU 2.

2.3 INTERIM REMEDIAL ACTION

In Spring 1996, an IRA was conducted at SWMU 2. The IRA was performed to prevent the further migration of pesticide contaminants from soil and sediment into other media and biota at the site. Dichlorodiphenyl dichloroethane (DDD), dichlorodiphenyl dichloroethylene (DDE), and DDT pesticide contamination had been identified in the soils of the site and in the sediment in the adjacent manmade ditch during the RFI. Surface-water runoff over the soil was believed to be transporting the contamination into the ditch during precipitation events. The extent of the excavation was determined by the RFI sampling results, and supplemented with delineation sampling as compared to the FDEP clean-up goals for soils, sediments and surface waters. The excavated area included the former location of Building 915 and the surrounding vicinity, encompassing slightly more than 1 acre. The boundaries of the excavation are shown on Figure 2-1.

The remedial action consisted of blocking water flow into the ditch, suction dredging of all sediments from the ditch, and excavation of the contaminated soil around the ditch. The water within the ditch was cleaned by repeated filtration. The removals were performed down to bedrock or approximately 1 foot deep in the soils and 1 to 1.5 ft bgs in sediments in the ditch. Best management practices were

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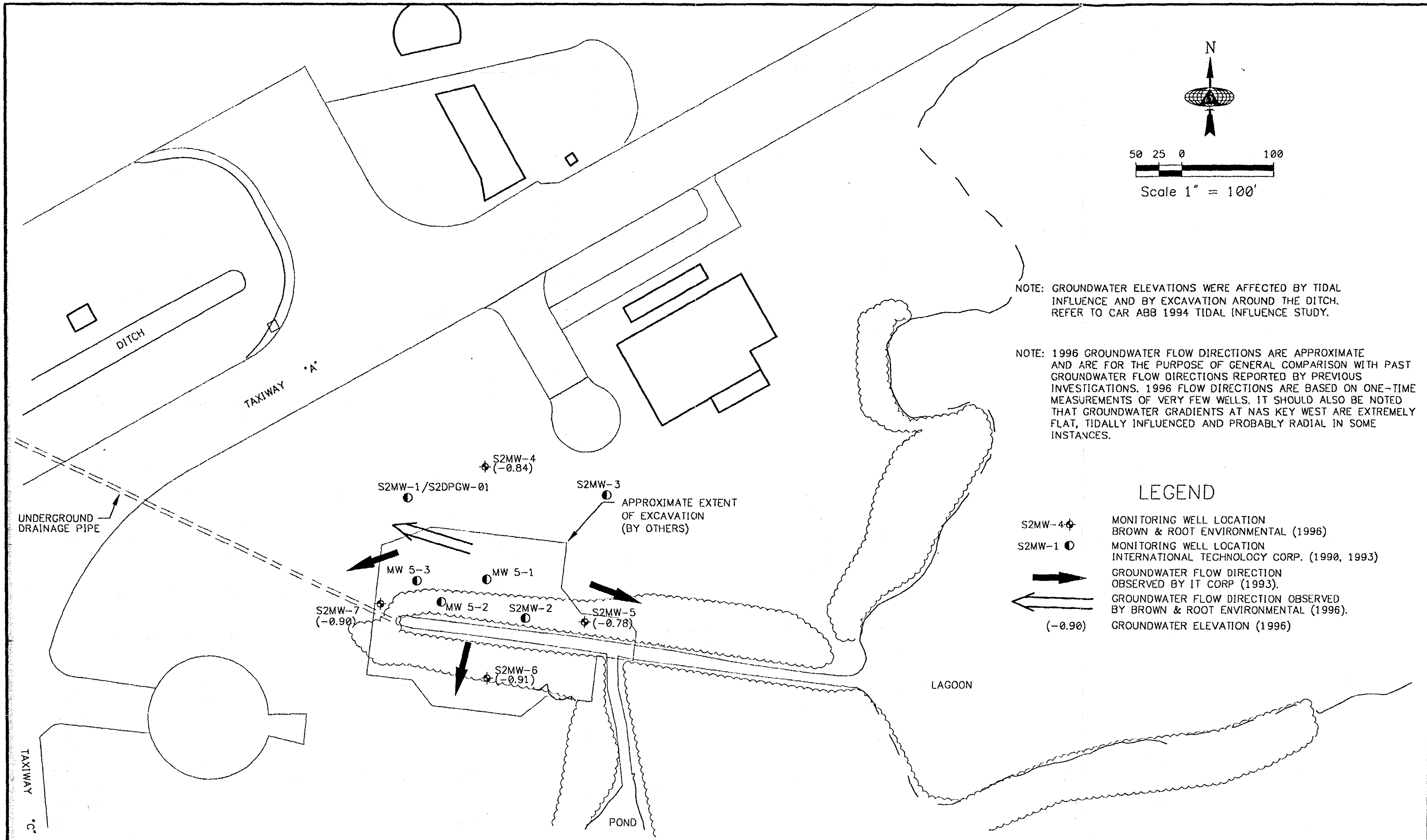

MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: BER
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 3/15/96
SCALE: 1" = 100'	
CAD DWG. NO.: 7046CM18	PROJ. NO.: 7046

Brown & Root Environmental

FIGURE 2-2
GROUNDWATER FLOW DIRECTION
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

used to prevent stormwater runoff from becoming a pathway for migration of contaminants. The practices included the use of cofferdams at each end of the ditch to prevent the movement of water from the ditch during dredging activities as well as sediment barriers along the ditch. Clean fill was placed in the soil excavation area to return it to grade. The ditch was left as bare limestone. Confirmation sampling of soil and surface water was performed to determine the effectiveness of the removal. The water in the ditch met surface-water standards prior to removal of the cofferdams. A total of 1,943 yd^3 (2,471 tons) of soil and sediment were removed from the excavation area. These solids were transported off-site for disposal in accordance with Federal and FDEP requirements. The excavated soil was replaced by 1,425 tons of clean backfill. Based on existing data, remaining soil and sediment at SWMU 2 is not considered to be a RCRA waste.

2.4 SUMMARY OF THE NATURE AND EXTENT OF CONTAMINATION

The pesticides 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE were present in all media at SWMU 2 prior to the IRA in the Spring of 1996. The only pesticide detections in surface water were within the limits of the ditch section remediated during the IRA. Based on groundwater, soil, and sediment analyses, pesticides other than 4,4'-DDT appear to have been used on the site.

Pesticide concentrations at SWMU 2 declined considerably between 1990 and 1996. Metals were the next most prevalent class of compounds detected above the limits set by ARARs and screening action levels (SALs) in soil, sediment, surface water, and groundwater. However, the occurrence of specific metals was not widespread, no obvious trends were evident, and there is no apparent source of metal or inorganic contamination based on the previous use of the site. Several volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) were also detected on the site in various media, but occurred to a significant degree only in groundwater samples from a single well.

The following discussions summarize the nature and extent of contamination. All of the chemicals detected were compared to ARARs and SALs for each medium. These ARARs/SALs are discussed in Section 2.3.1 of the Supplemental RFI/RI (B&R Environmental, 1997).

Groundwater

Chemicals detected in excess of ARAR/SAL criteria reported in the Supplemental RFI/RI Report in groundwater are depicted in Figures 2-3 through 2-5. These figures include analytical results from historical sampling events and current investigations. Groundwater results from 1996 are consistent with

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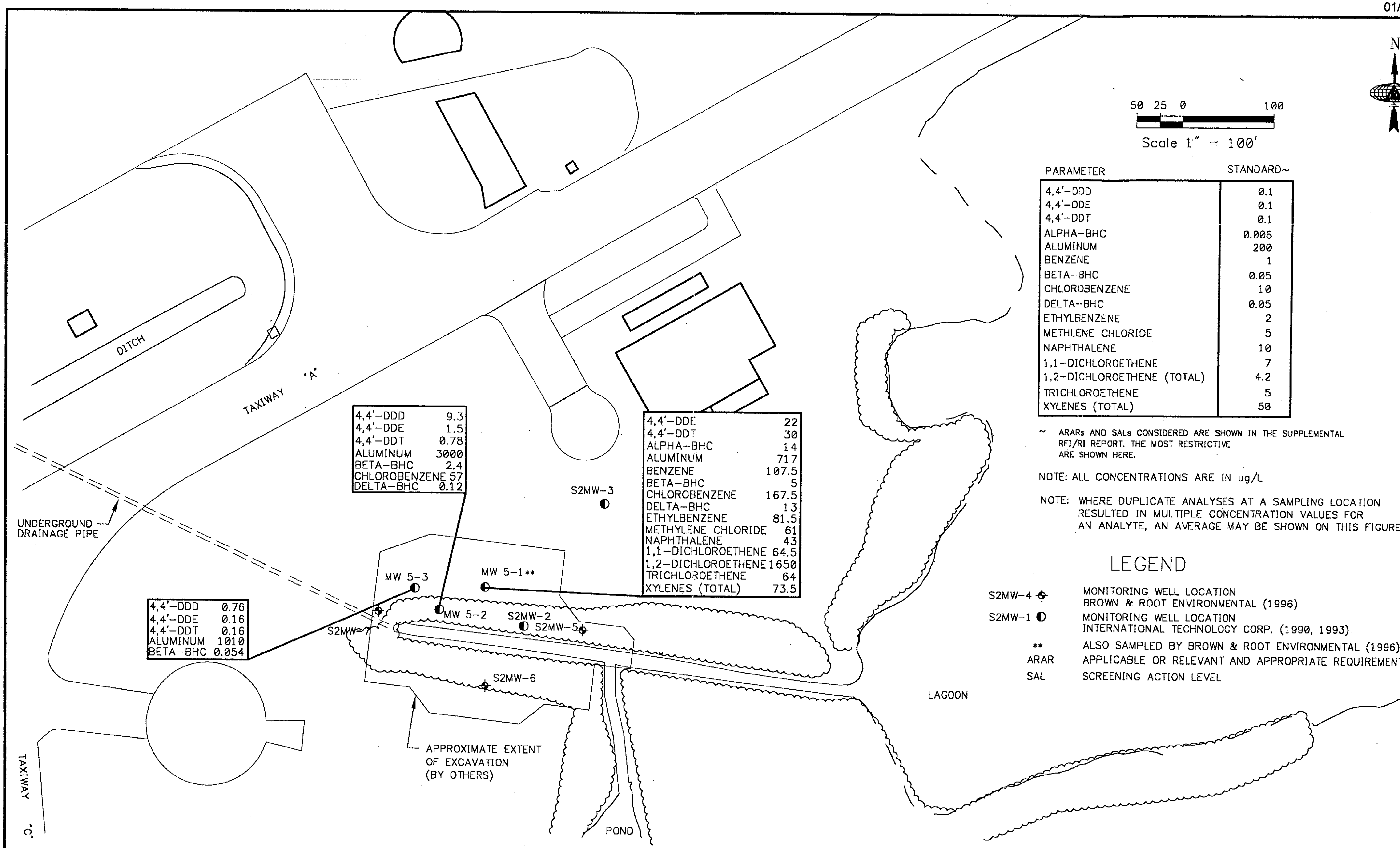


PARAMETER	STANDARD~
4,4'-DDD	0.1
4,4'-DDE	0.1
4,4'-DDT	0.1
ALPHA-BHC	0.006
ALUMINUM	200
BENZENE	1
BETA-BHC	0.05
CHLOROBENZENE	10
DELTA-BHC	0.05
ETHYLBENZENE	2
METHLENE CHLORIDE	5
NAPHTHALENE	10
1,1-DICHLOROETHENE	7
1,2-DICHLOROETHENE (TOTAL)	4.2
TRICHLOROETHENE	5
XYLENES (TOTAL)	50

~ ARARs AND SALs CONSIDERED ARE SHOWN IN THE SUPPLEMENTAL RFI/RI REPORT. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN ug/L

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE.

LEGEND

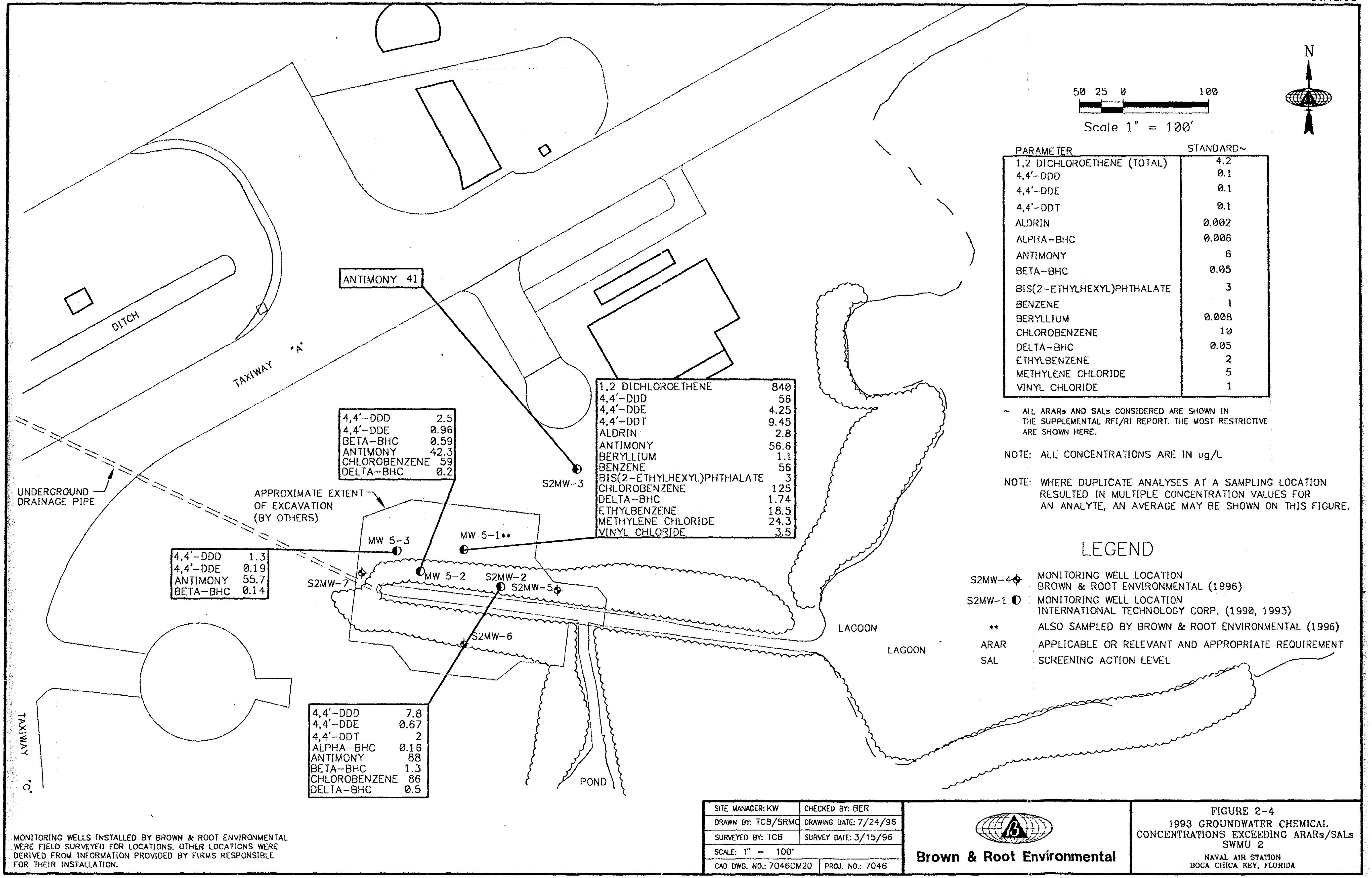
S2MW-4 ⊕	MONITORING WELL LOCATION BROWN & ROOT ENVIRONMENTAL (1996)
S2MW-1 ◐	MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990, 1993)
**	ALSO SAMPLED BY BROWN & ROOT ENVIRONMENTAL (1996)
ARAR	APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT
SAL	SCREENING ACTION LEVEL

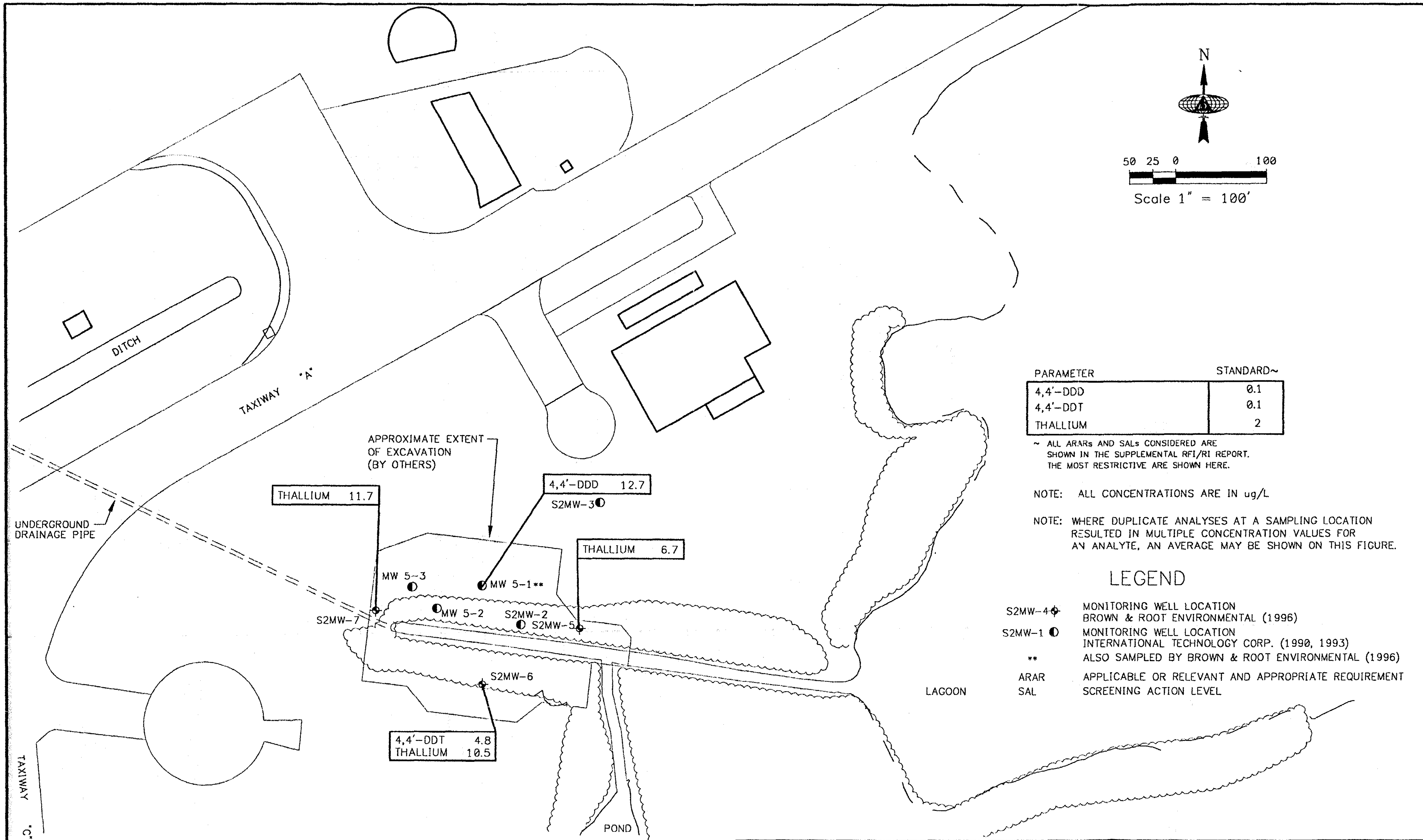
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: BER
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 3/15/96
SCALE: 1" = 100'	
CAD DWG. NO.: 7046CM19	PROJ. NO.: 7046

Brown & Root Environmental

FIGURE 2-3
1990 GROUNDWATER CHEMICAL CONCENTRATIONS EXCEEDING ARARs/SALs
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA


50 25 0 100
Scale 1" = 100'
N
PARAMETER STANDARD~
1,2 DICHLOROETHENE (TOTAL) 4.2
4,4'-DDD 0.1
4,4'-DDE 0.1
4,4'-DDT 0.1
ALDRIN 0.002
ALPHA-BHC 0.006
ANTIMONY 6
BETA-BHC 0.05
BIS(2-ETHYLHEXYL)PHTHALATE 3
BENZENE 1
BERYLLIUM 0.008
CHLOROBENZENE 10
DELTA-BHC 0.05
ETHYLBENZENE 2
METHYLENE CHLORIDE 5
VINYL CHLORIDE 1
~ ALL ARARs AND SALs CONSIDERED ARE SHOWN IN THE SUPPLEMENTAL RFI/RI REPORT. THE MOST RESTRICTIVE ARE SHOWN HERE.
NOTE: ALL CONCENTRATIONS ARE IN ug/L
NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE.
LEGEND
S2MW-4 MONITORING WELL LOCATION BROWN & ROOT ENVIRONMENTAL (1996)
S2MW-1 MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990, 1993)
** ALSO SAMPLED BY BROWN & ROOT ENVIRONMENTAL (1996)
ARAR APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT
SAL SCREENING ACTION LEVEL
DITCH
TAXIWAY "A"
TAXIWAY "C"
ANTIMONY 41
S2MW-3
1,2 DICHLOROETHENE 840
4,4'-DDD 56
4,4'-DDE 4.25
4,4'-DDT 9.45
ALDRIN 2.8
ANTIMONY 56.6
BERYLLIUM 1.1
BENZENE 56
BIS(2-ETHYLHEXYL)PHTHALATE 3
CHLOROBENZENE 125
DELTA-BHC 1.74
ETHYLBENZENE 18.5
METHYLENE CHLORIDE 24.3
VINYL CHLORIDE 3.5
4,4'-DDD 2.5
4,4'-DDE 0.96
BETA-BHC 0.59
ANTIMONY 42.3
CHLOROBENZENE 59
DELTA-BHC 0.2
UNDERGROUND DRAINAGE PIPE
APPROXIMATE EXTENT OF EXCAVATION (BY OTHERS)
MW 5-3
MW 5-1**
4,4'-DDD 1.3
4,4'-DDE 0.19
ANTIMONY 55.7
BETA-BHC 0.14
S2MW-7
MW 5-2
S2MW-2
S2MW-5
S2MW-6
LAGOON
LAGOON
POND
4,4'-DDD 7.8
4,4'-DDE 0.67
4,4'-DDT 2
ALPHA-BHC 0.16
ANTIMONY 88
BETA-BHC 1.3
CHLOROBENZENE 86
DELTA-BHC 0.5
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: BER
DRAWN BY: TCB/SRMC
DRAWING DATE: 7/24/96
SURVEYED BY: TCB
SURVEY DATE: 3/15/96
SCALE: 1" = 100'
CAD DWG. NO.: 7046CM20
PROJ. NO.: 7046
Brown & Root Environmental
FIGURE 2-4
1993 GROUNDWATER CHEMICAL CONCENTRATIONS EXCEEDING ARARs/SALs SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA



PARAMETER	STANDARD~
4,4'-DDD	0.1
4,4'-DDT	0.1
THALLIUM	2

~ ALL ARARs AND SALs CONSIDERED ARE SHOWN IN THE SUPPLEMENTAL RFI/RI REPORT. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN ug/L

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE.

LEGEND

- S2MW-4 — MONITORING WELL LOCATION BROWN & ROOT ENVIRONMENTAL (1996)
- S2MW-1 — MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990, 1993)
- ** — ALSO SAMPLED BY BROWN & ROOT ENVIRONMENTAL (1996)
- ARAR — APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT
- SAL — SCREENING ACTION LEVEL

MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: BER
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 3/15/96
SCALE: 1" = 100'	
CAD DWG. NO.: 7046CM21	PROJ. NO.: 7046

Brown & Root Environmental

FIGURE 2-5
1996 GROUNDWATER CHEMICAL CONCENTRATIONS EXCEEDING ARARs/SALs
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

a trend of contaminant concentrations decreasing with time. The 1996 results have only three detections of pesticides in groundwater. Pesticides 4,4'-DDD [12.7 micrograms/liter (µg/L)] and 4,4'-DDT (4.8 µg/L) are depicted in Figures 2-5. 4,4'-DDE (0.044 µg/L) was detected below the ARAR/SAL criteria and is not shown on Figure 2-5. All three contaminant levels decreased from the maximum concentrations seen in previous investigations (i.e., 56 mg/L, 22 mg/L and 30 mg/L respectively) depicted in Figures 2-4 and 2-5. 4,4'-DDT, 4,4'-DDD, and thallium (a metal that had not been detected previously on the site) exceeded the most conservative ARAR/SAL criteria in the 1996 groundwater samples. ARAR/SAL criteria are illustrated in the figures.

Soils

Pesticides and metals were the only compounds that exceeded ARAR/SAL criteria in soil at SWMU 2. The pesticide 4,4'-DDE exceeded the most conservative ARARs or SALs with the greatest frequency, which indicates that 4,4'-DDT has been in the soil and undergoing biotransformation for some time. The maximum 4,4'-DDE concentration was 0.82 mg/kg. The next most prevalent pesticide was 4,4'-DDT, (4.4 mg/kg maximum) followed by 4,4'-DDD (0.316 mg/kg maximum). These compounds were found around the perimeter of the excavation during the confirmation sampling that followed the interim removal, and there are no obvious trends in contaminant levels. In most cases, concentrations were comparable from sample to sample. As shown in Figure 2-6 pesticide contamination is limited predominantly to surface soil.

Several subsurface samples were obtained during the RFI/RI. Although 4,4'-DDT exceeds its 0.1 mg/kg ARAR/SAL level in two samples, pesticide contamination is limited predominantly to surface soil. Metals, including aluminum, arsenic, beryllium, and chromium, exceeded their associated ARAR/SAL levels in several soil samples from throughout the site as depicted in Figure 2-7; however, there did not appear to be any obvious focal point for the contamination. Most metals in the subsurface soil borings were either not detected or present in lower concentrations as depicted in Figure 2-8. Chromium contamination in subsurface samples was comparable to that detected at the surface. The concentration of cyanide in the two subsurface detections exceeded the single surface observation. Each figure includes analytical results from historical sampling events and current investigations which exceeds ARAR/SAL criteria. ARAR/SAL criteria are illustrated in the figures.

Sediment

Pesticides were also the dominant sediment contaminants, with 4,4'-DDT and its degradation products detected in each sample analyzed. The highest concentrations in 1996 were found in the excavation area

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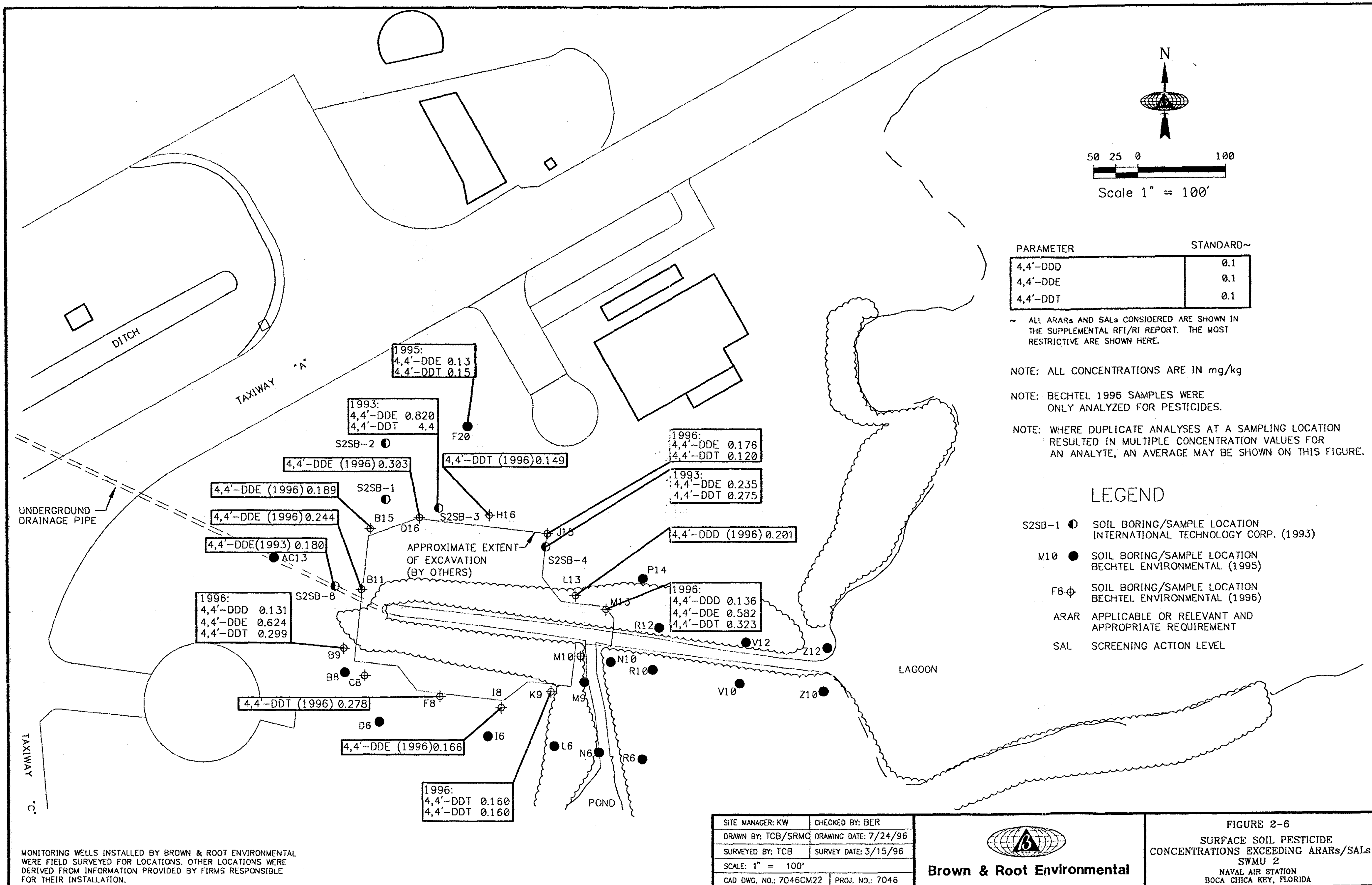

N
50 25 0 100
Scale 1" = 100'
PARAMETER STANDARD~
4,4'-DDD 0.1
4,4'-DDE 0.1
4,4'-DDT 0.1
~ ALL ARARs AND SALs CONSIDERED ARE SHOWN IN THE SUPPLEMENTAL RFI/RI REPORT. THE MOST RESTRICTIVE ARE SHOWN HERE.
NOTE: ALL CONCENTRATIONS ARE IN mg/kg
NOTE: BECHTEL 1996 SAMPLES WERE ONLY ANALYZED FOR PESTICIDES.
NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE.
LEGEND
S2SB-1 SOIL BORING/SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1993)
N10 SOIL BORING/SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1995)
F8 SOIL BORING/SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1996)
ARAR APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT
SAL SCREENING ACTION LEVEL
DITCH
TAXIWAY "A"
TAXIWAY "C"
UNDERGROUND DRAINAGE PIPE
1995: 4,4'-DDE 0.13 4,4'-DDT 0.15
F20
1993: 4,4'-DDE 0.820 4,4'-DDT 4.4
S2SB-2
4,4'-DDE (1996) 0.303
4,4'-DDT (1996) 0.149
4,4'-DDE (1996) 0.189
S2SB-1
4,4'-DDE (1996) 0.244
B15
D16
S2SB-3
H16
4,4'-DDE(1993) 0.180
AC13
APPROXIMATE EXTENT OF EXCAVATION (BY OTHERS)
1996: 4,4'-DDE 0.176 4,4'-DDT 0.120
1993: 4,4'-DDE 0.235 4,4'-DDT 0.275
J15
S2SB-4
4,4'-DDD (1996) 0.201
P14
L13
M13
S2SB-8
B11
1996: 4,4'-DDD 0.131 4,4'-DDE 0.624 4,4'-DDT 0.299
1996: 4,4'-DDD 0.136 4,4'-DDE 0.582 4,4'-DDT 0.323
R12
V12
Z12
B9
M10
N10
R10
LAGOON
B8
C8
I8
K9
M9
V10
Z10
4,4'-DDT (1996) 0.278
F8
D6
I6
4,4'-DDE (1996)0.166
L6
N6
R6
POND
1996: 4,4'-DDT 0.160 4,4'-DDT 0.160
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: BER
DRAWN BY: TCB/SRMC
DRAWING DATE: 7/24/96
SURVEYED BY: TCB
SURVEY DATE: 3/15/96
SCALE: 1" = 100'
CAD DWG. NO.: 7046CM22
PROJ. NO.: 7046
Brown & Root Environmental
FIGURE 2-6
SURFACE SOIL PESTICIDE CONCENTRATIONS EXCEEDING ARARs/SALs
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

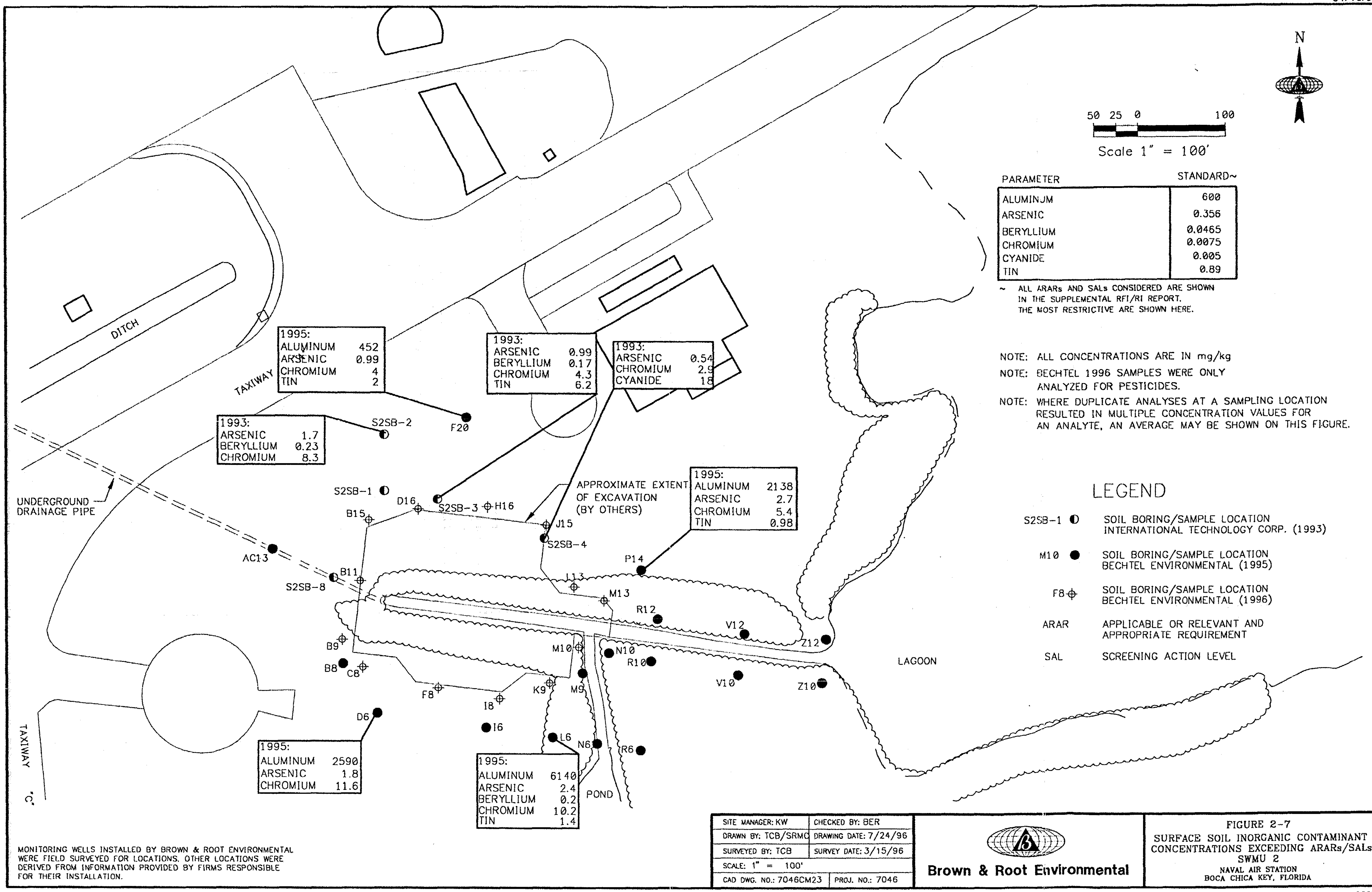
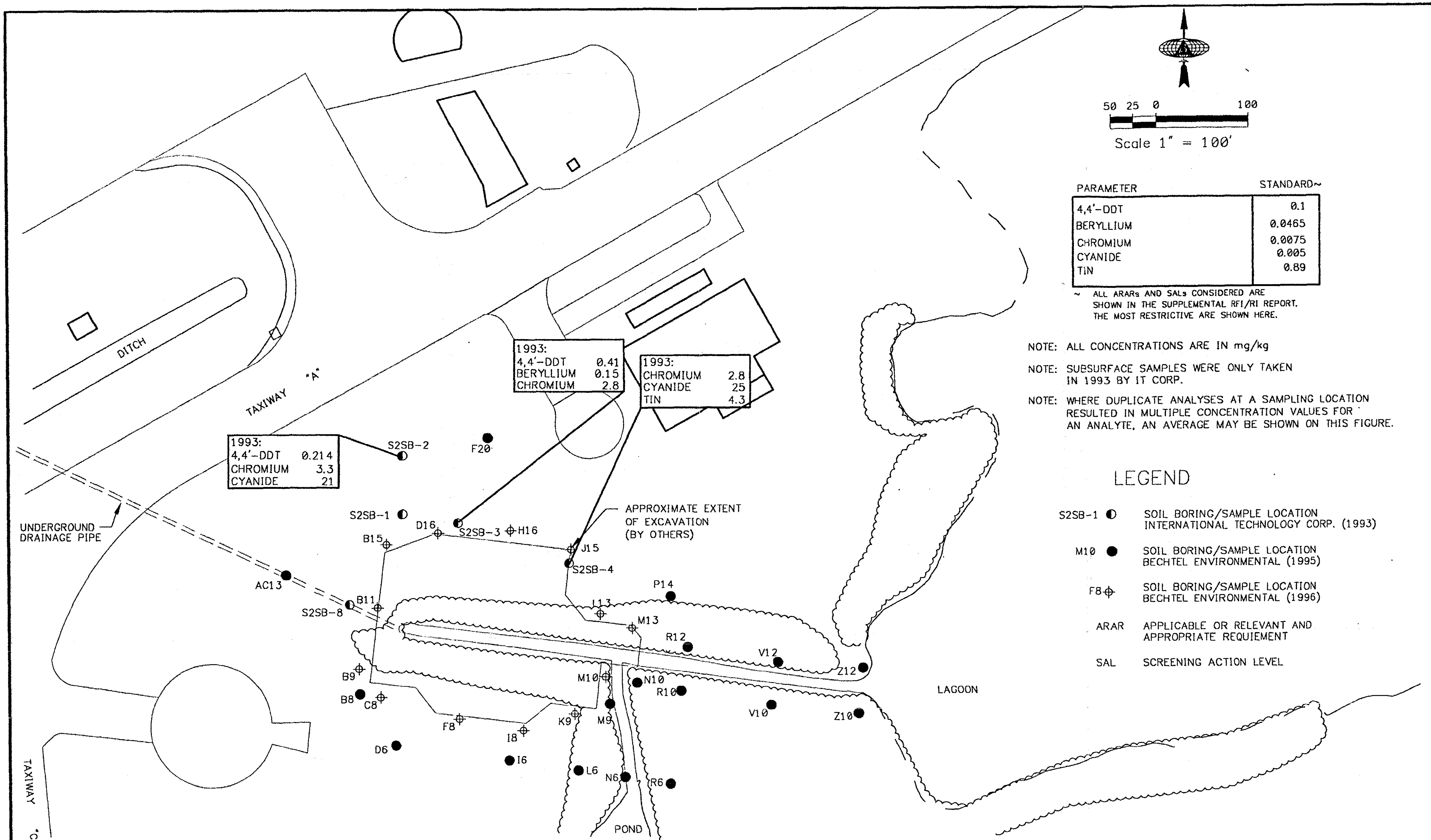


FIGURE 2-7
SURFACE SOIL INORGANIC CONTAMINANT CONCENTRATIONS EXCEEDING ARARs/SALs
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA



PARAMETER	STANDARD~
4,4'-DDT	0.1
BERYLLIUM	0.0465
CHROMIUM	0.0075
CYANIDE	0.005
TIN	0.89

~ ALL ARARs AND SALs CONSIDERED ARE SHOWN IN THE SUPPLEMENTAL RFI/RI REPORT. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN mg/kg

NOTE: SUBSURFACE SAMPLES WERE ONLY TAKEN IN 1993 BY IT CORP.

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE.

LEGEND

- S2SB-1 ◐ SOIL BORING/SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1993)
- M10 ● SOIL BORING/SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1995)
- F8 ⌖ SOIL BORING/SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1996)
- ARAR APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT
- SAL SCREENING ACTION LEVEL

MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: BER
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 3/15/96
SCALE: 1" = 100'	
CAD DWG. NO.: 7046CM24	PROJ. NO.: 7046

Brown & Root Environmental

FIGURE 2-8
SUBSURFACE SOIL CHEMICAL CONCENTRATIONS EXCEEDING ARARs/SALs
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

as depicted in Figure 2-9. Although this area underwent remediation in the Spring of 1996, it was also considered the most contaminated part of the site based on delineation sampling prior to the IRA. The western end of the main ditch contained the maximum concentrations of all three DDT compounds: 4,4'-DDD (13.9 mg/kg), 4,4'-DDE (4.63 mg/kg), and 4,4'-DDT (12.55 mg/kg). The eastern side of the ditch had much lower concentrations. Sediments outside the excavation area were sampled both before and after excavation. 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT were detected during both events.

Other pesticides, including dieldrin, endosulfan I, endrin, and delta-BHC, were detected in 1996 in the vicinity of the excavation at concentrations exceeding the levels specified by ARARs and SALs.

Some metal contamination was found in sediment, but the metal contamination was isolated. Arsenic was detected in two samples from the mouth of the ditch, but the highest concentration (1.5 mg/kg) was found in the northwestern part of the site adjacent to the taxiway as depicted in Figure 2-10. The maximum lead contamination (53.8 mg/kg) was found midway between the western end of the main ditch and the lagoon. Small amounts of VOCs and SVOCs were detected in sediment, but only the compound bis(2-ethylhexyl)phthalate (a common laboratory contaminant) was in excess of ARAR/SAL levels. In 1993, the compound was found at a concentration of 2.5 mg/kg in a sample taken from the mouth of the ditch and was not detected in later samples from the same area. The location of the detections is depicted in Figure 2-11. Figures 2-9 through 2-11 include analytical results from historical sampling events and current investigations which exceed the most restrictive ARAR/SAL levels. ARAR/SAL criteria are illustrated in the figures.

Surface Water

Consistent with the other media at the site, pesticides and metals were the dominant surface-water contaminants. Several compounds in each class were detected at levels that exceeded ARARs and SALs, but the surface-water contamination appears isolated, because most compounds were found only in a single sample. Pesticides found in surface water include: 4,4'-DDD (1.45 μg/L); 4,4'-DDT (0.33 μg/L); beta-BHC (0.15 μg/L); and heptachlor (0.064 μg/L). The beta-BHC was detected below the ARAR/SAL criteria. Aluminum (1,510 μg/L), antimony (13 μg/L), beryllium (0.21 μg/L), lead (53.6 μg/L), mercury (0.068 μg/L), and tin (10 μg/L), were metal contaminants in surface water which exceeded the most restrictive ARARs. The 4,4'-DDT detection values in the figures are averaged values. The only contaminants detected outside the area of the IRA were antimony and tin which were detected at the mouth of the lagoon. Chemicals detected in surface water in excess of ARAR/SAL criteria are presented in Figure 2-12. ARAR/SAL criteria are illustrated in the figure. The figure includes analytical results from historical sampling events and current investigations.

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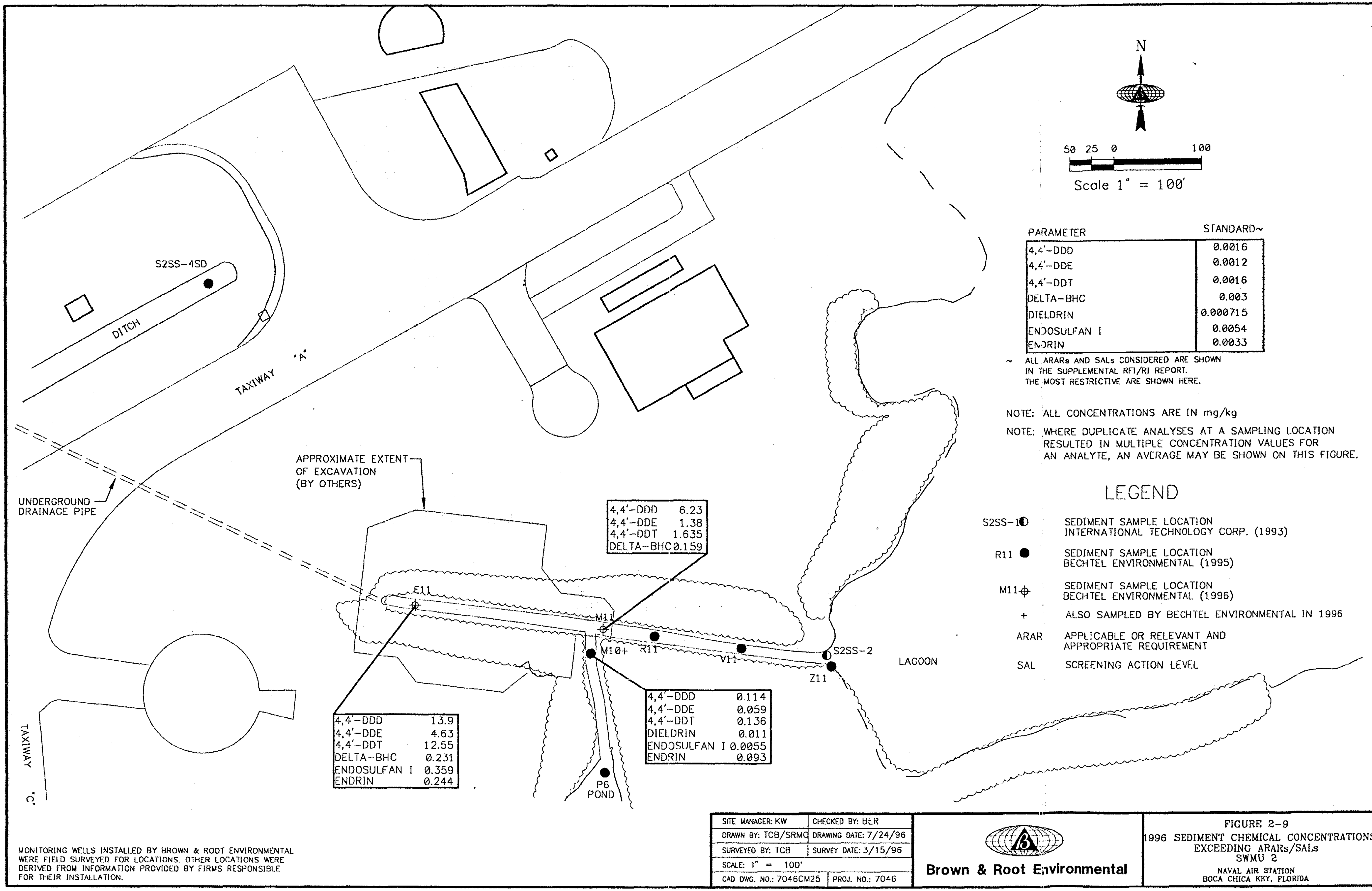
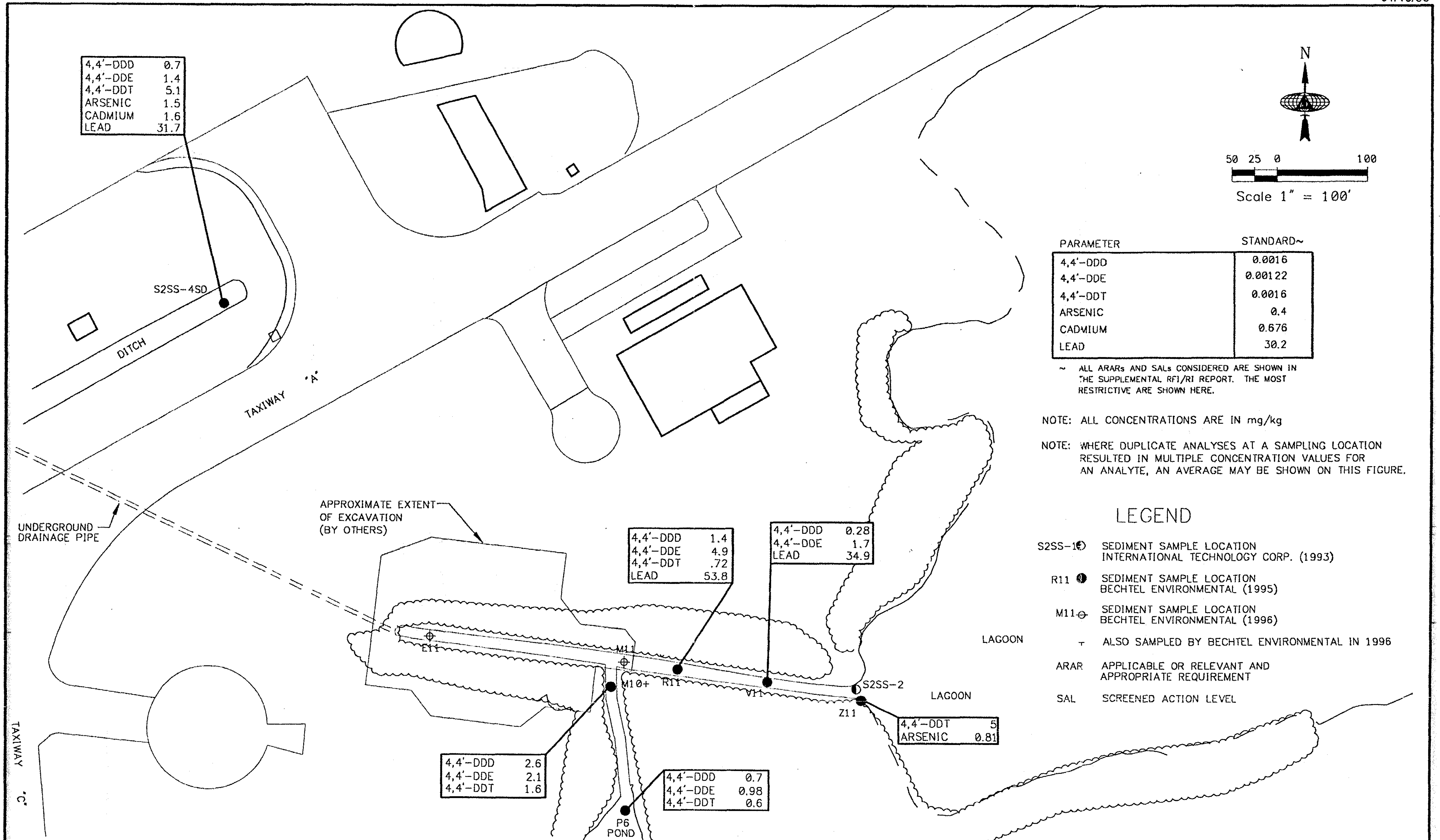

N
50 25 0 100
Scale 1" = 100'
PARAMETER STANDARD~
4,4'-DDD 0.0016
4,4'-DDE 0.0012
4,4'-DDT 0.0016
DELTA-BHC 0.003
DIELDRIN 0.000715
ENDOSULFAN I 0.0054
ENDRIN 0.0033
~ ALL ARARs AND SALs CONSIDERED ARE SHOWN IN THE SUPPLEMENTAL RFI/RI REPORT. THE MOST RESTRICTIVE ARE SHOWN HERE.
NOTE: ALL CONCENTRATIONS ARE IN mg/kg
NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE.
LEGEND
S2SS-1 SEDIMENT SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1993)
R11 SEDIMENT SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1995)
M11 SEDIMENT SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1996)
+ ALSO SAMPLED BY BECHTEL ENVIRONMENTAL IN 1996
ARAR APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT
SAL SCREENING ACTION LEVEL
S2SS-4SD
DITCH
TAXIWAY "A"
UNDERGROUND DRAINAGE PIPE
APPROXIMATE EXTENT OF EXCAVATION (BY OTHERS)
4,4'-DDD 6.23
4,4'-DDE 1.38
4,4'-DDT 1.635
DELTA-BHC 0.159
E11
M11
M10+
R11
V11
S2SS-2
Z11
LAGOON
4,4'-DDD 13.9
4,4'-DDE 4.63
4,4'-DDT 12.55
DELTA-BHC 0.231
ENDOSULFAN I 0.359
ENDRIN 0.244
4,4'-DDD 0.114
4,4'-DDE 0.059
4,4'-DDT 0.136
DIELDRIN 0.011
ENDOSULFAN I 0.0055
ENDRIN 0.093
P6 POND
TAXIWAY "C"
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: BER
DRAWN BY: TCB/SRMC
DRAWING DATE: 7/24/96
SURVEYED BY: TCB
SURVEY DATE: 3/15/96
SCALE: 1" = 100'
CAD DWG. NO.: 7046CM25
PROJ. NO.: 7046
Brown & Root Environmental
FIGURE 2-9
1996 SEDIMENT CHEMICAL CONCENTRATIONS EXCEEDING ARARs/SALs
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

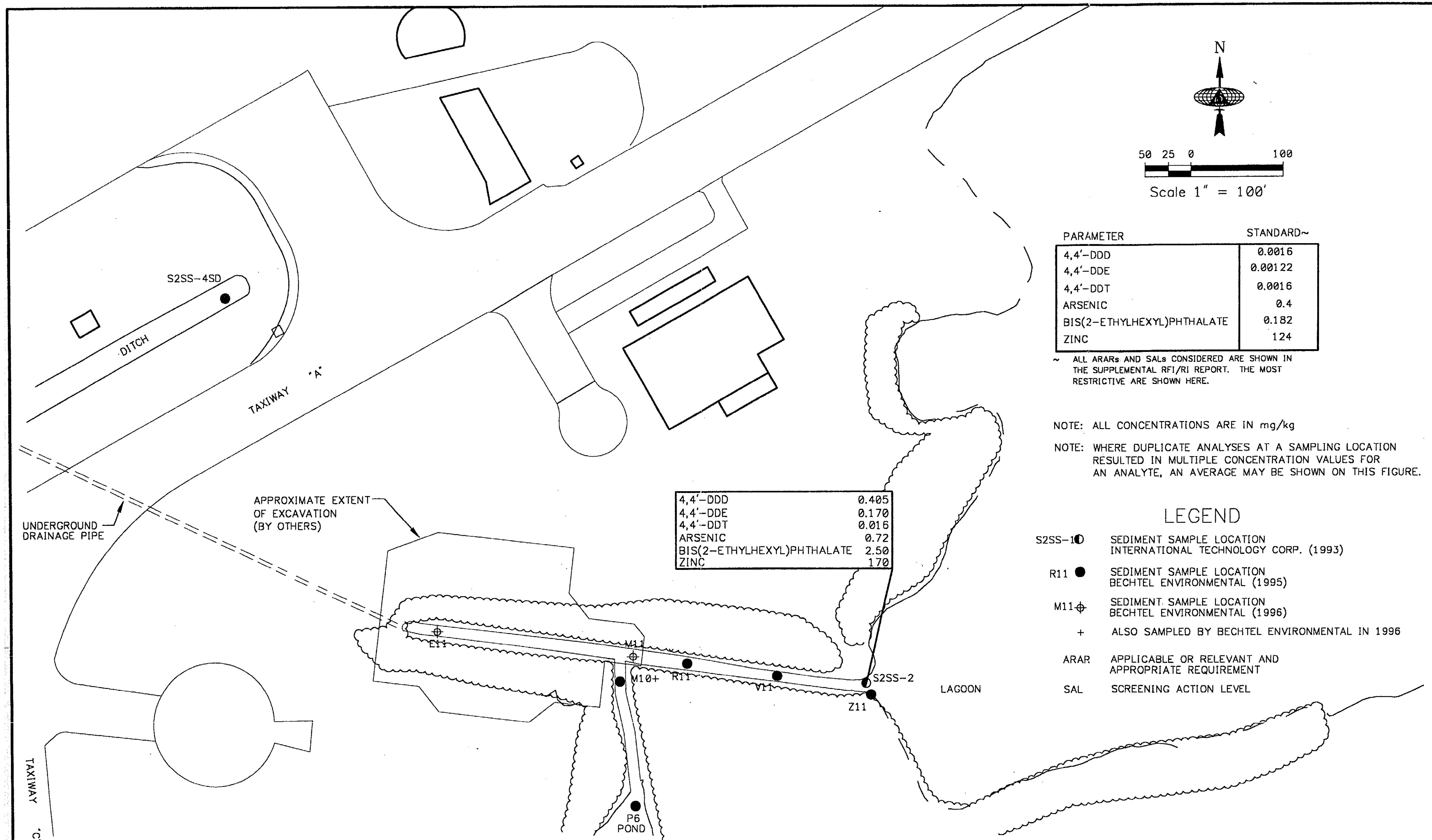


MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: BER
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 3/15/96
SCALE: 1" = 100'	
CAD DWG. NO.: 7046CM26	PROJ. NO.: 7046

Brown & Root Environmental

FIGURE 2-10
1995 SEDIMENT CHEMICAL CONCENTRATIONS EXCEEDING ARARs/SALs
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA



PARAMETER	STANDARD~
4,4'-DDD	0.0016
4,4'-DDE	0.00122
4,4'-DDT	0.0016
ARSENIC	0.4
BIS(2-ETHYLHEXYL)PHTHALATE	0.182
ZINC	124

~ ALL ARARs AND SALs CONSIDERED ARE SHOWN IN THE SUPPLEMENTAL RFI/RI REPORT. THE MOST RESTRICTIVE ARE SHOWN HERE.

4,4'-DDD	0.405
4,4'-DDE	0.170
4,4'-DDT	0.016
ARSENIC	0.72
BIS(2-ETHYLHEXYL)PHTHALATE	2.50
ZINC	170

NOTE: ALL CONCENTRATIONS ARE IN mg/kg

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE.

LEGEND

- S2SS-1 ◐ SEDIMENT SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1993)
- R11 ● SEDIMENT SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1995)
- M11 ⊕ SEDIMENT SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1996)
- \+ ALSO SAMPLED BY BECHTEL ENVIRONMENTAL IN 1996
- ARAR APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT
- SAL SCREENING ACTION LEVEL

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SURVEYED BY: TCB	SURVEY DATE: 3/15/96
SCALE: 1" = 100'	
CAD DWG. NO.: 7046CM27	PROJ. NO.: 7046

Brown & Root Environmental

FIGURE 2-11
1993 SEDIMENT CHEMICAL CONCENTRATIONS EXCEEDING ARARs/SALs
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

2.5 HUMAN HEALTH RISK ASSESSMENT SUMMARY

The baseline human health risk assessment (HHRA) performed as part of the Supplemental RFI/RI is a qualitative and quantitative assessment of actual or potential risks for SWMU 2. A discussion of the SWMU 2 baseline HHRA is presented in the Supplemental RFI/RI. A list of contaminants of potential concern (COPCs) was developed for each environmental medium, as necessary. Only those chemicals found to be of potential concern were considered for evaluation in the quantitative risk assessment.

The COPCs were selected for each environmental media sampled at SWMU 2 (surface soil, sediment, and surface water). The potential receptors that apply to media sampled at SWMU 2 include current adolescent and adult trespassers, current occupational workers, current site maintenance workers, future excavation workers, and future residents. Except for the excavation worker, all potential receptors and applicable exposure pathways were evaluated quantitatively. A quantitative evaluation of risks to excavation workers from subsurface soil was not performed since no COPCs were selected in subsurface soils.

The estimated cumulative carcinogenic and noncarcinogenic risks for hypothetical future residents, trespasser adults and adolescents, maintenance workers, excavation workers, and occupational workers at SWMU 2 are listed in Table 2-1. The total risk for each exposure route and the cumulative risk across all exposure pathways are also included. The HHRA was prepared in five parts: carcinogenic risks, noncarcinogenic risks, the result of the evaluation of lead in surface soils, a comparison of groundwater results to screening criteria, and a special note concerning fish.

Carcinogenic Risks: The estimated carcinogenic risk for future residents (6E-05), trespasser adults (1E-05), and trespasser adolescents (8E-06) are within the EPA target risk range of 1E-04 to 1E-06. Dermal contact with sediment and surface water for the future resident have incremental cancer risks (ICRs) of 2E-05. These exposure routes contribute the most to the cumulative carcinogenic risk for the future resident.

The principal COPCs contributing to these cancer risks were 4,4'-DDD (sediment and surface water) and 4,4'-DDT (sediment and surface water) for the hypothetical future resident and trespasser scenarios. The estimated carcinogenic risks for the maintenance worker (1E-07) and occupational worker (9E-07) are less than 1E-06. No quantitative carcinogenic risk was estimated for excavation workers exposure to subsurface soil because no COPCs were selected in subsurface soils.

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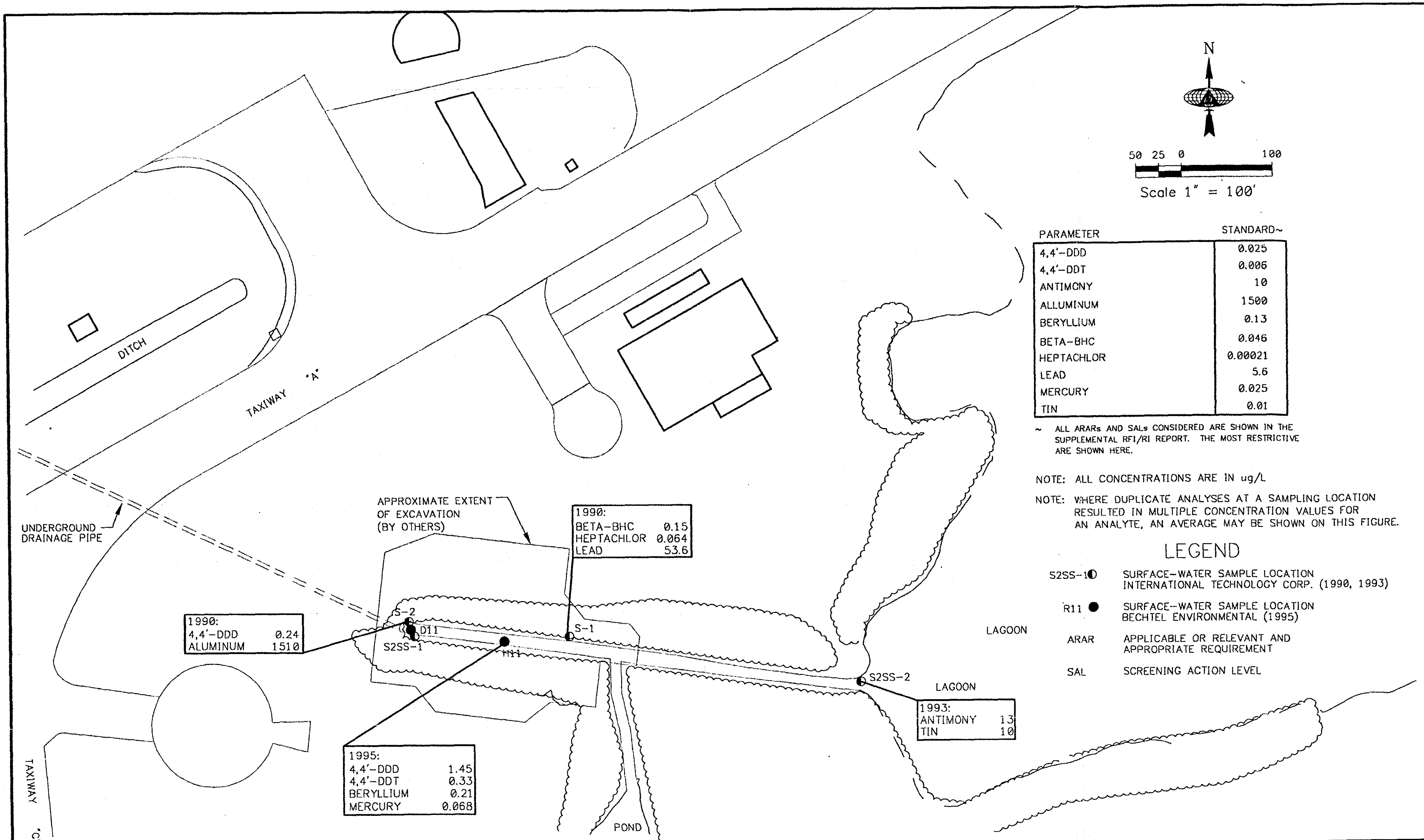

PARAMETER	STANDARD~
4,4'-DDD	0.025
4,4'-DDT	0.006
ANTIMONY	10
ALLUMINUM	1500
BERYLLIUM	0.13
BETA-BHC	0.046
HEPTACHLOR	0.00021
LEAD	5.6
MERCURY	0.025
TIN	0.01

~ ALL ARARs AND SALs CONSIDERED ARE SHOWN IN THE SUPPLEMENTAL RFI/RI REPORT. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN ug/L

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE.

LEGEND

S2SS-1 ◐	SURFACE-WATER SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990, 1993)
R11 ●	SURFACE-WATER SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1995)
ARAR	APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT
SAL	SCREENING ACTION LEVEL

MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

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SCALE: 1" = 100'	
CAD DWG. NO.: 7046CM28	PROJ. NO.: 7046

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FIGURE 2-12
SURFACE-WATER CHEMICAL CONCENTRATIONS EXCEEDING ARARs/SALs
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

TABLE 2-1

CUMULATIVE RISKS - SWMU 2
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 1 OF 2

Exposure Route	Resident	Trespasser Adult	Trespasser Adolescent	Maintenance Worker	Excavation Worker	Occupational Worker
INCREMENTAL CANCER RISK						
Surface Soil						
Dermal Contact	3E-06	1E-07	1E-07	8E-08	NA	7E-07
Incidental Ingestion	2E-06	4E-08	4E-08	3E-08	NA	2E-07
Inhalation of Fugitive Dust	2E-08	1E-10	1E-10	1E-10	NA	3E-09
Subtotal of Media	5E-06	1E-07	1E-07	1E-07	NA	9E-07
Subsurface Soil						
Dermal Contact	NA	NA	NA	NA	*	NA
Incidental Ingestion	NA	NA	NA	NA	*	NA
Inhalation of Fugitive Dust	NA	NA	NA	NA	*	NA
Subtotal of Media	NA	NA	NA	NA	*	NA
Sediment						
Dermal Contact	2E-05	6E-06	4E-06	NA	NA	NA
Incidental Ingestion	5E-06	5E-07	5E-07	NA	NA	NA
Subtotal of Media	3E-05	7E-06	5E-06	NA	NA	NA
Surface Water						
Dermal Contact	2E-05	4E-06	3E-06	NA	NA	NA
Incidental Ingestion	1E-06	2E-07	2E-07	NA	NA	NA
Subtotal of Media	2E-05	4E-06	3E-06	NA	NA	NA
Total	6E-05	1E-05	8E-06	1E-07	NA	9E-07
HAZARD INDEX						
Surface Soil						
Dermal Contact	3E-02	1E-03	2E-03	6E-04	NA	5E-03
Incidental Ingestion	2E-01	1E-03	3E-03	7E-04	NA	6E-03
Inhalation of Fugitive Dust	*	*	*	*	NA	*
Subtotal of Media	2E-01	2E-03	5E-03	1E-03	NA	1E-02
Subsurface Soil						
Dermal Contact	NA	NA	NA	NA	*	NA
Incidental Ingestion	NA	NA	NA	NA	*	NA
Inhalation of Fugitive Dust	NA	NA	NA	NA	*	NA
Subtotal of Media	NA	NA	NA	NA	*	NA
Sediment						
Dermal Contact	2E-01	6E-02	8E-02	NA	NA	NA
Incidental Ingestion	1E-01	7E-03	1E-02	NA	NA	NA
Subtotal of Media	3E-01	7E-02	9E-02	NA	NA	NA

TABLE 2-1

CUMULATIVE RISKS - SWMU 2
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 2 OF 2

Exposure Route	Resident	Trespasser Adult	Trespasser Adolescent	Maintenance Worker	Excavation Worker	Occupational Worker
HAZARD INDEX (cont.)						
Surface Water						
Dermal Contact	1E-01	3E-02	4E-02	NA	NA	NA
Incidental Ingestion	9E-02	9E-03	2E-02	NA	NA	NA
Subtotal of Media	2E-01	4E-02	6E-02	NA	NA	NA
Total	7E-01	1E-01	2E-01	1E-03	NA	1E-02

* = Either no COPCs were selected or the COPCs selected for this pathway did not have applicable toxicity values.
NA = Not Applicable, pathway is not applicable for the respective media.

Noncarcinogenic Risks: The cumulative hazard indices (HIs) for all potential receptors at SWMU 2 are less than 1.0, a benchmark below which adverse noncarcinogenic health effects are not anticipated under conditions established in the exposure assessment. No quantitative noncarcinogenic risk was calculated for excavation workers exposure to subsurface soil because no COPCs were selected in subsurface soils.

Lead Results: The Integrated Exposure and Uptake Biokinetic (IEUBK) Lead Model (v.0.99) was used to characterize potential effects associated with exposure to media containing lead. Based on model results, 0.02 percent of residential children exposed under similar conditions might have blood-lead levels exceeding 10 microgram/deciliter (µg/dL). This is less than the protective guideline of 5 percent for the maximum proportion of individuals with blood levels exceeding 10 µg/dL (EPA, 1994b). The assumed model inputs were default parameter values, 55.4 mg/kg lead in site-related soils and 2.5 µg/L lead in groundwater. Using the average concentration, the model predicts that 0.00 percent of residential children exposed under similar conditions might have blood-lead levels above 10 µg/dL. This is less than the protective guideline of 5 percent for the maximum proportion of individuals with blood levels above 10 µg/dL. The model inputs assumed were default parameter values, 15.9 mg/kg lead in site-related soils, and 2.2 µg/L lead in groundwater.

Quantitative/Qualitative Risk Assessment for Groundwater: Groundwater was not evaluated as part of the baseline HHRA because it is classified by FDEP as Class G-III, nonpotable water. As discussed in the Supplemental RFI/RI, groundwater obtained from the surficial aquifer at Key West has a high salinity, and the public water supply obtained from the mainland is officially designated as the only potable source. Only one freshwater public or registered domestic well exists on Boca Chica Key and is located approximately 1.5 miles southwest of SWMU 2 on the Atlantic Ocean. Other domestic wells are reportedly used for purposes such as flushing water. Although treatment could possibly be used to improve water quality, the local water authority regulates all potable supplies in the Keys. A preliminary comparison of groundwater concentrations at the SWMU 2 versus tap water risk-based concentrations (RBCs) (EPA, 1996a) and Maximum Contaminant Levels (MCLs) (EPA, 1995a) is presented in Tables 2-2 and 2-3. Because the groundwater at SWMU 2 is classified as nonpotable, it is not within the scope of this CMS.

Risk Assessment for Fish Consumption: Fish and shellfish at SWMU 2 were not considered a human health concern because site access is prevented by security monitoring the active airfield. A complete discussion of this subject is presented in Section 3.2.2.3, Appendix G of the Supplemental RFI/RI.

TABLE 2-2

OCCURRENCE, DISTRIBUTION, AND COMPARISON TO MCLs AND TAP WATER RBCs
INORGANICS IN GROUNDWATER - SWMU 2 (µg/L)
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

	Background			Site						
Chemical	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average	MCL*	Maximum Exceeds MCL?	Tap water RBC**	Maximum Exceeds RBC?
Aluminum	0/3	Not detected	NA	3/7	717-3,000	679.79	NL	NA	37,000	N
Antimony	0/5	Not detected	NA	5/11	41-88	29.05	6	Y	15	Y
Arsenic	3/6	4.1-11.9	4.33	9/11	2.6-24.65	12.25	50	N	0.045	Y
Barium	6/6	6.6-19.45	13.9	11/11	12.6-52.3	30.16	2,000	N	2,600	N
Beryllium	0/6	Not detected	NA	1/11	1.1	0.43	4	N	0.016	Y
Calcium	3/3	114,250-243,500	181,000	7/7	147,000-1,460,000	696,000	NL	NA	NL	NA
Chromium	2/6	0.71-13	4.09	6/11	12.1-33.7	10.70	100	N	180	N
Cyanide	2/3	2.4-5.525	2.76	1/7	14.2	10.77	200	N	730	N
Iron	2/3	76.9-97.4	62.6	5/7	90.8-1,700	427.69	NL	NA	11,000	N
Lead	1/5	2.5	1.19	4/11	2.5-5.4	4.53	15	N	NL	NA
Magnesium	3/3	123,750-820,250	433,000	7/7	159,000-719,000	387,857	NL	NA	NL	NA
Manganese	2/3	3.9-10.3	4.87	5/6	2.7-25.1	12.10	NL	NA	180	N
Mercury	1/6	0.13	0.08	5/11	0.13-0.25	0.13	2	N	11	N
Potassium	3/3	38,850-181,750	119,000	7/7	51,500-178,000	108,629	NL	NA	NL	NA
Sodium	3/3	982,250-6,615,000	3,670,000	7/7	1,460,000-6,010,000	3,288,571	NL	NA	NL	NA
Sulfide	3/3	10,000-52,000	28,000	1/1	47,750	47,750	NL	NA	NL	NA
Thallium	1/6	4.925	2.52	3/11	6.7-11.7	6.42	2	Y	2.9	Y
Tin	0/3	Not detected	NA	2/5	48.4-81.9	35.06	NL	NA	22,000	N
Zinc	3/6	3.425-15.3	4.94	7/12	8.3-49	13.37	NL	NA	11,000	N

NA = Not applicable.
NL = Not listed.
*MCL = Maximum contaminant level (EPA, 1995a).
**RBC = Risk-based concentration (EPA, 1996a).

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TABLE 2-3

OCCURRENCE, DISTRIBUTION, AND COMPARISON TO MCLs AND TAP WATER RBCs ORGANICS IN GROUNDWATER - SWMU 2 (µg/L) NAVAL AIR STATION KEY WEST BOCA CHICA KEY, FLORIDA

Chemical	Background			Site			MCL*	Maximum Exceeds MCL?	Tap water RBC**	Maximum Exceeds RBC?
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
PESTICIDES/PCBs										
4,4'-DDD	0/6	Not detected	NA	7/11	0.76-56	8	NL	NA	0.28	Y
4,4'-DDE	0/6	Not detected	NA	9/12	0.044-22	2.62	NL	NA	0.2	Y
4,4'-DDT	0/6	Not detected	NA	6/12	0.16-30	4.14	NL	NA	0.2	Y
Aldrin	0/6	Not detected	NA	1/11	2.8	0.41	NL	NA	0.004	Y
Alpha-BHC	0/6	Not detected	NA	2/12	0.16-14	1.28	NL	NA	0.011	Y
Beta-BHC	0/6	Not detected	NA	6/12	0.054-5	0.67	NL	NA	0.037	Y
Delta-BHC	0/6	Not detected	NA	5/12	0.12-13	1.38	NL	NA	NL	NA
Endosulfan I	0/6	Not detected	NA	1/11	0.039	0.15	NL	NA	220	N
SEMIVOLATILE ORGANIC COMPOUNDS										
1,2,4-trichlorobenzene	0/3	Not detected	NA	2/3	4-15.5	8.17	70	N	190	N
1,2-dichlorobenzene	0/4	Not detected	NA	4/7	2.8-3.6	2.70	600	N	270	N
1,3-dichlorobenzene	0/4	Not detected	NA	5/7	2-8.2	4.75	600	N	540	N
1,4-dichlorobenzene	0/4	Not detected	NA	4/7	7-37	9.87	75	N	0.44	Y
2-methylnaphthalene	0/4	Not detected	NA	1/3	53	21.08	NL	NA	1,500	N
4-methylphenol	0/4	Not detected	NA	1/3	2	4.08	NL	NA	180	N
Benzoic acid	0/4	Not detected	NA	1/3	4	18.50	NL	NA	150,000	N
Benzyl alcohol	0/4	Not detected	NA	1/3	7.75	5.92	NL	NA	11,000	N
Bis(2-ethylhexyl)phthalate	0/4	Not detected	NA	2/3	2-3	3.33	6	N	4.8	N
Naphthalene	1/4	2	4.09	1/7	43	7.65	NL	NA	1,500	N
VOLATILE ORGANIC COMPOUNDS										
1,1-dichloroethene	0/3	Not detected	NA	2/8	2.25-64.5	9.29	7	Y	0.044	Y
1,2-dichloroethene (total)	0/1	Not detected	NA	2/2	3.5-1,500	752	70	Y	55	Y
Acetone	1/3	5	5	2/4	10-93	28.25	NL	NA	3,700	N
Benzene	0/3	Not detected	NA	2/8	56-107.5	21.56	5	Y	0.36	Y
Carbon disulfide	0/3	Not detected	NA	4/4	2-60	17.25	NL	NA	1,000	N
Chlorobenzene	0/3	Not detected	NA	6/8	3.7-167.5	62.71	NL	NA	39	Y
Cis-1,2-dichloroethene	0/3	Not detected	NA	1/5	640-840	168.40	70	Y	55	Y
Ethylbenzene	0/3	Not detected	NA	3/8	2.8-81.5	13.85	700	N	1,300	N
Methylene chloride	2/3	1	1.5	3/8	1-61	14.84	5	Y	4.1	Y
Toluene	0/3	Not detected	NA	2/8	4-70.5	10.44	1,000	N	750	N
Trichloroethene	0/3	Not detected	NA	1/8	64	9.24	5	Y	1.6	Y
Vinyl chloride	0/3	Not detected	NA	1/8	3.5	18.08	2	Y	0.019	Y
Xylenes (total)	0/3	Not detected	NA	3/8	2-73.5	12.05	10,000	N	12,000	N

NA = Not applicable.
NL = Not listed.

*MCL = Maximum contaminant level (EPA, 1995a).
**RBC = Risk based concentration (EPA, 1996a).

2.5.1 Chemicals of Concern

From the COPCs chosen for each medium in the baseline HHRA, COCs were selected. HHRA-based selection of the COCs was not required at SWMU 2 because in no instance did any receptor scenario have a cumulative risk above a level of concern (1E-04 to 1.0E-06 for cancer risk or an HI of 1.0). However, five COCs were chosen and are listed in Table 2-4 because they exceed the most restrictive ARARs/SALs for surface-water quality criteria.

2.6 ECOLOGICAL RISK ASSESSMENT SUMMARY

The maximum detected contaminant concentrations in groundwater, surface water, sediment, and soil were used as exposure point concentrations for screening against benchmark values in the ecological risk screening assessment. Only analytical results from soil and sediment sample locations outside the area excavated during the IRA were used in this ecological risk screening assessment, except for sediment samples taken from the excavated area of the ditch during confirmatory sampling after remediation.

Potential exposure routes considered in the Supplemental RFI/RI for terrestrial and aquatic receptors are incidental ingestion of soil, ingestion of contaminated food items, direct aerial deposition, root translocation, drinking contaminated water, dermal contact, direct contact with contaminated surface water or sediments, and incidental ingestion of contaminated surface water and sediments.

Ecological contaminants of concern (ECC) or COCs have been identified in the ecological risk assessment (ERA) at SWMU 2 for each media as well as terrestrial plants. Tables 2-5 through 2-9 identify these COCs by media and include the range of detected values, ecological threshold values, hazard quotients (HQs), and the reason the contaminant was retained as a COC.

The Supplemental RFI/RI ERA concluded that there are potential risks to aquatic receptors and possibly piscivores present in surface water and sediment, primarily from organochlorine pesticides. However, the great majority of the contaminated sediment was removed during the IRA in the Spring of 1996. Because the source of ecological risk has been removed from SWMU 2 the implementation of long-term biomonitoring of pesticides in fish would be appropriate to confirm likely decreasing levels of site-related pesticides over time.

HQs for most COCs in surface soil indicate low potential risk. However, 4,4'-DDT and its degradation products were detected in most soil samples outside the excavated area, and some of the

TABLE 2-4

PRE-REMEDIATION ARAR EXCEEDANCES
CHEMICALS OF CONCERN FOR SURFACE WATER
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

Chemicals of Concern in Surface Water[a]	Representative Concentrations (µg/l)[b]	Surface Water Quality Criteria (µg/l)[c]
4,4'-DDD	1.45	0.025
4,4'-DDT	0.33	0.001
Aldrin	0.11	0.00014
Beta-BHC	0.066	0.046[d]
Heptachlor	0.062	0.0036

a. Selections Based on AWQC for Consumption of Aquatic Organisms
b Representative Concentrations are equal to maximum detected concentration limits for the selected chemicals.
c. EPA Region IV screening level unless otherwise noted
d. Florida Water Quality Standard (FDEP, 1995a)

TABLE 2-5

ECOLOGICAL CHEMICALS OF CONCERN IN GROUNDWATER - SWMU 2
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 1 OF 2

Ecological Chemicals of Concern (ECC)	Frequency of Detection	Average Background Concentration (µg/L)	Range of Detected Values (µg/L)	Ecological Threshold Value (µg/L)	Hazard Quotient	Reason for Retention as an ECC
INORGANICS						
Aluminum	3/7	ND	717-3,000	87	34.48	HQ > 1
Barium	11/11	13.88	12.6-52.3	3.9	13.4	HQ > 1
Beryllium	1/11	ND	1.1	0.13	8.46	HQ > 1
Chromium	6/11	4.09	12.1-33.7	11	3.06	HQ > 1
Cyanide	1/7	2.76	14.2	5.2	2.73	HQ > 1
Lead	4/11	1.19	2.5-5.4	1.32	4.09	HQ > 1
Mercury	5/11	0.08	0.13-0.25	0.012	20.8	HQ > 1
Thallium	3/11	3	6.7-11.7	6.3	1.86	HQ > 1
Tin	2/5	ND	48.4-81.9	NA		No suitable threshold was available
PESTICIDES/PCBs						
4,4'-DDD	7/11	ND	0.76-56	0.0064	8,750	HQ > 1
4,4'-DDE	9/12	ND	0.04-22	10.5	2.10	HQ > 1
4,4'-DDT	6/12	ND	0.16-30	0.00059	50,847	HQ > 1
Aldrin	1/11	ND	2.8	0.00014	20,000	HQ > 1
Beta-BHC	6/12	ND	0.05-5	0.046	108.7	HQ > 1
SEMIVOLATILE ORGANIC COMPOUNDS						
1,4-dichlorobenzene	4/7	ND	7-37	11.2	3.3	HQ > 1
2-methylnapthalene	1/3	ND	53	NA		No suitable threshold was available
4-methylphenol	1/3	ND	2	NA		No suitable threshold was available
Benzoic acid	1/3	ND	4	NA		No suitable threshold was available
Benzyl alcohol	1/3	ND	7.75	NA		No suitable threshold was available
Bis(2-ethylhexyl)phthalate	2/3	ND	2-3	0.3	10	HQ > 1

TABLE 2-5

ECOLOGICAL CHEMICALS OF CONCERN IN GROUNDWATER - SWMU 2
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 2 OF 2

Ecological Chemicals of Concern (ECC)	Frequency of Detection	Average Background Concentration (µg/L)	Range of Detected Values (µg/L)	Ecological Threshold Value (µg/L)	Hazard Quotient	Reason for Retention as an ECC
VOLATILE ORGANIC COMPOUNDS						
1,1-dichloroethene	2/8	ND	2.25-64.5	3.2	20.2	HQ > 1
1,2-dichloroethene (total)	2/4	ND	3.5-1,650	NA		No suitable threshold was available
Acetone	2/4	5	10-93	NA		No suitable threshold was available
Benzene	2/8	ND	56-107.5	71.3	1.51	HQ > 1
Carbon disulfide	4/4	ND	2-60	NA		No suitable threshold was available
Cis-1,2-dichloroethene	1/5	ND	840	NA		No suitable threshold available
Vinyl chloride	1/8	ND	3.5	NA		No suitable threshold available
Xylenes (total)	3/8	ND	2-73.5	1.8	40.8	HQ > 1

NA = No suitable ecological threshold value was available.
ND = Not detected.

TABLE 2-6

ECOLOGICAL CHEMICALS OF CONCERN IN SURFACE WATER - SWMU 2
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

ECC	Frequency of Detection	Average Background Concentration (µg/L)	Range of Detected Values (µg/L)	Ecological Threshold Value (µg/L)	Hazard Quotient	Reason for Retention as an ECC
INORGANICS						
Aluminum	3/3	37.93	33.9 - 1,510	1,500	1.0	HQ > 1
Lead	1/4	ND	53.6	5.6	9.57	HQ > 1
Silver	2/3	ND	6.8-8.2	0.012	683	HQ > 1
Tin	1/2	ND	10	0.01	1,000	HQ > 1
PESTICIDES/PCBs						
Aldrin	1/5	ND	5.0	NA		No suitable threshold available
4,4'-DDD	2/5	ND	0.24 - 1.45	0.025	58	HQ > 1
4,4'-DDT	1/5	ND	0.33	0.0006	550	HQ > 1
Beta-BHC	1/5	ND	0.15	0.046	3.26	HQ > 1
Heptachlor	1/5	ND	0.06	0.00021	295	HQ > 1
SEMIVOLATILE ORGANIC COMPOUNDS						
Benzyl alcohol	1/4	ND	5.0	NA		No suitable threshold available

NA = No suitable ecological threshold value was available.
ND = Not detected.

TABLE 2-7
ECOLOGICAL CHEMICALS OF CONCERN IN SEDIMENT - SWMU 2
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

ECC	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold Value[1]	Hazard Quotient	Reason for Retention as an ECC
INORGANICS (mg/kg)						
Cadmium	4/5	0.42	0.44 - 1.90	0.68/9.6	2.81/0.20	HQ > 1
Zinc	5/5	30.40	33.3 - 170	124/410	1.37/0.41	HQ > 1
PESTICIDES/PCBs (µg/kg)						
4,4'-DDD	8/10	ND	440 - 17,200	3.3/46	5,212/374	HQ > 1
4,4'-DDE	8/10	ND	170 - 4,640	1.22/27	3,803/172	HQ > 1
4,4'-DDT	9/10	ND	16 - 14,800	2.07/46	7,150/322	HQ > 1
Delta-BHC	2/8	ND	159 - 231	3	77.0	HQ > 1
Endosulfan I	1/8	ND	359	5.4	66.5	HQ > 1
Endrin	1/8	ND	244	3.3/3.5	73.9/69.7	HQ > 1
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)						
Bis(2-ethylhexyl)phthalate	1/2	2,299	2,500	182/8.90+0 8	13.7/2.81E-06	HQ > 1
VOLATILE ORGANIC COMPOUNDS (µg/kg)						
2-butanone	1/3	8.80	10	NA		No suitable threshold was available

NA = No suitable ecological threshold value was available.
ND = Not detected.

1 When two values are presented, the left value is the most conservative available and the right value is a less conservative value, if available. In these instances, two HQ values are presented. Contaminants were retained as final ECPCs if the most conservative ET value available was exceeded.

TABLE 2-8
ECOLOGICAL CHEMICALS OF CONCERN IN SOIL- SWMU 2
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

ECC	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold Value	Hazard Quotient	Reason for Retention as an ECC
INORGANICS (mg/kg)						
Aluminum	4/4	2,130	452 - 6,140	600	10.2	HQ > 1
Antimony	4/7	0.43	0.25 - 4.70	NA		No suitable threshold was available
Beryllium	6/7	0.05	0.09 - 0.23	NA		No suitable threshold was available
Cyanide	1/2	ND	18	0.005	3,600	HQ > 1
Tin	5/7	1.94	0.71 - 6.2	0.89	6.97	HQ > 1
PESTICIDES/PCBs (µg/kg)						
4,4'-DDD	26/36	5.71	3.9 - 316	100	3.16	HQ > 1
4,4'-DDE	33/36	12.38	7.0 - 1,160	100	11.6	HQ > 1
4,4'-DDT	32/36	7.62	4.95 - 4,400	100	44	HQ > 1
Alpha-BHC	2/36	ND	1.0	NA		No suitable threshold was available
Beta-BHC	2/36	ND	2.0	NA		No suitable threshold was available
Delta-BHC	2/36	ND	1.0	NA		No suitable threshold was available
PESTICIDES/PCBs (µg/kg) (cont.)						
Toxaphene	2/36	ND	91 - 343	NA		No suitable threshold was available
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)						
Bis(2-ethylhexyl)phthalate	2/2	471	200 - 310	NA		No suitable threshold was available
VOLATILE ORGANIC COMPOUNDS (µg/kg)						
2-butanone	1/6	ND	3.0	NA		No suitable threshold was available
Acetone	2/6	3.67	29 - 47	NA		No suitable threshold was available

NA = No suitable ecological threshold value was available.
ND = Not detected.

TABLE 2-9

ECOLOGICAL CHEMICALS OF CONCERN FOR TERRESTRIAL PLANTS - SWMU 2
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 1 OF 2

ECC	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold Value	Hazard Quotient	Reason for Retention as an ECC
INORGANICS (mg/kg)						
Aluminum	4/4	2,130	452 - 6,140	50	122.8	HQ > 1
Cyanide	1/2	ND	18	NA		No suitable threshold was available
Lead	16/17	16.8	0.27 - 55.4	50	1.1	HQ > 1
PESTICIDES/PCBs (µg/kg)						
4,4'-DDD	26/36	5.71	3.9 - 316	NA		No suitable threshold was available
4,4'-DDE	33/36	12.38	7.0 - 1,160	NA		No suitable threshold was available
4,4'-DDT	32/36	7.62	4.95 - 4,400	NA		No suitable threshold was available
Aldrin	3/36	ND	1.0	NA		No suitable threshold was available
Alpha-BHC	2/36	ND	1.0	NA		No suitable threshold was available
Beta-BHC	2/36	ND	2.0	NA		No suitable threshold was available
Delta-BHC	2/2	ND	1.0	NA		No suitable threshold was available
Endosulfan I	5/36	ND	1.0 - 2.0	NA		No suitable threshold was available
PESTICIDES/PCBs (µg/kg) (cont.)						
Endosulfan II	2/36	ND	1.0 - 7.0	NA		No suitable threshold was available
Endosulfan sulfate	1/36	ND	3.0	NA		No suitable threshold was available
Endrin	5/36	ND	2.0 - 7.0	NA		No suitable threshold was available
Endrin ketone	1/32	ND	3.0	NA		No suitable threshold was available
Gamma-BHC (lindane)	1/36	ND	1.0	NA		No suitable threshold was available
Heptachlor epoxide	2/36	ND	6 - 16	NA		No suitable threshold was available
Methylene chloride	2/9	2.8	24 - 27	NA		No suitable threshold was available
Toxaphene	2/36	ND	91 - 343	NA		No suitable threshold was available

TABLE 2-9

ECOLOGICAL CHEMICALS OF CONCERN FOR TERRESTRIAL PLANTS - SWMU 2
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 2 OF 2

ECC	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold Value	Hazard Quotient	Reason for Retention as an ECC
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)						
Bis(2-ethylhexyl)phthalate	2/2	471	200 - 310	NA		No suitable threshold was available
VOLATILE ORGANIC COMPOUNDS (µg/kg)						
2-butanone	1/6	ND	3.0	NA		No suitable threshold was available
Acetone	2/6	3.67	29 - 47	NA		No suitable threshold was available
Cis-1,2-dichloroethene	2/2	ND	6.0 - 8.0	NA		No suitable threshold was available
Methoxychlor	2/36	ND	3.0 - 9.0	NA		No suitable threshold was available

NA = No suitable ecological threshold value was available.
ND = Not detected.

concentrations suggest moderate potential risks to ecological receptors. Potential risks to terrestrial receptors from this pesticide are mitigated by the fact that most of the elevated concentrations were in samples from north of the ditch, where terrestrial habitat is of marginal quality. Estimated potential risks to the Lower Keys marsh rabbit were relatively low using the mean soil contaminant concentrations, after consideration of the mitigating uncertainties and conservative assumptions used in the model. Thus, it appears that site soil contaminants do not pose significant potential risks to the marsh rabbit or other terrestrial receptors.

The scarcity of terrestrial plant benchmarks for organic compounds precluded a detailed assessment of potential risks to terrestrial plants from organics in surface soil. However, plants do not translocate organics to the extent that they translocate inorganics. Estimated concentrations of most metals in plants were low and not believed to pose significant potential risks. However, a HQ indicative of high potential risk was identified for aluminum.

In summary, the ERA appears to be adequate in characterizing the potential ecological risks at SWMU 2. Potential risks to aquatic and piscivorous receptors from 4,4'-DDT and its degradation products in surface water and sediment appear to be present, as evidenced by exceedances of benchmark values and the results of toxicity tests and fish tissue analysis. However, despite some elevated levels of pesticides and related potential risks outside the area of recent excavation, most of the contaminated area was removed during the excavation. The extent of the excavation at SWMU 2 includes the locations where 4,4'-DDT was mixed and stored and surrounding areas.

3.0 CORRECTIVE ACTION OBJECTIVES

The following section describes the development of the proposed CAOs for the NAS Key West SWMU 2, Boca Chica DDT Mixing Area. These CAO's and media clean-up standards are based on promulgated Federal and State of Florida requirements, risk-derived standards, data and information gathered during the previous investigations, IRAs, Supplemental RFI/RI, and additional applicable guidance documents. The development of the CAO's included the consideration of cross-media concentrations which are concentrations in one media which are protective of the migration of contaminants into another media. The cross-media evaluation utilized modeling to determine the groundwater and surface-water runoff contaminant fate and transport.

3.1 INTRODUCTION

CAOs are developed for each site as media-specific and contaminant-specific objectives that will result in the protection of human health and the environment. The development of CAOs for a site SWMU or group of SWMUs are based on human health and environmental criteria, RFI/RI gathered information, EPA guidance, and applicable Federal and state regulations. Typically, CAOs are developed based on promulgated standards [e.g., Ambient Water Quality Criteria (AWQC)], background concentrations determined from a site-specific investigation, and human health and ecological risk-based concentrations developed in accordance with the EPA risk assessment guidance. The Supplemental RFI/RI presents a complete description of the nature and extent of contamination, contaminant fate and transport, baseline HHRA, and ERA. In addition, conclusions and recommendations for potential SWMU 2 corrective measures are presented. This section includes a brief discussion of the development of the CAOs for SWMU 2, a brief summary of the Supplemental RFI/RI nature and extent of contamination, HHRA and RGOs development, and ERA for SWMU 2.

3.2 ARARS, MEDIA OF CONCERN, AND COCS

3.2.1 ARAR Criteria

3.2.1.1 Introduction

The ARARs, which include the requirements, criteria, or limitations promulgated under the Federal and state law that address a contaminant, action, or location at a site, are presented in this section.

The definition of ARARs is as follows:

- Any standard, requirement, criterion, or limitation under federal environmental law.

- Any promulgated standard, requirement, criterion, or limitation under a state environmental or facility-citing law that is more stringent than the associated Federal standard, requirement, criterion, or limitation.

One of the primary concerns during the development of corrective action alternatives for hazardous waste sites under RCRA is the degree of human health and environmental protection afforded by a given remedy. Consideration should be given to corrective measures that attain or exceed ARARs.

Definitions of the two types of ARARs, as well as other to be considered (TBC) criteria, are given below:

- Applicable Requirements means those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law that directly and fully address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

- Relevant and Appropriate Requirements means those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law that, while not "applicable," address problems or situations sufficiently similar (relevant) to those encountered at the CERCLA site that their use is well suited (appropriate) to the particular site.

- TBC Criteria are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing remedial actions, or necessary for determining what is protective of human health and/or the environment. Examples of TBC criteria include EPA Drinking Water Advisories, Carcinogenic Potency Factors, and Reference Doses.

These requirements are included in order to provide the decision makers with a complete evaluation of potential ARARs in developing, identifying, and selecting a corrective measure alternative.

3.2.1.2 ARAR and TBC Categories

ARARs fall into three categories, based on the manner in which they are applied:

- Chemical Specific: Health/risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants. Examples of contaminant-specific ARARs include MCLs and Clean Water Act (CWA) water quality criteria. Contaminant-specific ARARs govern the extent of site clean-up.

- Location Specific: Restrictions based on the concentration of hazardous substances or the conduct of activities in specific locations. These may restrict or preclude certain remedial actions or may apply only to certain portions of site. Examples of location-specific ARARs include RCRA location requirements and floodplain management requirements. Location-specific ARARs pertain to special site features.

- Action Specific: Technology- or activity-based controls or restrictions on activities related to management of hazardous waste. Action-specific ARARs pertain to implementing a given remedy.

Table 3-1 presents a summary of potential Federal and state ARARs and TBCs for corrective measures undertaken for SWMU 2 at NAS Key West.

3.2.1.3 Chemical-Specific ARARs and TBCs

This section presents a summary of Federal and state chemical-specific ARAR criteria of potential concern in the case of SWMU 2. The ARAR criteria provide medium-specific guidance on "acceptable" or "permissible" concentrations of contaminants.

The Safe Drinking Water Act (SDWA) promulgated National Primary Drinking Water Standard Maximum Contaminant Levels (MCLs) (40 CFR Part 141). MCLs are enforceable standards for contaminants in public drinking water supply systems. They consider not only health factors, but also the economic and technical feasibility of removing a contaminant from a water supply system. Secondary MCLs (40 CFR Part 143) are not enforceable, but are intended as guidelines for contaminants that may adversely affect the aesthetic quality of drinking water, such as taste, odor, color, and appearance, and may deter public acceptance of drinking water provided by public water systems.

The SDWA also established Maximum Contaminant Level Goals (MCLGs) for several organic and inorganic compounds in drinking water. MCLGs are set at levels of no known or anticipated adverse

TABLE 3-1

POTENTIAL ARARs AND SALs
CORRECTIVE MEASURE STUDY FOR SWMU 2
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 1 OF 3

Chemical-Specific Requirements	Rationale
Clean Water Act (33 USC 1251-1376) Federal AWQCs (40 CFR Part 50)	Surface-water and fish samples have shown contamination. Corrective measures may result in surface-water discharges that could further impact aquatic life.
Clean Air Act (42 USC 7401) National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50) National Emission Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR 61.60-61.71) New Source Performance Standards (NSPS) (40 CFR Part 60) Florida State Implementation Plan (Chapter 62-204 F.A.C.)	Corrective measures may include treatment of media which could result in emissions to the atmosphere.
Threshold Limit Values, American Conference of Government Industrial Hygienists	May be applicable to air concentrations during implementation of corrective measures.
Proposed RCRA Action Levels (40 CFR Part 264)	Corrective measures may be driven by reducing chemical concentrations in any or all of the media at SWMU-2 to meet the Action Levels.
Benchmark Toxicity Values (EPA Region III, 1995b)	Corrective measures may be driven by reducing chemical concentrations in the soils at SWMU-2 to meet published levels.
Oak Ridge National Laboratory Benchmark Toxicity Values (Will and Suter, 1994)	
FDEP Soil Cleanup Goals (FDEP, 1995b and 1996)	
FDEP Sediment Quality Guideline (FDEP, 1994)	Corrective measures may be driven by reducing chemical concentrations in the sediments at SWMU-2 to meet published levels.
EPA Region IV Sediment Screening Values (EPA, 1995c)	
Federal Sediment Quality Screening Criteria (EPA, 1996b)	
EPA Sediment Quality Benchmark (EPA, 1996b)	
Florida Surface Water Quality Standards (Chapter 62-302 F.A.C.)	Corrective measures may be driven by reducing chemical concentrations in the surface waters at SWMU-2 to meet published levels.
EPA Region IV Chronic Surface Water Screening Values (EPA, 1995c)	
National Ambient Water Quality Standards	
EPA Region III Marine Standards (EPA, 1995b)	
EPA Region III Fresh Water Standards (EPA, 1995b)	
Safe Drinking Water Act MCLs (EPA, 1995a)	Corrective measures may include groundwater remediation to MCLs.
Florida Drinking Water Standards, Monitoring and Reporting (MCLs) (Chapter 62-550 F.A.C.)	
Florida Department of Environmental Protection Guidance (FDEP, 1989)	Corrective measures may include cleanup to FDEP Guidance.

TABLE 3-1

POTENTIAL ARARs AND SALs
CORRECTIVE MEASURE STUDY FOR SWMU 2
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 2 OF 3

Location-Specific Requirements	Rationale
Federal Protection of Wetlands Executive Order (E.O. 11990)	Wetland areas at SWMU-2 may have chemical contamination and may be affected by corrective measure.
Endangered Species Act of 1978 (16 USC 1531) (40 CFR 502)	There are endangered and threatened species at NAS Key West.
Fish and Wildlife Coordination Act of 1980 (16 USC 661) Fish and Wildlife Conservation Act (16 USC 2901) Fish and Wildlife Improvement Act of 1978 (16 USC 742a)	Corrective measures may affect fish and wildlife habitat
RCRA Standards for Owners and Operators of TSDFs.	Most of the NAS Key West facility is within the 100-year floodplain
Florida Surface Waters of the State (Chapter 62-301 F.A.C.)	Provides designation of landward extent of surface waters in the state.
Florida Delineation of Landward extent of Wetlands and Surface Waters (Chapter 62-340 F.A.C.)	Provides the delineation methodology of the extent of wetlands.
Florida Ground Water Classes, Standards, and Exemptions (Chapter 62-520 F.A.C.)	Provides designation criteria for the groundwater classes in the state.
Action-Specific Requirements	**Rationale**
Hazardous Waste Generator Requirements (40 CFR Part 262)	Standards applicable to generators of hazardous wastes that may have to be met depending on corrective measures implemented.
Hazardous Waste Transportation Requirements (40 CFR Part 263)	Corrective measures may require transportation of hazardous materials off site for treatment/disposal.
Standards for Owners and Operators of Hazardous Waste Treatment, Storage or Disposal TSDFs (40 CFR Part 264) Interim Status Standards for Owners and Operators of Hazardous Waste or TSD Facilities (40 CFR Part 264)	Corrective measures may involve hazardous waste treatment, storage and disposal facilities.
Land Disposal Restrictions (40 CFR Part 268)	Standards for the land disposal of hazardous waste.
Department of Transportation (DOT) Rules for Hazardous Materials Transport (49 CFR Parts 107, 171-179)	Corrective measures may include transport of waste for off-site treatment and disposal.
National Environmental Policy Act	Requires consideration of environmental effects due to Federal actions.
CWA (40 CFR Part 122, NPDES)	Corrective measures may involve discharge to surface waters.
Clean Air Act (CAA) (42 USC 7401), NAAQS (40 CFR Parts 50 and 53), NESHAPs (40 CFR Part 61) and NSPS (40 CFR Part 60)	Treatment technologies for emissions to air (incineration, surface impoundment's, waste piles landfills, and sources of fugitive emissions).
Occupational Safety and Health Act (29 USC 651-678)	Regulates worker health and safety.

TABLE 3-1

POTENTIAL ARARs AND SALs
CORRECTIVE MEASURE STUDY FOR SWMU 2
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 3 OF 3

Action-Specific Requirements	Rationale
Florida Pretreatment Requirements for Existing and New Sources of Pollution (Chapter 62-625 F.A.C.)	Corrective measures may include discharge to surface waters or a waste water treatment plant.
Florida Hazardous Waste (Chapter 62-730 F.A.C.)	Applicable to corrective measures that may handle and/or transport hazardous waste.
Land Use Restrictions at Environmental Remediation Sites On Board U.S. Navy Installations (CNBJAXINST 5090.2N4) (U.S. Navy, 1997)	Establishes a systematic program to govern land use at environmental remediation sites at U.S. Navy Installations.

health effects, with an adequate margin of safety. The NCP [40 CFR Part 300.430(e)(2)(i)] states that MCLGs that are set at levels above zero shall be attained by remedial actions for groundwaters or surface waters that are current or potential sources of drinking water [where the MCLGs are relevant and appropriate under the circumstances of the release based on the factors in Section 300.400(g)(2) of the NCP]. If an MCLG is found not to be relevant and appropriate, the corresponding MCL shall be achieved where relevant and appropriate to the circumstances of the release. For MCLGs that are set at zero, the MCL promulgated for that contaminant under the SDWA shall be attained by the remedial actions. In cases involving multiple contaminants or pathways where attainment of chemical-specific ARARs will result in a cumulative cancer risk in excess of 1E-04, criteria in paragraph (e)(2)(i)(A) of Section 300.430 (i.e., risk-based criteria) may be considered when determining the clean-up level to be attained. The NCP explains that clean-up levels set at zero (generally the case for carcinogens) are not appropriate because complete elimination of risk is not possible and because "true zero" cannot be detected.

Since the groundwater at SWMU 2 is brackish and not used as a potable water supply, the SDWA is neither applicable nor relevant and appropriate.

The CWA sets EPA AWQC that are non-enforceable guidelines developed for pollutants in surface waters pursuant to Section 304(a)(1) of the CWA. Although AWQCs are not legally enforceable, they should be considered as potential ARARs. AWQCs are available for the protection of human health from exposure to contaminants in surface water as well as from ingestion of aquatic biota and for the protection of freshwater and saltwater aquatic life. AWQCs may be considered for actions that involve groundwater treatment and/or discharge to nearby surface waters.

The CAA (42 USC 7401) consists of three programs or requirements that may be ARARs: NAAQS (40 CFR Parts 50 and 53), NESHAPs (40 CFR Part 61), and NSPS (40 CFR Part 60). NESHAPs, which are emission standards for source types (i.e., industrial categories) that emit hazardous air pollutants, are not likely to be applicable or relevant and appropriate for NAS Key West because they were developed for a specific source.

EPA requires the attainment and maintenance of primary and secondary NAAQS to protect public health and public welfare, respectively. These standards are not source specific but rather are national limitations on ambient air quality. States are responsible for assuring compliance with the NAAQS. Requirements in the EPA-approved State Implementation Plan (SIP) for the implementation, maintenance, and enforcement of NAAQS are potential ARARs.

NSPS are established for new sources of air emissions to ensure that the new stationary sources minimize emissions. These standards are for categories of stationary sources that cause or contribute to air pollution that may endanger public health or welfare. Standards are based upon the best demonstrated available technology (BDAT)

Florida SIP (Chapter 62-204 F.A.C.) establishes maximum allowable levels of pollutants in the ambient air necessary to protect human health and public welfare and maximum allowable increases in ambient concentrations for subject pollutants to prevent significant deterioration of air quality. It provides three general classifications for determining which set of prevention of significant deterioration increments apply.

Proposed RCRA Action Levels (40 CFR Part 264) define the chemical concentration in a media that would make that media a RCRA listed waste. Any media contaminated at or above these levels would be considered hazardous waste and should be managed, transported, and disposed of in accordance with Federal and RCRA requirements. Because of the regulatory status of proposed, these levels are only "To Be Considered".

Biological Technical Assistance Group (BTAG) Screening Levels (EPA Region III, 1995b), Oak Ridge National Laboratory Benchmark Toxicity Values (Will & Suter, 1994) and Florida Soil Cleanup Goals (FDEP, 1995b and 1996) are published listings of ARARs and SALs for soils.

FDEP Sediment Quality Guideline (FDEP, 1994), EPA Region IV Sediment Screening Values (EPA, 1995c), Federal Sediment Quality Screening Values (EPA, 1996b) and EPA Sediment Quality Benchmark (EPA, 1996b) are published listings of ARARs and SALs for sediments.

Florida Surface-Water Quality Standards (Chapter 62-302 F.A.C.), EPA Region IV Chronic Surface-Water Screening Values (EPA, 1995c), National Ambient Water Quality Standards , USEPA Region III Marine Standards (EPA, 1995b) and EPA Region III Fresh Water Standards (EPA, 1995b) are published listings of ARARs and SALs for surface-water.

Florida Drinking Water Standards, Monitoring, and Reporting (Chapter 62-550 F.A.C.) set forth drinking water quality standards at least as stringent as the National Primary Drinking Water Regulations. MCLs that are promulgated by EPA are automatically incorporated into the Florida SDWA. If a MCL does not exist for a contaminant, the Florida SDWA requires that no contaminant which creates or has the potential to create an imminent and substantial danger to the public shall be introduced into a public water system.

Since the groundwater at SWMU 2 is brackish and not used as a potable water supply, the Florida SDWA is neither applicable nor relevant and appropriate.

3.2.1.4 Location-Specific ARARs and TBCs

This section presents a summary of Federal and state location-specific ARAR criteria of potential concern in the case of SWMU 2. The ARAR criteria provide medium-specific guidance on "acceptable" or "permissible" concentrations of contaminants.

Federal Protection of Wetlands Executive Order (E.O. 11990) requires Federal agencies, in carrying out their responsibilities, to take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands (unless there is no practical alternative to that construction); minimize the harm to wetlands (if the only no practical alternative requires construction in the wetlands); and provide early and adequate opportunities for public review of plans involving new construction in wetlands.

Corrective measures at SWMU 2 may impact regulated wetland areas. Permits from both the State of Florida and the U.S. Army Corps of Engineers will be required if any corrective measures impact regulated wetland areas.

The Endangered Species Act of 1978 (16 USC 1531) (40 CFR Part 502) provides for consideration of the impacts on endangered and threatened species and their critical habitats. This act requires federal agencies, in consultation with the Secretary of the Interior, to ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any endangered or threatened species or adversely affect its critical habitat. A review of the available information indicates that the Lower Keys marsh rabbit (a state and Federally listed endangered species) is known to permanently reside in the vicinity of SWMU 2 and therefore this act would apply.

The Fish and Wildlife Coordination Act (16 USC 661) provides for consideration of the impacts on wetlands and protected habitats. The act requires that Federal agencies, before issuing a permit or undertaking Federal action for the modification of any body of water, consult with the appropriate state agency exercising jurisdiction over wildlife resources to conserve those resources. Consultation with the United States Fish and Wildlife Service is also required.

The Fish and Wildlife Improvement Act of 1978 (16 USC 742a) and The Fish and Wildlife Conservation Act of 1980 (16 USC 2901) require consideration of the impacts on wetlands and protected habitats.

Florida Surface Waters of the State (Chapter 62-301 F.A.C.) and Florida Delineation of Landward Extent of Wetlands and Surface Waters (Chapter 62-340 F.A.C.) define and provide the delineation methodology for determining the extent of surface waters and wetlands. SWMU 2 has ditches through it which contain surface water and may be bounded by wetlands or mangrove habitat.

Florida Ground Water Classes, Standards, and Exemptions (Chapter 62-520 F.A.C.) provides for the designation of the present and future most beneficial uses of all the ground waters in the state by means of a classification system. The state classification of the groundwater at Boca Chica Key is Class G-III (nonpotable water), which is water in an unconfined aquifer that has a total dissolved solids content of 10,000 milligrams per liter or greater.

3.2.1.5 Action-Specific ARARs and TBCs

This section presents a summary of Federal and state action-specific ARAR criteria of potential concern in the case of SWMU 2. The ARAR criteria provide medium-specific guidance on "acceptable" or "permissible" concentrations of contaminants.

RCRA Subtitle C regulates the treatment, storage, and disposal of hazardous waste from its generation until its ultimate disposal. In general, RCRA Subtitle C requirements for the treatment, storage, or disposal of hazardous waste will be applicable if:

- The waste is a listed or characteristic waste under RCRA.
- The waste was treated, stored, or disposed (as defined in 40 CFR 260.10) after the effective date of the RCRA requirements under consideration.
- The activity at the CERCLA site constitutes current treatment, storage, or disposal as defined by RCRA.

RCRA Subtitle C requirements may be relevant and appropriate when the waste is sufficiently similar to a hazardous waste and/or the on-site corrective action constitutes treatment, storage, or disposal and the particular RCRA requirement is well suited to the circumstances of the contaminant release and site. RCRA Subtitle C requirements may also be relevant and appropriate when the corrective action constitutes generation of a hazardous waste. All RCRA Subtitle C requirements must be met if the clean-up is not under Federal order and/or when the hazardous waste moves off-site.

An exemption from the hazardous waste rules is provided for wastewater treatment units that are tank systems discharging via regulated outfalls [40 CFR 264.1(g)(6), 25 PAC 264.1(c)(8), 40 CFR 260.10, 25 PAC 260.2]. An exclusion from permitting is provided for such facilities under 40 CFR 270.1(c)(2)(4) for owners and operators of wastewater treatment units and permit-by-rule is provided under 25 PAC 270.1(c).

The following requirements included in the RCRA Subtitle C regulations may pertain to the NAS Key West:

- Hazardous waste identification and listing regulations (40 CFR Part 261).
- Hazardous waste generator requirements (40 CFR Part 262).
- Transportation requirements (40 CFR Part 263).
- Standards for owners and operators of hazardous waste TSDFs (40 CFR Part 264).
- Interim status standards for owners and operators of hazardous waste TSDFs (40 CFR Part 265).
- Land disposal restrictions (LDR) (40 CFR Part 268).

Hazardous Waste Identification and Listing Regulations (40 CFR Part 261) define those solid wastes that are subject to regulation as hazardous waste under 40 CFR Parts 262 to 265 and Parts 124, 270, and 271.

A generator that treats, stores, or disposes of hazardous waste on site must comply with RCRA Standards Applicable to Generators of Hazardous Waste (40 CFR Part 262). These standards include manifest, pre-transport (i.e., packaging, labeling, and placarding), recordkeeping, and reporting requirements. The standards are applicable to actions taken at NAS Key West that constitute generation of a hazardous waste (e.g., generation of water treatment residues or excavation of contaminated soils and/or sediments that may be hazardous).

Standards Applicable to Transporters of Hazardous Waste (40 CFR Part 263) are applicable to off-site transportation of hazardous waste from NAS Key West. These regulations include requirements for compliance with the manifest and recordkeeping systems and requirements for immediate action and clean-up of hazardous waste discharges (spills) during transportation.

Standards and Interim Status Standards for Owners and Operators of Hazardous Waste TSDFs (40 CFR Parts 264 and 265) are applicable to remedial actions taken at NAS Key West and to off-site facilities that receive hazardous waste from the site for treatment and/or disposal and have a RCRA Part B permit. On-site facilities must also have a RCRA Part B permit if the site is not a Federally ordered CERCLA clean-up. Standards for TSDFs include requirements for preparedness and prevention, releases from SWMUs (i.e., corrective action requirements), closure and post-closure care, use and management of containers, and design and operating standards for tank systems, surface impoundments, waste piles, landfills, and incinerators.

RCRA LDR Requirements (40 CFR Part 268) restrict certain wastes from being placed or disposed on the land unless they meet specific BDAT treatment standards (expressed as concentrations, total or in the TCLP extract, or as specified technologies).

RCRA Criteria for Classification of Solid Waste Disposal Facilities and Practices (40 CFR Part 257) establish criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health and thereby constitute prohibited open dumps.

DOT Rules for Hazardous Materials Transport (49 CFR Parts 107 and 171-179) regulate the transport of hazardous materials, including packaging, shipping equipment, and placarding. These rules are considered applicable to wastes shipped off-site for laboratory analysis, treatment, or disposal.

National Environmental Policy Act (40 CFR Part 6) requires consideration of potential environmental impacts at NAS Key West of corrective measure actions on wetlands and endangered species.

The CWA, as amended, governs point-source discharges through the NPDES, discharge, dredge, or fill material, and oil and hazardous waste spills to United States waters. NPDES requirements (40 CFR Part 122) will be applicable if the direct discharge of pollutants into surface waters is part of the remedial action.

The Occupational Health and Safety Act (29 USC, Sections 651 through 678) regulates worker health and safety during implementation of remedial actions.

Florida Hazardous Waste (Chapter 62-730 F.A.C.) essentially parallel RCRA Subtitle C hazardous waste management regulations. Similar to RCRA Subtitle C regulations, Florida regulations include requirements for the following:

- Generators of hazardous waste (Chapter 262)
- Transporters of hazardous waste (Chapter 263)
- New and existing hazardous waste management facilities applying for a permit (Chapter 264)
- Interim status hazardous waste management facilities applying for a permit (Chapter 265)

The above regulations may be relevant and appropriate to on-site remedial actions and applicable to the transport of hazardous waste off-site.

Florida Pretreatment Requirements for Existing and New Sources of Pollution (Chapter 62-730 F.A.C.) implements the pretreatment requirements and establishes a state NPDES permit program. These rules may be applicable for corrective measures involving a discharge to surface water.

Land Use Restrictions at Environmental Remediation Sites On Board U.S. Navy Installations (CNBJAXINST 5090.2N4) establishes a systematic program to govern land use at environmental remediation sites at U.S. Navy Installations.

3.2.2 Media of Concern

Based upon the results of the Supplemental RFI/RI and previous investigations conducted at SWMU 2 involving the HHRAs and ERAs, the contaminated media at SWMU 2 were determined to be soil, sediment, and surface water.

Although groundwater at SWMU 2 contains several chemicals at concentrations above background, it was not considered as a primary media of concern in the Supplemental RFI/RI HHRA, because it is not a current or potential drinking water source. Additionally, ecological receptors are not directly exposed to groundwater. Potential ecological risks associated with groundwater contaminants will be reflected in the evaluation of the potential risks associated with surface water and sediment. Therefore, groundwater will not be directly addressed in the CMS in regards to corrective measure alternatives. However, it will be evaluated by predictive modeling to determine if there are any adverse impacts to surface water and sediment. If it is determined that groundwater is impacting other media at SWMU 2, corrective measure alternatives will be developed to prevent further adverse impacts. In addition, impacts to ecological receptors and contaminant exceedances to ARARs will be evaluated.

3.2.3 Chemicals of Concern

The nature and extent of contamination for SWMU 2 was determined in the Supplemental RFI/RI by analyzing samples from soil, sediment, surface water, and groundwater at the 4,4'-DDT Mixing Area. A list of COCs was developed by comparing maximum detected chemical concentrations for each medium to appropriate criteria as discussed below:

Soil

Figures 2-6, 2-7, and 2-8 in Section 2.4 show chemicals detected in surface and subsurface soils, around the perimeter of the IRA excavation. COCs were selected from these detected chemicals as explained in the Supplemental RFI/RI. The CMS evaluation presented below more fully develops and evaluates the Supplemental RFI/RI COCs to account for contaminant removal during the IRA as well as additional toxicity data.

The objectives of Supplemental RFI/RI HHRA were to estimate the actual or potential risks to human health resulting from the presence of contamination in each medium and to provide the basis of determining the need for remedial measures in the CMS. A summary of the Supplemental RFI/RI HHRA was provided in Section 2.5 of the CMS. All individual contaminants with an ICR greater than 1E-06 and/or a HI of more than 0.1 are retained as COCs for the CMS report. There are several contaminants that will not be retained and are as follows: delta-BHC, endosulfan sulfate, endrin ketone, and lead.

Delta-BHC, endosulfan sulfate, and endrin ketone were retained as COPCs in the Supplemental RFI/RI report because exposure risks were not estimated for each chemical. These chemicals did not have listed toxicity values for use in the quantitative risk assessment; therefore, no risks were estimated for exposure to these COPCs. These chemicals will not be retained as COCs for the CMS, because these chemicals generally had low frequencies of detection (i.e., generally less than 20 percent of the samples analyzed had detections) and low detected concentrations (as compared to other chemicals in the same class; e.g., pesticides). Lead will not be retained as a COC in the CMS based on the IEUBK Lead Model (v.0.99) results discussed in Section 2.5. The following COCs will be evaluated for soils in the CMS for SWMU 2:

- **Pesticides:** 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT
- **Inorganics:** Antimony and beryllium

The ERA also evaluated potential concerns associated with contamination in soil. A summary of the Supplemental RFI/RI ERA was provided in Section 2.6 of the CMS. Table 2-13 in Section 2.6 lists the ecological COCs presented in the ERA and includes SVOCs, VOCs, pesticides, and metals. Alpha-BHC, beta-BHC, delta-BHC, bis(2-ethylhexyl)pthalate, 2-butanone, and acetone were retained as ecological COCs in the Supplemental RFI/RI because no suitable benchmark values were available for these contaminants. However, the frequency of detection of alpha-BHC (2/36), beta-BHC (2/36), and delta BHC (2/36) were very low. Also, since the measured concentrations 1-2 µg/kg were well below a total BHC ecological threshold value of 100,000 µg/kg (EPA, 1995b), alpha-BHC, beta-BHC, and delta-BHC would not be expected to result in a ecological risk, and therefore, will not be retained as COCs in the CMS. Similarly, 2-butanone will not be retained as a COC because it was detected in only one soil location and at a low concentration (3 µg/kg). Acetone will not be retained as a COC because it was detected in two soil locations and at low concentrations (29-47 µg/kg). In addition, 2-butanone and acetone are relatively biodegradable and would not be expected to remain in the site medium for long. Bis(2-ethylhexyl)pthalate will not be retained as a COC based on a comparison of the detected values (200, 310 µg/kg) to a 70,000 µg/kg clean-up criteria used in a previous study (Richardson, 1987). Also, it should be noted that the values for bis(2-ethylhexyl)pthalate were less than the average background value of 471 µg/kg. As a result, the following chemicals will be retained as ecological COCs for soils in the CMS:

- **Pesticides:** 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and toxaphene
- **Inorganics:** Aluminum, antimony, beryllium, cyanide, and tin

In addition, the following chemicals will be retained as COC's for transport modeling for protection of sediment. The methodology and results of the transport modeling are presented in Appendix B.

- **Pesticides:** 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, aldrin, delta-BHC, endosulfin I, and endrin
- **Inorganics:** Aluminum, arsenic, beryllium, chromium, cyanide, silver, and tin

Also, the following chemicals will be retained as COCs for transport modelling for protection of surface water. The methodology and results of the transport modelling are presented in Appendix B.

- **Pesticides:** 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, aldrin, beta-BHL, and heptachlor
- **Inorganics:** Aluminum, arsenic, beryllium, chromium, cyanide, lead, silver, and tin

Sediment

Figures 2-9, 2-10, and 2-11 in Section 2.4 show chemicals detected in sediment before and after IRA. COCs were selected from these detected chemicals as explained in the Supplemental RFI/RI. The CMS evaluation presented below more fully develops and evaluates the Supplemental RFI/RI COCs to account for contaminant removal during the IRA as well as additional toxicity data.

A summary of the Supplemental RFI/RI HHRA was provided in Section 2.5 of the CMS. All individual contaminants with an ICR greater than 1E-06 and/or a HI of more than 0.1 will be retained as COCs for the CMS report. There are several contaminants that will not be retained and are as follows: delta-BHC and iron.

Delta-BHC was retained as a COPC in the Supplemental RFI/RI report because the exposure risk was not estimated for each chemical. Delta-BHC did not have a listed toxicity value for use in the quantitative risk assessment; therefore, no risk was estimated for exposure to this COPC. Delta-BHC will not be retained as a COC to human health for the CMS because it had a low frequency of detection (2/8) and was detected at a low concentrations (159-231 µg/kg), as compared to other chemicals in the same class (e.g., pesticides). Iron was the only inorganic compound selected as a COPC based on detected concentrations similar to background concentrations. Iron will not be retained as a COC for the CMS because of the high uncertainty associated with the reference oral dose and the uncertainty it might represent background concentrations, which would overestimate the risk. In addition, iron is a common mineral and essential nutrient to human health. The following contaminants of concern will be evaluated for sediments in the CMS for SWMU 2:

- **Pesticides:** 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT

The ERA evaluated risk associated with contamination in sediment at SWMU 2. Table 2-12 in Section 2.6 lists the ecological COCs presented in the Supplemental RFI/RI. The maximum concentrations of cadmium and zinc were not detected above their respective Effects Range-Median (ER-M) Sediment Guideline values, and therefore, will not be retained as ecological COCs for the CMS. 2-Butanone will not be retained as an ecological COC because it was detected in two soil locations and only one sediment location and all concentrations were significantly below the most restrictive screening criteria for either media. Bis(2-ethylhexyl)phthlate will not be retained as an ecological COC in the CMS because its single detected value (2,500 µg/kg) was less than the FDEP probable effects level of 2,647 µg/kg, and was orders of magnitude less than Hull and Suter's (1994) ecological threshold value of 892,000 µg/kg. It should also be noted that the value was only slightly higher than the average background value of 2,299 µg/kg. Bis(2-ethylhexyl)phthlate does not have an ER-M Sediment Guideline value, and therefore was evaluated against the most suitable sediment benchmark value. The following chemicals will be retained as ecological COCs for sediment in the CMS:

- **Pesticides:** 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, delta-BHC, endosulfan I, and endrin

Surface Water

Figure 2-12 in Section 2.4 shows contaminants detected in surface water which were based on surface-water samples collected prior to and within the area of excavation during the IRA. Only one surface-water sample was collected outside this area, for which only tin and antimony exceeded the ARAR/SAL. However, since contaminated soils and sediments remain, it is suspected that the surface waters have been impacted by soil and sediment contaminants. The CMS evaluation presented below more fully develops and evaluates the Supplemental RFI/RI COPCs to account for contaminant removal during the IRA as well as additional toxicity data.

A summary of the Supplemental RFI/RI HHRA was provided in Section 2.5 of the CMS. All individual contaminants with an ICR greater than 1E-06 and/or a HI of more than 0.1 will be retained as COCs for the CMS report. There are several contaminants that will not be retained and are as follows: beta-BHC, lead, and mercury.

Beta-BHC was selected as a COC in the Supplemental RFI/RI based on a very conservative comparison to Tap Water RBCs. Beta-BHC will not be retained as a surface-water COC for human health in the CMS based on an ICR less than 1E-06 and a HI less than 0.1. Lead will not be retained as a COC to human health in the CMS based on the IEUBK Lead Model (v.0.99) results discussed in Section 2.5. Mercury will not be retained as a COC in the CMS because it was detected in at a low concentration (0.095 µg/L) in only one surface-water location The following COCs will be evaluated for surface water in the CMS for SWMU 2:

- **Pesticides:** 4,4'-DDD and 4,4'-DDT

The ERA evaluated risk associated with contamination in surface water at SWMU 2. Table 2-6 in Section 2.6 lists the ecological COCs identified in the Supplemental RFI/RI. Aluminum will not be retained as an ecological COC because its maximum detected value (1,510 µg/L) only slightly exceeded the ecological threshold value (1,500 µg/L). Other aluminum concentrations in surface water were well below the ecological threshold value. Benzyl alcohol will not be retained as an ecological COC in surface water because it was detected in only one sample, and has not been detected at SWMU 2 since 1990. All other COCs shown in Table 2-6 will be retained as ecological COCs for surface water in the CMS, and consist of:

- **Pesticides:** 4,4'-DDD, 4,4'-DDT, beta-BHC, aldrin, and heptachlor
- **Inorganics:** Lead, silver, and tin

Groundwater

Figures 2-3, 2-4, and 2-5 in Section 2.4 show groundwater chemical concentrations for selected COCs in the Supplemental RFI/RI. COCs were selected from these detected contaminants as explained in the Supplemental RFI/RI. Although the groundwater is not a current drinking water source and is unlikely to be designated as one in the future, chemicals above the drinking water standards and ecological COCs were identified for fate and transport modeling. The predictive contaminant transport modeling was performed in order to evaluate and develop RGOs for groundwater to be protective of surface water and sediment. The development of sediment and surface-water RGOs through groundwater modeling is discussed further in Section 3.4, respectively. Following is a discussion of groundwater COCs resulting from the HHRA and ERA.

Groundwater was not evaluated as part of the baseline HHRA because it is classified as Class G-III, nonpotable water by the FDEP, as summarized in Section 2.5. The surficial aquifer is the principal aquifer of concern at NAS Key West due to the potential groundwater-to-surface-water contaminant migration pathway. Groundwater obtained from the surficial aquifer at Key West has a high salinity, unsuitable for drinking, as documented by a 1990 groundwater quality sampling study by the United States Geological Service (ABB, 1995a). The Monroe County Health Department recognizes the public water supply obtained from the mainland as the only potable water source available on Key West (B&R Environmental, 1997). Even though the groundwater is not used for potable waters, the groundwater concentrations at SWMU 2 were compared to Tap Water RBCs (EPA, 1996a) and MCLs (EPA, 1995a) for comparison purposes as presented in Tables 2-2 and 2-3 of Section 2.5.

The groundwater sampling conducted between 1990 to 1996 showed a decline in pesticide contamination at the 4,4'-DDT Mixing Area. In 1996, the most recent groundwater sampling effort, only two occurrences of 4,4'-DDD and 4,4'-DDT above the ARAR/SAL criteria were observed. The analytical results for both of these occurrences were at reduced levels from the maximum concentrations noted in previous investigations. Overall for SWMU 2, the pesticide analytical results tend to indicate a reduction in the levels of pesticide concentration in the groundwater. In addition, the IRA conducted in early 1996 removed the majority of pesticide contaminated soil considered to be the source of groundwater contamination. Most pesticides strongly adsorb to soil and sediment particles because of their relatively high soil/water partition coefficients. Therefore, pesticides maintain a low groundwater mobility.

The ERA evaluated risk associated with contamination in groundwater at SWMU 2. Table 2-5 in Section 2.6 lists the ecological COCs identified in the Supplemental RFI/RI. Since ecological receptors are not directly exposed to groundwater, it is assumed that any groundwater contaminant that is not an ecological COC in surface water or sediment is not an ecological concern. Potential ecological risks associated with groundwater contaminants will be reflected in the evaluation of the potential risks associated with surface water and sediment. The CMS will only retain groundwater COCs that are either ecological COCs for surface water or sediment. Aldrin, however, will not be retained as a final ecological COC since it was detected in only one of 11 groundwater samples. The following chemicals will be retained as ecological COCs for groundwater in the CMS to determine RGOs through modeling for transport to surface water and sediments:

- **Pesticides:** 4,4'-DDT, 4,4'-DDE 4,4'-DDD, and beta-BHC
- **Inorganics:** Lead and tin
- **VOCs:** Benzene and 1,2-DCE

3.3 REMEDIAL GOAL OPTIONS (RGOS)

RGOs are developed to ensure that contaminant concentration levels remaining at the site are at levels that are protective of human health and the environment. Human health RGO development calculations are included in Appendix A. RGOs are established to:

- Protect human receptors from adverse health effects
- Protect the environment from detrimental impacts from site-related contaminants
- Compliance with Federal and state ARARs

In order to evaluate and develop RGOs for soils which are protective of sediment and surface water, predictive contaminant transport modeling was performed. The following migratory pathways were modeled to determine RGOs for soil which are protective of various criteria in sediment and surface water:

- Surface-water protection from surface runoff based on maximum surface soil concentrations and the most restrictive surface-water criteria.

- Sediment protection from surface runoff based on maximum surface soil concentrations and sediment criteria.

The predictive contaminant transport modeling was also performed to evaluate and develop RGOs for groundwater which are protective of sediments and surface water based on the following criteria:

- Protection of surface water based on maximum groundwater concentrations and surface-water criteria.
- Protection of sediment based on maximum groundwater concentrations and sediment criteria.

The development of cross-media RGOs by using surface runoff and groundwater flow contaminant fate and transport models is presented in Appendix B.

3.3.1 Soil RGOs

Soil RGOs were determined for the COCs identified in Section 3.2. The soil RGOs were based on the following criteria:

- Protection of human health
- Protection of ecological receptors
- Protection of sediments
- Protection of surface water

3.3.1.1 Human Health Risk-Based RGOs

RGOs are developed for any receptor for which any individual contaminant has an ICRs greater 1E-06 and/or a HIs of more than 1.0 including all exposure pathways (considering all receptors, media, and routes of exposure). If the risk or hazard values approached these levels, then the scenarios were also included for initial consideration. For each scenario, individual chemicals which contributed at least 1E-06 to the ICR or 0.1 to the HI were selected. If the risk or hazard values approached these levels, the contributing chemicals were also included in the RGO calculations.

Site-specific RGOs accounted for all the exposure pathways and intake scenarios that were used in the baseline risk assessment. The RGOs were developed using the representative concentrations that were used in the Supplemental RFI/RI. However, in order to develop a range of potential RGOs, the representative concentration was proportioned to yield concentrations with a target risk equal to 1E-06, 1E-05, and 1E-04 excess cancer risks, or HIs of 0.1, 1.0, and 3.0. The calculated cancer and/or non-cancer risk values (ICR or HI) for each contributing route of exposure (ingestion, dermal, and inhalation) were added for each chemical selected and are presented in Appendix A. The following equation was then used to determine relevant RGOs:

RGO = (Exposure Concentration)(Desired Risk Level)/(Calculated Risk Value)

The exposure scenarios in which the risks exceeded an ICR of 1E-06 and/or a HI of 0.1 were for the future child/adult resident.

SWMU 2 is located within a restricted access area between an active taxiway and a runway. Only military personnel have access to this location and the site is not subject to any pedestrian traffic. Due to the restrictive site access, the human health pathway scenarios of the child/adult resident remain highly unlikely, as long as the installation is maintained as an active military base. Appendix A presents the RGO calculations for the pathway scenarios that exceeded the EPA ICR (1.0E-06) and/or HI (0.1). Table 3-2 presents the RGOs that would be protective (i.e., the most stringent) of all human exposure pathways of concern. Table 3-2 also includes the FDEP clean-up goals for an industrial exposure scenario for the human health COCs.

3.3.1.2 Ecological Risk-Based Soil RGOs

The ecological COCs for soil presented in Section 3.2.3 are retained because of the potential impacts to ecological receptors. The ecological RGOs for soil are presented in Table 3-2.

3.3.1.3 Soil RGOs for the Protection of Surface Water and Sediment

Modeling of contaminant migration from soil to the surface water and sediment via surface runoff was performed to determine the maximum concentration of contaminants in the soil that will be protective of surface water and sediment. To ensure protection of the surface water from soil migration, the most stringent SAL/ARAR presented in Table 2-5 of the Supplemental RFI/RI was used as an end point for the modeling (B&R Environmental, 1997).

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TABLE 3-2

SOIL RGOs
SWMU 2
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
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Chemical of Concern	Range of Detected Values	Remedial Goal Options[2]				
		Protection of Human Health[1]	Protection of Surface Water [4]	Protection of Sediment [5]	Protection of Ecological Receptors	FDEP Residential/ Industrial Soil Clean-up Goals[3]
INORGANICS (ug/kg):						
Aluminum	452,000 - 6,140,000	NA	126,000,000	NA	**600,000**[6]	75,000,000/ 1,000,000,000
Antimony	250 - 4,700	**2,999**[2]	NA	NA	NL	26,000/220,000
Arsenic	540 - 4,200	ND	58,000	3,920,000	60,000[6]	**800/3,700**
Beryllium	92 - 230	**131**	**112**	11,000	NL	**200/**1,000
Chromium (VI)	2,900 - 11,600	NA	53,000	20,720,000	**400**[6]	290,000/430,000
Cyanide	18,000	NA	**554**	**6,000**	**5**[7]	1,600,000/ 40,000,000
Lead	270-55,400	NA	84,670	NA	500,000	NA
Silver	150	NA	**107**	207,000	50,000	NA
Tin	710 - 6,200	NA	**73**	NA	**890**[7]	44,000,000/ 670,000,000
ORGANICS (ug/kg):						
4,4'-DDD	3.9 - 316	460	862	**180**	**100**[7]	4,500/17,000
4,4'-DDE	7 - 1,160	**340**	2,419	1,510	**100**[7]	3,000/11,000
4,4'-DDT	4.2 - 4,400	**320**	**32**	**2,580**	**100**[7]	3,100/12,000
Acetone	29 - 47	NA	NA	NA	NL	260,000/1,800,000
Aldrin	1	NA	19	2,240	100[7]	NA
Beta BHC	2	NA	10	NA	NL	NA
Delta BHC	1	NA	NA	170	NL	NA
Endosulfin I	1-2	NA	NA	160	100[7]	NA
Endrin	2-7	NA	NA	180	100[7]	NA
Heptachlor	6-16	NA	**1**	NA	100[7]	NA
Toxaphene	91 -343	NA	NA	NA	NL	900/3,000

TABLE 3-2

SOIL RGOs
SWMU 2
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
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(1) The protection of human health risk evaluation identified residential pathways with a cancer risk level > 1.0E-06. These levels will also be protective of other non-industrial receptors that are not residents.
(2) The protection of human health risk evaluation for antimony identified a residential pathway with hazard index > 0.1.
(3) FDEP Industrial Soil Clean-Up Goals (FDEP, 1996)
(4) Soil RGO for Surface Water Protection from Surface Runoff (Surface Water Criteria)
(5) Soil RGO for Sediment Protection from Surface Runoff (Sediment Criteria)
(6) Oak Ridge National Laboratory Benchmark Toxicity Value (Will and Suter, 1994)
(7) USEPA Region III Benchmark Toxicity Values (EPA, 1995b)
(8) A bold value indicates that the RGO is exceeded
NA Not Applicable
NL Not Listed

To be protective of the sediment from soil migration, the ER-M Sediment Value for specific contaminants was used as an endpoint value for the modeling . If an ER-M value was not available, the most stringent SAL/ARAR presented in Table 2-4 of the Supplemental RFI/RI was used (B&R Environmental, 1997). Since the ER-M is the median of sediment concentrations associated with the biological effects, the ER-M is the point above which adverse effects are expected to be frequent (Long et al. 1995). To be protective, concentrations above the ER-M should not be allowed. The use of the ER-M as a remediation goal means that this is the maximum allowable concentration; the average exposure concentration will necessarily be lower than the maximum. Its use creates a situation in which no concentration is in the range of frequent effects, and the average is in the range where effects are more likely not to occur.

Two surface runoff models were used for developing the surface soil to sediment and surface soil to surface-water RGOs protective of sediment and surface water. Assumptions, equations, and additional details used in developing the soil RGOs protective of sediment and surface water are included in Appendix B. Table 3-2 summarizes the RGOs for soil COCs.

3.3.2 <u>Sediment RGOs</u>

Sediment RGOs were determined for the COCs identified in Section 3.2. The sediment RGOs were based on the following criteria:

- Protection of human health
- Protection of ecological receptors

3.3.2.1 Human Health Risk-Based RGOs

Sediment RGOs were developed for any receptor for which any individual contaminant has an ICRs greater 1E-06 and/or a HIs of more than 1.0 including all exposure pathways (considering all receptors, media, and routes of exposure). If the risk or hazard values approached these levels, then the scenarios were also included for initial consideration. As described in Section 3.3.1.1 for soil RGOs, individual chemicals detected in sediment which contributed at least 1E-06 to the ICR or 0.1 to the HI were selected for each scenario. If the risk or hazard values approached these levels, the contributing chemicals were also included in the RGO calculations.

Site-specific RGOs accounted for all the exposure pathways and intake scenarios that were used in the baseline risk assessment. These RGOs were developed using the representative concentrations that were used in the Supplemental RFI/RI. However, in order to develop a range of potential RGOs, the representative concentration was proportioned to yield concentrations with a target risk equal to 1E-06, 1E-05, and 1E-04 excess cancer risks, or HIs of 0.1, 1.0, and 3.0. The calculated cancer and/or non-cancer risk values (ICR or HI) for each contributing route of exposure (ingestion, dermal, and inhalation) were added for each chemical selected and are presented in Appendix A.

Due to the restrictive site access, the human health pathway scenarios of the child/adult resident, adult trespasser, and adolescent trespasser remain highly unlikely for SWMU 2, as long as the installation is maintained as an active military base. The RGO calculations for the pathway scenarios that exceeded the EPA ICR (1.0E-06) and/or HI (0.1) are presented in Appendix A. Table 3-3 presents RGOs that would be protective (i.e., the most stringent) of all human exposure pathways of concern. This table does not include FDEP clean-up goals for industrial exposure scenario because these levels are not relevant to contaminated sediments.

3.3.2.2 Ecological Risk-Based RGOs

The ecological COCs for sediment presented in Section 3.2.3 are retained because of the potential impacts to ecological receptors. The ecological RGOs for sediment are presented in Table 3-3.

3.3.3 Surface Water RGOs

Surface Water RGOs were determined for the COCs identified in Section 3.2. The surface water RGOs were based on the following criteria:

- Protection of human health
- Protection of ecological receptors

3.3.3.1 Human Health Risk-Based RGOs

Due to the restrictive site access, the human health pathway scenarios of the child/adult resident, adult trespasser, and adolescent trespasser remain highly unlikely for SWMU 2, as long as the installation is maintained as an active military base. The RGO calculations for the pathway scenarios that exceeded the EPA ICR (1.0E-06) and/or HI (0.1) are presented in Appendix A. Table 3-4 presents RGOs that would be protective (i.e., the most stringent) of all human exposure pathways of concern. This table does not include RGOs for industrial worker protection because the exposure pathway is not relevant.

TABLE 3-3

SUMMARY OF SEDIMENT RGOs
SWMU 2
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical of Concern	Sediment Sample Results	Remediation Goal Options[1]	
	Range of Detected Values	ER-M[2][4]	Protection of Human Health[3]
INORGANICS (µg/kg):			
Arsenic	720 - 1,500	70,000	NA
Cadmium	440 - 1,900	9,600	NA
Lead	12,800 - 31,700	218,000	NA
Zinc	33,300 - 170,000	410,000	NA
ORGANICS (µg/kg):			
4,4'-DDD	440 - 17,200	**46**	**1,610**
4,4'-DDE	170 - 4,640	**27**	**1,140**
4,4'-DDT	16 - 14,800	**46**	**1,130**
Delta BHC	150 - 231	NA	NA
Endosulfan I	359	NA	NA
Endrin	244	NA	NA

1. A bold indicates the RGO has been exceeded.
2. Effects Range - Median (Long et. al., 1995; Long and Morgan, 1991)
3. The protection of human health risk evaluation identified pathways with a risk level > 1.0E-06.
4. The most conservative of effects range - low values (Long et al., 1995 and Morgan, 1991) and threshold effects levels (FDEP, 1994) were used as ecological screening criteria.

TABLE 3-4

SUMMARY OF SURFACE-WATER RGOs
SWMU 2
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical of Concern	Surface Water Sample Results	Remedial Goal Options[11]	
	Range of Detected Values	Protection of Ecological Receptors	Protection of Human Health[1]
INORGANICS (ug/L):			
Lead	53.6	**5.6 [6]**	NA
Silver	6.8 - 8.2	**0.012**	NA
Tin	10	**0.01 [6]**	NA
ORGANICS (ug/L):			
4,4'- DDD	0.24 - 1.45	**0.025 [6]**	**0.063**
4,4'- DDT	0.33	**0.001[9]**	**0.023/0.12[2]**
Aldrin	0.11	**NA**	NA
Beta-BHC	0.15	**1,400[10]**	NA
Heptachlor	0.064	**0.00021[10]**	**0.053**

1. Protection of human health risk evaluation identified the child/adult residential pathway with a risk > 1.0E-06.
2. The protection of human health risk evaluation for 4,4'-DDT identified the child/adult residential pathway with a hazard index >0.1.
3. Protection of human health risk evaluation identified the adolescent trespasser pathway with a risk > 1.0E-06.
4. The protection of human health risk evaluation for 4,4'-DDT identified the adolescent trespasser pathway with a hazard index >0.1.
5. Protection of human health risk evaluation identified the adult trespasser pathway with a risk > 1.0E-06.
6. Florida Department of Environmental Protection Surface Water Quality Criteria (FDEP, 1995a)
7. National Ambient Water Quality Standards
8. USEPA Region III Marine Standards (EPA, 1995b)
9. 40 CFR Part 264 Proposed RCRA Action Levels for Water
10. USEPA Region IV Chronic Surface Water Screening Values (EPA, 1995c)
11. A bold value indicates that the RGO has been exceeded.

HH Human Health
NL Not Listed
NA Not Applicable

3.3.3.2 Ecological Risk-Based RGOs

The ecological COCs for surface water presented in Section 3.2.3 are retained because of the potential impacts to ecological receptors. The ecological RGOs for surface water are presented in Table 3-4.

3.3.4 Groundwater RGOs Protective of Surface Water and Sediment

Groundwater RGOs were determined for the groundwater COCs identified in Section 3.2 Modeling of contaminant migration from the groundwater to the surface water was performed to determine the maximum concentration of contaminants in the groundwater that will be protective of surface water. To ensure protection of the surface water from the groundwater, the most stringent SAL/ARAR presented in Table 2-5 of the Supplemental RFI/RI was used as an endpoint concentration (B&R Environmental, 1997).

To be protective of the sediment from groundwater, the ER-M Sediment Value for specific contaminants was used as an endpoint concentration. If an ER-M value was not available, the most stringent SAL/ARAR presented in Table 2-4 of the Supplemental RFI/RI was used (B&R Environmental, 1997). Since the ER-M is the median of sediment concentrations associated with the biological effedts, the ER-M is the point above which adverse effects are expected to be frequent (Long et al. 1995). To be protective, concentrations above the ER-M should not be allowed. The use of the ER-M as a remediation goal means that this is the maximum allowable concentration; the average exposure concentration will necessarily be lower than the maximum. Its use creates a situation in which no concentration is in the range of frequent effects, and the average is in the range where effects are more likely not to occur.

Assumptions, equations, and additional details used in developing the groundwater RGOs protective of sediment and surface water are included in Appendix B. Table 3-5 summarizes the RGOs for surface water and sediment COCs.

The groundwater RGOs indicate that the current groundwater concentrations at SWMU 2 are substantially below the groundwater RGOs. The current maximum detected groundwater concentrations from 1996 for 4,4'-DDD, 4,4'-DDT, and thallium (i.e., the only chemicals detected during the confirmation sampling round) are 12.7, 4.8, and 11.7 µg/L respectively (Figure 2-5). Also, the developed groundwater RGOs of some chemicals which exhibit a highly immobile nature in the groundwater (i.e., groundwater RGO >1.0E+09 µg/L) will not reach the exposure point in the predictable time frame and will result in a corresponding RGO concentration of 100% (pure product). Therefore, the groundwater concentrations under the source area are not at levels that will adversely impact the surface water or sediment at the downgradient receptor (i.e., lagoon) in the foreseeable future. The mechanisms/processes affecting

TABLE 3-5

GROUNDWATER RGOs (µg/L)
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

COCs	Groundwater Sample Results	Remedial Goal Options(1)	
	Range of Detected Values	Protection of Surface Water	Protection of Sediment
Lead	2.5-5.4	>1.0E+09	>1.0E+09
Tin	48.4-81.9	>1.0E+09	NA
4,4'-DDT	0.16-30	>1.0E+09	>1.0E+09
4,4'-DDE	0.044-22	>1.0E+09	>1.0E+09
4,4'-DDD	0.76-56	>1.0E+09	>1.0E+09
Beta-BHC	0.054-5	15,200	16,200
Benzene	56-107.5	801	5,480
1,2-DCE (total)	3.5-1,500	4,070	NA

(1) NA indicates that no criteria is available for this COC.

chemical fate and transport in groundwater that were accounted for during the modeling include sorption, dilution, advection, dispersion,and chemical/biological decay.

3.4 CORRECTIVE ACTION OBJECTIVES

Site-specific CAOs specify COCs, media of interest, exposure pathways, and clean-up goals or acceptable contaminant concentrations. CAOs may be developed to permit consideration of a range of treatment and containment alternatives. This CMS addresses soil, sediment, and surface-water contamination within SWMU 2. To protect the public from potential current and future health risks, as well as to protect the environment, the following CAOs have been developed for SWMU 2 soil, sediment, and surface water to address the primary exposure pathways:

- Prevent human and ecological receptors from contacting contaminants in the soil, sediment, and surface water at concentrations which would result in adverse effects.
- Prevent the migration of surface soil contaminants to the drainage ditch via runoff and subsequent migration to surface water and sediment.
- Compliance at SWMU 2 with contaminant-specific, location-specific, and action-specific Federal and state ARARs

The RGOs that would attain these objectives have been discussed in Section 3.3.

3.5 VOLUMES OF CONTAMINATED MEDIA

The volumes of contaminated surface soil, surface water, and sediment were estimated based on a comparison of the RGOs and CAOs defined in Sections 3.3 and 3.4 respectively, using standard engineering practice. The values and assumptions used in estimating the volumes of contaminated media are presented in this section.

3.5.1 Contaminated Soil

Estimates of contaminated soil volumes have been presented for two scenarios: (1) protection of all human and ecological receptors and (2) protection of industrial workers only. Because of the high groundwater table and reported variations in soil depths, with bedrock encountered from at the surface to a depth of 4 ft, a depth of 1 ft was used to calculate the volume of contaminated surface soil for the area north of the ditch, a depth of 2 ft was used for the area west of the ditch, and a depth of 2.5 ft was used for the area south of the ditch. Figure 3-1 presents the estimated aerial extent of contaminated soil based on two criteria. The larger area is for soil contamination in excess of the RGOs which are based on impact to sediment and surface water and at SWMU 2. The smaller area of excavation is based on exceedances of FDEP Industrial RGOs. This volume estimate is somewhat conservative for costing purposes in this CMS and will require additional testing to refine the estimate of the extent of contamination.

Excavation Position	Estimated Area (ft^2)	Depth of Excavation	Volume of Soil (ft^3)	Volume of Soil (yd^3)
North	46,000	1.0	46,000	1,700
West	9,000	2.0	18,000	700
South	21,000	2.5	52,500	2,000
Total	76,000	-	116,500	4,400

The total estimated aerial extent of soil contaminated in excess of all non-industrial RGOs presented in the table above is approximately 76,000 square feet (ft^2) with an estimated volume of soil contaminated of 116,500 cubic feet (ft^3) or 4,400 yd^3.

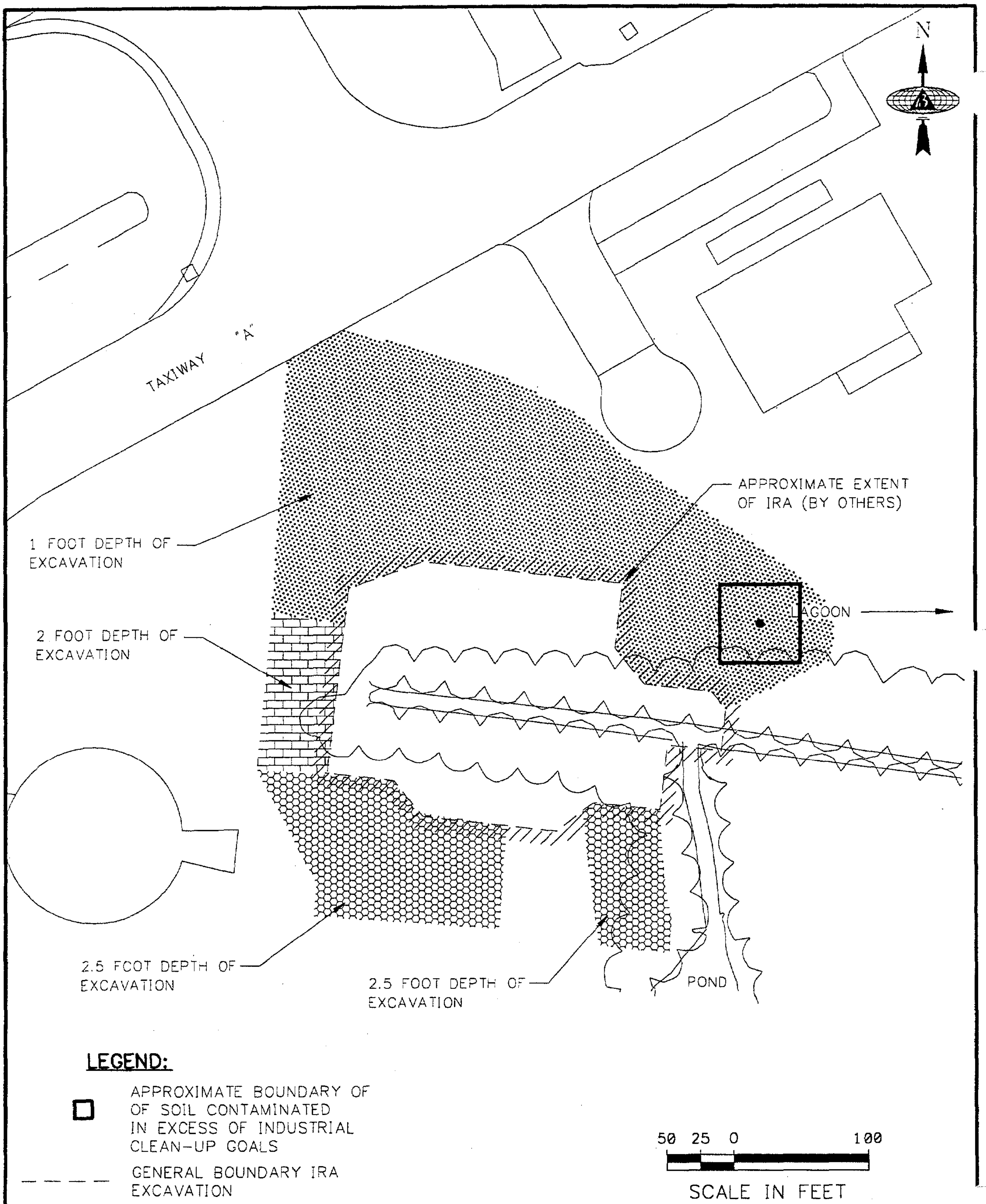
However, only one sample (one of 13), located north of the ditch, exceeds the FDEP Industrial RGOs presented in Table 3-2. The total estimated excavation area for these locations is 3,600 ft^2 (1 - 60' square excavation) with an estimated volume of soil contaminated in excess of the RGOs of 3,600 ft^3 or 140 yd^3. This volume estimate will be used for costing purposes in this CMS and will require additional sampling to refine the estimate of the extent of contamination.

3.5.2 Contaminated Surface Water

The entire volume of standing water present in the ditch was assumed to be contaminated at levels exceeding RGOs. The volume of contaminated surface water (approximately 237,000 gal) was estimated by dividing the ditch into three sections as shown in Figure 3-2 :

- West - ditch from headwall to the intersection of ditch from pond (255 ft long).
- East - ditch from intersection of ditch from pond to lagoon (270 ft long).
- South - ditch from pond to intersection with main ditch (135 ft long).

The water level in the ditch is under tidal influence and may fluctuate. It has been reported that the water is 3 to 4 ft deep throughout the ditch. The width of the ditch was reported to be 12 ft by the RFI/RI Report. The area of the ditch was calculated by multiplying the lengths for each segment by the width (approximately 12 ft). These areas were multiplied by 2 ft and by 4 ft, a conservative estimate which takes into account the probable tidal influences.



SITE MANAGER: KW	CHECKED BY: BER	Brown & Root Environmental	FIGURE 3-1
DRAWN BY: TAD	DRAWING DATE: 1/13/98		AREAL EXTENT OF CONTAMINATED SOIL
SURVEYED BY:	SURVEY DATE:		NAVAL AIR STATION KEY WEST BOCA CHICA KEY, FLORIDA
SCALE: 1" = 100'			
CAD DWG. NO.: 7046PM01	PROJ. NO.: 7046		

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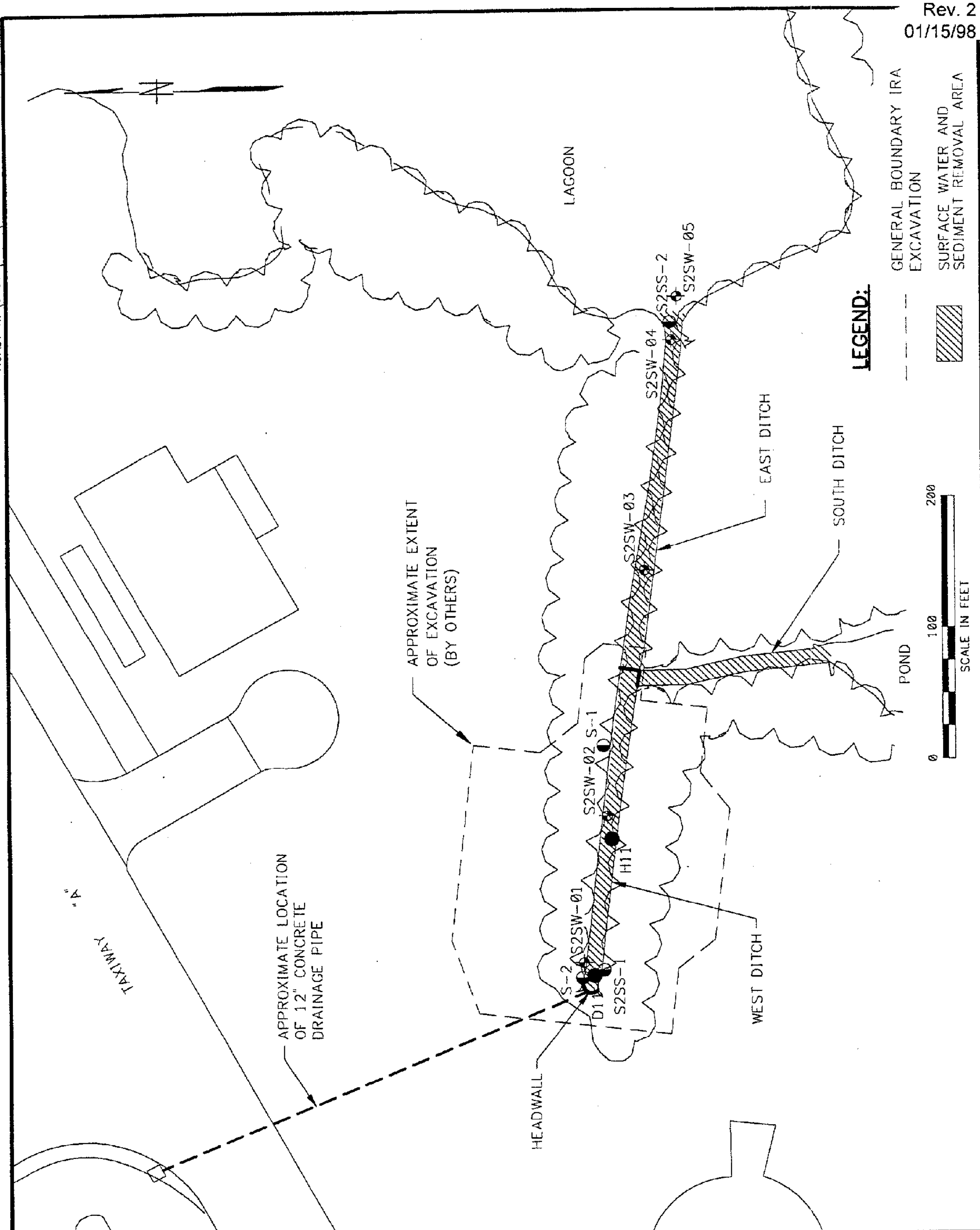

DRAWN BY HJP DATE 2/10/97	Brown & Root, Inc.	CONTRACT NO. HK7046	OWNER NO.
CHECKED BY DATE	SURFACE-WATER AND SEDIMENT LOCATIONS – SWMU 2 NAVAL AIR STATION KEY WEST BOCA CHICA KEY, FLORIDA	APPROVED BY	DATE
COST/SCHED-AREA		APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. FIGURE 3-2	REV. 0

The total volume of contaminated surface water in the ditch is estimated to be between 15,800 ft^3 and 31,600 ft^3 or 118,000 gallons to 237,000 gallons depending on the depth of the water. The table below depicts the calculations conducted for contaminated sediment.

Ditch	Length (ft)	Width (ft)	Area (ft^2)	Water volume using depth of 2 ft (ft^3/gallons)	Water volume using depth of 4 ft (ft^3/gallons)
West	255	12	3,060	6,100 / 45,650	12,200 / 91,300
East	270	12	3,240	6,500 / 48,650	13,000 / 97,300
South	135	12	1,620	3,200 / 23,700	6,400 / 47,400
Total	-	-	7,920	15,800 / 118,000	31,600 / 237,000

3.5.3 Contaminated Sediment

The entire area of sediment in the ditch was assumed to be contaminated at levels exceeding RGOs. The volume of contaminated sediment (approximately 470 yd^3) was estimated by dividing the ditch into three sections as shown in Figure 3-2:

- West - ditch from headwall to the intersection of ditch from pond (255 ft long).
- East - ditch from intersection of ditch from pond to lagoon (270 ft long).
- South - ditch from pond to intersection with main ditch (135 ft long).

Figure 3-3 depicts a typical cross-sectional view of the ditch. The sediment in the ditch was reported to be one to two feet deep in the Supplemental RFI/RI Report and the Bechtel Environmental, Inc. Sampling Delineation Report (BEI, 1995). The Supplemental RFI/RI also reported the ditch to be approximately 12 ft wide. The area of the sediment in the ditches was calculated by multiplying the lengths for each segment by the width (12 ft). These areas were multiplied by a depth to estimate volume. The east and south ditch areas were multiplied by the reported maximum depth of 2 ft to obtain a conservative estimate of sediment in each section of the ditch. The sediment in the west section was removed to bedrock during the IRA, however it is assumed that partial resedimentation through redistribution of the contaminated sediment in the other ditch segments has occurred. The west section was multiplied by 1 ft to account for this resedimentation. The table below depicts the calculations conducted for contaminated sediment.

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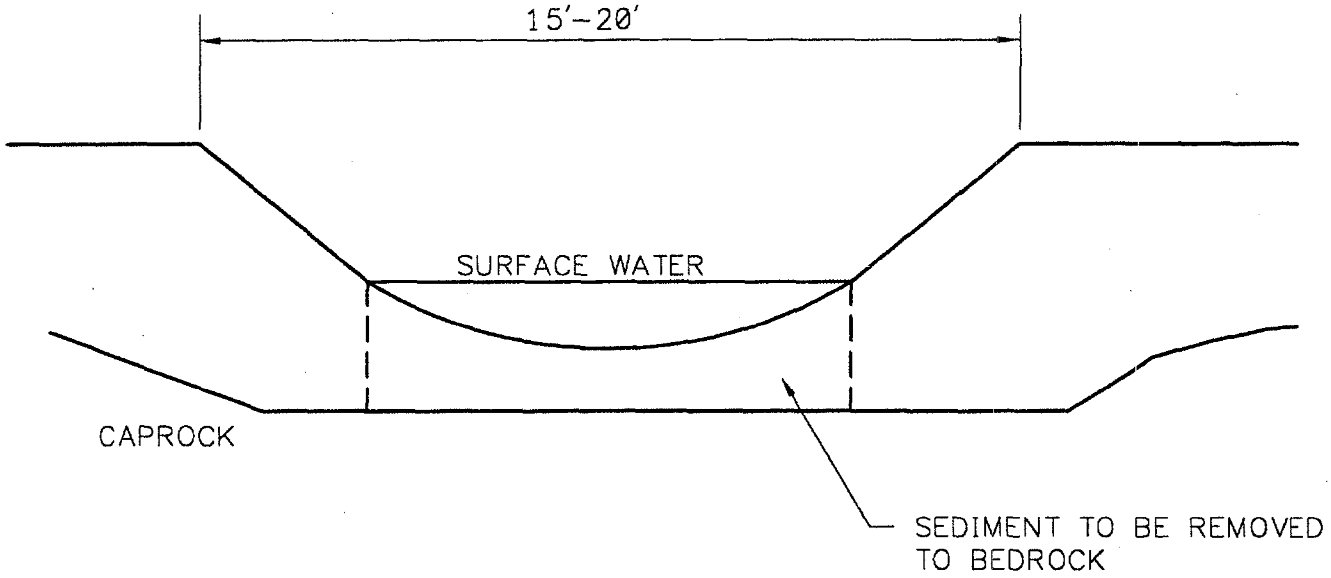


DRAWN BY HJP	DATE 2/10/97	Brown & Root, Inc.	CONTRACT NO. HK7046	OWNER NO.
CHECKED BY	DATE	TYPICAL CROSS–SECTION OF DRAINAGE DITCH – SWMU 2 NAVAL AIR STATION KEY WEST BOCA CHICA KEY, FLORIDA	APPROVED BY	DATE
COST/SCHED–AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. FIGURE 3–3	REV. 0

Ditch Segment	Length (ft)	Width (ft)	Area (ft^2)	Depth of sediment (ft)	Volume of sediment (ft^3)	Volume of sediment (yd^3)
West	255	12	3,060	1.0	3,060	110
East	270	12	3,240	2.0	6,480	240
South	135	12	1,620	2.0	3,240	120
Total	660	-	7,920	-	12,780	470

The total volume of contaminated sediment in the ditch was estimated to be 12,780 ft^3 or 473 yd^3. This volume is somewhat conservative for costing purposes in this CMS and will require additional testing to refine the actual extent of contamination.

4.0 IDENTIFICATION, SCREENING, AND DEVELOPMENT OF CORRECTIVE MEASURE ALTERNATIVES

4.1 INTRODUCTION

This section presents the identification, screening, and development of the corrective measure alternatives formulated to achieve the CAOs for SWMU 2. Section 3.0 presented the underlying basis for the initial identification and screening of the corrective measure technologies and included the following:

- Identification of ARARs.
- Development of CAOs and media-specific RGOs.
- Identification of volumes of contaminated media based on the RGOs.

The identification and screening of corrective measure technologies, and the development of corrective measure alternatives are based upon the information presented in Section 3.0 and involve the following activities:

- Identification of corrective measure technologies and applicable process options.
- Screening of potential corrective measure technologies and applicable process options.
- Development of corrective measure alternatives by assembling applicable technologies into alternatives that have the potential to achieve the defined CAOs.

4.2 IDENTIFICATION AND SCREENING OF CORRECTIVE MEASURE TECHNOLOGIES AND PROCESS OPTIONS

This section identifies and screens the corrective measure technologies and process options that may be used to achieve the CAOs for SWMU 2. This process was based on the review of current literature, vendor information, and previous experience in developing alternatives for sites with similar media-specific concerns and releases.

Corrective measure technologies and process options can be grouped according to general response actions. Corrective measure alternatives are then formulated by combining general response actions to completely address the CAOs. When implemented, the corrective measure alternative should be capable of achieving the CAOs, with the exception of the No Action Alternative. The categories of general response actions that could be implemented to achieve or address the CAOs for SWMU 2 include:

- No Action
- Institutional Controls
- Containment
- Removal
- Treatment
- Disposal

Each of the general response actions are discussed below (Section 4.2.1 through 4.2.6). Corrective measure technologies and process options for each of the general response actions which are potentially applicable to SWMU 2 are identified and screened in Tables 4-1, 4-2, and 4-3 for soil, sediment, and surface water, respectively. The criteria used for screening the technologies and process options are discussed in Section 4.2.7.

4.2.1 No Action

No Action is a general response action wherein the status quo is maintained at the site. No Action is normally retained to provide a baseline for comparison with other alternatives. No additional activities would be conducted at the site to address remaining contamination. There are no implementability concerns, because the contaminated media are considered to be left "as is". Institutional controls, containment, removal, treatment, or other mitigating actions are not provided to reduce the potential for exposure.

4.2.2 Institutional Controls

Access controls (e.g., physical barriers) and/or site development restrictions in the NAS Key West Master Plan are institutional control options that may be considered for implementation to reduce or eliminate pathways of exposure to hazardous substances at the site. Controls could involve the use of groundwater monitoring networks and/or groundwater use restrictions and educational programs. The application of institutional controls alone does not reduce the volume, mobility, or toxicity of the contaminants. Site development restrictions would be implemented in accordance with CNBJAXINST 5090.2N4 (U.S. Navy, 1997). This instruction has been provided as Appendix D.

4.2.3 Containment

Containment involves the application of physical measures to reduce the potential for contaminant migration and thereby reduce the risk to the public and the environment. The contaminated media must be isolated from the primary transport mechanisms (i.e., wind, erosion, surface water, and

TABLE 4-1
PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR SOILS
CORRECTIVE MEASURES STUDY
SWMU 2, BOCA CHICA DDT MIXING AREA
NAVAL AIR STATION KEY WEST, BOCA KEY, FLORIDA
PAGE 1 OF 4

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
			GENERAL RESPONSE ACTION: NO ACTION	
No Action	No Action	No activities proposed at SWMU 2 to address contamination	Retained as baseline for comparison.	Yes
			GENERAL RESPONSE ACTION: INSTITUTIONAL CONTROLS	
Institutional Controls (1)	Limited Site Access	Physical barrier used to restrict access to the site.	Only effective in preventing direct contact regarding human exposure. Does not reduce contaminant exposure to ecological receptors.	Yes
	Site Development Restrictions	Administrative action used to restrict future site use as documented in the NAS Key West Master Plan.	Administrative action is used to prevent direct contact regarding human exposure. Does not reduce contaminant exposure to ecological receptors.	Yes
	Monitoring	Sampling and analysis of environmental media to assess contaminant migration and future environmental impacts.	Effective only to assess contaminant levels on-site and migration off-site. Can be used to determine if conditions are changing in order to indicate the need for further corrective measures.	Yes
	Educational Programs	Educate public concerning site hazards.	Helps to inform the public concerning possible site hazards. However, does not reduce the exposure potential for human or ecological receptors. Information for risks can be provided at Restoration Advisory Board meetings.	Yes
			GENERAL RESPONSE ACTION: CONTAINMENT	
Soil Cover	Native Soil	Layer of native soil is placed over site to prevent direct contact and ingestion and migration to surface water.	Not effective in reducing toxicity of contaminants, but will provide a barrier for primary exposure pathways. Long-term monitoring and maintenance would be required. Would not reduce the mobility of contaminants or leaching of contaminants to groundwater.	Yes
Capping	Clay Cap/Synthetic Membrane/ Asphalt/ Concrete	Use of impermeable or semipermeable materials constructed over the site to provide a barrier to water infiltration and also prevent direct contact with and ingestion of chemicals, as well as migration to surface water.	Not effective in reducing toxicity of contaminants, but will provide a barrier for primary exposure pathways. Long-term monitoring and maintenance would be required. Would not reduce the leaching of contaminants to groundwater, since groundwater table elevations are shallow at SWMU 2 (1.0 to 2.5 feet bgs).	Yes
Vertical Barrier	Slurry Wall (2,3,4)	Soil/bentonite or soil/cement barriers are installed around waste area to isolate waste materials. This low permeable barrier restricts contaminant migration.	Not compatible with site hydrogeology. At SWMU 2, bedrock is shallow (1 to 2.5 feet bgs) with unrestricted groundwater flow to a depth of several hundred feet.	No
	Sheet Piling (2,3)	Use of barrier sheets driven into the subsurface to mitigate groundwater migration or to provide shoring/erosion control during excavation.	Not compatible with site hydrogeology. At SWMU 2, bedrock is shallow (1 to 2.5 feet bgs) with unrestricted groundwater flow to a depth of several hundred feet.	No
Horizontal Barrier	Grout Injection (2,3,5,6)	Pressure injection of cement at depth through closely spaced drill holes to prevent contaminant migration into groundwater.	Not compatible with site hydrogeology. At SWMU 2, bedrock is shallow (1 to 2.5 feet bgs) with unrestricted groundwater flow to a depth of several hundred feet.	No
			GENERAL RESPONSE ACTION: REMOVAL	
Bulk Excavation	Bulk Excavation (2,4)	Mechanical removal of solid materials using common construction equipment such as bulldozers and highlifts.	Effective in removing contaminated soils. Used in combination with ex situ or off-site treatment or disposal.	Yes

TABLE 4-1
PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR SOILS
CORRECTIVE MEASURES STUDY
SWMU 2, BOCA CHICA DDT MIXING AREA
NAVAL AIR STATION KEY WEST, BOCA CHICA KEY, FLORIDA

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
		GENERAL RESPONSE ACTION: EX SITU TREATMENT		
Thermal	Onsite Incineration (4,5,7)	Soil is excavated and treated by a mobile or on-site incinerator that employs thermal decomposition via thermal oxidation at high temperature to destroy organics.	Technology is not cost effective for the quantities of contaminated soil at SWMU 2. The quantities of soil to be treated are too small to justify the cost of mobilizing an incineration unit. In addition, incineration of RCRA waste would require empirical tests (trial burns) to demonstrate compliance and receive permits to operate.	No
	Offsite Incineration (4,5,7)	Excavated soil is transported to a licensed incinerator, which has applicable local, state, and Federal permits, that thermally destroys organics in a direct fire unit.	Widely used option for treatment of organic wastes. Organic destruction and removal efficiencies for properly operated incinerators are greater than 99.99 percent. However, most inorganics remain in soil and may require further treatment. Permitted facilities are available.	Yes
	Vitrification (4)	Excavated soil is melted at high temperature to form a glass and crystalline structure with very low leaching characteristics and destroys organics.	Technology is not cost effective nor practical for the concentrations and volume of contaminants.	No
	Low-Temperature Thermal Desorption (4)	Application of heat at relatively low temperature to remove organics from excavated soil by volatilization. Vapor phase, typically is treated by incineration or carbon adsorption.	Full-scale technology has been proven successful for remediating VOCs and DDT residuals. However, most inorganics remain in the soil and may require further treatment.	No
Physical/ Chemical	Soil Washing/ Solvent Extraction (4,8)	Separation of contaminants from a medium by contact with a liquid with a higher affinity for the COCs. Converts organic and inorganic contaminants to a more concentrated or less toxic form.	Questionable effectiveness for treating complex wastes (i.e., pesticides and inorganics). Extensive wastewater treatment would be required. Would not offer an advantage over other proven technologies.	No
	Supercritical Extraction (6)	Extraction of organics using gases at a certain temperature and pressure (critical point) such that their solvent properties are greatly altered.	Not a proven technology for pesticides. Ineffective for inorganic COCs. Would not offer an advantage over other proven technologies.	No
	Stabilization/ Solidification (2,4)	Excavated soil is mixed with cement lime, fly ash, or other pozzolanic materials to form a cement-like or soil-like product. Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions between stabilizing agent and contaminants to reduce their mobility (stabilization).	Limited effectiveness for pesticides; however, contaminant concentrations may be low enough that effectiveness would not be a concern. Onsite disposal of solidified mass is not recommended due to the site hydrology. The groundwater table is close to the surface and groundwater infiltration can significantly affect the integrity of the solidified mass.	Yes

TABLE 4-1
PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR SOILS
CORRECTIVE MEASURES STUDY
SWMU 2, BOCA CHICA DDT MIXING AREA
NAVAL AIR STATION KEY WEST, BOCA CHICA KEY, FLORIDA
PAGE 3 OF 4

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
		GENERAL RESPONSE ACTION: EX SITU TREATMENT		
Physical/ Chemical (Continued)	Chemical Oxidation [3,4,5]	Oxidation chemical reactions are used to reduce toxicity or transform the contaminant to a compound that is more stable, less mobile, and/or inert. Commonly used oxidizing agents include ozone, chlorine, and hydrogen peroxide.	Ineffective for site COCs (e.g., pesticides). Would not offer an advantage over other more implementable technologies.	No
Biological	Landfarming [4]	Controlled application of contaminated soil, nutrients, and microbes to land area that is tilled.	Questionable effectiveness for pesticides. Ineffective for inorganics.	No
		GENERAL RESPONSE ACTION: IN SITU TREATMENT		
Thermal	Vitrification [4,6]	Electrodes for applying electricity are used to melt contaminated soil, producing a glass and crystalline structure with very low leaching characteristics and destroys organics.	Technology is not cost effective nor practical for a site where groundwater is at a shallow depth.	No
Physical/ Chemical	Soil Flushing [4,8]	Soil contaminants are extracted with water or other suitable aqueous solutions. Extraction fluid passes through in-place soils using an injection or infiltration process. Contaminants are leached into the groundwater, which are then removed via extraction wells.	Although effective in removing a wide range of organic and inorganic contaminants from coarse-grained soil, there is the potential for uncontrolled migration of contaminants to groundwater. Also, the technology is not as cost-effective as compared to other technologies because of complex treatment train is required for washing fluid.	No
	Soil Vapor Extraction [4]	Vacuum is applied through extraction wells to create a pressure/concentration gradient that induces gas-phase volatiles to diffuse through soil to extraction wells.	Ineffective for pesticides and inorganics.	No
	Solidification/ Stabilization [2,3,4]	Process where cement, lime, or other pozzolanic materials are mixed with soil in the vadose zone to immobilize contaminants.	Solidified/stabilized material would be in contact with groundwater and would compromise the integrity of the solidified mass.	No
Biological	Biodegradation [4,9]	By circulating water-based nutrient solutions through contaminated soils, enhance naturally occurring microbes biological degrading of organic contaminants.	Technology is not effective for treatment of inorganics. Questionable effectiveness for pesticides.	No

TABLE 4-1
PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR SOILS
CORRECTIVE MEASURES STUDY
SWMU 2, BOCA CHICA DDT MIXING AREA
NAVAL AIR STATION KEY WEST, BOCA CHICA KEY, FLORIDA

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
			GENERAL RESPONSE ACTION: DISPOSAL	
Landfill	On-site Landfill (3,7)	Soil is excavated and characterized as required by land disposal restrictions. Hazardous wastes are treated to meet either RCRA or non-RCRA treatment standards prior to land disposal. Soil is then disposed of in a secure, on-site, RCRA-permitted facility.	Pesticide concentrations present at SWMU 2 exceed Federal land disposal restrictions. There is no approved disposal facility currently on-site.	No
	Off-site Landfill (3,4,7)	Soil is excavated and characterized as required by land disposal restrictions. Hazardous wastes are treated to meet either RCRA or non-RCRA treatment standards prior to land disposal. Soil is then disposed of in a secure, off-site, RCRA-permitted facility.	RCRA land disposal restrictions may limit wastes eligibility for disposal without treatment. Widely used and easily implemented technology.	Yes

(1) United States Environmental Protection Agency. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, October 1988.
(2) Rogosnewski, P., Bryson H., and Wagner, K., 1995. JRB Associates, Inc. for the U.S. EPA. Remedial Action Technology for Waste Disposal Sites, Noyes Data Corporation.
(3) Corbitt, Robert A. Standard Handbook of Environmental Engineering, McGraw-Hill Publishing Company, 1990.
(4) United States Department of Defense Environmental Technology Transfer Committee. Remediation Technologies Screening Matrix and Reference Guide, Second Edition, October 1994.
(5) Kiang, Yen-Hsiung and Metry, Amir A. Hazardous Waste Processing Technology, Butterworth Publishers, 1982.
(6) EM Database, January 1995. US Department of Energy Office of Environmental Management Information Posted on The Internet, January 19, 1995.
(7) Dillon, A.P. Pesticide Disposal and Detoxification, Noyes Data Corporation, 1981.
(8) ATTIC (Alternative Treatment Technology Information Center), November 1991. EPA/600/M-91/049, US Environmental Protection Agency.
(9) Matsumura, Fumio and Murti, C.R. Biodegradation of Pesticides, Plenum Press New York, 1982.

TABLE 4-2
PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR SEDIMENT
CORRECTIVE MEASURES STUDY FOR SWMU 2 - BOCA CHICA DDT MIXING AREA
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 1 OF 4

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
		GENERAL RESPONSE ACTION: NO ACTION		
No Action	No Action	No activities proposed at a site to address contamination.	Retained as baseline for comparison.	Yes
		GENERAL RESPONSE ACTION: INSTITUTIONAL CONTROLS		
Institutional Controls (1)	Limited Site Access	Physical barrier used to restrict access to the site.	Only effective in preventing direct contact regarding human exposure. Does not reduce contaminant exposure to ecological receptors.	Yes
	Site Development Restrictions	Administrative action used to restrict future site use as documented in the NAS Key West Master Plan.	Administrative action is used to prevent direct contact regarding human exposure. Does not reduce contaminant exposure to ecological receptors.	Yes
	Monitoring	Sampling and analysis of environmental media to assess contaminant migration and future environmental impacts.	Effective only to assess contaminant levels on-site and migration off-site. Can be used to determine if conditions are changing in order to indicate the need for further corrective measures.	Yes
	Educational Programs	Educate public concerning site hazards.	Helps to inform the public concerning possible site hazards. However, does not reduce the exposure potential for human or ecological receptors. Information for risks can be provided at Restoration Advisory Board meetings.	Yes
		GENERAL RESPONSE ACTION: CONTAINMENT		
Sediment Control Barrier	Cofferdam (2)	Emplacement of a low-permeability barrier to restrict groundwater migration into and/or out of a known area of sediment contamination.	Well-established construction technique to reduce downstream sediment transport and turbidity during remediation. This technology was used to isolate sediment in drainage ditch during the IRA.	Yes
	Bank Revetment (2,3)	Permanent or temporary sloping of banks and/or protecting the banks with stone rip rap or vegetation to stabilize slopes.	Would reduce impact to protect off-site habitat from possible contamination by sediment-laden runoff.	Yes
		GENERAL RESPONSE ACTION: REMOVAL		
Bulk Excavation	Bulk Excavation (2,4)	Mechanical removal of solid materials using common construction equipment such as bulldozers and highlifts.	Effective in removing contaminated sediment in combination with coffer dams. Used in combination with ex situ or off-site treatment or disposal.	Yes
Dredging	Dredging (2)	Use of mechanical, hydraulic, or pneumatic dredge to remove sediments or saturated soils.	Effective in removing contaminated sediments. Maximizes solids concentrations of removed sediments.	Yes

TABLE 4-2
PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR SEDIMENT
CORRECTIVE MEASURES STUDY
SWMU 2, BOCA CHICA DDT MIXING AREA
NAVAL AIR STATION KEY WEST, BOCA CHICA KEY, FLORIDA
PAGE 2 OF 4

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
		GENERAL RESPONSE ACTION: EX SITU TREATMENT		
Thermal	On-site Incineration (4,5,7)	Sediment is excavated and treated by a mobile or on-site incinerator that employs thermal decomposition via thermal oxidation at high temperature to destroy organics.	Technology is not cost effective for the quantities of contaminated sediment at SWMU 2. The quantities of sediment to be treated are too small to justify the cost of mobilizing an incineration unit. In addition, incineration of RCRA waste would require empirical tests (trial burns) to demonstrate compliance and receive permits to operate. Requires dewatering of sediment prior to treatment.	No
	Off-site Incineration (4,5,7)	Excavated sediment is transported to a licensed incinerator, which has applicable local, state, and Federal permits, that thermally destroys organics in a direct fire unit.	Widely used option for treatment of organic wastes. Organic destruction and removal efficiencies for properly operated incinerators are greater than 99.99 percent. However, most inorganics remain in sediment and may require further treatment. Permitted facilities are available. Requires dewatering of sediment prior to treatment.	Yes
	Vitrification (4)	Excavated soil is melted at high temperature to form a glass and crystalline structure with very low leaching characteristics and destroys organics.	Technology is not cost effective nor practical for the concentrations and volume of contaminants. Requires dewatering of sediment prior to treatment.	No
	Low-Temperature Thermal Desorption (4)	Application of heat at relatively low temperature to remove organics from excavated soil by volatilization. Vapor phase, typically is treated by incineration or carbon adsorption.	Full-scale technology has been proven successful for remediating VOCs and DDT residuals. However, VOCs are not COCs and most inorganics remain in the sediment and may require further treatment. Technology is not cost effective for very small quantities of contaminated material. Requires dewatering of sediment prior to treatment.	No
Physical/ Chemical	Dewatering (2,3)	Mechanical removal of free water from sediment using equipment such as a filter press or a vacuum filter for subsequent treatment. Passive, gravity-aided draining on a stockpile can also be performed.	Reduces the amount of moisture content in sediment for subsequent treatment and/or disposal. Treatment of removed or drained water is required. A drainage pad can be used for dewatering prior to treatment processes to reduce the volume of removed sediment. Sediments can be stockpiled in a manner to allow draining into the ditch.	Yes
	Stabilization/ Solidification (2,4)	Excavated soil is mixed with cement lime, fly ash, or other pozzolanic materials are mixed with excavated sediment to immobilize contaminants.	Limited effectiveness for pesticides; however, contaminant concentrations may be low enough that effectiveness would not be a concern. Onsite disposal of solidified mass is not recommended due to the site hydrology. The groundwater table is close to the surface and groundwater infiltration can significantly affect the integrity of the solidified mass.	Yes
	Chemical Oxidation (3,4,5)	Oxidation chemical reactions are used to reduce toxicity or transform the contaminant to a compound that is more stable, less mobile, and/or inert. Commonly used oxidizing agents include ozone, chlorine, and hydrogen peroxide.	Ineffective for inorganics. Would not offer an advantage over other more implementable technologies.	No

TABLE 4-2
PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR SEDIMENT
CORRECTIVE MEASURES STUDY
SWMU 2, BOCA CHICA DDT MIXING AREA
NAVAL AIR STATION KEY WEST, BOCA CHICA KEY, FLORIDA
PAGE 3 OF 4

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
		GENERAL RESPONSE ACTION: EX SITU TREATMENT		
Physical/ Chemical (Continued)	Soil Washing/ Solvent Extraction (4)	Separating hazardous contaminants from sediments by using an organic chemical as a solvent, therby reducing the volume of the hazardous waste.	Questionable effectiveness for treating complex wastes (i.e., pesticides and inorganics). Extensive wastewater treatment would be required.	No
Biological	Landfarming (4)	Contaminated sediments are applied onto a soil surface and periodically turned over or tilled into the soil to achieve aerobic conditions to promote biological degradation of the contaminants.	Questionable effectiveness for pesticides. Ineffective for inorganics.	No
		GENERAL RESPONSE ACTION: IN SITU TREATMENT		
Thermal	Vitrification (4,6)	Electrodes for applying electricity are used to melt contaminated soil, producing a glass and crystalline structure with very low leaching characteristics and destroys organics.	Not applicable to treatement of sediment.	No
Physical/ Chemical	Stabilization/ Solidification (2)(4)	Pressure injection or mechanical mixing of cement/pozzolanic materials to form an impermeable solid and immobilize contaminants.	Solidified/stabilized mass would be in contact with groundwater. Groundwater would compromise the integrity of the solidified mass.	No
		GENERAL RESPONSE ACTION: DISPOSAL		
Landfill	On-site Landfill (3,7)	Excavated sediment is characterized as required by land disposal restrictions. Hazardous wastes are treated to meet either RCRA or non-RCRA treatment standards prior to land disposal in a secure, on-site, RCRA-permitted facility.	Pesticide concentrations present at SWMU 2 exceed federal land disposal restrictions. There is no approved disposal facility currently on-site.	No
	Off-site Landfill (3,4,7)	Excavated sediment is characterized as required by land disposal restrictions. Hazardous wastes are treated to meet either RCRA or non-RCRA treatment standards prior to land disposal in a secure, off-site, RCRA-permitted facility.	RCRA land disposal restrictions may limit wastes eligibility for disposal without treatment. Widely used and easily implemented technology.	Yes

(1) United States Environmental Protection Agency. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, October 1988.
(2) Rogosnewski, P., Bryson H., and Wagner, K., JRB Associates, Inc. for the U.S. EPA. Remedial Action Technology for Waste Disposal Sites, Noyes Data Corporation.
(3) Corbitt, Robert A. Standard Handbook of Environmental Engineering, McGraw-Hill Publishing Company, 1990.
(4) United States Department of Defense Environmental Technology Transfer Committee. Remediation Technologies Screening Matrix and Reference Guide, Second Edition, October 1994.

TABLE 4-2
PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR SEDIMENT
CORRECTIVE MEASURES STUDY
SWMU 2, BOCA CHICA DDT MIXING AREA
NAVAL AIR STATION KEY WEST, BOCA CHICA KEY, FLORIDA

(5) Kiang, Yen-Hsiung and Metry, Amir A. Hazardous Waste Processing Technology, Butterworth Publishers, 1982.

(6) EM Database, January 1995. US Department of Energy Office of Environmental Management Information Posted on The Internet, January 19, 1995.

(7) Dillon, A.P. Pesticide Disposal and Detoxification, Noyes Data Corporation, 1981.

TABLE 4-3
PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR SURFACE WATER
CORRECTIVE MEASURES STUDY
SWMU 2, BOCA CHICA DDT MIXING AREA
NAVAL AIR STATION KEY WEST, BOCA KEY, FLORIDA
PAGE 1 OF 3

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
			GENERAL RESPONSE ACTION: NO ACTION	
No Action	No Action	No activities proposed at a site to address contamination.	Retained as baseline for comparison.	Yes
			GENERAL RESPONSE ACTION: INSTITUTIONAL CONTROLS	
Institutional Controls [1]	Limited Site Access	Physical barrier used to restrict access to the site.	Only effective in preventing direct contact regarding human exposure. Does not reduce contaminant exposure to ecological receptors.	Yes
	Site Development Restrictions	Administrative action used to restrict future site use as documented in the NAS Key West Master Plan.	Administrative action is used to prevent direct contact regarding human exposure. Does not reduce contaminant exposure to ecological receptors.	Yes
	Monitoring	Sampling and analysis of environmental media to assess contaminant migration and future environmental impacts.	Effective only to assess contaminant levels on-site and migration off-site. Can be used to determine if conditions are changing in order to indicate the need for further corrective measures.	Yes
	Educational Programs	Educate public concerning site hazards.	Helps to inform the public concerning possible site hazards. However, does not reduce the exposure potential for human or ecological receptors. Information for risks can be provided at Restoration Advisory Board meetings.	Yes
			GENERAL RESPONSE ACTION: CONTAINMENT	
Surface Water Controls	Grading [2,3]	Reshape existing topography and drainage patterns in order to manage infiltration and runoff, including erosion control.	Economical method of controlling infiltration, diverting runoff, and minimizing erosion. Potential design option after excavation and disposal of solids.	Yes
	Bank Revetment [2,3]	Permanent or temporary diversion and collection measures are used to control run-on and runoff and to reduce erosion. The slopes of the channels can be stabilized by stone rip rap or vegetation.	Protects off-site habitat from possible contamination by sediment-laden runoff. Potential design option after excavation and disposal.	Yes
			GENERAL RESPONSE ACTION: EX SITE TREATMENT	
Chemical	Precipitation [3,4,5]	Chemical precipitation involves the formation of a solid phase, usually particulate matter suspended in a liquid phase containing the pollutant to be removed. Process generates a sludge requiring collection, treatment, and disposal.	Proven method in treating metals contaminated waters. However, contaminant levels are relatively low and may not require precipitation.	Yes
	Ion Exchange [3,4]	Process in which ions, held by electrostatic forces to charged functional groups on the ion exchange resin surface, are exchanged for ions of similar charge in a water stream.	Not applicable to the primary chemicals of concern. Other more conventional technologies are more applicable for treatment of site surface water. In addition, high cost for minimal level of contamination in surface water.	No

TABLE 4-3
PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR SURFACE WATER
CORRECTIVE MEASURES STUDY
SWMU 2, BOCA CHICA DDT MIXING AREA
NAVAL AIR STATION KEY WEST, BOCA CHICA KEY, FLORIDA

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
		GENERAL RESPONSE ACTION: EX SITE TREATMENT		
Chemical (Continued)	Neutralization (3,5)	Neutralization is the simple application of the law of mass balance. Excess acidity or alkalinity is neutralized to bring about an acceptable pH by adding sulfuric or hydrochloric acids to basic solutions and caustic or lime to acidic solutions.	Neutralization is not required for effective treatment of surface water.	No
	Enhanced Oxidation (4,6,7)	Use of strong oxidizers, such as ultraviolet light, ozone, peroxide, chlorine, or permanganate, to chemically oxidize materials.	Not proven to be effective for pesticides. In addition, costs are higher than competing technologies.	No
	Reduction (3,5)	Use of strong reducers, such as sulfur dioxide, sulfite, or ferrous iron, to chemically reduce the oxidation state of materials. Reduction may be used as pretreatment for removal of inorganics, if required.	Technology is not applicable to the chemicals of concern.	No
	Coagulation (3,4,7)	The chemical process in which small particles of color, turbidity, and microscopic organisms are turned into larger flocs, either precipitates or suspended solids. The flocs are conditioned to be readily removed in subsequent processes.	Well-known treatment technology for removal of toxic metals and pretreatment of other metals. Process can produce a significant volume of sludge which requires further treatment. Often used in combination with flocculation, precipitation, and filtration.	Yes
Physical	Flocculation (3,4,5,7)	The mechanical process after coagulation in which particles are brought into contact so that they will collide, stick together, and grow to a size that will readily settle.	Well-known technology for removal of toxic metals and pretreatment of other metals. Process can produce a significant volume of sludge which requires further treatment. Often used in combination with coagulation, precipitation, and filtration.	Yes
	Filtration (3,4,5,7	Solids separation from water via entrapment in natural and/or synthetic porous media.	Reduces contaminant levels of particulate metals and organic compounds that are bound to suspended solids. Not effective in removing dissolved contaminants. Filters can be used prior to other treatment to remove suspended solids.	Yes
	Adsorption (3,4,5,7)	Adsorption of contaminants onto activated carbon, resins, or activated alumina.	Removal efficiencies can be high for pesticides, depending on system operating parameters. It is a well-proven and reliable technology that is particularly effective as a polishing step after other remedial technologies. Spent carbon would have to be regenerated or disposed in a hazardous waste facility.	Yes
	Volatilization (4,7)	Contact of contaminated water with air to remove volatile compounds. Air stripping or steam stripping methods are typically employed.	Although a well-proven and reliable technology effective in removing VOCs from contaminated water, this technology does not remove pesticides nor inorganics.	No

TABLE 4-3
PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR SURFACE WATER
CORRECTIVE MEASURES STUDY
SWMU 2, BOCA CHICA DDT MIXING AREA
NAVAL AIR STATION KEY WEST, BOCA CHICA KEY, FLORIDA

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
		GENERAL RESPONSE ACTION: EX SITE TREATMENT		
Biological	Aerobic (3,4,7)	Suspended growth or fixed film process employing aeration and biomass recycling to decompose organic contaminants.	Although a well-developed technology that has been used in treatment of municipal wastewater; this technology has not been proven to treat DDT/pesticides. Not effective for inorganics. Other physical treatment methods are more reliable.	No
	Anaerobic (3,4)	Suspended growth or fixed film process employing anaerobic biomass to decompose organic contaminants.	Although a well-developed technology that has been used in treatment of municipal wastewater; this technology has not been proven to treat DDT/pesticides. Not effective for inorganics. Other physical treatment methods are more reliable.	No
		GENERAL RESPONSE ACTION: DISPOSAL		
Discharge	Wastewater Treatment Facility	Disposal of extracted surface water to the base treatment facility. Surface water would require transport by means of a force main, gravity sewer, or transport truck.	NAS Key West wastewater treatment plant does not have the capabilities to handle pesticide contaminated wastewater. (8)	No
	Surface Discharge	Discharge of treated surface water to local surface-water location. This option would require a permitted outfall and means of transporting surface water to the discharge point	Permits are required from the state. Surface-water discharge could be a viable option for treatment and direct disposal.	Yes

(1) United States Environmental Protection Agency. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, October 1988.

(2) Rogosnewski, P., Bryson H., and Wagner, K., JRB Associates, Inc. for the U.S. EPA. Remedial Action Technology for Waste Disposal Sites, Noyes Data Corporation.

(3) Corbitt, Robert A. Standard Handbook of Environmental Engineering, McGraw-Hill Publishing Company, 1990.

(4) United States Department of Defense Environmental Technology Transfer Committee. Remediation Technologies Screening Matrix and Reference Guide, Second Edition, October 1994.

(5) Kiang, Yen-Hsiung and Metry, Amir A. Hazardous Waste Processing Technology, Butterworth Publishers, 1982.

(6) EM Database, January 1995. US Department of Energy Office of Environmental Management Information Posted on The Internet, January 19, 1995.

(7) DOE ReOpt (Remedial Options, Version 2.1), 1991 - 1993, Pacific N.W. Laboratory, operated by Batelle Memorial Institute, sponsored by the U.S. Department of Energy (DOE).

(8) Telecon between Stavros Patselas, Brown & Root Environmental, and Scott Rigowski, NASKW Public Works, on January 7, 1997.

groundwater) to reduce the migration of contaminants. Contaminated media are isolated by the installation of surface and subsurface barriers that either block or divert any transport media from the contaminants.

4.2.4 Removal

Removal action is a general response action wherein technologies are used to move contaminated media from its present location in order to be treated and/or disposed of elsewhere. Treatment and/or disposal process options can be combined with removal process options to develop alternatives.

4.2.5 Treatment

The treatment response action, including both in situ and ex situ treatment process options, includes physical, chemical, biological, solidification or thermal processes designed to reduce the mobility, toxicity, and/or volume of the contaminants present. Treatment can be used with removal and disposal process options to develop alternatives.

4.2.6 Disposal

Disposal technologies include placement of removed or treated materials in an on-site or an off-site permanent disposal facility. Removal options and possibly treatment options can be used with disposal process options to develop alternatives. The toxicity, mobility, or volume of the contaminants is not reduced through the singular application of disposal. This response action would reduce or eliminate exposure pathways related to direct human contact with contaminated material.

4.2.7 Screening Criteria for Corrective Measure Technologies and Process Options

Corrective measure technologies and process options are screened to eliminate those that are not feasible to implement, that rely on technologies unlikely to perform satisfactorily or reliably, or that do not achieve the CAOs within a reasonable time. The corrective measure technologies and process options are also eliminated based on SWMU 2 site-specific and waste-specific conditions.

The screening process focuses on eliminating those technologies and process options that have severe limitations for a given set of waste-specific and site-specific conditions. The screening step also eliminates technologies and process options based on inherent technology limitations. Site, waste, and technology characteristics that were used as screening criteria are described below. Tables 4-1, 4-2, and 4-3 provide the identification and screening of technologies and process options for soil, sediment, and surface water, respectively. Tables 4-4, 4-5, and 4-6 provide a summary of retained technologies for soil, sediment, and surface water, respectively.

4.2.7.1 Site Characteristics

Site characteristics include an evaluation of RGOs for SWMU 2 or contaminant concentrations to identify site conditions that may limit or advocate the use of certain technologies. Technologies and process options are evaluated for their applicability and limitations to site conditions, including compatibility with site hydrogeology or soils.

4.2.7.2 Waste Characteristics

Waste characteristics may limit the effectiveness or feasibility of technologies. Technologies and process options are evaluated for their applicability and limitations to the waste characteristics at the site, including contaminant type and concentrations and contaminated media.

4.2.7.3 Technology Limitations

Technology limitations include the level of technology development, performance record, and inherent construction, operation, and maintenance problems. Technologies and process options are evaluated based on their reliability, performance, and provenness.

4.3 IDENTIFICATION OF CORRECTIVE MEASURE ALTERNATIVES FOR SWMU 2

This section describes the development of the corrective measure alternatives for SWMU 2 considering the information provided in the previous sections. Additional site-specific information and assumptions are provided in this section to further explain the alternative development process. In addition, alternatives are briefly described in this section. A detailed description and analysis of alternatives is provided in Section 5.0.

Prior to the IRA, SWMU 2 was contaminated with various pesticides and inorganics (metals). The IRA was conducted at SWMU 2 in the Spring 1996 and included the excavation and disposal of the majority of the contaminated soil and sediment (approximately 2,500 tons). Low concentration soil contamination (pesticides and inorganics) still exists at the site and is dispersed around the perimeter of the area excavated during the IRA. Sediment and surface-water contamination (pesticides and inorganics) still exist in the ditch segments east and south of the area excavated and in the location that was underneath the cofferdams used to isolate the portion of the drainage ditch addressed as part of the IRA.

TABLE 4-4
SUMMARY OF RETAINED TECHNOLOGIES FOR SOILS
CORRECTIVE MEASURES STUDY
SWMU 2, BOCA CHICA DDT MIXING AREA
NAVAL AIR STATION KEY WEST, BOCA KEY, FLORIDA

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION
No Action	No Action	No Action
Institutional Controls	Institutional Controls	Limited Site Access
		Site Development Restrictions
		Monitoring
		Educational Programs
Containment	Soil Cover	Native Soil
	Capping	Clay Cap/Synthetic Membrane/Asphalt/Concrete
Removal	Bulk Excavation	Bulk Excavation
Ex Situ Treatment	Thermal	Off-site Incineration
	Physical/Chemical	Stabilization/Solidification
Disposal	Landfill	Off-site Landfill

TABLE 4-5
SUMMARY OF RETAINED TECHNOLOGIES FOR SEDIMENT
CORRECTIVE MEASURES STUDY
SWMU 2, BOCA CHICA DDT MIXING AREA
NAVAL AIR STATION KEY WEST, BOCA KEY, FLORIDA

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION
No Action	No Action	No Action
Institutional Controls	Institutional Controls	Limited Site Access
		Site Development Restrictions
		Monitoring
		Educational Programs
Containment	Sediment Control Barrier	Cofferdam
		Bank Revetment
Removal	Bulk Excavation	Bulk Excavation
		Dredging
Ex Situ Treatment	Thermal	Off-site Incineration
	Physical/Chemical	Stabilization/ Solidification
		Dewatering
Disposal	Landfill	Off-site Landfill

TABLE 4-6
SUMMARY OF RETAINED TECHNOLOGIES FOR SURFACE WATER
CORRECTIVE MEASURES STUDY
SWMU 2, BOCA CHICA DDT MIXING AREA
NAVAL AIR STATION KEY WEST, BOCA KEY, FLORIDA

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION
No Action	No Action	No Action
Institutional Controls	Institutional Controls	Limited Site Access
		Site Development Restrictions
		Monitoring
		Educational Programs
Containment	Surface-Water Controls	Grading
		Bank Revetment
Ex Situ Treatment	Chemical	Precipitation
		Coagulation
	Physical	Flocculation
		Filtration
		Adsorpton
Disposal	Discharge	Surface Discharge

Although groundwater at SWMU 2 contains several chemicals at concentrations above background, groundwater is not considered as a primary media of concern because it is not a current or potential drinking water source. The surficial aquifer is classified by Florida as Type G-III (nonpotable). Also, ecological receptors are not directly exposed to groundwater. Potential ecological risks associated with groundwater contaminants were reflected in the evaluation of the potential risks associated with surface water and sediment. Therefore, corrective measure technologies were not identified for groundwater. Groundwater was evaluated by predictive modeling to determine if there are any adverse impacts to surface water and sediment. For this effort, RGOs were developed for groundwater to be protective of surface water and sediment. Current groundwater conditions are substantially below the groundwater RGOs. Residual contaminants in groundwater would be addressed through soil, sediment, and surface-water corrective measure alternatives.

Alternatives were developed that address the COCs and exposure pathways for each of the three media in order to achieve the CAOs. Although all human health risks were considered acceptable (ICR within the range of 1E-06 to 1E-04 and HI less than 1.0), alternatives were developed to provide a range of corrective measure alternatives to address all contaminants that could potentially affect ecological receptors.

Based on the results of the risk assessment in the Supplemental RFI/RI, there are several assumptions which were used in developing these alternatives:

- Removed sediment would be initially dewatered and then managed in the same manner as soil. If excavated soil receives treatment, then excavated sediments would receive the same treatment, or vice versa.

- Removal of any sediment from the drainage ditch would include sampling and possible treatment of the surface water from the drainage ditch.

- Collected surface water would have to be treated to meet NPDES requirements prior to discharge.

- Groundwater at the Florida Keys is classified as nonpotable by the state. Therefore, no corrective measures for low level groundwater contamination at SWMU 2 are proposed.

- SWMU 2 is located within a restricted access area between an active taxiway and a runway. Only military personnel have access to this location and the site is not subject to any pedestrian traffic.

Because of the restrictive site access, residential exposure to contaminants at SWMU 2 is highly unlikely as long as the installation is maintained as an active military base.

The following alternatives have been developed for SWMU 2:

1. No Action
2. Limited Action (Institutional Controls)
3. Remove, Treat, and Dispose of Soils Contaminated at Concentrations Greater than Industrial RGOs and Sediment Contaminated at Concentrations Greater Than ER-M Sediment Guideline Values; Treat Associated Surface Waters
4. Remove, Treat, and Dispose of Contaminated Soil and Sediment at Concentrations Greater Than the Most Stringent Soil and Sediment RGOs; Treat Associated Surface Water

Note that containment of soils (i.e., soil cover or capping) was not developed as a corrective measure alternative. Because the groundwater table is shallow, contaminated soil is in contact with groundwater, and the majority of contaminated soil has already been removed (as part of the IRA), containment would not provide a significant increase in protection of human health and the environment over institutional controls. Therefore, evaluation of no action, institutional controls, and soil removal was considered to provide a sufficient range of corrective measure alternatives for SWMU 2.

A brief description of each alternative is provided in Sections 4.3.1 through 4.3.4.

4.3.1 Alternative 1 - No Action

The No Action alternative maintains the site at status quo. This alternative is retained to provide a baseline for comparison to other alternatives and therefore, does not address the remaining contamination of the soils, sediment, surface water, and groundwater. There would be no reduction in toxicity, mobility, or volume of the contaminants from treatment at SWMU 2 other than that which would result from natural dispersion, dilution, or other attenuating factors. Existing remedial activities, monitoring programs, and institutional controls would be discontinued, and the property would be available for unrestricted use.

4.3.2 Alternative 2 - Limited Action: Institutional Controls

This alternative consists of one major component, institutional controls (i.e., limited site access, monitoring, site development restrictions, and educational programs). Limited site access would be imposed to eliminate or reduce the pathways of human exposure to contaminants at the site. In addition, surface-water, groundwater, sediment sampling (quarterly for the first year and annually for the next nine years) and biennial (every two years) biomonitoring would be conducted. This sampling and biomonitoring would be performed based on state and Federal regulations and would measure changes in ecological impact resulting from the IRA. Site development restrictions would be implemented as stipulated in CNBJAXINST 5090.2N4 (U.S. Navy, 1997) and appropriate changes would be made to the NAS Key West Master Plan. Educational programs would inform the public concerning site hazards. A reevaluation of the site would be performed every 5 years to determine if any changes to the controls would be required.

4.3.3 Alternative 3 - Remove, Treat, and Dispose of Soil Contaminated at Concentrations Greater than FDEP RGOs and Sediment Contaminated at Concentrations Greater than ER-M Sediment Guideline Values; Treat Associated Surface Water

This alternative consists of five major components: (1) removal of contaminated soil, (2) removal of contaminated sediment, (3) transport of contaminated soils and sediments for off-site treatment and/or disposal , (4) treatment of associated surface waters; and (5) institutional controls. Alternative 3 would remove soils contaminated at concentrations in excess of industrial standards and all the contaminated sediment from the ditch and thereby reduce exposure to ecological receptors.

Approximately 140 yd^3 of contaminated soil in excess of FDEP Industrial RGOs would be excavated from one hot-spot outside the perimeter of the IRA. A predesign study would be conducted to survey original surface elevations, determine any potential wetlands impact, and calculate the area and volume of the excavation. Confirmation sampling would be conducted to ensure that the removal of contaminated soil in excess of FDEP Industrial RGOs has been completed. The excavated soils would be stockpiled within the limits of the excavation until sediments are removed and dewatered. Then soils and sediment would be managed as one media.

Cofferdams would be installed at the ends of the drainage ditches (where ditches enter/exit the pond and lagoon) to prevent contaminated surface-water migration from the ditch area. The ditch would be divided into four sections to enable a phased approach for the handling of the large volume of water and excavation of sediment. Cofferdams would be installed at the ends of the section prior to sediment excavation. Excavated sediment would be stockpiled on plastic sheeting to allow excess water to drain back into the ditch and dry. Approximately 470 yd^3 of contaminated sediment would be excavated from the entire ditch. Sediment that cannot be removed by the excavator would be dredged to bedrock. The dredged sediments would also be stockpiled on plastic sheeting to drain back into the ditch and air dry to be handled as soil. Sediment would be removed from the 12-inch drainage pipe extending northwest of the west end of the ditch to a catch basin. The type of cofferdam used (e.g., water-filled or steel plate) would be determined during remedial design.

Approximately 237,000 gallons of surface water in the entire ditch could be contaminated with pesticides, especially during excavation. Surface-water samples would be collected a minimum of 24 hours after sediment removal and prior to the removal of the cofferdams. Samples would be submitted to a laboratory for quick (24 to 48 hour) turnaround analysis for pesticides. If the laboratory results are under NPDES requirements, then the surface water would not be treated. Contaminated surface water would be treated on-site using carbon adsorption units with a bag prefilter for suspended solids.

Prior to starting the treatment of the surface water, measurements of the ditch section (width and depth) and water levels would be taken at three locations to calculate actual surface-water treatment volume. As performed during the IRA, a pump would be used to circulate water from the ditch through a carbon treatment system. The suction line would be placed in one end of the ditch section and the discharge would be placed in the opposite. The system would be operated at 50 gallons per minute (gpm) until four times the calculated volume of water in the ditch segment has been pumped through it (approximately 80 hours per segment). After the required volume of water has been pumped through the system the surface water would be sampled again for pesticides. Treatment of the surface water would continue until the clean-up goals (under NPDES requirements) have been reached; then the cofferdams would be removed.

Stockpiled soils and sediments would be transported to an off-site RCRA permitted TSDF for treatment, if required, and disposal. Treatment and disposal options include incineration, stabilization/solidification, and landfill.

Institutional controls (i.e., limited site access, monitoring, site development restrictions, and educational programs) would be established to eliminate or reduce pathways of exposure to contaminants at the site. Limited site access would be imposed to eliminate or reduce the pathways of human exposure to contaminants at the site. Monitoring would be conducted to verify that residual contaminants do not pose unacceptable risks. Surface-water, sediment, and groundwater sampling would be conducted quarterly for the first year and annually thereafter and biennial (every two years) biomonitoring would be conducted. This sampling would be performed based on state and Federal regulations and to measure decreases in the ecological impact. Site development restrictions added to the NAS Key West Master Plan in accordance with CNBJAXINST 5090.2N4 (U.S. Navy, 1997) would implement administrative actions to restrict future site use. Educational programs would inform the public concerning site hazards. A reevaluation of the site would be performed every 5 years to determine if any changes to the controls would be required.

4.3.4 Alternative 4 - Remove, Treat, and Dispose of Contaminated Soil and Sediment at Concentrations Greater Than the Most Stringent Soil and Sediment RGOs; Treat Associated Surface Water

This alternative consists of five major components: (1) soil removal, (2) sediment removal, (3) on-site surface water removal, treatment, and discharge, (4) transport of contaminated soils and sediments for off-site treatment and disposal (5) institutional controls. Alternative 4 addresses all soil and sediment above the most stringent soil and sediment RGOs, and thereby eliminates potential exposure to human and ecological receptors.

Approximately 4,400 yd^3 of contaminated soil would be excavated outside the perimeter of the IRA excavation to remove the remaining sediment and surface-water contamination source. A predesign study would be conducted to survey original surface elevations, determine any potential wetlands impact, and calculate the area and volume of the excavation. Confirmation sampling would be conducted to ensure that the removal of pesticide contaminated soil has been completed. The excavated soils would be stockpiled until sediments are removed and dewatered. Then soil and sediment would be managed as one media.

Cofferdams would be installed at the ends of the drainage ditches (where ditches enter/exit the pond and lagoon) to prevent contaminated surface-water migration from the ditch area. The ditch would be divided into four sections to enable a phased approach for the handling of the large volume of water and excavation of sediment. Cofferdams would be installed at the ends of the section prior to sediment excavation. Excavated sediment would be stockpiled on plastic sheeting to allow excess water to drain back into the ditch and dry. Approximately 470 yd^3 of contaminated sediment would be excavated from the entire ditch. Sediment that cannot be removed by the excavator would be dredged to bedrock. The dredged sediments would also be stockpiled on plastic sheeting to drain back into the ditch and air dry. After drying, the sediment would be handled as soil. Sediment would be removed from the 12-inch drainage pipe extending northwest of the west end of the ditch to a catch basin. The type of cofferdam used (e.g., water-filled or steel plate) would be determined during remedial design.

Approximately 237,000 gallons of surface water in the entire ditch could be contaminated with pesticides. Surface-water samples would be collected a minimum of 24 hours after sediment removal and prior to cofferdam removal. Samples would be submitted to a laboratory for quick (24 to 48 hour) turnaround analysis for pesticides. If the laboratory results are under NPDES requirements, then the surface water would not be treated. Contaminated surface water would be treated on site using carbon adsorption units with a bag prefilter for suspended solids.

Prior to starting the treatment of the surface water, measurements of the ditch section (width and depth) and water levels would be taken at three locations to calculate actual surface water treatment volume. As performed during the IRA, a pump would be used to circulate water from the ditch through a carbon treatment system. The suction line would be placed in one end of the ditch section and the discharge would be placed in the opposite. The system would be operated at 50 gpm until four times the calculated volume of water in the ditch segment has been pumped through it (approximately 80 hours per segment). After the required volume of water has been pumped through the system the surface water would be sampled again for pesticides. Treatment of the surface would continue until the clean-up goals (under NPDES requirements) have been reached, then the cofferdams would be removed.

Stockpiled soils and sediments would be transported to an off-site RCRA permitted TSDF for treatment and disposal in accordance with this permit. Treatment and disposal options include incineration, low-temperature thermal desorption, stabilization/solidification, and landfill.

Institutional controls (i.e., limited site access and monitoring) would be established to eliminate or reduce pathways of exposure to contaminants at the site. Limited site access would be imposed to eliminate or reduce the pathways of human exposure to contaminants at the site. Monitoring would be conducted to verify that residual contaminants do not pose unacceptable risks. Groundwater, sediment, and surface-water sampling would be conducted quarterly for the first year and groundwater would be sampled annually for the next 4 years to evaluate the site status. Also, biomonitoring would be conducted biennially. Sampling would be performed according to state and Federal regulations and to confirm decreases in the ecological impact.

5.0 EVALUATION OF THE CORRECTIVE MEASURE ALTERNATIVES FOR SWMU 2

This section presents a detailed description of each corrective measure alternative developed in Section 4.0, the rationale used in evaluating each corrective measure alternative, and the results of the evaluation for each specific evaluation standard. The evaluation of corrective measure alternatives was conducted in accordance with the EPA RCRA Corrective Action Plan Guidance (Final) (EPA, 1994a).

5.1 CORRECTIVE MEASURE ALTERNATIVES

This section describes in detail the corrective measure alternatives developed in Section 4.0.

5.1.1 Alternative 1 - No Action

This is a "walk-away" alternative retained to provide a baseline for comparing the other alternatives. This alternative does not address the remaining soil, sediment, and surface-water contamination at SWMU 2.

5.1.2 Alternative 2 - Limited Action: Institutional Controls

This alternative consists of only one component, institutional controls. This alternative relies upon limiting site access to eliminate or reduce exposure pathways and monitoring the effectiveness of the IRA. This alternative is based upon the assumption that SWMU 2 would continue to be owned and operated by the NAS. Therefore, the base would be secured as a Federal facility with perimeter fencing and continued access restrictions.

Institutional controls would consist of maintaining records of the contamination at SWMU 2 in the NAS Key West Master Plan in accordance with CNBJAXINST 5090.2N4 (U.S. Navy, 1997). Also, monitoring of surface water, sediment, groundwater, and ecological receptors would be conducted to assess the effectiveness of the IRA and determine the need for future actions. Additionally, this alternative includes posting warning signs around SWMU 2 to minimize human exposure to contaminated media.

The Master Plan documents the presence of contamination at the site and would ensure that at the time of future land development, the base would be able to take adequate measures to minimize adverse human health and environmental effects. Any future construction activity at SWMU 2 must be conducted in compliance with health and safety requirements that would minimize the potential for contaminants to enter the exposure pathways (incidental ingestion and dermal contact of soils) for construction workers on site.

Educational programs to inform the public concerning site hazards would be conducted through RAB meetings, public workshops, and other community relations activities.

Monitoring samples would be collected quarterly for the first year and annually for the next nine years from three groundwater, three surface water, and four sediment sampling locations. Samples from each location would be analyzed for pesticides and inorganic compounds. Additionally, groundwater samples would be analyzed for VOCs. Quality Assurance/Quality Control (QA/QC) samples would also be collected. If after the first year, a class of compounds (e.g., inorganics) are not detected in a given medium, that class of compounds will cease to be analyzed for in subsequent sampling events for that medium. Biomonitoring of ecological receptors would be collected every two years (biennially) and would involve pesticide and metals analysis of 25 tissue samples from fish. Additionally, toxicity testing would be conducted on 5 surface water and 5 sediment samples, biennially.

Warning signs would be posted to indicate to potential trespassers that a potential health threat is present. Signs are typically posted at equal intervals along the perimeter of the site and along roads leading to the site. It is estimated that 6 signs at 150-ft intervals would be required to encompass the entire site. The signs should be at least 2 ft by 2 ft, made of durable weather resistant material, with a white background and red lettering.

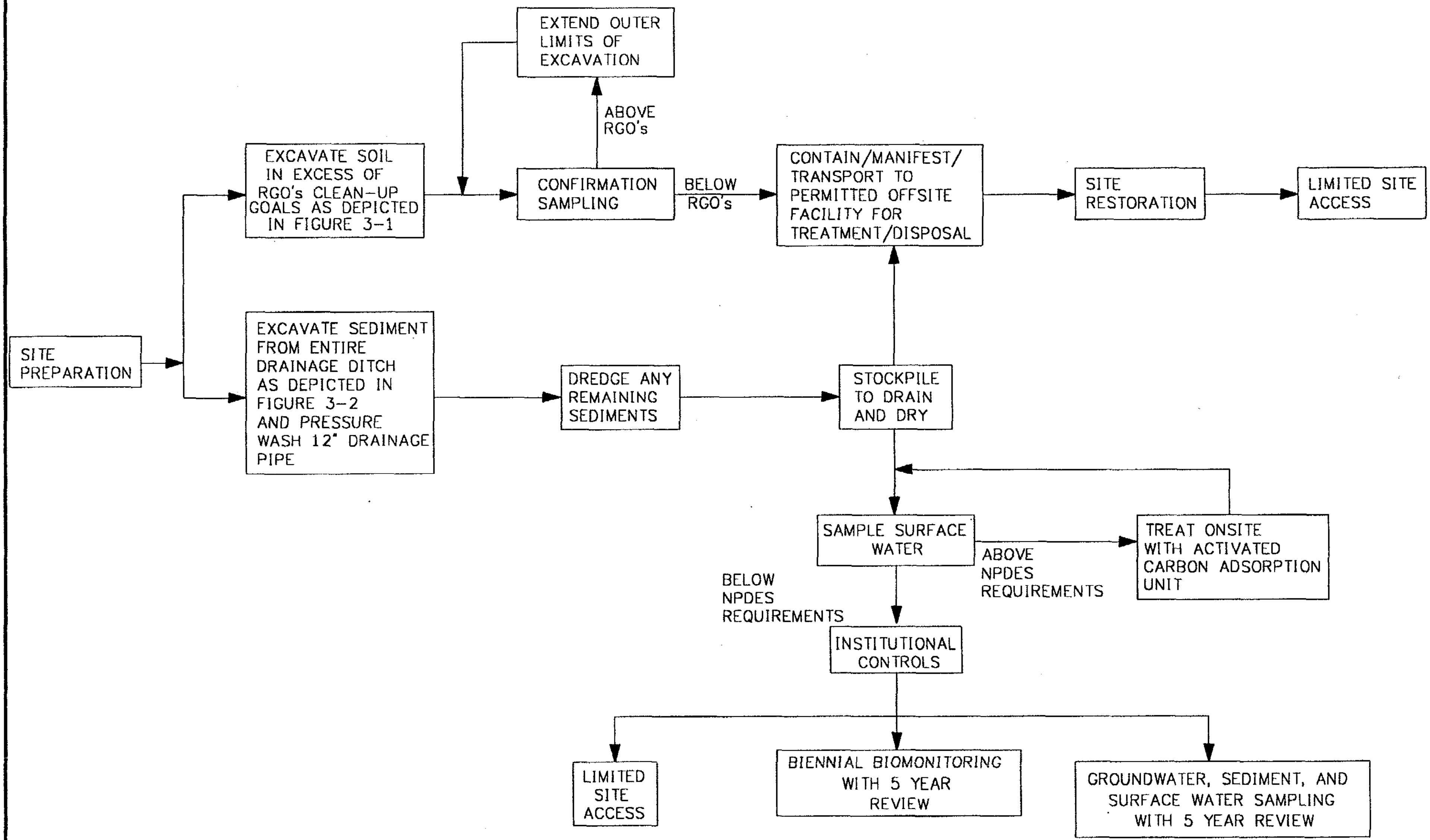
Every 5 years, a site review would be conducted to evaluate the site status and determine whether further action is necessary. The site review is required because this alternative allows contaminants to remain at levels that exceed RGOs.

5.1.3 Alternative 3 - Remove, Treat, and Dispose of Soil Contaminated at Concentrations Greater Than FDEP RGOs and Sediment Contaminated at Concentrations Greater Than ER-M Sediment Guideline Values; Treat Associated Surface Water

This alternative consists of five major components: (1) soil removal, (2) sediment removal, (3) on-site surface-water treatment and discharge, (4) transport of contaminated soils and sediments for off-site treatment and disposal , and (5) institutional controls. The block flow diagram for Alternative 3 is shown in Figure 5-1.

Component 1: Soil Removal

Contaminated soil in excess of FDEP Industrial RGOs would be excavated from the site. The estimated area and volume of soil excavation is based upon contaminant concentrations above FDEP Industrial RGOs



SITE MANAGER: KW	CHECKED BY: BER
DRAWN BY: TAD	DRAWING DATE: 1/12/98
SURVEYED BY:	SURVEY DATE:
SCALE:	
CAD DWG. NO.: 7046CF04	PROJ. NO.: 7046

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FIGURE 5-1

BLOCK FLOW DIAGRAM
SWMU 2 – ALTERNATIVE 3

NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

outside the perimeter of the IRA excavation as determined from previous sampling investigations. A predesign study would be conducted to verify the extent of contamination, survey original surface elevations, determine any potential wetlands impact, and calculate the area and volume of excavation. Approximately 10 samples will be taken prior to excavation as part of the predesign study. Federal and state permit requirements would be satisfied if it is determined that the boundaries of the excavation impact regulated wetlands, mangrove habitat, and/or endangered species. The area would be mowed and cleared of any vegetation prior to excavation. Soil would be excavated using conventional construction equipment. Typically, mechanical equipment such as back-hoes, bulldozers, and front-end loaders are used for excavation. Excavations would be performed in accordance with Occupational Safety and Health Administration (OSHA) requirements. It is estimated that 140 yd^3 of soil would require excavation, treatment, and disposal from SWMU 2. During removal, excavated soils would be stockpiled, if necessary, within the limits of the excavation. Confirmation sampling would be conducted to ensure that all contaminated soil is removed.

After the contaminated soils have been excavated, the area would be backfilled with clean material from off-site and regraded to achieve desired drainage patterns. The final grade would meet the original elevations measured during the initial excavation area survey. The excavation would be backfilled with crushed stone or graded sand to an elevation 6 inches below final grade. The only exception would be when final grade would be 6 inches from the top of bedrock because existing soil depths are less than 6 inches. A 6-inch vegetative layer of topsoil would be placed over the backfill to allow for revegetation to minimize soil erosion.

The vegetative layer of topsoil would be retained by implementing erosion control devices and methods. Sediment barriers installed during the IRA are assumed to still be in place along both sides of the western ditch. Similar barriers would be installed along sides of the eastern and southern sections of the ditch undergoing removal activities. Missing barriers would be replaced along both sides of the western ditch. Sandbags would be filled with backfill material. Filter fabric would be wrapped around sandbags stacked 1 ft high. The ends of the filter fabric would be placed underneath the backfill. Additional erosion protection such as erosion control matting could be utilized to provide further slope protection. These temporary controls would be implemented until revegetation by recolonization is established.

Component 2: Sediment Removal

Cofferdams would be installed at the ends of the drainage ditches (where ditches enter/exit the pond and lagoon) to prevent contaminated surface-water migration from the ditch area. The type of cofferdam used (e.g., water-filled or steel plate) would be determined during the remedial design. The ditch would be divided into four sections to enable a phased approach to the excavation of sediment and removal and the potential handling of the large volume of water. Cofferdams would be installed at the ends of the particular section undergoing removal activities. The locations of the cofferdams would not be the same as during the IRA. Different cofferdam locations would ensure contaminated sediment from under previous cofferdam locations would be removed. Sediment would be excavated using conventional construction equipment, as used in the soil excavation, and placed on plastic sheeting in a stockpile area to drain and dry. The stockpile would be located in an upland area next to the ditch to allow the water from sediments to drain into the ditch. Sediment that cannot be removed by the excavator would be dredged to bedrock in the bottom of the ditch. A dredge pump is a self-contained unit that uses a generator for power and is attached to the excavator arm for dredging. Dredged sediments would be pumped to a drying bed to allow water to filter and return to the ditch. All dredged sediments would be dewatered and then handled as soil. It is estimated that approximately 470 yd^3 of sediment would be removed.

Sediment in the 12-inch diameter concrete pipe which extends approximately 310 ft northwest of the western end of the ditch to a catch basin may contain pesticide and inorganic contaminants. Pressure washing will be used to remove the potentially contaminated sediment from the pipe. This is an estimated 2 to 3 yd^3 of sediment in this pipe. The pressure washing would be performed after the cofferdams are installed at the ends of the drainage ditches and prior to excavating the sediment in the west ditch. Confirmation samples would be collected to ensure that all contaminated soil and sediment from SWMU 2 were removed.

Component 3: On-site Surface Water Removal, Treatment, and Discharge

Surface-water levels in the drainage ditch are tidally influenced. Assuming a surface-water depth of 4 feet throughout the drainage ditch, there would be 237,000 gallons of surface water in the ditch which could require treatment. The surface water that remains in the ditch after all sediments are removed is expected to be contaminated with pesticides. Surface-water samples would be collected a minimum of 24 hours after removal of the sediments and submitted to a laboratory for quick (24 to 48 hours) turnaround analysis for pesticides. If laboratory analysis indicates contaminant levels are under the NPDES requirements the cofferdams would be removed with no further action on the surface waters. Surface water exceeding the NPDES discharge requirements would be treated on-site using carbon adsorption.

Measurements of each ditch segment (width and depth) and water levels should be taken at a minimum of three locations to calculate actual surface-water volume, before starting the treatment of the water. A 50 gpm carbon treatment system would be used to treat the water. Bag or cartridge filters would be installed prior to the carbon treatment system to prevent suspended solids from clogging the system. A 50 gpm gasoline powered pump would be used to circulate water through the carbon treatment system. The suction line should be placed at one end of the ditch segment and the discharge line at the opposite.

Based on information from the IRA, the treatment system would be operated initially until four times the calculated volume of water in the ditch section has been pumped through it. Based on the estimated volume of 237,000 gallons, the treatment system would be operated for approximately 320 hours total to treat four water volumes. After pumping the required volume through the treatment system the surface water would be resampled for pesticides. If laboratory analysis indicates contaminant levels are below the NPDES discharge requirements the cofferdams would be removed with no further action on the surface waters. However, if the results exceed the NPDES discharge requirements, treatment would continue until the surface water results are under the NPDES requirements. Actual carbon consumption will be determined in the field. However, assuming an inlet concentration of 80 parts per billion (ppb) of DDT and discharge concentration of non-detect, carbon would be consumed at a rate of approximately 0.13 pounds per day.

Component 4: Transport of Contaminated Soil and Sediment for Off-site Treatment and Off-site Disposal of Treated Soil and Sediment

All stockpiled soil and dewatered sediment would be loaded into suitable containers for transportation to an approved TSDF with the capability to handle pesticide and metal contaminated soil. Potential technologies include incineration, stabilization/solidification, and landfill. The treatment process, if required, would convert hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert. The treated soil would then be placed in a RCRA permitted landfill for final disposal. The transport of the contaminated soil must comply with the state and Federal requirements for transportation of hazardous waste.

Component 5: Institutional Controls

Institutional controls would consist of maintaining records of the contamination at SWMU 2 in the NAS Key West Master Plan in accordance with CNBJAXINST 5090.2N4 (U.S. Navy, 1997). Also, monitoring of surface water, sediment, groundwater, and ecological receptors would be conducted to assess the effectiveness of the IRA and determine if there is a need for future actions. Additionally, this alternative includes posting warning signs around SWMU 2 to minimize human exposure to contaminated media.

The Master Plan documents the presence of contamination at the site and would ensure that at the time of future land development, the base would be able to take adequate measures to minimize adverse human health and environmental effects. Any future construction activity at SWMU 2 must be conducted in compliance with health and safety requirements that would minimize the potential for contaminants to enter the exposure pathways (incidental ingestion and dermal contact of soils) for construction workers on site. Educational programs to inform the public concerning site hazards would be conducted through RAB meetings, public workshops, and other community relations activities.

Monitoring samples would be collected quarterly for the first year and annually for the next nine years from three groundwater, three surface water, and four sediment sampling locations. Samples from each location would be analyzed for pesticides and inorganic compounds. Additionally, groundwater samples would be analyzed for VOCs. QA/QC samples would also be taken. If after the first year, a class of compounds (e.g., inorganics) are not detected in a given medium, that class of compounds will cease to be analyzed for in subsequent sampling events for that medium. Biomonitoring of ecological receptors would be collected every two years (biennially) and would involve pesticide and metals analysis of 25 tissue samples from fish. Additionally, toxicity testing would be conducted on 5 surface water and 5 sediment samples, biennially.

Warning signs would be posted to indicate to potential trespassers that a potential health threat is present. Signs are typically posted at equal intervals along the perimeter of the site and along roads leading to the site. It is estimated that 6 signs at 150-ft intervals would be required to encompass the entire site. The signs should be at least 2 feet by 2 feet, made of durable weather resistant material, with a white background and red lettering.

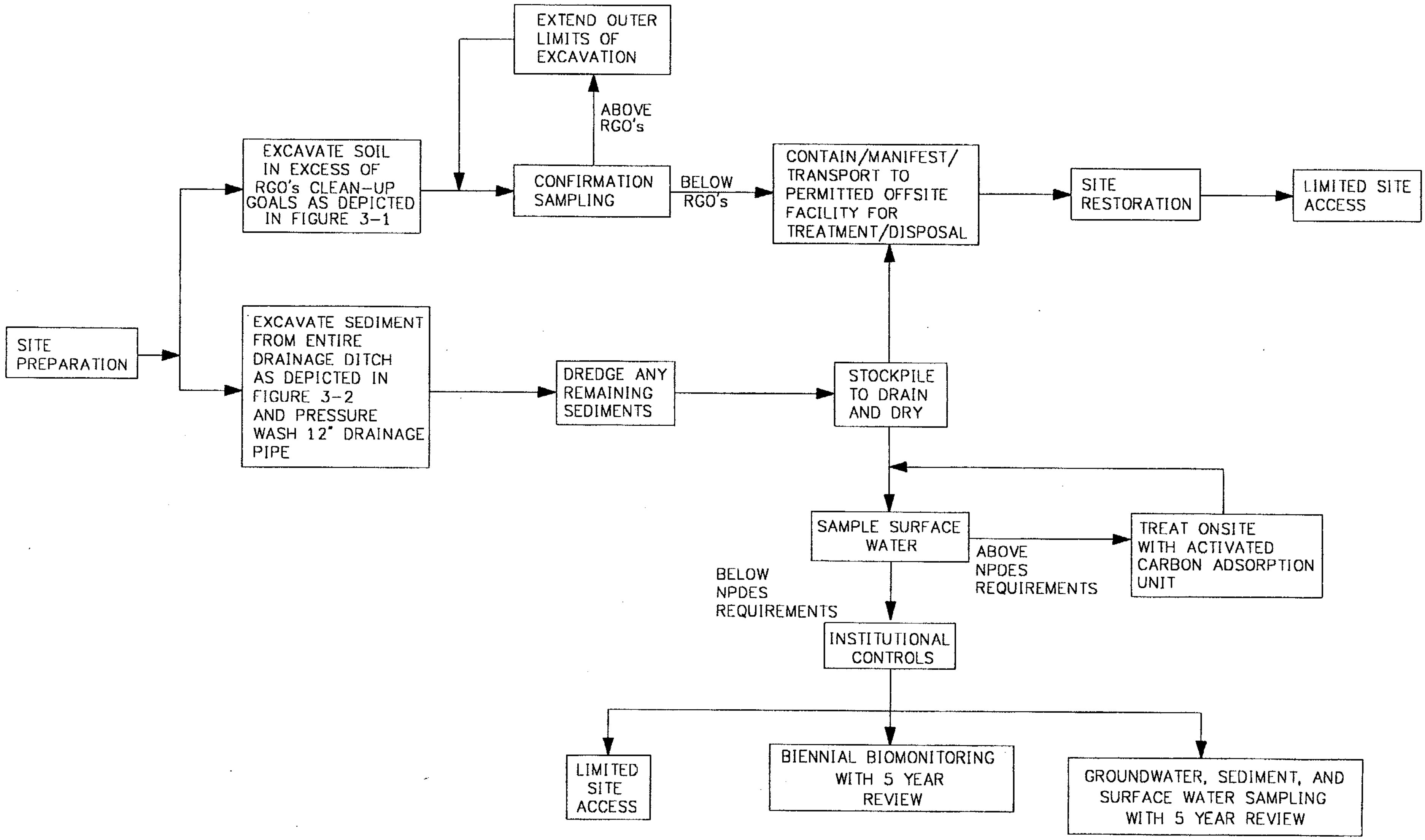
Every 5 years, a site review would be conducted to evaluate the site status and determine whether further action is necessary. The site review will be conducted because this alternative allows contaminants to remain at the SWMU.

5.1.4 Alternative 4 - Remove, Treat, and Dispose of Contaminated Soil and Sediment at Concentrations Greater Than the Most Stringent Soil and Sediment RGOs; Treat Associated Surface Water

This alternative consists of five major components: (1) soil removal, (2) sediment removal, (3) on-site surface water treatment and discharge, (4) transport of contaminated soils and sediments for off-site treatment and disposal , and (5) institutional controls. The block flow diagram for Alternative 4 is shown in Figure 5-2.

Component 1: Soil Removal

Contaminated soil in excess of the most stringent soil RGOs would be excavated from the site. The estimated area and volume of soil excavation is based upon contaminant concentrations above RGOs for the protection of ecological receptors outside the perimeter of the IRA excavation from previous sampling investigations. A predesign study would be conducted to verify the extent of contamination, survey original



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DRAWN BY: TAD	DRAWING DATE: 1/12/98
SURVEYED BY:	SURVEY DATE:
SCALE:	
CAD DWG. NO.: 7046CF05	PROJ. NO.: 7046

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FIGURE 5-2

BLOCK FLOW DIAGRAM
SWMU 2 - ALTERNATIVE 4

NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

surface elevations, determine any potential wetlands impact, and calculate area and volume of excavation. Approximately 15 samples would be taken prior to excavation as part of the predesign study. Federal and state permit requirements would have to be satisfied if it is determined that the boundaries of the excavation impact regulated wetlands, mangrove habitat, and/or endangered species. The area would be mowed and cleared of any vegetation prior to excavation. Soil would be excavated using conventional construction equipment. Typically, mechanical equipment such as back-hoes, bulldozers, and front-end loaders are used for excavation. Excavations would be performed in accordance with OSHA requirements. It is estimated that 4,400 yd^3 of soil would require excavation, treatment, and disposal from SWMU 2. During removal, excavated soils would be stockpiled, if necessary, within the limits of the excavation. Confirmation sampling would be conducted to ensure the removal of contaminated soils.

After the contaminated soils have been excavated, the area would be backfilled with clean material from off-site and regraded to achieve desired drainage patterns. The final grade would meet the original elevations measured during the initial excavation area survey. The excavation would be backfilled with crushed stone or graded sand to an elevation 6 inches below final grade. The only exception would be when final grade would be 6 inches from the top of bedrock because existing soil depths are less than 6 inches. A 6-inch vegetative layer of topsoil would be placed over the backfill to allow for revegetation to minimize soil erosion.

The vegetative layer of topsoil would be retained by implementing erosion control devices and methods. Sediment barriers installed during the IRA are assumed to still be in place along both sides of the western ditch. Similar barriers would be installed along sides of the eastern and southern sections of the ditch undergoing removal activities. Missing barriers would be replaced along both sides of the western ditch. Sandbags would be filled with backfill material. Filter fabric would be wrapped around sandbags stacked 1 ft high. The ends of the filter fabric would be placed underneath the backfill. Additional erosion protection, such as erosion control matting, could be utilized to provide further slope protection. These temporary controls would be implemented until revegetation by recolonization is established.

Component 2: Sediment Removal

This component is identical to Component 2 of Alternative 3.

Component 3: On-site Surface Water Removal, Treatment, and Discharge

This component is identical to Component 3 of Alternative 3.

Component 4: Transport of Contaminated Soil and Sediment for Off-site Treatment and Off-site Disposal of Treated Soil and Sediment

This component is identical to Component 4 of Alternative 3.

Component 5: Institutional Controls

Institutional controls would include 4 sampling events in the first year collected from three groundwater, three surface water, and four sediment sampling locations. Samples would be taken to verify that cleanup goals were met and would be analyzed for pesticides and inorganic compounds. Additionally, groundwater samples would be analyzed for VOCs. For the next four years, groundwater samples would be collected annually from three locations and analyzed for VOCs, pesticides, and inorganic compounds. Monitoring data would be used to evaluate any changes in groundwater contamination and determine potential impacts to offsite residents. If after the first year, a class of compounds (e.g., inorganics) are not detected in a given medium, that class of compounds will cease to be analyzed for subsequent sampling events for that medium.

Biomonitoring of ecological receptors would be collected biennially and would involve pesticide and metals analysis of 25 fish tissue samples. Additionally, toxicity testing would be conducted on 5 surface water and sediment samples, biennially.

After 5 years, a site review would be conducted to evaluate the site status and determine whether further action is needed.

5.2 EVALUATION STANDARDS

The evaluation of the corrective measure alternatives was conducted as provided in the Guidance for RCRA Corrective Action Plan (OSWER Directive 9902.3-2A, USEPA May, 1994). This section describes the specific standards to be used in evaluating each of the corrective measure alternatives. The five standards are as follows:

- Protection of Human Health and the Environment
- Media Clean-up Standards
- Source Control
- Waste Management Standards
- Other Factors.

5.2.1 Protection of Human Health and the Environment

The protection of human health and the environment provides an overall evaluation of the remedies which would be appropriate for SWMU 2. This standard considers the extent to which the corrective measure alternative mitigates potential short- and long-term potential exposure to residual contamination and how the remedy protects human health and the environment both during and after implementation of the alternative. In addition, the levels and characterization of contaminants remaining on-site, potential exposure pathways, potentially affected populations, the level of exposure to contaminants, and the associated reduction of exposure over time are considered. For management of mitigation measures, the relative reduction of environmental impact for each alternative are determined by comparing residual levels for each alternative with the existing criteria, standards, and gúidelines. The ecological considerations for this evaluation standard included: potential short- and long-term beneficial and adverse effects of the corrective measure, adverse effects on environmentally sensitive areas, and an analysis on how to mitigate adverse effects.

5.2.2 Media Clean-up Standards

The Media Clean-up Standard considers whether the corrective measure alternative would achieve the defined CAOs. In addition, this standard includes an assessment of relevant institutional needs for each corrective measure alternative. The effects of Federal, state, and local environmental and public standards, regulations, guidance, advisories, ordinances, or community relations on the design, operation, and timing of each alternative are considered.

5.2.3 Source Control

The Source Control standard evaluates how the corrective measure alternative addresses the source of the release, so as to reduce or eliminate, to the extent practicable, further releases that may pose a threat to human health and the environment. This criteria addresses whether source control measures are necessary and what type of source control actions would be appropriate. In addition, any source control measure proposed should include a discussion on how well the method is expected to work given the site situation and previous experiences of the specific technology.

5.2.4 Waste Management Standards

The corrective measure alternative must comply with applicable standards for the management of wastes. This includes a description of how the specific waste management activities would be conducted in order to maintain compliance with all applicable state and Federal regulations.

5.2.5 Other Factors

In addition to the first four standards, there are five general factors that are to be addressed as part of the evaluation of corrective measure alternatives. The five general decision factors to be considered under this standard are:

- Long-term Reliability and Effectiveness
- Reduction in Toxicity, Mobility, or Volume
- Short-term Effectiveness
- Implementability
- Cost

5.2.5.1 Long-term Reliability and Effectiveness

Long-term reliability and effectiveness evaluation includes an evaluation of the corrective measure alternatives performance. Performance considerations include the effectiveness and useful life of the corrective measure. The reliability of a corrective measure includes the operation and maintenance requirements and demonstrated reliability.

5.2.5.2 Reduction in Toxicity, Mobility, or Volume

This factor includes the ability of the corrective measure to reduce the toxicity, mobility, or volume of the contaminants and/or media through treatment.

5.2.5.3 Short-term Effectiveness

This factor includes an evaluation of the corrective measure effectiveness in the short-term (< 6 months), in comparison to the long-term effectiveness, and in particular potential risks to human health and the environment during implementation.

5.2.5.4 Implementability

This factor includes the relative ease of installation (constructability) and the time required to achieve a given level of response.

5.2.5.5 Cost

A cost estimate of the corrective measure includes both estimated capital and operation and maintenance costs. Capitals costs include both direct and indirect costs. Operation and maintenance costs are post-construction activities which may be necessary to ensure the continued effectiveness of a corrective measure.

5.3 EVALUATION OF ALTERNATIVES

This section presents the results evaluation conducted for each corrective measure alternative based on the specific standards described in Section 5.2.

5.3.1 Alternative 1 - No Action

5.3.1.1 Protection of Human Health and the Environment

Alternative 1 is considered primarily for comparative purposes to the other corrective measures. This alternative would not be protective of human health or the environment. Contaminants such as pesticides would remain in the sediment and surface water and potential human exposure through dermal contact would continue to exist. In addition, migration of the pesticide contamination in soil and sediment would continue to pose potential adverse ecological effects.

Based upon the ERA conducted as part of the RI/RFI process, it appears that existing contaminants at SWMU 2 do not pose significant potential risks to terrestrial receptors. However, potential risks to aquatic and piscivorous receptors from DDT and its degradation products would remain at the site.

DDT and its degradation products are known to biomagnify in the food chain. For this reason, currently impacted fish would probably continue to pose short-term potential ecological risks. However, the IRA conducted in the Spring of 1996 (after fish samples were collected for the risk assessment) removed most of the contaminated soil and sediment from the site. Thus, as existing fish are replaced by future generations, tissue concentrations of site-related contaminants are expected to decrease. As a result, the long-term ecological risks are expected to decrease as a result of the IRA. However, without monitoring, the extent of this reduced risk is uncertain.

5.3.1.2 Media Clean-up Standards

Alternative 1 would not comply with the media clean-up standards for soil, sediment, or surface water under either the industrial use criteria or the more stringent RGOs (residential and ecological).

5.3.1.3 Source Control

Alternative 1 involves no source control as no action would be performed at SWMU 2. However, it should be noted that an IRA in Spring 1996 removed the majority of the soil and sediment contamination that was detected above screening action levels at SWMU 2.

5.3.1.4 Waste Management Standards

There are no actions to be implemented for Alternative 1 and, therefore, no waste would be generated.

5.3.1.5 Other Factors

Long-term Reliability and Effectiveness

The current threat to human health and the environment would remain since there would be no access controls, removal of, or treatment of the contaminants. Except any decrease through natural attenuation, pesticide and inorganic contaminant concentration would remain in the soil at SWMU 2 at levels greater than the media clean-up standards.

There are no long-term management controls for SWMU 2 under this alternative. Therefore, the adequacy and reliability of controls are not applicable. Also, there would be no long-term monitoring programs to assess the migration of contaminants from the site.

Reduction in Toxicity, Mobility, and Volume

Alternative 1 involves no reduction in toxicity, mobility, or volume of the contaminants at SWMU 2 other than that which would result from natural dispersion, dilution, or other attenuating factors. There are no treatment processes employed, and therefore no materials are treated or destroyed.

Short-term Effectiveness

Alternative 1 involves no action and, therefore, would not pose any risks to on-site workers during implementation and no environmental impacts would be expected. This alternative would not achieve any of the CAOs.

Implementability

Since no actions would occur, this alternative is readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable.

Cost Analysis

There are no costs associated with the No Action alternative.

5.3.2 Alternative 2 - Limited Action: Institutional Controls

5.3.2.1 Protection of Human Health and the Environment

Alternative 2 would be partially protective of human health by limiting site access and land use within and around SWMU 2. Based upon the ERA conducted as part of the RI/RFI process, existing contaminants at SWMU 2 do not pose significant potential risks to terrestrial receptors. However, potential risks to aquatic and piscivorous receptors from DDT and its degradation products would remain at the site.

This alternative involves limiting site access and use. Warning signs would be posted and a number of other security measures would be employed. From a HHRA perspective, these actions would reduce, but not prevent exposure to the site contaminants. Residents or excavation workers would not be permitted on site. Trespassers would be actively discouraged from entering the site. Workers and trespassing adults would be expected to make an effort to avoid ingestion or skin contact with the media because of the hazard posting. Workers would be required to be on-site less of the time and use personal protective equipment (PPE). HHRA calculations are in Appendix A.

ICR from site contaminants for both adult and adolescent trespassers are less than 1.0E-04 but would still slightly exceed 1.0E-06 under the institutional controls alternative. Most of the risk arises from dermal contact with sediment and surface water. The calculated values for these pathways ranged from 1.16E-06 (dermal exposure to sediment by adolescents) to 2.26E-06 (dermal exposure to surface water by adults). There were no HIs (non-cancer risk values) greater than 0.1 when calculated under Alternative 2 conditions.

DDT and its degradation products are known to biomagnify in the food chain. For this reason, existing tissue concentrations of DDT and its degradation products in fish would continue to pose short-term potential ecological risks. However, the IRA conducted in the Spring of 1996 (after fish samples were collected for the risk assessment) removed most of the contaminated soil and sediment from the site. Thus, as existing fish are replaced by future generations, tissue concentrations of site related contaminants are expected to be considerably less than present concentrations. The long-term ecological risks, therefore, are expected to decrease as a result of the IRA. The extent of this reduced risk is uncertain.

Sampling of sediment and surface water and biomonitoring are included to determine the effectiveness of the IRA and to monitor potential pesticide soil contamination migration to the surface water and sediment. Periodic review of the site would be necessary to ensure that contaminant concentrations were not increasing and to determine whether additional measures would be necessary to protect human health and the environment.

5.3.2.2 Media Clean-up Standards

Alternative 2 would not comply with the media clean-up standards for soil, sediment, or surface water under either the industrial use criteria or the ARAR/SAL criteria. It, however, would include long-term monitoring to evaluate the effectiveness of the IRA and to determine whether contaminant concentrations were increasing. Institutional controls would be used to prevent exposure to media with contaminant concentrations above clean-up standards.

5.3.2.3 Source Control

Alternative 2 does not involve source control as only institutional controls would be implemented. However, it should be noted that an IRA in Spring 1996 removed the majority of the soil and sediment contamination that was detected above screening action levels at SWMU 2.

5.3.2.4 Waste Management Standards

Alternative 2 involves no removal of contaminated soil, sediment, or surface water and, therefore, this alternative would not generate any wastes.

5.3.2.5 Other Factors

<u>Long-term Reliability and Effectiveness</u>

Although no removal would occur in Alternative 2, the current threat to human health would be reduced and the effectiveness of the IRA in reducing risk would be monitored. Environmental concerns would remain from both soil contaminants migrating to the ditch and from the pesticide contamination in the soil and sediment would be monitored.

This limited action alternative would use institutional controls such as the NAS Key West Master Plan to limit future use of the site [in accordance with CNBJAXINST 5090.2N4 (U.S. Navy, 1997)]. Therefore, use of the soils or the surficial aquifer groundwater beneath the site could be restricted by prohibiting future development of SWMU 2.

Institutional controls have uncertain long-term effectiveness. The protection of the construction worker and the recreational user in the long term would depend on effective administration and management of the Master Plan. A reevaluation of the site would be performed every 5 years to determine whether any changes to the controls would be required.

Reduction in Toxicity, Mobility, and Volume

Alternative 2 would not result in reduction in toxicity, mobility, or volume through treatment of the hazardous substances at SWMU 2 other than that which would result from natural dispersion, dilution, or other attenuating factors.

Short-term Effectiveness

Alternative 2 would involve surface-water and sediment monitoring, biomonitoring of ecological receptors, administration of institutional controls, and potential restriction of residential land use. The short-term risks associated with these limited remedial activities would be minimal. Sampling personnel would wear the required PPE and receive the appropriate health and safety training. There would be no potential risk to the community or environmental impacts upon the implementation of institutional controls.

Implementability

Alternative 2 is expected to be readily implementable since SWMU 2 is located within a military facility, where rules and local ordinances can be strictly enforced. Restrictions for future residential property use would involve legal assistance and regulatory approval. Provisions in the NAS Key West Master Plan would be defined and enforced relatively easily because the site is located within a Federal facility. Sampling and analysis are also readily implemented.

Cost Analysis

The following costs are estimated for Alternative 2. It should be noted that to date, the Navy has spent approximately 7.9 million dollars on IRAs at nine sites/SWMUs/Areas of Concern. SWMU 2 was one of the SWMUs where an IRA was performed.

Capital Costs: $1,614
O&M Costs: $13,500/yr - $54,000/yr
Present-Worth: $219,768 estimated over 10 years.

Detailed cost estimates are included in Appendix C.

5.3.3 Alternative 3 - Remove, Treat, and Dispose of Soil Contaminated at Concentrations Greater Than FDEP RGOs and Sediment Contaminated at Concentrations Greater Than ER-M Sediment Guideline Values; Treat Associated Surface Water

5.3.3.1 Protection of Human Health and the Environment

Alternative 3 would be relatively protective of human health and the environment. This alternative would remove the most contaminated soils remaining at the site (soil with concentrations in excess of FDEP Industrial RGOs), and all the contaminated sediment. Confirmation samples would be collected from the perimeter of the excavation to ensure that the soil with contaminant concentrations greater than FDEP Industrial RGOs and sediment with concentrations greater than ER-M Sediment Guideline Values from SWMU 2 are removed.

The potential for human exposure to contaminated sediment and surface water as well as impacts on ecological receptors would be significantly reduced through implementation of this alternative. The environmental impact of the remaining pesticide contamination from future soil migration to the surface water and sediment would be monitored with quarterly (for the first year) and annual (for the next nine) sampling of the sediment, surface water, and groundwater and biennial biomonitoring of ecological receptors for a minimum of 5 years. After 5 years, the sampling results would be reviewed to determine if further monitoring would be required.

5.3.3.2 Media Clean-up Standards

Alternative 3 would achieve the media clean-up standards for soil and sediment FDEP Industrial RGOs for soils and ER-M Sediment Guideline Values for sediment) through removal of the contaminated soil and sediment from SWMU 2. Samples would be collected from the soil and sediment remaining after removal to confirm that they met clean-up standards. The contaminated soil and sediment would be treated prior to disposal to comply with LDRs and the TSDF permit. Treatment process would be selected to convert the hazardous contaminants to nonhazardous or less toxic compounds allowing the soil and sediment to meet applicable LDRs. Sediment and surface-water sampling and biomonitoring would be conducted to assess the decrease of contaminant concentrations in the environment. The media clean-up standards for surface water in the ditch would also be achieved.

5.3.3.3 Source Control

Approximately 140 yd^3 of the most contaminated soil, those in excess of FDEP Industrial RGOs , would be excavated from three hot-spot locations outside the perimeter of the IRA. Similarly, approximately 470 yd^3 of contaminated sediment would be excavated from the entire ditch. This action would reduce the potential for further releases that could pose a threat to human health and/or the environment. However, it should be noted that an IRA in Spring 1996 removed the majority of the soil and sediment contamination that was detected aboveSALs at SWMU 2.

5.3.3.4 Waste Management Standards

During implementation of Alternative 3, waste management practices would be used to control stormwater runoff from spreading contamination. Contaminated soil would be excavated and stockpiled, if necessary, within the limits of the excavation. Excavated sediment would be stockpiled on plastic sheeting to allow excess water to drain back into the ditch and dry. The excavated soil and sediment would be loaded into suitable containers for transportation to a RCRA-permitted TSDF. If treatment is required, the excavated soil and sediment would be transported to an appropriate facility to convert the hazardous contaminants to nonhazardous or less toxic compounds. The treated soil, which would meet LDRs and the TSDF permit, would then be placed in a RCRA-permitted landfill for final disposal.

Equipment used on-site may come in contact with potentially hazardous chemicals (contaminated media). The equipment would be decontaminated prior to leaving site. Decontamination water would be collected, sampled, and if required, properly treated and disposed of. Any treatment residuals from implementation of this alternative would be sampled and properly disposed of.

5.3.3.5 Other Factors

Long-term Reliability and Effectiveness

Alternative 3 would provide for moderate long-term effectiveness since excavation can be very effective at removing the most contaminated soil and sediment. However, even though significantly reduced, the ecological risk from pesticide contamination in the soils migrating to the surface water and sediment would potentially remain. Sediment and surface-water sampling and biomonitoring would be conducted to assess the decrease of contaminant concentrations in the environment.

The effectiveness of this alternative would be monitored through confirmation sampling after removal. Excavation and off-site transportation of contaminated material from SWMU 2 was done during the IRA. The effectiveness of the soil/sediment treatment would be confirmed by sampling and testing before the material is placed in a RCRA-permitted landfill. During excavation, PPE would be used and monitoring conducted to ensure that exposure of the workers to potentially contaminated material is minimized.

Reduction in Toxicity, Mobility, and Volume

Alternative 3 may utilize treatment of the contaminated soil, sediment, and surface water to reduce the toxicity, mobility, and volume of the waste. If required, treatment would provide for a reduction in the toxicity of the contaminants at SWMU 2. The contaminated soil/sediment would be transported off-site to a RCRA permitted TSDF. After treatment, soil/sediment would be placed in a RCRA permitted landfill at the facility. The treatment process converts hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert. Potential treatment processes include incineration and stabilization/solidification.

Short-term Effectiveness

Based on the relatively low concentration of contaminants, the short-term effectiveness for Alternative 3 would be moderate. Site workers would receive the appropriate health and safety training and would wear the required PPE during implementation. The only potential risk to the community would be during transport of the contaminated materials off-site for treatment and disposal. There are potential environmental impacts from the implementation of this alternative, since some excavation of wetlands, mangrove areas, and endangered species habitat could occur. After implementation, these areas are expected to re-established to natural conditions. The potential human exposure to contaminated sediment and surface water would be reduced through implementation of this alternative.

Implementability

Alternative 3 is considered to be implementable. Excavation contractors and equipment are readily available for soil and sediment removal. The remedial technologies are well proven and established in the remediation and construction industries. Additional removal of materials, if indicated by confirmation sampling, would require either supplemental excavation during the site work. TSDFs are available for treatment of soil contaminated with pesticides and metals. Sampling and analysis are also readily implementable.

Cost Analysis

The following costs are estimated for Alternative 3. It should be noted that to date, the Navy has spent approximately 7.9 million dollars on IRAs at nine sites/SWMUs/Areas of Concern. SWMU 2 was one of the SWMUs where an IRA was performed.

Capital Costs: $1,002,348
O&M Costs: $13,500/yr to $54,000/yr
Present-Worth: $ 1,220,502 estimated over 10 years.

Detailed cost estimates are included in Appendix C.

5.3.4 Alternative 4 - Remove, Treat, and Dispose of Contaminated Soil and Sediment at Concentrations Greater Than the Most Stringent Soil and Sediment RGOs; Treat Associated Surface Water

5.3.4.1 Protection of Human Health and the Environment

Alternative 4 would be protective of human health and the environment by eliminating the potential for exposure to contaminated media by lowering the levels of contamination. This alternative would remove all remaining contaminated soil and sediment above RGOs. Soil and sediment that exceed LDRs and TSDF permit requirements would be treated before final disposal. This treatment would convert hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert. The treated soil and sediment, which would meet LDRs, would then be placed in a RCRA permitted landfill associated with the treatment facility for final disposal. Soil and sediment which do not exceed LDRs and TSDF permit requirements would be landfilled without treatment.

This alternative includes institutional controls during implementation, removal of contaminated soils and sediment, and on-site treatment of surface water. Soil or sediment with a contaminant that exceeds its

RGO would be moved off-site. Additionally, water would be treated to ensure that it does not contain any contaminant exceeding its RGO. Human health risks for soil, sediment, and surface-water exposure were recalculated by modifying the representative concentrations that were used in the original calculations of cancer risk or HQ to give the new risks at the RGO level. Human health risks were recalculated through the use of computer spreadsheets for all COCs and applicable pathways as originally calculated. Human health risk values from all media were well below 1E-06 for carcinogens and 1.0 for non-carcinogens. HHRA calculations are in Appendix A.

Confirmation samples would be collected to ensure that all contaminated soil and sediment from SWMU 2 was removed. After removal of the contaminated sediments, the surface water would be sampled to determine if treatment is required. If contamination exceeds NPDES requirements, the surface water would be treated to reduce elevated contaminant concentrations.

5.3.4.2 Media Clean-up Standards

Alternative 4 would meet all media clean-up standards through removal and treatment of all contaminated soil and sediment from SWMU 2 and treatment of the surface water, if required. Samples would be collected from each media to confirm that the corrective measure actions achieve the clean-up standards. This alternative would achieve CAOs upon completion. A portion of the contaminated soil and sediment may require treatment to meet LDRs and the TSDF permit requirements. Treatment would convert the hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert allowing the soil and sediment to meet LDRs.

5.3.4.3 Source Control

The remaining source of contamination (4,400 yd^3 of soil and 470 yd^3 of sediment) would be removed during implementation of this alternative. Alternative 4 would remove the potential for further releases that could pose a threat to human health and/or the environment by excavation and disposal of the source. However, it should be noted that an IRA in Spring 1996 removed the majority of the soil and sediment contamination that was detected above screening action levels at SWMU 2.

5.3.4.4 Waste Management Standards

Waste management practices would be used to control stormwater runoff from spreading contamination during implementation of Alternative 4. Contaminated soil would be excavated and stockpiled, if necessary, within the limits of the excavation. The excavated soil and sediment would be loaded into suitable containers for transportation to RCRA permitted TSDFs and would be treated, if required. Treated soil, which would meet LDRs and the TSDF permit, would be placed in a RCRA permitted landfill associated with the TSDF for final disposal.

Equipment used on-site may come in contact with potentially hazardous chemicals (contaminated media). The equipment would be decontaminated prior to leaving the site. Decontamination water would be collected, sampled, and properly treated and disposed of, if contaminated. Any treatment residuals from implementation of this alternative would be sampled and properly disposed of.

5.3.4.5 Other Factors

Long-term Reliability and Effectiveness

Alternative 4 would provide for long-term reliability and effectiveness. Excavation and dredging, if required, would be effective at removing contaminated soil and sediment. Confirmation samples would be taken along the perimeter of the excavation to confirm that residual chemical concentrations in soil and sediment are at or below clean-up standards. By removing the contamination from SWMU 2, there should not be a residual risk to human health and the environment.

The effectiveness of this alternative would be monitored through confirmation sampling after removal. Excavation and off-site transportation of contaminated material from SWMU 2 was performed during the IRA. The effectiveness of the soil and sediment treatment would be confirmed by sampling and testing before placing of the material in a RCRA permitted landfill. During excavation PPE would be used and monitoring conducted to ensure that exposure of the workers to potentially contaminated material is minimized.

Reduction in Toxicity, Mobility, and Volume

Alternative 4 may utilize treatment of the contaminated soil, sediment, and surface water to reduce the toxicity, mobility, and volume of the waste. If required, treatment would provide for a reduction in the toxicity of the contaminants at SWMU 2. The contaminated soil/sediment would be transported off-site to a RCRA permitted TSDF, if required. After treatment, soil/sediment, soil would be placed in a RCRA permitted landfill at the facility. The treatment process converts hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert. Potential treatment processes include incineration, and stabilization/solidification.

Short-term Effectiveness

Associated short-term risks would only involve the personnel implementing Alternative 4. The workers would receive the appropriate health and safety training and would wear appropriate PPE during implementation. The only potential risk to the community would be during transport of the contaminated materials off-site for treatment and disposal. There are potential environmental impacts from the implementation of this alternative, since some excavation of wetlands, mangrove areas and endangered species habitat could occur. After implementation, these areas are expected to be re-established to natural conditions. The potential human exposure to contaminated soil, sediment, and surface water would be eliminated through implementation of this alternative.

Implementability

Alternative 4 is implementable. Excavation contractors and equipment are readily available for removal of the soil and sediment. Carbon adsorption units for removal of pesticides from water are readily available. The technologies are well proven and established within the remediation and construction industries. Additional removal of materials, if indicated by confirmation sampling, would require either supplemental excavation during the site work. TSDFs are available for treatment of soil and sediment contaminated with pesticides and metals. Sampling and analysis are readily implementable.

Cost Analysis

The following costs are estimated for Alternative 4. It should be noted that to date, the Navy has spent approximately 7.9 million dollars on IRAs at nine sites/SWMUs/Areas of Concern. SWMU 2 was one of the SWMUs where an IRA was performed.

Capital Costs: $6,230,131
O&M Costs: $10,500/yr to $54,000/yr .
Present-Worth: $6,350,432 estimated over 5 years.

Detailed cost estimates are included in Appendix C

6.0 RECOMMENDATION OF THE FINAL CORRECTIVE MEASURE

6.1 INTRODUCTION

This section presents a comparison of the corrective measure alternatives in Section 5.0 for each evaluation standard. The standards for comparison are identical to those used for the detailed analysis of individual alternatives.

The following corrective measure alternatives are being compared in this section:

- Alternative 1 - No Action
- Alternative 2 - Limited Action: Institutional Controls
- Alternative 3 -Remove, Treat, and Dispose of Soil Contaminated at Concentrations Greater Than FDEP RGOs and Sediment Contaminated at Concentrations Greater Than ER-M Sediment Guideline Values; Treat Associated Surface Water.
- Alternative 4 -Remove, Treat, and Dispose of Contaminated Soil and Sediment at Concentrations Greater Than the Most Stringent Soil and Sediment RGOs; Treat Associated Surface Water.

6.2 COMPARATIVE ANALYSIS OF ALTERNATIVES

A corrective measure alternative is selected based on a comparison between the alternatives using the standards presented in the detailed analysis in Section 5.0. This section presents a comparative discussion of the corrective measure alternatives versus the evaluation standard.

6.2.1 Protection of Human Health and the Environment

The cumulative risks from all the corrective measure alternatives are less than 1.0E-4 for ICR and 1.0 for non-carcinogenic risk (see Appendix A). Based on the risk estimates there would be a progressive reduction of risks as corrective measures become more aggressive. The ICR for a trespassing adult is 1.65E-05 for Alternative 1. As summarized in Appendix A, Table A 9, the risks would be reduced to 3.99E-06 for Alternative 2, 1.05E-07 for Alternative 3, and 5.08E-08 for Alternative 4. For the adolescent trespasser, the ICR values are 1.22E-05, 3.32E-06, 8.84E-08, and 5.29E-08, respectively. Maintenance workers and occupational workers have relatively low risk values (less than 1.0E-06) and as they would only be exposed to the surface soil, there is a similar risk reduction in the various corrective measures. As summarized in Appendix A, Table A-8, non-carcinogenic risk values for trespassers in Alternative 1 are 1.63E-01 and 2.13E-01 for adults and adolescents, respectively. Risk levels are reduced to 4.21E-02 and 5.82E-02 for adults and adolescent trespassers, respectively, for Alternative 2 and 2.81E-03 and 5.01E-03 for Alternative 3. The respective non-carcinogenic risks were 1.64E-03 and 2.88E-03 for Alternative 4. As noted previously, risks for workers were relatively low and somewhat less affected by the controls.

Soil contaminants at the site do not appear to pose significant potential risks to terrestrial plant and animal receptors. However, potential risks to aquatic receptors and possibly piscivores are present in surface water and sediment, primarily from organochlorine pesticides. The great majority of contaminated soil and sediment was removed from SWMU 2 subsequent to the collection and analyses of all fish tissue samples and most of the abiotic samples. Thus, concentrations of pesticides in fish tissue should decrease over time, as existing fish are replaced by future generations. There would be a progressive reduction of risks to aquatic receptors as corrective measures become more aggressive. The extent to which Alternatives 3 and 4 would reduce ecological risks is unknown. Alternatives 2, 3, and 4 would incorporate a biomonitoring program consisting of periodic toxicity tests of surface water and sediment, and periodic chemical analyses of fish tissue collected from the site. The long-term monitoring program would verify or refute the expectation that ecological risks will decrease as a result of the IRA.

- Alternative 1 would not change the current potential risks to human health or the environment.

- Alternative 2 would reduce the risk to human health but would not reduce the risk to the environment. This alternative would monitor the effect of the IRA, which removed the bulk of the contaminated soil and sediment, the primary contaminant sources at the site.

- Alternative 3 would reduce the risk to human health and the environment from contaminants present in soil, sediment, and surface water. This alternative would remove the contaminated soil with concentrations in excess of RCRA Action Levels and/or FDEP Industrial RGOs remove contaminated sediment, and treat the surface water to meet the media clean-up standards.

- Alternative 4 would reduce the risk to human health and the environment. This alternative would remove all contaminated soil and sediment and treat the surface water to meet the media clean-up standards.

6.2.2 Media Clean-up Standards

This standard considers whether the corrective measure alternative will achieve the Media Clean-up Standards. In addition, this standard includes an assessment of relevant institutional needs for each corrective measure alternative. The effects of Federal, State of Florida, and local environmental regulations are also considered.

- Alternative 1 and 2 would not comply with the Media Clean-up Standards. However, Alternative 2 would monitor the effectiveness of the IRA, which removed the bulk of the primary contaminant source, on sediment and surface-water contaminant levels.

- Alternative 3 would comply with FDEP Industrial RGOs and would achieve the sediment and surface-water Media Clean-up Standards but would not comply with all the Media Clean-up Standards for soils. This alternative would monitor the potential for soil contamination to migrate and adversely impact to the sediment and surface water.

- Alternative 4 would comply with all the Media Clean-up Standards for soil, sediment, and surface water through the removal of contaminated soil and sediment and treatment of surface water.

6.2.3 Source Control

This standard evaluates the corrective measure alternatives for control of the source of contamination so as to reduce or eliminate further releases that may pose a threat to human health and the environment, to the furthest extent possible. This standard addresses whether source control measures are necessary and what type of source control actions would be appropriate.

- Alternatives 1 and 2 do not include source control measures. However, Alternative 2 would monitor the effect of the IRA conducted in Spring of 1996, which removed the majority of the primary source of contamination, on sediment and surface-water contaminant levels.

- Alternative 3 includes partial source control measures for the soil. Removal and treatment of the soil above FDEP Industrial RGOs does provide for control of the most contaminated portion of the primary source of contamination. The sediment, a secondary source of contamination, would also be controlled by this corrective measure alternative.

- Alternative 4 includes complete source control measures for the contaminated soil and sediment. The source control measures would provide protection of human health and the environment.

6.2.4 Waste Management Standards

The corrective measure alternative must comply with applicable standards for the management of wastes. This standard includes a description of how the specific waste management activities will be conducted in order to maintain compliance with all applicable state and federal regulations.

- Alternatives 1 and 2 do not include removal of any waste materials, and therefore, the management of waste material standards do not apply.

- Alternative 3 includes the removal, treatment, and disposal of the contaminated soil and sediment and treatment of the surface water. Removal and treatment of the soil, sediment, and surface water would be conducted in accordance with RCRA (40 CFR 262, 263, 264, and 268) and State of Florida (Chapter 62-730 F.A.C.) regulatory requirements, as well as equivalent requirements for the TSDFs state. Since contaminant concentrations may exceed the LDRs, an approved TSDF would be utilized for receipt of the contaminated soil. In addition, a licensed waste hauler would be used for transportation of the containerized waste materials to the permitted TSDF. All applicable RCRA and State of Florida waste management requirements would be adhered to in the containerization, labeling, and manifesting of site waste materials.

- Alternative 4 includes the removal, treatment, and disposal of the contaminated soil and sediment, and treatment of the surface water. Removal and treatment of the soil, sediment, and surface water would be conducted in accordance with RCRA (40 CFR 262, 263, 264, and 268) and State of Florida (Chapter 62-730 F.A.C.) regulatory requirements, as well as equivalent requirements for the TSDFs . Since contaminant concentrations may exceed the LDRs, an approved TSDF would be utilized for receipt of the contaminated soil and sediments. In addition, a licensed waste hauler would be used for transportation of the containerized waste materials to the permitted TSDF. All applicable RCRA and State of Florida waste management requirements would be adhered to in the containerization, labeling, and manifesting of the site materials.

6.2.5 Long-term Reliability and Effectiveness

Long-term reliability and effectiveness of the corrective measure alternatives evaluation includes an assessment of useful life, operation and maintenance requirements, and demonstrate reliability.

- Alternative 1 would allow for the human health and ecological residual risks to remain in the long term.

- Alternative 2 would allow for the residual risk to remain and would monitor the effects of the IRA removal in the long term. Alternative 2 provides for institutional controls, which would be considered relatively reliable and protective of human health in the long term when properly implemented. This alternative may not be protective of ecological receptors. However, this alternative would monitor the long-term effects of residual contamination on the environment.

- Alternative 3 would remove the most contaminated soil and sediment and treat surface water. It should be relatively protective in the long term of human health but some environmental risks may remain. This alternative would monitor the long-term effects of the soil and sediment removal on the environment.

- Alternative 4 would remove all contaminated soil and sediment and treat surface water and is considered reliable and protective of human health and the environment in the long term.

6.2.6 Reduction in the Toxicity, Mobility, or Volume of Wastes Through Treatment

This standard includes the ability of the corrective measure to reduce the toxicity, mobility, or volume of the contaminated media through treatment.

- Alternatives 1 and 2 do not include treatment, therefore, no reduction in the toxicity, mobility, or volume would be achieved. However, Alternative 2 would monitor the effect of the IRA, which removed, treated, and disposed of the bulk of the contaminated soil and sediment.

- Alternatives 3 and 4 may include treatment of the soil and sediment if required and treatment of the surface water by carbon adsorption. Both of these treatment technologies provide for a reduction in the toxicity and mobility of contaminants in the soil, sediment, and surface water.

6.2.7 Short-term Effectiveness

This standard includes an evaluation of the potential effects to the workers and community during implementation of the corrective measure. This standard is not applicable to Alternative 1- No Action.

- No significant risks to the community are anticipated for the four alternatives, other than the minimal risk associated with transportation of the contaminated media through the community and during off-site treatment and disposal under Alternatives 3 and 4.

- Alternative 2 has only minimal short-term risk to workers during sampling activities.Monitoring will continue until results adequately demonstrate to the EPA and FDEP that protection of off-site residents and the environment is achieved.

- Alternative 3 would have some short-term risk to workers because of the removal and treatment of the contaminated soil and sediment and treatment of the surface water. However, the risk to workers would be incrementally lower than Alternative 4, but higher than Alternative 2. The time needed to complete the soil and sediment removal and treatment action is estimated to be less than 1 year; however, the time needed to complete the monitoring portion of the institutional controls is dependent on approval of the EPA and FDEP. Also there are potential environmental impacts from the implementation of this alternative, since some excavation of wetlands, mangrove areas, and endangered species habitat could occur.

- Alternative 4 would have the highest potential for risk to workers because of the removal and treatment of contaminated soil, sediment, and surface water. However, this risk is anticipated to be minimal. The time needed to complete Alternative 4 is estimated to be 1 year. Also there are potential environmental impacts from the implementation of this alternative, since some excavation of wetlands, mangrove areas, and endangered species habitat could occur.

6.2.8 <u>Implementability</u>

This standard includes consideration of the relative ease of implementation, availability of equipment and services, the technical complexity of the process, and the ability to obtain required permits. The time needed to complete each corrective measure alternative is also provided. This criteria is not applicable to Alternative 1, No Action.

Alternative 2 involves institutional controls and is considered to be readily implementable. Institutional controls infer administrative access restrictions will require enforcement to maintain human health protection. Monitoring will continue until results adequately demonstrate to the EPA and FDEP that protection of off-site residents and the environment is achieved.

- Alternative 3 includes the removal of the most contaminated soil and sediment and treatment of the surface water. The removal of the contaminated soil and sediment is considered to be readily implementable because of the use of proven and commercially available technologies. The IRA conducted in the Spring of 1996 used these same corrective measure technologies. Likewise, the institutional controls component for sediment and surface water are considered to be implementable. Institutional controls infer administrative access restrictions will require enforcement to maintain human health protection. The time needed to complete the removal and treatment of contaminated soil and sediment and treatment of surface water is estimated to be less than 1 year. The time needed to complete the monitoring component of this alternative is dependent on the approval of EPA and FEDP.

- Alternative 4 is considered to be implementable. This alternative includes the use of proven and commercially available technologies. The IRA conducted in the Spring of 1996 used these same corrective measure technologies. The time needed to complete Alternative 4 is estimated to be 1 year.

6.2.9 Cost

A cost estimate of each of the corrective measures includes both capital, operation, and maintenance costs. Capital costs include both direct and indirect costs. Operation and maintenance costs are post-construction activities which are necessary to ensure the continued effectiveness of a corrective measure.

Alternative	Capital ($)	Operating ($/year.)	Present Worth ($)
1	0	0	0
2	1,614	13,500-54,000	219,768
3	1,002,348	13,500-54,000	1,220,502
4	6,230,131	10,500-54,000	6,350,432

6.3 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

Table 6-1 provides a table summarizing the comparative analysis of the corrective measure alternatives for the four alternatives based on the results of the evaluation presented in Section 6.2.

6.4 RECOMMENDED CORRECTIVE MEASURE ALTERNATIVE

The recommended alternative for this site is Alternative 2 - Limited Action. The site is within an active air strip (surrounded by runways or taxiways) on an active military base with no planned change in usage for the foreseeable future. This alternative would perform sediment, surface-water, and groundwater sampling and biomonitoring to determine the effectiveness of the IRA and would provide for 5-year reviews of the data collected. If the planned usage of the site changes to a more residential use scenario a new CMS should be conducted. If the IRA is not found to be protective of the environment, then Alternative 3 or 4 should be reconsidered.

TABLE 6-1

SUMMARY OF COMPARATIVE ANALYSIS OF CORRECTIVE MEASURE ALTERNATIVES
SWMU 2 CMS REPORT
NAS KEY WEST - BOCA CHICA KEY, FLORIDA
PAGE 1 OF 2

Alternative 1:	Alternative 2:	Alternative 3:	Alternative 4:
Protection of Human Health and the Environment			
Would not be protective of human health would not monitor the risks to the environment.	Would be protective of human health and would monitor the extent of contamination in the environment.	This alternative would be protective of human health and the environment by removing some contaminated soil and sediment and surface-water treatment.	Soil contaminated above RGOs and sediment would be removed and surface water treated which would be protective of human health and the environment.
Media Clean-up Standards			
Would not comply with media clean-up standards.	Same as Alternative 1.	Would achieve industrial soil clean-up standards and sediment and surface-water media clean-up standards.	Would achieve soil, sediment, and surface water media clean-up standards.
Source Control			
No new source control would be implemented.	Same as Alternative 1 and monitoring the effect of the IRA on sediment and surface-water contaminant concentrations.	The contaminated soil, the primary source, in excess of the Industrial RGOs and sediment ERM values would be removed, treated, and disposed off-site and, if required, surface-water would be treated.	The soil contaminated in excess of the RGOs, the balance of the primary source, and sediment would be removed, treated, and disposed off-site and, if required, surface-water would be treated.
Waste Management Standards			
No standards applicable as no waste will be generated.	Same as Alternative 1.	Would comply with all applicable waste management standards during implementation.	Same as Alternative 3.
Long-term Reliability and Effectiveness			
No controls would be in place, residual contamination and existing risks would remain	Limited site access would provide control. The effectiveness of the IRA would be measured with long-term monitoring with 5-year reviews to determine need for further action.	Long-term effectiveness of this alternative which removes some of the primary source and the sediment is easily measured with long-term monitoring to assess the decrease of contamination concentrations in the environment.	This alternative would be very effective in the long-term by removing the contaminated soil, which is the balance of the primary source, and sediment and, if necessary, treating surface water.

TABLE 6-1

SUMMARY OF COMPARATIVE ANALYSIS OF CORRECTIVE MEASURE ALTERNATIVES
SWMU 2 CMS REPORT
NAS KEY WEST - BOCA CHICA KEY, FLORIDA
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Alternative 1: No Action	Alternative 2: Limited Action	Alternative 3: Removal/Treatment/ Disposal of Soil and Limited Actions for Sediment and Surface Water	Alternative 4: Removal/Treatment/ Disposal of Soil/Sediment and Removal/ Treatment of Surface Water
Reduction in Toxicity, Mobility, or Volume through Treatment			
This alternative involves no treatment to reduce toxicity, mobility, or volume of the contaminated media.	Same as Alternative 1.	This alternative involves treatment of soil, sediment, and surface water to reduce toxicity, mobility, and volume of the waste.	This alternative involves treatment of the soil, sediment, and surface water to reduce toxicity, mobility, and volume of the waste.
Short-term Effectiveness			
This alternative doesnot reduce risk of exposure to contamination and would not pose any new risk during implementation.	This alternative reduces risk of exposure through institutional controls and would pose only minimal risk during long-term monitoring.	The risks would be during the removal, treatment and disposal of contaminated soil and sediment. Community risk would only be during transport, treatment and disposal of the contaminated media.	The risks would be during the removal, treatment and disposal of contaminated soil and sediment. Community risk would only be during transport, treatment and disposal of the contaminated media.
Implementability			
Readily implementable since no action would occur.	Easily implementable as site is located within active military air strip where rules can be strictly enforced.	No difficulties are anticipated. Excavation contractors are readily available and the remediation technologies are well proven.	Same as Alternative 3.
Cost (Total Present Worth)			
$0.00	$219,768	$1,220,502	$6,350,432

Alternative 1 - No Action
Alternative 2 - Limited Action: Institutional Controls
Alternative 3 - Remove, Treat, and Dispose of Soil Contaminated at Concentrations Greater Than FDEP RGOS and Sediment Contaminated at Concentrations Greater Than ER-M Sediment Guideline Values; Treat Associated Surface Water
Alternative 4 - Remove, Treat, and Dispose of Contaminated Soil and Sediment at Concentrations Greater Than the Most Stringent Soil and Sediment RGOs; Treat Associated Surface Water

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APPENDIX A

HUMAN HEALTH RISK ASSESSMENT CALCULATIONS

A.1 HUMAN HEALTH RISK ASSESSMENT CALCULATIONS

A.1.1 REMEDIAL GOAL OPTIONS (RGOS)

Details of the RGO determinations are presented in the Supplemental RFI/RI report (BRE, 1996). They were calculated for several potential human receptors at NAS Key West. All exposure pathways (considering all receptors, media, and routes of exposure) with Incremental Cancer Risks (ICRs) of more than 1E-06 and/or Hazard Indices (HIs) of more than 1.0 were identified. For each scenario, individual chemicals which contributed at least 1E-06 to the ICR or 0.1 to the HI were selected. If the risk or hazard values approached these levels, the contributing chemicals were also included in the RGO calculations.

Site-specific RGOs accounted for all of the same exposure pathways and intake scenarios that were applied in the baseline risk assessment. They were developed by modifying the representative concentrations that were used in the calculation of cancer risks or HQs by the required proportion to yield concentrations with a target risks equal to several designated thresholds of risk (1E-06,1E-05, and 1E-04 cancer risks, or HQs of 0.1, 1.0, and 3.0). The calculated cancer and/or non-cancer risk values (ICR or HI) for each contributing route of exposure (ingestion, dermal, inhalation) were added for each chemical selected. The following equation was then used to determine the relevant RGOs:

RGO = (Exposure Concentration)(Desired Risk Level)/(Calculated Risk Value)

RGO calculations were completed through the use of computer spreadsheets.

A.1.2 RISKS FOR CORRECTIVE MEASURE ALTERNATIVES

Human health risk values were recalculated for each of several proposed corrective measure alternatives by modification of the cancer and non-cancer risks originally determined. In this way, the original input parameters remained intact and the original representative concentrations could be used. All original COCs were included in the new risk calculations and, wherever appropriate, all original exposure pathways were considered.

A.1.2.1 <u>Alternative 1 (No Action)</u>

This alternative assumes that there will be no institutional controls, media removal, or media treatment. The site will be left as is and, therefore, all human health risks originally calculated would still apply. This option is considered primarily for comparative purposes, as the various corrective measures are evaluated.

A.1.2.2 Alternative 2 (Institutional Controls)

This alternative involves limitation of site access and use. Warning signs would be posted and a number of other security measures would be employed. From a human health risk assessment perspective, the effect would be reduced exposure to the site media. No residents or excavation workers would be permitted on site. Trespassers would be actively discouraged from entering the site, and the assumed frequency of exposure would be no more than once a month. Workers and trespassing adults would be expected to make an effort to avoid ingestion or skin contact with the media because of the hazard posting. Reductions of these exposures were assumed to be reduced at least by half. Workers would be required to be on site less of the time - assumedly a frequency of half of the previous time. The reduction factors for the various scenarios are shown in Table A-1. These factors were multiplied times the associated risks previously calculated to give new risks values. The new risks are shown in Table A-2 and are compared to the original risk calculations in Table A-3.

Cancer risks for both adult and adolescent trespassers still exceed 1.0E-06 under the institutional controls alternative. Most of the risk arises from dermal contact with sediment and surface water. The values for these pathways ranged from 1.16E-06 (dermal exposure to sediment by adolescents) to 2.26E-06 (dermal exposure to surface water by adults). There were no hazard indices (non-cancer risk values) greater than 0.1 when calculated by Alternative 2 conditions.

A.1.2.3 Alternative 3 (Soil Removal and Institutional Controls)

This alternative includes institutional controls as described under A.1.2.2 and the further action of soil removal, sediment removal and on-site water treatment. In effect, any media with a contaminant that exceeds its preliminary remedial goal (PRG) would be moved off site or, in the case of surface water, treated to maintain PRG levels. The PRG concentration is selected from a number of values reflecting human health risk, ecological risk, and State or Federal screening or cleanup levels. Typically, the lowest value among these is chosen. However, for soil the PRG was the FDEP Industrial Clean-Up Goal.

For human health, risks from exposure to media would be limited to the risks associated with the PRG concentrations, since it would be the maximum soil concentration permitted at the site. Therefore, risks of exposure were recalculated by modifying the representative concentrations that were used in the

TABLE A-1
Factors for Recalculating Cumulative Risks
Corrective Measures Alternative 2 (Institutional Controls)[1]
SWMU 2
NAS Key West

	Trespassers				Workers			
Exposure Route	Adult Revised/Orig. Assumptions[2]	Adult Multplication Factor[3]	Adolesc. Revised/Orig. Assumptions	Adolesc. Multiplication Factor	Mainten. Revised/Orig. Assumptions	Mainten. Multiplication Factor	Occupat. Revised/Orig. Assumptions	Occupat. Multiplication Factor
Surface Soil								
Dermal Contact	EF=12/24	0.5	EF=12/30	0.4	IR=50/118	0.42	EF=125/250	0.5
Incidental Ingestion	IR=50/100 EF=12/24	0.25	EF=12/30	0.4	SA=2300/ 5750	0.4	EF=125/250	0.5
Inhalation of Fugitive Dust	EF=12/24	0.5	EF=12/30	0.4	All the same	1.0	EF=125/250	0.5
Sediment								
Dermal Contact	EF-12/45	0.27	EF=12/45	0.27				
Incidental Ingestion	IR=50/100 EF=12/45	0.13	EF=12/45	0.27				
Surface Water								
Dermal Contact	EF=12/45	0.27	EF=12/45	0.27				
Incidental Ingestion	IR=0.065/0.13 EF=12/45	0.13	EF=12/45	0.27				

[1] Exposure assumptions were revised to reflect changes that would result if institutional controls such as warning signs, access restrictions, use restrictions, etc. are implemented. No residents or excavation workers are included because resicence or building would not be permitted on the site.
[2] With institutional controls, it is assumed that any trespassing would occur no more than one time per month (12 events/year). Ingestion rate for soil and water would limited to one half of the previous level for adults because it is assumed that hazard posting would increase efforts to limit intake.
[3] The risk ratios are multiplied to develop multiplication factors which are then multiplied by the risks originally calculated to give new risks.

TABLE A-2
Cumulative Risks
Corrective Measures Alternative 2 (Institutional Controls)[1]
SWMU 2
NAS Key West

Incremental Cancer Risk	Trespassers		Workers	
Exposure Route	Adult	Adolescent	Maintenance	Occupational
Surface Soil				
Dermal Contact	6.05E-08	4.40E-08	3.19E-08	3.32E-07
Incidental Ingestion	8.78E-09	1.78E-08	1.15E-08	1.20E-07
Inhalation of Fugitive Dust	5.00E-11	5.08E-11	1.32E-10	1.37E-09
Sediment				
Dermal Contact	1.59E-06	1.16E-06	-	-
Incidental Ingestion	6.67E-08	1.40E-07	-	-
Surface Water				
Dermal Contact	2.26E-06	1.94E-06	-	-
Incidental Ingestion	6.93E-09	1.46E-08	-	-
Total	3.99E-06	3.32E-06	4.35E-08	4.53E-07

Hazard Index	Trespassers		Workers	
Exposure Route	Adult	Adolescent	Maintenance	Occupational
Surface Soil				
Dermal Contact	5.65E-04	7.12E-04	2.26E-04	2.36E-03
Incidental Ingestion	2.95E-04	1.03E-03	2.92E-04	3.07E-03
Inhalation of Fugitive Dust	-	-	-	-
Sediment				
Dermal Contact	1.63E-02	2.05E-02	-	-
Incidental Ingestion	8.79E-04	3.19E-03	-	-
Surface Water				
Dermal Contact	2.30E-02	2.89E-02	-	-
Incidental Ingestion	1.06E-03	3.86E-03	-	-
Total	4.21E-02	5.82E-02	5.18E-04	5.43E-03

[1] Exposure assumptions were revised to reflect fewer days on site for most receptors, lower intake rates for adults, and smaller exposure area for maintenance workers. Factors used are explained in Table 1. No residents or excavation workers are included here because institutional controls would prevent their presence on site.

TABLE A-3
Cumulative Risks
Corrective Measures Alternative 2 (Institutional Controls)[1]
SWMU 2
NAS Key West

Incremental Cancer Risk	Trespassers				Workers			
Exposure Route	Adult Altern. 1[2]	Adult Altern. 2	Adolesc. Altern. 1	Adolesc. Altern. 2	Mainten. Altern. 1	Mainten. Altern. 2	Occupat. Altern. 1	Occupat. Altern. 2
Surface Soil								
Dermal Contact	1.21E-07	6.05E-08	1.10E-07	4.40E-08	7.97E-08	3.19E-08	6.64E-07	3.32E-07
Incidental Ingestion	3.51E-08	8.78E-09	4.45E-08	1.78E-08	2.73E-08	1.15E-08	2.41E-07	1.20E-07
Inhalation of Fugitive Dust	1.00E-10	5.00E-11	1.27E-10	5.08E-11	1.32E-10	1.32E-10	2.74E-09	1.37E-09
Sediment								
Dermal Contact	5.90E-06	1.59E-06	4.30E-06	1.16E-06	-	-	-	-
Incidental Ingestion	5.13E-07	6.67E-08	5.20E-07	1.40E-07	-	-	-	-
Surface Water								
Dermal Contact	9.86E-06	2.26E-06	7.18E-06	1.94E-06	-	-	-	
Incidental Ingestion	5.33E-08	6.93E-09	5.40E-08	1.46E-08	-	-	-	
Total	1.65E-05	3.90E-06	1.22E-05	3.32E-06	1.07E-07	4.35E-08	9.08E-07	4.53E-07

Hazard Index	Trespassers				Workers			
Exposure Route	Adult Altern. 1	Adult Altern. 2	Adolesc. Altern. 1	Adolesc. Altern. 2	Mainten. Altern. 1	Mainten. Altern. 2	Occupat. Altern. 1	Occupat. Altern. 2
Surface Soil								
Dermal Contact	1.13E-03	5.65E-04	1.78E-03	7.12E-04	5.65E-04	2.26E-04	4.71E-03	2.36E-03
Incidental Ingestion	1.18E-03	2.95E-04	2.58E-03	1.03E-03	6.95E-04	2.92E-04	6.14E-03	3.07E-03
Inhalation of Fugitive Dust	-	-	-	-	-	-	-	-
Sediment								
Dermal Contact	6.04E-02	1.63E-02	7.60E-02	2.05E-02	-	-	-	-
Incidental Ingestion	6.76E-03	8.79E-04	1.18E-02	3.19E-03	-	-	-	-
Surface Water								
Dermal Contact	8.50E-02	2.30E-02	1.07E-01	2.89E-02	-	-	-	-
Incidental Ingestion	8.15E-03	1.06E-03	1.43E-02	3.86E-03	-	-	-	-
Total	1.63E-01	4.21E-02	2.13E-01	5.82E-02	1.26E-03	5.18E-04	1.08E-02	5.43E-03

[1] Exposure assumptions were revised to reflect fewer days on site for most receptors, lower intake rates for adults, and smaller exposure area for maintenance workers. Factors used are explained in a separate table. No residents or excavation workers are included here because institutional controls would prevent their presence on site.
[2] Alternative 1 assumes no action would be taken; therefore, the risks are the same as previously calculated.

calculation of cancer risks or HQs to give the new risks at the PRG level. The following equation was used:

Original Risk Value/Representative Concentration = Risk at PRG/(PRG Concentration)

Solving for the risk at the PRG, the equation becomes:

Risk at PRG = (Original Risk Value)(PRG Concentration)/Representative Concentration

Risks were recalculated through the use of computer spreadsheets for all COCs and applicable pathways as originally calculated. Cancer risks from contact with surface soil are well below the 1E-06 limit for all receptors under Alternative 3. The highest risk was 1.91E-05 for the adult trespasser. This is still below the unacceptable limit of 1.0E-04. These higher risks for Alternative 3 reflect the relatively high FDEP Clean-Up Goals compared to actual on-site concentrations. Otherwise, the risks were below 1.0E-06 for carcinogens and 1.0 for non-carcinogens as seen in Table A-4.

For comparative purposes, risks from exposure to soil to were calculated again, using the PRG levels and factoring in adjustments for institutional controls as done for Alternative 2. The factors shown in Table A-1 were again used. Of course, risks were lower than those considering only cleanup at PRGs with exposure to soil well below the 1.0E-06 limit. The values are presented in Table A-5.

A.1.2.4 Alternative 4 (Soil and Sediment Removal, Water Treatment, Institutional Controls)

This alternative includes institutional controls as described under A.1.2.2 and the further action of soil and sediment removal, as well as on-site treatment of surface water. In effect, any soil or sediment with a contaminant that exceeds its preliminary remedial goal (PRG) would be moved off site. Soil PRGs are based on the lowest of several ARARs and not based on FDEP Clean-Up Goals. Additionally, water would be treated to insure that it does not contain any contaminant exceeding its PRG. Human health risks, therefore, for soil, sediment, and surface water exposure were recalculated by modifying the representative concentrations that were used in the original calculations of cancer risk or HQ to give the new risks at the PRG level. The methodology discussed in A.1.2.3 was followed.

Risks were recalculated through the use of computer spreadsheets for all COCs and applicable pathways as originally calculated. Risk values from all media were well below 1E-06 for carcinogens and 1.0 for non-carcinogens as seen in Table A-6.

TABLE A-4
Cumulative Risks
Corrective Measures Alternative 3
(Soil and Sediment Removal, Surface Water Treatment; FDEP Soil Industrial Clean-Up)[1]
SWMU 2
NAS Key West

Incremental Cancer Risk	Trespassers		Workers	
Exposure Route	Adult	Adolescent	Maintenance	Occupational
Surface Soil				
Dermal Contact	3.49E-06	3.17E-06	2.30E-06	1.91E-05
Incidental Ingestion	3.03E-07	3.84E-07	2.35E-07	2.08E-06
Inhalation of Fugitive Dust	5.42E-10	6.88E-10	7.16E-10	1.49E-08
Sediment				
Dermal Contact	1.97E-08	1.43E-08	-	-
Incidental Ingestion	1.71E-09	1.74E-09	-	-
Surface Water				
Dermal Contact	1.13E-07	8.24E-08	-	-
Incidental Ingestion	4.52E-10	4.59E-10	-	-
Total	3.92E-06	3.65E-06	2.54E-06	2.12E-05

Hazard Index	Trespassers		Workers	
Exposure Route	Adult	Adolescent	Maintenance	Occupational
Surface Soil				
Dermal Contact	4.08E-02	6.42E-02	2.04E-02	1.70E-01
Incidental Ingestion	5.38E-02	1.18E-01	3.18E-02	2.81E-01
Inhalation of Fugitive Dust	-	-	-	-
Sediment				
Dermal Contact	1.86E-04	2.34E-04	-	-
Incidental Ingestion	1.62E-05	2.83E-05	-	-
Surface Water				
Dermal Contact	2.61E-04	3.29E-04	-	-
Incidental Ingestion	3.34E-05	5.83E-05	-	-
Total	9.51E-02	1.83E-01	5.22E-02	4.51E-01

[1] For Alternative 3, soil and sediment removal would be completed for areas where clean-up levels are exceeded. Therefore, risks for soil and sediment were recalculated to reflect contaminant concentrations at PRG levels, with soil PRGs based on the FDEP Industrial Clean-Up Goals. Surface water would be treated to PRG levels and risk calculations were completed accordingly. No residents or excavation workers are included here because institutional controls would prevent their presence on site.

TABLE A-5
Cumulative Risks
Corrective Measures Alternative 3
[Soil and Sedimint Removal, Surface Water Treatment; FDEP Soil Industrial Clean-Up (Institutional Controls Included for All Media)] [1]
SWMU 2
NAS Key West

Incremental Cancer Risk	Trespassers		Workers	
Exposure Route	Adult	Adolescent	Maintenance	Occupational
Surface Soil				
Dermal Contact	1.76E-06	3.17E-06	9.73E-07	9.64E-06
Incidental Ingestion	1.03E-07	2.09E-07	1.28E-07	1.42E-06
Inhalation of Fugitive Dust	2.17E-10	2.75E-10	7.16E-10	7.45E-09
Sediment				
Dermal Contact	5.33E-09	3.87E-09	-	-
Incidental Ingestion	2.23E-10	4.69E-10	-	-
Surface Water				
Dermal Contact	3.05E-08	2.22E-08	-	-
Incidental Ingestion	5.88E-11	1.24E-10	-	-
Total	1.87E-06	3.41E-06	1.10E-06	1.11E-05

Hazard Index	Trespassers		Workers	
Exposure Route	Adult	Adolescent	Maintenance	Occupational
Surface Soil				
Dermal Contact	2.04E-02	6.42E-02	8.57E-03	8.48E-02
Incidental Ingestion	1.34E-02	4.71E-02	1.27E-02	1.40E-01
Inhalation of Fugitive Dust	-	-	-	-
Sediment				
Dermal Contact	5.04E-05	6.33E-05	-	-
Incidental Ingestion	2.11E-06	7.65E-06	-	-
Surface Water				
Dermal Contact	7.06E-05	8.89E-05	-	-
Incidental Ingestion	4.34E-06	1.57E-05	-	-
Total	3.39E-02	1.11E-01	2.13E-02	2.25E-01

[1] For Alternative 3, soil and sediment removal would be completed for areas where clean-up levels are exceeded. Therefore, risks for soil and sediments were recalculated to reflect contaminant concentrations at PRG levels, with soil PRGs based on FDEP Industrial Clean-Up Goals. Surface water would be treated to PRG levels and risk calculations were completed accordingly. Institutional controls would be used to limit risk from exposure to all media. Exposure assumptions for the media were revised to reflect fewer days on site for most receptors, lower intake rates for adults, and a smaller exposure area for maintenance workers. Factors used are explained in Table 1. No residents or excavation workers are included here because institutional controls would prevent their presence on site.

TABLE A-6
Cumulative Risks
Corrective Measures Alternative 4
(Soil and Sediment Removal, Surface Water Treatment; Clean-Up to PRG)[1]
SWMU 2
NAS Key West

Incremental Cancer Risk	Trespassers		Workers	
Exposure Route	Adult	Adolescent	Maintenance	Occupational
Surface Soil				
Dermal Contact	2.70E-08	2.45E-08	1.78E-08	1.48E-07
Incidental Ingestion	2.34E-09	2.97E-09	1.82E-09	1.61E-08
Inhalation of Fugitive Dust	5.71E-12	7.25E-12	7.55E-12	7.85E-11
Sediment				
Dermal Contact	1.97E-08	1.43E-08	-	-
Incidental Ingestion	1.71E-09	1.74E-09	-	-
Surface Water				
Dermal Contact	1.13E-07	8.24E-08	-	-
Incidental Ingestion	4.52E-10	4.59E-10	-	-
Total	1.64E-07	1.26E-07	1.96E-08	1.64E-07

Hazard Index	Trespassers		Workers	
Exposure Route	Adult	Adolescent	Maintenance	Occupational
Surface Soil				
Dermal Contact	4.18E-04	6.58E-04	2.09E-04	1.74E-03
Incidental Ingestion	7.19E-04	1.57E-03	4.25E-04	3.76E-03
Inhalation of Fugitive Dust	-	-	-	-
Sediment				
Dermal Contact	1.86E-04	2.34E-04	-	-
Incidental Ingestion	1.62E-05	2.83E-05	-	-
Surface Water				
Dermal Contact	2.61E-04	3.29E-04	-	-
Incidental Ingestion	3.34E-05	5.83E-05	-	-
Total	1.64E-03	2.88E-03	6.34E-04	5.50E-03

[1] For Alternative 3, soil and sediment removal would be completed for areas where PRGs are exceeded and, therefore, risks for soil and sediment were recalculated to reflect contaminant concentrations at PRG levels. Surface water would be treated to PRG levels and risk calculations were completed accordingly. No residents or excavation workers are included here because institutional controls would prevent their presence on site.

For comparative purposes, risks from exposure to soil, sediment, and surface waster were calculated again, using the PRG levels and factoring in adjustments for institutional controls as done for Alternative 2. The factors shown in Table A-1 were again used. Of course, risks were even lower than considering only cleanup at PRGs. The values are presented in Table A-7.

A.1.3 COMPARISON OF RISKS FOR CORRECTIVE MEASURE ALTERNATIVES

The cumulative risks from all 4 corrective measure alternatives are summarized in Tables A-8 and A-9. In Table A-8, institutional controls are not considered for soil (Alternative 3) or for any media (Alternative 4). The data in this table show the progressive reduction of risks as corrective measure become more aggressive. The total cancer risk for a trespassing adult is 1.65E-05 with no controls (Alternative 1). The risks drops to 3.99E-06 (Alternative 2), 2.90E-07 (Alternative 3), and 1.64E-07 (Alternative 4) as controls are implemented. For the adolescent trespasser, the respective cancer risk values are 1.22E-05, 3.32E-06, 2.54E-07, and 1.26E-07. Maintenance workers and occupational workers have relatively low risk values and since they are only exposed to the surface soil, risk reduction is somewhat less marked by the various corrective measures, except that risks under Alternative 3 are equal to those under Alternative 4. As noted previously, FDEP Industrial Clean-Up Goals for soil are less stringent than other criteria and often exceed on-site conditions. Non-cancer risk values for trespassers are 1.63E-01 (adults) and 2.13E-01 (adolescents) without controls (Alternative 1). Risks levels are reduced to approximately 4.21E-02 and 5.82E-02 for adults and adolescent trespassers, respectively using Alternative 2 and 3.0E-03 and 5.0E-03 using Alternative 3. With Alternative 4, the respective non-cancer risks were 1.64E-03 and 2.88E-03. As noted previously, risks for workers were relatively low and somewhat less affected by the controls.

The risks summarized in Table A-9 include institutional controls for Alternatives 2, 3, and 4 for all media. Total cancer and non-cancer risks are, of course, identical to those in Table A-8 for Alternative 2 and are similar (somewhat less) for Alternatives 3 and 4.

TABLE A-7
Cumulative Risks
Corrective Measures Alternative 4
[Soil and Sedimint Removal, Surface Water Treatment; Clean-Up To PRG (Institutional Controls Included for All Media)] [1]
SWMU 2
NAS Key West

Incremental Cancer Risk	Trespassers		Workers	
Exposure Route	Adult	Adolescent	Maintenance	Occupational
Surface Soil				
Dermal Contact	1.37E-08	2.45E-08	7.55E-09	7.48E-08
Incidental Ingestion	8.93E-10	1.81E-09	1.11E-09	1.23E-08
Inhalation of Fugitive Dust	2.86E-12	2.90E-12	7.55E-12	7.85E-11
Sediment				
Dermal Contact	5.33E-09	3.87E-09	-	-
Incidental Ingestion	2.23E-10	4.69E-10	-	-
Surface Water				
Dermal Contact	3.05E-08	2.22E-08	-	-
Incidental Ingestion	5.88E-11	1.24E-10	-	-
Total	5.08E-08	5.29E-08	8.67E-09	8.72E-08

Hazard Index	Trespassers		Workers	
Exposure Route	Adult	Adolescent	Maintenance	Occupational
Surface Soil				
Dermal Contact	2.09E-04	6.58E-04	8.78E-05	8.69E-04
Incidental Ingestion	1.80E-04	6.30E-04	1.70E-04	1.88E-03
Inhalation of Fugitive Dust	-	-	-	-
Sediment				
Dermal Contact	5.04E-05	6.33E-05	-	-
Incidental Ingestion	2.11E-06	7.65E-06	-	-
Surface Water				
Dermal Contact	7.06E-05	8.89E-05	-	-
Incidental Ingestion	4.34E-06	1.57E-05	-	-
Total	5.16E-04	1.47E-03	2.58E-04	2.75E-03

[1] For Alternative 4, soil and sediment removal would be completed for areas where clean-up levels are exceeded. Therefore, risks for soil and sediments were recalculated to reflect contaminant concentrations at PRG levels. Surface water would be treated to PRG levels and risk calculations were completed accordingly. Institutional controls would be used to limit risk from exposure to all media. Exposure assumptions for the media were revised to reflect fewer days on site for most receptors, lower intake rates for adults, and a smaller exposure area for maintenance workers. Factors used are explained in Table 1. No residents or excavation workers are included here because institutional controls would prevent their presence on site.

Table A-8
Cumulative Cancer Risk Summary
Corrective Measures for Alternatives 1-4[1]
(Institutional Controls not Used in Alternatives 3 and 4 Calculations)
SWMU 2
NAS Key West

Incremental Cancer Risk	Trespassers		Workers	
Alternative and Medium	Adult	Adolescent	Maintenance	Occupational
Alternative 1				
Surface Soil	1.56E-07	1.55E-07	1.07E-07	9.08E-07
Sediment	6.41E-06	4.82E-06	-	-
Surface Water	9.91E-06	7.23E-06	-	-
Total	1.65E-05	1.22E-05	1.07E-07	9.08E-07
Alternative 2				
Surface Soil	6.93E-08	6.18E-08	4.35E-08	4.53E-07
Sediment	1.66E-06	1.30E-06	-	-
Surface Water	2.27E-06	1.95E-06	-	-
Total	3.99E-06	3.32E-06	4.35E-08	4.53E-07
Alternative 3				
Surface Soil[2]	1.56E-07	1.55E-07	1.07E-07	9.08E-07
Sediment	2.14E-08	1.60E-08	-	-
Surface Water	1.13E-07	8.29E-08	-	-
Total	2.90E-07	2.54E-07	1.07E-07	9.08E-07
Alternative 4				
Surface Soil	2.93E-08	2.75E-08	1.96E-08	1.64E-07
Sediment	2.14E-08	1.60E-08	-	-
Surface Water	1.13E-07	8.29E-08	-	-
Total	1.64E-07	1.26E-07	1.96E-08	1.64E-07

1. Alternative 1 is no action; Alternative 2 is institutional controls only; Alternatives 3 and 4 are soil and sediment removal, surface water treatment, and institutional controls (risks calculated here are not adjusted for institutional controls) . In Alternative 3, soil contaminant levels will be maintained below FDEP Industrial Clean-Up Goals. No residents or excavation workers are included here because institutional controls would prevent their presence on site under Alternatives 2-4.
2. Risk levels used were based on existing conditions without institutional controls (Alternative 1) as calculated risk levels for soil clean-up to Industrial Clean-Up Goals were higher than risk levels calculated for actual site contamination.

(continued)

TABLE A-8 (CONTINUED)

Cumulative Noncancer Risk Summary

Corrective Measures for Alternatives 1-4

(Institutional Controls not Used in Alternatives 3 and 4 Calculations)

SWMU 2

NAS Key West

Hazard Index	Trespassers		Workers	
Alternative and Medium	Adult	Adolescent	Maintenance	Occupational
Alternative 1				
Surface Soil	2.31E-03	4.36E-03	1.26E-03	1.08E-02
Sediment	6.72E-02	8.78E-02	-	-
Surface Water	9.32E-02	1.21E-01	-	-
Total	1.63E-01	2.13E-01	1.26E-03	1.08E-02
Alternative 2				
Surface Soil	8.60E-04	1.74E-03	5.18E-04	5.43E-03
Sediment	1.72E-02	2.37E-02	-	-
Surface Water	2.41E-02	3.28E-02	-	-
Total	4.21E-02	5.82E-02	5.18E-04	5.43E-03
Alternative 3				
Surface Soil[2]	2.31E-03	4.36E-03	1.26E-03	1.08E-02
Sediment	2.02E-04	2.62E-04	-	-
Surface Water	2.94E-04	3.87E-04	-	-
Total	2.81E-03	5.01E-03	1.26E-03	1.08E-02
Alternative 4				
Surface Soil	1.14E-03	2.23E-03	6.34E-04	5.50E-03
Sediment	2.02E-04	2.62E-04	-	-
Surface Water	2.94E-04	3.87E-04	-	-
Total	1.64E-03	2.88E-03	6.34E-04	5.50E-03

1. Alternative 1 is no action; Alternative 2 is institutional controls only; Alternatives 3 and 4 are soil and sediment removal, surface water treatment, and institutional controls (risks calculated here are not adjusted for institutional conrols). In Alternative 3, soil contaminant levels will be maintained below FDEP Industrial Clean-Up Goals. No residents or excavation workers are included here because institutional controls would prevent their presence on site under Alternatives 2-4.
2. Risk levels used were based on existing conditions without intsitutional controls (Alternative 1) as calculated risk levels for soil clean-up to Industrial Clean-Up Goals were higher than risk levels calculated for actual site contamination.

Table A-9
Cumulative Cancer Risk Summary
Corrective Measures for Alternatives 1-4[1]
(Institutional Controls Used in Alternatives 2- 4 Calculations)
SWMU 2
NAS Key West

Incremental Cancer Risk	Trespassers		Workers	
Alternative and Medium	Adult	Adolescent	Maintenance	Occupational
Alternative 1				
Surface Soil	1.56E-07	1.55E-07	1.07E-07	9.08E-07
Sediment	6.41E-06	4.82E-06	-	-
Surface Water	9.91E-06	7.23E-06	-	-
Total	1.65E-05	1.22E-05	1.07E-07	9.08E-07
Alternative 2				
Surface Soil	6.93E-08	6.18E-08	4.35E-08	4.53E-07
Sediment	1.66E-06	1.30E-06	-	-
Surface Water	2.27E-06	1.95E-06	-	-
Total	3.99E-06	3.32E-06	4.35E-08	4.53E-07
Alternative 3				
Surface Soil[2]	6.93E-08	6.18E-08	4.35E-08	4.53E-07
Sediment	5.55E-09	4.34E-09	-	-
Surface Water	3.06E-08	2.23E-08	-	-
Total	1.05E-07	8.84E-08	4.35E-08	4.53E-07
Alternative 4				
Surface Soil	1.46E-08	2.63E-08	8.67E-09	8.72E-08
Sediment	5.55E-09	4.34E-09	-	-
Surface Water	3.06E-08	2.23E-08	-	-
Total	5.08E-08	5.29E-08	8.67E-09	8.72E-08

1. Alternative 1 is no action; Alternative 2 is institutional controls only; Alternatives 3 and 4 are soil and sediment removal, surface water treatment, and institutional controls (risks calculated here are adjusted for institutional conrols) . No residents or excavation workers are included here because institutional controls would prevent their presence on site under Alternatives 2-4.
2. Risk levels used were based on existing conditions with institutional controls (Alternative 2) as calculated risk levels for soil clean-up to Industrial Clean-Up Goals were higher than risk levels calculated for actual site contamination.

(continued)

TABLE A-9(CONTINUED)

Cumulative Noncancer Risk Summary
Corrective Measures for Alternatives 1-4
(Institutional Controls Used in Alternatives 2-4 Calculations)
SWMU 2
NAS Key West

Hazard Index	Trespassers		Workers	
Alternative and Medium	Adult	Adolescent	Maintenance	Occupational
Alternative 1				
Surface Soil	2.31E-03	4.36E-03	1.26E-03	1.08E-02
Sediment	6.72E-02	8.78E-02	-	-
Surface Water	9.32E-02	1.21E-01	-	-
Total	1.63E-01	2.13E-01	1.26E-03	1.08E-02
Alternative 2				
Surface Soil	8.60E-04	1.74E-03	5.18E-04	5.43E-03
Sediment	1.72E-02	2.37E-02	-	-
Surface Water	2.41E-02	3.28E-02	-	-
Total	4.21E-02	5.82E-02	5.18E-04	5.43E-03
Alternative 3				
Surface Soil[2]	8.60E-04	1.74E-03	5.18E-04	5.43E-03
Sediment	5.25E-05	7.10E-05	-	-
Surface Water	7.49E-05	1.05E-04	-	-
Total	9.87E-04	1.92E-03	5.18E-04	5.43E-03
Alternative 4				
Surface Soil	3.89E-04	1.29E-03	2.58E-04	2.75E-03
Sediment	5.25E-05	7.10E-05	-	-
Surface Water	7.49E-05	1.05E-04	-	-
Total	5.16E-04	1.47E-03	2.58E-04	2.75E-03

1. Alternative 1 is no action; Alternative 2 is institutional controls only; Alternatives 3 and 4 are soil and sediment removal, surface water treatment, and institutional controls (risks calculated here are adjusted for institutional conrols) . No residents or excavation workers are included here because institutional controls would prevent their presence on site under Alternatives 2-4.
2. Risk levels used were based on existing conditions with institutional controls (Alternative 2) as calculated risk levels for soil clean-up to Industrial Clean-Up Goals were higher than risk levels calculated for actual site contamination.

REMEDIAL GOAL OPTIONS	
NAS KEY WEST	SWMU 2
RECEPTOR:	CHILD/ADULT RESID.
MEDIUM:	SURFACE SOIL

Chemical of Concern	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Exposure Conc (mg/kg)	Remedial Goal Options (mg/kg) 1.00E-06	1.00E-05	1.00E-04
Beryllium	1.55E-06	1.85E-07	1.53E-08		1.75E-06	0.23	0.131	1.31	13.14
4,4'-DDD	1.19E-07	5.69E-07			6.88E-07	0.316	0.46	4.59	45.93
4,4'-DDE	1.89E-07	1.39E-06			1.58E-06	0.544	0.34	3.45	34.45
4,4'-DDT	2.00E-07	9.59E-07	6.21E-10		1.16E-06	0.376	0.32	3.24	32.42
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.000	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.000	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.000	0.00	0.00
					0.00E+00		0.00	0.00	0.00
				Total	5.18E-06				

	Route -Specific Hazard Index Ingestion	Dermal	Inhalation		Total HI	Exposure Conc (mg/kg)	Remedial Goal Options (mg/kg) 0.1	1	3
Antimony	1.50E-01	7.20E-03			0.1572	4.7	2.99	29.90	89.69
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.0	0.0	0.00
					0		0.0	0.0	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
				Total	0.1572				

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REMEDIAL GOAL OPTIONS
NAS KEY WEST SWMU 2
RECEPTOR: CHILD/ADULT RESID.
MEDIUM: SEDIMENT

Chemical of Concern	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation	Total Risk	Exposure Conc (mg/kg)	Remedial Goal Options (mg/kg) 1.00E-06	1.00E-05	1.00E-04
4,4'-DDD	1.85E-06	8.85E-06		1.07E-05	17.2	1.61	16.07	160.75
4,4'-DDE	7.06E-07	3.38E-06		4.09E-06	4.64	1.14	11.36	113.56
4,4'-DDT	2.25E-06	1.08E-05		1.31E-05	14.8	1.13	11.34	113.41
				0.00E+00		0.00	0.00	0.00
				0.00E+00		0.00	0.00	0.00
				0.00E+00		0.00	0.00	0.00
				0.00E+00		0.00	0.00	0.00
				0.00E+00		0.00	0.00	0.00
			Total	2.78E-05				

	Route -Specific Hazard Index Ingestion	Dermal	Inhalation	Total HI	Exposure Conc (mg/kg)	Remedial Goal Options (mg/kg) 0.1	1	3
4,4'-DDT	1.08E-01	2.07E-01		0.315	14.8	4.70	46.98	140.95
				0		0.00	0.00	0.00
				0		0.00	0.00	0.00
				0		0.00	0.00	0.00
				0		0.00	0.00	0.00
				0		0.00	0.00	0.00
				0		0.00	0.00	0.00
				0		0.00	0.00	0.00
			Total	0.315				

REMEDIAL GOAL OPTIONS	
NAS KEY WEST	SWMU 2
RECEPTOR:	TRESPASS. ADULT
MEDIUM:	SEDIMENT

Chemical of Concern	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Exposure Conc (mg/kg)	Remedial Goal Options (mg/kg) 1.00E-06	1.00E-05	1.00E-04
4,4'-DDD	1.97E-07	2.27E-06			2.47E-06	17.2	6.97	69.72	697.20
4,4'-DDE	7.54E-08	8.67E-07			9.42E-07	4.64	4.92	49.24	492.36
4,4'-DDT	2.41E-07	2.77E-06			3.01E-06	14.8	4.92	49.15	491.53
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
				Total	6.42E-06				

Route -Specific Hazard Index Ingestion	Dermal	Inhalation		Total HI	Exposure Conc (mg/kg)	Remedial Goal Options (mg/kg) 0.1	1	3
				0		0.00	0.00	0.00
				0		0.00	0.00	0.00
				0		0.00	0.00	0.00
				0		0.00	0.00	0.00
				0		0.00	0.00	0.00
				0		0.00	0.00	0.00
				0		0.00	0.00	0.00
			Total	0				

REMEDIAL GOAL OPTIONS
NAS KEY WEST SWMU 2
RECEPTOR: TRESPASS. ADOLESC.
MEDIUM: SEDIMENT

Chemical of Concern	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Exposure Conc (mg/kg)	Remedial Goal Options (mg/kg) 1.00E-06	1.00E-05	1.00E-04
4,4'-DDD	2.00E-07	1.65E-06			1.85E-06	17.2	9.30	92.97	929.73
4,4'-DDE	7.64E-08	6.31E-07			7.07E-07	4.64	6.56	65.59	655.92
4,4'-DDT	2.44E-07	2.01E-06			2.25E-06	14.8	6.57	65.66	656.61
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
				Total	4.81E-06				

Chemical of Concern	Route -Specific Hazard Index Ingestion	Dermal	Inhalation		Total HI	Exposure Conc (mg/kg)	Remedial Goal Options (mg/kg) 0.1	1	3
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
				Total	0				

REMEDIAL GOAL OPTIONS	
NAS KEY WEST	SWMU 2
RECEPTOR:	CHILD/ADULT RESID.
MEDIUM:	SURFACE WATER

Chemical of Concern	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Exposure Conc (ug/L)	Remedial Goal Options (ug/L) 1.00E-06	1.00E-05	1.00E-04
4,4'-DDD	1.32E-07	2.28E-05			2.29E-05	1.45	0.063	0.63	6.32
4,4'-DDT	4.24E-08	1.46E-05			1.46E-05	0.33	0.023	0.23	2.25
Heptachlor	1.05E-07	1.06E-06			1.17E-06	0.062	0.053	0.53	5.32
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
				Total	3.87E-05				

	Route -Specific Hazard Index Ingestion	Dermal	Inhalation		Total HI	Exposure Conc (ug/L)	Remedial Goal Options (ug/L) 0.1	1	3
4,4'-DDT	1.57E-03	2.80E-01			0.28157	0.33	0.12	1.17	3.52
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
				Total	0.28157				

REMEDIAL GOAL OPTIONS	
NAS KEY WEST	SWMU 2
RECEPTOR:	TRESPASS. ADULT
MEDIUM:	SURFACE WATER

Chemical of Concern	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Exposure Conc (ug/L)	Remedial Goal Options (ug/L) 1.00E-06	1.00E-05	1.00E-04
4,4'-DDD	2.16E-08	5.85E-06			5.87E-06	1.45	0.25	2.47	24.70
4,4'-DDT	6.97E-09	3.74E-06			3.75E-06	0.33	0.088	0.88	8.81
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
				Total	9.62E-06				

	Route -Specific Hazard Index Ingestion	Dermal	Inhalation		Total HI	Exposure Conc (ug/L)	Remedial Goal Options (ug/L) 0.1	1	3
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
				Total	0				

REMEDIAL GOAL OPTIONS	
NAS KEY WEST	SWMU 2
RECEPTOR:	TRESPASS. ADOLESC.
MEDIUM:	SURFACE WATER

Chemical of Concern	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Exposure Conc (ug/L)	Remedial Goal Options (ug/L) 1.00E-06	1.00E-05	1.00E-04
4,4'-DDD	2.19E-08	4.26E-06			4.28E-06	1.45	0.34	3.39	33.86
4,4'-DDT	7.06E-09	2.72E-06			2.73E-06	0.33	0.12	1.21	12.10
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
					0.00E+00		0.00	0.00	0.00
				Total	7.01E-06				

	Route -Specific Hazard Index Ingestion	Dermal	Inhalation		Total HI	Exposure Conc (ug/L)	Remedial Goal Options (ug/L) 0.1	1	3
4,4'-DDT	2.64E-04	1.02E-01			0.102264	0.33	0.32	3.23	9.68
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
					0		0.00	0.00	0.00
				Total	0.102264				

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. SOIL: CHILD/ADULT RES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
Beryllium	FDEP Ind. Clean-up	1.55E-06				1.55E-06	0.23	1		6.74E-06
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
4,4'-DDT	FDEP Ind. Clean-up	2.00E-07				2.00E-07	0.376	12.00000		6.38E-06
4,4'-DDE	FDEP Ind. Clean-up	2.89E-07				2.89E-07	0.544	11.00000		5.84E-06
4,4'-DDD	FDEP Ind. Clean-up	1.19E-07				1.19E-07	0.316	17.00000		6.40E-06
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	2.16E-06	0.00E+00	0.00E+00	**Total:**	6.08E-07			**Total:**	1.86E-05

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00		0.00000		0.00E+00
Antimony	FDEP Ind. Clean-up	1.50E-01				1.50E-01	4.7	220.00		7.02E+00
Beryllium	FDEP Ind. Clean-up	5.88E-04				5.88E-04	0.23	1.00000		2.56E-03
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00				0.00E+00
4,4'-DDT	FDEP Ind. Clean-up	9.61E-03				9.61E-03	0.376	12.00000		3.07E-01
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	1.60E-01	0.00E+00	0.00E+00	**Total:**	1.60E-01			**Total:**	7.33E+00

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. SOIL: TRES. ADULT

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beryllium	FDEP Ind. Clean-up	2.52E-08				2.52E-08	0.23	1		1.10E-07	2.74E-08
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	FDEP Ind. Clean-up	3.26E-09				3.26E-09	0.376	12.00000		1.04E-07	2.6E-08
4,4'-DDE	FDEP Ind. Clean-up	4.71E-09				4.71E-09	0.544	11.00000		9.52E-08	2.38E-08
4,4'-DDD	FDEP Ind. Clean-up	1.93E-09				1.93E-09	0.316	17.00000		1.04E-07	2.6E-08
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	3.51E-08	0.00E+00	0.00E+00	Total:	9.90E-09			Total:	3.03E-07 ✓	1.03E-07 ✓

		Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00		0.00000		0.00E+00	0
Antimony	FDEP Ind. Clean-up	1.10E-03				1.10E-03	4.7	220.00000		5.15E-02	1.29E-02
Beryllium	FDEP Ind. Clean-up	4.32E-06				4.32E-06	0.23	1.00000		1.88E-05	4.7E-06
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	FDEP Ind. Clean-up	7.06E-05				7.06E-05	0.376	12.00000		2.25E-03	0.000563
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	1.17E-03	0.00E+00	0.00E+00	Total:	1.17E-03			Total:	5.38E-02 ✓	1.34E-02 ✓

:rk@gol

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. SOIL: TRES. ADOLESC.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beryllium	FDEP Ind. Clean-up	3.19E-08				3.19E-08	0.23	1		1.39E-07	5.55E-08
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	FDEP Ind. Clean-up	4.13E-09				4.13E-09	0.376	12.00000		1.32E-07	5.27E-08
4,4'-DDE	FDEP Ind. Clean-up	5.97E-09				5.97E-09	0.544	11.00000		1.21E-07	4.83E-08
4,4'-DDD	FDEP Ind. Clean-up	2.45E-09				2.45E-09	0.316	17.00000		1.32E-07	5.27E-08
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	4.45E-08	0.00E+00	0.00E+00	Total:	1.26E-08			Total:	3.84E-07	2.09E-07

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
Antimony	FDEP Ind. Clean-up	2.41E-03				2.41E-03	4.7	220.00000		1.13E-01	4.51E-02
						0.00E+00		0.00000		0.00E+00	0
Beryllium	FDEP Ind. Clean-up	9.45E-06				9.45E-06	0.23	1.00000		4.11E-05	1.64E-05
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	FDEP Ind. Clean-up	1.54E-04				1.54E-04	0.376	12.00000		4.91E-03	0.001966
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	2.57E-03	0.00E+00	0.00E+00	Total:	2.57E-03			Total:	1.18E-01	4.71E-02

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. SOIL: MAINT. WORKER

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beryllium	FDEP Ind. Clean-up	1.96E-08				1.96E-08	0.23	1		8.52E-08	3.41E-08
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	FDEP Ind. Clean-up	2.53E-09				2.53E-09	0.376	12.00000		8.07E-08	3.23E-08
4,4'-DDE	FDEP Ind. Clean-up	3.66E-09				3.66E-09	0.544	11.00000		7.40E-08	2.96E-08
4,4'-DDD	FDEP Ind. Clean-up	1.50E-09				1.50E-09	0.316	17.00000		8.07E-08	3.23E-08
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	2.73E-08	0.00E+00	0.00E+00	Total:	7.69E-09			Total:	2.35E-07 ✓	1.28E-07 ✓

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
Antimony	FDEP Ind. Clean-up	6.51E-04				6.51E-04	4.7	220.00		3.05E-02	1.22E-02
						0.00E+00		0.00000		0.00E+00	0
Beryllium	FDEP Ind. Clean-up	2.55E-06				2.55E-06	0.23	1.00000		1.11E-05	4.43E-06
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	FDEP Ind. Clean-up	4.17E-05				4.17E-05	0.376	12.00000		1.33E-03	0.000532
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	6.95E-04	0.00E+00	0.00E+00	Total:	6.95E-04			Total:	3.18E-02 ✓	1.27E-02 ✓

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. SOIL: OCCUP. WORKER

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beryllium	FDEP Ind. Clean-up	1.73E-07				1.73E-07	0.23	1		7.52E-07	3.76E-07
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	FDEP Ind. Clean-up	2.23E-08				2.23E-08	0.376	12.00000		7.12E-07	3.56E-07
4,4'-DDE	FDEP Ind. Clean-up	3.23E-08				3.23E-08	0.544	11.00000		6.53E-07	3.27E-07
4,4'-DDD	FDEP Ind. Clean-up	1.33E-08				1.33E-08	0.316	17.00000		7.16E-07	3.58E-07
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	2.41E-07	0.00E+00	0.00E+00	Total:	6.79E-08			Total:	2.08E-06	1.42E-06

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
Antimony	FDEP Ind. Clean-up	5.75E-03				5.75E-03	4.7	220.00		2.69E-01	1.35E-01
						0.00E+00		0.00000		0.00E+00	0
Beryllium	FDEP Ind. Clean-up	2.25E-05				2.25E-05	0.23	1.00000		9.78E-05	4.89E-05
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	FDEP Ind. Clean-up	3.68E-04				3.68E-04	0.376	12.00000		1.17E-02	0.005872
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	6.14E-03	0.00E+00	0.00E+00	Total:	6.14E-03			Total:	2.81E-01	1.40E-01

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. SOIL: EXCAV. WORKER

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
Beryllium	FDEP Ind. Clean-up	1.96E-09				1.96E-09	0.23	1		8.52E-09
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
4,4'-DDT	FDEP Ind. Clean-up	2.53E-10				2.53E-10	0.376	12.00000		8.07E-09
4,4'-DDE	FDEP Ind. Clean-up	3.66E-10				3.66E-10	0.544	11.00000		7.40E-09
4,4'-DDD	FDEP Ind. Clean-up	1.50E-10				1.50E-10	0.316	17.00000		8.07E-09
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	2.73E-09	0.00E+00	0.00E+00	Total:	7.69E-10			Total:	2.35E-08

		Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
Antimony	FDEP Ind. Clean-up	1.63E-03				1.63E-03	4.7	220.00		7.63E-02
						0.00E+00		0.00000		0.00E+00
Beryllium	FDEP Ind. Clean-up	6.37E-06				6.37E-06	0.23	1.00000		2.77E-05
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00				0.00E+00
4,4'-DDT	FDEP Ind. Clean-up	1.04E-04				1.04E-04	0.376	12.00000		3.32E-03
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	1.74E-03	0.00E+00	0.00E+00	Total:	1.74E-03			Total:	7.96E-02

INGEST. RISKS AT CLEANUP GOALS	
KEY WEST SWMU-2	
ALTERN. 3	(MEDIA REMOVAL)
SEDIMENT:	CHILD/ADULT RES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation	Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)	Risk at Goal
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00		0.00000	0.00E+00
4,4'-DDT	Eff. Range-Medium	2.25E-06			2.25E-06	14.8	0.04600	6.99E-09
4,4'-DDE	Eff. Range-Medium	7.06E-07			7.06E-07	4.64	0.02700	4.11E-09
4,4'-DDD	Eff. Range-Medium	1.85E-06			1.85E-06	17.2	0.04600	4.95E-09
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00		0.00000	0.00E+00
	Totals:	4.81E-06	0.00E+00	0.00E+00	Total: 4.81E-06		Total:	1.60E-08

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation	Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)	Risk at Goal
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
Iron		3.20E-02			3.20E-02	2630	0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
4,4'-DDT	Eff. Range-Medium	1.08E-01			1.08E-01	14.8	0.04600	3.36E-04
					0.00E+00		0.00000	0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00		0.00000	0.00E+00
	Totals:	1.40E-01	0.00E+00	0.00E+00	Total: 1.40E-01		Total:	3.36E-04

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SEDIMENT: ADULT TRESS.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
4,4'-DDT	Eff. Range-Medium	2.41E-07				2.41E-07	14.8	0.04600		7.49E-10	9.74E-11
4,4'-DDE	Eff. Range-Medium	7.54E-08				7.54E-08	4.64	0.02700		4.39E-10	5.7E-11
4,4'-DDD	Eff. Range-Medium	1.97E-07				1.97E-07	17.2	0.04600		5.27E-10	6.85E-11
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	5.13E-07	0.00E+00	0.00E+00	Total:	5.13E-07			Total:	1.71E-09 ✓	2.23E-10 ✓

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
Iron		1.54E-03				1.54E-03	2630	0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
4,4'-DDT	Eff. Range-Medium	5.21E-03				5.21E-03	14.8	0.04600		1.62E-05	2.11E-06
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	6.75E-03	0.00E+00	0.00E+00	Total:	6.75E-03			Total:	1.62E-05 ✓	2.11E-06 /

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INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SEDIMENT: ADOLES. TRESPASS.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
4,4'-DDT	Eff. Range-Medium	2.44E-07				2.44E-07	14.8	0.04600		7.58E-10	2.05E-10
4,4'-DDE	Eff. Range-Medium	7.64E-08				7.64E-08	4.64	0.02700		4.45E-10	1.2E-10
4,4'-DDD	Eff. Range-Medium	2.00E-07				2.00E-07	17.2	0.04600		5.35E-10	1.44E-10
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	5.20E-07	0.00E+00	0.00E+00	Total:	5.20E-07			Total:	1.74E-09	4.69E-10

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
Iron		2.70E-03				2.70E-03	2630	0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
4,4'-DDT	Eff. Range-Medium	9.12E-03				9.12E-03	14.8	0.04600		2.83E-05	7.65E-06
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	1.18E-02	0.00E+00	0.00E+00	Total:	1.18E-02			Total:	2.83E-05	7.65E-06

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. WATER: CHILD/ADULT RES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
Beta-BHC		4.49E-08				4.49E-08	0.066			0.00E+00
4,4'-DDD	FDEP S.W. Qual. St.	1.32E-07				1.32E-07	1.45	0.02500		2.28E-09
4,4'-DDT	RCRA Act. Level	4.24E-08				4.24E-08	0.33	0.00100		1.28E-10
Heptachlor	FDEP S.W. Qual. St.	1.05E-07				1.05E-07	0.062	0.00021		3.56E-10
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
	Totals:	3.24E-07	0.00E+00	0.00E+00	Total:	3.24E-07			Total:	2.76E-09

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
Mercury	Reg. IV S.W. Scrn.	6.65E-02				6.65E-02	8.4	0.02500		1.98E-04
Copper	Nat. Am. Wat. Q. St.	1.61E-02				1.61E-02	272	2.40000		1.42E-04
						0.00E+00				0.00E+00
4,4'-DDT	RCRA Act. Level	1.57E-03				1.57E-03	0.33	0.00100		4.76E-06
						0.00E+00				0.00E+00
Heptachlor	FDEP S.W. Qual. St.	2.94E-04				2.94E-04	0.062	0.00021		9.96E-07
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
	Totals:	8.45E-02	0.00E+00	0.00E+00	Total:	8.45E-02			Total:	3.46E-04

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. WATER: ADULT TRES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beta-BHC		7.38E-09				7.38E-09	0.066			0.00E+00	0
4,4'-DDD	FDEP S.W. Qual. St.	2.16E-08				2.16E-08	1.45	0.02500		3.72E-10	4.84E-11
4,4'-DDT	RCRA Act. Level	6.97E-09				6.97E-09	0.33	0.00100		2.11E-11	2.75E-12
Heptachlor	FDEP S.W. Qual. St.	1.73E-08				1.73E-08	0.062	0.00021		5.86E-11	7.62E-12
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
	Totals:	5.33E-08	0.00E+00	0.00E+00	Total:	5.33E-08			Total:	4.52E-10 ✓	5.88E-11 ✓

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Mercury	Reg. IV S.W. Scrn.	6.41E-03				6.41E-03	8.4	0.02500		1.91E-05	2.48E-06
Copper	Nat. Am. Wat. Q. St.	1.56E-03				1.56E-03	272	2.40000		1.38E-05	1.79E-06
						0.00E+00				0.00E+00	0
4,4'-DDT	RCRA Act. Level	1.51E-04				1.51E-04	0.33	0.00100		4.58E-07	5.95E-08
						0.00E+00				0.00E+00	0
Heptachlor	FDEP S.W. Qual. St.	2.84E-05				2.84E-05	0.062	0.00021		9.62E-08	1.25E-08
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
	Totals:	8.15E-03	0.00E+00	0.00E+00	Total:	8.15E-03			Total:	3.34E-05 ✓	4.34E-06 ✓

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. WATER: ADOLES. TRES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beta-BHC		7.48E-09				7.48E-09	0.066			0.00E+00	0
4,4'-DDT	RCRA Act. Level	7.06E-09				7.06E-09	0.33	0.00100		2.14E-11	5.78E-12
4,4'-DDD	FDEP S.W. Qual. St.	2.19E-08				2.19E-08	1.45	0.02500		3.78E-10	1.02E-10
Heptachlor	FDEP S.W. Qual. St.	1.76E-08				1.76E-08	0.062	0.00021		5.96E-11	1.61E-11
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	5.40E-08	0.00E+00	0.00E+00	Total:	5.40E-08			Total:	4.59E-10	1.24E-10

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
Mercury	Reg. IV S.W. Scrn.	1.12E-02				1.12E-02	8.4	0.02500		3.33E-05	9.00E-06
Copper	Nat. Am. Wat. Q. St.	2.72E-03				2.72E-03	272	2.40000		2.40E-05	6.48E-06
						0.00E+00				0.00E+00	0
4,4'-DDT	RCRA Act. Level	2.64E-04				2.64E-04	0.33	0.00100		8.00E-07	2.16E-07
						0.00E+00				0.00E+00	0
Heptachlor	FDEP S.W. Qual. St.	4.97E-05				4.97E-05	0.062	0.00021		1.68E-07	4.55E-08
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	1.42E-02	0.00E+00	0.00E+00	Total:	1.42E-02			Total:	5.83E-05	1.57E-05

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DERM. RISKS AT CLEANUP GOALS	
KEY WEST SWMU-2	
ALTERN. 3	(MEDIA REMOVAL)
SURF. SOIL:	CHILD/ADULT RES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation	Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)	Risk at Goal
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
Beryllium	FDEP Ind. Clean-up		1.85E-07		1.85E-07	0.23	1	8.04E-07
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
4,4'-DDT	FDEP Ind. Clean-up		9.59E-07		9.59E-07	0.376	12.00000	3.06E-05
4,4'-DDE	FDEP Ind. Clean-up		1.39E-06		1.39E-06	0.544	11.00000	2.81E-05
4,4'-DDD	FDEP Ind. Clean-up		5.69E-07		5.69E-07	0.316	17.00000	3.06E-05
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
	Totals:	0.00E+00	3.10E-06	0.00E+00	Total: 2.92E-06		Total:	8.93E-05

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation	Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)	Risk at Goal
Antimony	FDEP Ind. Clean-up		7.20E-03		7.20E-03	4.7	220.00	3.37E-01
					0.00E+00		0.00000	0.00E+00
Beryllium	FDEP Ind. Clean-up		2.82E-05		2.82E-05	0.23	1.00000	1.23E-04
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
					0.00E+00			0.00E+00
4,4'-DDT	FDEP Ind. Clean-up		1.84E-02		1.84E-02	0.376	12.00000	5.87E-01
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00		0.00000	0.00E+00
	Totals:	0.00E+00	2.56E-02	0.00E+00	Total: 2.56E-02		Total:	9.24E-01

DERM. RISKS AT CLEANUP GOALS	
KEY WEST SWMU-2	
ALTERN. 3	(MEDIA REMOVAL)
SURF. SOIL:	TRES. ADULT

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beryllium	FDEP Ind. Clean-up		7.25E-09			7.25E-09	0.23	1		3.15E-08	1.58E-08
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	FDEP Ind. Clean-up		3.75E-08			3.75E-08	0.376	12.00000		1.20E-06	5.98E-07
4,4'-DDE	FDEP Ind. Clean-up		5.42E-08			5.42E-08	0.544	11.00000		1.10E-06	5.48E-07
4,4'-DDD	FDEP Ind. Clean-up		2.22E-08			2.22E-08	0.316	17.00000		1.19E-06	5.97E-07
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	1.21E-07	0.00E+00	Total:	1.14E-07			Total:	3.49E-06	1.76E-06

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
Antimony	FDEP Ind. Clean-up		3.17E-04			3.17E-04	4.7	220.00000		1.48E-02	7.42E-03
						0.00E+00		0.00000		0.00E+00	0
Beryllium	FDEP Ind. Clean-up		1.24E-06			1.24E-06	0.23	1.00000		5.39E-06	2.7E-06
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	FDEP Ind. Clean-up		8.12E-04			8.12E-04	0.376	12.00000		2.59E-02	1.30E-02
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	1.13E-03	0.00E+00	Total:	1.13E-03			Total:	4.08E-02	2.04E-02

DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. SOIL: TRES. ADOLESC.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
Beryllium	FDEP Ind. Clean-up		6.60E-09			6.60E-09	0.23	1		2.87E-08
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
4,4'-DDT	FDEP Ind. Clean-up		3.41E-08			3.41E-08	0.376	12.00000		1.09E-06
4,4'-DDE	FDEP Ind. Clean-up		4.93E-08			4.93E-08	0.544	11.00000		9.97E-07
4,4'-DDD	FDEP Ind. Clean-up		2.02E-08			2.02E-08	0.316	17.00000		1.09E-06
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	0.00E+00	1.10E-07	0.00E+00	Total:	1.04E-07			Total:	3.17E-06

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
Antimony	FDEP Ind. Clean-up		4.99E-04			4.99E-04	4.7	220.00		2.34E-02
						0.00E+00		0.00000		0.00E+00
Beryllium	FDEP Ind. Clean-up		1.95E-06			1.95E-06	0.23	1.00000		8.48E-06
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00				0.00E+00
4,4'-DDT	FDEP Ind. Clean-up		1.28E-03			1.28E-03	0.376	12.00000		4.09E-02
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	0.00E+00	1.78E-03	0.00E+00	Total:	1.78E-03			Total:	6.42E-02

DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. SOIL: MAINT. WORKER

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beryllium	FDEP Ind. Clean-up		4.77E-09			4.77E-09	0.23	1		2.07E-08	8.71E-09
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	FDEP Ind. Clean-up		2.47E-08			2.47E-08	0.376	12.00000		7.88E-07	3.31E-07
4,4'-DDE	FDEP Ind. Clean-up		3.57E-08			3.57E-08	0.544	11.00000		7.22E-07	3.03E-07
4,4'-DDD	FDEP Ind. Clean-up		1.46E-08			1.46E-08	0.316	17.00000		7.85E-07	3.3E-07
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	7.98E-08	0.00E+00	Total:	7.50E-08			Total:	2.30E-06	9.73E-07

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
Antimony	FDEP Ind. Clean-up		1.59E-04			1.59E-04	4.7	220.00000		7.44E-03	3.13E-03
						0.00E+00		0.00000		0.00E+00	0.00E+00
Beryllium	FDEP Ind. Clean-up		6.21E-07			6.21E-07	0.23	1.00000		2.70E-06	1.13E-06
						0.00E+00		0.00000		0.00E+00	0.00E+00
						0.00E+00		0.00000		0.00E+00	0.00E+00
						0.00E+00		0.00000		0.00E+00	0.00E+00
						0.00E+00				0.00E+00	0.00E+00
4,4'-DDT	FDEP Ind. Clean-up		4.06E-04			4.06E-04	0.376	12.00000		1.30E-02	5.44E-03
						0.00E+00				0.00E+00	0.00E+00
						0.00E+00				0.00E+00	0.00E+00
						0.00E+00				0.00E+00	0.00E+00
						0.00E+00		0.00000		0.00E+00	0.00E+00
	Totals:	0.00E+00	5.66E-04	0.00E+00	Total:	5.66E-04			Total:	2.04E-02	8.57E-03

DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. SOIL: OCCUP. WORKER

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beryllium	FDEP Ind. Clean-up		3.97E-08			3.97E-08	0.23	1		1.73E-07	8.63E-08
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	FDEP Ind. Clean-up		2.05E-07			2.05E-07	0.376	12.00000		6.54E-06	3.27E-06
4,4'-DDE	FDEP Ind. Clean-up		2.97E-07			2.97E-07	0.544	11.00000		6.01E-06	3E-06
4,4'-DDD	FDEP Ind. Clean-up		1.22E-07			1.22E-07	0.316	17.00000		6.56E-06	3.28E-06
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	6.64E-07	0.00E+00	Total:	6.24E-07			Total:	1.91E-05	9.64E-06

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
Antimony	FDEP Ind. Clean-up		1.32E-03			1.32E-03	4.7	220.00000		6.18E-02	3.09E-02
						0.00E+00		0.00000		0.00E+00	0
Beryllium	FDEP Ind. Clean-up		5.18E-06			5.18E-06	0.23	1.00000		2.25E-05	1.13E-05
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	FDEP Ind. Clean-up		3.38E-03			3.38E-03	0.376	12.00000		1.08E-01	5.39E-02
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	4.71E-03	0.00E+00	Total:	4.71E-03			Total:	1.70E-01	8.48E-02

DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. SOIL: EXCAV. WORKER

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation	Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)	Risk at Goal
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
Beryllium	FDEP Ind. Clean-up		4.77E-10		4.77E-10	0.23	1	2.07E-09
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
4,4'-DDT	FDEP Ind. Clean-up		2.47E-09		2.47E-09	0.376	12.00000	7.88E-08
4,4'-DDE	FDEP Ind. Clean-up		3.57E-09		3.57E-09	0.544	11.00000	7.22E-08
4,4'-DDD	FDEP Ind. Clean-up		1.46E-09		1.46E-09	0.316	17.00000	7.85E-08
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
	Totals:	0.00E+00	7.98E-09	0.00E+00	Total: 7.50E-09			Total: 2.30E-07

		Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation	Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)	Risk at Goal
Antimony	FDEP Ind. Clean-up		3.97E-04		3.97E-04	4.7	220.00	1.86E-02
					0.00E+00		0.00000	0.00E+00
Beryllium	FDEP Ind. Clean-up		1.55E-06		1.55E-06	0.23	1.00000	6.74E-06
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
					0.00E+00			0.00E+00
4,4'-DDT	FDEP Ind. Clean-up		1.02E-03		1.02E-03	0.376	12.00000	3.26E-02
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00		0.00000	0.00E+00
	Totals:	0.00E+00	1.42E-03	0.00E+00	Total: 1.42E-03			Total: 5.11E-02

DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SEDIMENT: CHILD/ADULT RES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00		0.00000		0.00E+00
4,4'-DDT	Eff. Range-Medium		1.08E-05			1.08E-05	14.8	0.04600		3.36E-08
4,4'-DDE	Eff. Range-Medium		3.38E-06			3.38E-06	4.64	0.02700		1.97E-08
4,4'-DDD	Eff. Range-Medium		8.85E-06			8.85E-06	17.2	0.04600		2.37E-08
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	0.00E+00	2.30E-05	0.00E+00	Total:	2.30E-05			Total:	7.69E-08

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
Iron			1.53E-03			1.53E-03	2630	0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
4,4'-DDT	Eff. Range-Medium		2.07E-01			2.07E-01	14.8	0.04600		6.43E-04
						0.00E+00		0.00000		0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	0.00E+00	2.09E-01	0.00E+00	Total:	2.09E-01			Total:	6.43E-04

DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SEDIMENT: ADULT TRES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
4,4'-DDT	Eff. Range-Medium		2.77E-06			2.77E-06	14.8	0.04600		8.61E-09	2.32E-09
4,4'-DDE	Eff. Range-Medium		8.67E-07			8.67E-07	4.64	0.02700		5.05E-09	1.36E-09
4,4'-DDD	Eff. Range-Medium		2.27E-06			2.27E-06	17.2	0.04600		6.07E-09	1.64E-09
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	5.91E-06	0.00E+00	Total:	5.91E-06			Total:	1.97E-08	5.33E-09

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
Iron			4.44E-04			4.44E-04	2630	0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
4,4'-DDT	Eff. Range-Medium		6.00E-02			6.00E-02	14.8	0.04600		1.86E-04	5.04E-05
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	6.04E-02	0.00E+00	Total:	6.04E-02			Total:	1.86E-04	5.04E-05

DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SEDIMENT: ADOLES. TRESPAS.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation	Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)	Risk at Goal	New Risk with Instit. Controls
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00		0.00000	0.00E+00	0
					0.00E+00		0.00000	0.00E+00	0
4,4'-DDT	Eff. Range-Medium		2.01E-06		2.01E-06	14.8	0.04600	6.25E-09	1.69E-09
4,4'-DDE	Eff. Range-Medium		6.31E-07		6.31E-07	4.64	0.02700	3.67E-09	9.91E-10
4,4'-DDD	Eff. Range-Medium		1.65E-06		1.65E-06	17.2	0.04600	4.41E-09	1.19E-09
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00		0.00000	0.00E+00	0
	Totals:	0.00E+00	4.29E-06	0.00E+00	Total: 4.29E-06			Total: 1.43E-08	3.87E-09

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation	Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)	Risk at Goal	New Risk with Instit. Controls
					0.00E+00		0.00000	0.00E+00	0
					0.00E+00		0.00000	0.00E+00	0
Iron			5.58E-04		5.58E-04	2630	0.00000	0.00E+00	0
					0.00E+00		0.00000	0.00E+00	0
4,4'-DDT	Eff. Range-Medium		7.54E-02		7.54E-02	14.8	0.04600	2.34E-04	6.33E-05
					0.00E+00		0.00000	0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00		0.00000	0.00E+00	0
	Totals:	0.00E+00	7.60E-02	0.00E+00	Total: 7.60E-02			Total: 2.34E-04	6.33E-05

DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. WATER: CHILD/ADULT RES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
4,4'-DDD	FDEP S.W. Qual. St.		2.28E-05			2.28E-05	1.45	0.02500		3.93E-07
4,4'-DDT	RCRA Act. Level		1.46E-05			1.46E-05	0.33	0.00100		4.42E-08
Heptachlor	FDEP S.W. Qual. St.		1.06E-06			1.06E-06	0.062	0.00021		3.59E-09
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
	Totals:	0.00E+00	3.85E-05	0.00E+00	Total:	3.85E-05			Total:	4.41E-07

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
Mercury	Reg. IV S.W. Scrn.		3.43E-02			3.43E-02	8.4	0.02500		1.02E-04
Copper	Nat. Am. Wat. Q. St.		8.33E-03			8.33E-03	272	2.40000		7.35E-05
						0.00E+00				0.00E+00
4,4'-DDT	RCRA Act. Level		2.80E-01			2.80E-01	0.33	0.00100		8.48E-04
						0.00E+00				0.00E+00
Heptachlor	FDEP S.W. Qual. St.		1.54E-03			1.54E-03	0.062	0.00021		5.22E-06
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
	Totals:	0.00E+00	3.24E-01	0.00E+00	Total:	3.24E-01			Total:	1.03E-03

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DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. WATER: ADULT TRES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDD	FDEP S.W. Qual. St.		5.85E-06			5.85E-06	1.45	0.02500		1.01E-07	2.72E-08
4,4'-DDT	RCRA Act. Level		3.74E-06			3.74E-06	0.33	0.00100		1.13E-08	3.06E-09
Heptachlor	FDEP S.W. Qual. St.		2.72E-07			2.72E-07	0.062	0.00021		9.21E-10	2.49E-10
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
	Totals:	0.00E+00	9.86E-06	0.00E+00	Total:	9.86E-06			Total:	1.13E-07	3.05E-08

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Mercury	Reg. IV S.W. Scrn.		2.84E-03			2.84E-03	8.4	0.02500		8.45E-06	2.28E-06
Copper	Nat. Am. Wat. Q. St.		6.89E-04			6.89E-04	272	2.40000		6.08E-06	1.64E-06
						0.00E+00				0.00E+00	0
4,4'-DDT	RCRA Act. Level		8.10E-02			8.10E-02	0.33	0.00100		2.45E-04	6.63E-05
						0.00E+00				0.00E+00	0
Heptachlor	FDEP S.W. Qual. St.		4.45E-04			4.45E-04	0.062	0.00021		1.51E-06	4.07E-07
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
	Totals:	0.00E+00	8.50E-02	0.00E+00	Total:	8.50E-02			Total:	2.61E-04	7.06E-05

DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. WATER: ADOLES. TRES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation	Total Risk	Represent. Conc (ug/l)	Cleanup Goal (ug/l)	Risk at Goal	New Risk with Instit. Controls
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
4,4'-DDT	RCRA Act. Level		2.72E-06		2.72E-06	0.33	0.00100	8.24E-09	2.23E-09
4,4'-DDD	FDEP S.W. Qual. St.		4.26E-06		4.26E-06	1.45	0.02500	7.34E-08	1.98E-08
Heptachlor	FDEP S.W. Qual. St.		1.98E-07		1.98E-07	0.062	0.00021	6.71E-10	1.81E-10
					0.00E+00		0.00000	0.00E+00	0
					0.00E+00		0.00000	0.00E+00	0
	Totals:	0.00E+00	7.18E-06	0.00E+00	Total: 7.18E-06			Total: 8.24E-08	2.22E-08

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation	Total Risk (HI)	Represent. Conc (ug/l)	Cleanup Goal (ug/l)	Risk at Goal	New Risk with Instit. Controls
					0.00E+00		0.00000	0.00E+00	0
					0.00E+00		0.00000	0.00E+00	0
					0.00E+00		0.00000	0.00E+00	0
					0.00E+00		0.00000	0.00E+00	0
Mercury	Reg. IV S.W. Scrn.		3.57E-03		3.57E-03	8.4	0.02500	1.06E-05	2.87E-06
Copper	Nat. Am. Wat. Q. St.		8.66E-04		8.66E-04	272	2.40000	7.64E-06	2.06E-06
					0.00E+00			0.00E+00	0
4,4'-DDT	RCRA Act. Level		1.02E-01		1.02E-01	0.33	0.00100	3.09E-04	8.35E-05
					0.00E+00			0.00E+00	0
Heptachlor	FDEP S.W. Qual. St.		5.60E-04		5.60E-04	0.062	0.00021	1.90E-06	5.12E-07
					0.00E+00			0.00E+00	0
					0.00E+00		0.00000	0.00E+00	0
	Totals:	0.00E+00	1.07E-01	0.00E+00	Total: 1.07E-01			Total: 3.29E-04	8.89E-05

INHAL. RISKS AT CLEANUP GOALS	
KEY WEST SWMU-2	
ALTERN. 3	(MEDIA REMOVAL)
SURF. SOIL:	CHILD/ADULT RES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
Beryllium	FDEP Ind. Clean-up			1.53E-08		1.53E-08	0.23	1		6.65E-08
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
4,4'-DDT	FDEP Ind. Clean-up			6.21E-10		6.21E-10	0.376	12.00000		1.98E-08
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	0.00E+00	0.00E+00	1.59E-08	Total:	1.59E-08			Total:	8.63E-08

	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00				0.00E+00
					0.00E+00				0.00E+00
					0.00E+00				0.00E+00
					0.00E+00				0.00E+00
					0.00E+00				0.00E+00
					0.00E+00		0.00000		0.00E+00
Totals:	0.00E+00	0.00E+00	0.00E+00	Total:	0.00E+00			Total:	0.00E+00

INHAL. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. SOIL: TRESP. ADULT

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beryllium	FDEP Ind. Clean-up			9.61E-11		9.61E-11	0.23	1		4.18E-10	2.09E-10
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	FDEP Ind. Clean-up			3.89E-12		3.89E-12	0.376	12.00000		1.24E-10	6.21E-11
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	0.00E+00	1.00E-10	Total:	1.00E-10			Total:	5.42E-10	2.71E-10

		Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	0.00E+00	0.00E+00	Total:	0.00E+00			Total:	0.00E+00	0

INHAL. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. SOIL: TRESP. ADOLESC.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beryllium	FDEP Ind. Clean-up			1.22E-10		1.22E-10	0.23	1		5.30E-10	2.12E-10
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	FDEP Ind. Clean-up			4.93E-12		4.93E-12	0.376	12.00000		1.57E-10	6.29E-11
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	0.00E+00	1.27E-10	Total:	1.27E-10			Total:	6.88E-10	2.75E-10

	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
					0.00E+00		0.00000		0.00E+00	0
					0.00E+00		0.00000		0.00E+00	0
					0.00E+00		0.00000		0.00E+00	0
					0.00E+00		0.00000		0.00E+00	0
					0.00E+00		0.00000		0.00E+00	0
					0.00E+00		0.00000		0.00E+00	0
					0.00E+00				0.00E+00	0
					0.00E+00				0.00E+00	0
					0.00E+00				0.00E+00	0
					0.00E+00				0.00E+00	0
					0.00E+00				0.00E+00	0
					0.00E+00		0.00000		0.00E+00	0
Totals:	0.00E+00	0.00E+00	0.00E+00	Total:	0.00E+00			Total:	0.00E+00	0

INHAL. RISKS AT CLEANUP GOALS	
KEY WEST SWMU-2	
ALTERN. 3	(MEDIA REMOVAL)
SURF. SOIL:	MAINT. WORKER

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
Beryllium	FDEP Ind. Clean-up			1.27E-10		1.27E-10	0.23	1		5.52E-10
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
4,4'-DDT	FDEP Ind. Clean-up			5.12E-12		5.12E-12	0.376	12.00000		1.63E-10
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	0.00E+00	0.00E+00	1.32E-10	Total:	1.32E-10			Total:	7.16E-10

	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00				0.00E+00
					0.00E+00				0.00E+00
					0.00E+00				0.00E+00
					0.00E+00				0.00E+00
					0.00E+00				0.00E+00
					0.00E+00		0.00000		0.00E+00
Totals:	0.00E+00	0.00E+00	0.00E+00	Total:	0.00E+00			Total:	0.00E+00

k@gol

INHAL. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 (MEDIA REMOVAL)
SURF. SOIL: OCCUP. WORKER

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beryllium	FDEP Ind. Clean-up			2.64E-09		2.64E-09	0.23	1		1.15E-08	5.74E-09
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	FDEP Ind. Clean-up			1.07E-10		1.07E-10	0.376	12.00000		3.41E-09	1.71E-09
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	0.00E+00	2.75E-09	Total:	2.75E-09			Total:	1.49E-08	7.45E-09

		Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	0.00E+00	0.00E+00	Total:	0.00E+00			Total:	0.00E+00	0

INHAL. RISKS AT CLEANUP GOALS	
KEY WEST SWMU-2	
ALTERN. 3	(MEDIA REMOVAL)
SURF. SOIL:	EXCAV. WORKER

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
Beryllium	FDEP Ind. Clean-up			3.80E-11		3.80E-11	0.23	1		1.65E-10
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
4,4'-DDT	FDEP Ind. Clean-up			1.54E-12		1.54E-12	0.376	12.00000		4.91E-11
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	0.00E+00	0.00E+00	3.95E-11	Total:	3.95E-11			Total:	2.14E-10

	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00				0.00E+00
					0.00E+00				0.00E+00
					0.00E+00				0.00E+00
					0.00E+00				0.00E+00
					0.00E+00				0.00E+00
					0.00E+00		0.00000		0.00E+00
Totals:	0.00E+00	0.00E+00	0.00E+00	Total:	0.00E+00			Total:	0.00E+00

INGEST. RISKS AT CLEANUP GOALS	
KEY WEST SWMU-2	
ALTERN. 4	(MEDIA REMOVAL)
SURF. SOIL:	CHILD/ADULT RES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation	Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)	Risk at Goal
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
Beryllium	Soil RGO/St. Pr.	1.55E-06			1.55E-06	0.23	0.0112	7.55E-08
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
4,4'-DDT	Reg. III Eco. Bnch.	2.00E-07			2.00E-07	0.376	0.10000	5.32E-08
4,4'-DDE	Reg. III Eco. Bnch.	2.89E-07			2.89E-07	0.544	0.10000	5.31E-08
4,4'-DDD	Reg. III Eco. Bnch.	1.19E-07			1.19E-07	0.316	0.10000	3.77E-08
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
	Totals:	2.16E-06	0.00E+00	0.00E+00	Total: 6.08E-07		Total:	1.44E-07

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation	Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)	Risk at Goal
					0.00E+00		0.00000	0.00E+00
Antimony	Hum. Health (NC)	1.50E-01			1.50E-01	4.7	2.99000	9.54E-02
Beryllium	Soil RGO/Sd. Pr.	5.88E-04			5.88E-04	0.23	0.01120	2.86E-05
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
					0.00E+00			0.00E+00
4,4'-DDT	Reg. III Eco. Bnch.	9.61E-03			9.61E-03	0.376	0.10000	2.56E-03
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00		0.00000	0.00E+00
	Totals:	1.60E-01	0.00E+00	0.00E+00	Total: 1.60E-01		Total:	9.80E-02

lnrk@prg

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SURF. SOIL: TRES. ADULT

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beryllium	Soil RGO/Sd. Pr.	2.52E-08				2.52E-08	0.23	0.0112		1.23E-09	3.07E-10
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	Reg. III Eco. Bnch.	3.26E-09				3.26E-09	0.376	0.10000		8.67E-10	2.17E-10
4,4'-DDE	Reg. III Eco. Bnch.	4.71E-09				4.71E-09	0.544	0.10000		8.66E-10	2.16E-10
4,4'-DDD	Reg. III Eco. Bnch.	1.93E-09				1.93E-09	0.316	0.10000		6.11E-10	1.53E-10
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	3.51E-08	0.00E+00	0.00E+00	Total:	9.90E-09			Total:	2.34E-09	8.93E-10

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00		0.00000		0.00E+00	0
Antimony	Hum. Health (NC)	1.10E-03				1.10E-03	4.7	2.99000		7.00E-04	1.75E-04
Beryllium	Soil RGO/Sd. Pr.	4.32E-06				4.32E-06	0.23	0.01120		2.10E-07	5.26E-08
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	Reg. III Eco. Bnch.	7.06E-05				7.06E-05	0.376	0.10000		1.88E-05	4.69E-06
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	1.17E-03	0.00E+00	0.00E+00	Total:	1.17E-03			Total:	7.19E-04	1.80E-04

:rk@prg

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SURF. SOIL: TRES. ADOLESC.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beryllium	Soil RGO/Sd. Pr.	3.19E-08				3.19E-08	0.23	0.0112		1.55E-09	6.21E-10
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	Reg. III Eco. Bnch.	4.13E-09				4.13E-09	0.376	0.10000		1.10E-09	4.39E-10
4,4'-DDE	Reg. III Eco. Bnch.	5.97E-09				5.97E-09	0.544	0.10000		1.10E-09	4.39E-10
4,4'-DDD	Reg. III Eco. Bnch.	2.45E-09				2.45E-09	0.316	0.10000		7.75E-10	3.1E-10
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	4.45E-08	0.00E+00	0.00E+00	Total:	1.26E-08			Total:	2.97E-09	1.81E-09

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
Antimony	Hum. Health (NC)	2.41E-03				2.41E-03	4.7	2.99000		1.53E-03	6.13E-04
						0.00E+00		0.00000		0.00E+00	0
Beryllium	Soil RGO/Sd. Pr.	9.45E-06				9.45E-06	0.23	0.01120		4.60E-07	1.84E-07
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	Reg. III Eco. Bnch.	1.54E-04				1.54E-04	0.376	0.10000		4.10E-05	1.64E-05
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	2.57E-03	0.00E+00	0.00E+00	Total:	2.57E-03			Total:	1.57E-03	6.30E-04

lnrk@prg

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SURF. SOIL: MAINT. WORKER

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beryllium	Soil RGO/Sd. Pr.	1.96E-08				1.96E-08	0.23	0.0112		9.54E-10	3.82E-10
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	Reg. III Eco. Bnch.	2.53E-09				2.53E-09	0.376	0.10000		6.73E-10	2.69E-10
4,4'-DDE	Reg. III Eco. Bnch.	3.66E-09				3.66E-09	0.544	0.10000		6.73E-10	2.69E-10
4,4'-DDD	Reg. III Eco. Bnch.	1.50E-09				1.50E-09	0.316	0.10000		4.75E-10	1.9E-10
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	2.73E-08	0.00E+00	0.00E+00	Total:	7.69E-09			Total:	1.82E-09	1.11E-09

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
Antimony	Hum. Health (NC)	6.51E-04				6.51E-04	4.7	2.99000		4.14E-04	1.66E-04
						0.00E+00		0.00000		0.00E+00	0
Beryllium	Soil RGO/Sd. Pr.	2.55E-06				2.55E-06	0.23	0.01120		1.24E-07	4.97E-08
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	Reg III. Eco. Bnch.	4.17E-05				4.17E-05	0.376	0.10000		1.11E-05	4.44E-06
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	6.95E-04	0.00E+00	0.00E+00	Total:	6.95E-04			Total:	4.25E-04	1.70E-04

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SURF. SOIL: OCCUP. WORKER

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation	Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)	Risk at Goal	New Risk with Instit. Controls
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
Beryllium	Soil RGO/Sd. Pr.	1.73E-07			1.73E-07	0.23	0.0112	8.42E-09	4.21E-09
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
4,4'-DDT	Reg. III Eco. Bnch.	2.23E-08			2.23E-08	0.376	0.10000	5.93E-09	2.97E-09
4,4'-DDE	Reg. III Eco. Bnch.	3.23E-08			3.23E-08	0.544	0.10000	5.94E-09	2.97E-09
4,4'-DDD	Reg. III Eco. Bnch.	1.33E-08			1.33E-08	0.316	0.10000	4.21E-09	2.1E-09
					0.00E+00		0.00000	0.00E+00	0
					0.00E+00		0.00000	0.00E+00	0
	Totals:	2.41E-07	0.00E+00	0.00E+00	Total: 6.79E-08			Total: 1.61E-08	1.23E-08

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation	Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)	Risk at Goal	New Risk with Instit. Controls
Antimony	Human Health (NC)	5.75E-03			5.75E-03	4.7	2.99000	3.66E-03	1.83E-03
					0.00E+00		0.00000	0.00E+00	0
Beryllium	Soil RGO/Sd. Pr.	2.25E-05			2.25E-05	0.23	0.01120	1.10E-06	5.48E-07
					0.00E+00		0.00000	0.00E+00	0
					0.00E+00		0.00000	0.00E+00	0
					0.00E+00		0.00000	0.00E+00	0
					0.00E+00			0.00E+00	0
4,4'-DDT	Reg. III Eco. Bnch.	3.68E-04			3.68E-04	0.376	0.10000	9.79E-05	4.89E-05
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00		0.00000	0.00E+00	0
	Totals:	6.14E-03	0.00E+00	0.00E+00	Total: 6.14E-03			Total: 3.76E-03	1.88E-03

INGEST. RISKS AT CLEANUP GOALS	
KEY WEST SWMU-2	
ALTERN. 4	(MEDIA REMOVAL)
SURF. SOIL:	EXCAV. WORKER

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
Beryllium	Soil RGO/Sd. Pr.	1.96E-09				1.96E-09	0.23	0.0112		9.54E-11
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
4,4'-DDT	Reg. III Eco. Bnch.	2.53E-10				2.53E-10	0.376	0.10000		6.73E-11
4,4'-DDE	Reg. III Eco. Bnch.	3.66E-10				3.66E-10	0.544	0.10000		6.73E-11
4,4'-DDD	Reg. III Eco. Bnch.	1.50E-10				1.50E-10	0.316	0.10000		4.75E-11
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	2.73E-09	0.00E+00	0.00E+00	Total:	7.69E-10			Total:	1.82E-10

		Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
Antimony	Hum. Health (NC)	1.63E-03				1.63E-03	4.7	2.99000		1.04E-03
						0.00E+00		0.00000		0.00E+00
Beryllium	Soil RGO/Sd. Pr.	6.37E-06				6.37E-06	0.23	0.01120		3.10E-07
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00				0.00E+00
4,4'-DDT	Reg. III Eco. Bnch.	1.04E-04				1.04E-04	0.376	0.10000		2.77E-05
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	1.74E-03	0.00E+00	0.00E+00	Total:	1.74E-03			Total:	1.06E-03

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SEDIMENT: CHILD/ADULT RES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00		0.00000		0.00E+00
4,4'-DDT	Eff. Range-Medium	2.25E-06				2.25E-06	14.8	0.04600		6.99E-09
4,4'-DDE	Eff. Range-Medium	7.06E-07				7.06E-07	4.64	0.02700		4.11E-09
4,4'-DDD	Eff. Range-Medium	1.85E-06				1.85E-06	17.2	0.04600		4.95E-09
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	4.81E-06	0.00E+00	0.00E+00	Total:	4.81E-06			Total:	1.60E-08

		Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
Iron		3.20E-02				3.20E-02	2630	0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
4,4'-DDT	Eff. Range-Medium	1.08E-01				1.08E-01	14.8	0.04600		3.36E-04
						0.00E+00		0.00000		0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	1.40E-01	0.00E+00	0.00E+00	Total:	1.40E-01			Total:	3.36E-04

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SEDIMENT: ADULT TRES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
4,4'-DDT	Eff. Range-Medium	2.41E-07				2.41E-07	14.8	0.04600		7.49E-10	9.74E-11
4,4'-DDE	Eff. Range-Medium	7.54E-08				7.54E-08	4.64	0.02700		4.39E-10	5.7E-11
4,4'-DDD	Eff. Range-Medium	1.97E-07				1.97E-07	17.2	0.04600		5.27E-10	6.85E-11
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	5.13E-07	0.00E+00	0.00E+00	Total:	5.13E-07			Total:	1.71E-09	2.23E-10

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
Iron		1.54E-03				1.54E-03	2630	0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
4,4'-DDT	Eff. Range-Medium	5.21E-03				5.21E-03	14.8	0.04600		1.62E-05	2.11E-06
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	6.75E-03	0.00E+00	0.00E+00	Total:	6.75E-03			Total:	1.62E-05	2.11E-06

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SEDIMENT: ADOLES. TRESPAS.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
4,4'-DDT	Eff. Range-Medium	2.44E-07				2.44E-07	14.8	0.04600		7.58E-10	2.05E-10
4,4'-DDE	Eff. Range-Medium	7.64E-08				7.64E-08	4.64	0.02700		4.45E-10	1.2E-10
4,4'-DDD	Eff. Range-Medium	2.00E-07				2.00E-07	17.2	0.04600		5.35E-10	1.44E-10
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	5.20E-07	0.00E+00	0.00E+00	Total:	5.20E-07			Total:	1.74E-09	4.69E-10

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
Iron		2.70E-03				2.70E-03	2630	0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
4,4'-DDT	Eff. Range-Medium	9.12E-03				9.12E-03	14.8	0.04600		2.83E-05	7.65E-06
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	1.18E-02	0.00E+00	0.00E+00	Total:	1.18E-02			Total:	2.83E-05	7.65E-06

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SURF. WATER: CHILD/ADULT RES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation	Total Risk	Represent. Conc (ug/l)	Cleanup Goal (ug/l)	Risk at Goal
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
Beta-BHC		4.49E-08			4.49E-08	0.066		0.00E+00
4,4'-DDD	FDEP S.W. Qual. St.	1.32E-07			1.32E-07	1.45	0.02500	2.28E-09
4,4'-DDT	RCRA Act. Level	4.24E-08			4.24E-08	0.33	0.00100	1.28E-10
Heptachlor	FDEP S.W. Qual. St.	1.05E-07			1.05E-07	0.062	0.00021	3.56E-10
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
	Totals:	3.24E-07	0.00E+00	0.00E+00	Total: 3.24E-07			Total: 2.76E-09

		Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation	Total Risk (HI)	Represent. Conc (ug/l)	Cleanup Goal (ug/l)	Risk at Goal
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
Mercury	Reg. IV S.W. Scrn.	6.65E-02			6.65E-02	8.4	0.02500	1.98E-04
Copper	Nat. Am. Wat. Q. St.	1.61E-02			1.61E-02	272	2.40000	1.42E-04
					0.00E+00			0.00E+00
4,4'-DDT	RCRA Act. Level	1.57E-03			1.57E-03	0.33	0.00100	4.76E-06
					0.00E+00			0.00E+00
Heptachlor	FDEP S.W. Qual. St.	2.94E-04			2.94E-04	0.062	0.00021	9.96E-07
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
	Totals:	8.45E-02	0.00E+00	0.00E+00	Total: 8.45E-02			Total: 3.46E-04

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SURF. WATER: ADULT TRES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beta-BHC		7.38E-09				7.38E-09	0.066			0.00E+00	0
4,4'-DDD	FDEP S.W. Qual. St.	2.16E-08				2.16E-08	1.45	0.02500		3.72E-10	4.84E-11
4,4'-DDT	RCRA Act. Level	6.97E-09				6.97E-09	0.33	0.00100		2.11E-11	2.75E-12
Heptachlor	FDEP S.W. Qual. St.	1.73E-08				1.73E-08	0.062	0.00021		5.86E-11	7.62E-12
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
	Totals:	5.33E-08	0.00E+00	0.00E+00	Total:	5.33E-08			Total:	4.52E-10	5.88E-11
		Route -Specific Non-Cancer Risks Ingestion	**Dermal**	**Inhalation**		**Total Risk (HI)**	**Represent. Conc (ug/l)**	**Cleanup Goal (ug/l)**		**Risk at Goal**	**New Risk with Instit. Controls**
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Mercury	Reg. IV S.W. Scrn.	6.41E-03				6.41E-03	8.4	0.02500		1.91E-05	2.48E-06
Copper	Nat. Am. Wat. Q. St.	1.56E-03				1.56E-03	272	2.40000		1.38E-05	1.79E-06
						0.00E+00				0.00E+00	0
4,4'-DDT	RCRA Act. Level	1.51E-04				1.51E-04	0.33	0.00100		4.58E-07	5.95E-08
						0.00E+00				0.00E+00	0
Heptachlor	FDEP S.W. Qual. St.	2.84E-05				2.84E-05	0.062	0.00021		9.62E-08	1.25E-08
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
	Totals:	8.15E-03	0.00E+00	0.00E+00	Total:	8.15E-03			Total:	3.34E-05	4.34E-06

lnrk@prg

INGEST. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SURF. WATER: ADOLES. TRES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beta-BHC		7.48E-09				7.48E-09	0.066			0.00E+00	0
4,4'-DDT	RCRA Act. Level	7.06E-09				7.06E-09	0.33	0.00100		2.14E-11	5.78E-12
4,4'-DDD	FDEP S.W. Qual. St.	2.19E-08				2.19E-08	1.45	0.02500		3.78E-10	1.02E-10
Heptachlor	FDEP S.W. Qual. St.	1.76E-08				1.76E-08	0.062	0.00021		5.96E-11	1.61E-11
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	5.40E-08	0.00E+00	0.00E+00	Total:	5.40E-08			Total:	4.59E-10	1.24E-10

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
Mercury	Reg. IV S.W. Scrn.	1.12E-02				1.12E-02	8.4	0.02500		3.33E-05	9.00E-06
Copper	Nat. Am. Wat. Q. St.	2.72E-03				2.72E-03	272	2.40000		2.40E-05	6.48E-06
						0.00E+00				0.00E+00	0
4,4'-DDT	RCRA Act. Level	2.64E-04				2.64E-04	0.33	0.00100		8.00E-07	2.16E-07
						0.00E+00				0.00E+00	0
Heptachlor	FDEP S.W. Qual. St.	4.97E-05				4.97E-05	0.062	0.00021		1.68E-07	4.55E-08
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	1.42E-02	0.00E+00	0.00E+00	Total:	1.42E-02			Total:	5.83E-05	1.57E-05

DERM. RISKS AT CLEANUP GOALS	
KEY WEST SWMU-2	
ALTERN. 4	(MEDIA REMOVAL)
SURF. SOIL:	CHILD/ADULT RES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
Beryllium	Soil RGO/Sd. Pr.		1.85E-07			1.85E-07	0.23	0.0112		9.01E-09
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
4,4'-DDT	Reg. III Eco. Bnch.		9.59E-07			9.59E-07	0.376	0.10000		2.55E-07
4,4'-DDE	Reg. III Eco. Bnch.		1.39E-06			1.39E-06	0.544	0.10000		2.56E-07
4,4'-DDD	Reg. III Eco. Bnch.		5.69E-07			5.69E-07	0.316	0.10000		1.80E-07
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	0.00E+00	3.10E-06	0.00E+00	Total:	2.92E-06			Total:	6.91E-07

		Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
Antimony	Hum. Health (NC)		7.20E-03			7.20E-03	4.7	2.99000		4.58E-03
						0.00E+00		0.00000		0.00E+00
Beryllium	Soil RGO/Sd. Pr.		2.82E-05			2.82E-05	0.23	0.11200		1.37E-05
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00				0.00E+00
4,4'-DDT	Reg. III Eco. Bnch.		1.84E-02			1.84E-02	0.376	0.10000		4.89E-03
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	0.00E+00	2.56E-02	0.00E+00	Total:	2.56E-02			Total:	9.49E-03

DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SURF. SOIL: TRES. ADULT

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beryllium	Soil RGO/Sd. Pr.		7.25E-09			7.25E-09	0.23	0.0112		3.53E-10	1.77E-10
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	Reg. III Eco. Bnch.		3.75E-08			3.75E-08	0.376	0.10000		9.97E-09	4.99E-09
4,4'-DDE	Reg. III Eco. Bnch.		5.42E-08			5.42E-08	0.544	0.10000		9.96E-09	4.98E-09
4,4'-DDD	Reg. III Eco. Bnch.		2.22E-08			2.22E-08	0.316	0.10000		7.03E-09	3.51E-09
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	1.21E-07	0.00E+00	Total:	1.14E-07			Total:	2.70E-08	1.37E-08

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
Antimony	Hum. Health (NC)		3.17E-04			3.17E-04	4.7	2.99000		2.02E-04	1.01E-04
						0.00E+00		0.00000		0.00E+00	0
Beryllium	Soil RGO/Sd. Pr.		1.24E-06			1.24E-06	0.23	0.01120		6.04E-08	3.02E-08
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	Reg. III Eco. Bnch.		8.12E-04			8.12E-04	0.376	0.10000		2.16E-04	1.08E-04
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	1.13E-03	0.00E+00	Total:	1.13E-03			Total:	4.18E-04	2.09E-04

DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 & 4 (MEDIA REMOVAL)
SURF. SOIL: TRES. ADOLESC.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation	Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)	Risk at Goal
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
Beryllium	Soil RGO/Sd. Pr.		6.60E-09		6.60E-09	0.23	0.0112	3.21E-10
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
4,4'-DDT	Reg. III Eco. Bnch.		3.41E-08		3.41E-08	0.376	0.10000	9.07E-09
4,4'-DDE	Reg. III Eco. Bnch.		4.93E-08		4.93E-08	0.544	0.10000	9.06E-09
4,4'-DDD	Reg. III Eco. Bnch.		2.02E-08		2.02E-08	0.316	0.10000	6.39E-09
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
	Totals:	0.00E+00	1.10E-07	0.00E+00	Total: 1.04E-07			Total: 2.45E-08

		Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation	Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)	Risk at Goal
Antimony	Hum. Health (NC)		4.99E-04		4.99E-04	4.7	2.99000	3.17E-04
					0.00E+00		0.00000	0.00E+00
Beryllium	Soil RGO/Sd. Pr.		1.95E-06		1.95E-06	0.23	0.01120	9.50E-08
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
					0.00E+00			0.00E+00
4,4'-DDT	Reg. III Eco. Bnch.		1.28E-03		1.28E-03	0.376	0.10000	3.40E-04
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00		0.00000	0.00E+00
	Totals:	0.00E+00	1.78E-03	0.00E+00	Total: 1.78E-03			Total: 6.58E-04

DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 & 4 (MEDIA REMOVAL)
SURF. SOIL: MAINT. WORKER

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beryllium	Soil RGO/Sd. Pr.		4.77E-09			4.77E-09	0.23	0.0112		2.32E-10	9.76E-11
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	Reg. III Eco. Bnch.		2.47E-08			2.47E-08	0.376	0.10000		6.57E-09	2.76E-09
4,4'-DDE	Reg. III Eco. Bnch.		3.57E-08			3.57E-08	0.544	0.10000		6.56E-09	2.76E-09
4,4'-DDD	Reg. III Eco. Bnch.		1.46E-08			1.46E-08	0.316	0.10000		4.62E-09	1.94E-09
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	7.98E-08	0.00E+00	Total:	7.50E-08			Total:	1.78E-08	7.55E-09
		Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
Antimony	Hum. Health (NC)		1.59E-04			1.59E-04	4.7	2.99000		1.01E-04	4.25E-05
						0.00E+00		0.00000		0.00E+00	0
Beryllium	Soil RGO/Sd. Pr.		6.21E-07			6.21E-07	0.23	0.01120		3.02E-08	1.27E-08
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	Reg. III Eco. Bnch.		4.06E-04			4.06E-04	0.376	0.10000		1.08E-04	4.54E-05
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	5.66E-04	0.00E+00	Total:	5.66E-04			Total:	2.09E-04	8.78E-05

DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 & 4 (MEDIA REMOVAL)
SURF. SOIL: OCCUP. WORKER

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beryllium	Soil RGO/Sd. Pr.		3.97E-08			3.97E-08	0.23	0.0112		1.93E-09	9.67E-10
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	Reg. III Eco. Bnch.		2.05E-07			2.05E-07	0.376	0.10000		5.45E-08	2.73E-08
4,4'-DDE	Reg. III Eco. Bnch.		2.97E-07			2.97E-07	0.544	0.10000		5.46E-08	2.73E-08
4,4'-DDD	Reg. III Eco. Bnch.		1.22E-07			1.22E-07	0.316	0.10000		3.86E-08	1.93E-08
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	6.64E-07	0.00E+00	Total:	6.24E-07			Total:	1.48E-07	7.48E-08

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
Antimony	Hum. Health (NC)		1.32E-03			1.32E-03	4.7	2.99000		8.40E-04	4.20E-04
						0.00E+00		0.00000		0.00E+00	0
Beryllium	Soil RGO/Sd. Pr.		5.18E-06			5.18E-06	0.23	0.01120		2.52E-07	1.26E-07
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	Reg. III Eco. Bnch.		3.38E-03			3.38E-03	0.376	0.10000		8.99E-04	4.49E-04
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	4.71E-03	0.00E+00	Total:	4.71E-03			Total:	1.74E-03	8.69E-04

DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 3 & 4 (MEDIA REMOVAL)
SURF. SOIL: EXCAV. WORKER

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
Beryllium	Soil RGO/Sd. Pr.		4.77E-10			4.77E-10	0.23	0.0112		2.32E-11
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
4,4'-DDT	Reg. III Eco. Bnch.		2.47E-09			2.47E-09	0.376	0.10000		6.57E-10
4,4'-DDE	Reg. III Eco. Bnch.		3.57E-09			3.57E-09	0.544	0.10000		6.56E-10
4,4'-DDD	Reg. III Eco. Bnch.		1.46E-09			1.46E-09	0.316	0.10000		4.62E-10
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	0.00E+00	7.98E-09	0.00E+00	Total:	7.50E-09			Total:	1.78E-09

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
Antimony	Hum. Health (NC)		3.97E-04			3.97E-04	4.7	2.99000		2.53E-04
						0.00E+00		0.00000		0.00E+00
Beryllium	Soil RGO/Sd. Pr.		1.55E-06			1.55E-06	0.23	0.01120		7.55E-08
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00				0.00E+00
4,4'-DDT	Reg. III Eco. Bnch.		1.02E-03			1.02E-03	0.376	0.10000		2.71E-04
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	0.00E+00	1.42E-03	0.00E+00	Total:	1.42E-03			Total:	5.24E-04

DERM. RISKS AT CLEANUP GOALS	
KEY WEST SWMU-2	
ALTERN. 4	(MEDIA REMOVAL)
SEDIMENT:	CHILD/ADULT RES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00		0.00000		0.00E+00
4,4'-DDT	Eff. Range-Medium		1.08E-05			1.08E-05	14.8	0.04600		3.36E-08
4,4'-DDE	Eff. Range-Medium		3.38E-06			3.38E-06	4.64	0.02700		1.97E-08
4,4'-DDD	Eff. Range-Medium		8.85E-06			8.85E-06	17.2	0.04600		2.37E-08
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	0.00E+00	2.30E-05	0.00E+00	Total:	2.30E-05			Total:	7.69E-08

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
Iron			1.53E-03			1.53E-03	2630	0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
4,4'-DDT	Eff. Range-Medium		2.07E-01			2.07E-01	14.8	0.04600		6.43E-04
						0.00E+00		0.00000		0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	0.00E+00	2.09E-01	0.00E+00	Total:	2.09E-01			Total:	6.43E-04

DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SEDIMENT: ADULT TRES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
4,4'-DDT	Eff. Range-Medium		2.77E-06			2.77E-06	14.8	0.04600		8.61E-09	2.32E-09
4,4'-DDE	Eff. Range-Medium		8.67E-07			8.67E-07	4.64	0.02700		5.05E-09	1.36E-09
4,4'-DDD	Eff. Range-Medium		2.27E-06			2.27E-06	17.2	0.04600		6.07E-09	1.64E-09
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	5.91E-06	0.00E+00	Total:	5.91E-06			Total:	1.97E-08	5.33E-09

		Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
Iron			4.44E-04			4.44E-04	2630	0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
4,4'-DDT	Eff. Range-Medium		6.00E-02			6.00E-02	14.8	0.04600		1.86E-04	5.04E-05
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	6.04E-02	0.00E+00	Total:	6.04E-02			Total:	1.86E-04	5.04E-05

DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SEDIMENT: ADOLES. TRESPAS.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
4,4'-DDT	Eff. Range-Medium		2.01E-06			2.01E-06	14.8	0.04600		6.25E-09	1.69E-09
4,4'-DDE	Eff. Range-Medium		6.31E-07			6.31E-07	4.64	0.02700		3.67E-09	9.91E-10
4,4'-DDD	Eff. Range-Medium		1.65E-06			1.65E-06	17.2	0.04600		4.41E-09	1.19E-09
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	4.29E-06	0.00E+00	Total:	4.29E-06			Total:	1.43E-08	3.87E-09

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
Iron			5.58E-04			5.58E-04	2630	0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
4,4'-DDT	Eff. Range-Medium		7.54E-02			7.54E-02	14.8	0.04600		2.34E-04	6.33E-05
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	7.60E-02	0.00E+00	Total:	7.60E-02			Total:	2.34E-04	6.33E-05

DERM. RISKS AT CLEANUP GOALS	
KEY WEST SWMU-2	
ALTERN. 4	(MEDIA REMOVAL)
SURF. WATER:	CHILD/ADULT RES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
4,4'-DDD	FDEP S.W. Qual. St.		2.28E-05			2.28E-05	1.45	0.02500		3.93E-07
4,4'-DDT	RCRA Act. Level		1.46E-05			1.46E-05	0.33	0.00100		4.42E-08
Heptachlor	FDEP S.W. Qual. St.		1.06E-06			1.06E-06	0.062	0.00021		3.59E-09
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
	Totals:	0.00E+00	3.85E-05	0.00E+00	**Total:**	3.85E-05			**Total:**	4.41E-07

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
Mercury	Reg. IV S.W. Scrn.		3.43E-02			3.43E-02	8.4	0.02500		1.02E-04
Copper	Nat. Am. Wat. Q. St.		8.33E-03			8.33E-03	272	2.40000		7.35E-05
						0.00E+00				0.00E+00
4,4'-DDT	RCRA Act. Level		2.80E-01			2.80E-01	0.33	0.00100		8.48E-04
						0.00E+00				0.00E+00
Heptachlor	FDEP S.W. Qual. St.		1.54E-03			1.54E-03	0.062	0.00021		5.22E-06
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
	Totals:	0.00E+00	3.24E-01	0.00E+00	**Total:**	3.24E-01			**Total:**	1.03E-03

DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SURF. WATER: ADULT TRES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDD	FDEP S.W. Qual. St.		5.85E-06			5.85E-06	1.45	0.02500		1.01E-07	2.72E-08
4,4'-DDT	RCRA Act. Level		3.74E-06			3.74E-06	0.33	0.00100		1.13E-08	3.06E-09
Heptachlor	FDEP S.W. Qual. St.		2.72E-07			2.72E-07	0.062	0.00021		9.21E-10	2.49E-10
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
	Totals:	0.00E+00	9.86E-06	0.00E+00	Total:	9.86E-06			Total:	1.13E-07	3.05E-08

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Mercury	Reg. IV S.W. Scrn.		2.84E-03			2.84E-03	8.4	0.02500		8.45E-06	2.28E-06
Copper	Nat. Am. Wat. Q. St.		6.89E-04			6.89E-04	272	2.40000		6.08E-06	1.64E-06
						0.00E+00				0.00E+00	0
4,4'-DDT	RCRA Act. Level		8.10E-02			8.10E-02	0.33	0.00100		2.45E-04	6.63E-05
						0.00E+00				0.00E+00	0
Heptachlor	FDEP S.W. Qual. St.		4.45E-04			4.45E-04	0.062	0.00021		1.51E-06	4.07E-07
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
	Totals:	0.00E+00	8.50E-02	0.00E+00	Total:	8.50E-02			Total:	2.61E-04	7.06E-05

DERM. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SURF. WATER: ADOLES. TRES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	RCRA Act. Level		2.72E-06			2.72E-06	0.33	0.00100		8.24E-09	2.23E-09
4,4'-DDD	FDEP S.W. Qual. St.		4.26E-06			4.26E-06	1.45	0.02500		7.34E-08	1.98E-08
Heptachlor	FDEP S.W. Qual. St.		1.98E-07			1.98E-07	0.062	0.00021		6.71E-10	1.81E-10
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	7.18E-06	0.00E+00	Total:	7.18E-06			Total:	8.24E-08	2.22E-08

Chemical of Concern	Criteria for Goal	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (ug/l)	Cleanup Goal (ug/l)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
Mercury	Reg. IV S.W. Scrn.		3.57E-03			3.57E-03	8.4	0.02500		1.06E-05	2.87E-06
Copper	Nat. Am. Wat. Q. St.		8.66E-04			8.66E-04	272	2.40000		7.64E-06	2.06E-06
						0.00E+00				0.00E+00	0
4,4'-DDT	RCRA Act. Level		1.02E-01			1.02E-01	0.33	0.00100		3.09E-04	8.35E-05
						0.00E+00				0.00E+00	0
Heptachlor	FDEP S.W. Qual. St.		5.60E-04			5.60E-04	0.062	0.00021		1.90E-06	5.12E-07
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	1.07E-01	0.00E+00	Total:	1.07E-01			Total:	3.29E-04	8.89E-05

INHAL. RISKS AT CLEANUP GOALS	
KEY WEST SWMU-2	
ALTERN. 4	(MEDIA REMOVAL)
SURF. SOIL:	CHILD/ADULT RES.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
Beryllium	Soil RGO/Sd. Pr.			1.53E-08		1.53E-08	0.23	0.0112		7.45E-10
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
4,4'-DDT	Reg. III Eco. Bnch.			6.21E-10		6.21E-10	0.376	0.10000		1.65E-10
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	0.00E+00	0.00E+00	1.59E-08	Total:	1.59E-08			Total:	9.10E-10

	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00		0.00000		0.00E+00
					0.00E+00				0.00E+00
					0.00E+00				0.00E+00
					0.00E+00				0.00E+00
					0.00E+00				0.00E+00
					0.00E+00				0.00E+00
					0.00E+00		0.00000		0.00E+00
Totals:	0.00E+00	0.00E+00	0.00E+00	Total:	0.00E+00			Total:	0.00E+00

INHAL. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SURF. SOIL: TRESP. ADULT

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beryllium	Soil RGO/Sd. Pr.			9.61E-11		9.61E-11	0.23	0.0112		4.68E-12	2.34E-12
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	Reg. III Eco. Bnch.			3.89E-12		3.89E-12	0.376	0.10000		1.03E-12	5.17E-13
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	0.00E+00	1.00E-10	Total:	1.00E-10			Total:	5.71E-12	2.86E-12

	Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
					0.00E+00		0.00000		0.00E+00	0
					0.00E+00		0.00000		0.00E+00	0
					0.00E+00		0.00000		0.00E+00	0
					0.00E+00		0.00000		0.00E+00	0
					0.00E+00		0.00000		0.00E+00	0
					0.00E+00		0.00000		0.00E+00	0
					0.00E+00				0.00E+00	0
					0.00E+00				0.00E+00	0
					0.00E+00				0.00E+00	0
					0.00E+00				0.00E+00	0
					0.00E+00				0.00E+00	0
					0.00E+00		0.00000		0.00E+00	0
Totals:	0.00E+00	0.00E+00	0.00E+00	Total:	0.00E+00			Total:	0.00E+00	0

rk@prg

INHAL. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SURF. SOIL: TRESP. ADOLESC.

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation	Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)	Risk at Goal	New Risk with Instit. Controls
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
Beryllium	Soil RGO/Sd. Pr.			1.22E-10	1.22E-10	0.23	0.0112	5.94E-12	2.38E-12
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
					0.00E+00			0.00E+00	0
4,4'-DDT	Reg. III Eco. Bnch.			4.93E-12	4.93E-12	0.376	0.10000	1.31E-12	5.24E-13
					0.00E+00		0.00000	0.00E+00	0
					0.00E+00		0.00000	0.00E+00	0
					0.00E+00		0.00000	0.00E+00	0
					0.00E+00		0.00000	0.00E+00	0
	Totals:	0.00E+00	0.00E+00	1.27E-10	Total: 1.27E-10		Total:	7.25E-12	2.9E-12

Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation	Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)	Risk at Goal	New Risk with Instit. Controls
			0.00E+00		0.00000	0.00E+00	0
			0.00E+00		0.00000	0.00E+00	0
			0.00E+00		0.00000	0.00E+00	0
			0.00E+00		0.00000	0.00E+00	0
			0.00E+00		0.00000	0.00E+00	0
			0.00E+00		0.00000	0.00E+00	0
			0.00E+00			0.00E+00	0
			0.00E+00			0.00E+00	0
			0.00E+00			0.00E+00	0
			0.00E+00			0.00E+00	0
			0.00E+00			0.00E+00	0
			0.00E+00		0.00000	0.00E+00	0
Totals: 0.00E+00	0.00E+00	0.00E+00	Total: 0.00E+00		Total:	0.00E+00	0

INHAL. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SURF. SOIL: MAINT. WORKER

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation	Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)	Risk at Goal
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
Beryllium	Soil RGO/Sd. Pr.			1.27E-10	1.27E-10	0.23	0.0112	6.18E-12
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
4,4'-DDT	Reg. III Eco. Bnch.			5.12E-12	5.12E-12	0.376	0.10000	1.36E-12
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
	Totals:	0.00E+00	0.00E+00	1.32E-10	Total: 1.32E-10		Total:	7.55E-12

		Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation	Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)	Risk at Goal
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
					0.00E+00		0.00000	0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00			0.00E+00
					0.00E+00		0.00000	0.00E+00
	Totals:	0.00E+00	0.00E+00	0.00E+00	Total: 0.00E+00		Total:	0.00E+00

INHAL. RISKS AT CLEANUP GOALS
KEY WEST SWMU-2
ALTERN. 4 (MEDIA REMOVAL)
SURF. SOIL: OCCUP. WORKER

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
Beryllium	Soil RGO/Sd. Pr.			2.64E-09		2.64E-09	0.23	0.0112		1.29E-10	6.43E-11
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
4,4'-DDT	Reg. III Eco. Bnch.			1.07E-10		1.07E-10	0.376	0.10000		2.85E-11	1.42E-11
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	0.00E+00	2.75E-09	Total:	2.75E-09			Total:	1.57E-10	7.85E-11

		Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal	New Risk with Instit. Controls
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00				0.00E+00	0
						0.00E+00		0.00000		0.00E+00	0
	Totals:	0.00E+00	0.00E+00	0.00E+00	Total:	0.00E+00			Total:	0.00E+00	0

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INHAL. RISKS AT CLEANUP GOALS	
KEY WEST SWMU-2	
ALTERN. 4	(MEDIA REMOVAL)
SURF. SOIL:	EXCAV. WORKER

Chemical of Concern	Criteria for Goal	Route -Specific Cancer Risks Ingestion	Dermal	Inhalation		Total Risk	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
Beryllium	Soil RGO/Sd. Pr.			3.80E-11		3.80E-11	0.23	0.0112		1.85E-12
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
4,4'-DDT	Reg. III Eco. Bnch.			1.54E-12		1.54E-12	0.376	0.10000		4.10E-13
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	0.00E+00	0.00E+00	3.95E-11	Total:	3.95E-11			Total:	2.26E-12

		Route -Specific Non-Cancer Risks Ingestion	Dermal	Inhalation		Total Risk (HI)	Represent. Conc (mg/kg)	Cleanup Goal (mg/kg)		Risk at Goal
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00		0.00000		0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00				0.00E+00
						0.00E+00		0.00000		0.00E+00
	Totals:	0.00E+00	0.00E+00	0.00E+00	Total:	0.00E+00			Total:	0.00E+00

APPENDIX B

DEVELOPMENT OF CROSS-MEDIA REMEDIAL GOAL OPTIONS
SWMU 2

B.1 INTRODUCTION

The following sections describe the development of cross-media Remedial Goal Options (RGOs) for the Naval Air Station (NAS), Key West, Florida. The modeling was conducted to support the Corrective Measures Study (CMS) being conducted for SWMU 2, the Boca Chica DDT Mixing Area. Cross-media RGOs are concentrations in one media (e.g., soil or groundwater) which are protective of the migration of residual contaminants to another media (e.g., surface water or sediment). The cross-media RGOs were developed through the use of surface runoff and groundwater flow contaminant fate and transport models.

B.1.1 OBJECTIVES

A substantial interim removal of soil and sediment was conducted at SWMU 2 in the spring of 1996. This remedial action removed surface soils from an area approximately 200 feet by 250 feet and sediment in the adjacent manmade ditch that runs from the site to the lagoon on the east. A total of 1,943 cubic yards (2,471 tons) of soil and sediment were removed from the excavation area. Minor concentrations of contaminants are still present in the soil and sediment outside the excavated areas (B&R Environmental, 1997).

Four RGOs were developed as shown in Table 1. The soil to sediment and soil to surface water RGOs are the soil concentrations at the site which will not cause sediment or surface water concentrations at the exposure point to exceed the acceptable concentrations in the exposure media (i.e., sediment and surface water criteria). Groundwater to surface water and groundwater to sediment RGOs are the groundwater concentrations under the source which will not cause the surface water or sediment concentrations at the exposure point to exceed the acceptable. All of the RGOs developed are intended to be used as conservative screening values and are not final cleanup levels.

The following sections discuss the quantitative analysis used to predict the contaminant migration in the soil and groundwater at SWMU 2. This analysis differs from a full fate and transport modeling analysis in that a calibrated groundwater flow and transport model covering the entire site was not developed. In addition, this analysis relies heavily on conservative literature sources of chemical input parameters so that the chemical migration of contaminants is not specifically calibrated to site conditions. The results of this analysis, represent approximate, yet still conservative, results.

TABLE 1

SUMMARY OF TYPE OF CROSS-MEDIA RGO DEVELOPMENT
SWMU 2 CORRECTIVE MEASURE STUDY
NAVAL AIR STATION, KEY WEST, FLORIDA

Type of RGO	Source Media	Transport Pathway	Exposure Media	Exposure Point
Soil	Surface soil	Soil to sediment	Sediment	Lagoon
Soil	Surface soil	Soil to surface water	Surface water	Lagoon
Groundwater	Groundwater	Groundwater to sediment	Sediment	Lagoon
Groundwater	Groundwater	Groundwater to surface water	Surface water	Lagoon

B.2 TECHNICAL APPROACH

The technical approach used to develop the RGOs is described in the following subsections. The first subsection briefly describes the geology, hydrogeology, and the pattern of contaminant releases. The next subsection describes the surface water runoff model and the associated assumptions. The final subsection describes the analytical groundwater contaminant fate and transport model used for the tasks, the associated simplifying assumptions, and the supplemental equations.

B.2.1 SITE CONCEPTUAL MODEL

Rainwater which falls on the site can transport contaminants through runoff and/or by infiltrating into the soil. Runoff can transport contaminants from the surface soils in both the dissolved form and also in solid form sorbed to soil particles being eroded by the runoff. A portion of the rainwater which falls on the site reaches the groundwater by directly infiltrating into the soils. As the water infiltrates through the contaminated soil, contaminants leach out of the soil and are transported in dissolved form with the water through the unsaturated zone to the groundwater below. The contaminants can then be transported laterally in the groundwater and eventually enter either a surface water body or migrate to a groundwater exposure point.

There is a layer, about 0 to 4 feet thick, of fill material overlying the indigenous oolitic limestone at SWMU 2. A ditch runs from SWMU 2 to the lagoon on the east. Dredging during the interim remediation has incised the ditch to 4 to 5 feet deep, which intercepts the groundwater table. Conceptually, the groundwater contaminant pathway consists of an unsaturated zone and a shallow unconfined aquifer. The unsaturated zone and shallow aquifer consist of oolitic limestone covered by fill materials. The typical depth to groundwater is approximately 1 foot below the mean sea level. The thickness of the oolitic limestone averaged 20 feet below the center of the western half of Key West. Groundwater can travel horizontally and vertically in the saturated zone.

B.2.2 SURFACE RUNOFF MODEL

Two surface runoff models were set up for developing the surface soil to sediment and surface soil to surface water RGOs that are protective of sediment and surface water.

- Surface soil to sediment RGO protective of sediment

  It was assumed that the erosion capacity of runoff water is the same everywhere at the site. The ratio of eroded clean soil and eroded contaminated soil is approximately the same as the ratio of the runoff flows through the clean area and contaminated area. The soil RGO protective of sediment can be conservatively estimated by the following equation.

  Soil RGO = Sediment Criteria * Ratio of clean and contaminated runoff water.

- Surface soil to surface water RGO protective of surface water

  It is assumed that contaminant concentrations in the runoff water are zero from the clean area. It is also assumed that contaminant concentrations in the surface water are in equilibrium with the soil from the contaminated area. The surface soil to surface water RGO protective of surface water can be calculated from the following equation:

  Soil RGO = K_d * Surface Water criteria * Ratio of clean and contaminated runoff water * unit conversion factor (1/1000).

The calculation of the ratio of clean and contaminated water and ratio of clean and contaminated runoff water will be described in Section 3.2.1.

B.2.3 GROUNDWATER TRANSPORT MODEL

A portion of the rainfall which falls on the site will infiltrate through the unsaturated soil into the groundwater. The soil in the most contaminated area has been excavated. Minor surface soil contaminants were detected at the edge of the excavated area. For the groundwater RGO development, it is assumed that the soil in the unsaturated layer is clean in the groundwater conceptual model. Groundwater from upgradient is also assumed clean (zero concentration). Upgradient flow will combine with infiltration and carry the dissolved contaminants in the groundwater at the site to the lagoon area. Dissolved contaminants migrate through the groundwater at a slower velocity than the velocity of the groundwater. The velocity of the contaminants is said to be retarded. The amount of the retardation is chemical specific. Also, the contaminants may decay in the environment because of biological and/or chemical processes. Therefore, as contaminants migrate through the groundwater, they may decay and their concentrations will correspondingly decrease.

The groundwater to surface water RGO is the groundwater concentration at the site which is protective of surface water at the bank of lagoon. Correspondingly, the groundwater to sediment RGO is the groundwater concentration which is protective of the sediment at the bank of lagoon. The conceptual model for groundwater RGO development is shown in Figure 1. Also, the source area for the groundwater RGO development is shown in Figure 2.

B.2.3.1 Groundwater Model Tool

The groundwater modeling was performed using an analytical contaminant fate and transport model. This groundwater model is implemented on the spreadsheet software Excel 4.0 and Crystal Ball 3.0 and is called ECTran (which stands for Excel-Crystal Ball Transport). The ECTran model (Chiou, 1993) is based on straight forward mass-balances and advection/dispersion analytical equations, but can be used to simulate a variety of complex conditions. To date, ECTran and its predecessors have been employed at hazardous waste sites in U.S. EPA Regions III, V, VI, and X to evaluate soil cleanup goals, cleanup time estimations, and to support baseline risk assessments. It has been used at DOD, DOE, and industrial sites for both RCRA and CERCLA applications.

The ECTran model simulates vertical contaminant transport with uniform (thickness, concentration, porosity, etc.) layers. The model predicts the concentration down gradient of the source at a single point at a specified distance from the exposure point. This predicted concentration is at the centerline of the contaminant plume.

B.2.3.2 Groundwater Modeling Assumptions And Procedures

Source Area

The contaminated area was assumed to be a rectangular area with length 350 feet and width 300 feet. The previously contaminated surface soil was excavated within an area approximately 250 feet by 200 feet so as to include the edges of the excavated area. The source area was extended in each direction by 50 feet from the excavated area. Therefore, the selected source area is 350 feet long (parallel to the groundwater flow) by 300 feet wide (see Figures 1 and 2).

Soil concentration

During the interim remedial action in the Spring of 1996, soil in area of approximately 200 feet by 250 feet was removed and were replaced by clean backfill. Only minor concentrations of contaminants are

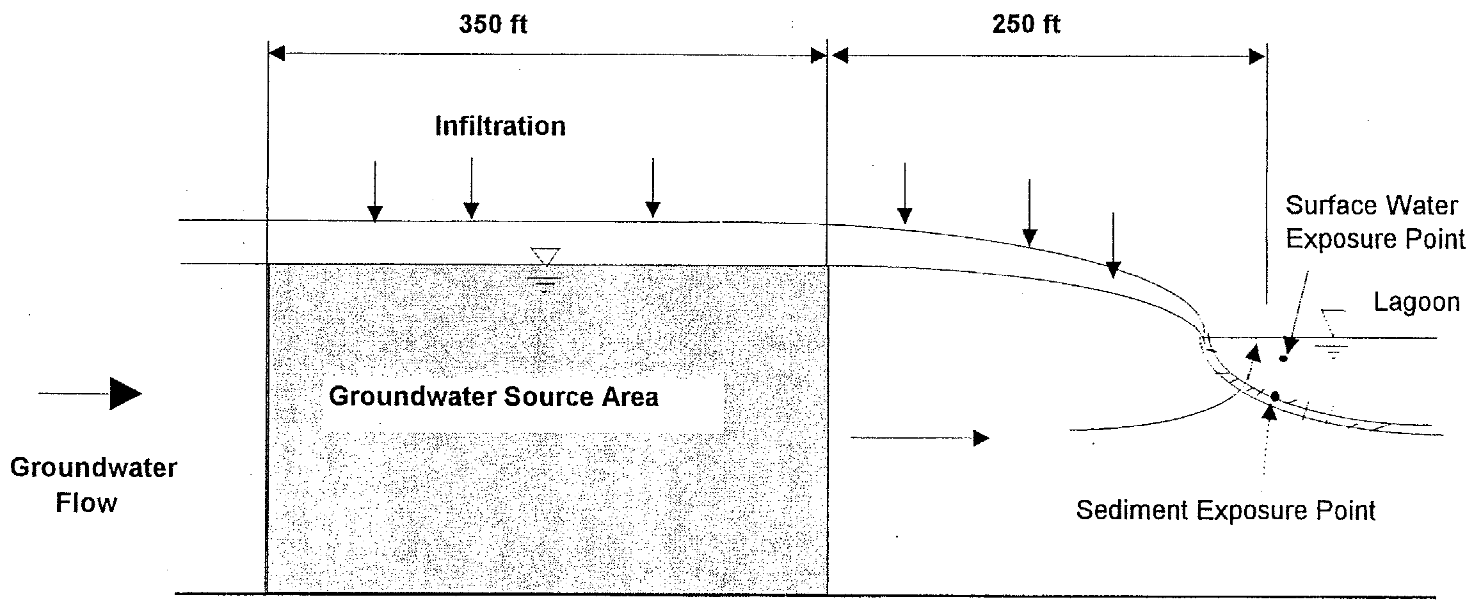

FIGURE 1
CONCEPTUAL MODEL FOR GROUNDWATER RGO DEVELOPMENT
SWMU 2 CORRECTIVE MEASURE STUDY
NAVAL AIR STATION, KEY WEST, FLORIDA

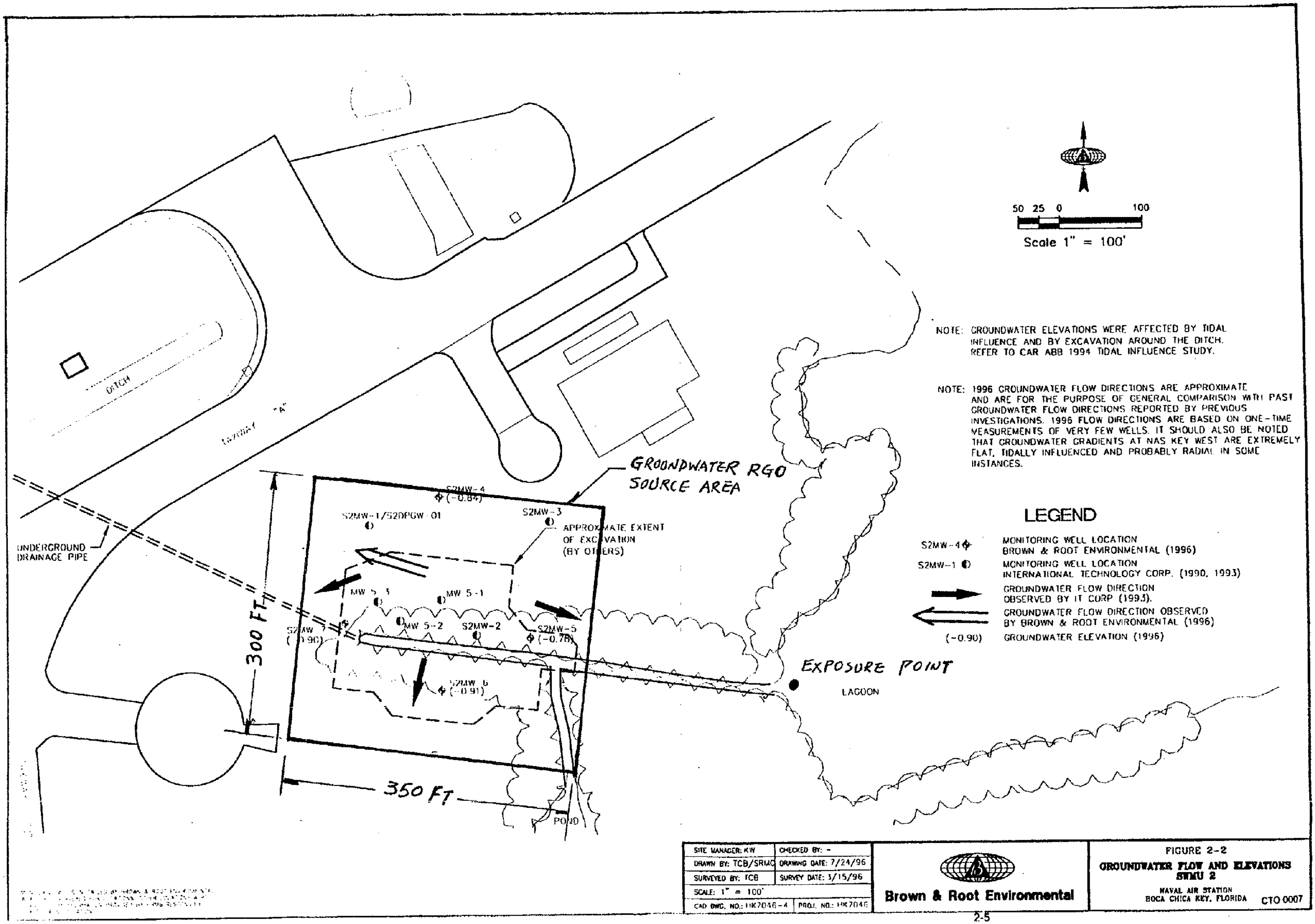

Figure 2 Source Area for Groundwater RGO Development

detected in the surface soil at the edge of the excavated area. Therefore, in the groundwater RGO development, the unsaturated soil is assumed to be clean.

Layer simulated in the model

The infiltration water reaching the groundwater is clean based the on the above assumption of surface soil remediation. Therefore, only one saturated layer with uniform thickness of 20 feet was assumed in the model. This 20-foot saturated layer is based on the mixing depth calculation.

Modeling Time Frame

The contaminant simulations were continued until the concentration at the exposure point peaked or until the simulation reached 1000 years. Typically, concentrations of organic chemicals will reach their peak concentrations at the exposure point earlier than inorganic chemicals. The further into the future the model is used to predict contaminant concentrations, the uncertainty of the results become greater due to the possibility of land use changes, changes in the properties of the contaminants, or even changes in climate. Due to this uncertainty, model simulations were limited to a 1000-year time frame. The 1000-year modeling time frame has been used previously at other government facilities. Some chemicals which move very slowly in the groundwater may not reach the exposure point in 1000 years and will result in an exposure point concentration of zero and a corresponding RGO concentration of 100% (pure product).

Chemical Fate and Transport

Several mechanisms/processes affecting chemical fate and transport in groundwater were accounted for during the development of the RGOs. They include sorption, dilution, advection, dispersion, and chemical/biological decay. Sorption is the reaction that occurs between solute and the surfaces of solids causing the solute to bond to varying degrees to the surface. Dilution occurs because of the mixing of contaminated groundwater with unaffected groundwater. Advection is the primary mechanism responsible for the movement of contaminants as a consequence of groundwater flow. Dispersion occurs because of fluid mixing due to effects of unresolved heterogeneities in the permeability distribution. Decay involves the degradation of a chemical by natural chemical and biological processes.

B.2.3.3 Groundwater to Surface Water Assumptions

To determine the groundwater to surface water RGO, an acceptable groundwater concentration protective of surface water at the surface water/groundwater interface at the lagoon was first calculated. This acceptable groundwater concentration was calculated based on the assumptions and equations presented in this section. The RGOs were then developed with the groundwater model and assumptions as described in the previous section, based on the acceptable groundwater concentration protective of the surface water. concentrations in the exposure media (i.e., surface water and sediment criteria). The assumed groundwater concentration under the source was iteratively changed until the model-predicted concentration at the edge of the lagoon was just below the acceptable groundwater concentration. The final assumed source groundwater concentration is the cross-media groundwater RGO.

The seepage concentration was based on the flux of contaminants out of the ground divided by the total flow of water out of the ground. The flux of contaminants into the lagoon was based on the chemical specific velocity of each of the contaminants in the groundwater. The contaminant velocity is the velocity of the groundwater divided by the retardation factor (Domenico, 1982). A retardation factor of one would correspond to a chemical which migrates through the groundwater at the same velocity as the groundwater. The higher the retardation factor, the slower the contaminant migrates in the groundwater. The following equation is used to calculate the chemical mass flux in the groundwater at the groundwater/surface water interface.

$$Q_C = \frac{V_{GW}\ A\ C}{R_C} \qquad (1)$$

where:

Q_C = Chemical flux (mass/time)

V_{GW} = Groundwater velocity (length/time)

C = Chemical concentration in the groundwater (mass/length^3) (Predicted with the ECTran model)

A = Cross sectional area of the mass flow (length^2) and RC is chemical specific retardation factor given by:

$$R_C = 1 + \frac{\rho_b}{n} K_d \qquad (2)$$

where:

R_C = Chemical specific retardation factor (dimensionless)

ρ_b = Dry bulk density of soil (mass/length3)

n = Porosity (dimensionless)

K_d = Soil / water partitioning coefficient (length3/mass)

The total flow of groundwater is given by the groundwater velocity multiplied by the cross sectional area of the groundwater flow. The seep concentration (Cs) is then

$$C_s = \frac{Q_C}{V_{GW} A} \quad (3)$$

After replacing Qc in Equation (3) by Equation (1), the groundwater velocity and the area cancel out so that the seep concentration is the groundwater concentration divided by the retardation factor.

$$C_s = \frac{C}{R_d} \quad (4)$$

Equation (4) was used to calculate the acceptable groundwater concentration at the groundwater/surface water interface assuming C_s is the surface water exposure criteria. The surface water exposure criteria are presented in Table 2 along with the other exposure criteria. The groundwater concentration was then iteratively changed until the predicted maximum groundwater concentration at the groundwater/surface water interface was just below the acceptable groundwater concentration based on the surface water exposure criteria.

B.2.3.4. <u>Groundwater to Sediment Assumptions</u>

Development of the groundwater to sediment RGOs was similar to development of the groundwater to surface water RGOs described in Section 2.3.3. The acceptable groundwater concentration in the sediment porewater was assumed to equal the acceptable sediment concentration divided by K_d. This acceptable groundwater concentration is presented in Table 2 with the other exposure criteria. The exposure point is the groundwater/surface water (approximately the same as the groundwater/sediment) interface.

TABLE 2

GROUNDWATER CRITERIA PROTECTIVE OF SURFACE WATER AND SEDIMENT
SWMU 2 CORRECTIVE MEASURE STUDY
NAVAL AIR STATION, KEY WEST, FLORIDA

Chemicals of Concern	Partitioning Coefficient Kd L/kg	Retardation Factor Rd	SurfaceWater Criteria (1) ug/L	Groundwater Criteria Protective of Surface Water (2) ug/L	Sediment Criteria (3) mg/kg	Groundwater Criteria Protective of Sediment (4) ug/L
INORGANICS						
Aluminum	1.50E+03	7.50E+03	1.50E+03	1.13E+07	n/a (5)	n/a
Antimony	4.50E+01	2.26E+02	1.00E+01	2.26E+03	1.20E+01	2.67E+02
Arsenic	2.90E+01	1.46E+02	3.60E+01	5.26E+03	7.00E+01	2.41E+03
Beryllium	2.50E+02	1.25E+03	8.00E-03	1.00E+01	2.00E-01	8.00E-01
Cadmium	7.50E+01	3.76E+02	9.30E+00	3.50E+03	9.60E+00	1.28E+02
Chromium	1.90E+01	9.60E+01	5.00E+01	4.80E+03	3.70E+02	1.95E+04
Cyanide	9.90E+00	5.05E+01	1.00E+00	5.05E+01	1.00E-01	1.01E+01
Lead	2.70E+02	1.35E+03	5.60E+00	7.57E+03	2.18E+02	8.07E+02
Mercury	5.20E+01	2.61E+02	2.50E-02	6.53E+00	7.10E-01	1.37E+01
Silver	8.30E+00	4.25E+01	2.30E-01	9.78E+00	3.70E+00	4.46E+02
Thallium	7.10E+01	3.56E+02	6.30E+00	2.24E+03	n/a	n/a
Tin	1.30E+02	6.51E+02	1.00E-02	6.51E+00	n/a	n/a
Vanadium	1.00E+03	5.00E+03	1.00E+04	5.00E+07	7.20E+02	7.20E+02
Zinc	6.20E+01	3.11E+02	8.10E+01	2.52E+04	4.10E+02	6.61E+03
PESTICIDES						
4,4'-DDD	6.16E+02	3.08E+03	2.50E-02	7.70E+01	3.30E-03	5.36E-03
4,4'-DDE	3.09E+02	1.54E+03	1.40E-01	2.16E+02	2.70E-02	8.75E-02
4,4'-DDT	9.76E+02	4.88E+03	5.90E-04	2.88E+00	4.60E-02	4.71E-02
Aldrin	2.45E+03	1.23E+04	1.40E-04	1.72E+00	4.00E-02	1.63E-02
Alpha BHC	4.07E+00	2.13E+01	1.40E+03	2.99E+04	1.00E-01	2.46E+01
Beta BHC	4.07E+00	2.13E+01	4.60E-02	9.82E-01	5.00E-03	1.23E+00
Delta-BHC	4.07E+00	2.13E+01	1.60E-02	3.42E-01	3.00E-03	7.37E-01
Endosulfan I	2.24E+00	1.22E+01	8.70E-03	1.06E-01	2.90E-03	1.29E+00
Endrin	1.23E+01	6.25E+01	2.30E-03	1.44E-01	3.30E-03	2.68E-01
Heptachlor	8.32E+01	4.17E+02	2.10E-04	8.76E-02	4.90E-03	5.89E-02
SVOCs						
Bis(2-ethylhexyl)phthalate	1.51E+04	7.55E+04	3.00E+00	2.27E+05	1.82E-01	1.21E-02
Naphthalene	2.00E+00	1.10E+01	2.40E+01	2.64E+02	2.10E+00	1.05E+03
VOCs						
1,2 DCE (Total)	3.55E-02	1.18E+00	1.13E+03	1.33E+03	n/a	n/a
Benzene	5.89E-02	1.29E+00	1.09E+02	1.41E+02	5.70E-02	9.68E+02
Chlorobenzene	6.17E-01	4.09E+00	1.05E+02	4.29E+02	8.20E-01	1.33E+03
Ethylbenzene	3.63E-01	2.82E+00	4.30E+00	1.21E+01	3.60E+00	9.92E+03
Methylene Chloride	1.17E-02	1.06E+00	5.00E+00	5.29E+00	4.27E-01	3.65E+04
Vinyl Chloride	1.86E-02	1.09E+00	1.16E+04	1.27E+04	n/a	n/a

Notes:
(1) Surface Water Criteria are the most restrictive ARAR or SAL (Table 2-5, Supplemental RFI/RI Report, 1996).
(2) Groundwater Criteria Protective of Surface Water are calculated by multiplying the surface water criteria by their corresponding Rd (retardation factor).
(3) Sediment Criteria are the ER-M or the most restrictive ARAR or SAL, if ER-M is not available (Table 2-4, Supplemental RFI/RI Report, 1996).
(4) Groundwater Criteria Protective of Sediment are calculated by dividing the sediment criteria by their corresponding Kd (partitioning coefficient) multiplied by an unit conversion factor.
(5) n/a indicates that no criteria is available for this COC

B.3 INPUT DATA FOR MODELING

The description of the input parameters required for the modeling is discussed in the following two subsections, chemical input and physical input parameters. The physical input parameter section is further subdivided into the surface water runoff input parameters and groundwater model input parameters.

B.3.1 CHEMICAL INPUT PARAMETERS

The primary chemical input parameters include the soil/water partitioning coefficient, K_d, the exposure criteria, and chemical and biological decay half-lives. The chemical input parameters used in the modeling are discussed below.

Chemicals of Concern (COC):

A chemical is considered as a COC if its concentration exceeds an ARAR/SAL value in any corresponding media. The following chemicals were considered as COCs based on the RFI/RI report.

Groundwater Modeling COICs

VOCs: 1,2-DCE, benzene, chlorobenzene, ethylbenzene, methylene chloride, and vinyl chloride.
SVOCs: Bis(2-ethylhexyl)phthalate and naphthalene.
Pesticides: 4,4'-DDT, 4,4'-DDE, 4,4'-DDD, aldrin, BHCs, endosulfan I, endrin, and heptachlor.
Inorganics: Aluminum, antimony, arsenic, beryllium, cadmium, chromium, cyanide, lead, mercury, silver, thallium, tin, vanadium, and zinc.

Surface Soil Modeling COCs

In the surface soil to surface water and surface soil to sediment RGOs development, only the chemicals detected in the surface soil were selected as COCs. The surface soil to sediment COCs are: aluminum, arsenic, beryllium, chromium, cyanide, silver, tin, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, aldrin, delta-BHC, endosulfan I, and endrin. The surface soil to surface water COCs are: aluminum, arsenic, beryllium, chromium, cyanide, lead, silver, tin, 4,4'-DDD, 4,4'-DDE, aldrin, beta-BHC, and heptachlor.

Soil/Water Partitioning Coefficient:

Chemical-specific soil/water partitioning coefficients (K_ds) were used to estimate each chemical's mobility. A chemical's K_d value is the ratio of its concentration in soil (or sediment) to its concentration in water when the two concentrations are in equilibrium. A high K_d value would be representative of a chemical which has a tendency to bind to the soil and is therefore less mobile in water. Depending on the chemical form of a certain contaminant (specifically for inorganics), the K_d value can vary substantially. No site-specific K_d values were available for NAS Key West. The K_d values used in this evaluation were taken from literature sources.

In order to closely follow the U.S. EPA procedures in the selection of K_d values, K_d values were taken directly from the EPA's Soil Screening Level (SSL) Guidance if available, or were calculated based on the procedures proposed in the SSL Guidance (EPA 1996).

The K_d values for organic constituents are typically calculated by multiplying the K_{oc} value (soil organic carbon/water partition coefficient) by the foc (fraction of organic carbon) (EPA, 1988). Only one composite soil sample from SWMU2 (Well MW5-2) was analyzed for foc. Therefore, because of a lack of site-specific data in the aquifer and the potential for foc values to be low in the oolitic limestone of Key West, a conservative foc of 0.001 or 0.1% was selected for calculating organic constituent K_d values. This foc value is the lowest acceptable value that can be used in the $K_d = K_{oc}$* foc model (EPA, 1988). The K_d values and their corresponding sources are presented in Table 3.

Half-life Decay Constants:

The inorganic chemicals are assumed not to decay during migration in the groundwater. Decay of organic contaminants can occur by biological and non-biological mechanisms. This decay is quantified by chemical specific half-life. Half-lives were taken from literature values. If a half-life could not be obtained from literature for a specific chemical, it was conservatively assumed that this chemical does not decay. Table 3 presents the half-life decay constants used in the modeling.

Exposure Criteria:

Two exposure criteria were used in this project, the sediment criteria and surface water criteria. These criteria were developed from the most recent publications of the screening criteria listed in Tables 2-4 and 2-5 of the Supplemental RFI/RI Report. The general rule is to use the most restrictive ARAR or SAL values. However, ER-M values were used for sediment criteria whenever it exists. Table 2 presents the two exposure criteria.

TABLE 3

SOIL PARTITIONING COEFFICIENTS AND HALF-LIVES
SWMU 2 CORRECTIVE MEASURE STUDY
NAVAL AIR STATION, KEY WEST, FLORIDA

Chemicals of Concern	Kow	Koc L/kg	Kd L/kg	Ref	Half-Life (6) (years)
INORGANICS					
Aluminum	n/a (7)	n/a	1500	2	NA(8)
Antimony	n/a	n/a	45	1	NA
Arsenic	n/a	n/a	29	1	NA
Beryllium	n/a	n/a	250	3	NA
Cadmium	n/a	n/a	75	1	NA
Chromium	n/a	n/a	19	1	NA
Cyanide	n/a	n/a	9.9	1	NA
Lead	n/a	n/a	270	3	NA
Mercury	n/a	n/a	52	1	NA
Silver	n/a	n/a	8.3	1	NA
Thallium	n/a	n/a	71	1	NA
Tin	n/a	n/a	130	3	NA
Vanadium	n/a	n/a	1000	1	NA
Zinc	n/a	n/a	62	1	NA
PESTICIDES					
4,4'-DDD	977,237	6.16E+05	6.16E+02	4	3.13E+01
4,4'-DDE	489,779	3.09E+05	3.09E+02	4	3.13E+01
4,4'-DDT	1,548,817	9.76E+05	9.76E+02	4	3.13E+01
Aldrin	n/a	2.45E+06	2.45E+03	4	3.20E+00
Alpha BHC	6460	4.07E+03	4.07E+00	4	2.00E+00
Beta BHC	6460	4.07E+03	4.07E+00	5	2.00E+00
Delta-BHC	6460	4.07E+03	4.07E+00	5	2.00E+00
Endosulfan I	n/a	2.24E+03	2.24E+00	4	2.50E-02
Endrin	n/a	1.23E+04	1.23E+01	1	0.00E+00
Heptachlor	n/a	8.32E+04	8.32E+01	1	1.50E-02
SVOCs					
Bis(2-ethylexyl)phthalate	n/a	1.51E+07	1.51E+04	1	1.07E+00
Naphthalene	n/a	2.00E+03	2.00E+00	1	7.07E-01
VOCs					
1,2 DCE (Total)	n/a	3.55E+01	3.55E-02	1	7.92E+00
Benzene	n/a	5.89E+01	5.89E-02	1	2.00E+00
Chlorobenzene	n/a	6.17E+02	6.17E-01	1	1.64E+00
Ethylbenzene	n/a	3.63E+02	3.63E-01	1	6.25E-01
Methylene Chloride	n/a	1.17E+01	1.17E-02	1	1.50E-01
Vinyl Chloride	n/a	1.86E+01	1.86E-02	1	7.92E+00

Organic Kd = foc*Koc, foc is minimum allowable value of 0.001 based on EPA Soil Screening User's guide, April 1996, and Superfund Exposure Assessment Manual, April 1988.
Koc = 0.63*Kow, if only Kow is available

(1) EPA Soil Screening Guidance User's Guide, April, 1996.
(2) Baes & Sharp et. al., 1984, "A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuc! ORNL 5786 Oak Ridges National Laboratory, Oak Ridge, TN.
(3) Thibault, D.H., M.I. Sheppard and P.A. Smith, 1990, "A Critical Compilation and Review of Default Soil Solid/Liquid Partition Coeffi Assessments," AECL 10125, Whiteshell Nuclear Research Center, Pinawa, Manitoba, Canada.
(4) Handbook of RCRA Ground-Water Monitoring Constituents (Appendix IX to 40 CFR Part 264), 1992.
(5) No Kd values are available for these COCs, the Kd value of Alpha BHC was used.
(6) Howard et. al., Handbook of Environmental Degradation Rates, 1991.
(7) n/a - Not Applicable.
(8) NA - Inorganic chemical assumed to not decay.

B.3.2 PHYSICAL INPUT PARAMETERS

The groundwater physical input parameters are described in the next two subsections.

B.3.2.1 Surface Water Infiltration and Water Budget

A HELP model (Schroeder et al., 1994) was used to estimate the water budget. The results are as follows:

Annual mean precipitation:	37.95 inches	(2 to 2.5 years average from NOAA, 1996)
Runoff:	0.06 inches	0.155% (estimate)
Evapotranspiration:	17.943 inches	47.28% (estimate)
Infiltration:	19.948 inches	52.56% (estimate)
Change in Storage:	0.005 inches	0.014%(estimate)

Mixing Ratio: The RFI/RI report indicates that 50% of the area has storm drainage system, but the drainage basin is not well defined. Conservatively, the ditch collects runoff from an area of 1000 ft of radius (3.14 million ft^2). All the infiltrated water within the concerned source area seeps to the ditch and mixes with the runoff water. This simplification yields the following water budget:

Source Area Size: The source area used in the surface soil modeling considered only areas extending 50 feet from each side of the excavated area because the soil within the excavated area has been remediated. The modeled source area is 350*300-250*200 ft^2 = 55,000 ft^2.

Surface Water

Annual runoff from the 1000 ft radius =	3.14 * 1000000 (ft^2) * 0.06 (in)/12 (in/ft)	= 15,700 ft^3
Annual runoff from the contaminated area =	55,000 ft^2 * 0.06 (in) /12 (in/ft)	= 275 ft^3
Clean runoff =	15,700 - 275	= 15,425 ft^3
Ratio of clean and contaminated runoff water =	15,425/275	= 56

B.3.2.2 Groundwater Physical Input Parameters

Layer Thickness: A typical thickness of the saturated zone was assumed to be 20 feet.

Source Area Size: It is assumed that the source area corresponds to the previously excavated area. The size of the excavated area was 250 feet by 200 feet. The source area was extended 50 feet from each side of the excavated area. The modeled source area is 350 feet long (parallel to the groundwater flow) by 300 feet wide.

Exposure Point: The exposure point for groundwater to surface water RGO is the surface water at the lagoon downgradient of the source area. The groundwater to sediment RGO is the bank of lagoon downgradient of the source area.

Distance to exposure point along groundwater flow path:

Surface water exposure point (surface water at lagoon)	= 250 feet
Sediment exposure point (sediment/groundwater interface at lagoon)	= 250 feet

Hydraulic Conductivity K: The porous limestone has a reported K of 72 to 1024 gallons per day per square ft (IT, 1994), or 3.4×10^{-3} cm/sec to 4.83×10^{-2} cm/sec, or 10 to 137 ft/day. An average K of 73 ft/day was selected for modeling.

Groundwater Gradient: The gradient was 0.0017 based on RI Report.

Effective Porosity: The effective porosity is assumed 0.3

Seepage Velocity: The seepage velocity V_{seep} can be calculated with the following equation.

$$V_{seep} = \frac{KI}{effective\ porosity}$$

Where:

K = hydraulic conductivity (73 ft/day)

I = groundwater gradient (0.0017)

Effective porosity = 0.3

The seepage velocity is then 151 ft/yr.

B.4 RESULTS

The results of the surface soil and groundwater modeling (i.e., RGOs) are discussed in the following two sections.

4.1 SURFACE SOIL MODELING RESULTS

Tables 4 and 5 present the surface soil RGOs protective of sediments and surface water, respectively at the site. The comparison of developed soil to sediment RGOs with maximum detected surface soil concentrations indicates that cyanide, 4,4'-DDD and 4,4'-DDT exceed RGOs. The comparison of developed soil to surface water RGOs with maximum detected surface soil concentrations shows that beryllium, cyanide, silver, tin, 4,4'-DDT, and heptachlor exceed RGOs. Maximum surface soil concentrations are the maximum detections based on samples obtained around the perimeter of the excavation, including samples collected during the confirmation sampling that followed the interim soil removal in the Spring of 1996.

4.2 GROUNDWATER MODELING RESULTS

Groundwater RGOs protective of surface water and sediment were developed for the groundwater beneath the source area and are presented in Table 6. Acceptable groundwater concentrations, protective of surface water at the lagoon and sediments at the groundwater interface at the lagoon, were developed (Table 2) in order to calculate the groundwater RGOs presented in Table 6. If a chemical concentration is detected in the groundwater under the source area, the groundwater RGOs presented in Table 6 would be appropriate for comparison. If a chemical concentration is detected in the groundwater near the lagoon, the acceptable groundwater concentrations presented in Table 2 would be appropriate for comparison.

The groundwater RGOs developed by the modeling with ECTran indicate that the current groundwater concentrations at SWMU 2 are substantially below the groundwater RGOs. The current maximum detected groundwater concentrations from 1996 for 4,4'-DDD, 4,4'-DDT, and thallium (i.e., the only chemicals detected during the confirmation sampling round) are 12.7, 4.8, and 11.7 ug/L respectively (Figure 2-5 of CMS report). Also, as indicated in Table 6, the developed groundwater RGOs of some chemicals which exhibit highly immobile nature in the groundwater (i.e., groundwater RGO > 1 E + 09 ug/L) will not reach the exposure point in the predictable time frame and will result in an exposure point concentration of zero and a corresponding RGO concentration of 100% (pure product). Therefore, the groundwater concentrations under the source area are not at levels that will adversely impact the surface

TABLE 4

SOIL TO SEDIMENT RGO PROTECTIVE OF SEDIMENT
SWMU 2 CORRECTIVE MEASURE STUDY
NAVAL AIR STATION, KEY WEST, FLORIDA

Chemicals	Sediment Criteria (1)		Soil RGO (2)	Surface Soil Max (3)	Exceeded RGO ?
	mg/kg	Reference	mg/kg	mg/kg	
INORGANICS					
Aluminum	n/a (4)		n/a	6140	n/a
Arsenic	70	ER-M	3,920	4.2	No
Beryllium	0.2	ARAR-SAL	11	0.23	No
Chromium	370	ER-M	20,720	11.6	No
Cyanide	0.1	ARAR-SAL	6	18	Yes
Silver	3.7	ER-M	207	0.15	No
Tin	n/a		n/a	6.2	n/a
ORGANICS					
4,4'-DDD	0.0033	ER-M	0.18	0.316	Yes
4,4'-DDE	0.0270	ER-M	1.51	1.160	No
4,4'-DDT	0.0460	ER-M	2.58	4.400	Yes
Aldrin	0.0400	ARAR-SAL	2.24	0.001	No
Delta-BHC	0.0030	OME, 1992	0.17	0.001	No
Endosulfan I	0.0029	USEPA SQB	0.16	0.002	No
Endrin	0.0033	EPA REG IV	0.18	0.007	No

Notes:

(1) Sediment Criteria are the ER-M or the most restrictive ARAR or SAL, if ER-M is not available (Table 2-4, Supplemental RFI/RI Report, 1996).

(2) Soil RGO = Sediment Criteria * Ratio of clean and contaminated surface water runoff (i.e., approximately 56).

(3) Maximum surface soil concentrations are the maximum detections based on samples obtained around the perimeter of the excavation, including sampl collected during the confirmation sampling that followed the interim soil removal in the Spring of 1996.

(4) n/a indicates that no criteria is available for this COC.

TABLE 5

SOIL TO SURFACE WATER RGO PROTECTIVE OF SURFACE WATER
SWMU 2 CORRECTIVE MEASURE STUDY
NAVAL AIR STATION, KEY WEST, FLORIDA

Chemicals	Koc L/kg	Partitioning Coefficient Kd L/kg	Ref	Surface Water Criteria (5) ug/L	Soil RGO (6) mg/kg	Surface Soil Maximum (7) mg/kg	Exceeded RGO ?
INORGANICS							
Aluminum	n/a (9)	1500	2	1500	126,000	6140	No
Arsenic	n/a	29	1	36	58	4.2	No
Beryllium	n/a	250	3	0.008	0.112	0.23	Yes
Chromium	n/a	19	1	50	53	11.6	No
Cyanide	n/a	9.9	1	1	0.554	18	Yes
Lead	n/a	270	3	5.6	84.67	55.4	No
Silver	n/a	8.3	1	0.23	0.107	0.15	Yes
Tin	n/a	130	3	0.01	0.073	6.2	Yes
ORGANICS							
4,4'-DDD	6.16E+05	616	4	0.025	0.862	0.316	No
4,4'-DDE	3.09E+05	309	4	0.14	2.419	1.16	No
4,4'-DDT	9.76E+05	976	4	0.00059	0.032	4.4	Yes
Aldrin	2.45E+06	2450	4	0.00014	0.019	0.001	No
Beta BHC	4.07E+03	4.07	8	0.046	0.010	0.002	No
Heptachlor	8.32E+04	83.2	1	0.00021	0.001	0.016	Yes

Organic Kd =foc*Koc, foc is minimum allowable value of 0.001 based on EPA Soil Screening User's Guide, April 1996, and Superfund Exposure Assessment Manual, April

(1) EPA Soil Screening Guidance User's Guide, April, 1996.
(2) Baes & Sharp et. al., 1984, "A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture," ORNL 5786 Oak Ridges National Laboratory, Oak Ridge, TN.
(3) Thibault, D.H., M.I. Sheppard and P.A. Smith, 1990, "A Critical Compilation and Review of Default Soil Solid/Liquid Partition Coefficients, Kd for use in Environmental Assessments," AECL 10125, Whiteshell Nuclear Research Center, Pinawa, Manitoba, Canada.
(4) Handbook of RCRA Ground-Water Monitoring Constituents (Appendix IX to 40 CFR Part 264), 1992.
(5) Surface Water Criteria are the most restrictive ARAR or SAL (Table 2-5, Supplemental RFI/RI Report, 1996).
(6) Soil RGO = Kd * Surface Water Criteria * Ratio of clean and contaminated surface water runoff (i.e., approximately 56) / 1000.
(7) Maximum surface soil concentrations are the maximum detections based on samples obtained around the perimeter of the excavation, including samples collected during the confirmation sampling that followed the interim soil removal in the Spring of 1996.
(8) No Kd value is available for Beta BHC, the Kd value of Alpha BHC was used.
(9) n/a - Not Applicable.

TABLE 6

GROUNDWATER RGOs PROTECTIVE OF SURFACE WATER AND SEDIMENT
SWMU 2 CORRECTIVE MEASURE STUDY
NAVAL AIR STATION, KEY WEST, FLORIDA

Chemicals of Concern	Groundwater RGO Protective of Surface Water ug/L	Groundwater RGO Protective of Sediment ug/L
INORGANICS		
Aluminum	>1E + 09 (1)	n/a (2)
Antimony	>1E + 09	5.03E+08
Arsenic	3.1E + 08	1.43E+08
Beryllium	>1E + 09	>1E + 09
Cadmium	>1E + 09	>1E + 09
Chromium	2.11E+07	8.40E+07
Cyanide	1.18E+04	2.46E+03
Lead	>1E + 09	>1E + 09
Mercury	4.62E+07	9.70E+07
Silver	1.33E+03	6.00E+04
Thallium	>1E + 09	n/a
Tin	>1E + 09	n/a
Vanadium	>1E + 09	>1E + 09
Zinc	>1E + 09	>1E + 09
PESTICIDES		
4,4'-DDD	>1E + 09	>1E + 09
4,4'-DDE	>1E + 09	>1E + 09
4,4'-DDT	>1E + 09	>1E + 09
Aldrin	>1E + 09	>1E + 09
Alpha BHC	4.61E+08	3.24E+05
Beta BHC	1.52E+04	1.62E+04
Delta-BHC	5.28E+03	9.75E+03
Endosulfan I	>1E + 09	>1E + 09
Endrin	7.75E+01	1.47E+02
Heptachlor	>1E + 09	>1E + 09
SVOCs		
Bis(2-ethylexyl)phthalate	>1E + 09	>1E + 09
Naphthalene	1.86E + 07	4.60E+07
VOCs		
1,2 DCE (Total)	4.07E+03	n/a
Benzene	8.01E+02	5.48E+03
Chlorobenzene	1.95E+04	6.05E+04
Ethylbenzene	2.13E+03	1.74E+06
Methylene Chloride	5.29E + 00 (3)	2.03E+07
Vinyl Chloride	1.27E + 04 (3)	n/a

(1) Indicates that a pure concentration of the contaminant will not result in exposure in exceedance of criteria.
(2) n/a indicates that no criteria is available for this COC.
(3) For Methylene Chloride and Vinyl Chloride, the default groundwater criteria protective of surface water were selected due to the highly mobile nature exhibited in both chemical and physical characteristics.

water or sediment at the downgradient receptor (i.e., lagoon) in the foreseeable future. The mechanisms/processes affecting chemical fate and transport in groundwater that were accounted for during the modeling include sorption, dilution, advection, dispersion, and chemical/biological decay.

B.5 REFERENCES

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APPENDIX C

COST ANALYSIS FOR ALTERNATIVES

NAVAL AIR STATION
Boca Chica Key, Florida
SWMU 2
Limited Action
Alternative No. 2
(NKF22)
12/27/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
WARNING SIGNS												
1) Warning Signs	6			70.00	15.00	10.00		420	90	60	570	
							0	420	90	60	570	
Burden @ 30% of Labor Cost									27		27	
Labor @ 10% of Labor Cost									9		9	
Material @ 10% of Material Cost								42			42	
SubContract @ 10% of Sub. Cost							0				0	
Total Direct Cost							0	462	126	60	648	
Indirects @ 75% of Total Direct Labor Cost									95		95	
Profit @ 10% of Total Direct Cost											65	
											807	
Health & Safety Monitoring @ 15%											121	
Total Field Cost											928	
Contingency @ 20% of Total Field Cost											186	
Engineering Cost											500	
TOTAL COST THIS PAGE											1614	

NAVAL AIR STATION
Boca Chica Key, Florida
SWMU 2
Limited Action
Alternative No. 2
Annual Cost

Item	Item Cost Year 1	Item Cost Years 2 - 10	Item Cost every 2 years	Item Cost every 5 years	Notes*
Sampling	$16,000	$4,000			Collect seven groundwater, six surface water and seven sediment samples, per sample period, plus travel, living and shipping cost
Fish Collection			$2,000		Collect fish, mud crab & vegetation per sample period years 2,4,6,8,10
Analysis	$22,000	$5,500			Seven groundwater, six surface water and seven sediment samples analyzed for Metals, Pesticides/PCBs (and VOCs for groundwater only)
Analysis			$7,500		Five surface water & five sediment samples for toxicity testing (years 2, 4, 6, 8, 10)
Analysis			$8,500		Fish, mud crab & vegetation samples (25 total) per monitoring (years 2, 4, 6, 8, 10) Metals & Pesticides/PCBs
Report	$16,000	$4,000			Forty hours per sampling report plus other direct cost
Site Review				$20,000	Analysis Review performed for years 5 & 10
TOTALS	$54,000	$13,500	$18,000	$20,000	

* Sample numbers include QA/QC samples

NAVAL AIR STATION
Boca Chica Key, Florida
SWMU 2
Limited Action
Alternative No. 2
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$1,614		$1,614	1.000	$1,614
1		$54,000	$54,000	0.935	$50,490
2		$31,500	$31,500	0.873	$27,500
3		$13,500	$13,500	0.816	$11,016
4		$31,500	$31,500	0.763	$24,035
5		$33,500	$33,500	0.713	$23,886
6		$31,500	$31,500	0.666	$20,979
7		$13,500	$13,500	0.623	$8,411
8		$31,500	$31,500	0.582	$18,333
9		$13,500	$13,500	0.544	$7,344
10		$51,500	$51,500	0.508	$26,162

TOTAL PRESENT WORTH **$219,768**

NAVAL AIR STATION
Boca Chica Key, Florida
SWMU 2
Excavation Soils & Sediments, Offsite Treatment &
Disposal At Off-Site RCRA Landfill,
Removal Contaminated Surface Water,
On-Site Treatment, Discharge To Existing Ditch
Alternative No. 3
Sheet 1 of 2
(NKF24)
1/13/98

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
MOBILIZATION/DEMOBILIZATION												
1) Office Trailer (1)	2	MO	500.00				1000				1000	
2) Storage Trailer (1)	2	MO	500.00				1000				1000	
3) Construction Survey		LS	8000.00				8000				8000	
4) Portable Communication Equipment	2	SETS	1500.00				3000				3000	
5) Equipment Mobilization/Demobilization		LS	10000.00				10000				10000	
6) Site Utilities	2	MO	4000.00				8000				8000	
7) Decontamination Trailer	2	MO	1500.00				3000				3000	
DECONTAMINATION FACILITIES AND SERVICES												
1) Laundry Service	8	WKS	250.00				2000				2000	
2) Truck Decon Pad												
a) Concrete Pad - 8"	40	CY		70.00	125.00	5.00		2800	5000	200	8000	
b) Gravel Base - 6"	30	CY		7.50	3.33	8.00		225	100	240	565	
c) Curb	120	LF		3.07	1.99	.05		368	239	6	613	
d) Collection Sump	1			1450.00	500.00	220.00		1450	500	220	2170	
e) Splash Guard	780	SF		1.25	1.00			975	780		1755	
3) Decontamination Services	2	MO	1200.00				2400				2400	
4) Decon Water	26400	GAL	.20				5280				5280	
5) Clean Water Storage Tank	1			3000.00	300.00			3000	300		3300	3000 Gallon
6) Spent Water Storage Tank	1			5000.00	400.00			5000	400		5400	5000 Gallon
WARNING SIGNS												
1) Warning Signs	6			70.00	15.00	10.00		420	90	60	570	
CONTAMINATED SOIL & SEDIMENT DISPOSAL												
1) Cofferdams (5 @ 377 SF)	1885	SF	16.45				31008				31008	12' dia. x 10' dp.
2) Excavate Cofferdams (5 @ 4 CY)	20	CY			4.86	5.88			97	118	215	
3) Excavate Contaminated Soil	140	CY			1.00	3.04			140	426	566	3-60'x60' Areas
4) Excavate Contaminated Sediment	470	CY			1.00	3.04			470	1429	1899	
5) Hauling To Stockpile/Dewatering Area	610	CY			.64	1.65			390	1007	1397	
6) Load Dewatered Soil & Sediment	610	CY			.51	.65			311	397	708	
7) Hauling Contaminated Soil & Sediment	64350	MI	5.00				321750				321750	39 Tr. @ 1650 Mi.
8) Soil Treatment & RCRA Landfill Disposal	824	TON	150.00				123600				123600	Belleville, Mi.
9) Pre-Design Sampling Analysis												
a) Pesticides, Metals	10		300.00				3000				3000	
10) Remove Sediments From 12" RCP		LS	1500.00				1500				1500	
SURFACE WATER REMOVAL & TREATMENT												
1) Surface Water Removal & Pumping	10	DAY			285.00	50.00			2850	500	3350	236968 gallon
2) Surface Water Treatment		LS		4000.00	400.00	400.00		4000	400	400	4800	
RESTORATION												
1) Confirmatory Sampling Analysis												
a) Pesticides, Metals	5		300.00				1500				1500	
2) Backfill Sand	397	CY		6.00	2.70	7.43		2382	1072	2950	6404	
a) Place, Spread & Compact	397	CY			.84	2.67			333	1060	1393	
3) Backfill Topsoil - 6"	213	CY		12.50	2.70	7.43		2663	575	1583	4820	
a) Place & Spread	213	CY			.65	.86			138	183	322	
4) Revegetation	11	MSF		24.60	8.40	6.68		271	92	73	436	
							526038	23554	14279	10850	574720	

NAVAL AIR STATION
Boca Chica Key, Florida
SWMU 2
Excavation Soils & Sediments, Offsite Treatment &
Disposal At Off-Site RCRA Landfill,
Removal Contaminated Surface Water,
On-Site Treatment, Discharge To Existing Ditch
Alternative No. 3
Sheet 2 of 2
(NKF24)
1/13/98

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
PAGE 1 TOTAL							526038	23554	14279	10850	574720	
Burden @ 30% of Labor Cost									4284		4284	
Labor @ 10% of Labor Cost									1428		1428	
Material @ 10% of Material Cost								2355			2355	
SubContract @ 10% of Sub. Cost							52604				52604	
Total Direct Cost							578642	25909	19990	10850	635391	
Indirects @ 75% of Total Direct Labor Cost									14993		14993	
Profit @ 10% of Total Direct Cost											63539	
											713923	
Health & Safety Monitoring @ 8%											57114	
Total Field Cost											771037	
Contingency @ 20% of Total Field Cost											154207	
Engineering @ 10% of Total Field Cost											77104	
TOTAL COST THIS PAGE											1002348	

NAVAL AIR STATION
Boca Chica Key, Florida
SWMU 2
Excavation Soils and Sediments, Off-Site Treatment & Disposal at RCRA Landfill,
Removal Contaminated Surface Water, On-Site Treatment, Discharge to Existing Ditch
Alternative No. 3
Annual Cost

Item	Item Cost Year 1	Item Cost Years 2 - 10	Item Cost every 2 years	Item Cost every 5 years	Notes*
Sampling	$16,000	$4,000			Collect seven groundwater, six surface water and seven sediment samples, per sample period, plus travel, living and shipping cost
Fish Collection			$2,000		Collect fish, mud crab & vegetation per sample period years 2,4,6,8,10
Analysis	$22,000	$5,500			Seven groundwater, six surface water and seven sediment samples analyzed for Metals, Pesticides/PCBs (and VOCs for groundwater only)
Analysis			$7,500		Five surface water & five sediment samples for toxicity testing (years 2, 4, 6, 8, 10)
Analysis			$8,500		Fish, mud crab & vegetation samples (25 total) per monitoring (years 2, 4, 6, 8, 10) Metals & Pesticides/PCBs
Report	$16,000	$4,000			Forty hours per sampling report plus other direct cost
Site Review				$20,000	Analysis Review performed for years 5 & 10
TOTALS	$54,000	$13,500	$18,000	$20,000	

* Sample numbers include QA/QC samples

NAVAL AIR STATION
Boca Chica Key, Florida
SWMU 2
Excavation Soils and Sediments, Off-Site Treatment & Disposal at RCRA Landfill,
Removal Contaminated Surface Water, On-Site Treatment, Discharge to Existing Ditch
Alternative No. 3
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$1,002,348		$1,002,348	1.000	$1,002,348
1		$54,000	$54,000	0.935	$50,490
2		$31,500	$31,500	0.873	$27,500
3		$13,500	$13,500	0.816	$11,016
4		$31,500	$31,500	0.763	$24,035
5		$33,500	$33,500	0.713	$23,886
6		$31,500	$31,500	0.666	$20,979
7		$13,500	$13,500	0.623	$8,411
8		$31,500	$31,500	0.582	$18,333
9		$13,500	$13,500	0.544	$7,344
10		$51,500	$51,500	0.508	$26,162
				TOTAL PRESENT WORTH	**$1,220,502**

NAVAL AIR STATION
Boca Chica Key, Florida
SWMU 2
Excavation Soils & Sediments, Offsite Treatment &
Disposal At Off-Site RCRA Landfill,
Removal Contaminated Surface Water,
On-Site Treatment, Discharge To Existing Ditch
Alternative No. 4
Sheet 1 of 2
(NKF23)
8/12/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
MOBILIZATION/DEMOBILIZATION												
1) Office Trailer (2)	6	MO	1000.00				6000				6000	
2) Storage Trailer (1)	6	MO	500.00				3000				3000	
3) Construction Survey		LS	10000.00				10000				10000	
4) Portable Communication Equipment	2	SETS	1500.00				3000				3000	
5) Equipment Mobilization/Demobilization		LS	15000.00				15000				15000	
6) Site Utilities	6	MO	4000.00				24000				24000	
7) Decontamination Trailer	6	MO	1500.00				9000				9000	
DECONTAMINATION FACILITIES AND SERVICES												
1) Laundry Service	24	WKS	250.00				6000				6000	
2) Truck Decon Pad												
a) Concrete Pad - 8"	40	CY		70.00	125.00	5.00		2800	5000	200	8000	
b) Gravel Base - 6"	30	CY		7.50	3.33	8.00		225	100	240	565	
c) Curb	120	LF		3.07	1.99	.05		368	239	6	613	
d) Collection Sump	1			1450.00	500.00	220.00		1450	500	220	2170	
e) Splash Guard	780	SF		1.25	1.00			975	780		1755	
3) Decontamination Services	6	MO	1200.00				7200				7200	
4) Decon Water	79200	GAL	.20				15840				15840	
5) Clean Water Storage Tank	1			3000.00	300.00			3000	300		3300	3000 Gallon
6) Spent Water Storage Tank	1			5000.00	400.00			5000	400		5400	5000 Gallon
CONTAMINATED SOIL & SEDIMENT DISPOSAL												
1) Cofferdams (5 @ 377 SF)	1885	SF	16.45				31008				31008	12' dia. x 10' dp.
2) Excavate Cofferdams (5 @ 4 CY)	20	CY			4.86	5.88			97	118	215	
3) Excavate Contaminated Soil	4400	CY			1.00	3.04			4400	13376	17776	
4) Excavate Contaminated Sediment	474	CY			4.86	5.88			2304	2787	5091	
5) Hauling To Stockpile/Dewatering Area	4874	CY			.64	1.65			3119	8042	11161	
6) Load Treated/Dewatered Soil & Sediment	4874	CY			.51	.65			2486	3168	5654	
7) Hauling Contaminated Soil & Sediment	503250	MI	5.00				2516250				2516250	305 Tr. @ 1650 Mi.
8) Soil Treatment & RCRA Landfill Disposal	6580	TON	150.00				987000				987000	Belleville, Mi.
9) Pre-Design Sampling Analysis												
a) Pesticides, Metals	15		300.00				4500				4500	
10) Remove Sediment From 12" RCP		LS	1500.00				1500				1500	
SURFACE WATER REMOVAL & TREATMENT												
1) Surface Water Removal & Pumping	10	DAY			285.00	50.00			2850	500	3350	236968 gallon
2) Surface Water Treatment		LS		4000.00	400.00	400.00		4000	400	400	4800	
RESTORATION												
1) Confirmatory Sampling Analysis												
a) Pesticides, Metals	5		300.00				1500				1500	
2) Backfill Sand	3466	CY		6.00	2.70	7.43		20796	9358	25752	55907	
a) Place, Spread & Compact	3466	CY			.84	2.67			2911	9254	12166	
3) Backfill Topsoil - 6"	1408	CY		12.50	2.70	7.43		17600	3802	10461	31863	
a) Place & Spread	1408	CY			.65	.86			915	1211	2126	
4) Revegetation	76	MSF		24.60	8.40	6.68		1870	638	508	3016	
							3640798	58084	40599	76244	3815725	

NAVAL AIR STATION
Boca Chica Key, Florida
SWMU 2
Excavation Soils & Sediments, Offsite Treatment &
Disposal At Off-Site RCRA Landfill,
Removal Contaminated Surface Water,
On-Site Treatment, Discharge To Existing Ditch
Alternative No. 4
Sheet 2 of 2
(NKF23)
8/12/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
PAGE 1 TOTAL							3640798	58084	40599	76244	3815725	
Burden @ 30% of Labor Cost									12180		12180	
Labor @ 10% of Labor Cost									4060		4060	
Material @ 10% of Material Cost								5808			5808	
SubContract @ 10% of Sub. Cost							364080				364080	
Total Direct Cost							4004878	63892	56839	76244	4201853	
Indirects @ 75% of Total Direct Labor Cost									42629		42629	
Profit @ 10% of Total Direct Cost											420185	
											4664668	
Health & Safety Monitoring @ 6%											279880	
Total Field Cost											4944548	
Contingency @ 20% of Total Field Cost											988910	
Engineering @ 6% of Total Field Cost											296673	
TOTAL COST THIS PAGE											6230131	

NAVAL AIR STATION
Boca Chica Key, Florida
SWMU 2
Excavation Contaminated Soils, Offsite Treatment & Disposal at RCRA Landfill
Excavation Soils & Sediments, Offsite Disposal at Local Landfill
Alternative No. 4
Annual Cost

Item	Item Cost Year 1	Item Cost Years 2 - 5	Item Cost every 2 years	Item Cost every 5 years	Notes*
Sampling	$16,000	$4,000			Collect seven groundwater, [redacted] Six surface water and seven sediment samples, per sample period, plus travel, living and shipping cost
Fish Collection			$2,000		Collect fish, mud crab & vegetation per sample period years 2 & 4
Analysis	$22,000	$2,500			Seven groundwater, seven surface water and seven sediment samples analyzed for Metals, Pesticides/PCBs and VOCs for groundwater, only for year 1. Seven groundwater samples analyzed for VOCs, Metals and Pesticides/PCBs for years 2 through 5
Analysis			$7,500		Five surface water & five sediment samples for toxicity testing (years 2 & 4)
Analysis			$8,500		Fish, mud crab & vegetation samples (25 total) per monitoring (years 2 & 4) Metals & Pesticides/PCBs
Report	$16,000	$4,000			Forty hours per sampling report plus other direct cost
Site Review				$10,000	Analysis Review performed for year 5
TOTALS	$54,000	$10,500	$18,000	$10,000	

* Sample numbers include QA/QC samples

NAVAL AIR STATION
Boca Chica Key, Florida
SWMU 2
Excavation Contaminated Soils, Offsite Treatment & Disposal at RCRA Landfill
Excavation Soils & Sediments, Offsite Disposal at Local Landfill
Alternative No. 4
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$6,230,131		$6,230,131	1.000	$6,230,131
1		$54,000	$54,000	0.935	$50,490
2		$28,500	$28,500	0.873	$24,881
3		$10,500	$10,500	0.816	$8,568
4		$28,500	$28,500	0.763	$21,746
5		$20,500	$20,500	0.713	$14,617
				TOTAL PRESENT WORTH	**$6,350,432**

APPENDIX D

CNBJAXINST 5090.2N4

5-AUG-97

DEPARTMENT OF THE NAVY
COMMANDER NAVAL BASE JACKSONVILLE
BOX 102, NAVAL AIR STATION
JACKSONVILLE, FLORIDA 32212-0102

CNBJAXINST 5090.2
N4

COMMANDER, NAVAL BASE, JACKSONVILLE INSTRUCTION 5090.2

Subj: LAND USE RESTRICTIONS (LURS) AT ENVIRONMENTAL REMEDIATION SITES ON BOARD U.S. NAVY INSTALLATIONS

Ref: (a) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § § 9601 *et seq.*
(b) Resource Conservation and Recovery Act (RCRA), 42 U.S.C. §§ 6901 *et seq.*
(c) OPNAVINST 5090.1B

1. Purpose. To establish a systematic program, protective of human health and the environment, governing land use at environmental remediation sites on board selected U.S. Navy installations in the Commander, Naval Base, Jacksonville (COMNAVBASE JAX) Area of Responsibility (AOR).

2. Applicability. This instruction applies to sites undergoing environmental remediation at Naval Air Station, Jacksonville, FL, Naval Air Station Key West, FL, and Naval Station, Mayport, FL.

3. Discussion. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (references (a) and (b)) are the two primary federal laws governing the remediation of sites contaminated with hazardous substances and hazardous wastes. The U.S. Navy created the environmental remediation program to oversee the clean-up of these sites on board Naval facilities. Per reference (c), the Naval Facilities Engineering Command (NAVFAC) has been assigned the responsibility for centralized management of the installation restoration program. Southern Division (SOUTHDIV) is the NAVFAC component responsible for administration of the environmental remediation program for the U.S. Navy installations in the COMNAVBASE JAX AOR. The Florida Department of Environmental Protection (FDEP) and the U.S. Environmental Protection Agency (EPA) Region IV (hereafter referred to as "the agencies") have oversight and coordinating responsibilities over NAVFAC remediation actions. Remediation standards for clean-up of contaminated sites are established to ensure protection for human health and the environment.

a. Environmental restoration is a very costly process. There are an estimated 3300 sites nation-wide on board U.S. Navy and U.S. Marine Corps installations. Currently, the U.S. Navy's nationwide funding level is projected at just under $300 million per year.

b. Tens to hundreds of millions of dollars can be saved through the selection of clean-up remedies which appropriately reflect the current and future land use. However, to be effective, these future LURs must be strictly monitored and enforced. The agencies have expressed concern that the U.S. Navy lacks an effective mechanism to adequately ensure retention of identified LURs. This could allow the U.S. Navy to benefit from less stringent and thereby less costly remediation.

c. Consequently, the agencies are reluctant to accept final agreements (Records of Decision (ROD)) which do not include LURs (AKA institutional controls). This has impacted the "close out" of action at remediation sites on several installations. This instruction establishes a mechanism through which each Naval installation can enter into a Memorandum of Agreement (MOA) with the agencies, promulgate local instructions, develop a process to change land use where required, select optimum land use categories, optimize the use of scarce remediation funds, and ensure the maintenance of the identified land use category.

4. <u>Action</u>

a. <u>Commanding Officers (COs)</u>: COs of installations conducting environmental remediation projects <u>shall</u> adopt local instructions which include, at a <u>minimum</u>, the following:

(1) A mechanism to enter into a MOA between the installation (including installation planners, Resident Officer-in-Charge of Construction (ROICC), installation environmental personnel and SOUTHDIV) and the agencies overseeing the present and anticipated land use category on a site-by-site basis. This will allow selection of clean-up standards that are protective of human health and the environment without unnecessary expenditure of limited fiscal resources. The local MOA can be supported and reinforced through RODs, closure permit restrictions (in the case of RCRA corrective actions) and environmental documentations performed under the National Environmental Policy Act (NEPA).

(2) Retention of the identified land use category throughout the specified remediation period. Restrictions on changes in land shall be accomplished through strict adherence to such vehicles as the base master <u>planning</u> process.

(3) A requirement for the installation environmental program manager to conduct routine LUR review of identified remediation sites, with incorporation of this responsibility into the environmental program manager's position description.

(4) A requirement for the installation Environmental Compliance Board (ECB) (developed under paragraph 1-2.14 of reference (c)) to review on a quarterly basis the status of adherence to the LURs.

(5) A requirement to forward an annual report to the agencies (with a copy to SOUTHDIV) certifying retention of the specified LUR category for each affected site on the installation.

(6) The installation CO must follow identification of the proper procedures in order to obtain concurrence from the agencies to change a previously identified LUR for a site. Concurrence of the agencies must be obtained in writing prior to commencing any construction or other activity inconsistent with the previous LUR. Requests for review of a LUR change proposal will consider the degree of change proposed, the effectiveness of the remediation effort to date, any natural remediation which may have occurred since the original remedial actions, etc.

(7) A requirement to notify the agencies if, despite proper precautions, an unauthorized change in land use is discovered by the installation. The change in land use will be reported immediately to the agencies for collaborative determination of an appropriate remedy.

(8) A notation that any funding associated with additional remediation caused by a LUR change (whether approved or unauthorized) will be the responsibility of the installation CO.

b. SOUTHDIV: As the agency responsible for the management of environmental remediation projects, SOUTHDIV shall accomplish the following:

(1) Take the lead in coordinating the drafting of a MOA to establish the specific agreement between each covered installation, the agencies and SOUTHDIV. At a minimum, the MOA will address real estate issues, LURs and remediation requirements.

(2) Support the installation CO, as required, during negotiations with the agencies.

(3) Review the installation's LUR instruction when conducting the tier two Environmental Compliance Evaluation (ECE) in support of the major claimant.

5. Special Note. The FDEP-EPA-U.S. Navy partnering team will view strong participation in this process to govern land use at environmental remediation sites positively, i.e., funding priority will be given to the most efficient site remediations.

Kevin F. Delaney

KEVIN F. DELANEY

Distribution:
CNBJINST 5605.1
List IV: FA6a, FA6b, FA7a
List II: 26JJ1a, FA47a, FT48a

APPENDIX E

RESPONSES TO REGULATORY COMMENTS

Comment 3:

Appendix B, Section 2.3.2. Extend the source area to account for the extra 50 feet of excavation. Also modify Figure 2.

Response 3: Concur. Figure 2 will be marked to properly illustrate the 350 feet by 300 feet estimation of the source area.

Comment 4:

Appendix B, Section 4.2. The text should refer to Table 6 and not to Table 5 as stated in the text.

Response 4: Concur. The text will be corrected.

Comment 5:

Appendix C. Costs for groundwater sampling are not included in the economic analysis for the alternatives. Modify the analysis to include costs for groundwater sampling and analysis.

Response 5: The analysis will be modified to include the costs for groundwater sampling.

DRAFT SWMU 2 CORRECTIVE MEASURE STUDY
NAS KEY WEST, FLORIDA

RESPONSE TO COMMENTS FROM M. BERRY, U.S. EPA REGION 4

GENERAL COMMENTS

Comment 1:

The Draft CMS Report does not contain a consolidated list of acronyms used throughout the report. A list of acronyms should be included in the report.

Response 1: Concur. A list of acronyms will be included in the revised CMS.

Comment 2:

Some discrepancies were found between the values presented in Table 2-5 titled "Ecological Contaminants of Concern in Groundwater - SWMU 2" and values presented in the corresponding table in the Draft RFI/RI Report, Table 4-57. Discrepancies were also found in values presented in Table 2-6 titled "Ecological Contaminants of Concern in Surface Water" and the values presented in the corresponding table in the Draft RFI/RI Report, Table 4-58. These discrepancies, between the Draft CMS Report summary data and the Draft RFI/RI Report values, are detailed in the specific comments. In general, the text between the two documents agree, except for discussion of the Ecological Contaminants of Concern (ECC)s.

Response 2: The data contained in the Draft CMS report correspond to the data contained within the latest revision of the Draft RFI/RI report (Revision 2 - July 1997). No change is proposed.

Specific Comments:

Comment 1:

Page ES-4, 1st Paragraph. The text states that "The costs are itemized in the detailed cost sheets presented in Appendix A." However, Appendix A contains the human health risk assessment calculations. Appendix C contains the cost analysis for alternatives. The text should be corrected.

Response 1: Concur. Appendix C will be properly referenced as containing the cost analysis.

Comment 2:

Page 1-1, 1st Paragraph. The next to the last sentence in this paragraph refers to "human ecological risk assessments." This sentence should be modified to read "human health and ecological risk assessments."

Response 2: Concur. The text will be revised accordingly.

Comment 3:

Pages 2-41 and 2-42, Table 2-5. Some discrepancies were found between data presented in the Draft CMS Report and in the Draft RFI/RI Report. In Table 2-5, the following ECCs were not found in the corresponding Draft RFI/RI Report, Table 4-57: 4-methylphenol, benzoic acid, and acetone. The following ECCs have different values for the frequency of Detection: barium, beryllium, chromium, cyanide, lead, mercury, thallium, 4-4'-DDE, 4,4'-DDT, aldrin, beta-BHC, 1,4-dichlorobenzene, 2-methylnaphthalene, benzyl alcohol, bis(2-ethylhexyl)phthalate, 1,1-dichloroethene, 1,1-dichloroethene (total), benzene, carbon disulfide, cis-1,2-dichloroethene, vinyl chloride, and xylenes (total). Increased values in the Frequency of Detection column infer that additional samples were used in the summary Table 2-5. Furthermore, some values in the summary Range of Detected Values differ from the values in the Draft RFI/RI Report Range of Detected Values. Values differ from the values in the Draft RFI/RI Report Range of Detected Values. These values are also attributed to additional sampling. Consequently, the summary ECC ranges that differ from the Draft RFI/RI Report ranges have expected discrepancies in their Hazard Quotient (HQ) values. Further discussion is necessary to clarify the discrepancies between data.

Response 3: The data contained in the Draft CMS report correspond to the data contained within the latest revision of the Draft RFI/RI report (Revision 2 - July 1997). No change is proposed.

Comment 4:

Page 2-43, Table 2-6. Some discrepancies were found between data presented in the Draft CMS Report and in the Draft RFI/RI Report. In Table 2-6, the Ecological Threshold Value differs between the summary Table 2-6 and the corresponding Draft RFI/RI Report, Table 4-58 for 4,4'-DDD and heptachlor. Consequently, the HQ values also differ. See below. Further discussion is necessary to clarify the discrepancies between values.

	Draft CMS Report (Table 2-6)		Draft RFI/RI Report (Table 4-58)	
COC	Threshold Value	HQ	Threshold Value	HQ
4,4'-DDD	0.025μg/L	58	0.0006 μg/L	2.416
Heptachlor	0.00021 μg/L	2.95	0.0036 μg/L	17.2

Response 4: For 4,4'-DDD, the value listed in the Draft CMS report corresponds to the value contained within the latest revision of the Draft RFI/RI report (Revision 2 - July 1997). For Heptachlor, a mistake was made in the Draft CMS Report. The value of 2.95 will be corrected to 295 in the next revision of the CMS Report.

Comment 5:

Page 3-18, 2nd Paragraph. The text states that "groundwater concentrations at SWMU 2 were compared to Tap Water RBCs [Risk-Based Concentrations] (EPA, 1996) and MCLs [Maximum Contaminant Levels] (EPA, 1995c) for comparison and purposes as presented in Tables 2-7 and 2-8 of Section 2.5." However, tables 2-7 and 2-8 present ecological contaminants of concern in sediment and soil respectively, for SWMU 2. Tables 2-2 and 2-3 present the occurrence, distribution and comparison to MCLs and Tap Water RBCs for inorganic analytes and organic compounds in groundwater, respectively. The text should be corrected.

Response 5: Concur. The reference to Tables 2-7 and 2-8 will be corrected to properly reference Tables 2-2 and 2-3.

Comment 6:

Page 3-21, 1st Paragraph and Page 3-22, Table 3-2. The text states that "Table 3-2 presents the RGOs [remedial goal options] that would be protective (i.e., the most stringent) of all human exposure pathways of concern. Table 2-3 also includes the Florida Department of Environmental Protection (FDEP) clean-up goals for an industrial exposure scenario for the human health COCs [chemicals of concern]." However, although Table 3-2 has footnotes for the protection of human health risk evaluation [footnotes 1 and 2] and a footnote for the FDEP Industrial Soil Clean-Up Goals [footnote 3], this information is not included in the table. The table should be corrected to include the information from footnotes 1, 2, and 3.

Response 6: Concur. FDEP values and human health risk-based RGOs will be presented in Table 3-2.

Comment 7:

Page 3-28, Section 3.5.1, 2nd Paragraph. The text states that "The total estimated aerial extent of soil ... in Table 3-2 is approximately 66,000 ft^2 ...." However, Table 3-2 presents the soil RGOs for ecological receptor, surface water, and sediment protection. The table identified in the text is not Table 3-2 but the untitled table located directly above the text. In addition, the total estimated area is approximately 76,000 ft^2, not 66,000 ft^2. The text should be revised.

Response 7: Concur. The text will be revised accordingly.

Comment 8:

Page 3-30, 1st Paragraph. The text states that "only some samples (3 of 13) all of which are located north of the ditch exceed 'RCRA Action Levels and/or FDEP Industrial Soil Clean-Up Goals presented in Table 3-2'." However, the FDEP Industrial Soil Clean-Up Goals are not presented in Table 3-2.

Response 8: The FDEP Industrial Soil Clean-Up Goals will be presented in an appropriate table.

Comment 9:

Page 3-32, 2nd Paragraph. The text states that "Figure 3-3 depicts a typical cross-sectional view of the ditch." However, Figure 3-3 was not included in the Draft CMS Report. Figure 3-3 should be included in the report.

Response 9: Concur. A cross-section of the ditch will be provided in the revised CMS report.

Comment 10:

Page 4-9, Table 4-2. According to Table 4-2, dewatering was a process option that was not retained. Explanations are provided under the Screening Comments heading for all of the process options not retained except for dewatering. In addition, for the solvent extraction process, there is no text under the Screening Comments and Option Retained headings. The table should be corrected.

Response 10: Table 4-2 incorrectly states that dewatering will not be retained as a process option. Dewatering will be a process option retained for remediation of sediment. Appropriate sections will be revised accordingly.

Solvent extraction will not be retained. This process is not effective for inorganic contaminants. Additionally, the technology has a relatively high cost compared to other comparable technologies. Table 4-2 will be revised to reflect this information.

Comment 11:

Page 5-3, Figure 5-1. In Figure 5-1, the block flow diagram for Alternative 3, there is an arrow pointing from the "contain/manifest/transport to permitted offsite facility for treatment/disposal" block downward to the "stockpile to drain and dry" block. The arrow should be pointing from the "stockpile to drain and dry" block upward to the "contain/manifest/transport to permitted offsite facility for treatment/disposal" block as shown in Figure 5-2. Figure 5-1 should be corrected.

Response 11: Concur. Figure 5-1 will be corrected as suggested.

Comment 12:

Page 5-8, 2nd Paragraph. For Alternative 4, the text states that "Including QA/QC samples, seven sediment and five surface water samples would be collected and be analyzed for pesticides and metals." However, review of the Alternative 4 cost analysis (located in Appendix C) shows sampling for five surface water samples and five sediment samples and analysis (including duplicates for each medium) for seven surface water samples and seven sediment samples. This discrepancy needs to be corrected.

Response 12: Concur. This discrepancies will be corrected.

Comment 13:

Page A-6, Section A.1.2.3, 1st Paragraph. This paragraph states that "cancer risks from contact with surface soil exceeded 1E-06 for all receptors under Alternative 3. The highest risk was 1.91E-05 for the occupational worker." However, Table A-4, which is supposed to reflect these risks, indicates that cancer risks from contact with surface soil are well below the 1E-06 limit and that the highest risk is for the adult trespasser instead of the occupational worker. The discrepancies between the text and Table A-4 should be corrected.

Response 13: Concur. The discrepancies will be corrected.

Comment 14:

Page A-6, Section A.1.2.3, 2nd Paragraph. This paragraph states that exposure to soils yields cancer risks greater than 1.0E-06 and refers the reader to Table A-5 for a summary of risk values. However, Table A-5 indicates that cancer risks from exposure to surface soil are all well below 1.0E-06. The discrepancy between the text and Table A-5 should be corrected.

Response 14: Concur. The discrepancy will be corrected.

Comment 15:

Page A-10, Section A.1.3, 1st Paragraph. This paragraph lists cancer and non-cancer risks associated with Alternatives 1 through 4. The risk values should match those in Table A-8 on pages A-12 and A-13, but in many cases, they do not. The discrepancies between the text and Table A-8 should be corrected.

Response 15: Concur. The discrepancies will be corrected.

Comment 16:

Page A-12 through A-15, Tables A-8 and A-9. It is not possible to reproduce many of the risk values and hazard indices listed in these tables for Alternatives 3 and 4, especially for trespasser scenarios. These calculations should be verified for accuracy.

Response 16: Concur. The calculations will be verified for accuracy and corrections will be made as appropriate.

Comment 17:

Appendix B, Section 2.3.2, 1st Paragraph and Figure 2. The text states that "...contaminated surface soil was excavated with an area about 250 feet by 200 feet. The source area was extended in each direction by 50 feet from the excavated area. Therefore, the source area is 350 feet by 300 feet (see Figure 2)." However, in Figure 2 the source area is 350 feet by 250 feet. The text and/or Figure 2 should be corrected.

Response 17: Concur. Figure 2 will be marked to properly illustrate the 350 feet by 300 feet estimation of the source area.

Comment 18:

Appendix B, Section 4.2, 1st Paragraph. The text states that "Acceptable groundwater concentrations protective of surface water at lagoon and sediments at the Groundwater interface at lagoon were developed in order to calculate the groundwater RGOs presented in Table 5." However, Table 5 presents "Soil Partitioning Coefficients and Half-Life." It appears that the table mentioned should be Table 6 which presents "Groundwater Criteria Protective of Surface Water and Sediment." The text should be corrected.

Response 18: Concur. The text will be revised accordingly.

Comment 19:

Appendix C. In Section 5.0 of the Draft CMS Report (Evaluation of the Corrective Measure Alternatives for SWMU 2), the text states that there will be annual groundwater sampling and biomonitoring of *ecological receptors for Alternatives 2 and 3. Also, for Alternative 4, groundwater, sediment, and surface water sampling and ecological receptor biomonitoring will be conducted one year after completion of Alternative 4. However, review of Appendix C (Cost Analysis for Alternatives) shows that groundwater sampling was not included in the annual costs. This discrepancy should be corrected.*

Response 19: Concur. The cost of groundwater sampling will be included in the costs analysis. All costs for sampling will be reviewed compared to text for alternative descriptions to ensure consistency.

FINAL SWMU 2 CORRECTIVE MEASURE STUDY

NAS KEY WEST FLORIDA

RESPONSE TO COMMENTS FROM JORGE CASPARY, FDEP

Comment 1:

The engineer in responsible charge should be familiar with Chapter 61615-23.001, Florida Administrative Code, concerning "seals acceptable to the board."

Response 1: The signature page with the engineer's certification and seal will be reissued using the professional engineer's dry seal (imprint stamp).

Comment 2:

Table 3-3 presents a summary of sediment RGOs for SWMU 1. Long et al., 1195, and Long and Morgan, 1991, are used as the sources of "effects range – median" values used as ecological RGOs. Other DoD facilities in Florida have been using the most conservative of either these values or the Department's numerical Sediment Quality Assessment Guidelines (FDEP, 1994) to screen ecological risks in sediments. If risks are suspected, site-specific assessments are typically conducted to justify more appropriate RGOs.

Response 2: The following sentence will be added as a footnote to the end of Table 3-3:

> "The most conservative of effects range-low values (Long et al, 1995; Long and Morgan 1991) and threshold effects levels (FDEP, 1994) were used as ecological screening criteria."